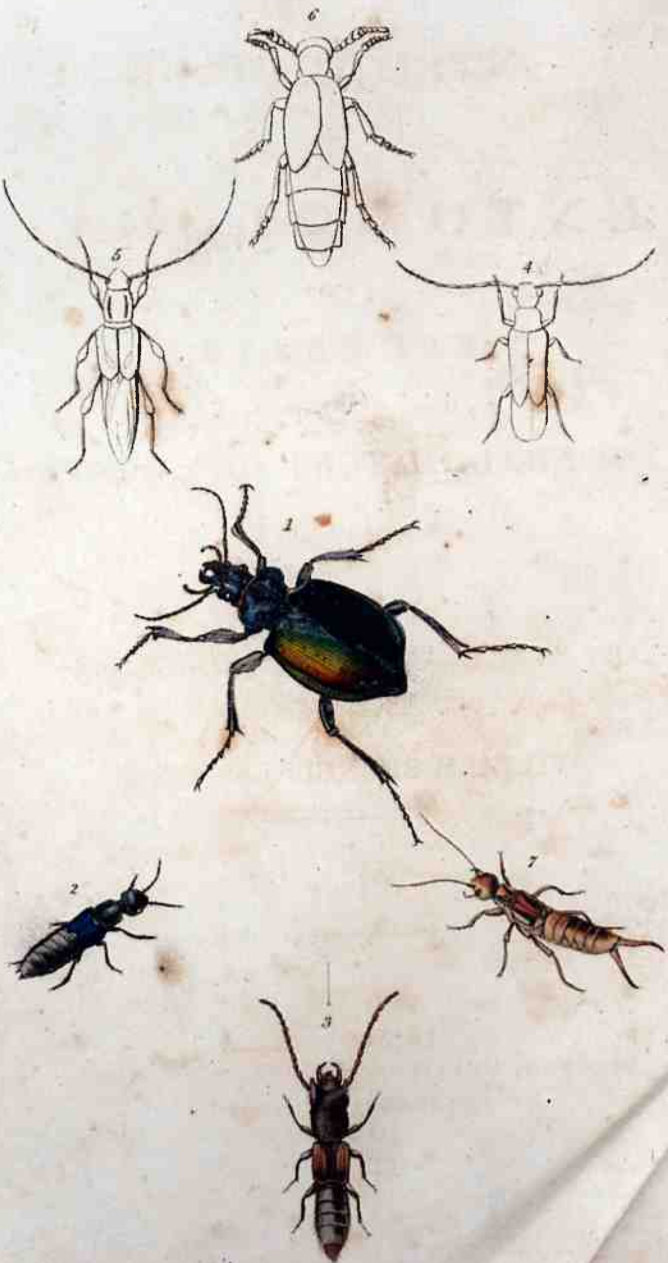
Plate I.



J. Curtis del. et sculp

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AN INTRODUCTION TO ENTOMOLOGY:

OR

ELEMENTS

OF THE

NATURAL HISTORY OF INSECTS:

WITH PLATES.

BY WILLIAM KIRBY, B.A. F.L.S.
RECTOR OF BARHAM,
AND
WILLIAM SPENCE, ESQ. F.L.S.

VOL. I.

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TO

THE RIGHT HONOURABLE

SIR JOSEPH BANKS, BARONET,

ONE OF HIS MAJESTY'S MOST HONOURABLE PRIVY COUNCIL,

KNIGHT GRAND CROSS OF THE ORDER OF THE BATH,

PRESIDENT OF THE ROYAL SOCIETY, ETC.

WHOSE UNRIVALLED LIBRARY AND

PERSONAL COMMUNICATIONS

HAVE FURNISHED MUCH OF THE MOST INTERESTING

MATTER THAT IT CONTAINS,

THE FOLLOWING WORK,

IN WHICH AN ATTEMPT IS MADE TO COPY

HIS ILLUSTRIOUS EXAMPLE,

BY POINTING OUT THE CONNECTION THAT EXISTS

BETWEEN NATURAL SCIENCE, AND AGRICULTURE,

AND THE ARTS,

IS, WITH HIS PERMISSION,

MOST GRATEFULLY INSCRIBED

BY HIS MOST OBLIGED

AND OBEDIENT SERVANTS,

THE AUTHORS.

SIR JOSEPH BANKS, BARONET,

PREFACE.

ONE great cause of the little attention paid to Entomology in this country, has doubtless been the ridicule so often thrown upon the science. The Botanist, sheltered formerly by the prescriptive union of his study with medicine, and now by the sanction of fashion, may dedicate his hours to [illegible] without reproach: but in the minds of most men, the learned as well as the vulgar, the idea of the trifling nature of his pursuits is so strongly associated with that of the diminutive size of its objects, that an Entomologist (between whom and a Butterfly-hunter they seem unable to perceive any distinction) is synonymous with every thing futile and childish. Now, when so many other roads to fame and distinction are open, when a man has merely to make himself a Botanist, a Mineralogist, or a Chemist—a student of classical literature or political economy—to insure attention and respect, there are evidently no great attractions to

PREFACE.

One principal cause of the little attention paid to Entomology in this country, has doubtless been the ridicule so often thrown upon the science. The Botanist, sheltered formerly by the prescriptive union of his study with medicine, and now by the sanction of fashion, may dedicate his hours to mosses and lichens without reproach; but in the minds of most men, the learned as well as the vulgar, the idea of the trifling nature of his pursuit is so strongly associated with that of the diminutive size of its objects, that an Entomologist (betweeen whom and a Butterfly-hunter they seem unable to perceive any distinction) is synonymous with every thing futile and childish. Now, when so many other roads to fame and distinction are open, when a man has merely to avow himself a Botanist, a Mineralogist, or a Chemist—a student of classical literature or of political economy—to insure attention and respect, there are evidently no great attractions to lead him to a science which promises only to signalize him as an object of pity or contempt in nine out of ten companies with which he may associate. Even if he have no other aim than self-gratification, yet "the sternest Stoic of us all wishes at least for some one to enter into his views and feelings, and confirm him in the opinion which he entertains of himself:" but how can he look for sympathy in a pursuit unknown to the world, except as indicative of littleness of mind?

Yet such are the genuine charms of this branch of the study of nature, that here as well as on the continent, where, from being equally slighted, Entomology now divides the empire with her sister Botany, this obstacle would not have been sufficient to deter numbers from the study, had not another more powerful impediment existed—the want of a popular and comprehensive Introduction to the science. While elementary books on Botany have been multiplied amongst us without end and in every shape, Curtis's translation of the *Fundamenta Entomologiæ*, published in 1772; Yeats's *Institutions of Entomology*, which appeared the year after; and Barbut's *Genera Insectorum*, which came out in 1781—the two former in too unattractive, and the latter in too expensive a form for general readers—are the only works professedly devoted to this object, which the English language can boast.

Convinced that this was the chief obstacle to the spread of Entomology in Britain, the authors of the present work resolved to do what was in their power to remove it, and to introduce their countrymen to a mine of pleasure, new, boundless, and inexhaustible, and which, to judge from their own experience—formed in no contracted field of comparison—they can recommend as possessing advantages and attractions equal to those held forth by most other branches of human learning.

The next question was, in what way they should attempt to accomplish this intention. If they had contented themselves with the first suggestion that presented itself, and merely given a translation of one of the many Introductions to Entomology extant in Latin, German, and French, adding only a few obvious improvements, their task would have been very easy; but the slightest examination showed that, in thus proceeding, they would have stopped far short of the goal which they were desirous of reaching.—In the technical department of the science they found much confusion, and numerous errors and imperfections—the same name sometimes applied to parts anatomically quite different, and different names to parts essentially the same, while others of primary importance were without any name at all. And with reference to the anatomy and physiology of insects, they could no where meet with a full and accurate generalization of the various facts connected with these subjects, scattered here and there in the pages of the authors who have studied them.

They therefore resolved to begin, in some measure, *de novo*—to institute a rigorous revision of the terms employed, making such additions and improvements as might seem to be called for; and to attempt a more complete and connected account of the existing discoveries respecting the anatomical and physiological departments of the science than has yet been given to the world:—and to these two points their plan at the outset was limited.

It soon, however, occurred to them, that it would be of little use to write a book which no one would peruse; and that in the present age of love for light reading, there could not be much hope of leading students to the dry abstractions of the science, unless they were conducted through the attractive portal of the economy and natural history of its objects. To this department, therefore, they resolved to devote the first and most considerable portion of their intended work, bringing into one point of view, under distinct heads, the most interesting discoveries of Reaumur, De Geer, Bonnet, Lyonet, the Hubers, &c., as well as their own individual observations, relative to the noxious and beneficial properties of insects; their affection for their young; their food, and modes of obtaining it; their habitations; societies; &c. &c.: and they were the more induced to adopt this plan, from the consideration, that, though many of the most striking of these facts have before been presented to the English reader, a great proportion are unknown to him; and that no similar generalization (if a slight attempt towards it in Smellie's *Philosophy of Natural History*, and a confessedly imperfect one in Latreille's *Histoire Naturelle des Crustacées et des Insectes* be excepted) has ever been attempted in any language.—Thus the entire work would be strictly on the plan of the *Philosophia Entomologica* of Fabricius, only giving a greater extent to the *Œconomia* and *Usus*, and adverting to these in the first place instead of in the last.

The epistolary form was adopted, not certainly from any idea of their style being particularly suited to a mode of writing so difficult to keep from running into incongruities; but simply because this form admitted of digressions and allusions called for in a popular work, but which might have seemed misplaced in a stricter kind of composition;—because it is better suited to convey those practical directions, which in some branches of the pursuit the student requires;—and lastly, because by this form, the objection against speaking of the manners and economy of insects before entering upon the definition of them, and explaining the terms of the science—a retrograde course, which they have chosen from their desire to present the most alluring side of the science first—is in great measure, if not wholly, obviated.

Such is the plan which the authors chalked out for themselves—a plan which in the execution they have found so much more extensive than they calculated upon, that, could they have foreseen the piles of volumes through which it has entailed upon them the labour of wading, often to glean scarcely more than a single fact—the numerous anatomical and technological investigations which it has called for—and the long correspondence, almost as bulky as the entire work, unavoidably rendered necessary by the distant residence of the parties—they would have shrunk from an undertaking, of which the profit, if by great chance there should be any, could not be expected to repay even the cost of books required in it, and from which any fame must necessarily be confined to a very limited circle. But having entered upon it, they have persevered; and if they succeed in their grand aim, that of making converts amongst their countrymen to a study equally calculated for promoting the glory of God and the delight and profit of man, they will not deem the labour of the leisure hours of six years ill bestowed.

And here it may be proper to observe, that one of their first and favourite objects has been to direct the attention of their readers "from nature up to nature's God." For, when they reflected upon the fatal use which has too often been made of Natural History, and that from the very works and wonders of God, some philosophists, by an unaccountable perversion of intellect, have attempted to derive arguments either against his being and providence, or against the Religion revealed in the Holy Scriptures, they conceived they might render some service to the most important interests of mankind, by showing how every department of the science they recommend illustrates the great truths of Religion, and proves that the doctrines of the Word of God, instead of being contradicted, are triumphantly confirmed by his Works.

"To see all things in God" has been accounted one of the peculiar privileges of a future state; and in this present life, "to see God in all things," in the mirror of the creation to behold and adore the reflected glory of the Creator, is no mean attainment; and it possesses this advantage, that thus we sanctify our pursuits, and, instead of loving the creatures for themselves, are led by the survey of them and their instincts to the love of Him who made and endowed them.

Of their performance of the first part of their plan, in which there is the least room for originality, it is only necessary for the authors to say that they have done their best to make it as comprehensive, as interesting, and as useful as possible: but it is requisite to enter somewhat more fully into what has been attempted in the anatomical, physiological, and technical parts of the work.

As far as respects the general physiology and *interior* anatomy of insects, they have done little more than bring together and combine the observations of the naturalists who have attended to these branches of the science: but the *exterior* anatomy they have examined for themselves through the whole class, and, they trust, not without some new light being thrown upon the subject; particularly by pointing out and giving names to many parts never before noticed.

In the *Terminology*, or what, to avoid the barbarism of a word compounded of Latin and Greek, they would beg to call the *Orismology* of the science, they have endeavoured to introduce throughout a greater degree of precision and concinnity—dividing it into *general* and *partial* Orismology; —under the former head defining such terms as relate to *Substance, Resistance, Density, Proportion, Figure, Form, Superficies,* (under which are introduced *Sculpture, Clothing, Colour,* &c.), *Margin, Termination, Incision, Ramification, Division, Direction, Situation, Connection, Arms,* &c.; and under the latter those that relate to the body and its parts and members, considered in its great subdivisions of *Head, Trunk* and *Abdomen.* In short, they may rest their claim of at least aiming at considerable improvement in this department upon the great number of new terms, and alterations of old ones, which they have introduced—in external Anatomy alone falling little short of 150. If it should be thought by any one that they have made too many changes, they would remind him of the advice of Bergman to Morveau, when reforming the nomenclature of Chemistry, the soundness of which Dugald Stewart has recognised—"*Ne faites grace à aucune dénomination impropre. Ceux qui savent déjà, entendront toujours; ceux qui ne savent pas encore, entendront plutôt.*"

Throughout the whole publication, wherever any fact of importance not depending on their own authority is mentioned, a reference to the source whence it has been derived is generally given; so that, if the work should have no other value, it will possess that of saving much trouble to future inquirers, by serving as an index to direct them in their researches.

The authors are perfectly sensible that, notwithstanding all their care and pains, many imperfections will unavoidably remain in their work. There is no science to which the adage, *Dies diem docet*, is more strikingly applicable than to Natural History. New discoveries are daily made, and will be made, it is probable, to the end of time. So that whoever flatters himself that he can produce a perfect work in this department will be miserably disappointed. The utmost that can reasonably be expected from Naturalists is to keep pace with the progress of knowledge, and this the authors have used their best diligence to accomplish. Every new year since they took the subject in hand up to the very time when the first sheets were sent to the press, numerous corrections and alterations have suggested themselves; and thus they are persuaded it would be were they to double the period of delay prescribed by Horace. But Poetry and Natural History are on a different footing; and though an author can plead little excuse for giving his verses to the world while he sees it possible to polish them to higher excellence, the Naturalist, if he wishes to promote the extension of his science, must be content to submit his performances to the public disfigured by numerous imperfections.

In the introductory letter, several of the advantages to be derived from the study of Entomology are pointed out; but there is one, which, though it could not well have been insisted upon in that place, is too important to be passed over without notice—its value in the education of youth.

All modern writers on this momentous subject unite in recommending in this view, Natural History; and if "the quality of accurate discrimination"—the ready perception of resemblances amongst diversities, and still more the quick and accurate perception of diversity in the midst of resemblances—"constitutes one of the most important operations of the understanding; if it be indeed the foundation of clear ideas, and the acquisition of whatever can be truly called knowledge depends most materially on the possession of it:" if "the best logic be that which teaches us to suspend our judgements;" and "the art of seeing, so useful, so universal, and yet so uncommon, be one of the most valuable a man can possess"—there can be no doubt of the judiciousness of their advice. Now of all the branches of Natural History, Entomology is unquestionably the best fitted for thus disciplining the mind of youth; and simply from this circumstance, that its objects have life, are gifted with surprising instincts admirably calculated to attract youthful attention, and are to be met with every where. It is not meant to undervalue the good effects of the study of Botany or Mineralogy: but it is self-evident that nothing inanimate can excite such interest in the mind of a young person as beings endowed with vitality; exercising their powers and faculties in so singular a way; which, as Reaumur observes, are not only alive themselves, but confer animation upon the leaves, fruits, and flowers that they inhabit; which every walk offers to view; and on which new observations may be made without end.

Besides these advantages, nothing affords a fairer opportunity of leading the young mind by a natural and pleasing path to the great truths of Religion, and of impressing it with the most lively ideas of the power, wisdom, and goodness of the Creator, than the study of these wonderful little beings.

Not that it is recommended to make children collectors of insects, nor that young people, to the neglect of more important duties and pursuits, should generally become professed Entomologists; but, if the former be familiarized with their names, manners, and economy, and the latter initiated into their classification, it will be an excellent method of strengthening their habits of observation, attention, and memory, equal perhaps, in this respect, to any other mental exercise: and then, like Major Gyllenhal, who studied Entomology under Thunberg about 1770, and after an interval of twenty years devoted to the service of his country, resumed his favourite pursuit with all the ardour of youth, and is at this time giving to the world a description of the insects of Sweden invaluable for its accuracy and completeness—they would be provided in their old age with an object capable not merely of keeping off that *tædium vitæ* so often inseparable from the relinquishment of active life, but of supplying an unfailing fund of innocent amusement, an incentive to exercise, and consequently no mean degree of health and enjoyment.

Some, who with an ingenious author * regard as superfluous all pains to show the utility of Natural History in reference to the common purposes of life, asking "if it be not enough to open a source of copious and cheap amusement, which

* Dr. Aikin.

tends to harmonize the mind, and elevate it to worthy conceptions of nature and its Author? if a greater blessing to a man can be offered than happiness at an easy rate unalloyed by any debasing mixture?"—may think the earnestness displayed on this head, and the length which has been gone in refuting objections, needless. But Entomology is so peculiarly circumstanced, that without removing these obstacles there could be no hope of winning votaries to the pursuit. Pliny felt the necessity of following this course in the outset of his book which treats on insects, and a similar one has been originally called for in introducing the study even to those countries where the science is now most honoured. In France, Reaumur, in each of the successive volumes of his immortal work, found it essential to seize every opportunity of showing that the study of insects is not a frivolous amusement, nor devoid of utility, as his countrymen conceived it; and in Germany Sulzer had to traverse the same road, telling us, in proof of the necessity of this procedure, that on showing his works on insects with their plates to two very sensible men, one commended him for employing his leisure hours in preparing prints that would amuse children and keep them out of mischief, and the other admitted that they might furnish very pretty patterns for ladies' aprons! And though in this country things are not now quite so bad as they were when Lady Glanville's will was attempted to be set aside on the ground of lunacy, evinced by no other act than her fondness for collecting insects, and Ray had to appear at Exeter on the trial as a witness of her sanity*, yet nothing less than line upon line can be expected to eradicate the deep-rooted prejudices which prevail on this subject. "Old impressions," as Reaumur has well observed, "are with difficulty effaced. They are weakened, they appear unjust even to those who feel them, at the moment they are attacked by arguments which are unanswerable; but the next instant the proofs are forgotten, and the perverse association resumes its empire."

The authors do not know that any curiosity will be excited to ascertain what share has been contributed to the work by each of them; but if there should, it is a curiosity they must be excused from gratifying. United in the bonds of a friendship, which, though they have to thank Entomology for giving birth to it, is founded upon a more solid basis than mere community of scientific pursuits, they wish that, whether blame or praise is the fate of their labours, it may be jointly

* See Harris's *Aurelian* under *Papilio Cinxia*.

awarded. All that they think necessary to state is, that the composition of each of the different departments of the work has been, as nearly as possible, divided between them;—that though the letter, or series of letters, on any particular subject, has been usually undertaken by one, some of the facts and illustrations have generally been supplied by the other, and there are a few to which they have jointly contributed;—and that, throughout, the facts for which no other authority is quoted, are to be considered as resting upon that of one or other of the authors, but not always of him who, from local allusions, may be conceived the writer of the letter in which they are introduced, as the matter furnished by each to the letters of the other must necessarily be given in the person of the supposed writer.

In acknowledging their obligations to their friends, the first place is due to SIMON WILKIN, ESQ. of Costessey near Norwich, to whose liberality they are indebted for the numerous plates which illustrate and adorn the work; the whole of which have been drawn and engraved by his artist Mr. JOHN CURTIS, whose intimate acquaintance with the subject has enabled him to give to the figures an accuracy which they could not have received from one less conversant with the science. Nor is the reader less under obligation to Mr. Wilkin's liberality than the authors, who, if the drawings &c. had been to be paid for, must necessarily have contented themselves with giving a much smaller number.

To Alexander MacLeay, Esq. they are under particular obligations, both for the warm interest he has all along taken in the work, the judicious advice he has on many occasions given, the free access in which he has indulged the authors to his unrivalled cabinet and well-stored library, and the numerous other attentions and accommodations by which he has materially assisted them in its progress.

To the other friends who have kindly aided them in this undertaking in any way, they beg here to offer their best thanks.

It now only remains that they should assign their reasons for sending the work into the world, contrary to their original intentions, in an imperfect state, by the publication of the first volume only. One inducement to this course has been the occurrence of unexpected interruptions, which, though the bulk of the work has been long written, have hitherto precluded the completion of the entire plan; but their principal reason has been the wish to render the physiological and anatomical departments more perfect by the consultation of various continental works published within the last six or eight years, now for the first time accessible; and to ascertain, by the public reception of this first part, whether it will be expedient to give the remainder that extension which was at one time contemplated, or to contract it within narrower limits. A history of Entomology, and a complete list of entomological works, (for which last Mr. Dryander's admirable catalogue of Sir Joseph Banks's library affords the fullest materials,) entered into the original plan, and the rough draught of both is completed; but whether these (which are not essential to a work of this nature) will be published, must depend upon the judgement of the public as to the value of that portion now submitted to them.

The contents of the two remaining volumes will be nearly as follows. Societies of insects, including the History of Ants, Wasps, Bees, &c. Motions of insects. Noises of insects. Means of defence from their enemies. Luminous insects. Hybernation of insects. Instinct of insects. Diseases of insects. Definition of the term *Insect*. States of insects, Egg; Larva; Pupa; Imago.—Their general *exterior* Anatomy—Head; Trunk; Abdomen.—Their *interior* Anatomy and Physiology—Sensation; Respiration; Circulation; Digestion; Secretion; Generation, &c.—Senses of insects. Orismology and Definitions of terms. Characters of insects; Class, Order, Family, Genus, Species, Variety. Investigation of insects. Seasons in which they appear. Instruments and mode of taking and preserving them,—with other particulars which it is not necessary here to enumerate.

The List of Authors quoted in this work will be found in the last volume. It was intended to have given with this all the plates illustrative of the orders, but only three could be finished in time: the remainder will appear in the second volume, and those which relate to the anatomy and definitions in the third.

CONTENTS OF VOL. I.

LETTER I.

Dear Sir,

I CANNOT wonder that an active mind like yours should experience no small degree of tedium in a situation so far removed, as you represent your new residence to be, from "the busy hum of men." Nothing certainly can compensate for the want of agreeable society; but since your case, in this respect, admits of no remedy but patience, I am glad you are desirous of turning your attention to some pursuit which may amuse you in the intervals of severer study, and in part, supply the void of which you complain. I am not a little flattered that you wish to be informed which class, in the three kingdoms of nature, is, in my opinion, most likely to answer your purpose, at the same time intimating that you feel inclined to give the preference to Entomology, provided some objections can be satisfactorily obviated, which you have been accustomed to regard as urged with a considerable semblance of reason against the cultivation of that science.

Mankind in general, not excepting even philosophers, are prone to magnify, often beyond its just merit, the science or pursuit to which they have addicted themselves, and to depreciate any that seems to stand in competition with their favourite; like the redoubted champions of romance, each thinks himself bound to take the field against every one that will not subscribe to the peerless beauty and accomplishments of his own Dulcinea. In such conflict for pre-eminence I know no science that, in this country, has come off worse than Entomology. Her champions hitherto have been so few, and their efforts so unavailing, that all her rival sisters have been exalted above her; and I believe there is scarcely any branch of Natural History that has had fewer British admirers: while Botany boasts of myriads, she, though not her inferior either in beauty, symmetry, or grace, has received the homage of a very slender train indeed. Since, therefore, the merits of Entomology have been so little acknowledged, you will not deem it invidious if I advocate the cause of this distressed damsel, and endeavour to effect her restoration to her just rights, privileges, and rank.

Things that are universally obvious and easy of examination, as they are the first that fall under our notice, so are they also most commonly those which we first feel an inclination to study; while, on the contrary, things that must be sought for in order to be seen, and which when sought for avoid the approach and inquiring eye of man, are often the last to which he directs his attention. The vegetable kingdom stands in the former predicament. Flora, with a liberal hand, has scattered around us her charming productions; they every where meet and allure us, enchanting us by their beauty, regaling us by their fragrance, and interesting us as much by their subservience to our luxuries and comfort, as to the necessary support and well-being of our life. Beasts, birds, and fishes also, in some one or other of these respects, attract our notice; but insects, unfortunate insects, are so far from attracting us, that we are accustomed to abhor them from our childhood. The first knowledge that we get of them is as tormentors; they are usually pointed out to us by those about us, as ugly, filthy, and noxious creatures; and the whole insect world, butterflies perhaps and some few others excepted, are devoted by one universal ban to proscription and execration, as fit only to be trodden under our feet, and crushed: so that often, before we can persuade ourselves to study them, we have to remove from our minds prejudices deeply rooted and of long standing.

Another principal reason which has contributed to keep Entomology in the back ground arises from the diminutive size of the objects of which it treats. Being amongst the most minute of nature's productions, they do not so readily catch the eye of the observer; and when they do, mankind in general are so apt to estimate the worth and importance of things by their bulk, that because we usually measure them by the duodecimals of an inch instead of by the foot or by the yard, insects are deemed too insignificant parts of the creation, and of too little consequence to its general welfare to render them worthy of any serious attention or study. What small foundation there is for such prejudices and misconception I shall endeavour to shew in the course of our future correspondence; my object now, as the champion and advocate of Entomology, is to point out to you her comparative advantages, and to remove the veil which has hitherto concealed those attractions, and that grace and beauty, which entitle her to equal admiration at least, with her sister branches of Natural History.

In estimating the comparative value of the study of any department in this branch of science, we ought to contrast it with others as to the rank its objects hold in the scale of being; the amusement and instruction which the student may derive from it, and its utility to society at large. With respect to public utility the study of each of the three kingdoms may, perhaps, be allowed to stand upon nearly an equal footing; I shall not, therefore, enter upon that subject till I come to consider the question *cui bono?* and to point out the uses of Entomology, but confine myself now to the two first of these circumstances.

As to rank I must claim for the entomologist some degree of precedence before the mineralogist and the botanist. The mineral kingdom, whose objects are neither organized nor sentient, stands certainly at the foot of the scale. Next above this is the vegetable, whose lovely tribes, though not endued with sensation, are organized. In the last and highest place ranks the animal world, consisting of beings that are both organized and sentient. To this scale of precedence the great modern luminary of Natural History, notwithstanding that Botany was always his favourite pursuit, has given his sanction, acknowledging, in the preface to his *Fauna Suecica*, that although the vegetable kingdom is nobler than the mineral, yet the animal is more excellent than the vegetable. Now it is an indisputable axiom, I should think, that the more exalted the object, the more excellent the study. By this observation, however, I would by no means be thought to depreciate or discountenance the study either of plants or minerals. All the works of our Creator are great and worthy of our attention and investigation, the lowest in the scale as well as the highest, the most minute and feeble, as well as those that exceed in magnitude and might. Nor ought those whose inclination or genius leads them to one department to say to those who prefer another—"we have no need of you"—for each in his place, by diffusing the knowledge of his works and adding to the stock of previous discoveries, contributes to promote the glory of the Great Architect of the universe and the good of his creatures.

It is not my wish to claim for my favourite science more than of right belongs to her, therefore when the question is concerning rank I must concede to the higher orders of animals, I mean Fishes, Amphibia, Birds, and Quadrupeds, their due priority and precedence. I shall only observe here, that there may exist circumstances which countervail rank, and tend to render the study of a lower order of beings more desirable than that of a higher: when, for instance, the objects of the higher study are not to be come at or preserved without great difficulty and expense; when they are few in number, or already well ascertained and known: circumstances which attach to the study of those animals that precede insects, while they do not attach to the study of insects themselves.

With regard to the amusement and instruction of the student, much doubtless may be derived from any one of the sciences alluded to, but Entomology certainly is not behind any of her sisters in these respects; and if you are fond of novelty, and anxious to make new discoveries, she will open to you a more ample field for these than either Botany or the higher branches of Zoology.

A new animal or plant is seldom to be met with even by those that have leisure and opportunity for extensive researches; but if you collect insects, you will find, however limited the manor upon which you can pursue your game, that your efforts are often rewarded by the capture of some non-descript or rarity, at present not possessed by other entomologists, for I have seldom seen a cabinet so meager as not to possess some unique specimen. Nay, though you may have searched every spot in your neighbourhood this year, turned over every stone, shaken every bush or tree, and fished every pool, you will not have exhausted its insect productions. Do the same another and another, and new treasures will still continue to enrich your cabinet. If you leave your own vicinity for an entomological excursion, your prospects of success are still further increased, and even if confined in bad weather to your inn, the windows of your apartment, as I have often experienced, will add to your stock. If a sudden shower obliges you at any time to seek shelter under a tree, your attention will be attracted and the tedium of your station relieved, even where the botanist could not hope to find a new lichen or moss, by the appearance of several insects, driven there perhaps by the same cause as yourself, that you have not observed before. Should you, as I trust you will, feel a desire to attend to the manners and economy of insects, and are ambitious of making discoveries in this part of entomological science, I can assure you, from long experience, that you will here find an inexhaustible fund of novelty. For more than twenty years my attention has been directed to them, and, during most of my summer walks, my eyes have been employed in observing their ways; yet I can say with truth, that so far from having exhausted the subject, within the last six months I have witnessed more interesting facts respecting their history than in many preceding years. To follow only the insects that frequent your own garden from their first to their last state, and to trace all their proceedings, would supply an interesting amusement for the remainder of your life, and at its close you would leave much to be done by your successor; for where we know thoroughly the history of one insect, there are hundreds concerning which we have ascertained little besides the bare fact of their existence.

As to the amusement and instruction which the study itself promises to afford you, these you will find not inferior to what any other science can offer. Insects, indeed, appear to have been nature's favourite productions, in which, to manifest her power and skill, she has combined and concentrated almost all that is either beautiful and graceful, interesting and alluring, or curious and singular, in every other class and order of her children. To these, her valued miniatures, she has given the most delicate touch and highest finish of her pencil. Numbers she has armed with glittering mail, which reflects a lustre like that of burnished metals[a]; in others she lights up the dazzling radiance of polished gems[b]. Some she has decked with what look like liquid drops or plates of gold and silver[c], or with scales or pile, which mimic the colour and emit the ray of the same precious metals[d]. Some exhibit a rude exterior, like stones in their native state[e], while others represent their smooth and shining face after they have been submitted to the tool of the polisher: others, again, like so many pigmy Atlases bearing on their backs a microcosm, by the rugged and various elevations and depressions of their tuberculated crust, present to the eye of the beholder no unapt imitation of the unequal surface of the earth, now horrid with mis-shapen rocks, ridges, and precipices—now swelling into hills and mountains, and now sinking into vallies, glens, and caves[f]; while not a few are covered with branching spines, which fancy may form into a forest of trees[g].

What numbers vie with the charming offspring of Flora in various beauties! Some in the delicacy and variety of their colours, colours not like those of

[a] The Genera *Eumolpus*, F. *Lamprima*, Latr. *Rynchites*, Herbst.
[b] A non-descript *Rynchænus*, F. from Brazil.
[c] *Hesperia Cupido*, F. *Papilio Passifloræ*, *Lathonia*, L. &c.
[d] *Pepsis fuscipennis*, *argentata*, F. &c.
[e] The species of the genus *Trox*, F.
[f] Many of the *Scarabæidæ*.
[g] Reaum. v. *t* 12, *f* 7, 8—14.

flowers evanescent and fugitive, but fixed and durable, surviving their subject, and adorning it as much after death as they did when it was alive. Others, again, in the veining and texture of their wings; and others in the rich cottony down that clothes them. To such perfection, indeed, has nature in them carried her mimetic art, that you would declare, upon beholding some insects, that they had robbed the trees of their leaves to form for themselves artificial wings, so exactly do they resemble them both in their form, substance, and vascular structure; some representing green leaves, and others those that are dry and withered[h]. Nay, sometimes this mimicry is so exquisite, that you would mistake the whole insect for a portion of the branching spray of a tree[i]. No mean beauty in some plants arises from the fluting and punctation of their stems and leaves, and a similar ornament conspicuously distinguishes numerous insects, which also imitate, with multiform variety, as may particularly be seen in the caterpillars of many species of the genus *Papilio*, the spines and prickles, which are given as a *Noli me tangere* armour to several vegetable productions.

In fishes the lucid scales of varied hue that cover and defend them are universally admired, and esteemed their peculiar ornament; but place a butterfly's wing under a microscope, that avenue to unseen glories in new worlds, and you will discover that nature has endowed the most numerous of the insect tribes with the same privilege, multiplying in

[h] Various species of the genera *Locusta* and *Mantis*, F.
[i] Many species of *Phasma*.

them the forms[j], and diversifying the colouring of this kind of cloathing beyond all parallel. The rich and velvet tints of the plumage of birds are not superior to what the curious observer may discover in a variety of *Lepidoptera*; and those many-coloured eyes which deck so gloriously the peacock's tail are imitated with success by one of our most common butterflies[k]. Feathers are thought to be peculiar to birds, but insects often imitate them both in their antennæ[l], wings[m], and even sometimes in the covering of their bodies[n].—We admire with reason the coats of quadrupeds, whether their skins be covered with pile, or wool, or fur, yet are not perhaps aware that a vast variety of insects are clothed with all these kinds of hair, but infinitely finer and more silky in texture, more brilliant and delicate in colour, and more variously shaded than what any other animals can pretend to.

In variegation, insects certainly exceed every other class of animated beings. Nature, in her sportive mood, when painting them, sometimes imitates the clouds of heaven; at others, the meandring course of the rivers of the earth, or the undulations of their waters; many are veined like beautiful marbles; others have the semblance of a robe of the finest net-work thrown over them; some she blazons with heraldic insignia, giving them to bear in fields sable—azure—vert—gules—argent and or, fesses—bars—

[j] De Geer. I. *t* 3. *f* 1—34, &c. [k] *Papilio Io*, L.

[l] *Culex*, L. *Chironomus*, Meig. and other *Tipulidæ*.

[m] *Pterophorus*, F.

[n] Hairs of many of the *Apidæ*. *Mon. Ap. Ang.* I. *t* 10, ** d. 1. *f* 1. *b*.

bends—crosses—crescents—stars, and even animals[o]. On many, taking her rule and compasses, she draws with precision, mathematical figures; points, lines, angles, triangles[p], squares, and circles. On others she pourtrays, with mystic hand, what seem like hieroglyphic symbols, or inscribes them with the characters and letters of various languages, often very correctly formed[q]; and what is more extraordinary, she has registered in others, figures which correspond with several dates of the Christian era[r].

Nor has nature been lavish only in the apparel and ornament of these privileged tribes; in other respects she has been equally unsparing of her favours. To some she has given fins like those of fish, or a beak resembling that of birds[s]; to others horns, nearly the counterparts of those of various quadrupeds. The bull[t], the stag[u], the rhinoceros[v], and even the hitherto vainly sought for unicorn[w], have, in this respect, many representatives amongst insects. One is armed with tusks not unlike those of the elephant[x]; another is bristled with spines, as the porcupine and hedge-hog with quills[y]; a third is an armadillo in miniature; the disproportioned hind legs of the kanguroo give a most grotesque appearance to a fourth[z]; and the threatening head of the snake is

[o] *Ptinus imperialis*, L. [p] *Trichius delta*, F.

[q] *Prionus longimanus*, F. *Papilio C. album*, L. *Bombyx* ⸸ *Noctua* γ. F.

[r] On the underside of the primary wings near the margin in *Papilio Aglaia*, *Lathonia*, *Silene*, &c. [s] *Empis*, L. *Asilus*, L.

[t] *Copris Taurus*, F. [u] *Lucanus Cervus*, L.

[v] *Oryctes*, Latr. [w] *Geotrupes Hercules*, F.

[x] *Melitta spinigera*, Kirby. [y] *Hispa*, L.

[z] *Cetonia macropus*, Mus. Francill.

found in a fifth[a]. It would, however, be endless to produce all the instances which occur of such imitations, and I shall only remark, that generally speaking, these arms and instruments in structure and finishing far exceed those which they resemble.

But further, insects not only mimic, in a manner infinitely various, every thing in nature, they may also, with very little violence, be regarded as symbolical of beings out of and above nature. The butterfly, adorned with every beauty and every grace, borne by radiant wings through the fields of ether, and extracting nectar from every flower, gives us some idea of the blessed inhabitants of happier worlds, of the spirits of the just arrived at their state of perfection. Again, other insects seem emblematical of a different class of unearthly beings. When we behold some tremendous for the numerous horns and spines projecting in horrid array from their head or shoulders;—others for their threatening jaws of fearful length, and armed with cruel fangs: when we survey the dismal hue and demoniack air that distinguish others, the dens of darkness in which they live, the impurity of their food, their predatory habits and cruelty, the nets which they spread, and the pits which they sink to entrap the unwary, we can scarcely help regarding them as apt representations of evil demons, the enemies of man, or of impure spirits, for their vices and crimes driven from the regions of light into darkness and punishment[b].

[a] *Raphidia ophiopsis*, L.

[b] This idea seems to have been present to the mind of Linne and Fabricius, when they gave to insects such names as *Belzebub*, *Belial*, *Titan*, *Typhon*, *Nimrod*, *Geryon*, and the like.

The sight indeed of a well-stored cabinet of insects will bring before every beholder not conversant with them, forms in endless variety, which before he would not have thought it possible could exist in nature, resembling nothing that the other departments of the animal kingdom exhibit, and exceeding even the wildest fictions of the most fertile imaginations. Besides prototypes of beauty and symmetry, there in miniature he will be amused to survey (for the most horrible creatures when deprived of the power of injury became sources of interest and objects of curiosity) to use the words of our great poet:

> ——————— all prodigious things
> Abominable, unutterable, and worse
> Than fables yet have feign'd, or fear conceiv'd,
> Gorgons, and Hydras, and Chimæras dire.

But the pleasures of a student of the science to which I am desirous of introducing you, are far from being confined to such as result from an examination of the exterior form and decorations of insects; for could these, endless as they seem, be exhausted, or wonderful as they are, lose their interest; yet new sources, exuberant in amusement and instruction, may be opened, which will furnish an almost infinite fund for his curiosity to draw upon. The striking peculiarity and variety of structure which they exhibit in their instruments of nutrition, motion, and oviposition, in their organs of sensation, generation, and the great fountains of vitality, indeed their whole system anatomically considered, will open a world of wonders to you with which you will not soon be satiated, and during your survey of which you will at every step feel disposed to exclaim with the Roman naturalist—"In these beings so minute, and as it were such non-entities, what wisdom is displayed, what power, what unfathomable perfection[c]!" But even this will not bring you to the end of your pleasures: you must leave the dead to visit the living; you must behold insects when full of life and activity, engaged in their several employments, practising their various arts, pursuing their amours, and preparing habitations for their progeny: you must notice the laying and kind of their eggs, their wonderful metamorphoses, their instincts, whether they be solitary or gregarious, and the other miracles of their history—all of which will open to you a richer mine of amusement and instruction, I speak it without hesitation, than any other department of Natural History can furnish. A minute enumeration of these particulars would be here misplaced, and only forestall what will be detailed more at large hereafter; but a rapid glance at a very few of the most remarkable of them, may serve as a stimulus to excite your curiosity, and induce you to enter with greater eagerness into the wide field to which I shall conduct you.

The lord of the creation plumes himself upon his powers of invention, and is proud to enumerate the various useful arts and machines to which they have given birth, not aware that, "He who teacheth man knowledge," has instructed these despised insects to anticipate him in many of them. The

[c] Plin. *Hist. Nat.* l. 11. c. 2.

builders of Babel doubtless thought their invention of turning earth into artificial stone, a very happy discovery[d]; yet a little bee[e] had practised this art, using indeed a different process, on a small scale, and the white ants, on a large one, ever since the world began. Man thinks that he stands unrivalled as an architect, and that his buildings are without a parallel among the works of the inferior orders of animals. He would be of a different opinion did he attend to the history of insects: he would find that many of them have been architects from time immemorial; that they have had their houses divided into various apartments, and containing staircases, gigantic arches, domes, colonnades, and the like. Nay, that even tunnels are excavated by them so immense, compared with their own size, as to be twelve times bigger than that projected by Mr. Dodd to be carried under the Thames at Gravesend. The modern fine lady, who prides herself on the lustre and beauty of the scarlet hangings which adorn the stately walls of her drawing-room, or the carpets that cover its floor, fancying that nothing so rich and splendid was ever seen before, and pitying her vulgar ancestors, who were doomed to unsightly white-wash and rushes, is ignorant, all the while, that before she or her ancestors were in existence, and even before the boasted Tyrian dye was discovered, a little insect had known how to hang the walls of its cell with tapestry of a scarlet more brilliant than any her rooms can exhibit[f], and that

[d] Gen. xi. 3.

[e] *Megachile muraria*, Latr.

[f] *Megachile Papaveris*, Latr.

others daily weave silken carpets, both in tissue and texture, infinitely superior to those she so much admires. Other arts have been equally forestalled by these creatures. What vast importance is attached to the invention of paper! For near six thousand years one of our commonest insects has known how to make and apply it to its purposes[g]; and even pasteboard, superior in substance and polish to any we can produce, is manufactured by another[h]. We imagine that nothing short of human intellect can be equal to the construction of a diving bell or an air pump—yet a spider is in the daily habit of using the one, and what is more, one exactly similar in principle to ours, but more ingeniously contrived; by means of which she resides unwetted in the bosom of the water, and procures the necessary supplies of air by a much more simple process than our alternating buckets—and the caterpillar of a little moth knows how to imitate the other, producing a vacuum, when necessary for its purposes, without any piston besides its own body. If we think with wonder of the populous cities which have employed the united labours of man for many ages, to bring them to their full extent, what shall we say to the white ants, which require only a few months to build a metropolis capable of containing an infinitely greater number of inhabitants than even imperial Nineveh, Babylon, Rome, or Pekin, in all their glory?

That insects should thus have forestalled us in our inventions, ought to urge us to pay a closer attention

[g] The common wasp. [h] *Polistes nidulans*, Latr.

to them and their ways than we have hitherto done, since it is not at all improbable that the result would be many useful hints for the improvement of our arts and manufactures, and perhaps for some beneficial discoveries. The painter might thus probably be furnished with more brilliant pigments, the dyer with more delicate tints, and the artisan with a new and improved set of tools. In this last respect insects deserve particular notice. All their operations are performed with admirable precision and dexterity, and though they do not usually vary the mode, yet that mode is always the best that can be conceived for attaining the end in view. The instruments also with which they are provided, are no less wonderful and various than the operations themselves. They have their saws, and files, and augers, and gimlets, and knives, and lancets, and scissors, and forceps, with many other similar implements; several of which act in more than one capacity, and with a complex and alternate motion, to which we have not yet attained in the use of our tools. Nor is the fact so extraordinary as it may seem at first, since "He who is wise in heart and wonderful in working," is the inventor and fabricator of the apparatus of insects; which may be considered as a set of miniature patterns drawn for our use by a Divine hand. I shall hereafter give you a more detailed account of some of the most striking of these instruments, and if you study insects in this view, you will be well repaid for all the labour and attention you bestow upon them.

But a more important species of instruction than any hitherto enumerated, may be derived from entomological pursuits. If we attend to the history and manners of insects, they will furnish us with many useful lessons in Ethics, and from them we may learn to improve ourselves in various virtues. We have indeed the inspired authority of the wisest of mankind for studying them in this view, since he himself wrote a treatise upon them, and sends his sluggard to one for a lesson of wisdom[1]. And if we value diligence and indefatigable industry; judgment, prudence, and foresight; economy and frugality; if we look upon modesty and diffidence as female ornaments; if we revere parental affection—of all these, and many more virtues, insects in their various instincts exhibit several striking examples, as you will see in the course of our correspondence.

With respect to religious instruction insects are far from unprofitable; indeed in this view Entomology seems to possess peculiar advantages above every other branch of Natural History. In the larger animals, though we admire the consummate art and wisdom manifested in their structure, and adore that Almighty power and goodness which by a wonderful machinery kept in motion by the constant action and re-action of the great positive and negative powers of nature, maintains in full force the circulations necessary to life, perception, and enjoyment; yet as there seems no disproportion between the objects and the different operations that are going on in them, and we see that they afford sufficient space for the play of their systems, we do

[1] 1 Kings, iv. 33. Prov. vi. 6—8.

not experience the same sensations of wonder and astonishment that strike us when we behold similar operations carried on without interruption in animals scarcely visible to the naked eye. That creatures, which in the scale of being are next to non-entities, should be elaborated with so much art and contrivance, have such a number of parts, both internal and external, all so highly finished and each so nicely calculated to answer its end, that they should include, in this evanescent form, such a variety of organs of perception and instruments of motion, exceeding in number and peculiarity of structure those of other animals; that their nervous and respiratory systems should be so complex, their secretory and digestive vessels so various and singular, their parts of generation so clearly developed, and that these minims of nature should be endowed with instincts in many cases superior to all our boasted powers of intellect—truly these wonders and miracles declare to every one who attends to the subject, "The hand that made us is divine." We are the work of a Being infinite in power, in wisdom, and in goodness.

But no religious doctrine is more strongly established by the history of insects than that of a superintending Providence. That of the innumerable species of these beings, many of them beyond conception fragile and exposed to dangers and enemies without end, no link should be lost from the chain, but all be maintained in those relative proportions necessary for the general good of the system; that if one species for a time preponderate, and instead of preserving seem to destroy, yet counterchecks should at the same time be provided to reduce it within its due limits; and further, that the operations of insects should be so directed and over-ruled as to effect the purposes for which they were created and never exceed their commission—nothing can furnish a stronger proof than this, that an unseen hand holds the reins, now permitting one to prevail and now another, as shall best promote certain wise ends, and saying to each, "Hitherto shalt thou come and no further."

So complex is this mundane system, and so incessant the conflict between its component parts, an observation which holds good particularly with regard to insects, that if, instead of being under such control, it were left to the agency of blind chance, the whole must inevitably soon be deranged and go to ruin. Insects, in truth, are a book in which whoever reads under proper impressions cannot avoid looking from the cause to the effect, and acknowledging his eternal power and godhead thus wonderfully displayed and irrefragably demonstrated: and whoever beholds these works with the eyes of the body, must be blind indeed if he cannot, and perverse indeed if he will not, with the eye of the soul behold in all his glory the Almighty Workman, and feel disposed, with every power of his nature, to praise and magnify

Him first, Him last, Him midst, Him without end.

And now having led you to the vestibule of an august temple, which, in its inmost sanctuary, exhibits, enshrined in glory, the symbols of the Divine

Presence, I should invite you to enter and give a tongue to the Hallelujahs, which every creature in its place, by working his will with all its faculties, pours forth to its great Creator; but I must first endeavour to remove, as I trust I shall effectually, those objections to the study of these interesting beings which I alluded to in the outset of this letter, and this shall be the aim of my next address.

I am, &c.

LETTER II.

OBJECTIONS ANSWERED.

In my last I gave you a general view of the science of Entomology, and endeavoured to prove to you that it possesses attractions and beauty sufficient to reward any student who may profess himself its votary. I am now to consider it in a less alluring light, as a pursuit attended by no small degree of obloquy, in consequence of certain objections thought to be urged with great force against it. To obviate these and remove every scruple from your mind shall be the business of the present letter.

Two principal objections are usually alleged with great confidence against the study and pursuit of insects. By some they are derided as trifling and unimportant, and deemed an egregious waste of time and talents; by others they are reprobated as unfeeling and cruel, and as tending to harden the heart.

I shall begin with the first of these objections—that the entomologist is a mere trifler. As for the silly outcry and abuse of the ignorant vulgar, who are always ready to laugh at what they do not understand, and because insects are minute objects conclude that the study of them must be a childish pursuit, I shall not waste words upon what I so cordially despise. But since even learned men and philosophers, from a partial and prejudiced view of the subject, having recourse to this common-place logic, are sometimes disposed to regard all inquiry into these minutiæ of nature as useless and idle, and the mark of a little mind; to remove such prejudice and misconceptions I shall now dilate somewhat upon the subject of *Cui bono?*

When we see many wise and learned men pay attention to any particular department of science, we may naturally conclude that it is on account of some profit and instruction which they foresee may be derived from it, and therefore in defending Entomology I shall first have recourse to the *Argumentum ad verecundiam*, and mention the great names that have cultivated or recommended it.

We may begin the list with the first man that ever lived upon the earth, for we are told that he gave a name to every living creature[j], amongst which insects must be included, and to give an appropriate name to an object necessarily requires some knowledge of its distinguishing properties. Indeed one of the principal pleasures and employments of the paradisiacal state was probably the study of the various works of creation[k]. Before the fall the book of nature was the Bible of man, in which he could read the perfections and attributes of the invisible Godhead[l], and in it, as in a mirror, behold an image

[j] Gen. ii. 19. [k] Linn. *Fn. Suec.* Præf.
[l] Rom. i. 19, 20.

of the things of the spiritual world. Moses also appears to have been conversant with our little animals, and to have studied them with some attention. This he has shewn, not only by being aware of the distinctions which separate the *Gryllidæ* (*Gryllus*, Linn.) into different genera[m], but also by noticing the different direction of the two anterior from the four posterior legs of insects, for as he speaks of them as going upon four legs[n], it is evident that he considered the two anterior as arms. Solomon, the wisest of mankind, made Natural History a peculiar object of study, and left treatises behind him upon its various branches, in which *creeping things* or insects were not overlooked[o]; and a wiser than Solomon directs our attention to natural productions, when he bids us *consider* the lilies of the field[p], teaching us that they are more worthy of our notice than the most glorious works of man: he also not obscurely intimates that insects are symbolical beings, when he speaks of scorpions as synonymous with evil spirits[q], thus giving into our hands a clue for a more profitable mode of studying them, as furnishing moral and spiritual instruction.

If to these scriptural authorities we add those of uninspired writers, ancient and modern, the names of many worthies, celebrated both for wisdom and virtue, may be produced. Aristotle among the Greeks, and Pliny the elder among the Romans, may be denominated the fathers of Natural History, as well as the greatest philosophers of their day, yet both

[m] Levit. xi. 21, 22. Lichtenstein in *Linn. Trans.* iv. 51, 52.

[n] Levit. xi. 20. conf. Bochart. *Hierozoic.* ii. l. 4. c. 9. 497—8.

[o] 1 Kings, iv. 33. [p] Luke xii. 27. [q] Ibid. x. 19, 20.

these made insects a principal object of their attention: and in more recent times, if we look abroad, what names greater than those of Redi, Malpighi, Vallisnieri, Swammerdam, Leeuwenhoek, Reaumur, Linné, De Geer, and Bonnet? and at home, what philosophers have done more honour to their country and to human nature, than Ray, Willughby, Lister, and Derham? yet all these made the study of insects one of their most favourite pursuits; and, as if to prove that this study is not incompatible with the highest flights of genius, we can add to the list the name of one of the most sublime of our poets, Gray, who was very zealously devoted to Entomology. As far therefore as names have weight, the above enumeration seems sufficient to shelter the votaries of this pleasing science from the charge of folly.

But we do not wish to rest our defence upon authorities alone, let the voice of reason be heard and our justification will be complete. The entomologist, or, to speak more generally, the naturalist, (for on this question of *Cui bono?* every student in all departments of Natural History is concerned), if the following considerations be allowed their due weight, may claim a much higher station amongst the learned than has hitherto been conceded to him.

There are two principal avenues to knowledge—the study of words, and the study of things. Skill, in the learned languages, being often necessary to enable us to acquire knowledge in the former way, is usually considered as knowledge itself, so that no one asks *Cui bono?* when a person devotes himself to the study of verbal criticism, and employs his time in correcting the errors that have crept into the text of an ancient writer. Indeed it must be owned, though perhaps too much stress is sometimes laid upon it, that this is very useful to enable us to ascertain his true meaning. But after all, words are but the arbitrary signs of ideas, and have no value independent of those ideas, further than what arises from congruity and harmony, the mind being dissatisfied when an idea is expressed by inadequate words, and the ear offended when their collocation is inharmonious. To account the mere knowledge of words, therefore, as wisdom, is to mistake the cask for the wine, and the casket for the gem. I say all this because knowledge in words is often extolled beyond its just merits, and put for all wisdom, while knowledge of things, especially of the productions of nature, is derided as if it were mere folly. We should recollect that God hath condescended to instruct us by both these ways, and therefore neither of them should be depreciated. He hath set before us his word and his world. The former is the great avenue to truth and knowledge by the study of words, and, as being the immediate and authoritative revelation of his will, is entitled to our principal attention; the latter leads us to the same conclusions, though less directly, by the study of things, which stands next in rank to that of God's word, and before that of any work of man. And whether we direct our eyes to the planets rolling in their orbits, and endeavour to trace the laws by which they are guided through the vast of space, whether we analyze those powers and agents by which all the operations of nature are performed, or whether we consider the various productions of this our globe, from the mighty cedar to the microscopic mucor—from the giant elephant to the invisible mite, still we are studying the works and wonders of our God. The book, to whatever page we turn, is written by the finger of him who created us, and in it, provided our minds be rightly disposed, we may read his eternal verities. And the more accurate and enlarged our knowledge of his works, the better shall we be able to understand his word, and the more practised we are in his word, the more readily shall we discern his truth in his works, for proceeding from the same great Author, they must, when rightly interpreted, mutually explain and illustrate each other.

Who then shall dare maintain, unless he has the hardihood to deny that God created them, that the study of insects and their ways is trifling or unprofitable? Were they not arrayed in all their beauty, and surrounded with all their wonders, and made so instrumental (as I shall hereafter prove them to be) to our welfare, that we might glorify and praise him for them? Why were insects made attractive, if not, as Ray well expresses it, that they might ornament the universe aud be delightful objects of contemplation to man[r]? And is it not clear, as Dr. Paley has observed, that the production of beauty was as much in the Creator's mind in painting a butterfly

[r] "Quæri fortasse à nonnullis potest, Quis Papilionum usus sit? Respondeo, ad ornatum Universi, et ut hominibus Spectaculo sint: ad rura illustranda velut tot bracteæ inservientes. Quis enim eximiam earum pulchritudiuem et varietatem contemplans mira Voluptate non alliciatur? Quis tot colorum et Schematum elegantias naturæ ipsius ingenio excogitatas et artifici penicillo depictas curiosis oculis intuens, divinæ artis vestigia eis impressa non agnoscat et miretur?" Rai. *Hist. Ins.* 109.

or in studding a beetle, as in giving symmetry to the human form, or the covering provided for its contents[s]? And shall we think it beneath us to study what he hath not thought it beneath him to adorn and place on this great theatre of creation? Nay, shall we extol those to the skies who bring together, at a vast expense, the most valuable specimens of the arts, the paintings and statues of Italy and Greece, all of which, however beautiful, as works of man, fall short of perfection; and deride and upbraid those who collect, for the purpose of admiring their beauty, the finished and perfect chef d'œuvres of a Divine artist? May we gaze with rapture unblamed upon an Apollo of Belvidere, or Venus de Medicis, or upon the exquisite paintings of a Raphael or a Titian, and yet when we behold with extacy sculptures that are produced by the chisel of the Almighty, and the inimitable tints laid on by his pencil, because an insect is the subject, be exposed to jeers and ridicule?

But there is another reason, which, in the present age, renders the study of Natural History an object of importance to every well-wisher to the cause of religion, who is desirous of exerting his faculties in its defence. For as enthusiasm and false religion have endeavoured to maintain their ground by a perversion of the text of *scripture*, so also the patrons of infidelity and atheism have laboured hard to establish their impiety by a perversion of the text of *nature*. To refute the first of these adversaries of truth and sound religion, it is necessary to be well

[s] *Nat. Theol.* 213.

acquainted with the *word* of God, to refute the second requires an intimate knowledge of his *works;* and no department can furnish him with more powerful arguments of every kind than the world of insects —every one of which cries out in a audible voice— there is a God—he is Almighty, all-wise, all-good —his watchful providence is ever, and every where, at work for the preservation of all things.

But since mankind in general are too apt to look chiefly at this world, and to regard things as important, or otherwise in proportion as they are connected with sublunary interests, and promote our present welfare, I shall proceed further to prove that the study of insects may be productive of considerable utility, even in this view, and may be regarded, in some sort, as a necessary, or at least a very useful concomitant of many arts and sciences.

The importance of insects to us both as sources of good or evil, I shall endeavour to prove at large hereafter; but for the present, taking this for granted, it necessarily follows that the study of them must also be important. For when we suffer from them, if we do not know the cause, how are we to apply a remedy that may diminish or prevent their ravages? Ignorance in this respect often occasions us to mistake our enemies for our friends, and our friends for our enemies; so that when we think to do good we only do harm, destroying the innocent and letting the guilty escape. Many such instances have occurred. You know the *Cecidomyia* of the wheat, (*Tipula Tritici*. Linn. Trans.) and have read the account of the damage done by this little fly to that important grain; you are aware also that it is given in charge to three little parasites to keep it within due limits; yet, at first, it was the general opinion of unscientific men, that these destroyers of our enemy were its parents, and the original source of all the mischief[t]. Middleton, in his "Agriculture of Middlesex," speaking of the aphis that is so injurious to the bean, tells us that the lady-birds are supposed either to generate or to feed upon them[u]. Had he been an entomologist he would have been in no doubt whether they were beneficial or injurious; on the contrary, he would have recommended that they should be encouraged as friends to man, since no insects are greater devourers of the aphides. The confounding of the apple aphis, that has done such extensive injury to our orchards, with others, has led to proceedings still more injurious. This is one of those species from the skin of which transpires a white cottony secretion. Some of the proprietors of orchards about Evesham, observing an insect which secreted a similar substance upon the poplar, imagined that from this tree the creature, which they had found so noxious, was generated; and in consequence of this mistaken notion, cut down all their poplars[v]. The same indistinct ideas might have induced them to fell all their larches and beeches, since they also are infested by aphides which transpire a similar substance. Had these persons possessed any entomological knowledge, they would have examined and compared the insects before they had formed their opinions, and being

[t] Kirby, in *Linn. Trans.* iv. 232. 235. See also a letter signed C. in the *Gent. Mag.* for August, 1795.
[u] P. 192.
[v] Collet, in *Month. Mag.* xxxii. 320.

convinced that the poplar and apple aphis are distinct species, would have saved their trees.

But could an entomological observer even ascertain the species of any noxious insect, still, in many cases, without further information, he may still fall short of his purpose of prevention. Thus we are told, that in Germany the gardeners and country people, with great industry, gather whole baskets full of the caterpillar of the destructive cabbage moth, (*Noctua Brassicæ*, Fab.) and then bury them, which, as Roesel well observes[*], is just as if we should endeavour to kill a crab by covering it with water; for many of them being full grown and ready to pass into their next state, which they do underground, instead of destroying them by this manœuvre, their appearing again the following year in greater numbers is actually facilitated. Yet this plan applied to our common cabbage catterpillar, which does not go underground, would succeed. So that some knowledge of the manners of an insect is often requisite to enable us to check its ravages effectually. With respect to noxious caterpillars in general, agriculturists and gardeners are not usually aware that the best mode of preventing their attacks is to destroy the female fly before she has laid her eggs, to do which the moth proceeding from each must be first ascertained. But if their research were carried still further, so as to enable them to distinguish the pupa and discover its haunts, and it would not be at all difficult to detect that of the greatest pest of our gardens, the cabbage butterfly, the work

[*] Roesel I. iv. 170.

might be still more effectually accomplished. Some larvæ are polyphagous, or feed upon a variety of plants, amongst others that of *Bombyx chrysorhœa*, F. yet gardeners think they have done enough if they destroy the web-like nests which so often deform our fruit trees, without suspecting that new armies of assailants will wander from those on other plants which they have suffered to remain. Thus will thousands be produced in the following season, which, had they known how to distinguish them, might have been extirpated. Another instance occurred to me last year, when walking with a gentleman in his estate at a village in Yorkshire. Our attention was attracted by several circular patches of dead grass, each having a stick with rags suspended to it, placed in the centre. I at once discerned that the larva of the cock-chafer had eaten the roots of the grass, which being pulled up by the rooks that devour this mischievous grub, these birds had been mistaken by the tenant for the cause of the evil, and the rags were placed to frighten away his best friends. On enquiry why he had set up these sticks, he replied, "He could n't beer to see'd nasty craws pull up all'd gess, and sae he'd set'd bairns to hing up some aud clouts to flay 'em away. Gin he'd letten 'em alean they'd sean hev reated up all'd close." Nor could I convince him by all that I could say, that the rooks were not the cause of the evil. Even philosophers sometimes fall into gross mistakes from this species of ignorance. Dr. Darwin has observed, that destroying the beautiful but injurious woodpeckers is the only alternative for preventing the injury they do to our forest trees by boreing into them[x]; not being aware that they bore only those trees which insects have previously attacked, and that they diminish very considerably the number of such as are prejudicial to our forests.

From these facts it is sufficiently evident that entomological knowledge is necessary both to prevent fatal mistakes, and to enable us to check with effect the ravages of insects. But ignorance in this respect is not only unfit to remedy the evil; on the contrary, it may often be regarded as its cause. A large proportion of the most noxious insects in every country are not indigenous, but have been imported. It was thus that *Tinea melonella*, so destructive in bee-hives, and *Chrysomela Asparagi* were made denizens of Sweden[y]. The insect that has destroyed all the peach-trees in St. Helena was imported from the Cape: and at home, not to mention bugs and cock-roaches, the great pest of our orchards, before mentioned, the apple Aphis there is good reason to believe was introduced with some foreign apple-trees. Now, extensive as is our commerce, it is next to impossible, by any precautions, to prevent the importation of these noxious agents. A cargo, or even a sample, of peas from North America might present us with that ravager of pulse, *Bruchus Pisi*, L., or the famed Hessian fly, which some years ago caused such trepidation in our cabinet, might be conveyed here in a ship-load of wheat. Leeuwenhoek's wolf (*Tinea granella*, F.) might visit us, in a similar conveyance, from Holland or France. But though introduced, were entomology

[x] *Phytologia*, 518.

[y] *Fn. Suec.* 567. 1383.

a more general pursuit, their presence would soon be detected, and the evil at once nipt in the bud; whereas in a country where this science was not at all or little cultivated, they would most probably have increased to such an extent before they attracted notice, that every effort to extirpate them would be ineffectual.

It is needless to insist upon the importance of the study of insects, as calculated to throw light upon some of the obscurest points of general physiology; nor would it be difficult, though the task might be invidious, to point out how grossly incorrect and deficient are many of the speculations of our most eminent philosophers, solely from their ignorance of this important branch of natural history. How little qualified would that physiologist be to reason conclusively upon the mysterious subject of generation, who should be ignorant of the wonderful and unlooked-for fact, brought to light by the investigations of an entomologist, that one sexual intercourse is sufficient to fertilize the eggs of numerous generations of Aphides! And how defective would be all our reasonings on the powers of nutrition and secretion, had we yet to learn that in insects both are in action unaccompanied by the circulating system and glands of larger animals!

In another point of view entomological information is very useful. A great deal of unnecessary mischief is produced, and unnecessary uneasiness occasioned, by what are called vulgar errors, and that superstitious reliance upon charms, which prevents us from having recourse to remedies that are really efficacious. Thus, for instance, eating figs and sweet things has been supposed to generate lice [z]. Nine larvæ of the moth of the wild teasel inclosed in a reed or goose quill have been reckoned a remedy for ague [a]. Matthiolus gravely affirms that every oak-gall contains either a fly, a spider, or a worm, and that the first foretells war, the second pestilence, and the third famine [b]. In Sweden the peasants look upon the grub of the cock-chafer as furnishing an unfailing prognostic whether the ensuing winter will be mild or severe: if the animal have a bluish hue (a circumstance which arises from its being replete with food) they affirm it will be mild, but on the contrary if it be white the weather will be severe: and they carry this so far as to foretel, that if the anterior part be white and the posterior blue, the cold will be most severe at the beginning of the winter. Hence they call this grub *Bemärkelse-mask*, or prognostic worm [c]. The appearance of the death's head moth (*Sphinx Atropos*, L.) has in some countries produced the most violent alarm and trepidation amongst the people, who, because it emits a plaintive sound, and is marked with what looks like a death's head upon its back, regarded it as the messenger of pestilence and death [d]. We learn from Linné that a similar superstition, built upon its black hue and strange aspect, prevails in Sweden with respect to *Blaps mortisaga* [e]; and in Barbadoes, according to Hughes, the ignorant deem the appearance of a certain grasshopper in their

[z] Amoreux, 276. [a] Rai. *Cat. Cant.* 45. *Hist. Ins.* 341.
[b] *Comment. in Dioscor.* l. 1. c. 23. 214. Lesser. *L.* ii. 280.
[c] De Geer, iv. 275-6. [d] Reaum. ii. 289-90. [e] *Faun. Suec.* 822.

houses as a sure presage of illness to some of the family[f].

One would not think that the excrements of insects could be objects of terror, yet so it has been. Many species of Lepidoptera, when they emerge from the pupa state, discharge from their anus a reddish fluid, which, in some instances, where their numbers have been considerable, has produced the appearance of a shower of blood; and by this natural fact, all those bloody showers, recorded by historians as preternatural, and regarded where they happened as fearful prognostics of impending evils, are stripped of their terrors, and reduced to the class of events that happen in the common course of nature. That insects are the cause of these showers is no recent discovery; for Sleidan relates that in the year 1553 a vast multitude of butterflies swarmed through a great part of Germany, and sprinkled plants, leaves, buildings, clothes, and men with bloody drops, as if it had rained blood[g]. But the most interesting account of an event of this kind is given by Reaumur, from whom we learn that in the beginning of July 1608 the suburbs of Aix, and a considerable extent of country round it, were covered with what appeared to be a shower of blood. We may conceive the amazement and stupor of the populace upon such a discovery, the alarm of the citizens, the grave reasonings of the learned. All agreed however in attributing this appearance to the powers of darkness, and in regarding it as the prognostic and

[f] *Nat. Hist. of Barbad.* 85.

[g] Quoted in Mouffet, 107.

precursor of some direful misfortune about to befal them. Fear and prejudice would have taken deep root upon this occasion, and might have produced fatal effects upon some weak minds, had not M. Peiresc, a celebrated philosopher of that place, paid attention to insects. A chrysalis, which he preserved in his cabinet, let him into the secret of this mysterious shower. Hearing a fluttering, which informed him his insect was arrived at its perfect state, he opened the box in which he kept it. The animal flew out and left behind it a red spot. He compared this with the spots of the bloody shower, and found they were alike. At the same time he observed there was a prodigious quantity of butterflies flying about, and that the drops of the miraculous rain were not to be found upon the tiles, nor even upon the upper surface of the stones, but chiefly in cavities and places where rain could not easily come. Thus did this judicious observer dispel the ignorant fears and terror which this natural phenomenon had caused[h].

The same author relates an instance of the gardener of a gentleman being thrown into a horrible fright by digging some of the curious cases, which I shall hereafter describe to you, of the leaf-cutter bees, and which he conceived to be the effect of witchcraft portending some terrible misfortune. By the advice of the priest of the parish he even took a journey from Rouen to Paris, to show them to his master: but he, happily having more sense than the man, carried them to M. Nollet, an eminent naturalist, who having seen simi-

[h] Reaum. i. 667.

lar productions was aware of the cause, and opening one of the cases, while the gardener stood aghast at his temerity, pointed out the grub that it contained, and thus sent him back with a light heart, relieved from all his apprehensions [1].

Every one has heard of the death-watch, and knows of the superstitious notion of the vulgar, that in whatever house its drum is heard one of the family will die before the end of the year. These terrors, in particular instances, where they lay hold of weak minds, especially of sick or hypochondriac persons, may cause the event that is supposed to be prognosticated. A small degree of entomological knowledge would relieve them from all their fears, and teach them that this heart-sickening tick is caused by a small beetle (*Anobium tessellatum*, F.) which lives in timber, and is merely a call to its companion. Attention to entomology may therefore be rendered very useful in this view, since nothing certainly is more desirable than to deliver the human mind from the dominion of superstitious fears, and false notions, which having considerable influence on the conduct of mankind are the cause of no small portion of evil.

But as we cannot well guard against the injuries produced by insects, or remove the evil, whether real or arising from misconceptions respecting them, which they occasion, unless we have some knowledge of them; so neither without such knowledge can we apply them, when beneficial, to our use. Now it is extremely probable that they might be made vastly more

[1] Reaum. vi. 99-100. Kirby *Mon. Ap. Ang.* i. 157-8.

subservient to our advantage and profit than at present, if we were better acquainted with them. It is the remark of an author, who himself is no entomologist: "We have not taken animals enough into alliance with us. The more spiders there were in the stable, the less would the horses suffer from the flies. The great American fire-fly should be imported into Spain to catch mosquitos. In hot countries a reward should be offered to the man who could discover what insects feed upon fleas[j]." It would be worth our while to act upon this hint, and a similar one of Dr. Darwin. Those insects might be collected and preserved that are known to destroy the Aphides and other injurious tribes; and we should thus be enabled to direct their operations to any quarter where they would be most serviceable: but this can never be done till experimental agriculturists and gardeners are conversant with insects, and acquainted with their properties and economy. How is it that the great Being of beings preserves the system that he has created from permanent injury, in consequence of the too great redundancy of any individual species, but by employing one creature to prey upon another, and so overruling and directing the instincts of all, that they may operate most where they are most wanted? We cannot better employ the reasoning powers and faculties with which he has endowed us, than by copying his example. We often employ the larger animals to destroy each other, but the smaller, especially insects, we have totally neglected. Some may think, perhaps, that in

[j] Southey's *Madoc*, 4to. Notes, 519.

aiming to do this we should be guilty of presumption, and of attempting to take the government and direction of things out of the hands of Providence: but this is a very weak argument, which might with equal reason be adduced to prove that when rats and mice become troublesome to us, we ought not to have recourse to dogs, ferrets, and cats to exterminate them. When any species multiplies upon us, so as to become noxious, we certainly have a just right to destroy it, and what means can be more proper than those which Providence itself has furnished? We can none of us go further or do more than the Divine Will permits; and he will take care that our efforts shall not be injurious to the general welfare, or effect the annihilation of any individual species.

Again, with regard to insects that are employed in medicine or the arts, if the apothecary cannot distinguish a Lytta from a Carabus or Cetonia, both of which I have found mixed with the former, how can he know whether his druggist furnishes him with a good or bad article? And the same observation may with still greater force apply to the dyer in his purchase of cochineal, since it is still more difficult to distinguish the wild sort from the cultivated. There are, it is probable, many insects that might be employed with advantage in both these departments: but unless entomology be more generally studied by scientific men, who are the only persons likely to make discoveries of this kind, than it has hitherto been, we must not hope to derive further profit from them. It seems more particularly incumbent upon the professors of the divine art of healing to become conversant with this as well as the other branches of natural history; for not only do they derive some of their most useful drugs from insects, but many also of the diseases upon which they are consulted, as we shall see hereafter, are occasioned by them. For want of this kind of information medical men run the risk of confounding diseases perfectly distinct, at least as to the animal that causes them. It would be a most desirable thing to have professors in each branch of natural history in our universities, and to make it indispensable, in order to the obtaining of any degree in physic, that the candidate should have attended these lectures. We may judge from the good effects that the arts have derived from the present very general attention to chemistry, how beneficial would be the consequence if entomology were equally cultivated: and I shall conclude this paragraph with what I think may be laid down as an incontrovertible axiom: —That the profit we derive from the works of creation will be in proportion to the accuracy of our knowledge of them and their properties.

I trust I have now said enough to convince you and every thinking man that the study of insects, so far from being vain, idle, trifling, or unprofitable, may be attended with very important advantages to mankind, and ought at least to be placed upon a level with many other branches of science, against which such accusations are never alleged.

But I must not conceal from you that there are objectors who will still return to the charge. They will say, "We admit that the pursuits of the entomologist are important when he directs his views to the destruction of noxious insects; the discovery of new ones likely to prove beneficial to man; and to practical experiments upon their medical and economical properties. But where are the entomologists that in fact pursue this course? Do they not in reality wholly disregard the economical department of their science, and content themselves with making as large a collection of species as possible; ascertaining the names of such as are already described; describing new ones; and arranging the whole in their cabinets under certain families and genera? And can a study with these sole ends in view deserve a better epithet than trifling? Even if the entomologist advance a step further, and invent a new system for the distribution of all known insects, can his laborious undertaking be deemed any other than busy idleness? What advantage does the world derive from having names given to ten or twenty thousand insects of which numbers are not bigger than a pin's head, and of which probably not a hundredth part will ever be of any use to mankind?"

Now in answer to this supposed objection, which I have stated as forcibly as I am able, and which, as it may be, and often is, urged against every branch of natural history as at present studied, well deserves a full consideration, I might in the first place deny that those who have the highest claim to rank as entomologists do confine their views to the systematic department of the science to the neglect of economical observations; and in proof of my assertion, I might refer abroad to a Linne, a Reaumur, a De Geer, a Huber, and various other names of the highest reputation; and at home to a Ray, a Lister, a Derham, a Marsham, a Curtis, a Clark, a Roxburgh, &c. But I do not wish to conceal that though a large proportion of entomologists direct their views much further than to the mere nomenclature of their science, there exist a great number, probably the majority, to whom the objection will strictly apply. Now I contend, and shall next endeavour to prove, that entomologists of this description are devoting their time to a most valuable end; and are conferring upon society a benefit incalculably greater than that derived from the labours of many of those who assume the privilege of despising their pursuit.

Even in favour of the mere butterfly-hunter—he who has no higher aim than that of collecting a *picture* of Lepidoptera, and is attached to insects solely by their beauty or singularity, it would not be difficult to say much. Can it be necessary to declaim on the superiority of a people amongst whom intellectual pleasures, however trifling, are preferred to mere animal gratifications? Is it a thing to be lamented that some of the Spitalfields weavers occupy their leisure hours in searching for *Papilio Adonis*, and others of the more splendid Lepidoptera[k], instead of spending them in playing at skittles or in an alehouse? Or is there in truth any thing more to be wished than that the cutlers of Sheffield were accustomed to employ their *Saint Mondays*, and to recreate themselves after a hard day's work, by breathing the pure air of their surrounding hills, while in search of this "untaxed

[k] Haworth *Lepid. Brit.* 44. 57.

and undisputed game[l];" and that more of the Norwich weavers were fond of devoting their vacant time to plant-hunting, like Joseph Fox recorded by Dr. Smith as the first raiser of a Lycopodium from seed[m]?"

Still more easy is it to advocate the cause of another description of entomologists—the general collectors. These, though not concerning themselves with the system, contribute most essentially to its advancement. We cannot expect that princes, noblemen, and others of high rank or large fortune, who collect insects, should be able or willing to give up the time necessary for studying them systematically: but their museums being accessible to the learned entomologist afford

[l] Oft have I smiled the happy pride to see
Of humble tradesmen in their evening glee,
When of some pleasing fancied good possest,
Each grew alert, was busy and was blest;
Whether the call-bird yield the hour's delight,
Or magnified in microscope the mite;
Or whether tumblers, croppers, carriers seize
The gentle mind, they rule it and they please.

There is my friend the weaver; strong desires
Reign in his breast; 'tis beauty he admires:
See to the shady grove he wings his way,
And feels in hope the rapture of the day—
Eager he looks, and soon to glad his eyes,
From the sweet bower by nature form'd arise
Bright troops of virgin moths, and fresh born butterflies.
- - - - - - - - - -
He fears no bailiff's wrath, no baron's blame,
His is untax'd and undisputed game.

Crabbe's *Borough*, p. 110.

[m] *Linn. Trans.* ii. 315.

him the use of treasures which his own limited funds or opportunities could never have brought together. As to others of less consequence that content themselves with the title of collectors, they also have their use. Having devoted themselves to this one department, they become more expert at it, than the philosopher who combines deep researches with the collection of objects; and thus are many species brought together for the use of the systematist, that would otherwise not be found.

But to proceed to the defence of systematic entomologists.—These may be divided into two great classes: the first comprising those who confine themselves to ascertaining the names of the insects they collect; the second, those who, in addition, publish descriptions of new species; new arrangements of intricate genera; or extrications of entangled synonyms; and who, in other respects, actively contribute to the perfection of the system.

Now with regard to the first class, setting aside what may be urged in behalf of the study of insects considered as the work of the Creator, it is easy to show that, even with such restricted views, their pursuit is as commendable, and as useful both to themselves and the community, as many of those on which we look with the greatest respect. To say the least in their favour, they amuse themselves innocently, which is quite as much as can be urged for persons who recreate their leisure hours with music, painting, or desultory reading. They furnish themselves with an unfailing provision for that "grand panacea for the *tædium vitæ*" employment—no unimportant acquisition when even Gray was forced to exclaim, with reference to the necessity of "always having something going forward" towards the enjoyment of life, "Happy they who can create a rose-tree or erect a honey-suckle; that can watch the brood of a hen, or see a fleet of their own ducklings launch into the water[a]!" and like the preceding class, they collect valuable materials for the use of more active labourers, being thus at least upon a par with the majority of book-collectors and antiquarians.

But this is the smallest half of the value of their pursuit. With what view is the study of the mathematics so generally recommended? Not certainly for any practical purpose—not to make the bulk of those who attend to them, astronomers or engineers. But simply to exercise and strengthen the intellect—to give the mind a habit of attention and of investigation. Now for all these purposes, if I do not go so far as to assert that the mere ascertaining of the names of insects is equal to the study of the mathematics, I have no hesitation in affirming that it is nearly as effectual; and with respect to giving a habit of minute attention, superior. Such is the intricacy of nature, such the imperfection of our present arrrangements, that the discovery of the name of almost any insect is a problem, calling in all cases for acuteness and attention, and in some for a balancing of evidence, a calculation of the chances of error, as arduous as are required in a perplexed law-case; and a process of ratiocination not less strict than that which satisfies the mathema-

[a] Letter to Dr. Wharton. Mason's *Life of Gray*, p. 287.

tician. In proof of which assertion I need only refer any competent judge to the elaborate disquisitions of Laspeyres, called for by one work alone on the Lepidopterous Insects of a single district—the *Wienen Verzeichniss*, which occupy above two hundred 8vo pages[o]. and must have cost the learned author nearly as much labour of mind as the *Ductor Dubitantium* did Bishop Taylor.

Do not apprehend that this occasional perplexity is any deduction from the attractions of the science: though in itself, in some respects, an evil, it forms in fact to many minds one of the chief of them. The pursuit of Truth, in whatever path, affords pleasure: but the interest would cease if she never gave us trouble in the chase. Horace Walpole used to say that from a child he could never bring himself to attend to any book that was not full of proper names; and the satisfaction which he felt in dry investigations concerning noble authors and obscure painters, is experienced by many an entomologist who spends hours in disentangling the synonymy of a doubtful species. Nor would it be easy to prove that the wordy researches of the one are not to every practical purpose as valuable as those of the other. We smile at the Frenchman told of by Manege, that was so enraptured with the study of heraldry and genealogy, that he used to lament the hard case of our forefather Adam, who could not possibly amuse himself with such investigations[p]? But many an entomologist who has felt the delicious sensation attendant upon the indisputable ascertainment

[o] Illig. *Mag.* ii. 33. iv. 3.

[p] Andrews's *Anecdotes*, 152.

of an insect's name after a long search, will feel inclined to indulge in similar grief for the unhappy lot of his successors, when all shall be smooth sailing in the science.

But in behalf of those who are more eminently entitled to be called entomologists—those who, not content with collecting and investigating insects, occupy themselves in naming and describing such as have been before unobserved; in instituting new genera or reforming the old; and, to say all in one word, in perfecting the system of the science, still higher claims can be urged. Suppose that at this moment our dictionaries of the French and German languages were so very defective, that we were unable by the use of them to profit from the discoveries of their philosophers; the labours of a Michaelis being a sealed book to our theologists, and those of La Place to our astronomers. On this supposition, would not one of the most important literary undertakings be the compilation of more perfect dictionaries, and would not the humblest contributer to such an end be deemed most meritoriously engaged? Now precisely what an accurate dictionary of a particular language is towards enabling the world to participate in the discoveries published in that language, is a system of entomology towards enabling mankind to derive advantage from any discoveries relative to insects. A good system of insects containing all the known species, arranged in appropriate genera, families, orders, and classes, is in fact a dictionary, putting it within our power to ascertain the name of any given insect, and thus to learn what has been observed respecting its properties and history as readily as we determine the meaning of a new word in a lexicon. In order to impress upon you more forcibly the absolute need of such a system, I must enter into still further detail.

There is scarcely a country in which several thousand insects may not be found. Now, without some scientific arrangement, how is the observer of a new fact respecting any one of them, to point out to distant countries and to posterity, the particular insect he had in view? Suppose an observer in England were to find a certain beetle which he had demonstrated to be a specific for consumption; and that it was necessary that this insect, which there was reason to believe was common in every part of the world, should be administered in a recent state. Would he not be anxious to proclaim the happy discovery to sufferers in all quarters of the globe? As his remedy would not admit of transportation, he would have no other means than by describing it. Now the question is, whether, on the supposition that no system of entomology existed, he would be able to do this, so as to be intelligible to a physician in North America, for instance, who was eager to administer so precious a medicine to his expiring patients? It would evidently be of no use to say that the specific was a beetle: there are probably thousands of different beetles in North America. Nor would size or colour be any better guide: there are hundreds of beetles of the same size and the same colour. Even the plant on which it fed would be no sufficient clue; for many insects, resembling each other to an unpractised eye, feed on the same plant; and the same insect in different countries feeds upon different plants. His only resource, then, would be a coloured figure and full description of it. But every entomologist knows that there exist insects perfectly distinct, yet so nearly resembling each other, that no engraving, nor any language other than that strictly scientific, can possibly discriminate them. After all, therefore, the chances are, that our discoverer's remedy, invaluable as it might be, must be confined to his own immediate neighbourhood, or to those who came to receive personal information from him. But with what ease is it made known when a system of the science exists! If the insect be already described, he has but to mention its generic and trivial names, and by aid of two words alone every entomologist, though in the most distant region—whether a Swede, a German, or a Frenchman; whether a native of Europe, of Asia, of America, or of Africa, knows instantly the very species that is meant, and can that moment ascertain whether it be within his reach. If the species be new and undescribed, it is only necessary to indicate the genus to which it belongs, the species to which it is most nearly allied, and to describe it in scientific terms, which may be done in few words, and it can at once be recognised by every one acquainted with the science.

You will think it hardly credible that there should be so much difficulty in describing an insect intelligibly without the aid of system; but an *argumentum ad hominem*, supported by some other facts, will, I conjecture, render this matter more comprehensible. You have doubtless, like every one else, in the showery days of summer, felt no little rage at the *flies*, which at such times take the liberty of biting our legs, and continue to make a comfortable meal through the interstices of their silken or cotton coverings. Did it, I pray, ever enter into your conception, that these blood-thirsty tormentors are a different species from those flies which you are wont to see extending the lips of their little proboscis to a piece of sugar or a drop of wine? I dare say not. But the next time you have sacrificed one of the former to your just vengeance, catch one of the latter and compare them. I question if, after the narrowest comparison, you will not still venture a wager that they are the very same species. Yet you would most certainly lose your bet. They are not even of the same genus—one belonging to the genus Musca (*M. domestica*, L.), and the other to the genus Stomoxys (*S. calcitrans*, F.); and on a second examination you will find that, however alike in most respects, they differ widely in the shape of their proboscis; that of the Stomoxys being a horny sharp-pointed weapon, capable of piercing the flesh, while the soft blunt organ of the Musca is perfectly incompetent to any such operation. In future, while you no longer load the whole race of the house-fly with the execrations which properly belong to a quite different tribe, you will cease being surprised that an ordinary description should be insufficient to discriminate an insect. It is to this insufficiency that we must attribute our ignorance of so many of the insects mentioned by the older naturalists, previously to the systematic improvements of the immortal Linné: and to the same cause we must refer the impossibility of determining what species are alluded to in the accounts of many modern travellers and agriculturists who have been ignorant of entomology as a science. Instances without number of this impossibility might be adduced, but I shall confine myself to two.

One of the greatest pests of Surinam and other low regions in South America, is the insect called in the West Indies, where it is also troublesome, the chigoe (*Pulex penetrans*, L.), a minute species, to the attacks of which I shall again have occasion to advert. This insect is mentioned by almost all the writers on the countries where it is found. Not less than eight or ten of them have endeavoured to give a full description of it, and some of them have even figured it; and yet, strange to say, it was not certainly known whether it was a flea (*Pulex*) or a mite (*Acarus*), till a competent naturalist undertook to investigate its history, and in a short paper in the *Swedish Transactions*[q] proved that Linne was not mistaken in referring it to the former genus.

The second instance of the insufficiency of popular description is even more extraordinary. In 1788 an alarm was excited in this country by the probability of importing, in cargoes of wheat from North America, the insect known by the name of the Hessian fly, whose dreadful ravages will be adverted to hereafter. However the insect tribes are in general despised, they had on that occasion ample revenge. The privy council sat day after day anxiously debating what measures should be adopted to ward off the danger of a calamity, more to be dreaded, as they well knew, than the

[q] Swartz in *Kongl. Vet. Ac. Nya. band.* ix. 40.

plague or pestilence. Expresses were sent off in all directions to the officers of the customs at the different outports respecting the examination of cargoes—dispatches written to the ambassadors in France, Austria, Prussia, and America, to gain that information of the want of which they were now so sensible: and so important was the business deemed, that the minutes of council and the documents collected from all quarters fill upwards of two hundred 8vo pages [r]. Fortunately England contained one illustrious naturalist, the most authentic source of information on all subjects which connect natural history with agriculture and the arts, to whom the privy council had the wisdom to apply; and it was by Sir Joseph Banks's entomological knowledge, and through his suggestions, that they were at length enabled to form some kind of judgement on the subject. This judgement was after all, however, very imperfect. As Sir Joseph Banks had never seen the Hessian fly, nor was it described in any entomological system, he called for facts respecting its nature, propagation, and economy, which could be had only from America. These were obtained as speedily as possible, and consist of numerous letters from individuals; essays from magazines; the reports of the British minister there, &c. &c. One would have supposed that from these statements, many of them drawn up by farmers who had lost entire crops by the insect, which they profess to have examined in every stage, the requisite information might have been acquired. So far however was this from being the case, that many

[r] Young's *Annals of Agriculture*, xi. 406.

of the writers seem ignorant whether the insect be a moth, a fly, or what they term a bug. And though from the concurrent testimony of several its being a two-winged fly seemed pretty accurately ascertained, no intelligible description is given, from which any naturalist can infer to what genus it belongs, or whether it is a known species. With regard to the history of its propagation and economy the statements were so various and contradictory, that though he had such a mass of materials before him, Sir Joseph Banks was unable to reach any satisfactory conclusion.

Nothing can more incontrovertibly demonstrate the importance of studying entomology as a science than this fact. Those observations, to which thousands of unscientific sufferers proved themselves incompetent, would have been readily made by one entomologist well versed in his science. He would at once have determined the order and genus of the insect, and whether it was a known or new species; and in a twelvemonth at furthest he would have ascertained in what manner it made its attacks, and whether it were possible that it might be transmitted along with grain into a foreign country: and on these solid data he could have satisfactorily pointed out the best mode of eradicating the pest, or preventing the extension of its ravages.

But it is not merely in travellers and popular observers that the want of a systematic knowledge of entomology is so deplorable. A great portion of the labours of the profoundest naturalists have been from a similar cause lost to the world. Many of the insects concerning which Reaumur and Bonnet have recorded the most interesting circumstances, cannot, from their neglect of system, be at this day ascertained[s]. The former, as Beckmann[t] states on the authority of his letters, was before his death sensible of his great error in this respect: but Bonnet, with singular inconsistency, constantly maintained the inutility of system, even on an occasion when, from his ignorance of it, Dr. Smith, speaking of his experiments on the Barberry, found it quite impossible to make him comprehend what plant he referred to[u].

Such, then, is the vast importance of a systematic arrangement of insects. Yet no such arrangement has yet been completed. Various fragments towards it indeed exist. But the work itself is in the state of a dictionary, wanting a considerable proportion of the words of the language it professes to explain; and placing those which it does contain in an order often so arbitrary and defective, that it is difficult to discover even the page containing the word you are in search of. Can it be denied then that they are most meritoriously employed who devote themselves to the removal of these defects—to the perfecting of the system—and to clearing the path of future economical or physiological observers from the obstructions which now beset it? And who that knows the vast extent of the science, and how impossible it is that a divided attention can embrace the whole, will contend that it is not desirable that some labourers in the field of lite-

[s] No one knew Reaumur's *Abeille Tapissiere* until Latreille, happily combining system with attention to the economy of insects, proved it to be a new species—his *Megachile Papaveris*.—*Hist. de Fourmis*, 297.

[t] *Bibliothek*, vii. 310.

[u] *Tour on the Continent*, iii. 150.

rature should devote themselves entirely and exclusively to this object? Who that is aware of the importance of the comprehensive views of a Fabricius, an Illiger, or a Latreille, and the infinite saving of time of which their inquiries will be productive to their followers, will dispute their claim to rank amongst the most honourable in science?

II. No objection, I think, now remains against addicting ourselves to entomological pursuits, but that which seems to have the most weight with you, and which indeed is calculated to make the deepest impression upon the best minds. I mean the charge of inhumanity and cruelty. That the science of entomology cannot be properly cultivated without the death of its objects, and that this is not to be effected without putting them to some pain, must be allowed; but that this substantiates the charge of cruelty against us I altogether deny. Cruelty is an unnecessary infliction of suffering, when a person is fond of torturing or destroying God's creatures from mere wantonness, with no useful end in view; or when, if their death be useful and lawful, he has recourse to circuitous modes of killing them, where direct ones would answer equally well. This is cruelty, and this with you I abominate; but not the infliction of death when a just occasion calls for it.

They who see no cruelty in the sports of the field, as they are called, can never, of course, consistently allege such a charge against the entomologist; the tortures of wounded birds, of fish that swallow the hook and break the line, or of the hunted hare, being, beyond comparison, greater than those of insects destroyed in the usual mode. With respect to utility, the sportsman, who, though he adds indeed to the general stock of food, makes amusement his primary object, must surely yield the palm to the entomologist, who adds to the general stock of mental food, often supplies hints for useful improvements in the arts and sciences, and the objects of whose pursuit, unlike those of the former, are preserved and may be applied to use for many years.

But in the view even of those few who think inhumanity chargeable upon the sportsman, it will be easy to place considerations which may rescue the entomologist from such reproof. It is well known that, in proportion as we descend in the scale of being, the sensibility of the objects that constitute it diminishes. The tortoise walks about after losing its head; and the Polypus, so far from being injured by the application of the knife, thereby acquires an extension of existence. Insensibility almost equally great may be found in the insect world. This, indeed, might be inferred *à priori*, since Providence seems to have been more prodigal of insect life than of that of any other order of creatures, animalcula perhaps alone excepted. No part of the creation is exposed to the attack of so many enemies, or subject to so many disasters; so that the few individuals of each kind which enrich the valued museum of the entomologist, many of which are dearer to him than gold or gems, are snatched from the ravenous maw of some bird or fish or rapacious insect, would have been driven by the winds into the waters and drowned; or trodden underfoot by man or beasts,—

for it is not easy, in some parts of the year, to set foot to the ground without crushing these minute animals: and thus also, instead of being buried in oblivion, they have a kind of immortality conferred upon them. Can it be believed that the beneficent Creator, whose tender mercies are over all his works, would expose these helpless beings to such innumerable enemies and injuries, were they endued with the same sense of pain and irritability of nerve with the higher orders of animals?

But this inference is reduced to certainty, when we attend to the facts which insects every day present to us, proving that the very converse of our great poet's conclusion,

——"The poor beetle that we tread upon,
In corporal sufferance finds a pang as great
As when a giant dies,"

must be regarded as nearer the truth. Not to mention the peculiar organization of insects, which strongly favours the idea I am inculcating, but which will be considered more properly in another place, their sang froid upon the loss of their limbs, even those that we account most necessary to life, irrefragably proves that the pain they suffer cannot be very acute. Had a giant lost an arm or a leg, or were a sword or spear run through his body, he would feel no great inclination for running about, dancing or eating. Yet a Tipula will leave half its legs in the hands of an unlucky boy who has endeavoured to catch it, and will fly here and there with as much agility and unconcern as if nothing had happened to it; and an insect impaled upon a pin will often devour its prey with as much avidity as when at liberty. Were a giant eviscerated, his body divided in the middle, or his head cut off, it would be all over with him; he would move no more; he would be dead to the calls of hunger; or the emotions of fear, anger, or love. Not so our insects. I have seen the common cockchafer walk about with apparent indifference after some bird had nearly emptied its body of its viscera; a humble bee will eat honey with greediness though deprived of its abdomen: and I myself lately saw an ant, which had been brought out of the nest by its comrades, walk when deprived of its head. The head of a wasp will attempt to bite after it is separated from the rest of the body; and the abdomen under similar circumstances, if the finger be moved to it, will attempt to sting. And what is more extraordinary, the headless trunk of a male Mantis has been known to unite itself to the other sex[v]. These facts, out of hundreds that might be adduced, are surely sufficient to prove that insects do not experience the same acute sensations of pain with the higher orders of animals, which Providence has endowed with more ample means of avoiding them; and since they were to be exposed so universally to attack and injury, this is a most merciful provision in their favour; for, were it otherwise, considering the wounds, and dismemberments, and lingering deaths that insects often suffer, what a vast increase would there be of the general sum of pain and misery! You will now, I think, allow that the most humane person need not hesitate a

[v] Dr. Smith's *Tour*, i. 162. *Journ. de Phys.* xxv. 336.

moment, whether he shall devote himself to the study of entomology, on account of any cruelty attached to the pursuit.

But if some morbid sentimentalist should still exclaim, "Oh! but I cannot persuade myself even for scientific purposes to inflict the slightest degree of pain upon the most insensible of creatures—" Pray, sir or madam, I would ask, should your green-house be infested by Aphides, or your grapery by the semianimate Coccus, would this extreme of tenderness induce you to restrict your gardener from destroying them? Are you willing to deny yourself these unnecessary gratifications, and to resign your favourite flowers and fruit at the call of your fine feelings? Or will you give up the shrimps, which by their relish enable you to play a better part with your bread and butter at breakfast, and thus, instead of adding to it, contribute to diminish the quantity of food? If not, I shall only desire you to recollect that, for a mere personal indulgence, you cause the death of an infinitely greater number of animals, than all the entomologists in the world destroy for the promotion of science.

To these considerations, which I have no doubt you will think conclusive as to the unreasonableness and inconsistency of the objections made against the study of entomology on the score of cruelty, I shall only add that I do not intend them as any apology for other than the most speedy and least painful modes of destroying insects; and these will be pointed out to you in a subsequent letter. Every degree of unnecessary pain becomes cruelty, which I need not assure you I abhor; and from my own observations, however ruthlessly the entomologist may seem to devote the few specimens wanted for scientific purposes to destruction, no one in ordinary circumstances is less prodigal of insect life. For my own part, I question whether the drowning individuals, which I have saved from destruction, would not far out-number all that I ever sacrificed to science.

My next letter will be devoted to the metamorphoses of insects, a subject on which some previous explanation is necessary to enable you to understand those distinctions between their different states, which will be perpetually alluded to in the course of our correspondence: and having thus cleared the way, I shall afterwards proceed to the consideration of the injuries and benefits of which insects are the cause.

I am, &c.

LETTER III.

METAMORPHOSES OF INSECTS.

WERE a naturalist to announce to the world the discovery of an animal which for the first five years of its life existed in the form of a serpent; which then penetrating into the earth, and weaving a shrowd of pure silk of the finest texture, contracted itself within this covering into a body without external mouth or limbs, and resembling more than any thing else an Egyptian mummy; and which, lastly, after remaining in this state without food and without motion for three years longer, should at the end of that period burst its silken cerements, struggle through its earthy covering, and start into day a winged bird,—what think you would be the sensation excited by this strange piece of intelligence? After the first doubts of its truth were dispelled, what astonishment would succeed! Amongst the learned, what surmises!—what investigations! Amongst the vulgar, what eager curiosity and amazement! All would be interested in the history of such an unheard-of phenomenon; even the most torpid would flock to the sight of such a prodigy.

But you ask, "To what do all these improbable suppositions tend?" Simply to rouse your attention to the metamorphoses of the insect world, almost as strange and surprising, to which I am now about to direct your view,——miracles, which, though scarcely surpassed in singularity by all that poets have feigned, and though actually wrought every day beneath our eyes, are, because of their commonness, and the minuteness of the objects, alike unheeded by the learned and the ignorant.

That butterfly which amuses you with its aërial excursions, one while extracting nectar from the tube of the honeysuckle, and then, the very image of fickleness, flying to a rose as if to contrast its wings with the hue of the flower on which it reposes—did not come into the world as you now behold it. At its first exclusion from the egg, and for some months of its existence afterwards, it was a worm-like caterpillar, crawling upon sixteen short legs, greedily devouring leaves with two jaws, and seeing by means of twelve eyes so minute as to be nearly imperceptible without the aid of a microscope. You now see it furnished with wings capable of rapid and extensive flights: of its sixteen feet ten have disappeared, and the remaining six are in most respects wholly unlike those to which they have succeeded; its jaws have vanished, and are replaced by a curled-up proboscis suited only for sipping liquid sweets; the form of its head is entirely changed,—two long horns project from its upper surface; and, instead of twelve invisible eyes, you behold two, very large, and composed of at least twenty thousand convex lenses, each supposed to be a distinct and effective eye!

Were you to push your examination further, and by dissection to compare the internal conformation of the caterpillar with that of a butterfly, you would witness changes even more extraordinary. In the former you would find some thousands of muscles, which in the latter are replaced by others of a form and structure entirely different. Nearly the whole body of the caterpillar is occupied by a capacious stomach. In the butterfly this has become changed into an almost imperceptible thread-like viscus; and the abdomen is now filled by two large packets of eggs, or other organs not visible in the first state. In the former, two spirally-convoluted tubes were filled with a silky gum; in the latter, both tubes and silk have almost totally vanished; and changes equally great have taken place in the economy and structure of the nerves and other organs.

What a surprising transformation! Nor was this all. The change from one form to the other was not direct. An intermediate state not less singular intervened. After casting its skin even to its very jaws several times, and attaining its full growth, the caterpillar attached itself to a leaf by a silken girth. Its body greatly contracted: its skin once more split asunder, and disclosed an oviform mass, without exterior mouth, eyes, or limbs, and exhibiting no other symptom of life than a slight motion when touched. In this state of death-like torpor, and without tasting food, the insect existed for several months, until at length the tomb burst, and out of a case not more than an inch long, and a quarter of an inch in diameter, proceeded the butterfly before you, which covers a surface of nearly four inches square.

Almost every insect which you see has undergone a transformation as singular and surprising, though varied in many of its circumstances. That active little fly, now an unbidden guest at your table[w], whose delicate palate selects your choicest viands, one while extending his proboscis to the margin of a drop of wine, and then gaily flying to take a more solid repast from a pear or a peach; now gamboling with his comrades in the air, now gracefully currying his furled wings with his taper feet,—was but the other day a disgusting grub, without wings, without legs, without eyes, wallowing, well pleased, in the midst of a mass of excrement.

The "grey-coated gnat," whose humming salutation, while she makes her airy circles about your bed, gives terrific warning of the sanguinary operation in which she is ready to engage, was a few hours ago the inhabitant of a stagnant pool, more in shape like a fish than an insect. Then to have been taken out of the water would have been speedily fatal; now it could as little exist in any other element than air. Then it breathed through its tail; now through openings in its sides. Its shapeless head, in that period of its existence, is now exchanged for one adorned with elegantly tufted antennæ, and furnished, instead of jaws, with an apparatus more artfully constructed than the cupping glasses of the phlebotomist—an apparatus which, at

[w] "Cœnis etiam non vocatus ut Musca advolo." Aristophon *in Pythagorista* apud Athenæum. (Mouffet, 56.)

the same time that it strikes in the lancets, composes a tube for pumping up the flowing blood.

The "shard-born beetle," whose "sullen horn," as he directs his "droning flight" close past your ears in your evening walk, calling up in poetic association the lines in which he has been alluded to by Shakespear, Collins, and Gray, was not in his infancy an inhabitant of air; the four first years of his life being spent in gloomy solitude, as a grub, under the surface of the earth. The shapeless maggot, which you scarcely fail to meet with in some one of every handful of nuts you crack, would not always have grovelled in that humble state. If your unlucky intrusion upon its vaulted dwelling had not left it to perish in the wide world, it would have continued to dwell there until its full growth had been attained. Then it would have gnawed itself an opening, and having entered the earth, and passed a few months in a state of inaction, would at length have emerged an elegant beetle, furnished with a slender and very long ebony beak; two wings and two wing cases, ornamented with yellow bands; six feet; and in every respect unlike the worm from which it proceeded.

That bee——but it is needless to multiply instances. A sufficient number has been adduced to show, that the apparently extravagant supposition with which I set out may be paralleled in the insect world; and that the metamorphoses of its inhabitants are scarcely less astonishing than would be the tranformation of a serpent into an eagle.

These changes I do not purpose explaining minutely in this place: they will be adverted to more fully in subsequent letters. Here I mean merely to give you such a general view of the subject as shall impress you with its claims to attention, and such an explanation of the states through which insects pass, and of the different terms made use of to designate them in each, as shall enable you to comprehend the frequent allusions which must be made to them in our future correspondence.

The states through which insects pass are four: the *egg*; the *larva*; the *pupa*; and the *imago*.

The first of these need not be here adverted to. In the *second*, or immediately after the exclusion from the egg, they are soft, without wings, and in shape usually somewhat like worms. This Linné called the *larva* state, and an insect when in it a *larva*, adopting a Latin word signifying a *mask*, because he considered the real insect while under this form to be as it were masked. In the English language we have no common term that applies to the second state of all insects, though we have several for that of different tribes. Thus we call the coloured and often hairy larvæ of butterflies and moths *caterpillars*; the white and more compact larvæ of flies, many beetles, &c. *grubs* or *maggots*; and the depressed larvæ of many other insects *worms*. The two former terms I shall sometimes use in a similar sense, rejecting the last, which ought to be confined to true *vermes*; but I shall more commonly adopt Linné's term, and call insects in their first state, *larvæ*.

In this period of their life, during which they eat voraciously and cast their skin several times, insects live a shorter or longer period, some only a few days or weeks, others several months or years. They then cease eating; fix themselves in a secure place; their skin separates once more and discloses an oblong body, and they have now attained the *third* state of their existence.

From the swathed appearance of most insects in this state, in which they do not badly resemble in miniature a child trussed up like a mummy in swaddling cloathes, according to the barbarous fashion once prevalent here, and still retained in many parts of the continent; Linne has called it the *pupa* state, and an insect when under this form a *pupa*;—terms which will be here adopted in the same sense. In this state most insects eat no food; are incapable of locomotion; and if opened seem filled with a watery fluid, in which no distinct organs can be traced. Externally, however, the shape of the pupa of different tribes varies considerably, and different names have been applied to them.

Those of the beetle and bee tribes are covered with a membranous skin, inclosing in separate and distinct sheaths the external organs, as the antennæ, legs, and wings, which are consequently not closely applied to the body, but have their form for the most part clearly distinguishable. To these Aristotle originally gave the name of *nymphæ*[x], which was continued by Swammerdam and other authors prior to Linné, and has been adopted by many English writers on insects.

Butterflies, moths, and some of the two-winged tribe, are in their pupa state also inclosed in a similar membranous envelope; but their legs, antennæ, and wings,

[x] *Hist. Anim.* l. 5. c. 10.

are closely folded over the breast and sides; and the whole body inclosed in a common case or covering of a horny consistence, which admits a much less distinct view of the organs beneath it. As these pupæ are often tinged of a golden colour, they were called from this circumstance *chrysalides* by the Greeks, and *aureliæ* by the Romans, both which terms are in some measure become anglicized; and though not strictly applicable to ungilded pupæ, are now often given to those of all lepidopterous insects[y].

I have said that *most* insects eat no food in the pupa state. This qualification is necessary, because in the

[y] In explanation of the terms *Lepidoptera, Lepidopterous, Coleoptera,* &c. which will frequently occur in the following pages before we come regularly to definitions, it is necessary here to state that they have reference to the names given by entomologists to the different *orders* or tribes of insects, as under:

1 *Coleoptera* consisting of *Beetles.*
2 *Strepsiptera* ——— of the genera *Xenos* and *Stylops.*
3 *Dermaptera* ——— of the *Earwigs.*
4 *Orthoptera* ——— of *Cockroaches, Locusts, Grasshoppers, Crickets, Spectres, Mantes, &c.*
5 *Hemiptera* consisting of *Bugs, Cicadæ, Water-scorpions, Water-boatmen, Leaf-lice, Cochineal* Insects, &c.
6 *Trichoptera* consisting of the *flies* produced by the various species of *Case-worms, Phryganea,* L.
7 *Lepidoptera* consisting of *Butterflies, Hawkmoths,* and *Moths.*
8 *Neuroptera* ——— of *Dragon-flies, Ant-lions, Ephemeræ, &c.*
9 *Hymenoptera* ——— of *Bees, Wasps,* and other insects armed with a *sting* or *ovipositor,* and its *valves.*
10 *Diptera* consisting of *Flies, Gnats,* and other *two-winged* insects.
11 *Aphaniptera* ——— of the *Flea* genus.
12 *Aptera* ——— of *Mites, Lice,* &c.

N. B. The plates, which will be given in the course of this work, will give an example of each of these orders.

metamorphoses of insects, as in all her other operations, nature proceeds by measured steps, and a very considerable number (the tribe of locusts, cockroaches, bugs, spiders, &c.) not only greatly resemble the perfect insect in form but are equally capable with it of eating and moving. As these insects, however, cast their skins at stated periods, and undergo changes, though slight, in their external and internal conformation, they are regarded also as being subject to metamorphoses. These pupæ may be subdivided into two classes: first, those comprised, with some exceptions, under the Linnean aptera, which in almost every respect resemble the perfect insect, and were called by Linné *complete* pupæ; and secondly, those of the Linnean order *hemiptera*, which resemble the perfect insect, except in having only the rudiments of wings, and to which the name of *semi-complete* pupæ was applied by Linné, and that of semi-nymphs by some other authors. There is still a fifth kind of pupæ, which are not, as in other instances, excluded from the skin of the larva, but remain concealed under it, and were hence called by Linné *coarctate* pupæ. These, which are peculiar to flies and other dipterous genera, may be termed *cased-nymphs*.

When, therefore, we employ the term *pupa*, we may refer indifferently to the third state of any insect, the particular order being indicated by the context, or an explanatory epithet. The terms *chrysalis*, (dropping *aurelia*, which is superfluous), *nymph*, *semi-nymph*, and *cased-nymph*, on the other hand definitely pointing out the particular sort of pupa meant: just as in botany, the common term *pericarp* applies to all seed-vessels, the several kinds being designated by the names of capsule, silicle, &c.

The envelope of *cased-nymphs*, which is formed of the skin of the larva, considerably altered in form and texture, may be conveniently called the *puparium*: but to the artificial coverings of different kinds, whether of silk, wood, or earth, &c. which many insects of the other orders fabricate for themselves previously to assuming the pupa state, and which have been called by different writers, *pods*, *cods*, *husks*, and *beans*, I shall continue the more definite French term *cocon*, anglicized into *cocoon*.

After remaining a shorter or longer period, some species only a few hours, others months, others one or more years, in the pupa state, the inclosed insect, now become mature in all its parts, bursts the case which inclosed it, quits the pupa, and enters upon the fourth and last state.

We now see it (unless it be an apterous species) furnished with wings, capable of propagation, and often under a form altogether different from those which it has previously borne—a perfect beetle, butterfly, or other insect. This Linne termed the *imago* state, and the animal that had attained to it the *imago*; because having laid aside its *mask*, and cast off its *swaddling bands*, being no longer disguised or confined, or in any respect imperfect, it is now become a true representative or *image* of its species. This state is in general referred to when an insect is spoken of without the restricting terms larva or pupa.

Such being the singularity of the transformations of insects, you will not think the ancients were so wholly unprovided with a show of argument as we are accustomed to consider them, for their belief in the possibility of many of the marvellous metamorphoses which their poets recount. Utterly ignorant as they were of modern physiological discoveries, the conversion of a caterpillar into a butterfly, must have been a fact sufficient to put to a nonplus all the sceptical oppugners of such transformations. And, however we may smile in this enlightened age at the inference drawn not two centuries ago by Sir Theodore Mayerne, the editor of Mouffet's work on insects, "that if animals are transmuted so may metals[z]," it was not, in fact, with his limited knowledge on these subjects, so very preposterous. It is even possible that some of the wonderful tales of the ancients were grafted on the changes which they observed to take place in insects. The death and revivification of the phœnix, from the ashes of which, before attaining its perfect state, arose first a *worm* (σκωληξ), in many of its particulars resembles what occurs in the metamorphoses of insects. Nor is it very unlikely that the doctrine of the metempsychosis took its rise from the same source. What argument would be thought by those who maintained this doctrine more plausible in favour of the transmigration of souls, than the seeming revivification of the dead *chrysalis*? What, more probable, than that its apparent reassumption of life should be owing to its receiving for tenant the soul of some criminal doomed to animate

[z] Preface.

an insect of similar habits with those which had defiled his human tenement[a]?

At the present day, however, the transformations of insects have lost that excess of the marvellous, which might once have furnished arguments for the fictions of the ancients, and the dreams of Paracelsus. We call them metamorphoses and transformations, because these terms are in common use, and are more expressive of the sudden changes that ensue, than any new ones. But, strictly, they ought rather to be termed a series of developements. A caterpillar is not, in fact, a simple but a compound animal, containing within it the germ of the future butterfly, inclosed in what will be the case of the pupa, which is itself included in the three or more skins, one over the other, that will successively cover the larva. As this increases in size these parts expand, present themselves, and are in turn thrown off, until at length the perfect insect, which had been concealed in this succession of masks, is displayed in its genuine form. That this is the proper explanation of the phenomenon has been satisfactorily proved by Swammerdam, Malpighi, and other anatomists. The first-mentioned illustrious naturalist discovered, by accurate dissections, not only the skins of the larva and of the pupa incased in each other, but within them the very butterfly itself, with

[a] A priest who has drunk wine shall migrate into a moth or fly, feeding on ordure. He who steals the gold of a priest shall pass a thousand times into the bodies of spiders. If a man shall steal honey, he shall be born a great stinging gnat; if oil, an oil drinking beetle; if salt, a cicada; if a household utensil, an ichneumon fly. *Institutes of Menu*, 353.

its organs indeed in an almost fluid state, but still perfect in all its parts[b]. Of this fact you may convince yourself without Swammerdam's skill, by plunging into vinegar or spirit of wine a caterpillar about to assume the pupa state, and letting it remain there a few days for the purpose of giving consistency to its parts; or by boiling it in water for a few minutes. A very rough dissection will then enable you to detect the future butterfly; and you will find that the wings, rolled up into a sort of cord, are lodged between the first and second segment of the caterpillar; that the antennæ and trunk are coiled up in front of the head; and that the legs, however different their form, are actually sheathed in its legs. Malpighi discovered the eggs of the future moth. in the chrysalis of a silkworm only a few days old[c], and Reaumur those of *Bombyx dispar* even in the caterpillar, and that seven or eight days before its change into the pupa[d]. A caterpillar, then, may be regarded as a locomotive egg, having for its embryo the included butterfly, which after a certain period, assimilates to itself the animal substances by which it is surrounded; has its organs gradually developed; and at length breaks through the shell which incloses it.

This explanation strips the subject of every thing miraculous, yet by no means reduces it to a simple or uninteresting operation. Our reason is confounded at the reflection that a larva, at first not thicker than a thread, includes its own triple, or sometimes octuple,

[b] Hill's *Swamm.* ii. 24. t. 37. f. 2. 4.

[c] *De Bombyce*, 29.

[d] Reaum. i. 359.

teguments; the case of a chrysalis and a butterfly, all curiously folded in each other; with an apparatus of vessels for breathing and digesting, of nerves for sensation, and of muscles for moving; and that these various forms of existence will undergo their successive evolutions, by aid of a few leaves received into its stomach. And still less able are we to comprehend how this organ should at one time be capable of digesting leaves, at another only honey; how one while a silky fluid should be secreted, at another none; or how organs at one period essential to the existence of the insect, should at another be cast off, and the whole system which supported them vanish.

Nor does this explanation, though it precludes the idea of that resemblance, in every particular, which, at one time, was thought to obtain between the metamorphosis of insects, especially of the Lepidoptera order, and the resurrection of the body, do away that general analogy, which cannot fail to strike every one who at all considers the subject. Even Swammerdam, whose observations have proved that the analogy is not so complete as had been imagined, speaking of the metamorphosis of insects, uses these strong words. "This process is formed in so remarkable a manner in butterflies, that we see therein the resurrection painted before our eyes, and exemplified so as to be examined by our hands[c]." To see, indeed a caterpillar crawling upon the earth, sustained by the most ordinary kinds of food, which, when it has existed a few weeks or months under this humble form, its appointed work

[c] Hill's *Swamm.* i. 127 a.

being finished, passes into an intermediate state of seeming death, when it is wound up in a kind of shrowd and encased in a coffin, and is most commonly buried under the earth, (though sometimes its sepulchre is in the water, and at others in various substances in the air,) and after this creature and others of its tribe have remained their destined time in this deathlike state, to behold earth, air, and water, give up their several prisoners: to survey them, when, called by the warmth of the solar beam, they burst from their sepulchres, cast off their cerements, from this state of torpid inactivity, come forth, as a bride out of her chamber,—to survey them, I say arrayed in their nuptial glory, prepared to enjoy a new and more exalted condition of life, in which all their powers are developed, and they are arrived at the perfection of their nature; when no longer confined to the earth they can traverse the fields of air, their food is the nectar of flowers, and love begins his blissful reign;—who that witnesses this interesting scene can help seeing in it a lively representation of man in his threefold state of existence, and more especially of that happy day, when at the call of the great sun of righteousness, all that are in the graves shall come forth, the sea shall give up her dead, and death being swallowed up of life, the nations of the blessed shall live and love to the ages of eternity?

But although the analogy between the different states of insects and those of the body of man is only general, yet it is much more complete with respect to his soul. He first appears in this frail body—a child of the earth, a crawling worm, his soul being in a course of training and preparation for a more perfect and glorious existence. When it has finished this course it casts off this vile body, and goes into a hidden state of being in Hades, where it rests from its works, and is prepared for its final consummation. The time for this being arrived, it comes forth clothed with a glorious body, not like its former, though germinating from it, for though "it was sown an animal body, it shall be raised a spiritual body," endowed with augmented powers, faculties and privileges commensurate to its new and happy state. And here the parallel holds perfectly between the insect and the man. The butterfly, the representative of the soul, is prepared in the *larva* for its future state of glory; and if it be not destroyed by the ichneumons and other enemies to which it is exposed, symbolical of the vices that destroy the spiritual life of the soul, it will come to its state of repose in the *pupa*, which is its Hades; and at length, when it assumes the *imago*, break forth with new powers and beauty to its final glory and the reign of love. So that in this view of the subject well might the Italian poet exclaim:

> Non v' accorgete voi, che noi siam' vermi
> Nati a formar l' angelica farfalla[f]?

The Egyptian fable, as it is supposed to be, of Cupid and Psyche, seems built upon this foundation. "Psyche," says an ingenious and learned writer, "means in Greek the human soul; and it means also a

[f] Do you not perceive that we are caterpillars, born to form the angelic butterfly?

butterfly[g], of which apparently strange double sense, the undoubted reason is, that a butterfly was a very ancient symbol of the soul—from the prevalence of this symbol, and the consequent coincidence of the names, it happened that the Greek sculptors frequently represented Psyche as subject to Cupid in the shape of a butterfly; and that even when she appears in their works under the human form, we find her decorated with the light and filmy wings of that gay insect[h]."

The following beautiful little poem falls in so exactly with the subject I have been discussing, that I cannot resist the temptation I feel to copy it for you, especially as I am not aware that it has appeared any where but in a newspaper.

THE BUTTERFLY'S BIRTH-DAY,

BY THE

AUTHOR OF THE "BUTTERFLY'S BALL."

The shades of night were scarcely fled;
  The air was mild, the winds were still;
And slow the slanting sun-beams spread
  O'er wood and lawn, o'er heath and hill.

[g] It is worthy of remark that in the north and west of England, the moths that fly into candles are called *saules* (souls), perhaps from the old notion that the souls of the dead fly about at night in search of light. For the same reason probably the common people in Germany call them *ghosts* (geistchen).

[h] Nares's *Essays*, i. 101-2.

From fleecy clouds of pearly hue
   Had dropt a short but balmy shower,
That hung like gems of morning dew
   On every tree and every flower.

And from the Blackbird's mellow throat
   Was pour'd so loud and long a swell,
As echoed with responsive note
   From mountain side and shadowy dell.

When bursting forth to life and light,
   The offspring of enraptur'd May,
The BUTTERFLY, on pinions bright,
   Launch'd in full splendor on the day.

Unconscious of a mother's care,
   No infant wretchedness she knew;
But as she felt the vernal air,
   At once to full perfection grew.

Her slender form, ethereal light,
   Her velvet-textur'd wings enfold;
With all the rainbow's colours bright,
   And dropt with spots of burnish'd gold.

Trembling with joy awhile she stood,
   And felt the sun's enlivening ray;
Drank from the skies the vital flood,
   And wonder'd at her plumage gay!

And balanc'd oft her broider'd wings,
   Thro' fields of air prepar'd to sail:
Then on her vent'rous journey springs,
   And floats along the rising gale.

Go, child of pleasure, range the fields,
   Taste all the joys that spring can give,
Partake what bounteous summer yields,
   And live, whilst yet 'tis thine to live.

Go sip the roses fragrant dew,
   The lily's honied cup explore,
From flower to flower the search renew,
   And rifle all the woodbine's store:

And let me trace thy vagrant flight,
   Thy moments too of short repose,
And mark thee then with fresh delight
   Thy golden pinions ope and close.

But hark! whilst thus I musing stand,
   Pours on the gale an airy note;
And breathing from a viewless band,
   Soft silvery tones around me float!

—They cease—but still a voice I hear,
   A whisper'd voice of hope and joy,
" Thy hour of rest approaches near,
   " Prepare thee, mortal!—thou must die!

" Yet start not!—on thy closing eyes
   " Another day shall still unfold,
" A sun of milder radiance rise,
   " A happier age of joys untold.

" Shall the poor worm that shocks thy sight,
   " The humblest form in nature's train,
" Thus rise in new-born lustre bright,
   " And yet the emblem teach in vain?

"Ah! where were once her golden eyes,
"Her glittering wings of purple pride?
"Conceal'd beneath a rude disguise,
"A shapeless mass to earth allied.

"Like thee the hapless reptile liv'd,
"Like thee he toil'd, like thee he spun,
"Like thine his closing hour arriv'd,
"His labour ceas'd, his web was done.

"And shalt thou, number'd with the dead,
"No happier state of being know?
"And shall no future morrow shed
"On thee a beam of brighter glow?

"Is this the bound of power divine,
"To animate an insect frame?
"Or shall not he who moulded thine
"Wake at his will the vital flame?

"Go, mortal! in thy reptile state,
"Enough to know to thee is given;
"Go, and the joyful truth relate;
"Frail child of earth! high heir of heaven!"

A question here naturally presents itself—Why are insects subject to these changes? For what end is it that, instead of preserving like other animals[1] the same

[1] A few vertebrate animals, viz. frogs, toads, and newts, undergo metamorphoses in some respects analogous to those of insects; their first form as tadpoles being very different from that which they afterwards assume. These reptiles too, as well as snakes, cast their skin by an operation somewhat similar to that in *larvæ*. There is nothing, however, in their metamorphoses at all resembling the *pupa* state in insects.

general form from infancy to old age, they appear at one period under a shape so different from that which they finally assume; and why should they pass through an intermediate state of torpidity so extraordinary? I can only answer that such is the will of the Creator, who doubtless had the wisest ends in view, although we are incompetent satisfactorily to discover them. Yet one reason for this conformation may be hazarded. A very important part assigned to insects in the economy of nature, as I shall hereafter show, is that of speedily removing superabundant and decaying animal and vegetable matter. For such agents an insatiable voracity is an indispensable qualification. and not less so unusual powers of multiplication. But these faculties are in a great degree incompatible. An insect occupied in the work of reproduction could not continue its voracious feeding. Its life, therefore, after leaving the egg, is divided into three stages. In the first, as *larva*, it is in a state of sterility; its sole object is the satisfying its insatiable hunger; and, for digesting the masses of food which it consumes, its intestines are almost all stomach. This is usually by much the longest period of its existence. Having now laid up a store of materials for the developement of the future perfect insect, it becomes a *pupa*; and during this inactive period the important process slowly proceeds, uninterrupted by the calls of appetite. At length the perfect insect is disclosed. It now often requires no food at all; and scarcely ever more than a very small quantity; for the reception of which its stomach has been contracted, in some instances, to a tenth of its former bulk. Its almost sole object is now the multiplication of its kind, from which it is diverted by no other propensity; and this important duty being performed, the end of its existence has been answered, and it expires.

It must be confessed that some objections might be thrown out against this hypothesis, yet I think none that would not admit of a plausible answer. To these it is foreign to my purpose now to attend, and I shall conclude this letter by pointing out to you the variety of new relations which this arrangement introduces into nature. One individual unites in itself, in fact, three species, whose modes of existence are often as different as those of the most distantly related animals of other tribes. The same insect often lives successively in three or four worlds. It is an inhabitant of the water during one period; of the earth during another; and of the air during a third: and fitted for its various abodes by new organs and instruments, and a new form in each. Think (to use an illustration of Bonnet) but of the cocoon of the silk-worm! How many hands, how many machines does not this little ball put into motion! Of what riches should we not have been deprived, if the moth of the silk-worm had been born a moth, without having been previously a caterpillar! The domestic economy of a large portion of mankind would have been formed on a plan altogether different from that which now prevails.

I am, &c.

LETTER IV.

INJURIES CAUSED BY INSECTS.

DIRECT INJURIES.

In the letter which I devoted to the defence of entomology, I gave you reason to expect, more effectually to obviate the objection drawn from the supposed insignificance of insects, that I should enter largely into the question of their importance to us both as instruments of good and evil. This I shall now attempt; and as I wish to leave upon your mind a pleasant impression, with respect to my favourites, I shall begin with the last of these subjects—the *injury* which they do to us.

The Almighty ordains various instruments for the punishment of offending nations: sometimes he breaks them to pieces, as at the present awful crisis[1], with the iron rod of war; at others the elements are let loose against them; earthquakes and floods of fire, at his word, bring sudden destruction upon them; seasons unfriendly to vegetation threaten them with famine;

[1] This was written during the late war.

the blight and mildew realize these threats; and often, the more to manifest and glorify his power, he employs means, at first sight, apparently the most insignificant and inadequate to effect their ruin; the numerous tribes of *insects* are his armies[k], marshalled by him, and by his irresistible command impelled to the work of destruction: where he directs them they lay waste the earth, and famine and the pestilence often follow in their train.

The generality of mankind overlook or disregard these powerful, because minute, dispensers of punishment; seldom considering in how many ways their welfare is affected by them: but the fact is certain, that should it please God to give them a general commission against us, and should he excite them to attack, at the same time, our bodies, our clothing, our houses, our cattle, and the produce of our fields and gardens, we should soon be reduced, in every possible respect, to a state of extreme wretchedness; the prey of the most filthy and disgusting diseases, divested of a covering, unsheltered, except by caves and dungeons, from the inclemency of the seasons, exposed to all the extremities of want and famine, and in the end, as Sir Joseph Banks, speaking on this subject, has well observed[l], driven with all the larger animals from the face of the earth. You may smile, perhaps, and think this a high-coloured picture, but you will recollect—I am not stating the mischiefs that insects commonly do, but what they would do according to all probability, if certain counterchecks restraining them within due li-

[k] Joel ii. 25.

[l] *On the Blight in Corn*, p. 9.

mits had not been put in action; and which they actually do, as you will see, in particular cases, when those counterchecks are diminished or removed.

Insects may be said, without hyperbole, to have established a kind of universal empire over the earth and its inhabitants. This is principally conspicuous in the injuries which they occasion, for nothing in nature that possesses or has possessed animal or vegetable life, is safe from their inroads. Neither the cunning of the fox, nor the swiftness of the horse or deer, nor the strength of the buffalo, nor the ferocity of the lion or tiger, nor the armour of the rhinoceros, nor the giant bulk or sagacity of the elephant, nor even the authority of imperial man, who boasts himself to be the lord of all, can secure them from becoming a prey to these despised beings. The air affords no protection to the birds, nor the water to the fish; insects pursue them all to their most secret conclaves and strongest citadels, and compel them to submit to their sway. Flora's empire is still more exposed to their cruel domination and ravages; and there is scarcely one of her innumerable subjects, from the oak, the glory of the forest, to the most minute lichen that grows upon its trunk, that is not destined to be the food of these next to nonentities in our estimation. And when life departs from man, or the inferior animals or vegetables, they become universally, sooner or later, the inheritance of insects.

I shall principally bespeak your attention to the injuries in question as they affect ourselves. These may be divided into direct and indirect. By *direct* injuries I mean every species of attack upon our own persons, and by *indirect*, such as are made upon our property. To the former of these I shall confine myself in the present letter.

Insects, as to their *direct* attacks upon us, may be arranged in three principal classes. Those, namely, which seek to make us their food; those whose object is to prevent or revenge an injury which they either fear, or have received from us; and those which indeed offer us no violence, but yet incommode us extremely in other ways.

I hope I shall not too much offend your delicacy if I begin the first class of our insect assailants with a very disgusting genus, which Providence seems to have created to punish inattention to personal cleanliness. But though this pest of man must not be wholly passed over, yet, since it is unfortunately too well known, it will not be at all necessary for me to enlarge upon its history. I shall only mention one fact which shows the astonishingly rapid increase of these animals, where they have once gotten possession. It is a vulgar notion, that a louse in twenty-four hours may see two generations; but this is rather overshooting the mark. Leeuwenhoek, whose love for science overcame the nausea that such creatures are apt to excite, proves that their nits or eggs are not hatched till the eighth day after they are laid, and that they do not themselves commence laying before they are a month old. He ascertained, however, that a single female louse may, in eight weeks, witness the birth of five thousand descendants[m]. You remember how wolves were extirpated

[m] Leeuw. *Epist.* 98. 1696.

from this country, but perhaps never suspected any monarch of imposing a tribute of *lice* upon his subjects. Yet we are gravely told that in Mexico and Peru such a *poll*-tax was exacted, and that bags full of these treasures were found in the palace of Montezuma[n]!!! Were our own taxes paid in such coin what little grumbling would there be!

Two other species of this genus, besides the common louse, are, in this country, parasites upon the human body——But already I seem to hear you exclaim, "Why dwell so long on creatures so odious and nauseating, whose injuries are confined to the *profanum vulgus*? Leave them therefore to the canaille—they are nothing to us." Not so fast, my friend—recollect what historians and other writers have recorded concerning the *Phthiriasis* or pedicular disease, and you must own that, for the quelling of human pride, and to pull down the high conceits of mortal man, this most loathsome of all maladies, or one equally disgusting, has been the inheritance of the rich, the wise, the noble, and the mighty; and in the list of those that have fallen victims to it, you will find poets, philosophers, prelates, princes, kings, and emperors. It seems more particularly to have been a judgement of God upon oppression and tyranny, whether civil or religious. Thus the inhuman Pheretima mentioned by Herodotus, Antiochus Epiphanes, the Dictator Sylla, the two Herods, the Emperor Maximian, and, not to mention more, the great persecutor of the Protestants, Philip the Second, were carried off by it.

[n] Bingley, *Anim. Biogr.* first edition, iii. 437. St. Pierre's *Studies*, &c. i. 312.

I say by this malady, *or one equally disgusting*, because it is not by any means certain, though some learned men have so supposed, that all these instances, and others of a similar nature, standing also upon record, are to be referred to the same specific cause; since there is very sufficient reason for thinking that at least *three* different descriptions of insects are concerned in the various cases that have been handed down to us under the common name of *Phthiriasis*. As the subject of maladies connected with insects, or produced by them, is both curious and interesting, although no writer, that I am aware of, has given it full consideration, and at the same time falls in with my general design, I hope you will not regard me as guilty of presumption, and of intruding into the province of medical men, if I enter rather largely into it, and state to you the reasons that have induced me to embrace the above hypothesis, leaving you full liberty to reject it if you do not find it consonant to reason and fact. The three kinds of insects to which I allude, as concerned in cases that have been deemed Phthiriasis, are *Pediculi*, *Acari*, and *Larvæ* in general.

As far as the habits of the genus *Pediculus*, whether inhabiting man or the inferior animals, are at present known, it does not appear, from any well ascertained fact, that the species belonging to it are ever *subcutaneous*. For this observation, as far as it relates to man, I can produce the highest medical authority. "The louse feeds on the surface of the skin," says the learned Dr. Mead in his *Medica Sacra*; and Dr. Willan, in his palmary work on *Cutaneous Diseases*, remarks with respect to the body-louse, "that the nits, or eggs, are deposited on the small hairs of the skin," and that "the animals are found on the skin, or on the linen, and not under the cuticle, as some authors have represented." And he further observes, that "many marvellous stories are related by Forestus, Schenkius and others respecting lice bred under the skin, and discharged in swarms from abscesses, strumous ulcers, and vesications. The mode in which Pediculi are generated being now so well ascertained, no credit can be given to these accounts." Thus far this great man, who however supposes (in which opinion Dr. Bateman concurs with him) that the authors to whom he alludes had mistaken for lice some other species of insects, which are not unfrequently found in putrefactive sores.

If these observations be allowed their due weight, it will follow, that a disease produced by animals residing under the cuticle cannot be a true Phthiriasis, and therefore the death of the poet Alcman, and of Pherecydes Syrius the philosopher, mentioned by Aristotle, must have been occasioned by some other kind of insect. For, speaking of the lice to which he attributes these catastrophes, he says that "they are produced in the flesh in small pustule-like tumours, which have no pus, and from which, when punctured, they issue[o]." For the same reason, the disorder which Dr. Heberden has described in his Commentaries, from the communications of Sir E. Wilmot, under the name of *Morbus Pedicularis*, must also be a different disease, since with Aristotle, he likewise represents the insects as inhabiting tumours, from which they may be extracted

[o] *Hist. Animal.* l. 5. c. 31.

when opened by a needle. He says, indeed, that in every respect they resemble the common lice, except in being whiter; but medical men, who were not at the same time entomologists, might easily mistake an Acarus for a Pediculus[p].

Dr. Willan, in one case of *Prurigo senilis*, observed a number of small insects on the patient's skin and linen. They were quick in their motion, and so minute that it required some attention to discover them. He took them at first for small Pediculi; but under a lens they appeared to him rather to be a nondescript species of Pulex[q]; yet the figure he gives has not the slightest likeness to the latter genus, while it bears a striking resemblance to the former. It is not clear whether his draughtsman meant to represent the insect with six or with eight legs: if it had only six, it was probably a Pediculus; but if it had eight, it would form a new genus between the *Acaridæ* and the hexapod *Aptera*. Dr. Bateman, in reply to some queries put to him, at my request, by our common and lamented friend Dr. Reeve, relates that he understood from Dr. Willan, in conversation, that the insect in question jumped in its motion. This circumstance he regards as conclusive against its being a Pediculus; but such a consequence does not necessarily follow, since it not seldom happens that insects of the same genus either have or have not this faculty; for instance, *Cyphon hemisphæricus Acarus scabiei*, &c.

Dr. Willan has quoted with approbation two cases

[p] From the terms employed by Aristotle and Dr. Mead in their Account of these cases, it does not appear that the animal they meant could be maggots, but something bearing a more general resemblance to lice.

[q] *On Cutaneous Diseases*, 87, 88; and *t.* 7. *f.* 4.

from Amatus Lusitanus, which he seems to think correctly described as Phthiriasis. In one of them, however, which terminated fatally, the circumstances seem rather hyperbolically stated—I mean, where it is said that two black servants had no other employment than carrying baskets full of these insects to the sea!! Perhaps you will think I draw largely upon your credulity, if I call upon you to believe this; I shall therefore leave you to act as you please. Thus much for pure Phthiriasis, which term ought to be confined to maladies produced by *lice*.—I shall only further observe, that as many species as exist of these, which are the causes of disease, so many kinds of Phthiriasis will there be.

Acari, or mites, are the next insect sources of disease in the human species, and that not of one, but probably of many kinds both local and general. They are distinguished from Pediculi not only by their form, but also often by their situation, since they frequently establish themselves under the cuticle. With respect to local disorders, Dr. Adams conjectures that Acari may be the cause of certain cases of *Ophthalmia*. Sir J. Banks, in a letter to that gentleman, relates that some seamen belonging to the Endeavour brig, being tormented with a severe itching round the extremities of the eyelids, one of them was cured by an Otaheitan woman, who with two small splinters of bamboo, extracted from between the *ciliæ* abundance of very minute lice, which were scarcely visible without a lens, though their motion, when laid on the thumb, was distinctly perceived. These insects were probably synonymous with the *Ciron des paupieres* of Sauvages[r].—Le Jeune, a French physician

[r] *On Morbid Poisons*, 306, 307.

quoted in Mouffet, describes a case, in which what seems a different species, since he calls them rather large, infested the white of the eye, exciting an intolerable itching[s].—Dr. Mead, from the *German Ephemerides*, gives an account of a woman suckling her child, from whose breast proceeded very minute vermicles[t]. These were probably Acari, and perhaps that species, which, from its feeding upon milk, Linné denominates *A. Lactis*. The great author last mentioned describes an insect, a native of America, under the name of *Pediculus ricinoides*, which, upon the authority of Rolander, he informs us gets into the feet of people as they walk, sucks their blood, oviposits[u] in them, and so occasions very dangerous ulcers. It would be an Acarus, he observes, but it has only six legs. Now Herman affirms, that some species of *Trombidium* (a genus separated by Fabricius from *Acarus*) have in no state more than six legs[v]. Others of the tribe of *Acaridæ*, and the insect in question amongst the rest, may be similarly circumstanced; or those that Rolander examined might have been larvæ, which in this tribe are usually hexapods.

Linné appears to have been of opinion that many contagious diseases are caused by Acari[w]. How far he

[s] Mouffet, 267. [t] *Medica Sacra*, 104, 105.

[u] It is to be hoped this new word may be admitted, as the *laying of eggs* cannot otherwise be expressed without a periphrasis. For the same reason its substantive *Oviposition* will be employed.

[v] *Mem. apterologique*, 19.

[w] Insecta ejusmodi minutissima, forte *Acaros* diversæ speciei causas esse diversorum morborum contagiosorum, ab analogia et experientia hactenus acquisita, facili credimus negotio. *Amœn. Ac.* v. 94.

was justified in this opinion I shall not here inquire; facts alone can decide the question, and observations made by men acquainted with entomology as well as the science of diseases. Considerable deference and attention, however, are certainly due to the sentiments of so great a naturalist, in whom these necessary qualifications were united in no common degree. With respect to the dysentery and the itch, he affirms that this had been manifested to his eyes. You will wish probably to know the arguments that may be adduced in confirmation of this opinion; I will therefore endeavour to satisfy you as well as I am able. The following history given by Linné seems to prove the dysentery connected with Acari.

Rolander, a student in entomology, while he resided in the house of the illustrious Swede, was attacked by the disease in question, which quickly gave way to the usual remedies. Eight days after it returned again, and was as before soon removed. A third time, at the end of the same period, he was seized with it. All the while he had been living like the rest of the family, who had nevertheless escaped. This, of course, occasioned no little inquiry into the cause of what had happened. Linné, aware that Bartholinus had attributed the dysentery to *insects*, which he professed to have seen, recommended it to his pupil to examine his feces. Rolander, following this advice, discovered in them innumerable animalcules, which upon a close examination proved to be Acari. It was next a question how he alone came to be singled out by them; and thus he accounts for it. It was his habit not to drink at his meals; but in the night, growing thirsty, he often sipped some liquid out of a vessel made of juniper wood. Inspecting this very narrowly, he observed, in the chinks between the ribs, a white line, which, when viewed under a lens, he found to consist of innumerable Acari, precisely the same with those that he had voided. Various experiments were tried with them, and a preparation of rhubarb was found to destroy them most effectually. He afterwards discovered them in vessels containing acids, and often under the bung of casks[x]. In the instance here recorded the dysentery, or diarrhœa, was evidently produced by these Acari; but it would be going too far, I apprehend, to assert that they are invariably the cause of that disease.

That *Scabies*, or the itch, is occasioned by an Acarus is not a doctrine peculiar to the moderns. Mouffet mentions Abinzoar, called also Avenzoar, a celebrated Hispano-Arabian physician of Seville, who flourished in the twelfth century, as the most ancient author that notices it. He calls these Acari little lice that creep under the skin of the hands, legs, and feet, exciting pustules full of fluid[y]. Joubert, quoted by the same author, describes them under the name of *Sirones* or mites, as always being concealed beneath the epidermis, under which they creep like moles, gnawing it, and causing a most troublesome itching. It appears that Mouffet, or whoever was the author of that part of the *Theatrum Insectorum*, was himself also well acquainted with these animals, since he remarks that their habitation is not in the pustule but near it. A remark afterwards confirmed by Linné[z], and more recently by

[x] *Amœn. Ac.* v. 94-98. [y] Mouffet, 266.

[z] Acarus sub ipsa pustula minime quærendus est, sed longius recessit, sequendo rugam cuticulæ observatur. *Amœn. Ac.* v. 95. not. * *.

Dr. Adams[a]. In common with the former of these authors, Mouffet further notices the effect of warmth upon them in exciting motion[b]. Our intelligent countryman also observes that they cannot be Pediculi, since they live under the cuticle, which lice never do[c]. In the epistle dedicatory, the editor speaks also of these Acari, as living in burrows which they have excavated in the skin near a lake of water; from which if they be extracted with a needle and put upon the nail, they show in the sun their red head and the feet with which they walk[d]. And to close my *veteran* authorities, Junius thus explains the word Acarus, as I find him quoted in Gouldman's useful Dictionary, "A small worm, which eats under the skin, and makes burrows in itching hands[e]."

In more modern times, microscopical figures have been added to descriptions of the insect. Bonomo first furnished this valuable species of elucidation. His figures, however, which are copied by Baker in his

[a] *Observations, &c.* 296.

[b] Extractus aeu et super ungue positus, movet se si solis etiam calore adjuvetur. *ubi supr.* Ungui impositus vix movetur: si vero oris calido halitu affletur, agilis in ungue cursitat. *Fn. Suec.* 1975.

[c] Neque Syrones isti sunt de pediculorum genere, ut Joannes Langius ex Aristotele videtur asserere: nam illi extra cutem vivunt, hi vero non. *ubi supr.*

[d] Imo ipsi *Acari* præ exiguitate indivisibiles, ex cuniculis prope aquæ lacum quos foderunt in cute, acu extracti et ungue impositi, caput rubrum, et pedes quibus gradiuntur ad solem produnt. p. vi.

[e] Teredo sive exiguus vermiculus, qui subter cutim erodit agitque cuniculos in pruriginosis manibus. Gouldman tells us these *Acari* were also called *Hand-worms*. Another English name is given in Mouffet, viz. *Wheale-worms*.

work on the microscope, are far from accurate[f]. Those of De Geer and Dr. Adams are much more satisfactory, and mutually confirm each other[g]. From them it is evident that the same insect inhabits the scabies of Sweden and Madeira. Dr. Bateman, in the letter before alluded to, informs his correspondent, that he had seen that from Madeira, and gives it as his opinion, that there cannot be a doubt of the existence of an *Acarus Scabiei*; an opinion which he repeats in his late work on *Cutaneous Diseases*. From all this we may regard the point as so far settled, that such an animal exists at least as an occasional concomitant of scabies.

This fact being ascertained, a more complex inquiry remains, which branches out into two distinct questions. Is scabies always produced by these insects? Or, if this be not the case, Is the *animate* scabies a distinct disease from the *inanimate*?

It is very remarkable that Linné, a physician as well as a naturalist; and De Geer, one of the most accurate observers that ever existed; should both assign the insect in question as the undoubted cause of the *common* scabies of their country: the one applying to the disease he was speaking of the epithet of *communissima*, and observing the fact to be notorious, (*cuique liquet*,) and the other designating it by its well known French name "*La Gale*[h]." And is it not equally remarkable

[f] *Osservazioni intorno à pellicelli del corpo umano fatte dal Dottor* Gio Cosimo Bonomo, &c. *f.* 1-3. Baker *On Microsc.* i. *t.* 13. *f.* 2.

[g] De Geer, vii. *t.* 5. *f.* 12-14.

[h] I am informed by my learned friend Alexander MacLeay, Esq. Secretary to the Linnean Society, that, in the north of Scotland, the insect of the itch is well known, and easily discovered and extracted.

that such men as John Hunter, Dr. Heberden, Dr. Bateman, Dr. Adams, and Mr. Baker should never, in this country, have been able to meet with it? Did it indeed exist in our common scabies, it seems impossible that it could have escaped the observation of the two last of these gentlemen; Dr. Adams being so well qualified to detect it from his observations in Madeira, and Mr. Baker from his expertness in microscopical researches. Dr. Bateman, in the letter above quoted, says, "I have hunted it with a good magnifier, in many cases of itch, both in and near the pustules, and in the red streaks or furrows, but always without success." In his work on *Cutaneous Diseases* he tells us, however, that he has seen it, in one instance, when it had been taken from the diseased surface by another practitioner. And though Dr. Willan in his book speaks of the Acarus as the concomitant of this disease, yet his learned friend just mentioned observes, that he admitted that the insect was not to be found in ordinary cases, and indeed never seemed to have made up his mind upon the subject. When I was at Norwich last year (1812) Dr. Reeve very kindly accompanied me to the House of Industry there, to examine a patient whose body was very full of the pustules of this disorder; but though we used a good magnifier, we could discover nothing like an insect. I must observe, however, that our examination was made in December, in severe weather, when the cold might, perhaps, render the animal torpid, and less easy to be discovered.

From the above facts it seems fair to infer that this animal is not invariably the cause of scabies, but that there are cases with which it has no connection. Now, from this inference, would not another also follow, that the disease produced by the insect is specifically distinct from that in which it cannot be found? Sauvages and Dr. Adams are both of this opinion[i], the former assigning to it the trivial name of *vermicularis*; and the latter proving, by very satisfactory arguments, that it is different from the other. If they were both *animate* diseases, but derived from two distinct species of animals, (for it seems not impossible that even our common itch may be caused by an Acarus more minute than the other, and so more difficult to find,) they would properly be considered as distinct species; much more, therefore, if one be *animate* and the other *inanimate*. Nay this, I should think, would lead to a doubt whether even their *genus* were the same. I shall dismiss this part of my subject with the mention of a discovery of Dr. Adams, which seems to have escaped both Linné and De Geer—that the *Acarus Scabiei* is endowed with the faculty of leaping; (in this respect resembling the insect found by Willan in *Prurigo senilis* mentioned above,) for which purpose its four posterior thighs are incrassated[j].

But besides these *Acarine* diseases, there seems to be one (unless with Linné we regard the plague as of this class[k]) more fearful and fatal than them all. You will, perhaps, conjecture I am speaking of that de-

[i] This opinion Dr. Bateman thinks probably the true one. *Cutan. Dis.* 197.

[j] Probably this Acarus in the modern system would form a distinct genus. Latreille places it in his *Sarcoptes* with the *Ac. passerinus*, L. Latr. *Gen.* i. 152. 2.

[k] *Amœn. Ac.* ubi supr. 101.

scribed by Aristotle and Sir E. Wilmot as the Phthiriasis, and your conjecture will be right. But some think, and those men of merited celebrity, that *Acari* have nothing to do in these and similar cases, for that *maggots* were the parasites mistaken for lice. This, from the passage above quoted, appears to have been Dr. Willan's opinion; it was also Professor Murray's, to which, in the letter so often referred to, Dr. Bateman subscribes, adding as a reason for excluding Acari from being concerned, that "they are too minute, and never have been seen in such numbers as to be mistaken for lice." But both Acari and Pediculi vary in size, some of the former being larger than some of the latter. And allowing them to be ever so minute, yet when they issue in swarms, as mites from a cheese, they would be very visible, were it only from their motion. Besides, as they are furnished with legs, their motions resemble those of lice infinitely more than do the contortions of maggots. So that an Acarus would be deemed a louse much sooner by an unentomological observer than would a maggot. Whether Acari have ever been seen in such numbers as to be mistaken for lice, is the point in question; and therefore, by itself, cannot be admitted for a valid argument. Though *Acarus Scabiei* does not appear to swarm in ordinary cases, yet this is certainly no reason why other species may not do so. Where it has once made a settlement, how incredibly, and in how short a space of time, does the *Siro* or cheese-mite multiply! *Acarus destructor*, and many other species, are equally rapid in their increase.

I shall now produce two instances where Acari were evidently concerned. Dr. Mead, from the *German Ephemerides*, relates the miserable case of a French nobleman, from whose eyes, nostrils, mouth, and urinary passage animalcules of a red colour, and excessively minute, broke forth day and night, attended by the most horrible and excruciating pains, and at length occasioning his death. The account further says, that they were produced from his corrupted blood. This was probably a fancy originating in their red colour: but the whole history, whether we consider the size and colour of the animals, or the places from which they issue, is inapplicable to *larvæ* or maggots, and agrees very well with *Acari*, some of which, particularly *A. autumnalis*, are of a bright red colour. The other case, and a very similar one, is that recorded by Mouffet of Lady Penruddock; concerning whom he expressly tells us, that Acari swarmed in every part of her body—her head, eyes, nose, lips, gums, the soles of her feet, &c., tormenting her day and night, till, in spite of every remedy, all the flesh of her body being consumed, she was at length relieved by death from this terrible state of suffering. Mouffet attributes her disease to the *Acarus Scabiei*; but from the symptoms and fatal result it seems to have been a different and much more terrific animal. He supposes, in this instance, the insect to have been generated by drinking goat's milk too copiously. This, if correct, would lead to a conjecture that it might have been the *A. lactis*, L.

These cases I hope will satisfy you that Acari, as well as Pediculi, are the cause of diseases in the human frame. This, indeed, as has been before observed, is allowed on all hands with respect to that of the itch; and it is, certainly, not more improbable that man should be exposed to the attack of several species of this genus, than that three or four kinds of Pediculus should infest him. If you are convinced by what I have written, you will concur with me in thinking that the one are as much entitled to give their name to the disease which they produce as the other; and the term *Acariasis*, by which, with due deference to medical men, I propose to distinguish generically all acarine diseases, will not be refused its place amongst your *Genera Morborum*.

I shall now proceed to the remaining class of diseases mistaken for Phthiriasis; those, namely, which are produced by *larvæ*. There are two terms employed by ancient authors, *Eulæ* (Ευλαι) and *Scolex* (Σκωληξ), which seem properly to denote larvæ; but there is often such a want of precision in the language of writers unacquainted with Natural History, that it is very difficult to make out what objects they mean; and expressions which, strictly taken, should be understood of larvæ, may probably sometimes have been used to denote the cause of either the pedicular or acarine disease. *Eulæ*, which term, though given by Hesychius as synonymous with *Scolex*, is by Plutarch used as of different import[l], seems properly to mean those larvæ which are generated in dead carcases, at least so Homer has more than once applied it[m]: it is therefore a word of a much more restricted sense than *Scolex*, which probably belongs to the larvæ of every

[l] *In Artaxerx.*

[m] *Il.* χ. l. 599. ω. l. 414.

order of insects; at least so Aristotle employs it, when he says that all insects produce a *Scolex*, or are larviparous[n]. Yet when Homer compares Harpalion stretched dead upon the ground to a *Scolex*[o], it should seem as if he used the word for an earth-worm, which Aristotle commonly calls by a figurative periphrasis, "Entrails of the earth[p]." In the Holy Scriptures this word is used to signify larvæ which prey upon and are the torment of living bodies[q]. It may on this account, perhaps, be regarded as generally meaning such larvæ to whatever order or genus they belong.

Dr. Mead, therefore, is most probably right when he considers the disease stated by the ancients to be caused by *Eulæ* or *Scoleches*, commonly translated worms, as distinct from Phthiriasis; and if so, the inhuman Pheretima, who swarmed with *Eulæ*, and Herod Agrippa, who was eaten of *Scoleches*[r], were probably neither of them destroyed either by Pediculi or Acari, but by larvæ or maggots. And when Galen prescribed a remedy for ulcers inhabited by *Scoleches*, observing that animals similar to those generated by putrid substances are often found in abscesses, he probably meant the same thing. The proper appellation of this genus of diseases would be *Scolechiasis*.

This dissertation may perhaps appear to you rather prolix and tedious: yet to settle the meaning of terms is of the first importance. To inquire what ancient writers intended by the words which they employ, and

[n] Τα δε εντομα παντα σκωληκοτοκει. *De Generat. Animal.* l. 2. c. 1.

[o] *Il. υ.* l. 654-5.

[p] Γης εντερα. *De Animal. incessu*, c. 9. *De Generat. Animal.* l. 3. c. 11.

[q] Mark ix. 44. 46. 48.

[r] Σκωληκοβρωτος. Acts xii. 23.

whether such as have been usually regarded as synonymous are really so, may often furnish us with a clue to some useful or interesting truth; and not seldom enable us to rescue their reputation from much of the censure which has been inconsiderately cast upon it. Because they did not know every thing, or so much as we do, we are too apt to think that they knew nothing. That they fell into very considerable errors, especially in subjects connected with Natural History, cannot be denied; but then it ought to be considered that they possessed scarcely any of those advantages by which we are enabled to penetrate into nature's secrets. The want of the microscope alone was an effectual bar to their progress in this branch of science. Yet, in some instances, when they took a general view of a subject, they appear to have had very correct ideas. This observation particularly applies to the philosopher of Stagyra, whose mighty mind and lyncean eye, in spite of those mists of prejudice and fable that enveloped the age in which he lived, enabled him in part to pierce through the gloom, and comprehend and behold the fair outline that gives symmetry, grace and beauty to the whole of nature's form, though he mistook, or was not able to trace out, her less prominent features and minor lineaments.

It is now time to return from this long digression, which however is closely connected with the subject of this letter, to the point from which I deviated. Taking my leave of the disgusting animals which gave rise to it, I proceed to call your attention to another of our pygmy tormentors, which, in the opinion of some, seems to have been regarded as an agreeable rather than a repulsive object. "Dear Miss," said a lively old Lady to a friend of mine, (who had the misfortune to be confined to her bed by a broken limb, and was complaining that the fleas tormented her,) "don't you like *fleas?* Well, I think they are the prettiest little merry things in the world.—I never saw a dull flea in all my life." The celebrated Willughby kept a favourite flea, which used at stated times to be admitted to suck the palm of his hand; and enjoyed this privilege for three months, when the cold killed it. And Dr. Townson, from the encomium which he bestows upon these vigilant little vaulters, as supplying the place of an alarum and driving us from the bed of sloth, should seem to have regarded them with feelings much more complacent than those of Dr. Clarke and his friends, when their hopes of passing "one night free from the attacks of vermin" were changed into despair by the information of the laughing Sheik, that "the king of the fleas held his court at Tiberias." If you unhappily view them in this unfavourable light, and have found ordinary methods unavailing for ridding yourself of these unbidden guests; I can furnish you with a *probatum est* recipe, which the first-mentioned traveller tells us the Hungarian shepherds (who seem to have been stupidly insensible to their value as alarums) find completely effectual to put to flight these insects and their neighbours the lice. This is not, as you may be tempted to think, by a remarkable attention to cleanliness.—Quite the reverse.—They grease their linen with hog's lard, and thus render themselves disgusting even to fleas!!! If this does not satisfy, I have another recipe in store for you. You may shoot at them with a cannon, as report says did Christina Queen of Sweden, whose piece of artillery, of Liliputian calibre, which was employed in this warfare, is still exhibited in the arsenal of Stockholm[s].

To this genus belongs an insect, abundant in the West Indies and South America, the attacks of which are infinitely more serious than those of the common flea. You will readily conjecture that I am speaking of the celebrated *Chigoe* or *Jiggers*, called also *Nigua*, *Tungua* and *Pique*[t], (*Pulex penetrans*, L.,) one of the direst personal pests with which the sins of man have been visited. All disputes concerning the genus of this insect would have been settled long before Swartz's time (who first gave a satisfactory description and figure of it, proving it to be a *Pulex*, as has been observed above[u]) had success attended the patriotic attempt of the Capuchin friar recorded by Walton in his *History of St. Domingo*, who brought away with him from that island a colony of these animals, which he permitted to establish themselves in one of his feet; but unfortunately for himself, and for science, the foot intrusted with the precious deposit mortified, was obliged to be amputated, and with all its inhabitants committed to the waves. According to Ulloa, and his opinion is confirmed by Jussieu, there are two South

Linn. *Lach. Lapp.* ii. 32, note *.

[t] Latreille supposes the *Pique* and *Nigua* to be synonymous with *Acarus Americanus*, L. *Hist. Nat.* vii. 364.—The *Chigoe* also he calls an *Acarus*. Ibid. 390.

[u] See above, p. 52.

American species of this mischievous insect. It is described as generally attacking the feet and legs[v], getting, without being felt, between the skin and the flesh, usually under the nails of the toes, where it nidificates and lays its eggs; and if timely attention be not paid to it, which, as it occasions no other uneasiness than itching, (the sensation at first, I am assured, is rather pleasing than otherwise,) is sometimes neglected, it multiplies to such a degree, as to be attended by the most fatal consequences, often, as in the above instance, rendering amputation necessary, and sometimes causing death[w].

You have already, perhaps, been satiated with the account before given of our enemies of the *Acarus* tribe; there are a few, however, which I could not with propriety introduce there, as they do not take up their abode and breed in us, which nevertheless annoy us considerably. One of these is a hexapod so minute, that, were it not for the uncommon brilliancy of its colour, which is the most vivid crimson that can be conceived, it would be quite invisible. It is known by the name of the Harvest-bug, (*Acarus autumnalis*, Shaw,) and is so called, I imagine, from its attacking the legs of the labourers employed in the harvest, in the flesh of which it buries itself at the root of the hairs, producing intolerable itching, attended by inflammation and considerable tumours, and sometimes even occa-

[v] Captain Hancock, late commander of His Majesty's ship the Foudroyant, to whose friendly exertions I am indebted for one of the finest collections of Brazil insects ever brought to England, informs me that they will attack any exposed part of the body. He had one in his hand. K.

[w] Piso and Margr. *Ind.* 289.

sioning fevers[x].—More serious consequences have been known to follow the bite of another Acarus related to the above, if not the same species, common in Martinique, and called there the *Bete rouge*. When our soldiers in camp were attacked by this animal, dangerous ulcers succeeded the symptoms just mentioned, which, in several cases, became so bad, that the limb affected was obliged to be taken off[y].

I was once collecting insects in Norwood, near London, when my hands were covered by a number of small hungry ticks, which were so greedy after my blood, that they penetrated deep into my flesh, giving me no little pain; and it was not without difficulty that I extracted them. I suspect that this was the dog-tick (*A. ricinus*, L.) which is often found on plants; but I am not certain, as I neglected to examine it, my attention at that time being almost wholly given to Coleoptera. Lyonnet seems to have been attacked, in one of his entomological excursions, by the same or a similar insect, which he broke, so firmly had it fixed itself, in endeavouring to extract it; and he was obliged to lay open the place lest an abscess should be formed[z]. But the worst of all the tick tribe is the *Acarus Americanus*, L. described by Professor Kalm. This insect, which is related to the preceding, is found in the woods of North America, and is equally an enemy to man and beast. They are there so infinitely numerous, that if you sit down upon the ground, or upon

[x] *Natural. Miscell.* ii. *t.* 42.

[y] I owe this information to Robinson Kittoe, Esq. formerly Clerk of the Cheque in the King's Yard, Woolwich.

[z] Lesser *L.* ii. 222, note *.

the trunk of a tree, or walk with naked feet or legs, they will cover you, and, plunging their serrated rostrum into the bare places of the body, begin to suck your blood, going deeper and deeper till they are half buried in the flesh. Though at first they occasion no uneasiness, when they have thus made good their settlement, they produce an intolerable itching, followed by acute pain and large tumours. It is now extremely difficult to extract them, the animal rather suffering itself to be pulled to pieces than let go its hold: so that the rostrum and head being often left in the wound, produce an inflammation and suppuration which render it deep and dangerous. These ticks are at first very small, sometimes scarcely visible, but by suction will swell themselves out till they are as big as the end of one's finger, when they often fall to the ground of themselves[a]. The serrated haustellum of the ticks, which, like the barbed sting of a bee, cannot be extracted unless the animal cooperates, is well worth your inspection; and the species which infests our dogs is so common that you will have no difficulty in procuring one for examination.

I have now introduced you to the principal insects of the *Aptera* order of Linné, which, in spite of all his care and all his power, assail the lord of the creation, and make him their food. You will here, however, perhaps accuse me of omitting one very prominent annoyer of our comfort and repose, which you think belongs to this tribe—the bed-bug (*Cimex lectularius*, L.) When you are a more practiced entomologist, you will see

[a] De Geer, vii. 154-60.

clearly that this, though it has no wings, appertains to another order: nevertheless it may be introduced here without impropriety. Though now too common and well known, in this country it was formerly a rare insect. Had it not, two noble ladies, mentioned by Mouffet, would scarcely have been thrown into such an alarm by the appearance of bug-bites upon them; which, until their fears were dispelled by their physician, who happened also to be a naturalist, they considered as nothing less than symptoms of the plague. Being shown the living cause of their fright, their fears gave place to mirth and laughter[b]. Commerce, with many good things, has also introduced amongst us many great evils, of which noxious insects form no small part; and one of her worst presents were doubtless the disgusting animals now before us. They seem, indeed, as the above fact proves, to have been productive of greater alarm at first than mischief, at least if we may judge from the change of name which took place upon their becoming common. Their original English name was *Chinche* or *Wall-louse*[c]; and the term *Bug*, which is a Celtic word, signifying a ghost or goblin, was applied to them after Ray's time, most probably because they were considered as "terrors by night[d]." But however horrible bugs may have been

[b] *Theatr. Ins.* 270. This happened in 1503; which circumstance refutes Southall's opinion that bugs were not known in England before 1670.

[c] Rai. *Hist. Ins.* 7. Mouffet, 269. They were called also *punez*, from the French *punaise*.

[d] Hence our English word *Bug-bear*. In Matthews's *Bible*, Ps. xci. 5. is rendered, "Thou shalt not nede to be afraid of any *bugs* by night." The

in the estimation of some, or nauseating in that of others, many of the good people of London seem to regard them with the greatest apathy, and take very little pains to get rid of them; not generally, however, it is to be hoped, to such an extent as the predecessor of a correspondent in Nicholson's *Journal*, who found his house so dreadfully infested by them, that it resembled the Banian hospital at Surat[e], all his endeavours to destroy them being at first in vain. And no wonder; for, as he learned from a neighbour, his predecessor would never suffer them to be disturbed or his bedsteads to be removed, till, in the end, they swarmed to an incredible degree, crawling up even the walls of his drawing-room; and after his death millions were found in his bed and chamber furniture[f].

The winged insects of the order to which the bed-bug belongs, often inflict very painful wounds.—I was once attacked by a small species, *Cimex nemorum*, L. I believe, which put me nearly to as much torture as the sting of a wasp. The water boatman, (*Notonecta glauca*, L.,) an insect related to the *Cimicidæ*, which

word in this sense often occurs in Shakespear. *Winter's Tale*, act iii. sc. 2. 3 *Hen.* VI. act v. sc. 2. *Hamlet*, act v. sc. 2. See Donee's *Illustrations of Shakespear*, i. 329.

[e] The Banian hospital at Surat is a most remarkable institution. At my visit, the hospital contained horses, mules, oxen, sheep, goats, monkeys, poultry, pigeons, and a variety of birds. The most extraordinary ward was that appropriated to rats and mice, *bugs*, and other noxious vermin. The overseers of the hospital frequently hire beggars from the streets, for a stipulated sum, to pass a night amongst the *fleas*, *lice* and *bugs*, on the express condition of suffering them to enjoy their feast without molestation. Forbes's *Oriental Memoirs*, 356.

[f] Nicholson's *Journal*, xvii. 40.

always swims upon its back, made me suffer still more severely, as if I had been burned, by the insertion of its rostrum; but the wound was not followed by any inflammation; and long before me Willughby had made the same discovery and observation[g]. St. Pierre, in his Voyage to Mauritius, mentions a species of bug found in that island, the bite of which is more venomous than the sting of a scorpion, and is succeeded by a tumour as big as the egg of a pigeon, which continues for four or five days. You are well acquainted with the history and properties of the *Raia Torpedo* and *Gymnotus electricus*; but, I dare aver, have no idea that any *insect* possesses their extraordinary powers.—Yet I can assure you, upon good authority, that *Reduvius serratus*, F., commonly known in the West Indies by the name of the *wheel-bug*, can, like them, communicate an electric shock to the person whose flesh it touches. The late Major-general Davies, of the Royal Artillery, well known as a most accurate observer of nature and an indefatigable collector of her treasures, as well as a most admirable painter of them, once informed me, that when abroad, having taken up this animal and placed it upon his hand, it gave him a considerable shock, as if from an electric jar, with its legs, which he felt as high as his shoulders; and, dropping the creature, he observed six marks upon his hand where the six feet had stood.

You may now possibly think that I have nearly gone through the catalogue of our *personal* assailants

[g] Proboscis in cutem intrusa acerrimum dolorem excitat, qui tamen brevi cessat. Rai. *Hist. Ins.* 58.

of the insect tribes. If such, however, is your expectation, I fear you will be disappointed, since I have many more, and some tremendous ones, to enumerate: but as a small compensation for such a detail of evils and injuries to which our species is exposed from foes seemingly so insignificant, and of acts of rebellion of the vilest and most despised of our subjects against our boasted supremacy, the objects to which I shall next call your attention are not, like most of our apterous enemies, calculated to excite disgust and nausea when we see them or speak of them; nor do they usually steal upon us during the silent hours of repose, (though I must except here the gnat or mosquito,) but are many of them very beautiful, and boldly make their attack upon us in open day, when we are best able to defend ourselves. Borne on rapid wings, wherever they find us, they endeavour to lay us under contribution, and the tribute they exact is our blood. Wonderful and various are the weapons that enable them to enforce their demand. What would you think of any large animal that should come to attack you with a tremendous apparatus of knives and lancets issuing from its mouth? Yet such are the instruments by means of which the fire-eyed and blood-thirsty horse-fly (*Tabanus*, L.) makes an incision in your flesh; and then, forming a siphon of them, often carries off many drops of your blood[h]. The pain they inflict, when they open a vein, is usually very acute. In this country, however, their attacks are not frequent enough to make them more than a minor "misery of

[h] One took eight drops from Reaumur, iv. 230.

human life;" but the burning fly of America[i] and the sand-fly of the West Indies[j] cause a much more intolerable anguish, which has been compared to what a red-hot needle or a spark of fire would occasion us to endure. Yet we have one species (*Stomoxys calcitrans*, F.), alluded to in a former letter as so nearly resembling the common horse-fly[k], which, though its oral instruments are to appearance not near so tremendous, is a much greater torment than the *Tabanus*. This little pest, I speak feelingly, incessantly interrupts our studies and comfort in showery weather, making us even stamp like the cattle by its attacks on our legs; and, if we drive it away ever so often, returning again and again to the charge.

But of all the insect-tormentors of man none are so loudly and universally complained of as the species of the genus *Culex*, L., whether known by the name of gnats or mosquitos. Pliny, after Aristotle, distinguishes well between Hymenoptera and Diptera, when he says the former have their sting in their tail, and the latter in their mouth; and that to the one this weapon is given as the instrument of vengeance, and to the other of avidity[l]. But the instrument of avidity in the genus of which I am speaking, is even more terrible than that of vengeance in most insects that are armed with it: like the latter also, as appears from the consequent inflammation and tumour, it instills a poison

[i] Bartram's *Travels*, 383.

[j] My information with respect to this insect is derived from Robinson Kittoe, Esq.

[k] See above, p. 51.

[l] Plin. *Hist. Nat.* l. xi. c. 28. Aristot. *Hist. Animal.* l. i. c. 5.

into its wound; the principal use of which, however, is to render the blood more fluid and fitter for suction. This weapon, which is more complex than the sting of hymenopterous insects, consisting of five pieces besides the exterior sheath, some of which seem simply lancets, while others are barbed like the spicula of a bee's sting, is at once calculated for piercing the flesh and forming a siphon adapted to imbibe the blood[m]. There are several species of this genus whose bite is severe, but none is to be compared to the common gnat (*Culex pipiens*, L.), if, as has been generally affirmed, it be synonymous with the mosquito (though perhaps several species are confounded under both names); and to this, the most insatiable of blood-suckers, I shall principally direct your attention.

In this country they are justly regarded as no trifling evil; for they follow us to all our haunts, intrude into our most secret retirements, assail us in the city and in the country, in our houses and in our fields, in the sun and in the shade: nay, they pursue us to our pillows, and either keep us awake by the ceaseless hum of their droning pipe, and their incessant endeavours to fix themselves upon our face, or some uncovered part of our body; or, if in spite of them we fall asleep, awaken us by the acute pain which attends the insertion of their oral stings; attacking with most avidity the softer sex, and trying their temper by disfigur-

[m] Pliny was aware of this double office of the proboscis of a gnat, and has well described it. "Telum vero perfodiendo tergori quo spiculavit ingenio? Atque ut in capaci, cum cerni non possit exilitas, ita reciproca geminavit arte, ut *fodiendo* acuminatum pariter *sorbendoque* fistulosum esset." *Hist. Nat.* l. xi. c. 2.

ing their beauty. But although with us they are usually rather teasing than injurious; yet upon some occasions they have approached nearer to the character of a plague, and emulated with success the mosquitos of other climates. Thus, we are told that in the year 1736 they were so numerous, that vast columns of them were seen to rise in the air from Salisbury cathedral, which at a distance resembled columns of smoke, and occasioned many people to think that the cathedral was on fire. And in the year 1766, in the month of August, they appeared in such incredible numbers at Oxford as to resemble a black cloud, darkening the air and almost totally intercepting the beams of the sun. One day, a little before sun-set, six columns of them were observed to ascend from the boughs of an apple-tree, some in a perpendicular and others in an oblique direction, to the height of fifty or sixty feet. Their bite was so envenomed, that it was attended by violent and alarming inflammation; and one when killed usually contained as much blood as would cover three or four square inches of wall [n]. Our great poet Spenser seems to have witnessed a similar appearance of them, which furnished him with the following beautiful simile:

As when a swarme of gnats at eventide
Out of the fennes of Allan doe arise,
Their murmuring small trumpets sownden wide,
Whiles in the air their clustring army flies,
That as a cloud doth seem to dim the skies;

[n] *Philos. Trans.* 1767, 111-13.

Ne man nor beast may rest or take repast
For their sharp wounds and noyous injuries,
Till the fierce northern wind with blustering blast
Doth blow them quite away, and in the ocean cast.

In Marshland in Norfolk, as I learn from a lady who had an opportunity of personal inspection, the inhabitants are so annoyed by the gnats, that the better sort of them have recourse to a gauze covering for their beds, to keep them off during the night. Whether this practice obtains in other fen districts I do not know.

But these evils are of small account compared with what other countries, especially when we approach the poles or the line, are destined to suffer from them; for there they interfere so much with ease and comfort, as to become one of the worst of pests and a real misery of human life. We may be disposed to smile perhaps at the story Mr. Weld relates from General Washington, that in one place the mosquitos were so powerful as to pierce through his boots[o] (probably they crept within the boots); but in various regions scarcely any thing less impenetrable than leather can withstand their insinuating weapons and unwearied attacks. One would at first imagine that regions where the polar winter extends its icy reign would not be much annoyed by insects: but however probable the supposition, it is the reverse of fact, for nowhere are gnats more numerous. These animals, as well as the *Tipulidæ*, seem endued with the privilege of resisting

[o] Weld's *Travels*, 8vo edit. 205. Yet Mouffet affirms the same: "Morsu crudeles et venenati, triplices caligas, imo *ocreas*, item perforantes." 81.

any degree of cold, and of bearing any degree of heat. In Lapland their numbers are so prodigious as to be compared to a flight of snow when the flakes fall thickest, or to the dust of the earth. The natives cannot take a mouthful of food, or lie down to sleep in their cabins, unless they be fumigated almost to suffocation. In the air you cannot draw your breath without having your mouth and nostrils filled with them; and unguents of tar, fish-grease, or cream; or nets steeped in fetid birch-oil, are scarcely sufficient to protect even the case-hardened cuticle of the Laplander from their bite[p]. In certain districts of France, the accurate Reaumur informs us that he has seen people whose arms and legs have become quite monstrous from wounds inflicted by gnats; and in some cases in such a state as to render it doubtful whether amputation would not be necessary[q]. In the neighbourhood of the Crimea the Russian soldiers are obliged to sleep in sacks to defend themselves from the mosquitos; and even this is not a sufficient security, for several of them die in consequence of mortification produced by the bites of these furious blood-suckers. This fact is related by Dr. Clarke, and to its probability his own painful experience enabled him to speak. He informs us that the bodies of himself and his companions, in spite of gloves, clothes, and handkerchiefs, were rendered one entire wound, and the consequent excessive irritation and swelling excited a considerable degree of fever. In a most sultry night, when not a breath of

[p] Acerbi's *Travels*, ii. 5. 34-5. 51. Linn. *Flor. Lapp.* 380-1. *Lach. Lapp.* ii. 108. De Geer, vi. 303-4.

[q] Reaum. iv. 573.

air was stirring, exhausted by fatigue, pain, and heat, he sought shelter in his carriage; and, though almost suffocated, could not venture to open a window for fear of the mosquitos. Swarms nevertheless found their way into his hiding-place; and, in spite of the handkerchiefs with which he bad bound up his head, filled his mouth, nostrils, and ears. In the midst of his torment he succeeded in lighting a lamp, which was extinguished in a moment by such a prodigious number of these insects, that their carcases actually filled the glass chimney, and formed a large conical heap over the burner. The noise they make in flying cannot be conceived by persons who have only heard gnats in England. It is to all that hear it a most fearful sound[r]. Travellers and mariners who have visited warmer climates give a similar account of the torments there inflicted by these little demons. One traveller in Africa complains that after a fifty miles journey they would not suffer him to rest, and that his face and hands appeared, from their bites, as if he was infected with the small-pox in its worst stage[s]. And Captain Stedman in America, as a proof of the dreadful state to which he and his soldiers were reduced by them, mentions that they were forced to sleep with their heads thrust into holes made in the earth with their bayonets, and their necks wrapped round with their hammocks[t].

It is not therefore incredible that Sapor, king of Persia, as is related, should have been compelled to

[r] Dr. Clarke's *Travels*, i. 388.

[s] Jackson's *Marocco*, 57.

[t] *Travels*, ii. 93.

raise the siege of Nisibis by a plague of gnats, which attacking his elephants and beasts of burthen, so caused the rout of his army, whatever we may think of the miracle to which it was attributed[u]; nor that the inhabitants of various cities, as Mouffet has collected from different authors[v], should, by an extraordinary multiplication of this plague, have been compelled to desert them; or that by their power to do mischief, like other conquerors who have been the torment of the human race, they should have attained to fame, and have given their name to bays, towns, and even to considerable territories[w].

And now, which seems to you the greater terror, that the forest should resound with the roar of the lion or the tiger, or with the hum of the gnat? Which evil is most to be deprecated, the neighbourhood of these ferocious animals, terrible as they are for their cruelty and strength, or to live amidst the polar or tropical myriads of mosquitos, and be subject to the torture of their incessant attacks? When you consider that from the one prudence and courage may secure or defend us without any material sacrifice of our daily comforts; while to be at rest from the other we must either render ourselves disgusting by filthy unguents, or be suffocated by fumigations, or be content to be bound, head, hand and foot, shut out from the respiration of the common air, and even thus scarcely escape from their annoyance; you will feel

[u] Theodorit. *Hist. Eccl.* l. ii. c. 30-5.

[v] Mouffet, 85. Amoreux, 119.

[w] Viz. *Mosquito* Bay in St. Christopher's; *Mosquitos*, a town in the Island of Cuba; and the *Mosquito* country in North America.

convinced that the former is the more tolerable evil of the two, and be inclined to think that those cities, from which the lions were driven away by the more powerful gnats, were no great gainers by the exchange [x]. With what grateful hearts ought the privileged inhabitants of these happy islands to acknowledge and glorify the goodness of that kind Providence which has distinguished us from the less favoured nations of the globe, by what may be deemed an immunity from this tormenting pest! for the inroads which they make on our comfort, when contrasted with what so many other people of every climate suffer from them, are mere nothings. When we behold on one side of us the ravages of the wide-wasting sword, on another those of infectious disease or pestilence, on a third famine destroying its myriads, and on a fourth life rendered uncomfortable by the terror of "noisome beasts" and the attack of noxious insects: and when we look at home and see every one eating his bread in peace, protected in his enjoyments by equal laws, executed by a mild government, under a paternal king, without fearing the sword of the oppressor; not scourged by pestilence or famine, exposed to the attack of no ferocious animal, and comparatively speaking but slightly visited by the annoyance of insect tormentors; and especially when we further reflect that it is his mercy and not our merits which has induced him thus to overwhelm us with blessings, while other countries have been made to drink deep of the cup of his fury, we shall see reason for an increased degree of thankfulness and

[x] Mouffet, 85.

gratitude, and, instead of repining, be well content with our lot, though our offences have not wholly been passed over, and we have been "beaten with few stripes."[y]

Besides the insects that seek to make us their food, there are others, which, although we are apt to regard them with the greatest horror, do not attack us with this view, but usually to revenge some injury which they have received, or apprehend from us. Foremost in the list of these are those with four wings, which, according to the observation of Pliny before quoted, carry their weapon, an instrument of revenge in their tail. These all belong to the Linnean order *Hymenoptera*; and the tremendous arms with which they annoy us are two darts finer than a hair, furnished on their outer side at the end with several barbs not visible to the naked eye, and each moving in the groove of a strong curved sheath, often mistaken for the sting, which, when the darts enter the flesh, usually injects a drop of subtle venom, furnished from a peculiar vessel in which it is secreted, into the wound, occasioning, especially if the darts be not extracted, a considerable humour, accompanied by very acute pain. Many in-

[y] *Ornithomyia Hirundinis*, Latr., whose natural food is the bird after which it is named, has been known to make its repast upon the human species. One found its way into a bed of the Rev. R. Sheppard, where it first, for several nights, sorely annoyed a friend of his, and afterwards himself, without their suspecting the culprit. After a close search, however, it was discovered in the form of this fly, which forsaking the nest of the swallow, had by some chance taken its station between the sheets, and thus glutted itself with the blood of man.* K.

sects are thus armed and have this power. I have been stung by an Ichneumon, of the tribe with a concealed sting, and very severely by *Pompilus viaticus*, F. But the insects which in this respect principally attract our notice by exciting our fears, are the hive-bee, the wasp, and the hornet. The first of these, the *Bee*, sometimes manifests an antipathy to particular individuals, whom it attacks and wounds without provocation; but the two last, though apparently the most formidable, are nevertheless not so ill-tempered as they are conceived to be, seldom molesting those who do not first interfere with or disturb them. We learn from Scripture that the *Hornet* (but whether it was the common species is uncertain) was employed by Providence to drive out the impious inhabitants of Canaan, or subdue them under the hand of the Israelites[z]. The effect produced by the sting of these animals is different in different persons. To some they occasion only a very slight inconvenience or a momentary pain; others feel the smart of the wounds which they inflict for several days, and are thrown into fevers by them; and to some they have even proved fatal[a]. Yet these insects are certainly, in general, but a trifling evil. They become, however, especially *Wasps*, a very serious one to many, from the mere dread of being stung by them, even though they should not carry their fears to the same length with the lady mentioned in the *Philosophical Transactions* by Dr. Fairfax[b], who had such a horror of them, that during the season in which they

[z] Deut. vii. 20. Josh. xxiv. 12.

[a] Amoreux, 242.

[b] *Philos. Trans.* i. 201.

abound in houses, she always confined herself to her apartment.

Ants are an insect of this order, which, though our indigenous species may be regarded as harmless, in some countries are gifted with double means of annoyance, both from their sting and their bite. A green kind in New South Wales was observed by Sir Joseph Banks to inflict a wound scarcely less painful than the sting of a bee[c]. Another, from the intolerable anguish occasioned by its bite, which resembles that produced by a spark of fire, and seems attended by venom, is called the fire-ant. Captain Stedman relates that this caused a whole company of soldiers to start and jump about as if scalded with boiling water; and its nests were so numerous that it was not easy to avoid them[d]. We are told of a third species, which emulates the scorpion in the malignity of its sting or bite[e]. Knox, in his account of Ceylon, mentions a black ant, called by the natives *Caddia*, which he says "bites desperately, as bad as if a man were burnt by a coal of fire; but they are of a noble nature, and will not begin unless you disturb them." The reason the Cinghalese assign for the horrible pain occasioned by their bite is curious, and will serve to amuse you. "Formerly these ants went to ask a wife of the *Noya*, a venomous and noble kind of snake; and because they had such a high spirit to dare to offer to be related to such a generous creature, they had this virtue bestowed upon them, that they should sting after this manner. And

[c] Hawkesworth's *Cook*, iii. 223.
[d] Stedman, ii. 94.
[e] Bingley, iii. 385. first edit.

if they had obtained a wife of the Noya, they should have had the privilege to sting full as bad as he[f]." Stedman's story of a large ant that stripped the trees of their leaves, to feed, as was supposed, a blind serpent under ground[g], is somewhat akin to this: as is also another, related to me by a friend of mine, of a species of Mantis, now in my cabinet, taken in one of the Indian islands, which, according to the received opinion amongst the natives, was the parent of all their serpents. Whence, unless perhaps from their noxious qualities, could this idea of a connexion between insects and these reptiles be derived? But to return from this digression——Madame Merian's Ant of Visitation will be considered in a subsequent letter: but I cannot here omit a circumstance mentioned by Don Felix de Azara, a late Spanish traveller, who confirms her account,—that these animals are so alarming and tremendous in their attacks, that if they enter a house in the night, the inhabitants are obliged to rise with all speed and run off in their shirts.

I must next direct your attention to an insect, which perhaps more than any other has in every age been an object of terror and abhorrence. I mean the redoubted *scorpion:* and though I shall not, with Aristotle, tell you of Persian kings employing armies for several days in destroying them; or, with Pliny, of countries that they have depopulated; yet my account will not be devoid of that species of interest which the dread of its power to do us injury imparts to any object. Could you see one of these ferocious animals,

[f] Knox's *Ceylon*, 24. [g] Stedman, ii. 142.

perhaps a foot in length, a size to which they sometimes attain, advancing towards you in their usual menacing attitude, with its claws expanded, and its many-jointed tail turned over its head; were your heart ever so stout, I think you would start back and feel a horror come across you; and, though you knew not the animal, you would conclude that such an aspect of malignity must be the precursor of malignant effects. Nor would you be mistaken, as you will presently see. This alarming animal, though like hymenopterous insects it is armed with a sting, is in no respect related to that order, and forms the only genus, at present known, of the others that is so armed. Even its sting is totally different from that of bees, wasps, and other Hymenoptera, being more analogous to the venomous tooth of serpents; it wounds us with no barbed darts concealed in a sheath, but only with a simple incurved mucro terminating an ampullaceous joint. Two orifices, or according to some three, are said to instill the poison, which, we are informed, is sometimes as white as milk. This venom, though in our European species it is seldom attended, except to minor animals, by any very serious consequences; yet when it is communicated by the scorpion of warmer climates it produces more baneful effects. The sting of certain kinds common in South America causes fevers, numbness in various parts of the body, tumours in the tongue, and dimness of sight, which symptoms last from twenty-four to forty-eight hours. The only means of saving the lives of our soldiers who were stung by them in Egypt, was amputation. One species is said to occasion madness; and the black scorpion, both of South America and Ceylon, frequently inflicts a mortal wound[h]. No known animal is more cruel and ferocious in its manners; they kill and devour their own young without pity as soon as they are born, and they are equally savage to their fellows when grown up. Terrible however and revolting as these creatures appear, we are gravely told by Naudé, that there is a species of scorpion in Italy which is domesticated and put between the sheets to cool the beds during the heats of summer[i]!!!

I must next say something of insects that annoy us solely by their *jaws*. Of this description is *Solpuga araneoides*, F. (*Galeodes*, Oliv.) which is related to the scorpion, although devoid of a sting. The bite of this animal, which is a native of the Cape of Good Hope and of Russia[j], is represented to be often fatal both to man and beast. Another species of Solpuga is described by Professor Lichtenstein, which, from the trivial name that he has given it (*fatale*), may be supposed to be as venomous as the former[k].

The bite of *Scolopendra morsitans*, L., the under jaws of which are armed with a strong claw furnished like the sting of a scorpion with an orifice, visible under a common lens, from which poison issues, is less tremendous than the *Solpuga:* but though not mortal, its wounds are more painful than those produced by the sting of the scorpion; and as these animals creep every where, even into beds, they must be very annoying in

[h] Ulloa's *Voy.* i. 61, 62. Dr. Clarke's *Travels*, i. 486. Amoreux, 197.

[i] Andrews's *Anecdotes*, 427. See on the subject of Scorpions Amoreux, 41-54. 176-205. [j] Fab. *Suppl.* 294. 2. [k] *Catal. Ham.* 1797. 151-195.

warm climates where they abound. Dr. Martin Lister, in his Travels, has given us a figure of an insect related to this genus, that he saw in Plumier's collection, which appears to have been eighteen inches in length, and three quarters of an inch in width, having ninety-five legs on each side, the first eight of which are armed with double claws, and two inches of the tail being without legs. It may form a distinct genus, and is probably a native of South America. Yet even this monstrous insect is nothing to those at Carthagena, mentioned by Ulloa, (if indeed we may credit his account, or if his translator has not mistaken his meaning,) which sometimes exceeded a yard in length and five inches in breadth! The bite of this gigantic serpent-like creature, he tells us, is mortal, as well it may, if a timely remedy be not applied. From its cylindrical form it should be a Julus[1].

In this catalogue of noxious insects I must not omit those which every where force themselves upon our notice, and are viewed with general disgust. I mean the numerous family of Arachne, the insidious spiders. Few of these, however, are really personal assailants of man. The principal is that which has given rise to so much discussion, and has so much employed the pens of naturalists and physicians—the famous *Tarentula*. (*Lycosia Tarentula*, Walck.) The effects ascribed to its wounds, and their wonderful cure supposed to be wrought by music and dancing, have long been celebrated: but after all there seems to have been more of fraud than of truth in the business; and

[1] Ulloa's *Voyage*, i. 61.

the whole evil appears to consist in swelling and inflammation. Dr. Clavitio submitted to be bitten by this animal, and no bad effects ensued; and the Count de Borch, a Polish nobleman, bribed a man to undergo the same experiment, in whom the only result was a swelling in the hand, attended by intolerable itching. The fellow's sole remedy was a bottle of wine, which charmed away all his pain without the aid of pipe and tabor[m].

There is however a spider (*Aranea* 13-*guttata Rossi*) the bite of which is said to be very dangerous, and even mortal. Thiébaut de Berneaud, in his Voyage to Elba *, affirms that in the Volterrano he knew that several country people and domestic animals died in consequence of it.

I suspect you will think this list long enough; and I believe it includes the most remarkable insects that assail the surface of our bodies, to answer either the demands of hunger or the stimulus of revenge. There is however a third class of insect annoyers, as I observed at the beginning of this letter, which, though they neither make us their food, nor attack us under the impulse of fear or revenge, incommode us extremely in other ways. These must now be detailed to you.

How extremely unpleasant is the sensation which that very minute creature, *Thrips physapus*, L., excites in sultry weather, merely by creeping over our skin! I have sometimes found this almost intolerable.

[m] Amoreux, 217-226. See also 67-70. * p. 31.

A similar torment, reckoned by Uloa a kind of Mosquito, infests the inhabitants of Carthagena in South America. They are there called *Mantas blancas*, and creeping between the threads of the gauze curtains that keep off the former pest, though they do not bite, occasion an itching that is dreadfully tormenting[n]. But these are nothing compared with the teasing attacks of the *Simulium reptans*, Latr., which, as Linné informs us, who misnamed it a Culex, is so incredibly numerous in Lapland, as entirely to cover a man's body, turning a white dress into a black one, occupying the whole atmosphere, filling the mouth, nostrils, eyes, and ears of travellers, and thus preventing respiration, and almost choking them. These little animals do not bite, but torture incessantly by their titillation[o]. In New South Wales a small ant was observed by Sir Joseph Banks, inhabiting the roots of a plant, which when disturbed rushed out by myriads, and running over the uncovered parts of the body produced a sensation of this kind that was worse than pain.

You know that the hair taken from the pods of *Dolichos pruriens* and *urens*, L., commonly called *Cowhage* and *Cow-itch*[p], occasions a most violent itching,

[n] Ulloa, i. 64. These insects probably belong to Latreille's genus *Simulium*, and may be what are distinguished by French travellers from the Mosquitos, (which they call *Maringouins* or *Maragoins*,) under the name of *Moustiques*, of which he had examined specimens, having all the characters of that genus, brought from America by Michaux. *Hist. Nat.* xiv. 272. 283.

[o] *Lach. Lapp.* i. 208, 209. *Fl. Lapp.* 382, 383.

[p] Cowhage has been administered with success as an *anthelmintic*, as has likewise spun-glass pounded; the spicula of these substances destroying the worms. The hair of the caterpillars here alluded to, and perhaps also of the larva of *Bombyx Caja* (The Tiger-Moth), might probably be equally efficacious.

but perhaps are not aware that those of the *caterpillars* of several *Bombyces*, a family of Moths, will produce the same disagreeable effect. One of these is the *Procession-Moth*, of which Reaumur has given so interesting an account. In consequence of their short stiff hairs sticking in his skin, after handling them, he suffered extremely for several days; and being ignorant at first of the cause of the itching, and rubbing his eyes with his hands, he brought on a swelling of the eyelids, so that he could scarcely open them. Ladies were affected even by going too near the nest of the animal, and found their necks full of troublesome tumours, occasioned by short hairs, or fragments of hair, brought by the wind[q]. Of this nature also is the famous *Pityocampa* of the ancients, the moth of the fir (*B. Pityocampa*, F.), the hairs of which are said to occasion a very intense degree of pain, heat, fever, itching and restlessness. It was accounted by the Romans a very deleterious poison, as is evident from the circumstance of the Cornelian law "*De sicariis*" being extended to persons who administered *Pityocampa*[r].

In these cases the injury was the consequence of irritation produced by the hair of the animal; but there are facts on record, which prove that the juices of many insects are equally deleterious. Amoreux, from a work of Turner's, an English writer on cutaneous diseases, has given the following remarkable history of the ill effects produced by those of *spiders*. When Turner was a young practitioner, he was called to visit a woman,

[q] Reaum. ii. 191-5.

[r] Mouffet, 185. Plin. *Hist. Nat.* l. xxxviii. c. 9. Amoreux, 158.

whose custom it was, every time she went into the cellar with a candle, to burn the spiders and their webs. She had often observed, when she thus cruelly amused herself, that the odour of the burning spiders had so much affected her head, that all objects seemed to turn round, which was occasionally succeeded by faintings, cold sweats, and slight vomitings: but, notwithstanding this, she found so much pleasure in tormenting these poor animals, that nothing could cure her of this madness, till she met with the following accident: The legs of one of these unhappy spiders happened to stick in the candle, so that it could not disengage itself; and, the body at length bursting, the venom was ejaculated into the eyes and upon the lips of its persecutrix. In consequence of this, one of the former became inflamed, the latter swelled excessively, even the tongue and gums were slightly affected, and a continual vomiting attended these symptoms. In spite of every remedy the swelling of the lips continued to increase, till at length an old woman, by the simple application for fifteen days of the leaves and juice of plantain, together with some spider's web, ran away with all the glory of the cure[s].—Ulloa gives us a remarkable account of a species of Acarus, of a fiery red colour, common in Popayan, called *Coya* or *Coyba*, and usually found in the corners of walls and among the herbage, the venom of which is of such malignity, that on crushing the insect, if any fall on the skin of either man or beast, it immediately penetrates into the flesh, and causes large tumours, which are soon succeeded by

[s] Amoreux, 210-212.

death. Yet, he further observes, if it be crushed between the palms of the hands, which are usually callous, no bad consequence ensues. People who travel along the valleys of the Neyba, where these insects abound, are warned by their Indian attendants, if they feel any thing stinging them, or crawling on their neck or face, not so much as to lift up their hand to the place, the texture of the Coya being so delicate that the least force causes them to burst, without which there is no danger, as they seem otherwise harmless animals. The traveller points out the spot where he feels the creature to one of his companions, who, if it be a Coya, blows it away. If this account does not exaggerate the deleterious quality of the juices of this insect, it is the most venomous animal that is known; for he describes it as much smaller than a bug. The only remedy to which the natives have recourse for preventing the ill effects arising from its venom is, on the first appearance of the swelling, to swing the patient over the flame of straw or long grass, which they do with great dexterity: after this operation he is reckoned to be out of danger.—The poisoned arrows which Indians employ against their enemies have been long celebrated. The Coya may, in the western world, have furnished the poison for this purpose. An author quoted in Lesser tells us that an ant as big as a bee is sometimes used, and that the wound inflicted by weapons tinctured with their venom is incurable. Patterson also gives a recipe by which the natives of the southern extremity of Africa prepare what they reckon the most effectual poison for the point of their arrows. They mix the juice of a species of Euphorbia, and a caterpillar that feeds on a kind of sumach, (*Rhus*, L.) and when the mixture is dried it is fit for use.

And now I think you will allow that I have made out a tolerable list of insects that attack or annoy man's body externally, and a sufficiently doleful history of them. That the subject, however, may be complete, I shall next enumerate those that, not content with afflicting him with *exterior* pain or evil, whether on the surface or under the skin, bore into his flesh, descend even into his stomach and viscera, derange his whole system, and thus often occasion his death. The punitive insects here employed are usually larvæ of the various orders, and they are the cause of that genus of diseases I before noticed, and proposed to call *Scolechiasis*.

I shall begin my account with the first order of Linné, because people in general seem not aware that any *beetles* make their way into the human stomach. Yet there is abundant evidence, which proves beyond controversy that the meal-worm, (*Tenebrio molitor*, L.) although its usual food is flour, has often been voided both by male and female patients; and in one instance is stated to have occasioned death[t]. How these grubs should get into the stomach it is difficult to say—perhaps the eggs may have been swallowed in some preparation of flour. But that the animal should be able to sustain the heat of this organ, so far exceeding the temperature to which it is usually accustomed, is the

[t] Tulpius, *Obs. Med.* l. ii. c. 51. t. 7. f. 3. *Edinb. Med. and Surg. Journ.* n. 35. 42-48. Derham, *Physic. Theol.* 378. note *b*. Lowth. *Philos. Trans.* iii. 135.

most extraordinary circumstance of all.—Dr. Martin Lister, who to the skill of the physician added the most profound knowledge of nature, mentions an instance, communicated to him by Mr. Jessop, of a girl who voided three hexapod larvæ similar to what are found in the carcases of birds[u], probably belonging either to the genus *Dermestes*, F., or *Byrrhus*, L.: and in the *German Ephemerides* the case also of a girl is recorded, from an abscess in the calf of whose leg crept black worms resembling beetles[v].

No one would suppose that *caterpillars*, which feed upon vegetable substances, could be met with alive in the stomach; yet Dr. Lister gives an account of a boy who vomited up several, which, he observes, had sixteen legs[w]. The eggs perhaps might have been swallowed in sallad; and, as vegetables make a part of most people's daily diet, enough might have passed into the stomach to support them when hatched.—Linné tells us that the caterpillar of a moth, (*Crambus pinguinalis*, F.) common in houses, has also been found in a similar situation, and is one of the worst of our insect infesters.—But the most extraordinary account with respect to lepidopterous larvæ (unless he has mistaken his insects) is given by Azara, the Spanish traveller before quoted; who says that in South America there is a large brown *moth*, which deposits its young in a kind of saliva upon the flesh of persons who sleep naked; these introduce themselves under the skin without being perceived, where they occasion

[u] *Philos. Trans.* 1665. x. 391. Shaw's *Abridg.* ii. 224.

[v] Mead, *Med. Sacr.* 105.

[w] *Philos. Trans.* ubi supr.

swelling attended by inflammation and violent pain. When the natives discover it, they squeeze out the larvæ, which usually amount to five or six[x].

But amongst all the orders, none is more fruitful in devourers of man than the Diptera; and these are chiefly to be found in the numerous tribe of the *Muscidæ*. The Gad-fly (*Oestrus*, L.) you have, doubtless, often heard of, and how sorely it annoys our cattle and other quadrupeds; but I suspect have no notion that there is a species appropriated to man. This indeed no entomologist dreamed of, till such a species was lately discovered in South America (but they mention it only incidentally) by Humboldt and Bonpland. Speaking of the low regions of the torrid zone, where the air is filled with those myriads of mosquitos which render uninhabitable a great and beautiful portion of the globe, they observe that to these may be joined the *Oestrus humanus*, which deposits its eggs in the skin of man, causing there painful tumours[y].—Even the gad-fly of the ox, leaving its proper food, has been known to oviposit in the jaw of a woman, and the bots produced from the eggs finally occasioned her death[z].—Other flies also of various kinds thus penetrate into us, either preying upon our flesh, or getting into our intestines. Leeuwenhoek mentions the case of a woman whose leg had been enlarging with glandular bodies for some years. Her surgeon gave him one that he had cut from it, in which were many small maggots:

[x] Azara, 217. I cannot help suspecting this to be synonymous with the *Oestrus humanus* next mentioned.

[y] *Essai sur la Geograph. des Plantes*, 136.

[z] Clark in *Linn. Trans.* iii. 323, note.

these he fed with flesh till they assumed the pupa, when they produced a fly as large as the flesh-fly[a]—A patient of Dr. Reeve of Norwich, after suffering for some time great pain, was at last relieved by voiding a considerable number of maggots, which agree precisely with those described by De Geer as the larva of his *Musca domestica minor*, a fly which he speaks of as very common in apartments[b].—In Paraguay the flesh-flies are said to be uncommonly numerous and noxious. Azara relates[c] that, after a storm, when the heat was excessive, he was assailed by such an army of them, that in less than half an hour his clothes were quite white with their eggs, so that he was forced to scrape them off with a knife; adding, that he has known instances of persons, who, after having bled at the nose in their sleep, were attacked by the most violent head-aches; when at length several great maggots, the off-spring of these flies, issuing from their nostrils, gave them relief.—In Jamaica a large blue fly buzzes about the sick in the last stages of fever; and when they sleep or doze with their mouths open, the nurses find it very difficult to prevent these flies from laying their eggs in the nose, mouth, or gums. An instance is recorded of a lady who, after recovering from a fever, fell a victim to the maggots of this fly, which from the nose found their way through the *os cribriforme* into the cavity of the skull, and afterwards into the brain[d]. One of the most shocking cases of *Scolechiasis* I ever met with is

[a] Leeuw. *Epist.* Oct. 17, 1687.

[b] *Edinb. Med. and Surg. Journ.* ubi supr. De Geer, vi. 26, 27.

[c] 216. [d] Lempriere *On the Diseases of the Army in Jamaica*, ii, 182.

related in Bell's *Weekly Messenger* in the following words: "On Thursday, June 25, died at Asbornby, (*Lincolnshire*,) John Page, a pauper belonging to Silk-Willoughby, under circumstances truly singular. He being of a restless disposition, and not choosing to stay in the parish workhouse, was in the habit of strolling about the neighbouring villages, subsisting on the pittance obtained from door to door: the support he usually received from the benevolent was bread and meat; and after satisfying the cravings of nature, it was his custom to deposit the surplus provision, particularly the meat, betwixt his shirt and skin. Having a considerable portion of this provision in store, so deposited, he was taken rather unwell, and laid himself down in a field in the parish of Scredington—when from the heat of the season at that time, the meat speedily became putrid, and was of course struck by the flies: these not only proceeded to devour the inanimate pieces of flesh, but also literally to prey upon the living substance; and when the wretched man was accidentally found by some of the inhabitants, he was so eaten by the maggots that his death seemed inevitable. After clearing away as well as they were able these shocking vermin, those who found Page conveyed him to Asbornby, and a surgeon was immediately procured, who declared that his body was in such a state that dressing it must be little short of instantaneous death; and in fact the man did survive the operation but a few hours. When first found, and again when examined by the surgeon, he presented a sight loathsome in the extreme; white maggots of enormous size were crawling in and upon his body, which they had most shockingly mangled, and the removing of the external ones served only to render the sight more horrid[e]."—I shall only mention one more instance, because it is a singular one. The larva of *Elophilus pendulus*, F., which is peculiarly formed by nature for inhabiting fluids, has been found in the stomach of a woman[f].

You will smile when I tell you that I have met with the prescription of a famous urine-doctor, in which he recommends to his credulous patient to take a certain number of *sow-bugs* per diem, by this name distinguishing, as I suppose, *Armadillo vulgaris*, Latr., once a very favourite remedy. What effect they produced in this case I was not informed; but the learned Bonnet relates that he had seen a certificate of an English physician, dated July 1763, stating that a young woman who had swallowed these animals alive, as is usually done, some time before threw up a prodigious number of them of all sizes, which must have bred in her stomach[g].

It was customary in many countries in ancient times to punish certain malefactors by exposing them to be devoured by wild beasts: but to expose them to *insects* for the same purpose was a refinement in cruelty, which seems to have been peculiar to the despots of Persia. We are informed that the most severe punishment amongst the Persians was that of shutting up the offender between two boats, which were made so equal

[e] In passing through this parish last spring, I inquired of the mail-coachman whether he had heard of this story; and he said the fact was well known. K.

[f] *Philos. Mag.* ix, 366.

[g] Bonnet, v. 144.

that one was neither broader nor longer than the other; they laid him in one of them upon his back, and covered him with the other, his hands, feet, and head being left bare. His face, which was placed full in the sun, they moistened with honey, thus inviting the flies and wasps, which tormented him no less than the swarms of maggots that were bred in his excrements and body, and devoured him to the very entrails. He was compelled to take as much food as was necessary to support life, and thus existed sometimes for several days. Plutarch informs us that Mithridates, whom Artaxerxes Longimanus condemned to this punishment, lived seventeen days in the utmost agony: and that, the uppermost boat being taken off at his death, they found his flesh all consumed, and myriads of worms gnawing his bowels[h]. Could any natural objects be made more horrible and effectual instruments of torture than *insects* were in this most diabolical invention of tyranny?

In this enumeration of evils derived from insects, I must not wholly pass over the serious and sometimes fatal effects produced upon some persons by eating honey, or even by drinking mead. I once knew a lady upon whom these acted like poison, and have heard of instances in which death was the consequence. Sometimes, when bees extract their honey from poisonous plants, such results have not been confined to individuals of a particular habit or constitution. A remarkable proof of this is given by Dr. Barton in the fifth volume of *The American Philosophical Transactions*. In the autumn and winter of the year 1790, an

[h] *Universal History*, iv. 70. Ed. 1779.

extensive mortality was produced amongst those who had partaken of the honey collected in the neighbourhood of Philadelphia. The attention of the American Government was excited by the general distress, a minute inquiry into the cause of the mortality ensued, and it was satisfactorily ascertained that the honey had been chiefly extracted from the flowers of *Kalmia latifolia*.

Amongst other *direct* injuries occasioned by these creatures, perhaps, out of regard for the ladies, I ought to notice the alarm which many of them occasion to the loveliest part of the creation. When some females retire from society to avoid a wasp; others faint at the sight of of a spider; and others, again, die with terror if they hear a death-watch: these groundless apprehensions and superstitious alarms are as much real evils to those who feel them, as if they were well founded. But having already adverted to this subject, I shall here only quote the observation of a wise man, that "Fear is a betraying of the succours that reason offereth[1]." The best remedy, therefore, in such cases is going to reason for succour. In a few instances, indeed, the evil may take root in a constitutional defect, for there seems to be some foundation for the doctrine of natural antipathies: but, generally speaking, in consequence of the increased attention to natural history, the reign of imaginary evils is ceasing amongst us, and what used to shake the stout hearts of our superstitious ancestors with anile terrors, is become a subject of interesting inquiry to their better informed descendants, even of the weaker sex.

[1] Wisd. xvii. 12.

And now, my friend, I flatter myself you feel disposed to own the truth of my position, however it might startle you at first, and will candidly acknowledge that I have proved the empire of these despised insects over man's person; and that, instead of being a race of insignificant creatures, which we may safely overlook, as having no concern with them, they may, in the hands of Divine Providence, and even of man, become to us fearful instruments of evil and of punishment. I shall next endeavour to give you some idea of the *indirect* injuries which they occasion us by attacking our property, or interfering with our pleasure or comfort—but this must be the subject of another letter.

I am, &c.

LETTER V.

INJURIES CAUSED BY INSECTS.

INDIRECT INJURIES.

Having detailed to you the *direct* injuries which we suffer from insects, I am now to call your attention to their *indirect* attacks upon us, or the injury which they do our property; and under this view also you will own, with the fullest conviction, that they are not beings that can with prudence or safety be disregarded or despised. Our property, at least that part exposed to the annoyance of these creatures, may be regarded as consisting of animal and vegetable productions, and that in two states; when they are living, namely, and after they are dead. I shall therefore endeavour to give you a sketch of the mischief which they occasion, first to our *living animal* property, then to our *living vegetable* property; and lastly, to our *dead stock*, whether animal or vegetable.

Next to our own persons, the *animals* which we employ in our business or pleasures, or fatten for food, individually considered, are the most valuable part of our possessions—and, at certain seasons, hosts of insects of various kinds are incessant in their assaults upon most of them.—To begin with that noble animal the *horse*.—See him, when turned out to his pasture, unable to touch a morsel of the food he has earned by his labours. He flies to the shade; evidently in great uneasiness, where he stands continually stamping from the pain produced by the insertion of the weapons sheathed in the proboscis of a little fly (*Stomoxys calcitrans*) before noticed as attacking ourselves[j]. This alights upon him sometimes in one place and sometimes in another, and never lets him rest while the day lasts. See him again when in harness and travelling.—He is bathed in blood flowing from innumerable wounds made by the knives and lancets of various Tabani, which assail him as he goes, and allow him no respite[k]; and consider that even this is nothing to what he suffers in other climates from the same pest. In North America, vast clouds of different species—so abundant as to obscure every distant object, and so severe in their bite as to merit the appellation of burning flies—cover and torment the horses to such a degree as to excite compassion even in the hearts of the pack-horsemen. Some of them are nearly as big as humble bees; and, when they pierce the skin and veins of the unhappy beast, make so large an orifice that, besides what they suck, the blood flows down its neck, sides, and shoulders in large drops like tears, till, to use Bartram's expression, "they are all in a gore of blood." Acari also,

[j] See above, p. 114.

[k] Once travelling through Cambridgeshire with a brother entomologist in a gig, our horse was in the condition here described, from the attack of *Tabanus rusticus*, L. K.

both the dog-tick and the American tick before mentioned, especially the latter, infest the horse. Kalm affirms, that he has seen the under parts of the belly, and other places of the body, so covered by them, that he could not introduce the point of a knife between them. They were deeply buried in the flesh; and in one instance that he witnessed, the miserable creature was so exhausted by continual suction, that it fell, and afterwards died in great agonies[1].

No quadruped is more infested by the *Oestrus*, or gad-fly, sometimes also called the Breese, than the horse. In this country no fewer than three species attack it. The most common sort, known by the name of the horse-bee, (*Oe. Equi*, L.,) deposits its eggs (which being covered with a slimy substance adhere to the hairs) on such parts of the body as the animal can reach with its tongue; and thus, unconscious of what it is doing, it unwarily introduces into its own citadel the troops of its enemy.—Another species (*Oe. hæmorrhoidalis*, L.) is still more troublesome to it, ovipositing upon the lips; and in its endeavours to effect this, from the excessive titillation it occasions, giving the poor beast the most distressing uneasiness. At the sight of this fly horses are always much agitated, tossing their heads about in the air to drive it away; and, if this does not answer, galloping off to a distant part of their pasture, and, as their last resource, taking refuge in the water, where the gad-flies never follow them. We learn from Reaumur, that in France the grooms, when they observe any bots (which is the vul-

[1] De Geer, vii. 158.

gar name for the larvæ and pupæ of Oestri) about the anus of a horse or in its dung, thrust their hand into the passage to search for more; but this seems a useless precaution, which must occasion the animal great pain to answer no good end; for when the bots are passing from the body, having ceased feeding, they can do no further injury. In Sweden, as De Geer informs us, they act much more sensibly: those that have the care of horses are accustomed to clean their mouths and throats with a particular kind of brush, by which method they free them from these disagreeable inmates before they have got into the stomach, or can be at all prejudicial to them[m].

Providence has doubtless created these animals to answer some beneficial purpose; and Mr. Clark's judicious conjectures are an index which points to the very kind of good our cattle may derive from them, as acting the part of perpetual stimuli or blisters: yet when they exceed certain limits, as is often the case with similar animals employed for purposes equally beneficial, they become certainly the cause of disease, and sometimes of death.

How troublesome and teasing is that cloud of flies (*Musca meteorica*, L.) which you must often have noticed in your summer rides, hovering round the head and neck of your horse, accompanying him as he goes, and causing a perpetual tossing of the former!—And still more annoying in Lapland, as we learn from Linne[n], is the furious assault of the minute horse-gnat, (*Culex equinus*, L.,) which infests these beasts in infi-

[m] De Geer, vi. 295.

[n] Linn. *Flor. Lapp.* 376. *Lach. Lapp.* i. 233, 234.

nite numbers, running under the mane and amongst the hair, and piercing the skin to suck their blood.—An insect of the same genus is related to attack them in a particular district in India in so tremendous a manner as to cause incurable cancers, which finally destroy them[o].—But of all the insect tormentors of these useful creatures, there is none more trying to them than the forest-fly (*Hippobosca equina*, L.). Attaching themselves to the parts least covered with hair, particularly under the belly between the hind legs, they irritate the quietest horse, and make him kick so as often to hazard the safety of his rider or driver. This singular animal runs sideways or backwards like a crab; and, being furnished with an unusual number of claws, it adheres so firmly that it is not easy to take it off; and even if you succeed in this, its substance is so hard, that by the utmost pressure of your finger and thumb it is difficult to kill it; and if you let it go with life, it will immediately return to the charge.—Amongst the insect plagues of horses, I should also have enumerated the larva of *Curculio paraplecticus*, L., which Linné considers as the cause of the equine disease, called in Sweden, after the *Phellandrium aquaticum*, "*Stakra*," had not the observations of the accurate De Geer rendered it doubtful whether the insect be at all connected with this malady[p].

Another quadruped contributing greatly to our domestic comfort, from which we derive a considerable portion of our animal food, and which, on account of its patient and laborious character when employed in

[o] *Life of General Thomas*, 186.

[p] Linn. *It. Scan.* 182. De Geer, v. 227-30.

agriculture, is an excellent substitute for the horse, (you will directly perceive I am speaking of the *ox*, whether male or female,) is also not exempt from insect domination. At certain seasons the whole terrified herd, with their tails in the air, or turned upon their backs, or stiffly stretched out in the direction of the spine, gallop about their pastures, making the country re-echo with their lowings, and finding no rest till they get into the water. Their appearance and motions are at this time so grotesque, clumsy, and seemingly unnatural, that we are tempted rather to laugh at the poor beasts than to pity them, though evidently in a situation of great terror and distress. The cause of all this agitation and restlessness is a small gad-fly, (*Oe. Bovis*, L.) less than the horse-bee, the object of which, though it be not to bite them, but merely to oviposit in their hides, is not put into execution without giving them considerable pain. Virgil, in his Georgics, has beautifully and accurately described the effects of the approach and assault of the Oestrus upon the cattle. As the passage has not been very correctly translated, I shall turn poet on the occasion, and attempt to give it you in a new dress.

Through waving groves[q] where Selo's torrent flows,
And where, Alborno, thy green Ilex grows,
Myriads of insects flutter in the gloom
(Oestrus in Greece, Asilus nam'd at Rome)
Fierce and of cruel hum. By the dire sound
Driven from the woods and shady glens around

[q] Reaumur observes that the Oestri infest cattle principally in woody countries, and not in the plains. iv. 506.

The universal herds in terror fly;
Their lowings shake the woods and shake the sky,
And Negro's arid shore ——

When oxen are employed in agriculture, the attack of this fly is often attended with great danger, since they then become perfectly unmanageable; and, whether in harness or yoked to the plough, will run directly forward. At the season when the Oestrus infests them, close attention should be paid, and their harness so constructed that they may easily be let loose.

Reaumur has minutely described the ovipositor, or singular organ by which these insects are enabled to bore a round hole in the skin of the animal and deposit their eggs in the wound. The anus of the female is furnished with a tube of a corneous substance, consisting of four pieces, which, like the pieces of a telescope, are retractile within each other. These terminate in five pointed hooks, three of which are longer than the rest: when united together they form an instrument very much like an auger or gimlet; only, having these points, it can bite with more effect. He thinks the infliction of the wound is not attended by much pain, except where very sensible nerves are injured, when the animal, appearing to be seized with a kind of phrensy, begins to gambol, and run with such swiftness that nothing can stop it. From this semblance of temporary madness in oxen when pursued and bored by the Oestrus, the Greeks applied the term to any sudden fit of fury or violent impulse in the human species, calling such ebullitions an *Oestrus*. The female fly is observed to be very expeditious in oviposition, not more than a few seconds; and while she is performing the operation, the animal attempts to lash her off, as it does other flies, with its tail. The circular hole, made by the auger just described, always continues open, and increases in diameter as the larva increases in size; thus enabling it to receive a sufficient supply of air by means of its anal respiratory plates, which are usually near the orifice.—But though these insects thus torment and terrify our cattle, they do them no material injury. Indeed they occasion considerable tumours under the skin, where the bots reside, varying in number from three or four to thirty or forty; but these seem unattended by any pain, and are so far from being injurious, that they are rather regarded as proofs of the goodness of the animal, since these flies only attack young and healthy subjects. The tanners also prefer those hides that have the greatest number of bot-holes in them, which are always the best and strongest[r].

The Stomoxys, and several of the other flies before enumerated, as well as the dog and American ticks, are as prejudicial to the ox as to the horse. One species of Hippobosca I have reason to believe is appropriated to them; yet, since a single specimen only has hitherto been taken[s], little can be said with respect to it.—A worse pest than any hitherto enumerated, is a minute fly concerning the genus of which there is some doubt, Fabricius considering it as a Rhagio, (*R. colum-*

[r] Much of the information here collected is taken from Reaum. iv, *Mem.* 12; and Clark in *Linn. Trans.* iii. 289.

[s] The writer of the present letter is possessor of this specimen, which he took on himself in a field where oxen were feeding.

baschensis,) and Latreille as a Simulium. Perhaps neither of these authors may be right; for, from the mischief it does to cattle in particular districts, it must be furnished with the means of penetrating the skin of certain parts of the animal; (Latreille relates that he suffered great pain from the bite of this insect himself;) yet it is evident from the accounts of Linne and Ulloa before quoted, that the Simulium does not bite, but is only troublesome on account of the itching it occasions. It does not appear indeed, from Latreille's characters, to have oral instruments proper for piercing. Similar reasons prove that it can scarcely be a *Rhagio* —but to whatever genus it may belong, it is certainly a most destructive little creature. In Servia and the Bannat it attacks the cattle in infinite numbers, penetrates their generative organs, and by its poisonous bite destroys them in the short space of four or five hours[t].—Tabani in this country do not seem to annoy our oxen so much as they do our horses: perhaps for this immunity they may be indebted to the thickness of their hides; but in some parts of Africa insects of this tribe do incredible mischief. What would you think, should you be told that one species of fly drives both inhabitants and their cattle from a whole district? Yet the terrible *Tsalt-salya* or *Zimb* of Bruce,—and the world seems now disposed to give more credit to the accounts of that traveller,—has power to produce such an effect. This fly, which is a native of Abyssinia, both from its habits and the figure, appears to belong to Latreille's genus *Pangonia*, taken from

[t] Fabr. *Ent. Syst. Em.* iv. 276. 22. Latr. *Hist. Nat.* &c. xiv. 283.

Tabanus, L., and perhaps is congenerous with the *Oestrus* of the Greeks[u].

Small as this insect is, we must acknowledge the elephant, rhinoceros, lion and tiger vastly his inferior. The appearance, nay the very sound of it occasions more trepidation, movements and disorder both in the human and brute creation, than whole herds of the most ferocious wild beasts in tenfold greater numbers than they ever are would produce. As soon as this plague appears, and their buzzing is heard, all the cattle forsake their food, and run wildly about the plain

[u] It is by no means clear that the *Oestrus* of modern entomologists is synonymous with the insects which the Greeks distinguish by that name. Aristotle not only describes these as *blood-suckers*, (*Hist. Animal.* l. viii. c. 11.) but also as furnished with a *strong proboscis* (l. iv. c. 7.). He observes likewise that they are produced from an animal inhabiting the *waters*, in the vicinity of which they most abound (l. viii. c. 7.). And Ælian (*Hist.* l. vi. c. 38) gives nearly the same account. Comparing the Oestrus with the Myops (synonymous perhaps with *Tabanus*, Latr., except that Aristotle affirms that its larvæ live in wood, l. v. c. 19.) he says, the Oestrus for a fly is one of the largest; it has a stiff and large sting, (meaning a proboscis,) and emits a certain humming and harsh sound—but the Myops is like the Cynomyia—it hums more loudly than the Oestrus, though it has a smaller sting.

These characters and circumstances do not at all agree with the modern Oestrus, which, so far from being a blood-sucker furnished with a strong proboscis, has scarcely any mouth. It shuns also the vicinity of water, to which our cattle generally fly as a refuge from it. It seems more probable that the Oestrus of Greece was related to Bruce's *Zimb*, represented in his figure with a long proboscis, which makes its appearance in the neighbourhood of rivers, and belongs, perhaps, to Latreille's genus *Pangonia*, as observed above, (*Tanyglossa*, Meig.) or to his *Nemestrina*. Olivier, indeed, speaks of the former genus as frequenting flowers like the Bombylii; but this the male Tabani do, while the females are furious blood-suckers. See Latr. *Hist. Nat.* xiv. 318; and *Gen. Crust. & Ins.* iv. 281, 307. K.

till they die worn out with fatigue, fright, and hunger. No remedy remains for the residents on such spots but to leave the black earth and hasten down to the sands of Albara, and there they remain while the rains last. Camels, and even elephants and rhinoceroses, though the two last coat themselves with an armour of mud, are attacked by this winged assassin and afflicted with numerous tumours. All the inhabitants of the sea-coast of Melinda down to Cape Gardefan, to Saba and the south of the Red Sea, are obliged in the beginning of the rainy season to remove to the next sand to prevent all their stock of cattle from being destroyed. This is no partial emigration—the inhabitants of all the countries from the mountains of Abyssinia northward, to the confluence of the Nile and Astaboras, are once a year obliged to change their abode and seek protection in the sands of Beja; nor is there any alternative or means of avoiding this, though a hostile band were in the way capable of spoiling them of half their substance[v]. This fly is truly a Beelzebub[w]; and perhaps it was this, or some species related to it, that was the prototype of the Philistine idol worshipped under that name and in the form of a fly.

I must not conclude this subject of insects hurtful to our cattle without noticing one much talked of by the ancients for its mischievous properties in this respect. You will soon and rightly conjecture that I am speaking of the *Buprestis*[x], so called from the injury

[v] Bruce's *Travels*, 8vo. ii. 315.

[w] Heb. בעל זבוב literally "Lord-Fly." See 2 Kings, i. 2; and Bochart. *Hierozoic.* ps. ii. l. 4. c. 9. p. 490.

[x] *Burn-Cow* or *Ox*, from βȣς and πρηθω inflammo. M. Latreille translates it *Crève-bœuf*, but improperly.

which it has been supposed to occasion to oxen or kine.

Modern writers have been much divided in their opinion to what genus this celebrated insect belongs. All indeed have regarded it as of the Coleoptera order; but here their agreement ceases. Linné should seem to have looked upon it as a species of the genus to which he has given its name; but these, being timber insects, are not very likely to be swallowed by cattle with their food. Geoffroy thinks it to be a *Carabus* or *Cicindela*, but with as little reason, since the species of these genera do not feed amongst the herbage; and though they are sometimes found running there, yet their motions are so rapid, that it is not very likely that cattle would often swallow them while feeding.

M. Latreille, in an ingenious essay on this insect[y], suspects it to belong to the genus *Meloë*, F.; and as this feeds upon herbs, (*M. Proscarabæus*, L. and *M. violaceus*, E. B. upon the Ranunculi, so widely disseminated in our pastures,) his opinion seems to rest upon more solid grounds than that of his predecessors: but yet I think the insect in question rather belongs to *Mylabris*, F. and for the following reason.

In order rightly to ascertain what insect this really was, we must endeavour to trace it in the country in which it received its name and character. This country was certainly Greece; and there such an animal, retaining nearly its old name, and accused of being the cause of the same injury to cattle, still exists. For Belon informs us that on Mount Athos there is found a winged insect like the blister-beetle, but yellow,

[y] *Annales du Muscum*—X[e] Ann. N° xi. p. 129.

larger, and of a very offensive smell, which feeds upon various plants, and is called by the Caloyers or Monks *Voupristi*, who assert that when horses or other cattle even feed upon the herbs which the animals have touched they die from inflammation, and that it is an immediate poison to oxen[z]. This therefore most probably was the Buprestis of the Greek writers; and as Pliny usually compiled from them, it may be regarded as his also, which he tells us was a caustic insect and prepared in the same manner as the Blister-fly[a]. He further observes that it was scarce in Italy. The Greek insect of Mount Athos M. Latreille supposes to be a Mylabris, and in this I agree with him; and therefore this is the proper genus to which the original Greek Buprestis, the true type of the insect in question, ought to be referred, and not Meloë.

Whether this animal be really guilty to the extent of which it is accused admits of considerable doubt; but as I have not the means of ascertaining this, I shall leave the question for others who are better informed to decide.

But, of all our cattle, none are more valuable and important to us than our *flocks;* to them we look not only for a principal part of our food, but also for clothing and even light. Thick as is their coat of wool, it does not shield them from the attack of all-subduing insects: on the contrary it affords a comfortable shelter to one of their enemies of this class, regarded by Linné as a species of *Hippobosca*, but properly sepa-

[z] *Observations de plusieurs Singularités &c.* l. i. c. 45. p. 73, of the Edition in Sir Jos. Banks's Library.

[a] *Hist. Nat.* l. xxix. c. 4.

rated from that genus by Latreille under the name of *Melophagus*. This is commonly called the sheep-louse, and is so tenacious of life that we are told by Ray it will exist in a fleece twelve months after it is shorn, and its excrements are said to give a green tinge to the wool very difficult to be discharged.—You have doubtless often observed in the heat of the day the sheep shaking their heads and striking the ground violently with their fore feet; or running away and getting into ruts, dry dusty spots or gravel pits, where crowding together they hold their noses close to the ground. The object of all these actions and movements is to keep the gad-fly appropriated to them (*Oe. Ovis*, L.) from getting at their nostrils, on the inner margin of which they lay their eggs, from whence the maggots make their way into the head, feeding in the maxillary and frontal sinuses on the mucilage there produced. When full-grown, they fall through the nostrils to the ground and assume the pupa. Whether the animal suffers much pain from these troublesome assailants is not ascertained. Sometimes the maggots make their way even into the brain. I have been informed by a very accurate and intelligent friend, that, on opening the head of one of his sheep which died in consequence of a vertigo, three maggots were found in it in a line just above the eyes, and that behind them there was a bladder of water.—Perhaps you are not aware that the bots we are speaking of, or rather those in the head of goats, have been prescribed as a remedy for the epilepsy, and that from the tripod of Delphos. Yet so we are told on the authority of Alexander Trallien. Whether Democrates, who consulted the oracle, was cured by this remedy does not appear: the story shows however that the ancients were aware of the station of these larvæ.—The common saying that a whimsical person is *maggoty*, or has got *maggots in his head*, perhaps arose from the freaks the sheep have been observed to exhibit when infested by their bots.—The flesh-fly is also a great annoyance to the fleecy tribe, especially in fenny countries; and if constant attention be not paid them, they are soon devoured by its insatiable larvæ. In Lincolnshire, the principal profit of the druggists is derived from the sale of a mercurial ointment used to destroy them. —In tropical countries the sheep frequently suffer from the ants. Bosman relates that when in Guinea, if one of his was attacked by them in the night, which often happened, it was invariably destroyed, and was so expeditiously devoured that in the morning only the carcase would be left.

Of all our domestic animals the least infested by insects, I mean as to the number of species that attack it, is the *swine*. With the exception of its louse, which seems to annoy it principally by exciting a violent itching, it is exposed to scarcely any other plague of this class, unless we may suppose that it is the biting of flies, which in hot weather drives it to "its wallowing in the mire."

Under this head we may include the *deer* tribe, for, though often wild, those kept in parks may strictly be deemed domestic; and the rein-deer is quite as much so to the Laplander, as our oxen and kine are to us. We learn from Reaumur that the fallow-deer is subject to the attack of two species of gad-fly: one, which, like that of the ox, deposits its eggs in an orifice it makes in the skin of the animal, and so produces tumours; and another in imitation of that of the sheep, ovipositing in such a manner that its larvæ when hatched can make their way into the head, where they take their station in a cavity near the pharynx. He relates a curious notion of the hunters with respect to these two species. Conceiving them both to be the same, they imagine that they mine for themselves a painful path under the skin to the root of the horns; which is their common rendezvous from all parts of the body; where by uniting their labours and gnawing indefatigably, they occasion the annual casting of these ornamental as well as powerful arms. This fable, improbable and ridiculous as it is, has had the sanction of grave authorities[b].—The Oestri last mentioned inhabit, in considerable numbers, two fleshy bags as big as a hen's egg, and of a similar shape, near the root of the tongue. Reaumur took between sixty and seventy bots from one of them, and even then some had escaped. What other purpose these two remarkable purses are intended to answer it is not easy to conjecture. He supposes that the parent fly must enter the nostrils of the deer, and pass down the air passages to oviposit in them: but probably such a manœuvre is unnecessary, since there seems no reason, supposing the eggs to be laid in the nostrils, why the larva when hatched cannot itself make its way down to the above station, as easily as that of the sheep into the maxillary sinuses. Or, which perhaps is more likely, when the animal

[b] Reaum. v. 69. *Dictionnaire de Trevoux, article* Cerf.

draws in the air, the eggs or larvæ may be carried down with it, in both cases, to the place assigned to them by Providence[c].

No animal, however, is so cruelly tormented by Oestri as the Rein-deer; for besides one synonymous apparently with this of the deer (*Oe. nasalis*, L.) from which they endeavour to relieve themselves by snorting and blowing[d], they have a second which produces bots under their skin: not improbably the same species that in a similar way attacks the latter, as I have stated above. We have heard that the vaccine disease is derived from the cow and the horse, and the small pox is said to have originated in the heels of the camel: but neither the ingenious Dr. Jenner nor any other writer on this subject has informed us that the rein-deer is subject to the distemper last named; yet Linné quotes the learned work of a Swedish physician on *Syphilis*, who gravely gives this as a fact[e]!! The inoculator, in truth, is the gad-fly, the tumours it causes are the pustules, and its larvæ are the pus.—It is astonishing how dreadfully these poor animals in hot weather are terrified and injured by them: ten of these flies will put a herd of five hundred into the greatest

[c] For the account of the Oestrus of the deer, see Reaum. *ibid.* 67-77.

[d] Linn. *Lach. Lapp.* ii. 45. In the passage here referred to, Linne speaks of two species of Oestrus, though the mode of expression indicates that he considered them as the same. One was *Oe. nasalis* from which they freed themselves by snorting &c., the other *Oe. Tarandi* which formed the pustules in their backs. In *Syst. Nat.* 969. 3. he strangely observes under the former species, "*Habitat in equorum* fauce, per nares intrans!" confounding probably *Oe. veterinus* of Mr. Clark with the true *Oe. nasalis*. K.

[e] *Lach. Lapp.* i. 280.

agitation. They cannot stand still a minute, no not a moment, without changing their posture, puffing and blowing, sneezing and snorting, stamping and tossing continually; every individual trembling and pushing its neighbour about. The ovipositor of this fly is similar to that of the ox-breese, consisting of several tubular joints which slip into each other; and therefore Linné was probably mistaken in supposing that it lays its eggs *upon* the skin of the animal, and that the bot, when it appears, eats its way through it[f]: there can be little doubt (or else what is the use of such an apparatus?) that it bores a hole in the skin and there deposits the eggs. About the beginning of July the rein-deer sheds its hair, which then stands erect—at this time the fly is always fluttering about it, and takes its opportunity to oviposit. The bots remain under the skin through the whole winter, and grow to the size of an acorn. Six or eight of these are often to be found in a single rein-deer that has only seen one winter; and these so emaciate them, that frequently one third of their number perish in consequence of it. Even those that are full grown suffer greatly from this insect. The fly follows the animals over precipices, valleys, the snow-covered mountains, and even the highest alps; to which in order to avoid it they often fly with great swiftness in a direction contrary to the wind. By this constant agitation and endeavour to escape from the attack of their enemy they are kept from eating during the day, standing always upon the watch, with erect ears and attentive eyes, that they

[f] *Flor. Lapp.* 379.

may observe whether it comes near them[g]. The rein-deer are teased also by a peculiar species of Tabanus (*T. tarandinus*, L.) which, by a singular instinct, instead of their skin, makes its incision in their horns when tender.

Our *dogs*, the faithful guardians of our other domestic animals and possessions, the attached companions of our walks, and instruments of many of our pleasures and amusements, cannot defend themselves from insect annoyance. They have their peculiar louse, and the flea sucks their blood in common with that of their master: you must also often have noticed how much they suffer from the dog-tick, which, when once it has fixed itself in their flesh, will in a short time, from the size of a pin's head, so swell itself out by gorging their blood, that it will equal in dimensions what is called the tick-bean. In the West Indies these ticks, or one like them, get into the ears and head of the dogs, and so annoy them and wear them out that they either die or are obliged to be killed[h].

Some of the most esteemed dainties of our tables are supplied from such of the winged part of the creation as we have domesticated. These also have a louse (*Ricinus*, De Geer) appropriated to them, and the gorgeous Peacock is infested by one of extraordinary dimensions and singular form. Pigeons, in addition, often swarm with the bed-bug, which makes it advisable never to have their lockers fixed to a dwelling-house. In their young, if your curiosity urges you to

[g] Linn. *Flor. Lapp.* 379. [h] Mr. Kittoe.

examine them, you may find the larva of the flea. In its perfect state it often swarms in poultry.

Amongst our most valuable domestic animals I shall be very unjust and ungrateful, if I do not enumerate those industrious little creatures the *bees*, from whose incessant labours and heaven-taught art we derive the two precious productions of honey and wax. They also are infested by numerous insect-enemies, some of which attack the bees themselves, while others despoil them of their treasures.—They have parasites of a peculiar genus, although at present regarded as belonging to Pediculus[1], and mites (*Acarus gymnopterorum*, L.) are frequently injurious to them. That universal plunderer the wasp, and his formidable congener the hornet, often seize and devour them, sometimes ripping open their body to come at the honey, and at others carrying off that part in which it is situated. The former frequently take possession of a hive, having either destroyed or driven away its inhabitants, and consume all the honey it contains. Nay there are cer-

[1] *Melittophagus*, Mus. Kirby. See *Mon. Ap. Angl.* ii. 168. I copy the following memorandum respecting *M. Melittæ* from my common-place-book, May 7, 1812. On the flowers of Ficaria, Taraxicum and Bellis, I found a great number of this insect, which seemed extremely restless, running here and there over the flowers, and over each other, with great swiftness, mounting the anthers, and sometimes lifting themselves up above them, as if looking for something. One or two of them leaped upon my hand. Near one of these flowers I found a small Melitta, upon which some of these creatures were busy sucking the poor animal, so that it seemed unable to fly away. When disclosed from the egg, I imagine they get on the top of these flowers to attach themselves to any Melitta that may alight on them, or come sufficiently near for them to leap on it. K.

tain idlers of their own species, called by Apiarists Corsair-bees, which plunder the hives of the industrious.—From the curious account which Latreille has given us of *Philanthus apivorus* it appears that great havoc is made by it of the unsuspecting neuters, which it seizes while intent upon their daily labours, and carries off to feed its young[k]. Another insect, never till lately suspected of marauding propensities, must here be introduced. M. Huber discovered in 1804, that the death's-head hawk-moth, (*Sphinx Atropos*, L.) before celebrated as the innocent cause of alarm[l], had made its way into his hives and those of his vicinity, and had robbed them of their honey. This moth has the faculty of emitting a remarkable sound, which he supposes may produce an effect upon the bees of a hive somewhat similar to that caused by the voice of their queen, which as soon as uttered strikes them motionless, and thus it may be enabled to commit with impunity such devastation in the midst of myriads of armed bands[m]. The larvæ of two species of moth (*Tortrix cereana*, F., and *Tinea melonella*, F.) exhibit equal hardihood with equal impunity. They indeed pass the whole of their initiatory state in the midst of the combs. Yet in spite of the stings of the bees of a whole republic, they continue their depredations unmolested, sheltering themselves in tubes made of grains of wax, and lined with silken tapestry, spun and wove by themselves, which the bees (however disposed they

[k] Latreille, *Hist. des Fourmis*, 307-20.

[l] See above, p. 35.

[m] Huber. *Pref.* xi-xiii.

may be to revenge the mischief which they do them, by devouring, what to all other animals would be indigestible, their wax,) are unable to penetrate. These larvæ are sometimes so numerous in a hive, and commit such extensive ravages, as to oblige the poor bees to desert it and seek another habitation.

I shall not delay you longer upon this subject by detailing what *wild animals* suffer from insects, further than by observing that the two creatures of this description in which we seem rather interested, the *hare* and the *rabbit*, do not escape their attack. The hare in Lapland is more tormented by the gnats than any other quadruped. To avoid this pest it is obliged to leave the cover of the woods in full day, and seek the plains: hence the hunters say—that of three litters which a hare produces in a year—the first dies by the cold, the second by gnats, and only the third escapes and comes to maturity[n].—We learn from the ingenious Mr. Clark, that the American rabbit and hare are infested by the largest species of Oestrus yet discovered; and our domestic rabbits sometimes swarm with the bed-bug. This was the case with some kept by two young gentlemen at my house last summer to such a degree, that I was obliged to have them killed.

Nor are the *inhabitants of the waters* sheltered by their peculiar element from these universal assailants. The larvæ of Dytisci fixing themselves by their suctorious mandibles to the body of *fish*, doubtless destroy an infinite number of the young fry of our

[n] De Geer, ii. 83.

ponds. Some species of Salmon (*Salmo Fario*, L.) are the food of an animal which Linnė has arranged under Pediculus; and probably many others of the finny tribes may, like the birds, have their peculiar parasites. Even *shell-fish* do not escape, for the *Nymphon grossipes*, Latr. enters the shell of the muscle and devours its inhabitant.

I am, &c.

LETTER VI.

INJURIES CAUSED BY INSECTS.

INDIRECT INJURIES CONTINUED.

Having endeavoured to give you some idea of the mode in which insects establish and maintain their empire over man and his train of dependent animals, I shall next call your attention to his *living* vegetable possessions, whether the produce of the forest, the field, or the garden; whether necessary to him for his support, convenient for his use, or ministering to his comfort, pleasure and delight:—and here you will find these little creatures as busily engaged in the work of mischief as ever, destroying what is necessary, deranging what is convenient, marring what is beautiful, and turning what should give us pleasure into an object of disgust.

Let us begin with the produce of our *fields*.—Bread is called "the staff of life:" yet should Divine Providence in anger be pleased to give the rein to the various insects which, in the different stages of its growth, attack the plant producing it, how quickly would this staff be broken! From the moment that *wheat* begins to emerge from the soil, to the time when it is carried into the barn, it is exposed to their ravages. One of its earliest assailants in this country is that of which Mr. Walford has given an account in the Linnean Transactions, taking it for the wire-worm; but, as Mr. Marsham observed, not correctly; it being probably the larva of some coleopterous insect, perhaps of one of the numerous tribe of *Staphylinidæ*, which are not universally carnivorous. This animal was discovered to infest the wheat in its earliest stage of growth after vegetation had commenced; and there was reason to believe that it began even with the grain itself. It eats into the young plant about an inch below the surface, devouring the central part; and thus, vegetation being stopped, it dies. Out of fifty acres sown with this grain in 1802, ten had been destroyed by the grub in question so early as October[o].

Mr. Markwick has given us the history of a fly that attacks wheat in a later period of its growth, which, if it be not indeed the same, appears to be nearly related to the *Musca Pumilionis* of Bierkander[p], accused by him of being extremely injurious to rye in the spring. Our insect was discovered on the first sown wheats early in that season, making its lodgement in the very heart of the principal stem just above the root, which stem it invariably destroyed, giving the crop at first a most unpromising appearance, so that there seemed scarcely a hope of any produce. But it proved in this

[o] *Linn. Trans.* ix. 156-61.

[p] *Act. Stockh.* 1778. 3. n. 11. and 4. n. 4. Marsham in *Linn. Trans.* ii. 79. This insect probably belongs to Latreille's genus *Mosillus*, and seems related to *Mosillus arcuatus*, *Gen. Crust. & Ins.* iv. 357.

and other instances that year (1791) that the plant, instead of being injured, derived great benefit from this circumstance; for, the main stem perishing, the root (which was not hurt) threw out fresh shoots on every side, so as to yield a more abundant crop than in other fields where the insect had not been busy. These flies therefore seem to belong to our insect benefactors; and I should not have introduced them here, had it not been probable that in some instances later in the spring they may attack the lateral shoots of the wheat, and so be injurious. It is also not unlikely that the new progeny, which is disclosed in May, may oviposit in barley or some other spring corn, which would bring the next generation out in time for the wheat sown in the autumn.—These flies are amongst the last, and, in some seasons, the most numerous, that take shelter in the windows of our apartments when the first frosts indicate the approach of winter, previous to their becoming torpid during that season. When this little animal was first observed in England, it created no small alarm amongst agriculturists lest it should prove to be the *Hessian fly*, so notorious for its depredations in North America; but Mr. Marsham, by tracing out the species, proved the alarm to be unfounded[q]. That there was sufficient cause for apprehension, should it have so turned out, what I have formerly stated concerning the latter insect, and the additional facts which I shall now adduce, will amply show.

The ravages of the animal just alluded to, which was first noticed in 1776, and received its name from

[q] *Linn. Trans.* ii. 76-80.

an erroneous idea that it was carried by the Hessian troops in their straw from Germany, were at one time so universal as to threaten, where it appeared, the total abolition of the culture of wheat; though, by recent accounts, the injury which it now occasions is much less than at first. It commences its depredations in autumn, as soon as the plant begins to appear above ground, when it devours the leaf and stem with equal voracity until stopped by the frost. When the return of spring brings a milder temperature the fly appears again, and deposits its eggs in the heart of the main stems, which it perforates and so weakens, that when the ear begins to grow heavy, and is about to go into the milky state, they break down and perish. All the crops, as far as it extended its flight, fell before this ravager. It first showed itself in Long-Island, from whence it proceeded inland at about the rate of fifteen or twenty miles annually, and by the year 1789 had reached 200 miles from its original station. I must observe, however, that some accounts state its progress at first to have been very slow, at the rate only of seven miles per annum, and the damage inconsiderable; and that the wheat crops were not materially injured by it before the year 1788. Though these insect hordes traverse such a tract of country in the course of the year, their flights are not more than five or six feet at a time. Nothing intercepts them in their destructive career, neither mountains nor the broadest rivers. They were seen to cross the Delaware like a cloud. The numbers of this fly were so great, that in wheat-harvest the houses swarmed with them to the extreme annoyance of the inhabitants. They filled every plate or vessel that was in use; and five hundred were counted in a single glass tumbler exposed to them a few minutes with a little beer in it[r].

America suffers also in its wheat and maize from the attack of an insect of a different order; which, for what reason I know not, is called the chintz-bug-fly. It appears to be apterous, and is said in scent and colour to resemble the bed-bug. They travel in immense columns from field to field, like locusts destroying every thing as they proceed; but their injuries are confined to the states south of the 40th degree of north latitude[s]. From this account the depredator here noticed should belong to the tribe of *Cimicidæ*; but it seems very difficult to conceive how an insect that lives by suction, and has no mandibles, could destroy these plants so totally.

When the wheat blossoms, another marauder, to which Mr. Marsham first called the attention of the public, takes its turn to make an attack upon it, under the form of an orange-coloured gnat, which, introducing its long retractile ovipositor into the centre of the corolla, there deposits its eggs. These being hatched, the larvæ, perhaps by eating the pollen, prevent the impregnation of the grain, and so in some seasons destroy the twentieth part of the crop[t].

One would think, when laid up in the barn or in the granary, that wheat would be secure from injury; but even there the weevil (*Calandra granaria*, F.), in its

[r] *Encyclopæd. Britann.* viii. 489-95.

[s] Young's *Annals of Agriculture*, xi. 471.

[t] *Tipula Tritici*, K. belonging to Latreille's genus *Cecidomya*. Marsham and Kirby in *Linn. Trans.* iii. 242-5. iv. 224-39. v. 96-110.

imago as well as in its larva state, devours it; and sometimes this pest becomes so infinitely numerous, that a sensible man, engaged in the brewing trade, once told me, speaking perhaps rather hyperbolically, that they collected and destroyed them by bushels; and no wonder, for a single pair of these destroyers may produce in one year above 6000 descendants.—There are three other insects that attack the stored wheat, which are more injurious to it than even the weevil. One is a minute species of moth, (*Tinea granella*, F.,) happily not much if at all known in this country; of which Leeuwenhoek has given us a full history under the name of the wolf. Another is a species of the same genus, at present not named, which, as we are informed by Du Hamel, at one time committed dreadful ravages in the province of Angoumois in France. The third is *Trogosita caraboides*, F., a kind of beetle, the grub of which called *Cadelle*, Olivier tells us, did more damage to the housed grain in the southern provinces of France than either the weevil or the wolf [u].—Here I may just mention a few other insects which devour grains that are the food of man, concerning which I have collected no other facts. The rice-weevil (*Calandra Oryzæ*, F.) is very injurious to the useful grain after which it is named, as is likewise another small beetle, *Lyctus dentatus*, F.; and an Indian grain, called in the country *Joharré*, which appears to be a species of Holcus or Milium, is the apropriate food of another species of Calandra [v], which I found abundant in it.

[u] Oliv. ii. n. 19. 3-4.

[v] *Curculio testaceus*, Ent. Brit.

Rye, in this island, is an article of less importance than wheat; but in some parts of the continent it forms a principal portion of the bread-corn. Providence has also appointed the insect means of causing a scarcity of this species of food. The fly before noticed (*Musca Pumilionis*) introduces its eggs into the heart of the shoots of rye, and occasions so many to perish, that from eight to fourteen are lost in a square of two feet.—A small moth also (*Pyralis Secalis*, F.) which eats the culm of this plant within the vagina, thus destroys many ears[w]. In common with wheat and barley it also suffers from Leeuwenhoek's wolf and the weevil.

Barley likewise, another of our most valuable grains, has several insect foes. The gelatinous larva of a saw-fly (*Tenthredo*, L.) preys upon the upper surface of the leaves, and so occasions them to wither. *Musca Hordei* of Bierkander also assails the plant. A tenth part of the produce of this grain, Linné affirms, is annually destroyed in Sweden by another fly, not yet discovered in Britain, (*Musca Frit*, L.,) which does the mischief by getting into the ear.—A small species of moth described by Reaumur, though not named by Linné, which may be called *Tinea Hordei*, devours the grain when laid up in the granary. This fly deposits several eggs, perhaps twenty or thirty, on a single grain; but as one grain only is to be the portion of one larva, they disperse when hatched, each selecting one for itself, which it enters from without at a place more

[w] Marsham in *Linn. Trans.* ii. 80. De Geer notices the injury done by this fly to Rye, and observes that before it had been attributed to frost. ii. 68.

tender than the rest;—and this single grain furnishes a sufficient supply of food to support the caterpillar till it is ready to assume the pupa. Concealed within this contracted habitation, the little animal does nothing that may betray it to the watchful eye of man, not even ejecting its excrements from its habitation; so that there may be millions within a heap of corn, where you would not suspect there was one[x].

I have not observed that *oats* suffer from insects, except from the universal subterranean destroyer of the grasses, the wire-worm, of which I shall give you a more full account hereafter. The only important grain that now remains unnoticed is the *maize* or Indian corn. Besides the chintz-bug-fly, a little beetle (*Phaleria cornuta*, Latr.) appears to devour it; and it has probably other unrecorded enemies[y].

Next to grain *pulse* is useful to us both when cultivated in our gardens and in our fields. Peas and beans, which form so material a part of the produce of the farm, are exposed to the attack of a numerous host of insect depredators; indeed the former, on account of their ravages, is one of the most uncertain of our crops. The animals from which in this country both these plants suffer most are the *Aphides*, commonly called Leaf-lice. As almost every animal has its peculiar *louse*, so has almost every plant its peculiar *leaf-louse*; and, next to locusts, these are the greatest enemies of the vegetable world, and like them are sometimes so nu-

[x] *Act. Stockh.* 1750. 128. Reaumur ii. 480 &c.

[y] This insect was taken in Maize by Mr. Sparshall of Norwich.

merous as to darken the air[z]. The multiplication of these little creatures is infinite and almost incredible. Providence has endued them with privileges promoting fecundity, which no other insects possess: at one time they are viviparous, at another oviparous; and, what is most remarkable and without parallel, the sexual intercourse of one original pair serves for all the generations which proceed from the female for a whole succeeding year. Reaumur has proved that in five generations one Aphis may be the progenitor of 5,904,900,000 descendants; and it is supposed that in one year there may be twenty generations[a]. This astonishing fecundity exceeds that of any known animal; and we cannot wonder that a creature so prolific should be proportionably injurious: some species, however, seem more so than others. Those that attack wheat, oats, and barley, of which there are more kinds than one, seldom multiply so fast as to be very noxious to those plants; while those which attack pulse spread so rapidly, and take such entire possession, that the crop is greatly injured, and sometimes destroyed by it. This was the case with respect to peas in the year 1810, when the produce was not much more than the seed sown; and many farmers turned their swine into their pea-fields, not thinking them worth harvesting. The damage in this instance was caused solely by the Aphis, and was universal throughout the kingdom, so that a sufficient supply for the navy could not be ob-

[z] I say this upon the authority of Mr. Wolnough of Alderton (late of Boyton) in Suffolk, an intelligent agriculturist, and a most acute and accurate observer of nature. [a] Reaum. vi. 566.

tained. The earlier peas are sown, the better chance they stand of escaping, at least in part, the effects of this vegetable Phthiriasis.—Beans are also often great sufferers from another species of leaf-louse, in some districts from its black colour called the *Collier*, which begins at the top of the plant, and so keeps multiplying downwards. The best remedy in this case, which also tends to set the beans well, and improves both their quality and quantity, is to top them as soon as the Aphides begin to appear, and carrying away the tops to burn[b] or bury them.—In a late stage of growth great havoc is often made in peas by the grub of a small beetle, (*Bruchus granarius*, L.,) which will sometimes lay an egg in every pea of a pod, and thus destroy it. —Something similar I have been told (I suspect it is a short-snouted weevil) occasionally injures beans. In this country, however, the mischief caused by the Bruchus is seldom very serious; but in North America another species (*B. Pisi*, L.) is most alarmingly destructive, its ravages being at one time so universal as to put an end in some places to the cultivation of that favourite pulse. No wonder then that Kalm should have been thrown into such a trepidation upon discovering some of these pestilent insects just disclosed in a parcel of peas he had brought from that country, lest he should be the instrument of introducing so fatal an evil into his beloved Sweden[c]. In the year 1780 an alarm was spread in some parts of France, that people had been poisoned by eating worm-eaten peas; and they were forbidden by authority to be exposed for

[b] Where there is a large breadth of beans the ashes thus produced would make good manure.

[c] Kalm's *Travels*, i. 173.

sale in the market: but the fears of the public were soon removed by the examination of some scientific men, who found the cause of the injury to be the insect of which I am now speaking[d]. Another species of Bruchus (*B. pectinicornis*, L.) devours the peas in China and Barbary. Molina, in his History of Chili, tells us of a Lucanus, which he names *L. Pilmus*, that infests the beans in that country;—a circumstance quite at variance with the habits of the *Lucanidæ*, which all prey upon timber. This insect was probably a Phaleria, Latr., in which genus the mandibles are protruded from the head like those of Lucanus; and one species, as we have seen above, feeds upon maize.

Great profits are sometimes derived by farmers from their crops of *clover-seed:* but this does not happen very often; for a small weevil, (*Apion flavifemoratum*), which abounds every where at almost all times of the year, feeds upon the seed of the purple clover, and in most seasons does the crop considerable damage; so that a plant of the fairest appearance will, in consequence of the voracity of this little enemy, produce scarcely any thing. Another species (*Apion flavipes*) infests the Dutch or white clover[e].

But not only, if let loose to the work of destruction, might insects annihilate our grain and pulse; they would also deprive the earth of that beautiful green carpet that now covers it, and is so agreeable and so refreshing to the sight. When you see a large tract of land lying fallow, as is sometimes the case in open

[d] Amoreux, 288.

[e] Markwick, Marsham and Lehmann in *Linn. Trans.* vi. 142.—and Kirby in ditto, ix. 37, 42. n. 19. 23.

districts, with no intervening patches of verdure, how unpleasant and uncomfortable is it to your eye! What then would be your sensations, were the whole face of the earth bare, and not dressed by Flora? But such a state of things would soon take place, if to punish us, or to teach us thankfulness to the great Arbiter of our fate, the insects that feed upon the *grass* of our pastures were to become as generally numerous as they are occasionally permitted to do. One of the worst of these ravagers is the grub of the common cockchafer (*Melolontha vulgaris*, F.). This insect, which is found to remain in the *larva* state four years, sometimes destroys whole acres of grass, as I can aver from my own observation. It undermines the richest meadows, and so loosens the turf that it will roll up as if cut with a turfing-spade. These grubs did so much injury about seventy years ago to a poor farmer near Norwich, that the court of that city, out of compassion, allowed him 25*l*., and the man and his servant declared that he had gathered eighty bushels of the beetle [f]. In the year 1785 many provinces of France were so ravaged by them, that a premium was offered by the government for the best mode of destroying them. They do not confine themselves to grass, but eat also the roots of corn; and it is to feast upon this grub more particularly that the rooks follow the plow.

The larva also of another species of this genus (*Melolontha pulverulenta*, F.) is extremely destructive in moist meadows, rooting under the herbage, so that, the soil becoming loose, the grass soon withers and dies.

[f] *Philos. Trans.* 1741. 581.

Swine are very fond of these grubs, and will devour vast numbers of them, and the rooks lend their assistance.

Amongst the Lepidoptera, the greatest enemy of our pastures is the *Bombyx Graminis*, F. which, however, is said not to touch the foxtail grass. In the years 1740, 1741, 1742, they multiplied so prodigiously and committed such ravages in many provinces of Sweden, that the meadows became quite white and dry as if a fire had passed over them[g]. This destructive insect, though found in this country, is luckily scarce amongst us; but our northern neighbours appear occasionally to have suffered greatly from it. In 1759, and again in 1802, the high sheep farms in Tweedale were dreadfully infested by a caterpillar, which was probably the larva of this moth; spots of a mile square were totally covered by them, and the grass devoured to the root[h].

Most of the insects I have hitherto mentioned attack our crops partially, confining themselves to one or two kinds only; but there are some species which extend their ravages indifferently to *all*. Of this description is the *Phalæna frumentalis*, L. which Pallas tells us is an almost universal pest in the government of Kasan in Russia, often eating the greater part of the spring corn to the root[i]. To this we are fortunately strangers; but another, well known by the name of the wire-worm, causes annually a large diminution of the produce of our fields, destroying indiscriminately wheat, rye, oats and grass. This insect, which has its

[g] De Geer, ii. 341. [h] *Farmer's Mag.* iii. 487.

[i] Pallas's *Travels in South Russia*, i. 30.

name apparently from its slender form, and uncommon hardness and toughness, is the grub of a beetle termed by Linne *Elater lineatus*, but by Bierkander, to whom we are indebted for its history, *E. Segetis*[j], which name is now generally adopted. The other species, however, of the genus have similar grubs, many of which probably contribute to the mischief. When told that it lives in its first (or feeding) state not less than five years, during the greatest part of which time it is supported by devouring the roots of grain, you will not wonder that its ravages should be so extensive, and that whole crops should sometimes be cut off by it. As it abounds chiefly in newly broken up land, though the roots of the grasses supply it with food, it probably does not do any great injury to our meadows and pastures[k].

[j] Marsham in *Communications to the Board of Agriculture*, iv. 412. *Plate* xviii. *fig*. 4. and *Linn. Trans.* ix. 60.

[k] The wire-worm is particularly destructive for a few years in gardens recently converted from pasture ground. In the Botanic Garden at Hull thus circumstanced a great proportion of the annuals sown in 1813 were destroyed by it. A very simple and effectual remedy in such cases was mentioned to me by Sir Joseph Banks. He recommended that slices of potato stuck upon skewers should be buried near the seeds sown, examined every day, and the wire-worms which collect upon them in great numbers destroyed. S.

This plan of decoying destructive animals from our crops by offering them more tempting food, is excellent, and deserves to be pursued in other instances. It was very successfully employed last year (1813) by J. M. Rodwell, Esq. of Barham Hall near Ipswich, one of the most skilful and best informed agriculturists in the county of Suffolk, to preserve some of his wheat-fields from the ravages of a small gray slug, which threatened to demolish the plant. Having heard that turnips had been used with success to entice these slugs from wheat, he caused a sufficient quantity to dress eight acres to be got together; and then, the tops being divided and the apples sliced, he directed the pieces to be laid se-

Here also may be included the larva of the long-legged gnat, (*Tipula oleracea*, L.) known in many parts by the name of the *grub*, which is sometimes very prejudicial to the grass in marshy lands, and at others not less so to corn. Reaumur informs us, that in Poitou, in certain years, the grass of whole districts has been so destroyed by it, as not to produce the food necessary for the sustenance of the cattle[l]. In many parts of England, in Holderness particularly, it cuts off a large proportion of the wheat crops, especially if sown upon clover-lays[m]. Reaumur concludes from the observations he made that it lives solely upon earth, and conse-

parately, dressing two stetches with them and omitting two alternately, till the whole field of eight acres was gone over. On the following morning he employed two women to examine and free from the slugs, which they did into a measure, the tops and slices; and when cleared they were laid upon those stetches that had been omitted the day before.

It was observed invariably, that in the stetches dressed with the turnips no slugs were to be found upon the wheat or crawling upon the land, though they abounded upon the turnips; while on the undressed stetches they were to be seen in great numbers both on the wheat and on the land. The quantity of slugs thus collected was near a bushel.

Mr. Rodwell is persuaded that by this plan he saved his wheat from essential injury. K.

[l] Reaum. v. 11.

[m] Two species are confounded under the appellation of *the grub*, the larva namely of *Tipula oleracea* and *cornicina* (which last is very injurious, though not equally with the first). In the rich district of *Sunk Island* in Holderness, in the spring of the present year (1813), hundreds of acres of pasture have been entirely destroyed by them, being rendered as completely brown as if they had suffered a three months drought, and destitute of all vegetation except that of a few thistles. A square foot of the dead turf being dug up, 210 grubs were counted in it! and what furnishes a striking proof of the prolific powers of these insects, last year it was difficult to find a single one. S.

quently that the injury which it occasions, arises from its loosening the roots of corn and grass by burrowing amongst them: but my friend Mr. Stickney, the intelligent author of a treatise upon this insect, is inclined to think from his experiments that it feeds on the roots themselves. However this may be, the evil produced is evident; and it appears too from the observations of the gentleman last mentioned, that this animal is not killed by lime applied in much larger doses than usual[n].

Our national beverage ale, so valuable and heartening to the lower orders, and so infinitely preferable to ardent spirits, is indebted to another vegetable, the *hop*, for its agreeable conservative bitter. This plant so precious has numberless enemies in the Lilliputian world to which I am introducing you. Its roots are subject to the attack of the caterpillar of a singular species of moth, (*Hepialus Humuli*, F.) known to collectors by the name of the Ghost, that sometimes does them considerable injury[o].—A small beetle also (*Haltica concinna*) is particularly destructive to the tender shoots early in the year; and upon the presence or absence of Aphides, known by the name of the *fly*, as in the case of peas, the crop of every year depends: so that the hop-grower is wholly at the mercy of insects. They are the barometer that indicates the rise and fall of his wealth.

If the beer-drinker be thus interested in the history of these animals, equally so is the drinker of tea. Indeed *sugar* is an article so universally useful and

[n] Stickney's *Observations on the Grub*. [o] De Geer, i. 487.

agreeable, that what concerns the cane that produces it seems to concern every one. This also affords a tempting food to insects. The caterpillar of a white moth, called the borer, for destroying which a reward of fifty guineas is offered by the Society of Arts, is in this respect a great nuisance, as is an unknown species of horned beetle[p]. An ant also (*Formica analis*, Latr.) makes a lodgement in the interior of the sugar-cane in Guinea, and destroys it.—But the creature of this class most destructive to the sugar-cane, is one of the latter genus that does not devour it, and is therefore improperly called *Formica saccharivora* by Linné; but, by making its nest for shelter under the roots, so injures the plants that they become unhealthy and unproductive. These insects about seventy years ago appeared in such infinite hosts in the island of Granada, as to put a stop to the cultivation of this vegetable; and a reward of 20,000*l*. was offered to any one who should discover an effectual mode of destroying them. Their numbers were incredible. They descended from the hills like torrents, and the plantations as well as every path and road for miles were filled with them. Many domestic quadrupeds perished in consequence of this plague. Rats, mice, and reptiles of every kind became an easy prey to them; and even the birds, which they attacked whenever they alighted on the ground in search of food, were so harassed as to be at length unable to resist them. Streams of water opposed only a temporary obstacle to their progress, the foremost rushing blindly on to certain death, and fresh

[p] I owe this information to Robinson Kittoe, Esq.

armies instantly following, till a bank was formed of the carcases of those that were drowned sufficient to dam up the waters, and allow the main body to pass over in safety below. Even the all-devouring element of fire was tried in vain. When lighted to arrest their route, they rushed into the blaze in such myriads of millions as to extinguish it. Those that thus patriotically devoted themselves to certain death for the common good, were but as the pioneers or advanced guard of a countless army, which by their self-sacrifice was enabled to pass unimpeded and unhurt. The entire crops of standing canes were burnt down, and the earth dug up in every part of the plantations. But vain was every attempt of man to effect their destruction, till in 1780 it pleased Providence at length to annihilate them by the torrents of rain which accompanied a hurricane most fatal to the other West India Islands. This dreadful pest was thought to have been imported[q]. Besides these enemies, the sugar-cane has also its Aphis, which sometimes destroys the whole crop[r].

Two other vegetable productions of the New World, *cotton* and *tobacco*, which are also valuable articles of commerce, receive great injury from the depredations of insects. M'Kinnen, in his Tour through the West Indies, states that in 1788 and 1794 two-thirds of the crop of cotton in Crooked Island, one of the Bahamas, was destroyed by the *Chenille* (probably a lepidopterous larva); and the *red bug*, an insect equally

[q] Castle in *Philos. Trans.* xxx. 346.

[r] Browne's *Civil and Nat. Hist. of Jamaica*, 430.

noxious, stained it so much in some places as to render it of little or no value. Browne relates that in Jamaica a bug destroys whole fields of this plant, and the caterpillar of the beautiful *Papilio Cupido*, L. also feeds upon it[s]. That of the *Sphinx Carolina*, L. is the great pest of Tobacco; and it is attacked likewise by other insects of the names and kind of which I am ignorant.

Roots are another important object of agriculture, which, however, as to many of them, they may seem to be defended by the earth that covers them, do not escape the attack of insect enemies.—The carrot, which forms a valuable part of the crop of the sand-land farms in Suffolk, is often very much injured, as is also the parsnip, by a small scolopendra, (*S. electrica*, L.) and another polypod, (*Polydesmus complanatus*, Latr.) which eat into various labyrinths the upper part of their roots; and they are both sometimes totally destroyed by the maggot of some dipterous insect, probably a *Musca*. I had an opportunity of noticing this in the month of July, in the year 1812, in the garden of our valued friend the Rev. Revett Sheppard of Offton in Suffolk. The plants appeared many of them in a dying state; and upon drawing them out of the ground to ascertain the cause, these larvæ were found with their head and half of their body immersed in the root in an oblique direction, and in many instances they had eaten off the end of it.

America has made us no present more extensively beneficial, compared with which the mines of Potosi

[s] M'Kinnen, 171. Browne *ubi supr.* Merian, *Ins. Sur.* 10.

are worthless, than the *Potato*. This invaluable root, which is now so universally cultivated, is often, in this country, considerably injured by the two insects first mentioned as attacking the carrot. In America it is said to suffer much from two beetles, (*Lytta cinerea* and *vittata*, F.) of the same genus with the blister-beetle[t]; and in the island of Barbadoes some hemipterous insect, supposed to be a Tettigonia, occasionally attacks them. In 1734 and 1735 vast swarms of them devoured almost every vegetable production of that island, particularly the potato, and thus occasioned such a failure of this excellent esculent, particularly in one parish, that a collection was made throughout the island for the relief of the poor, whose principal food it forms.

The chief dependance of our farmers for the sustenance oftheir cattle in the winter is another most useful root, the *turnip*. And they have often to lament the distress occasioned by a failure in this crop, of which these minor animals are the cause. On its first coming up, as soon as the cotyledon leaves are unfolded, a whole host of little jumping beetles, composed chiefly of *Haltica nemorum* called by farmers the *fly* and *black jack*, attack and devour them; so that on account of their ravages the land is often obliged to be resown, and frequently with no better success. It has been calculated by an eminent agriculturist, that from this cause alone the loss sustained in the turnip crops in Devonshire in 1786 was not less than 100,000*l*[u]. Almost as much damage is sometimes occasioned by

[t] Illiger, *Mag.* i. 256.

[u] Young's *Annals of Agriculture*, vii. 102.

the little *Curculio contractus*, E.B., which in the same manner pierces a hole in the cuticle. When the plant is more advanced, and out of danger from these pygmy foes, the black larva of a saw-fly (*Tenthredo*, L.) takes their place, and occasionally does no little mischief, whole districts being sometimes nearly stripped by them; so that in 1783 many thousand acres were on this account ploughed up[v].—The caterpillar of the cabbage-butterfly (*Papilio Brassica*, L.) is also sometimes found upon the turnip in great numbers; and Sir Joseph Banks informs me that forty or fifty of the insects before mentioned[w], called by Mr. Walford the wire-worm, have been discovered in October just below the leaves in a single bulb of this plant.—The small knob or tubercle often observable on these roots is inhabited by a *grub*, which, from its resemblance to one found in similar knobs on the roots of *Sinapis arvensis*, from which I have bred *Rynchænus assimilis*, F., is probably the same or an allied species[x]. This, however, does not seem to affect their growth. Great mischief is occasionally done to the young plants by the wire-worm. I last summer was shown a field in which they had destroyed one-fourth of the crop, and the gentleman who showed them to me calculated that his loss by them would be 100*l*. One year he sowed a field thrice with turnips, which were twice wholly, and the third time in great part, cut off by this insect. Whether the disease to which turnips are subject, in some parts of the kingdom, from the form of the excres-

[v] Marshall in *Philos. Trans.* lxxiii. 1783. [w] See above, p. 167.

[x] Swamm. ii. 81. *col.* b.

cences into which the bulb shoots, called *fingers and toes*, be occasioned by insects, is not certainly known[y].

We have wandered long enough about the fields to observe the progress of insect devastation; let us now return home to visit the domains of Flora and Pomona, that we may see whether their subjects are exposed to equal maltreatment. If we begin with the *kitchen-garden*, we shall find that its various productions, ministering so materially to our daily comfort and enjoyment, almost all suffer more or less from the attack of the animals we are considering.—Thus, the earliest of our table dainties, radishes, are devoured by the maggot of a fly, (*Musca radicum*, L.) and our lettuces by the caterpillars of several species of moth; one of which is the beautiful tiger-moth (*Bombyx Caja*, F.), another the pot-herb-moth (*Noctua oleracea*, F.), a third anonymous, described by Reaumur as beginning at the root, eating itself a mansion in the stem, and so destroying the plant before it cabbages[z].—And when they are come to their perfection and appear fit for the table, their beauty and delicacy are often marred by the troublesome earwig, which, insinuating itself into them, defiles them with its excrements.—What more acceptable vegetable in the spring than Brocoli? Yet how dreadfully is its foliage often ravaged in the autumn by numerous hordes of the cabbage butterfly! so that, in an extensive garden, you will sometimes see nothing left of the leaves except the veins and stalks.—

[y] Spence's *Observations on the Disease in Turnips called Fingers and Toes*, Hull 1812. 8vo.

[z] Reaum. ii. 471.

What more useful, again, than the cabbage? Besides the same insect, which injures them in a similar way, in some countries they are infested by the caterpillar of a most destructive moth (*Noctua Brassicæ*, F.), to which indeed I have before alluded[a]; which, not content with the leaves, penetrates into the very heart of the plant[b].—One of the most delicate and admired of all table vegetables, concerning which gardeners are most apt to pride themselves, and bestow much pains to produce in perfection, I mean the cauliflower, is often attacked by a fly, which ovipositing in that part of the stalk covered by the earth, the maggots when hatched occasion the plant to wither and die, or to produce a worthless head[c]. Even when the head is good and handsome, if not carefully examined previous to being cooked, it is often rendered disgusting by earwigs that have crept into it, or the green caterpillar of *Papilio Rapæ*, L.

Our peas, beans, carrots, parsnips, turnips and potatos are attacked in the garden by the same enemies that injure them in the fields; I shall therefore dismiss them without further notice, and point out those which infest another of our most esteemed kinds of pulse, kidney beans. These are principally Aphides, which in dry seasons are extremely injurious to them. The fluid which they secrete, falling upon the leaves, causes them to turn black as if sprinkled with soot; and the

[a] See above, p. 31. [b] De Geer, ii. 440.

[c] Perhaps this fly is the same which Linne confounded with *Musca Larvarum*, L., which he says he had found in the roots of the cabbage (*Syst. Nat.* 992. 78.). I say "*confounded*," because it is not likely that the same species should be parasitic in an insect, and also inhabit a vegetable.

nutriment being subtracted from the pods by their constant suction, they are prevented from coming to their proper size or perfection. The beans also which they contain are sometimes devoured by the caterpillar of a small moth[d].—Onions, which add a relish to the poor man's crusts and cheese, and form so material an ingredient in the most savoury dishes of the rich, are also the favourite food of the maggot of a fly, the species of which I have not yet been able to discover, that often does considerable damage to the crop.—The diuretic Asparagus, towards the close of the season, is sometimes rendered unpalatable by the numerous eggs of *Lema Asparagi*, F., and its larvæ feed upon the foliage after the heads branch out.—Cucumbers with us enjoy an immunity from insect assailants; but in America they are deprived of this privilege, an unascertained species, called there the Cucumber-fly, doing them great injury[e].—And, to name no more, mushrooms, which are frequently cultivated and much in request, often swarm with the maggots of various Diptera and Coleoptera.

The insects just enumerated are partial in their attacks, confining themselves to one or two kinds of our pulse or other vegetables. But there are others that devour more indiscriminately the produce of our gardens: and of these in certain seasons and countries we have no greater and more universal enemy than the caterpillar of a moth called by entomologists *Noctua Gamma*, from its having a character inscribed in gold on its primary wings, which resembles that Greek letter. This creature affords a pregnant instance of the

[d] Reaum. ii. 479. [e] Barton in *Philos. Magaz.* ix. 62.

power of Providence to let loose an animal to the work of destruction and punishment. Though common with us, it is seldom the cause of more than trivial injury; but in the year 1735 it was so incredibly multiplied in France as to infest the whole country. On the great roads, wherever you cast your eyes, you might see vast numbers traversing them in all directions to pass from field to field; but their ravages were particularly felt in the kitchen gardens, where they devoured every thing, whether pulse or pot-herbs, so that nothing was left besides the stalks and veins of the leaves. The credulous multitude thought they were poisonous, report affirming that in some instances the eating of them had been followed by fatal effects. In consequence of this alarming idea, herbs were banished for several weeks from the soups of Paris. Fortunately these destroyers did not meddle with the corn, or famine would have followed in their train. Reaumur has proved that a single pair of these insects might in one season produce 80,000; so that, were the friendly Ichneumons removed, to which the mercy of Heaven has given it in charge to keep their numbers within due limits, we should no longer enjoy the comfort of vegetables with our animal food, and probably soon become the prey of scorbutic diseases[f].

The *flowers* and *shrubs*, that form the ornament of our parterres and pleasure-grounds, seem less exposed to insect depredation than the produce of the kitchen-garden; yet still there are not a few that suffer from it. The foliage of one of our greatest favourites, the

[f] Reaum. ii. 337.

rose, often loses all its loveliness and lustre from the excrements of the Aphides that prey upon it. The leaf-cutter bee also (*Apis centuncularis*, L.) by cutting pieces out to form for its young its cells of curious construction, disfigures it considerably; and the froth Cicada (*C. spumaria*, L.), aided by *Tenthredo Rosæ*, L., contributes to check the luxuriance of its growth, and to diminish the splendour of its beauty.—Reaumur has given the history of a fly (*Eristalis Narcissi*) whose larva feeds in safety within the bulbs of the Narcissus, and destroys them; and also of another, though he neglects to describe the species, which tarnishes the gay parterre of the florist, whose delight is to observe the freaks of nature exhibited in the various many-coloured streaks which diversify the blossom of the tulip, by devouring its bulbs[g].—Ray notices a fly mentioned by Swammerdam, probably *Bibio hortulana*, Latr., which he calls the deadliest enemy of the flowers of the spring. He accuses it of despoiling the gardens and fields of every blossom, and so extinguishing the hope of the year. But you must not take up a prejudice against an innocent creature, even under the warrant of such weighty authority; for the insect which our great naturalist has arraigned as the author of such devastation is scarcely guilty, if it be at all a culprit, in the degree here alleged against it. As it is very numerous early in the year, it may perhaps discolour the vernal blossoms, but its mouth is furnished with no instrument to enable it to devour them[h].

In our *stoves* and *green-houses* the Aphides often

[g] Reaum. iv. 499.

[h] Rai. *Hist. Ins.* Prolegom. xi.

reign triumphant; for, if they be not discovered and destroyed when their numbers are small, their increase becomes so rapid and their attack so indiscriminate, that every plant is covered and contaminated by them, beauty being converted into deformity, and objects before the most attractive now exciting only nausea and disgust. The Coccus also, which looks like an inanimate scale upon the bark, does considerable injury to the two prime ornaments of our conservatories, the orange and the myrtle; drawing off the sap by its pectoral rostrum, and thus depriving the plant of a portion of its nutriment, at the same time that it causes unpleasant sensations in the beholder from its resemblance to the pustule of some cutaneous disease.

I must next conduct you from the garden into the *orchard* and *fruitery*; and here you will find the same enemies still more busy and successful in their attempts to do us hurt.—The strawberry, which is the earliest and at the same time most grateful of our fruits, enjoys also the privilege of being almost exempt from insect injury. A jumping weevil (*Curculio Fragariæ*, F.) is said by Fabricius to inhabit this plant; but as the same species is abundant in this country upon the beech, the beauty of which it materially injures by the numberless holes with which it pierces the leaves, and has I believe never been taken upon the strawberry, it seems probable that Smidt's specimens might have fallen upon the latter from that tree[1]. The only insect I

[1] This kind of misnomer frequently occurs in entomological authors.—Thus, for instance, the *Curculio Alliariæ* of Linne feeds upon the hawthorn, and *Curculio Lapathi* upon the willow (Curtis in *Linn. Trans.* i. 86.); but as *Alliaria* is common in hawthorn hedges, and docks often

have observed feeding upon this fruit is the ant, and the injury that it does is not material.—The raspberry, the fruit of which arrives later at maturity, has more than one species of these animals for its foes. Its foliage sometimes suffers much from the attack of *Melolontha Horticola*, F., a little beetle related to the cockchafer; when in flower the footstalks of the blossom are occasionally eaten through by a more minute animal of the same order, *Dermestes tomentosus*, which I once saw prove fatal to a whole crop; and bees frequently anticipate us, and by sucking the fruit with their proboscis spoil it for the table.—Gooseberries and currants, those agreeable and useful fruits, a common object of cultivation both to poor and rich, have their share of enemies in this class. The all-attacking Aphides do not pass over them, and the former especially are sometimes greatly injured by them; their excrement falling upon the berries renders them clammy and disgusting, and they soon turn quite black from it. In July 1812 I saw a currant-bush miserably ravaged by a species of Coccus, very much resembling the Coccus of the vine. The eggs were of a beautiful pink, and enveloped in a large mass of cotton-like web, which could be drawn out to a considerable length. Sir Joseph Banks lately showed me a branch of the same shrub perforated down to the pith by the caterpillar of *Sesia tipuliformis*, F.: the diminished size of the fruit points out, he observes, where this enemy has been at work. In

grow under willows, the mistake in question easily happened: when, however, such mistakes are discovered, the *Trivial Name* ought certainly to be altered.

Germany, where perhaps this insect is more numerous, it is said to destroy not seldom the larger bushes of the red currant[1]. The foliage of these fruits often suffers much from the black and white caterpillar of *Phalæna grossulariata*, L.; (this was the case last spring at Hull); but their worst and most destructive enemy is that of a small saw-fly (*Tenthredo flava*, L.) of a green colour, shagreened as it were with minute black tubercles, which it loses at its last moult. This insect attaches its eggs in rows to the underside of the leaves. When first hatched, the little animals feed in society; but having consumed the leaf on which they were born, they separate from each other, and the work of devastation proceeds with such rapidity, that frequently, where many families are produced on the same bush, nothing of the leaves is left but the veins, and all the fruit for that year is spoiled.

Upon the leaves of the cherry, which usually succeeds the gooseberry, in common with those of the pear and several other fruit-trees, the slimy larva of another saw-fly (*T. Cerasi*, L.) makes its repast, yet without being the cause of any very material injury. But in North America a second species nearly related to it, known there by the name of the *slug-worm*, has become prevalent to such a degree as to threaten the destruction not only of the cherry, but also of the pear, quince, and plum. In 1797 they were so numerous that the smaller trees were covered by them; and a breeze of air passing through those on which they abounded became charged with a very disagreeable

[1] *Wiener Verzeich.* 8vo. 29.

and sickening odour. Twenty or thirty were to be seen on a single leaf; and many trees, being quite stripped, were obliged to put forth fresh foliage, thus anticipating the supply of the succeeding year and cutting off the prospect of fruit[k].—In some parts of Germany the cherry-tree has an enemy equally injurious. A splendid beetle of the weevil tribe (*Rynchites Bacchus*, Herbst,) bores with its rostrum through the half-grown fruit into the soft stone, and there deposits an egg. The grub produced from it feeds upon the kernel, and, when about to become a pupa, gnaws its way through the cherry, and sometimes not one in a thousand escapes[l]. This insect is fortunately rare with us, and has usually been found upon the black-thorn. The cherry-fly also (*Tephrites Cerasi*, Latr.) provides a habitation for its maggot in the same fruit, which it invariably spoils[m].

The blossoms of our pear-trees, as we learn from Mr. Knight, are often rendered abortive by the grub of a brown beetle: and a considerable quantity of its fruit is destroyed by that of a small four-winged fly, which occasions it to drop off prematurely[n]. This would seem to be a saw-fly, and is probably the species which Reaumur saw enter the blossom of a pear before it was quite open, doubtless to deposit its eggs in the embryo fruit. He often found in young pears, on opening them, a larva of this genus[o].—A little moth

[k] Peck's *Nat. Hist. of the Slug-worm*, 9.

[l] *Trost Kleiner Beytrag.* 38.

[m] Reaum. ii. 477.

[n] *On the Apple and Pear*, 158. The Beetle Mr. Knight alludes to is probably the *Curculio oblongus*, L., which answers his description, and is common on pear-trees.

[o] Reaum. *ubi supr.* 475.

likewise is mentioned by Mr. Forsyth as very injurious to this tree[p].

But of all our fruits none is so useful and important as the apple, and none suffers more from insects. The figure-of-eight-moth (*Bombyx cæruleocephala*, F.) Linne denominates the pest of Pomona and the destroyer of the blossoms of the apple, pear, and cherry.—He also mentions another (*Tinea corticella*, F.) as inhabiting apple-bearing trees under the bark.—And Reaumur has given us the history of a species common in this country, and producing the same effect, often to the destruction of the crop, the caterpillar of which feeds in the centre of our apples, thus occasioning them to fall[q]. Even the young grafts, I am informed by an intelligent friend[r], are frequently destroyed, sometimes many hundreds in one night, in the nurseries about London, by *Curculio vastator*, Marsh. one of the short-snouted weevils—and the foundation of canker in full grown trees is often laid by the larvæ of *Tortrix Wœberana*[s].—But the greatest enemy of this tree, and which has been known in this country only about twenty years, is the apple-aphis, called by some the *Coccus*, and by others the *American blight*. This is a minute insect, covered with a long cotton-like wool transpiring from the pores of its body, which takes its station in the chinks and rugosities of the bark, where it increases abundantly, and by constantly drawing off the sap causes ultimately the destruction of the tree. Whence this pest was first introduced is not certainly known.

[p] *On Fruit Trees*, 271. [q] Reaum. ii. 499. [r] Mr. Scales.

[s] See Observations on this Insect in the 2d volume of the *Horticultural Society's Transactions*, p. 25. By W. Spence.

Sir Joseph Banks has traced its origin to a nursery in Sloane Street; and at first he was led to conclude that it had been imported with some apple-trees from France. On writing, however, to gardeners in that country, he found it to be wholly unknown there. It was therefore most probably derived from North America, from whence apple-trees had also been imported by the proprietor of that nursery. Whatever its origin, it spread rapidly. At first it was confined to the vicinity of the metropolis, where it destroyed thousands of trees. But it has now found its way into other parts of the kingdom, particularly into the cyder counties; and no later than last year so many perished from it in Gloucestershire, that, if some mode of destroying it were not discovered, it was feared the making of cyder must be abandoned. This valuable discovery, it is said, has since been made; the application of the spirit of tar to the bark being recommended as effectual[t]. Sir Joseph Banks long ago extirpated it from his own apple-trees, by the simple method of taking off all the rugged and dead old bark, and then scrubbing the trunk and branches with a hard brush.

Our more dainty and delicate fruits, at least such as are usually so accounted, the apricot, the peach, and the nectarine, originally of Asiatic origin, are not less subject to the empire of insects than the homelier

[t] This Aphis is evidently the insect described in Illiger's *Magazine*, i. 450. under the name of *A. lanigera*, as having done great injury to the apple-trees in the neighbourhood of Bremen in 1801. That it is an Aphis and no Coccus is clear from its *oral* rostrum and the wings of the male, of which Sir Joseph Banks possesses an admirable drawing by Mr. Bauer. On this Aphis see Forsyth, 265. *Monthly Mag*. xxxii. 320; and also for August 1811.

natives of Europe. Certain Aphides form a convenient and sheltered habitation for themselves, by causing portions of the leaves to rise into hollow red convexities; in these they reside, and with their rostrum pumping out the sap in time occasion them to curl up, and thus deform the tree and injure the produce. The fruit is attacked by various other enemies of this class, against which we find it not easy to secure it: wasps, earwigs, flies, woodlice, and ants, which last communicate to it a disagreeable flavour, all share with us these ambrosial treasures; the first of them as it were opening the door, by making an incision in the rind, and letting in all the rest.—The nucleus of the apricot is also sometimes inhabited by the caterpillar of a moth, which devouring the kernel causes the fruit to fall prematurely[u].—In this country, however, these fruits may be regarded as mere luxuries, and therefore are of less consequence; but in North America they constitute an important part of the general produce, at least the peach, serving both as food for swine, and furnishing by distillation a useful spirit. The ravages committed upon them there by insects are so serious, that premiums have been offered for extirpating them. A species of weevil, perhaps a *Rynchites* of Herbst, enters the fruit when unripe, probably laying its eggs within the stone, and so destroys them. And two kinds of *Zygæna*, F., by attacking the roots, do a still greater injury to the trees[v].—A Coccus, as it should seem from the description, imported about thirty years ago from the Mauritius, or else with the Constantia vine from

[u] M. de la Hire in Reaum. ii. 478.

[v] Dr. Smith Barton's Letter in *Philos. Magaz.* xxii. 210.

the Cape of Good Hope, has destroyed nearly nine-tenths of the peach trees in the Island of St. Helena, where formerly they were so abundant, that, as in North America, the swine were fed with them. Various means have been employed to destroy this plague, but hitherto without success[w].—The imperial pine-apple, the glory of our stoves, and the most esteemed of the gifts of Pomona, cannot, however precious, be defended from the injuries of a singular species of mite (*Acarus telarius*, L.) which covers them, and other stove plants, with a most delicate but at the same time very pernicious web[x].—The olive tree, so valuable to the inhabitants of the warmer regions of Europe, often nourishes in its berries the destructive maggot of a fly (*Oscinis Oleæ*, Latr.); and the caterpillar of a little moth (*Tinea oleella*, F.), which preys upon the kernel of the nucleus, occasions them to fall before they are ripe.—Every one who eats nuts knows that they are very often inhabited by a small white grub: this is the offspring of a weevil (*Curculio Nucum*, L.) remarkable for its long and slender rostrum, with which it perforates the shell when young and soft, and deposits an egg in the orifice.—In France it sometimes happens, when the chestnuts promise an abundant crop, that the fruit falls before it comes to maturity, scarcely any remaining upon the trees. The caterpillar of a moth which eats into its interior is the cause of this disappointment[y].—Of fruits the date has the hardest nucleus; yet an insect of the same tribe with the above, that feeds upon its kernel, is armed

[w] *Descr. of the I. of St. Helena*, 147.

[x] Willdenow's *Introduct. to Botany*, 381.

[y] Reaum. ii. 505.

with jaws sufficiently strong to perforate it, that it may make its escape when the time of its change is arrived, and assume the pupa between the stone and the flesh. The date is eaten also by a beetle which Hasselquist calls a *Dermestes*[*].

One of the most delicious, and at the same time most useful, of all our fruits is the grape: to this, as you know, we are indebted for our raisins, for our currants, for our wine, and for our brandy; you cannot therefore but feel interested in its history, and desire to be informed, whether, like those before enumerated, this choice gift of heaven, whose produce "cheereth God and man[a]," must also be the prey of insects. There is a singular beetle, common in Hungary, (*Lethrus cephalotes*, F.) which gnaws off the young shoots of the vine, and drags them backward into its burrow, where it feeds upon them: on this account the country people wage continual war with it, destroying vast numbers[b].—Three other beetles also attack this noble plant: two of them, mentioned by French authors, (*Rynchites Bacchus* and *Eumolpus Vitis*,) devour the young shoots, the foliage, and the footstalks of the fruit, so that the latter is prevented from coming to maturity[c]; and a third by a German, which seems closely allied to *Curculio vastator*, E. B., if it be not the same insect. This destroys the young vines, often killing them the first year; and is accounted so terrible an enemy to them, that not only the animals but even their eggs are searched for and destroyed, and to for-

[*] Reaum. ii. 507. and Hasselquist's *Travels in the Levant*, 428.
[a] That is "High and Low." Judges, ix. 13.
[b] Sturm *Deutschland's Fauna*, i. 5. [c] Latreille, *Hist. Nat.* xi. 66. 331.

ward this work people often call in the assistance of their neighbours[d].—In the Crimea the small caterpillar of a Procris or Zygæna, related to *P. Statices*, F., is a still more destructive enemy. As soon as the buds open in the spring, it eats its way into them, especially the fruit buds, and devours the germ of the grape. Two or three of these caterpillars will so injure a vine, by creeping from one germ to another, that it will bear no fruit, nor produce a single regular shoot the succeeding year[e].—Vine leaves in France are also frequently destroyed by the larva of a moth (*Pyralis vitana*, F.); in Germany another species does great injury to the young bunches, preventing their expansion by the webs in which it involves them[f]; and a third (*Pyralis fasciana*, F.), makes the grapes themselves its food: a similar insect is alluded to in the threat contained in Deuteronomy[g].—The worst pest of the vine in this country is its Coccus (*C. Vitis*, L.). This animal, which fortunately is not sufficiently hardy to endure the common temperature of our atmosphere, sometimes so abounds upon those that are cultivated in stoves and greenhouses, that their stems seem quite covered with little locks of white cotton; which appearance is caused by a filamentous secretion transpiring through the skin of the animal, in which they envelop their eggs. Where they prevail they do great injury to the plant by subtracting the sap from its foliage and fruit, and causing it to bleed.—And to close the list, you are perfectly aware of the eagerness with

[d] Host in *Jacquin. Collect.* iii. 297.

[e] Pallas's *Travels in S. Russia*, ii. 241.

[f] Jacquin. *Collect.* ii. 97.

[g] Deut. xxviii. 39.

which wasps, flies, and other insects attack the grapes when ripe, often leaving nothing but the mere skin for their lordly proprietor.

There are some of these creatures that attack indiscriminately all fruit-trees. One of these is the *Tettigonia septendecim*, F., (so called because, according to Kalm, it appears only once in seventeen years[h].) The female oviposits in the pith of the twigs of trees, where the grubs are hatched, and do infinite damage both to fruit and forest trees[i].—Another, the caterpillar of the butterfly of the hawthorn, (*Papilio Cratægi*, L.) which in 1791, in some parts of Germany, stripped the fruit trees in general of their foliage[j].—In France also in 1731 and 1732 that of a moth which seems related to the brown-tailed moth (*Bombyx phæorhæa*, F.), whose history has been given by the late Mr. Curtis, was so numerous as to occasion a general alarm. The oaks, elms, and white-thorn hedges looked as if some burning wind had passed over them and dried up their leaves; for, the insect devouring only one surface of them, that which is left becomes brown and dry. They also laid waste the fruit-trees, and even devoured the fruit; so that the parliament published an edict to compel people to collect and destroy them: but this would in a great measure have been ineffectual, had not some cold rains fallen, which so completely annihilated them, that it was difficult to meet with a single individual[k].

If we quit the orchard and fruit-garden for a walk in

[h] *Travels*, ii. 6.
[i] Collinson in *Philos. Trans.* liv. x. 65.
[j] Rosel, I. ii. 15.
[k] Reaum. ii. 122.

our *plantations* and *groves*, we shall still be forced to witness the sad effects of insect devastation; and when we see, as sometimes happens, the hedges and trees entirely deprived of their foliage, and ourselves of the shade we love from the fervid beam of the noon-day sun; when the singing birds have deserted them; and all their music, which has so often enchanted us by its melody, variety, and sweetness, has ceased—we shall be tempted in our hearts to wish the whole insect race was blotted from the page of creation. Numerous are the agents employed in this work of destruction. Amongst the beetles, various cockchafers (*Melolontha vulgaris*, *solstitialis*, and *horticola*, F.) in their perfect state act as conspicuous a part in injuring the trees, as their grubs do in destroying the herbage. Besides the leaves of fruit-trees, they devour those of the sycamore, the lime, the beech, the willow, and the elm. They are sometimes, especially the common one, astonishingly numerous. Mouffet relates (but one would think that there must be some mistake in the date, since they are never so early in their appearance,) that on the 24th of February 1574 such a number of them fell into the river Severn as to stop the wheels of the water-mills[1]. It is also recorded in the Philosophical Transactions, that in 1688 they filled the hedges and trees of part of the county of Galway in such infinite numbers, as to cling to each other in clusters like bees when they swarm; on the wing they darkened the air, and produced a sound like that of distant drums. When they were feeding, the noise of their jaws might be mistaken for the sawing of timber. Travellers and

[1] Mouffet, 160.

people abroad were very much annoyed by their continual flying in their faces; and in a short time the leaves of all the trees for some miles round were so totally consumed by them, that at Midsummer the country wore the aspect of the depth of winter[m].

But the criminals to whom it is principally owing that our groves are sometimes stripped of the green robe of summer, are the various tribes of Lepidoptera, myriads of whose caterpillars, in certain seasons, despoil whole districts of their beauty, and our walks of all their pleasure. In 1731 the oaks in France were terribly devastated by the larva of *Bombyx dispar*, F.[n], and in 1797 many of the forests about Bayreuth suffered a similar injury from that of *B. monacha*, F.[o]. *Noctua brumata*, F. is also a fearful enemy to the foliage of almost every kind of tree[p]. The woods in certain provinces of North America are in some years entirely stripped by another, which eats all kinds of leaves. This happening at a time of the year when the heat is most excessive is attended by fatal consequences. For, being deprived of the shelter of their foliage, whole forests are sometimes entirely dried up and ruined[q].—The brown-tail-moth, before alluded to, which occasionally bares our hawthorn hedges, has been rendered famous by the alarm it caused to the inhabitants of the vicinity of the metropolis in 1782, when rewards were offered for collecting the caterpillars, and the churchwardens and overseers of the parishes attended to see them burnt by bushels.—You

[m] *Philos. Trans.* xix. 741.
[n] Reaum. i. 387.
[o] *Wiener Verzeich.* 8vo. 55.
[p] De Geer, ii. 452.
[q] Kalm's *Travels*, ii. 7.

may have observed perhaps in some cabinets of foreign insects an ant, the head of which is very large in proportion to the size of its body, with a piece of leaf in its mouth many times bigger than itself. These ants, called in Tobago Parasol Ants (*Formica cephalotes*, L.), cut circular pieces out of the leaves of various trees and plants, which they carry in their jaws to their nests, and they will strip a tree of its leaves in a night, a circumstance which has been confirmed to me by Captain Hancock[r]. Stedman mentions another very large ant, being at least an inch in length, which has the same instinct. It was a pleasant spectacle, he observes, to behold this army of ants marching constantly in the same direction, and each individual with its bit of green leaf in its mouth[s]. The injury thus caused to trees by insects is not confined to the mere loss of their leaves for one season; for it occasions them to draw upon the funds of another, by sending forth premature shoots and making gems unfold, that, in the ordinary course, would not have put forth their foliage till the following year.

Other insects, though they do not entirely devour the leaves of trees and plants, yet considerably diminish their beauty. Thus, for instance, sometimes the subcutaneous larvæ undermine them, when the leaf exhibits the whole course of their labyrinth in a pallid,

[r] The same intelligent gentleman related to me, that a person having taken some land at Bahia in the Brazils, he was compelled by these ants, which were so numerous as to render every effort to destroy them ineffectual, to relinquish the occupation of it. Their nests were excavated to the astonishing depth of fourteen feet. Merian *Insect. Sur.* 18. Smeathman on *Termites*, *Philos. Trans.* lxxi. 39. note 35. K.

[s] Stedman, ii. 142.

tortuous, gradually dilating line—at others the Tortrices disfigure them by rolling them up, or the leafcutter bees by taking a piece out of them, or certain Tineæ again by eating their under surface, and so causing them to wither either partially or totally. You have doubtless observed what is called the honey-dew upon the maple and other trees, concerning which the learned Roman naturalist Pliny gravely hesitates whether he shall call it the sweat of the heavens, the saliva of the stars, or a liquid produced by the purgation of the air[1]!!! Perhaps you may not be aware that it is a secretion of Aphides, whose excrement has the privilege of emulating sugar and honey in sweetness and purity. It however often tarnishes the lustre of those trees in which these insects are numerous, and is the lure that attracts the swarms of ants which you may often see travelling up and down the trunk of the oak and other trees. The larch in particular is inhabited by an Aphis transpiring a waxy substance like filaments of cotton: this is sometimes so infinitely multiplied upon it as to whiten the whole tree, which often perishes in consequence of its attack. The beech is infested by a similar one. Some animals also of this genus inhabiting the poplar, elm, lime, and willow, reside in galls they have produced, that disfigure the leaves or their footstalks. Perhaps those resembling fruit, or flowers, or moss, produced by the *Aphis abietis*, the different species of *Cecidomya*, Latr., or occasioned by the puncture and oviposition of the various kinds of *Cynips*, L., may be regarded rather as an ornament than as an in-

[1] *Hist. Nat.* l. xi. c. 12.

jury to a tree or shrub; yet when too numerous they must deprive it of its proper nutriment, and so occasion some defect. And probably the enormous wens, and other monstrosities and deformities observable in trees, may have been originally produced by the bite or incision of insects.

Besides exterior insect enemies, living trees are liable to the ravages of many that are *interior*. The caterpillar of *Bombyx cossus*, F., *Sesia crabroniformis*, F., *Nitidula grisea*, F., and *Curculio Lapathi*, L., devour the wood of the willow and sallow, which thus in time often become so hollow as to be easily blown down. *Sesia apiformis*, F[u], and probably *Rynchites Populi*, feeds upon the *poplar*—*Prionus coriarius* is sometimes found in the oak and sometimes in the elm, and *Bostrichus Pini*, F. in the Scotch fir. When the sap flows from wounds in a tree it is attended by various beetles, (I have observed *Cetonia aurata*, F., and several *Nitidulæ* and *Staphylinidæ* busy in this way,) which prevent it from healing so soon as it would otherwise do; and if the bark be any where separated from the wood, a numerous army of wood-lice, earwigs, spiders, *Cimicidæ*, and other *subcortical* insects take their station there and prevent a re-union.

The mischief however produced by any or all of these, is not to be compared with that sometimes sustained in Germany from the attacks of *Bostrichus typographus*, F., a small beetle, so called on account of a fancied resemblance between the paths it erodes and letters, which bores into the fir. This insect, in its preparatory state, feeds upon the soft inner bark only:

[u] Lewin in *Linn. Trans.* iii. 1.—Curtis in do. i. 86.

but it attacks this important part in such vast numbers, 80,000 being sometimes found in a single tree, that it is infinitely more noxious than any of those that bore into the wood: and such is its vitality, that though the bark be battered and the tree plunged into water, or laid upon the ice or snow, it remains alive and unhurt. The leaves of the trees infested by these insects first become yellow, the trees themselves then die at the top, and soon entirely perish. Their ravages have long been known in Germany under the name of *Wurm trökniss* (decay caused by worms); and in the old liturgies of that country the animal itself is formally mentioned under its vulgar appellation, "The Turk." This pest was particularly prevalent and caused incalculable mischief about the year 1665. In the beginning of the last century it again showed itself in the Hartz forests—it reappeared in 1757, redoubled its injuries in 1769, and arrived at its height in 1783, when the number of trees destroyed by it in the above forests alone, was calculated at a million and a half, and the inhabitants were threatened with a total suspension of the working of their mines, and consequent ruin. At this period these Bostrichi, when arrived at their perfect state, migrated in swarms like bees into Suabia and Franconia. At length, between the years 1784 and 1789, in consequence of a succession of cold and moist seasons, the numbers of this scourge were sensibly diminished. It appeared again however in 1790, and so late as 1796 there was great reason to fear for the few fir-trees that were left [v].

[v] Wilhelm's *Recreations from Nat. Hist.* quoted by Latreille *Hist. Nat.* xi. 194.

The *seeds* of forest as well as fruit trees are doubtless subject to injuries from the same quarter, but these being more out of the reach of observation have not been much noticed. Acorns, however, a considerable article with nursery-men, are said to have both a moth and a beetle that prey upon them; and what is remarkable, though sometimes one larva of each is found in the same acorn, yet two of either kind are never to be met with together [w]. The beetle is probably the *Curculio Glandium* of Mr. Marsham, and is nearly related to the species whose grub inhabits the nut.

Having now conducted you round and exhibited to you the melancholy proofs of the universal dominion of insects over our vegetable treasures, while growing or endued with the principle of vitality, in their separate departments,—I must next introduce you to a pest worse than all put together, which indiscriminately attacks and destroys every vegetable substance that the earth produces, and which wherever it prevails carries famine, pestilence and death in its train. Happily for this country, and we cannot be too thankful for the privilege, we know this scourge of nations only by report. The name of *Locust*, which has been such a sound of horror in other countries, here only suggests an object of interesting inquiry. But the ravages of locusts are so copious a theme that they merit to be considered in a separate letter.

I am, &c.

[w] Reaum. ii. 502.

LETTER VII.

INJURIES CAUSED BY INESCTS.

INDIRECT INJURIES CONTINUED.

To look at a *locust* in a cabinet of insects, you would not, at first sight, deem it capable of being the source of so much evil to mankind as stands in record against it. "This is but a small creature," you would say, "and the mischief which it causes cannot be far beyond the proportion of its bulk. The locusts so celebrated in history must surely be of the Indian kind mentioned by Pliny, which were three feet in length, with legs so strong that the women used them as saws. I see indeed some resemblance to the horse's head, but where are the eyes of the elephant, the neck of the bull, the horns of the stag, the chest of the lion, the belly of the scorpion, the wings of the eagle, the thighs of the camel, the legs of the ostrich, and the tail of the serpent, all of which the Arabians mention as attributes of this widely dreaded insect-destroyer[1]; but of which in the insect before me I discern little or no

[1] Bochart, *Hierozoic.* P. ii. l. iv. c. 5. 475.

likeness?" But although this animal be not very tremendous for its size, nor very terrific in its appearance; yet it is the very same whose ravages have been the theme of naturalists and historians in all ages, and upon a close examination you will find it to be peculiarly fitted and furnished for the execution of its office. It is armed with two pair of very strong jaws, the upper terminating in short and the lower in long teeth, by which it can both lacerate and grind its food—its stomach is of extraordinary capacity and powers—its hind legs enable it to leap to a considerable distance, and its ample vans are calculated to catch the wind as sails, and so to carry it sometimes over the sea; and although a single individual can effect but little evil, yet when the entire surface of a country is covered by them, and every one makes bare the spot on which it stands, the mischief produced may be as infinite as their numbers. So well do the Arabians know their power, that they make a locust say to Mahomet—"We are the army of the Great God; we produce ninety-nine eggs; if the hundred were completed, we should consume the whole earth and all that is in it[y]."

Since it is possible you may not have paid particular attention to the accounts given by various authors both ancient and modern, of the almost incredible injury done to the human race by these creatures, I shall now lay before you some of the most striking particulars of their devastations that I have been able to collect.

The earliest plague of this kind which has been recorded, appears also to have been the most direful in

[y] Bochart, *ubi supr.* c. 6. 485.

its immediate effects that ever was inflicted upon any nation. I am speaking, as you may well suppose, of the locusts with which the Egyptian tyrant and his people were visited for their oppression of the Israelites. Only conceive to yourself a country so covered by them that no one can see the face of the ground—a whole land darkened, and all its produce, whether herb or tree, so devoured that not the least vestige of green is left in either[z].—But it is not necessary for me to enlarge further upon a history the circumstances of which are so well known to you.

To this species of devastation Africa in general seems always to have been peculiarly subject. This may be gathered from the law in Cyrenaica mentioned by Pliny, by which the inhabitants were enjoined to destroy the locusts in three different states, three times in the year—first their eggs, then their young, and lastly the perfect insect[a]. And not without reason was such a law enacted; for Orosius tells us that in the year of the world 3,800 Africa was infested by such infinite myriads of these animals, that, having devoured every green thing, after flying off to sea they were drowned, and being cast upon the shore they emitted a stench greater than could have been produced by the carcases of 100,000 men[b]. St. Augustine also mentions a plague to have arisen in that country from the same cause, which destroyed no less than 800,000

[z] Exod. x. 5. 14, 15.

[a] *Hist. Nat.* l. xi. c. 29. A similar law was enacted in Lemnos, by which every one was compelled to bring a certain measure of locusts annually to the magistrates. Plin. *ibid.*

[b] Oros. *contra Pag.* l. v. c. 2.

persons (*octingenta hominum millia*) in the kingdom of Masanissa alone, and many more in the territories bordering upon the sea[c].

From Africa this plague was occasionally imported into Italy and Spain; and a historian quoted in Mouffet relates that in the year 591 an infinite army of locusts, of a size unusually large, grievously ravaged part of Italy; and being at last cast into the sea, from their stench arose a pestilence which carried off near a million of men and beasts. In the Venetian territory, also, in 1478 more than 30,000 persons are said to have perished in a famine occasioned by these terrific scourges. Many other instances of their devastations in Europe, in France, Spain, Italy, Germany, &c.[d], are recorded by the same author. In 1650 a cloud of them was seen to enter Russia in three different places, which from thence passed over into Poland and Lithuania, where the air was darkened by their numbers. In some places they were seen lying dead heaped one upon another to the depth of four feet; in others they covered the surface like a black cloth, the trees bent with their weight, and the damage they did exceeded all computation[e]. At a later period in Languedoc when the sun became hot they took wing and fell upon the corn, devouring both leaf and ear, and that with such expedition that in three hours they would consume a whole field. After having eaten up the corn they attacked the vines, the pulse, the willows, and lastly the hemp notwithstanding its bitterness[f]. Sir

[c] Lesser, *L.* 247. note 46.
[d] Mouffet, 123.
[e] Bingley, iii. 258.
[f] *Philos. Trans.* 1686.

H. Davy informs us[g] that the French government is at this time (1813) issuing a decree with a view to occasion the destruction of grasshoppers.

Even this happy island, so remarkably distinguished by its exemption from most of those scourges to which other nations are exposed, was once alarmed by the appearance of locusts. In 1748 they were observed here in considerable numbers, but providentially they soon perished without propagating. These were evidently stragglers from the vast swarms which in the preceding year did such infinite damage in Wallachia, Moldavia, Transylvania, Hungary and Poland. One of these swarms, which entered Transylvania in August, was several hundred fathoms in width, (at Vienna the breadth of one of them was three miles,) and extended to so great a length as to be four hours in passing over the Red Tower; and such was its density that it totally intercepted the solar light, so that when they flew low one person could not see another at the distance of twenty paces[h]. A similar account has been given me by a friend of mine[i] long resident in India. He relates that when at Poonah he was witness to an immense army of locusts which ravaged the Mahratta country, and was supposed to come from Arabia (this, if correct, is a strong proof of their power to pass the sea under favourable circumstances). The column they composed, my friend was informed, extended five hundred miles; and so compact was it, when on the wing, that like an eclipse it completely hid the sun, so

[g] *Elements of Agricultural Chemistry*, 233. [h] *Philos. Trans.* xlvi. 30.

[i] Major Moor, author of *The Narrative of Captain Little's Detachment*, *The Hindu Pantheon*, &c.

that no shadow was cast by any object, and some lofty tombs, distant from his residence not more than two hundred yards, were rendered quite invisible. This was not the *Gryllus migratorius*, L., but a red species; which circumstance much increased the horror of the scene; for, clustering upon the trees after they had stripped them of their foliage, they imparted to them a sanguine hue. The peach was the last tree that they touched.

Dr. Clarke, to give some idea of the infinite numbers of these animals, compares them to a flight of snow when the flakes are carried obliquely by the wind. They covered his carriage and horses, and the Tartars assert that people are sometimes suffocated by them. The whole face of nature might have been described as covered by a living veil. They consisted of two species, *G. tataricus* and *migratorius*, L.; the first is almost twice the size of the second, and, because it precedes it, is called by the Tartars the herald or messenger[j].—The account of another traveller, Mr. Barrow, of their ravages in the southern parts of Africa, is still more striking: an area of nearly two thousand square miles might be said literally to be covered by them. When driven into the sea by a N.W. wind, they formed upon the shore for fifty miles a bank three or four feet high, and when the wind was S.E. the stench was so powerful as to be smelt at the distance of 150 miles[k].

From 1778 to 1780 the empire of Morocco was terribly devastated by them, every green thing was eaten

[j] *Travels*, i. 348. [k] *Travels*, &c. 257.

up, not even the bitter bark of the orange and pomegranate escaping—a most dreadful famine ensued.—The poor were seen to wander over the country deriving a miserable subsistence from the roots of plants; and women and children followed the camels, from whose dung they picked the indigested grains of barley, which they devoured with avidity: in consequence of this vast numbers perished, and the roads and streets exhibited the unburied carcases of the dead. On this sad occasion, fathers sold their children, and husbands their wives[1]. When they visit a country, says Mr. Jackson, speaking of the same empire, it behoves every one to lay in provision for a famine, for they stay from three to seven years. When they have devoured all other vegetables, they attack the trees, consuming first the leaves and then the bark. From Mogador to Tangier, before the plague in 1799, the face of the earth was covered by them—at that time a singular incident occurred at El Araiche. The whole region from the confines of Sahara was ravaged by them: but on the other side of the river El Kos not one of them was to be seen, though there was nothing to prevent their flying over it. Till then they had proceeded northward; but upon arriving at its banks they turned to the east, so that all the country north of El Araiche was full of pulse, fruits and grain,—exhibiting a most striking contrast to the desolation of the adjoining district. At length they were all carried by a violent hurricane into the Western Ocean; the shore, as in former instances, was covered by their carcases, and a

[1] Southey's *Thalaba*, i. 171.

pestilence was caused by the horrid stench which they emitted:—but when this evil ceased, their devastations were followed by a most abundant crop. The Arabs of the Desert, "whose hands are against every man [m]," and who rejoice in the evil that befalls other nations, when they behold the clouds of locusts proceeding from the north are filled with gladness, anticipating a general mortality, which they call *El-Khere* (the benediction); for, when a country is thus laid waste, they emerge from their arid deserts and pitch their tents in the desolated plains [n].

The noise the locusts make when engaged in the work of destruction has been compared to the sound of a flame of fire driven by the wind, and the effect of their bite to that of fire [o]. A wild poet of our day has very strikingly described the noise produced by their flight and approach:

"Onward they came a dark continuous cloud
Of congregated myriads numberless,
The rushing of whose wings was as the sound
Of a broad river headlong in its course
Plung'd from a mountain summit, or the roar
Of a wild ocean in the autumn storm
Shattering its billows on a shore of rocks [p]!"

But no account of the appearance and ravages of these terrific insects, for correctness and sublimity, comes near that of the prophet Joel, "A day of darkness and of gloominess, a day of clouds and of thick dark-

[m] Genes. xvi. 12. [n] Jackson's *Travels in Marocco*, 54.
[o] See Bochart, *Hierozoic.* P. ii. l. iv. c. 5. 474-5.
[p] Southey's *Thalaba*, i. 169.

ness, as the morning spread upon the mountains: a great people and a strong: there hath not been ever the like, neither shall be any more after it, even to the years of many generations. A fire devoureth before them; and behind them a flame burneth: the land is as the garden of Eden before them, and behind them a desolate wilderness; yea, and nothing shall escape them. Like the noise of chariots[q] on the tops of mountains shall they leap, like the noise of a flame of fire that devoureth the stubble, as a strong people set in battle array. Before their faces the people shall be much pained: all faces shall gather blackness. They shall run like mighty men; they shall climb the wall like men of war; and they shall march every one on his ways, and they shall not break their ranks; neither shall one thrust another, they shall walk every one in his path: and when they fall upon the sword they shall not be wounded. They shall run to and fro in the city; they shall run upon the wall, they shall climb up upon the houses; they shall enter in at the windows like a thief. The earth shall quake before them, the heavens shall tremble: the sun and the moon shall be dark, and the stars shall withdraw their shining!" The usual way in which they are destroyed is also noticed by the prophet. "I will remove far off from you the northern army, and will drive him into a land barren and desolate, with his face toward the east sea and his hinder part toward the utmost sea,

[q] Of the symbolical locusts in the Apocalypse it is said—"And the sound of their wings was as the sound of chariots, of many horses running to battle." ix. 9.

and his stink shall come up, and his ill savour shall come up, because he hath done great things[r]!"

I think, after a serious consideration of all these well attested facts, when locusts contend with the two-legged destroyers of the human race for proud pre-eminence in mischief, you will find it difficult to determine to which the palm should be decreed; and you will admire the propriety with which, in the above and other passages of Holy Writ, they are selected as symbols of the great ravagers of the earth of our own species.

In many of the above instances these devastators appear to have crossed the seas, but Hasselquist asserts that they are not formed for such extensive flights. "The grasshopper or locust," says he, "is not formed for travelling over the sea,—it cannot fly far, but must alight as soon as it rises;—for one that came on board us a hundred certainly were drowned. We observe in the months of May and June a number of these insects coming from the south, and directing their course to the northern shore; they darken the sky like a thick cloud: but scarcely have they quitted the shore, when they, who a moment before ravaged and ruined the country, cover the surface of the sea with their dead bodies.—By what instinct do these creatures undertake this dangerous flight? Is it not the wise institution of the Creator to destroy a dreadful plague to the country[s]?" Locusts however, as we have seen, take much longer flights than this author supposes them able to do. It is probable that their ability in this respect

[r] Joel ii. 2-10. 20. [s] *Voyage to the Levant*, 444.

may depend a good deal upon their species, their age, and the state and direction of the wind; for, as was the case with the Egyptian plague,

> ——— a pitchy cloud
> Of locusts warping on the eastern wind

may by a powerful blast be carried over a broad river, or even the sea, from one country to another. This idea is strongly confirmed by an account, exhibiting internal marks of authenticity, which appeared in the Alexandria Herald, an American newspaper; in which it is stated, that at the distance of 200 miles from the Canary Islands, the nearest land, the ship Georgia, Capt. Stokes, from Lisbon to Savannah, while sailing with a fine breeze from the south-east, was, on the 21st of Nov. 1811, all at once becalmed. "A light air afterwards sprang up from the north-east, at which time there fell from the cloud an innumerable quantity of large grasshoppers, so as to cover the deck, the tops, and every part of the ship they could alight upon. They did not appear in the least exhausted; on the contrary, when an attempt was made to take hold of them, they instantly jumped, and endeavoured to elude being taken. The calm, or a very light air, lasted fully an hour, and during the whole of the time these insects continued to fall upon the ship and surround her: such as were within reach of the vessel alighted upon her; but immense numbers fell into the sea, and were seen floating in masses by the sides." Two bottles of them were preserved for inspection; the insects were of a reddish hue, with red and gray speckled wings. It is clear from this account, if it be admitted as authentic, that locusts can go far from land when the wind is strong, and likewise it seems equally clear that in a calm they cannot support themselves in the air. The principal difficulty is, how these locusts could make their way against the wind, which they must have done if they came with the black cloud, as the words seem to intimate. Perhaps this cloud was brought by a different current of air from that which impelled the ship.

With respect to the course which the locusts pursue, Hasselquist has observed that they migrate in a direct meridian line from south to north, passing from the deserts of Arabia, which is the great cradle of them, to Palestine, Syria, Carmania, Natolia, Bythinia, Constantinople, Poland, &c.—they never turn either to the east or to the west[t]. But this must be a mistaken notion; for those which Major Moor saw at Poonah, of which I have given an account above[u], must have come due east. Mr. Jackson also noticed their course north of the line to be towards the south[v]; and Sparrman tells us, that those south of the line migrate in the same direction[w].

I fear that Hasselquist's question, Could they not by fright, or some other method, be turned from their dreadful course, to steer for some river, and by that means be obliged to destroy themselves[x]? must be answered in the negative. All such experiments, it is to be apprehended, would be about as effectual as sending an army, with all the apparatus of war, to take the

[t] *Voyage to the Levant*, p. 446-7. [u] See p. 214.
[v] *Travels*, 54. [w] *Travels*, i. 366. [x] *Travels*, 455.

field against them, as this author says is done in Asia, where the Bashaw of Tripoli once raised a force of 4000 soldiers to fight the locusts, and very summarily ordered all to be hanged who, thinking it beneath them to waste their valour upon such pygmy foes, refused to join the party[y].

I am, &c.

[y] *Travels*, 447.

LETTER VIII.

INJURIES CAUSED BY INSECTS.

INDIRECT INJURIES CONCLUDED.

I HAVE not yet arrived at the end of my catalogue of noxious insects. I have introduced you, indeed, to those that annoy man in his own person, in his domestic animals, in the produce of his fields, gardens, orchards, and forests; in a word, in every thing that is endued with the vital principle: but I have as yet said nothing of the injuries which he receives from them in that part of his property, consisting either of animal or vegetable matter, *from which that principle is departed.* And with these I shall conclude this melancholy detail of evil inflicted upon us by the very animals I am enticing you to study. The rest of my correspondence, I flatter myself, will paint them in more inviting colours.

The insects to which I now allude may be divided into those that attack and injure our food, our drugs and medicines, our clothes, our houses and furniture, our timber, and even the objects of our studies and amusements.

Various are those that attempt to share our *food* with us. Flour and meal are eaten by the grub of *Tenebrio Molitor*, L., best known by the name of the meal-worm, which will remain in it two years before it goes into its state of inactivity :—its ravages however are not confined to flour alone, for it will eat any thing made of that article, such as bread, cakes, and the like. Old flour is also very apt to be infested by the cheese-mite. In long voyages the biscuit sometimes so swarms with the weevil and another beetle (*Dermestes paniceus*, L.) that they are swallowed with every mouthful; and even the ground peas so abound with these little vermin, that a spoonful of soup cannot be taken free from them[z]. Bread is also devoured by *Trogosita caraboides*, a larger beetle before alluded to[a].

Every one is aware that our animal food suffers still more than our farinaceous from insects; but perhaps you would not expect that our hams, bacon, and dried meats should have their peculiar beetle. Yet so it is; and this beetle, (*Dermestes lardarius*, L.,) when a grub, sometimes commits great devastation in them; as does that of another described by De Geer under the name of *Tenebrio lardarius*[b]. How much our fresh

[z] Sparrman, i. 103. This insect, by Swedish entomologists, is supposed to be a species of *Anobium*, F., (*Ptinus*, L.,) but the specimen preserved in the Linnean cabinet is *Silpha rosea* of Mr. Marsham. (*Chrysomela pectoralis*, F.) K. A small beetle of the first family of *Cryptophagus* of Major Gyllenhal swarms often in the ship biscuit, and may probably be the insect Sparrman here complains of under the name of *Dermestes paniceus*. S.

[a] See above, p. 171.

[b] De Geer, v. 46. This insect appears nearly related to Mr. Marsham's *Corticaria pulla* (*E. B.* i. 11. 14.), if it be not the same insect.

meat of all kinds, our poultry and fish, are exposed to the flesh-fly, whose maggots will turn us disgusted from our tables, if we do not carefully guard these articles from being blown by them, you well know;—and assailants more violent, hornets, wasps, and *Staphylinus maxillosus*, L., if butchers do not protect their shambles, will carry off no inconsiderable portion of their meat. A small cock-roach (*Blatta lapponica*, L.), which I have taken upon our eastern coast, swarms in the huts of the Laplanders, and will sometimes annihilate in a single day, a work in which *Silpha lapponica*, L., joins, their whole stock of dried fish. The quantity of sugar that flies and wasps will devour, if they can come at it, especially the latter, the diminutive size of the creatures considered, is astonishing:—in one year long ago, when sugar was much cheaper than it is now, a tradesman told me he calculated his loss, by the wasps alone, at twenty pounds. Our butter and lard are stated to be eaten by the caterpillar of a moth (*Crambus pinguinalis*, F.). *Musca putris*, L., the parent of the jumping cheese-maggot, loses no opportunity, we know, of laying its eggs in our fresh cheeses, and when they get dry and old the mite (*Acarus Siro*, L.) settles her colonies in them, which multiply incredibly. Other substances more unlikely do not escape from our pygmy depredators. Thus Reaumur tells us of a little moth whose larva feeds upon chocolate, observing very justly that this could not have been its original food[c]. Both a moth and a beetle (*Dermestes surinamensis*, L.) were detected by Leeu-

[c] Reaum. iii. 276.

wenhoek preying upon two of our spices, the mace and the nutmeg[d]. The maggots of flies are found in vinegar; and sometimes even water in the casks of ships, in long voyages, so abounds with them as to render it extremely disgusting. Browne, in his History of Jamaica, mentions an ant (*Formica omnivora*, L.) that consumes or spoils all kinds of food; which perhaps may be the same species that has been observed in Ceylon by Percival, and is described by him as inhabiting dwelling-houses, and speedily devouring every thing it can meet with. If at table any one drops a piece of bread, or of other food, it instantly appears in motion as if animated, from the vast number of these creatures that fasten upon it in order to carry it off. They can be kept, he tells us, by no contrivance from invading the table, and settling in swarms on the bread, sugar, and such things as they like. It is not uncommon to see a cup of tea, upon being poured out, completely covered with these creatures, and floating dead upon it like a scum[e].

In some countries the number of flies and other insects that enter the house in search of food, or allured by the light, is so great as to spoil the comfort of almost every meal. We are told that during the rainy season in India, insects of all descriptions are so incredibly numerous, and so busy every where, that it is often absolutely necessary to remove the lights from the supper-table:—were this not done, moths, flies, bugs, beetles, and the like would be attracted in such numbers as to extinguish them entirely. When the lights are retained on the table, in some places they are

[d] Leeuwenh. *Epist.* 99.

[e] *Ceylon*, 307.

put into glass cylinders, which St. Pierre tells us is the custom in the Island of Mauritius[f]; in others the candlesticks are placed in soup-plates, into which the insects are precipitated and drowned. Nothing can exceed the irritation caused by the stinking bugs when they get into the hair or between the linen and the body; and if they be bruised upon it the skin comes off[g]. To use the language of a poet of the Indies, from whom the above facts are selected,

"On every dish the booming beetle falls,
The cock-roach plays, or caterpillar crawls;
A thousand shapes of variegated hues
Parade the table and inspect the stews.
To living walls the swarming hundreds stick,
Or court, a dainty meal, the oily wick;
Heaps over heaps their slimy bodies drench,
Out go the lamps with suffocating stench.
When hideous insects every plate defile,
The laugh how empty, and how forced the smile[h]!"

Drugs and medicines also, though often so nauseous to us, form occasionally part of the food of insects. A small Sinonendrum (*S. pusillum*, F.[i]) eats the roots of rhubarb, in which I detected it in the East India Company's warehouses. Opium is a dainty *morceau* to the white ants[j];—and, what is more extraordinary, *Ano-*

[f] *Voyage*, &c. 72.

[g] Williamson's *East India Vade Mecum*.

[h] *Calcutta, a Poem*, 85.

[i] *Ptinus piceus*, Marsh.

[j] On examining ninety-two chests of *opium*, part of the cargo saved from the Charlton, previously to reshipping them from Chittagong for China, thirteen were found to be full of white ants, which had almost wholly devoured the opium. *Article from Chittagong*, *Nov.* 1812, *in one of the Newspapers*, *July* 31, 1813.

bium paniceum, F.[k] has been known to devour the blister-beetle.—Swammerdam amongst his treasures mentions "a detestable beetle," produced from a worm that eats the roots of ginseng; and he likewise notices another, the larva of which devours the bag of the musk[l].—The cochineal at Rio de Janeiro is the prey of an insect resembling an Ichneumon, but furnished with only two wings; its station is in the cotton that envelops the Coccus. Previous to its assumption of the pupa it ejects a large globule of pure red colouring matter[m]. And lastly, the Coccus that produces the lac (*C. Lacca*, F.) is, we are told, devoured by various insects[n].

Perhaps you imagine that these universal destroyers spare at least our garments, in which you may at first conceive there can be nothing very tempting to excite even the appetite of an insect. Your housekeeper, however, would probably tell you a different story, and enlarge upon the trouble and pains it costs her to guard those under her care against the ravages of the moths. Upon further inquiry you would find that nothing made of wool, whether cloth or stuff, comes amiss to them. There are five species described by Linné, which are more or less engaged in this work.—*Tinea vestianella*, *tapetzella*, *pellionella*, *sarcitella*, and *Mellonella*. Of the first we have no particular history, except that it destroys garments in the summer; but of the others Reaumur has given a complete one. *T. tapetzella*, or the tapestry moth, not uncommon in our

[k] *Ptinus rubellus*, Marsh.

[l] *Bibl. Nat.* i. 125. b. 126. a.

[m] Sir Geo. Staunton's *Voy.* 8vo. 189.

[n] Kerr in *Philos. Trans.* 1781.

houses, is most injurious to the lining of carriages, which are more exposed to the air than the furniture of our apartments. These do not construct a moveable habitation like the common species, but, eating their way in the thickness of the cloth, weave themselves silken galleries in which they reside, and which they render close and warm by covering them with some of the eroded wool[o]. *T. pellionella* is a most destructive insect, and ladies have often to deplore the ravages which it commits in their valuable furs, whether made up into muffs or tippets—it pays no more respect to the regal ermine than to the woollen habiliments of the poor; its proper food, indeed, being hair, though it devours both wool and fur. This species, if hard pressed by hunger, will even eat horse-hair, and make its habitation, a moveable house or case, in which it travels from place to place, of this untractable material. These little creatures will shave the hair from a skin as neatly and closely as if a razor had been employed[p].—The most natural food of the next species, *T. sarcitella*, is wool; but in case of necessity it will eat fur and hair. To woollen cloths or stuffs it often does incredible injury, especially if they are not kept dry and well aired[q]. Of the devastation committed by *T. Mellonella* in our bee-hives I have before given you an account; to this I must here add, that if it cannot come at wax, it will content itself with woollen cloth, leather, or even paper[r]. Besides these moths, a small beetle of the Capricorn tribe (*Callidium pygmæun*, F.)

[o] Reaum. iii. 266. [p] Ibid. 59.

[q] Ibid. 42. [r] Ibid. 257.

I have good reason to believe devours leather, since I have found it abundant in old shoes.

Next to our garments our houses and buildings, which shelter us and our property from the inclemency and injuries of the atmosphere, are of consequence to us: yet these, solid and substantial as they appear, are not secure from the attack of insects; and even our furniture often suffers from them. A great part of our comfort within doors depends upon our apartments being kept clean and neat.—Spiders by their webs, which they suspend in every angle, and flies by their excrements, which they scatter indiscriminately upon every thing, interfere with this comfort, and add much to the business of our servants. Even ants will sometimes plant their colonies in our kitchens, (I have known the horse-ant, *Formica rufa*. L., do this,) and are not easily expelled. Those of Sierra Leone, as I was once informed by the learned Professor Afzelius, make their way by millions through the houses. They resolutely pursue a straight course; and neither buildings nor rivers, even though myriads perish in the attempt, can divert them from it. Numerous are the tribes of insects that seek their food in our timber, whether laid up in store for our future use, employed in our houses, buildings, gates or fences, or made up into furniture. The several species of Mr. Marsham's genus *Ips* (which includes the genera *Apate*, *Bostrichus*, *Hylessinus*, *Hylurgus*, *Tomicus*, *Platypus*, *Scolytus*, and *Phloitribus* of modern systematists) all prey upon timber, feeding between the bark and the wood, and many of them excavating curious pinnated labyrinths. Almost every kind of tree has a species of this genus appropriated to it, and some have more than one[s]. The Stag-beetle tribe, or *Lucanidæ*, and several of the weevils[t], have a similar appetite, but penetrate deeper into the wood. The most extensive family, however, of timber-borers are the capricorn beetles, including the Fabrician genera of *Prionus*, *Cerambyx*, *Lamia*, *Stenocorus*, *Calopus*, *Rhagium*, *Gnoma*, *Saperda*, *Callidium*, and *Clytus*. The larva of these as soon as hatched leaves its first station between the bark and wood, and begins to make its way into the solid timber, (some of them plunging even into the iron heart of the oak, and one even perforating lead[u],) where it eats for itself tortuous paths, at its first starting perhaps not bigger than a pin's head, but gradually increasing in dimensions as the animal increases in magnitude, till it attains in some instances to a diameter of one or two inches. Only conceive what havoc the grub of the vast *Prionus giganteus* must make in a beam! Percival is probably speaking of this beetle, when, in his account of Ceylon, he tells us, "There is an insect found here which resembles an immense overgrown beetle. It is called by

[s] Kirby in *Linn. Trans.* v. 250.

[t] *Curculio lignarius*, Marsh. *Rhinosimus ruficollis*, Latr.

[u] The *larva* of a *Cerambyx* (which Dr. Leach has discovered to be *C. Bajulus*, L.) sometimes does material injury to the wood-work of the roofs of houses in London, piercing in every direction the fir rafters, and, when arrived at the perfect state, making its way out even through sheets of lead one-sixth of an inch thick, when they happen to have been nailed upon the rafter in which it has assumed its final metamorphosis. I am indebted to the kindness of Sir Joseph Banks for a specimen of such a sheet of lead, which, though only eight inches long and four broad, is thus pierced with twelve oval holes, of some of which the longest diameter is a quarter of an inch! S.

us a carpenter, from its boring large holes in timber, of a regular form, and to the depth of several feet, in which, when finished, it takes up its habitation[v]." Seeing the perfect insect come out of these holes, an unentomological observer would naturally conclude that the beetle he saw had formed it, and lived in it; but, doubtless, the whole was the work of the grub[w].—Of all the coleopterous genera there is none the species of which are generally so rich, resplendent and beautiful as those of Buprestis: these likewise, in their first state, there is abundant reason to believe, derive their nutriment from the produce of the forest, in which they sometimes remain for many years before they assume their perfect state, and appear in their full splendour, as if nature required more time than usual to decorate these lovely insects. We learn from Mr. Marsham, that the grub of *B. splendida* was ascertained to have existed in the wood of a deal table more than twenty years[x].—In this enumeration of timber-eating beetles, I must not forget the Fabrician genera, Anobium and Ptilinus, because of one of them (*Anobium pertinax*) Linné complains "*terebravit et destruxit sedilia mea*[y];" and I can renew the same complaint against *A. striatum*, which not only has destroyed my chairs, but also picture frames, and has perforated in every direction the deal floor of my chamber, from which it annually emerges through its little round apertures in great

[v] P. 310.

[w] See Kirby, *ubi supr.* 253.—More than a hundred species of the Capricorn tribe, many of them nondescripts, were collected in the neighbourhood of Rio de Janeiro by Captain Hancock, of the Foudroyant. K.

[x] In *Linn. Trans.* x. 399.

[y] *Syst. Nat.* 565. 2.

numbers.—The utility of entomological knowledge in economics was strikingly exemplified, when the great naturalist just mentioned, at the desire of the king of Sweden, traced out the cause of the destruction of the oak-timber in the royal dock-yards; and, having detected the lurking culprit under the form of a beetle, (*Limexylon navale*, F.), by directing the timber to be immersed during the time of the metamorphosis of that insect and its season of oviposition, furnished a remedy which effectually secured it from its future attacks[z]. —No coleopterous insects are more singular than those that belong to the genus *Pausus*, L.; and one of them at least, remarkable for emitting a phosphoric light from the globes of its antennæ, is also a timber-feeder[a]. —Amongst the Hymenoptera there are many insects that injure us in this department. The species of the genus *Sirex*, probably all of them in their *larva* state have no appetite but for ligneous food. Linné has observed this with respect to *S. Spectrum* and *Camelus*; and Mr. Marsham, on the authority of Sir Joseph Banks, relates that several specimens of *S. Gigas* were seen to come out of the floor of a nursery in a gentleman's house, to the no small alarm and discomfiture of both nurse and children[b].—The genus *Trypoxylon*, F., many species of *Crabro*, F., *Vespa Parietum*, L., Latreille's genera *Xylocopa*, *Chelostoma*, *Heriades*, *Megachile* and *Anthophora*, (all separated from *Apis*, L.) perforate posts and rails and other timber, to form cells for their young[c].

[z] Dr. Smith's *Introduction to Botany*, Pref. xv.

[a] Afzelius in *Linn. Trans.* iv. 261.

[b] *Linn. Trans.* x. 403.

[c] Kirby, *Mon. Ap. Ang.* i. 152-194. Latreille, *Gen.* iv. 161—.

How dear are their books, their cabinets of the various productions of nature, and their collections of prints and other works of art and science, to the learned, the scientific, and the virtuosi! Even these precious treasures have their insect enemies. The larva of *Crambus pinguinalis*, whose ravages in another quarter I have noticed before[d], will establish itself upon the binding of a book, and spinning a robe, which it covers with its own excrement[e], will do it no little injury. *Acarus eruditus* eats the paste that fastens the paper over the edges of the binding, and so loosens it[f]. I have also often observed the caterpillar of another little moth, of which I have not ascertained the species, that takes its station in damp old books, between the leaves, and there commits great ravages; and many a black-letter rarity, which in these days of Bibliomania would have been valued at its weight in gold, has been snatched by these destroyers from the hands of book-collectors. Besides, this *Anobium striatum* will bore through an entire volume. The two animals last mentioned also destroy prints and drawings, whether framed or preserved in a porte-feuïlle. Our collections of quadrupeds, birds, insects and plants have likewise several terrible insect enemies, which without pity or remorse often destroy or mutilate our most highly prized specimens. *Ptinus Fur*, L. and *Byrrhus Musæorum*, L. are amongst the worst, especially the latter, whose singular gliding larva, when once it gets amongst them, makes astonishing havoc, the birds soon shedding their feathers, and the insects falling to pieces.—One of the

[d] See p. 225. [e] Reaum. iii. 270.
[f] Schrank *Enum. Ins. Austr.* 513. 1058.

worst plagues of the entomologist are the mites (*Acarus destructor*, Schrank): these, if his specimens be at all damp, eat up all the muscular parts, (*Lytta vesicatoria* being almost the only insect that is not to their taste,) and thus entirely destroy them.—If spiders by any means get amongst them, they will do no little mischief.—Some I have observed to be devoured by a minute moth, perhaps *Tinea insectella*, F.; and in the posterior thighs of a species of *Gryllus*, F. from China, I once found, one in each thigh, a small beetle congenerous with *Tenebrio pallens*, L. that had devoured the interior. It is, I believe, either *Acarus destructor* or *eruditus* that eats the gum employed to fasten down dried plants.

There are other insects which do not confine themselves to one or two articles, but make a general and indiscriminate attack upon our dead stock. Ulloa mentions one peculiar to Carthagena, called there the *Comegen*, which he describes as a kind of moth or maggot so minute as to be scarcely visible to the naked eye. This destroys, says he, the furniture of houses, particularly all kinds of hangings, whether of cloth, linen, or silk, gold or silver stuffs or lace; in short, every thing except solid metal. It will ruin all the goods of a warehouse in which it has got footing in a single night, reducing bales of merchandize to dust without altering their appearance, so that the mischief is not perceived till they come to be handled[g]. If we make some deduction from this account for exaggeration, still the amount of damage will be very considerable.

[g] Ulloa, i. 67.

There are three kinds of insects better known, to whose ravages, as most prominent and celebrated, I shall last call your attention. The insects I mean are the Cock-roach (*Blatta orientalis*, L.), the house-cricket, (*Acheta domestica*, F.), and the various species of white ants (*Termes*, L.). The last of these, most fortunately for us, are not yet naturalized.

The Cock-roaches hate the light, at least the kind that is most abundant in Britain, (for *B. germanica*, which abounds in some houses, is bolder, making its appearance in the day, and running up the walls and over the tables, to the great annoyance of the inhabitants,) and never come forth from their hiding-places till the lights are removed or extinguished. In the London houses, especially in the ground-floor, they are most abundant, and consume every thing they can find, flour, bread, meat, clothes and even shoes. As soon as light, natural or artificial, re-appears, they all scamper off as fast as they can, and vanish in an instant. These pests are not indigenous here, and perhaps no where in Europe, but are one of the evils which commerce has imported.

The house-cricket may perhaps be deemed a still more annoying insect, adding an incessant noise to its ravages; since although, for a short time, it may not be unpleasant to hear

> "The cricket chirrup in the hearth,"

so constant a din every evening must very much interrupt comfort and conversation. These garrulous animals, which live in a kind of artificial torrid zone, are very thirsty souls, and are frequently found drowned

drowned in pans of water, milk, broth, and the like. Whatever is moist, be they even stockings or linen hung out to dry, is to them a *bonne bouche*; they will eat the scummings of pots, yeast, crumbs of bread, and even salt, or any thing within their reach. Sometimes they are so abundant in houses as to become absolute pests, flying into the candles and into people's faces.

But the *white ants*, wherever they prevail, are a still worse plague than either of these insects—they are the great calamity, as Linne terms them, of both the Indies. When they find their way into houses or warehouses, nothing less hard than metal or glass escapes their ravages. Their favourite food, however, is wood; and so infinite are the multitudes of the assailants, and such is the excellence of their tools, that all the timber-work of a spacious apartment is often destroyed by them in a few nights. Exteriorly, however, every thing appears as if untouched; for these wary depredators, and this is what constitutes the greatest singularity of their history, carry on all their operations by sap and mine, destroying first the inside of solid substances, and scarcely ever attacking their outside, until first they have concealed it and their operations with a coat of clay. A general similarity runs through the proceedings of the whole tribe; but the large species, known by the name of *Termes bellicosus*, is the most formidable. These insects live in large clay nests, from whence they excavate tunnels all round, often to the extent of several hundred feet; from these they will descend a considerable depth below the foundation of a house, and rise again through the floors; or, boring through the posts and supports of the building, enter the roof, and construct there their galleries in various directions. If a post be a convenient path to the roof, or has any weight to support, which how they discover is not easily conjectured, they will fill it with their mortar, leaving only a trackway for themselves; and thus, as it were, convert it from wood into stone, as hard as many kinds of free-stone. In this manner they soon destroy houses, and sometimes even whole villages when deserted by their inhabitants, so that in two or three years not a vestige of them will remain.

These insidious insects are not less expeditious in destroying the wainscoting, shelves, and other fixtures of a house than the house itself. With the most consummate art and skill they eat away all the inside of what they attack, except a few fibres here and there which exactly suffice to keep the two sides, or top and bottom, connected, so as to retain the appearance of solidity after the reality is gone; and all the while they carefully avoid perforating the surface, unless a book or any other thing that tempts them should be standing upon it. Kæmpfer, speaking of the white ants of Japan, gives a remarkable instance of the rapidity with which these miners proceed. Upon rising one morning he observed that one of their galleries of the thickness of his little finger had been formed across his table; and, upon a further examination, he found that they had bored a passage of that thickness up one foot of the table, formed a gallery across it, and then pierced down another foot into the floor: all this was done in the few hours that intervened between his retiring to rest and his rising[h]. They make their way also with the greatest ease into trunks and boxes, even though made of mahogany, (for only iron wood can withstand their jaws,) and destroy papers and every thing they contain, constructing their galleries and sometimes taking up their abode in them. In one night they will devour all the boots and shoes that are left in their way; cloth, linen, or books are equally to their taste. I myself have to deplore that they entirely consumed a collection of insects made for me by a friend in India, more especially as it sickened him of the employment. In a word, nothing, as I said before, but metal or stone comes amiss to them. Mr. Smeathman relates, that a party of them once took a fancy to a pipe of fine old Madeira, not for the sake of the wine, almost the whole of which they let out, but of the staves, which however I suppose were strongly imbued with it, and perhaps on that account were not less to the taste of our epicure Termites. Having left a compound microscope in a warehouse at Tobago for a few months, on his return he found that a colony of a small species of white ant had established themselves in it, and had devoured most of the wood-work, leaving little besides the metal and glasses[i]. But not content with the dominions they have acquired, and the cities they have laid low on Terra Firma, encouraged by success the white ants have also aimed at the sovereignty of the ocean, and once had the hardihood to attack even a British ship of the line; and in spite of the efforts of her commander and his

[h] *Japan*, ii. 127.

[i] This account of the *Termites* is chiefly taken from Smeathman in *Philos. Trans.* 1781. and Percival's *Ceylon*, 307—.

valiant crew, having boarded they got possession of her, and handled her so roughly, that when brought into port, being no longer fit for service, she was obliged to be broken up[j].

And here, I think, I see you throw aside my papers, and hear you exclaim—"Will this enumeration of scourges, plagues, and torments never be finished? Was the whole insect race created merely with punitive views, and to mar the fair face of universal nature? Are they all, as our Saviour said figuratively of one genus, the scorpion, the powerful agents and instruments of the great enemy of mankind[k]?" If you view the subject in another light, you will soon, my friend, be convinced that, instead of this, insects generally answer the most beneficial ends, and promote in various ways, and in an extraordinary degree, the welfare of man and animals; and that the series of evils I have been engaged in enumerating mostly occur partially; and where they exceed their natural limits, God permitting this occasionally to take place not merely with punitive views, but also to show us what mighty effects he can produce by instruments seemingly the most insignificant. Thus calling upon us to glorify his power, wisdom, and goodness, so evidently manifested whether he relaxes

[j] The ship here alluded to was the Albion, which was in such a condition from the attack of insects, supposed to be white ants, that, had not the ship been firmly lashed together, it was thought she would have foundered on her voyage home.—Mr. Kittoe informs me that the *Droguers* or *Draguers*, a kind of lighter employed in the West Indies in collecting the sugar, sometimes so swarm with ants, of the common kind, that they have no other way of getting rid of these troublesome insects than by sinking the vessel in shallow water. K.

[k] Luke x. 19.

or draws tight the reins by which he guides insects in their course, and regulates their progress; and more particularly to acknowledge his overruling Providence so conspicuously exhibited by his measuring them, as it were, and weighing them, and telling them out, so that, their numbers, forces and powers being annually proportioned to the work he has prescribed to them, they may neither exceed his purpose nor fall short of it.

From the picture I have drawn, and I assure you it is not overcharged, you will be disposed to admit, however, the empire of insects over the works of creation, and to own that our prosperity, comfort and happiness are intimately connected with them; and consequently that the knowledge and study of them may be extremely useful and necessary to promote these desirable ends, since the knowledge of the cause of any evil is always a principal, if not an indispensable, step towards a remedy.

I shall now bid adieu to this unpromising subject, which has so long occupied my pen, and I fear wearied your attention, and in my next bring before you a more agreeable scene, in which you will behold the *benefits* we receive by the ministry of insects.

I am, &c.

LETTER IX.

BENEFITS DERIVED FROM INSECTS.

INDIRECT BENEFITS.

My last letters contained, I must own, a most melancholy though not an overcharged picture of the injuries and devastation which man, in various ways, experiences through the instrumentality of the insect world. In this and the following I hope to place before you a more agreeable scene, since in them I shall endeavour to point out in what respects these minute animals are made to benefit us, and what advantages we reap from their extensive agency.

God, in all the evil which he permits to take place, whether spiritual, moral, or natural, has the ultimate good of his creatures in view. The evil that we suffer is often a countercheck which restrains us from greater evil, or a spur to stimulate us to good: we should therefore consider every thing, not according to the present sensations of pain, or the present loss or injury that it occasions, but according to its more general, remote, and permanent effects and bearings;—whether by it we are not impelled to the practice of many virtues which otherwise might lie dormant in us—whether our moral habits are not improved—whether we are not rendered by it more prudent, cautious, and wary, more watchful to prevent evil, more ingenious and skilful to remedy it—and whether our higher faculties are not brought more into play, and our mental powers more invigorated, by the meditation and experiments necessary to secure ourselves. Viewed in these lights, what was at first regarded as wholly made up of evil, may be discovered to contain a considerable proportion of good.

This reasoning is here particularly applicable: and if the ultimate benefit to man seems in any case problematical, it is merely because to discover it requires more extended and remote views than we are enabled by our limited faculties to take, and a knowledge of distant or concealed results which we are incompetent to calculate or discover. The common good of this terraqueous globe requires that all things endowed with vegetable or animal life should bear certain proportions to each other; and if any individual species exceeds that proportion, from beneficial it becomes noxious, and interferes with the general welfare. It was requisite therefore for the benefit of the whole system that certain means should be provided, by which this hurtful luxuriance might be checked, and all things taught to keep within their proper limits: hence it became necessary that some should prey upon others, and a part be sacrificed for the good of the whole.

Of the counterchecks thus provided, none act a more important part than insects, particularly in the vegetable kingdom, every plant having its insect enemies. Man, when he takes any plant from its natural state and makes it an object of cultivation, must expect that these agents will follow it into the artificial state in which he has placed it, and still prey upon it; and it is his business to exert his faculties in inventing means to guard against their attacks. It is a wise provision that there should exist a race of beings empowered to remove all her superfluous productions from the face of nature; and in effecting this, whatever individual injury may arise, insects must be deemed general benefactors. Even the locusts which lay waste whole countries clear the way for the renovation of their vegetable productions, which were in danger of being destroyed by the exuberance of some individual species, and thus are fulfilling the great law of the Creator, that of all which he has made nothing should be lost. A region, Sparrman tells us, which had been choked up by shrubs, perennial plants, and hard half-withered and unpalatable grasses, after being made bare by these scourges, soon appears in a far more beautiful dress, clothed with new herbs, superb lilies, and fresh annual grasses, and young and juicy shoots of the perennial kinds, affording delicious herbage for the wild cattle and game[1]. And though the interest of individual man is often sacrificed to the general good, in many cases the insect pests which he most execrates, will be found to be positively beneficial to him, unless when suffered to increase beyond their due bounds. Thus the insects that attack the roots of the grasses,

[1] Sparrman's *Voyage*, i. 367.

and, as has been before observed, so materially injure our herbage, the wire-worm, the larvæ of *Melolontha vulgaris*, *Tipula oleracea*, &c., in ordinary seasons only devour so much as is necessary to make room for fresh shoots, and the production of new herbage; in this manner maintaining a constant succession of young plants, and causing an annual though partial renovation of our meadows and pastures. In the rich fields near Rye I particularly observed this effect; and I have since at home remarked, that at certain times of the year dead plants may be every where observed, pulled up by the cattle as they feed, whose place is supplied by new offsets. So that, when in moderate numbers, these insects do no more harm to the grass than would the sharp-toothed harrows which it has been sometimes advised to apply to hide-bound pastures, and the beneficial operation of which in loosening the sub-soil these insect borers closely imitate.

Nor would it be difficult to show that the ordinary good effects of some of those insects, which torment ourselves and our cattle, preponderate over their evil ones. Mr. Clark is inclined to think that the gentle irritation of *Oestrus Equi* is useful to the stomach of the horse rather than the contrary. On the same principle it is not improbable that the Tabani often act as useful phlebotomists to our full-fed animals; and that the constant motion in which they are kept in summer by the attacks of the Stomoxys and other flies, may prevent diseases that would be brought on by indolence and repletion. And in the case of man himself, if I do not go so far as with Linné to give the louse the credit of preserving full-fed boys from coughs, epilepsy, &c., we may safely regard as no small good, the stimulus which these, and others of the insect assailants of the persons of the dirty and the vicious, afford to personal cleanliness and purity.

I might enlarge greatly upon the foregoing view of the subject: but this is unnecessary, as numerous facts will occur in subsequent letters which you will readily perceive have an intimate bearing upon it; and I shall therefore proceed to point out the more evident benefits which we derive from insects, arranging them under the two great heads of *direct* benefits, and those which are *indirect;* beginning with the latter.

The insects which are *indirectly* beneficial to us, may be considered under three points of view: First, as removing various nuisances and deformities from the face of nature: Secondly, as destroying other insects, that but for their agency would multiply so as greatly to injure and annoy us: and Thirdly, as supplying food to useful animals, particularly to fish and birds.

To advert in the first place to the former. All substances must be regarded as nuisances and deformities, when considered with relation to the whole, which are deprived of the principle of animation. In this relation stand a dead carcase, a dead tree, or a mass of excrement, which are clearly incumbrances that it is desirable to have removed; and the office of effecting this removal is chiefly assigned to insects, which have been justly called the great scavengers of nature. Let us consider their little but effective operations in each of their vocations.

How disgusting to the eye, how offensive to the smell, would be the whole face of nature, were the vast quantity of excrement daily falling to the earth from the various animals which inhabit it, suffered to remain until gradually dissolved by the rain or decomposed by the elements! That it does not thus offend us, we are indebted to an inconceivable host of insects which attack it the moment it falls; some immediately beginning to devour it, others depositing in it eggs from which are soon hatched larvæ that concur in the same office with tenfold voracity: and thus every particle of dung, at least of the most offensive kinds, speedily swarms with inhabitants which consume all the liquid and noisome particles, leaving nothing but the undigested remains, that soon dry and are scattered by the winds, while the grass upon which it rested, no longer smothered by an impenetrable mass, springs up with increased vigour.

Numerous are the tribes of insects to which this office is assigned, though chiefly if not entirely selected from the two orders Coleoptera and Diptera. A large proportion of the genera formed from *Scarabæus* of Linné, *viz.* *Scarabæus* Fab., *Copris*, *Ateuchus*, *Sisyphus*, *Onitis*, *Onthophagus* and *Aphodius* Latr., and *Psammodius*, Gyll.; also *Hister*, *Sphæridium* Fab., and amongst the *Staphylinidæ*, the majority of *Staphylini*, many *Aleocharæ*, especially of the third family, many *Oxyteli* and some *Omalia*, *Tachini* and *Tachypori* Grav., including in the whole many hundred species—unite their labours to effect this useful purpose: and what is remarkable, though they all work their way in these filthy masses, and at first can have no paths, yet their bodies are never soiled by the ordure they inhabit. Many of these insects content themselves with burrowing in the dung alone; but *Ateuchus pilularius* [m], a species called in America the *Tumble-dung*, whose singular manœuvres I shall subsequently have to advert to, *Copris lunaris*, *Scarabœus stercorarius* and many others of the *Scarabœidæ*, make large cylindrical holes, often of great depth, under the heap, and there deposit their eggs surrounded by a mass of dung in which they have previously enveloped them; thus not only dispersing the dung, but actually burying it at the roots of the adjoining plants, and by these means contributing considerably to the fertility of our pastures, supplying the constant waste by an annual conveyance of fresh dung laid at the very root; by these canals, also, affording a convenient passage for a portion of it when dissolved to be carried thither by the rain.

The coleopterous insects found in dung inhabit it in their perfect as well as imperfect states: but this is not the case with those of the order Diptera, whose larvæ alone find their nutriment in it; the imago, which would be suffocated did it attempt to burrow

[m] The *Coprion*, *Cantharus*, and *Heliocantharus* of the ancients was evidently this beetle, or one nearly related to it, which is described as rolling backwards large masses of dung, and attracted such general attention as to give rise to the proverb *Cantharus pilulam*. It should seem from the name, derived from a word signifying an ass, that the Grecian beetle made its pills of *asses'* dung; and this is confirmed by a passage in one of the plays of Aristophanes, the Irene, where a beetle of this kind is introduced, on which one of the characters rides to heaven to petition Jupiter for peace. The play begins with one domestic desiring another to feed the Cantharus with some bread, who afterwards orders his companion to give him another kind of bread made of asses dung.

into a material so soft, only laying its eggs in the mass. These also are more select in their choice than the Coleoptera,—not indeed as to delicacy,—but they do not indiscriminately oviposit in all kinds, some preferring horse-dung, others swine's-dung, others cow-dung, which seems the most favourite pabulum of all the dung-loving insects, and others that of birds. The most disgusting of all is the rat-tailed larva that inhabits our privies, which changes to a fly (*Elophilus tenax*, Latr.) somewhat resembling a bee.

Still more would our olfactory nerves be offended, and our health liable to fatal injuries, if the wisdom and goodness of Providence had not provided for the removal of another nuisance from our globe—the dead carcases of animals. When these begin to grow putrid, every one knows what dreadful miasmata exhale from them, aud taint the air we breathe. But no sooner does life depart from the body of any creature, at least of any which from its size is likely to become a nuisance, than myriads of different sorts of insects attack it, and in various ways. First come the Histers and pierce the skin. Next follow the flesh-flies, some, that no time may be lost, (as *Musca carnaria*, &c.) depositing upon it their young already hatched; others (*M. Cæsar*, &c.) covering it with millions of eggs, whence in a day or two proceed innumerable devourers. An idea of the dispatch made by these gourmands may be gained from the combined consideration of their numbers, voracity, and rapid development. One female of *M. carnaria* will give birth to 20,000 young; and the larvæ of many flesh-flies, as Redi ascertained, will in twenty-four hours devour so much food, and grow so quickly, as to increase their weight two hundred fold! In five days after being hatched they arrive at their full growth and size; which is a remarkable instance of the care of Providence in fitting them for the part they are destined to act: for if a longer time was required for their growth their food would not be a fit aliment for them, or they would be too long in removing the nuisance it is given in charge to them to dissipate. Thus we see there was some ground for Linné's assertion under *M. vomitoria*, that three of these flies will devour a dead horse as quickly as would a lion.

As soon as the various tribes of muscæ have opened the way, and devoured the softer parts, different *Necrophori*, *Silphæ*, *Necrobia*, *Dermestides*, *Cholevæ*, and *Staphylinidæ*, actively second their labours. Wasps and hornets also come in for their portion of the spoil; and even ants, which prowl every where, rival their giant competitors in the quantity consumed by them; so that in no very long time, especially in warm climates, the muscular covering is removed from the skeleton, which is then cleansed from all remains of it by the little *Corynetes cœruleus* and *ruficollis*, (which last is so interesting, as having been the means of saving the life of Latreille[p],) and several *Nitidulæ*[q]. Even the horns of animals have an appropriate genus (*Trox*)

[p] See Latr. *Gen.* i. 275.

[q] This property in the carrion insects may be turned to good account by the comparative anatomist, who has only to flay the body of one of the smaller animals, anoint it with honey, and bury it in an ant hill; and in a short time he will obtain a perfect skeleton, denudated of every fibril of muscle, though with the ligaments and cartilages untouched.

which inhabits them, and feeds upon their contents. And not only are large animals thus disposed of, even the smallest are not suffered long to annoy us. *Necrophorus Vespillo* buries the bodies of small animals, such as mice, several assisting each other in the work; and those to which they commit their eggs afford an ample supply of food to their larvæ[r]. Ants also in some degree emulate these burying insects, at least they will carry off the carcases of insects into their nests; and I once saw some of the horse-ants dragging away a half-dead snake of about the size of a quill[s].

But insects are not only useful in removing and dissipating dead animal matter, they are also intrusted with a similar office with respect to the vegetable kingdom. The interior of rotten trees is inhabited by the larvæ of Tipulæ and other insects, which there find an appropriate nutriment; and a similar diet is furnished to the grubs of the rose-beetle (*Cetonia aurata*) by the dead leaves and stalks usually to be found in an ant's nest. *Staphylinidæ*, *Sphæridia*, and other Coleoptera are always found under heaps of putrescent vegetables; and an infinite number are to be met with in decomposing fungi, which seem to be a kind of substance intermediate between animal and vegetable. The Boleti in particular have a genus of coleopterous insects appropriated to them[t], and the Lycoperdons another.

[r] Gleditsch *Abhandlungen*, iii. 200.

[s] It is to be observed that in our cold climates, during the winter months, when excrement and putrescent animal matter are not so offensive, they are left to the action of the elements, insects being then torpid.

[t] Surely Mr. Marsham's name for this genus, *Boletaria*, is much more proper than that of Fabricius, *Mycetophagus* (Agaric-eater), since these insects seldom eat agarics.

—Stagnant waters, which would otherwise exhale putrid miasmata and be often the cause of fatal disorders, are purified by the innumerable larvæ of gnats, Ephemeræ, and other insects which live in them and abstract from them all the unwholesome part of their contents. This, Linné says, will easily appear if any one will make the experiment by filling two vessels with putrid water, leaving the larvæ in one and taking them out of the other. For then he will soon find the water that is full of larvæ pure and without any stench, while that which is deprived of them will continue stinking[u].

Benefits equally great are rendered by the wood-destroying insects. We indeed, in this country, who find use for ten times more timber than we produce, could dispense with their services; but to estimate them at their proper value, as affecting the great system of nature, we should transport ourselves to tropical climes, or to those under the temperate zones, where millions of acres are covered by one interminable forest. How is it that these untrodden regions, where thousands of their giant inhabitants fall victims to the slow ravages of time, or the more sudden operations of lightning and hurricanes, should nevertheless exhibit none of those scenes of ruin and desolation that might have been expected, but are always found with the verdant characters of youth and beauty? It is to the insect world that this great charge of keeping the habitations of the Dryads in perpetual freshness has been committed. A century almost would elapse before the removal from the face of nature of the mighty ruins of one of the hard-wooded tropical trees, by the

[u] *Œcon. Nat. Amœn. Ac.* ii. 50. Stillingfleet's *Tracts*, 122.

mere influence of the elements. But how speedy its decomposition when their operations are assisted by insects! As soon as a tree is fallen, one tribe attack its bark[v], which is often the most indestructible part of it; and thousands of orifices into the solid trunk are bored by others. The rain thus insinuates itself into every part, and the action of heat promotes the decomposition. Various fungi now take possession and assist in the process, which is followed up by the incessant attacks of other insects, that feed only upon wood in an incipient state of decay. And thus in a few months a mighty mass, which seemed inferior in hardness only to iron, is mouldered into dust, and its place occupied by younger trees full of life and vigour. The insects to which this duty is intrusted have been already mentioned in a former letter (p. 230-1); but none of them do their business so expeditiously or effectually as the Termites, which ply themselves in such numbers and so unremittingly, that Mr. Smeathman assures us they will in a few weeks destroy and carry away the trunks of large trees, without leaving a particle behind; and in places where two or three years before there has been a populous town, if the inhabitants, as is frequently the case, have chosen to abandon it, there shall be a very thick wood, and not the vestige of a post to be seen.

I observed in a former letter, that the devastations

[v] Maupertuis observes, that in Lapland he saw many birch-trees lying on the ground, which had probably been there for a very long time, with the bark entire, though the wood was decayed. Hence we may probably infer, that in that country there are few or none of the bark-boring insects.

of insects are not the same in every season, their power of mischief being evident only at certain times, when Providence, by permitting an unusual increase of their numbers, gives them a commission to lay waste any particular country or district. The great agents in preventing this increase, and keeping the noxious species within proper limits, are other insects; and to these I shall now call your attention.

Numerous are the tribes upon which this important task devolves, and incalculable are the benefits which they are the means of bestowing upon us; for to them we are indebted, or rather to Providence who created them for this purpose, that our crops and grain, our cattle, our fruit- and forest-trees, our pulse and flowers, and even the verdant covering of the earth, are not totally destroyed. Of these insects, so friendly to man, some exercise their destructive agency only while in the larva state: others only in the perfect state; others in both states; and lastly, others again in all the three states of larva, pupa, and imago. For order's sake, and to give you a more distinct view of the subject, I shall say something on each separately.

The first, those which are insectivorous only in their *larva* state, may be further subdivided into *parasites* and *imparasites*, meaning by the former term those that feed upon a *living* insect, and only destroy it when they have attained their full growth; and by the latter, those that prey upon insects already dead, or that kill them in the act of devouring them.

The *imparasitic* insect devourers chiefly belong to the Hymenoptera order; and though it is in the larva state that their prowess is exhibited, the task of providing the prey is usually left to the female, of which each species for the most part selects a particular kind of insect. Thus many species of *Cerceris* and the splendid *Chrysidæ* feed upon hymenopterous insects. One of the latter (*Panorpes incarnata*, Latr.) commits her eggs to the progeny of *Bembex rostrata*: another (*Chrysis bidentata*) attacks the young of *Vespa spinipes*.

Bembex and *Mellinus* confine themselves to Diptera, the former preying upon *Elophilus tenax*, *Bombylii*, and the like[w]; the latter amongst others ridding us of the troublesome *Stomoxys calcitrans*. One of these last I have observed stationed on dung watching for flies, which, when seized, she carried to her burrow.

Vespa spinipes feeds upon certain green apod larvæ, of which the female deposits ten or twelve with each egg. *Amarophila vulgaris* destroys caterpillars of a larger size; and it is probable that most of the other Vespoid and Sphecoid *Hymenoptera*, viz. *Trypoxylon*, *Philanthus*, *Larra*, *Crabro*, &c. assist in this great work.

Pompilus, to which genus probably several species mentioned by Reaumur as preying on these insects should be referred, has it in charge to keep the number of spiders within due bounds: and some *Ammophilæ* lend their aid. One of these last, mentioned by Catesby, (*Sphex cærulea*, Linn.), has been known to seize a spider eight times its own weight[x]. Another species of this genus, which is common in the Isle of France, attacks an insect still more difficult, one would think, to turn to its purpose, the all-devouring *Blatta*,

[w] Latreille, *Observations nouvelles sur les Hyménoptères. Annal. de Mus.* II.

[x] *Nat. Hist. of Carolina*, ii. 105.

and is therefore one of the great benefactors to mankind. When this insect perceives a Blatta (called there Kakerlac and Cancrelas) it stops immediately: both animals eye each other; but in an instant the Sand-wasp darts upon its prey, seizes it by the muzzle with its strong jaws, and, bending its abdomen underneath it, pierces it with its fatal sting. Sure of its victim, it now walks or flies away, leaving the poison to work its effect; but in a short time returns, and, finding it deprived of power to make resistance, seizes it again by the head, and drags it away, walking backwards, to deposit it in a hole or chink of a wall[y].

Grasshoppers are the prey of another Ammophila, supposed to be the *Sphex pensylvanica* of Linné, a native of North America, each of which in its larva state devours those of a large green species with which its mother has provided it[z].

From none of the imparasitic insectivorous larvæ do we derive more advantage than from those which devour the destructive Aphides, whose ravages, as we have seen above, are more detrimental to us in this island than those of any other insect. A great variety of species, of different orders and genera, are employed to keep them within due limits. There is a beautiful genus of four-winged flies, whose wings resemble the finest lace, and whose eyes are often as brilliant as burnished metals, (*Hemerobius*, Linn.), the larvæ of which Reaumur, from their being insatiable devourers of them, has named the lions of the Aphides. The

[y] Reaum. vi. 282. St. Pierre's *Voyage*, 72.

[z] Bartram in *Phil. Trans. of Royal Society*, xlvi. 126.

singular pedunculated eggs from which these larvæ proceed I shall describe when we come to treat upon the eggs of insects; the larvæ themselves are furnished with a pair of long crooked mandibles resembling horns, which terminate in a sharp point, and, like those of the ant-lion are perforated, serving the insect instead of a mouth; for through this orifice the nutriment passes down into the stomach. When amongst the Aphides, like wolves in a sheep-fold, they make dreadful havoc: half a minute suffices them to suck the largest of them; and the individuals of one species clothe themselves, like Hercules, with the spoils of their hapless victims.

Next in importance to these come the aphidivorous *Muscidæ*, (many species of *Syrphus*, F.) whose grubs are armed with a singular mandible, furnished like a trident with three points, with which they transfix their prey. They may often be seen laid at their ease under a leaf or upon a twig, environed by such hosts of Aphides, that they can devour hundreds without changing their station; and their silly helpless prey, who are provided with no means of defence, so far from thinking of escaping, often walk over the back of their enemy, and put themselves in his way. When disposed to feed, he fixes himself by his tail, and, being blind, gropes about on every side, as the Cyclops did for Ulysses and his companions, till he touches one, which he immediately transfixes with his trident, elevates into the air, that he may not be disturbed by its struggles, and soon devours. The havoc which these grubs make amongst the Aphides is astonishing. It was but last week that I observed the top of every young shoot of the currant-trees in my garden curled up by myriads of these insects. On examining them today, not an individual remained; but beneath each leaf were three or four full-fed larvæ of aphidivorous flies, surrounded with heaps of the skins of the slain, the trophies of their successful warfare; and the young shoots, whose progress had been entirely checked by the abstraction of sap, are again expanding vigorously.

But even these serviceable insects must yield the palm to the lady-bird or lady-cow, (*Coccinella*, Linn.) the favourite of our childhood, which, as well as all its congeners, in the larva state feeds entirely on Aphides; and the havoc made amongst them may be conceived from the myriads upon myriads of these little interesting animals, which are often to be seen in years when the leaf-louse abounds. In 1807 the shore at Brighton and all the watering-places on the south coast was literally covered with them, to the great surprise and even alarm of the inhabitants, who were ignorant that their little visitors were emigrants from the neighbouring hop-grounds, where in their larva state each had slain his thousands and tens of thousands of the Aphis, which under the name of the *Fly* so frequently blasts the hopes of the hop-grower. It is fortunate that in most countries the children have taken these friendly Coccinellæ under their protection. In France they regard them as sacred to the Virgin, and call them *Vaches a Dieu*, *Betes de la Vierge*, &c.; and with us, commiseration for the hard fate of a mother, whose "house is on fire and her children at home," ensures them kind treatment and liberty. Even the hop-growers are becoming sensible of their services, and, as I am informed, hire boys to prevent birds from destroying them.—If we could but discover a mode of increasing these insects at will, we might not only, as Dr. Darwin has suggested, clear our hot-houses of Aphides by their means, but render our crops of hops much more certain than they now are. Even without this knowledge, nothing is more easy, as I have experienced, than to clear a plant or small tree by placing upon it several larvæ of Coccinellæ or of aphidivorous Muscæ collected from less valuable vegetables.

Lastly, to close this list of imparasitic insectivorous larvæ, I may mention those of Latreille's genus *Volucella* (*Syrphus*, F.), so remarkable for their radiated anus, which live in the nests of humble-bees, braving the fury of their stings and devouring their young; and the ant-lion (*Myrmeleon*) and Reaumur's improperly named worm-lion, (*Rhagio*, F.) whose singular stratagems will be detailed in a subsequent letter, both of which destroy great numbers of insects that are so unfortunate as to fall into their toils.

The parasitic larvæ, an extremely numerous tribe, must next be considered. These, with the exception of a very few individuals, belong to the order Hymenoptera, and were included by Linné under his vast genus *Ichneumon*, so named from the analogy between their services and those of the Egyptian Ichneumons (*Viverra Ichneumon*, L.), the former being equally important as destroyers of insects, with the latter as devourers of serpents, the eggs of crocodiles, &c.

The habits of the whole of this tribe, which properly includes a great number of distinct genera, are similar.

They all oviposit in living insects, chiefly while in the larva state, sometimes while pupæ (*Ich. puparum*, L.); and even while in the egg state (*Ich. ovulorum*, L.); but not, as far as is known, in perfect insects. The eggs thus deposited soon hatch into grubs, which immediately attack their victim, and in the end insure its destruction. The number of eggs committed to each individual varies according to its size, and that of the grubs which are to spring from them; being in most cases one only, but in others amounting to some hundreds.

From the observations hitherto made by entomologists, the great body of the Ichneumon tribe is principally employed in keeping within their proper limits the infinite host of lepidopterous larvæ, destroying, however, many insects of other orders; and perhaps if the larvæ of these last fell equally under our observation with those of the former, we might discover that few exist uninfested by their appropriate parasite. Such is the activity and address of the *Ichneumonidæ*, that scarcely any concealment, except perhaps the waters, can secure their prey from them; and neither bulk, courage, nor ferocity avail to terrify them from effecting their purpose. They attack the ruthless spider in his toils: they discover the retreat of the little bee, that for safety bores deep into timber; and though its enemy Ichneumon cannot enter its cell, by means of her long ovipositor she reaches the helpless grub, which its parent vainly thought secured from every foe, and deposits in it an egg, which produces a larva that destroys it[a]. In vain does the destructive *Cecidomyia*

[a] Marsham in *Linn. Trans.* iii. 26.

of the wheat conceal its larvæ within the glumes that so closely cover the grain; three species of these minute benefactors of our race, sent in mercy by Heaven, know how to introduce their eggs into them, thus preventing the mischief they would otherwise occasion, and saving mankind from the horrors of famine[b]. In vain also the Cynips by its magic touch produces the curious excrescences on various trees and plants, called galls, for the nutriment and defence of its progeny: the parasite species attached to it discovers its secret chamber, pierces its wall however thick, and commits the destroying egg to its offspring. Others are not more secured by the repulsive nature of the substance they inhabit; for two species at least of Ichneumon[c] know how to oviposit in stercorarious larvæ without soiling their wings or bodies.

The ichneumonidan parasites are either external or internal. Thus the species above alluded to, which attacks spiders, does not live within their bodies, but remains on the outside[d]; and the larva of *Ichneumon luteus*, which adheres by one end to the shell of the bulbiferous egg that produced it, does not enter the caterpillar of *Bombyx villica* upon which it feeds[e]. But the great majority of these animals oviposit within the body of the insect to which they are assigned, from whence, after having consumed the interior and become pupæ, they emerge in their perfect state. An idea of

[b] See above, p. 170.

[c] *I. manducator*, Panz. *Fn. Germ.* 72. 4.; and another species allied to *I. debellator*, F., which I have named *I. stercorator*.

[d] De Geer, ii. 863. [e] Ibid. 851-5.

the services rendered to us by those Ichneumons which prey upon noxious larvæ may be formed from the fact, that out of thirty individuals of the common cabbage caterpillar (the larvæ of *Papilio Brassicæ*) which Reaumur put into a glass to feed, twenty-five were fatally pierced by an Ichneumon (*I. globatus*[f]). And if we compare the myriads of caterpillars that often attack our cabbages and brocoli with the small number of butterflies of this species that usually appear, we may conjecture that they are commonly destroyed in some such proportion—a circumstance that will lead us thankfully to acknowledge the goodness of Providence, which by providing such a check has prevented the utter destruction of the Brassica genus, including some of our most esteemed and useful vegetables.

The parasites are not wholly confined to the order Hymenoptera: some insects of other orders, though comparatively very few, destroy our little enemies in the same way. *Musca larvarum*, and another like it described by De Geer, lay their eggs in caterpillars and other larvæ[g]: and Reaumur describes several other *Muscidæ* of similar habits[h]. The order also of Strepsiptera, lately established[i], appears to be altogether parasitic, but with this difference from the *Ichneumonidæ*, that these extraordinary animals are found only upon Hymenoptera in their perfect state, and do not appear to destroy the insects upon which they prey, but probably prevent their breeding. The

[f] Reaum. ii. 419.
[g] De Geer, i. 196. vi. 14. 24.
[h] Reaum. ii. 440-4.
[i] *Linn. Trans.* xi. 86.

species at present known are formed into two genera, *Xenos* and *Stylops*, which are confined to *Melitta*[j] and *Vespa*[k].

The next description of insect destroyers are those which devour them in their *first* and *last* states.—No beetles are more common after the summer is confirmed, than the species of the genus *Cantharis*. Preyssler informs us that the grub of *C. fusca* destroys a great many other larvæ[l]. and I have observed the imago devour these and also Diptera.—Linné has with justice denominated the *Cicindelæ* the tigers of insects. Though decorated with brilliant colours, they prey upon the whole insect race; their formidable jaws which cross each other are armed with fearful fangs, showing to what use they are applicable; and the extreme velocity with which they can either run or fly, renders hopeless any attempt to elude their pursuit. Their larvæ are also equally tremendous with the imago, having six eyes, three on each side, seated on a lateral elevation of the head, which look like those of spiders, and besides their threatening jaws armed with a strong internal tooth, being furnished with a pair of spines resembling somewhat the sting of a scorpion, which stand erect upon the back of the abdomen and give them a most ferocious aspect. This last apparatus, according to Clairville, serves the purpose of an anchor for retaining them at any height in their deep cells[m]. Most of the aquatic beetles, at least the Gyrini and Dytisci, prey upon other insects both in their first and final state. The larvæ of the latter have long

[j] Kirby's *Mon. Ap. Ang.* ii. 110-113.
[k] Rossi *Fn. Etrusc. Mant.*
[l] Preys. *Bömisch. Insekt.* 59. 61.
[m] *Entom. Helvetique*, ii. 158.

been observed and described under the name of *Squillæ*, and are remarkable for having their mandibles adapted for suction like those of Hemerobius and Myrmeleon: but they are not like them deprived of a mouth, being able to devour by mastication as well as by suction. Another tribe of this order which abounds in species, the *Carabidæ*, is universally insectivorous. One of the most destructive is the grub of a very beautiful species, an English specimen of which would be a great acquisition to your cabinet, it being one of our rarest insects[n], I mean *Calosoma Sycophanta*. This animal takes up its station in the nests of *Bombyx processionea* and other moths, and sometimes fills itself so full with these caterpillars, which we cannot handle or even approach without injury, as to be rendered incapable of motion and appear ready to burst. Another beautiful insect of this tribe, *Carabus auratus*, known in France by the name of *Vinaigrier*, is supposed to destroy more cockchafers than all their other enemies, attacking and killing the females at the moment of oviposition, and thus preventing the birth of thousands of young grubs[o]. Lastly come the *Staphylinidæ*, many of which prey upon insects as well as on putrescent substances. Mr. Lehmann tells us that some of them are very useful in destroying the great enemy of our crops of clover seed, *Apion flavifemoratum*[p].

Amongst the devourers of insects in their *perfect*

[n] One was taken at Aldeburgh in Suffolk by Dr. Crabbe, the celebrated poet; another by a young lady at Southwold, which is now in the cabinet of W. J. Hooker, esq.; and a third by a boy at Norwich, crawling up a wall, which was purchased of him by S. Wilkin, esq.

[o] Latr. *Hist. Nat.* x. 181.

[p] *Linn. Trans.* vi. 149. Kirby, *Ibid.* ix. 42. 23.

state only, must be ranked a few of the social tribes, ants, wasps and hornets. The first-mentioned indefatigable and industrious creatures kill and carry off great numbers of insects of every description to their nests, and prodigious are their efforts in this work. I have seen an ant dragging a wild bee many times bigger than itself; and there was brought to me this very morning while writing this letter, an Elater quite alive and active, which three or four ants in spite of its struggles were carrying off. An observing friend of mine[q], who was some time in Antigua, informed me that in that island, a kind of ant which construct their nests in the roofs of houses, when they meet with any animal larger than they can carry off alive, such as a cockroach &c., will hold it by the legs so that it cannot move, till some of them get upon it and dispatch it, and then with incredible labour carry it up to their nest. Madam Merian, in her account of the periodical ants mentioned to you before[r], and which is confirmed by Azara[s], notices their clearing the houses of cockroaches and similar animals; and the *Formica omnivora* is very useful in Ceylon in destroying the larger ant, the white ant and the cockroach[t].

You are not perhaps accustomed to regard wasps and hornets as of any use to us; but they certainly destroy an infinite number of flies and other annoying insects. Last year (1811) was remarkable for the small number of wasps, though many females appeared in the spring, scarcely any neuters being to be seen in the

[q] R. Kittoe, Esq. [r] p. 125.
[s] *Voyages*, i. 185. [t] Percival's *Ceylon*, 307.

autumn[u]; and probably in consequence of this circumstance, flies in many places were so extremely numerous as to be quite a nuisance. Reaumur has observed that in France the butchers are very glad to have wasps attend their stalls, for the sake of their services in driving away the flesh-fly; and if we may believe the author of Hector St. John's *American Letters*, the farmers in some parts of the United States are so well aware of their utility in this respect, as to suspend in their sitting rooms a hornet's nest, the occupants of which prey upon the flies without molesting the family.

There are other devourers of insects in their perfect state the manners and food of whose larvæ we are unacquainted with. St. Pierre speaks of a lady-bird, but it probably belonged to some other genus, of a fine violet colour with a head like a ruby, which he saw carry off a butterfly[v]. Linne informs us that *Clerus formicarius* devours *Anobium pertinax*. A fly related to the *Panorpa communis* appears created to instill terror into the pitiless heart of the tyrants of our lakes and pools,—the all-devouring *Libellulidæ*[w]. The Asili also, which are always upon the chase, seize insects with their anterior legs and suck them with their haustellum. The cognate genus Dioctria, particularly *D. oelandica*, prey upon Hymenoptera, by some unknown means instantaneously killing the insect they seize. Many species also of Empis, whose haustellum

[u] Mr. Knight made the same observation in 1806, and supposes the scarcity of neuters arose from the want of males to impregnate the females. *Philos. Trans.* 1807, p. 243.

[v] St. Pierre, *Voy.* 72.

[w] Lesser. i. 263, note.

resembles the beak of a bird, carry off in it *Tipulidæ* and other small *Diptera*; and what is remarkable, you can seldom take these insects in coitu, but the female has a Tipula, some fly, or sometimes beetle, in her mouth. Can this be to deposit her eggs in, as soon as they are impregnated by the male? or is it designed for the nuptial feast? Even *Scatophaga stercoraria* and *scybalaria*, and probably many others of the same tribe, feed upon small flies, though their proboscis does not seem so well adapted for animal as for vegetable food.

The most unrelenting devourers of insects seem to be those belonging to my fourth division, which attack them under *every* form. These begin the work of destruction when they are larvæ, and continue it during the whole of their existence.—The Earwig that haunts every close place in our gardens, and defiles whatever it enters, probably in some degree makes up for its ravages by diminishing the number of other insects. The cowardly and cruel Mantis, which runs away from an ant, will destroy in abundance helpless flies, using its anterior tibiæ, which with the thigh form a kind of forceps, to seize its prey. The water-scorpions (*Nepa Ranatra* and *Naucoris*), whose fore-legs are made like those of the Mantis, the water-boatman (*Notonecta*), which always swims upon its back, and the Sigara, all live by rapine and prey upon aquatic insects. Some of this tribe are so savage that they seem to love destruction for its own sake. One (*Nepa cinerea*) which was put into a basin of water with several young tad-poles, killed them all without attempting to eat one.

Those remarkable genera of the extensive tribe of *Cimicidæ*, which glide over the surface of every pool with such rapidity, being gifted with the faculty of walking upon the water, the *Hydrometra*, *Velia*, and *Gerris* of Latreille, subsist also upon aquatic insects. A large number of the same tribe plunge their rostrum into the larvæ of Lepidoptera, and suck the contents of their bodies; and *Reduvius personatus*, which ought on that account to be encouraged, is particularly fond of the bed-bug.

But of all the insects that are locomotive and pursue their prey in every state, none are greater enemies of their fellow tribes than the *Libellulidæ*, and none are provided with more powerful and singular instruments of assault. In the larva and pupa states, during which they live in the water and prey upon aquatic insects, they are furnished with two pair of strong jaws, covered by a kind of mask armed with a pair of forceps or claws, which the animal has the power of pushing from it to catch any thing at a distance[x]. When an aquatic insect passes within its reach, it suddenly darts forth the mask, opens the forceps, seizes the unfortunate victim, and brings it within the action of its jaws.

When they assume the imago state, their habits do not, like those of the white ants, become more mild and gentle, but on the contrary are more sanguinary and rapacious than ever; so that the name given to them in England, "Dragon-flies," seems much more applicable than "Demoiselles," by which the French distinguish them. Their motions it is true are light

[x] Reaum. vi. 400. *t.* 36—38.

and airy; their dress is silky, brilliant and variegated, and trimmed with the finest lace:—so far the resemblance holds; but their purpose, except at the time of love, is always destruction, in which surely they have no resemblance to the ladies. I have been much amused by observing the proceedings of a species not uncommon here, which however is nondescript. It keeps wheeling round and round, and backwards and forwards, over a considerable portion of the pool it frequents. If one of the same species comes in its way, a battle ensues; if other species of *Libellulidæ* presume to approach, it drives them away, and it is continually engaged in catching Phryganeæ and other insects (for the species of this tribe all catch their prey when on the wing, and their large eyes seem given them to enable them the more readily to do this,) that fly over the water, pulling off their wings with great adroitness and devouring in an instant the contents of the body. From the number of insects of this tribe which are every where to be observed, we may conjecture how useful they must be in preventing too great a multiplication of the other species of the class to which they belong.

Lastly, under this head, not to dwell upon some other apterous genera, devourers of insects, as the Scorpion and Scolopendra, Phalangium and Solpuga, must be enumerated the whole world of Spiders, extremely numerous both in species and individuals, which subsist entirely upon insects, spreading with infinite art and skill their nets and webs to arrest the flight of the heedless and unwary summer tribes that fill the air, which are hourly caught by thousands in their toils; one of them (*Aranea 13-guttata* Rossi) we are told, even attacking the redoubted Scorpion[y].

So much for the insect benefactors to whom it is given in charge to keep the animals of their own class within their proper limits; and I cannot doubt that you will recognise the goodness of the Great Parent in providing such an army of counterchecks to the natural tendency of almost all insects to incalculable increase. But before I quit this subject I must call your attention to what may be denominated Cannibal Insects, since in spite of those declaimers who would persuade us that man is the only animal that preys upon his own species[z], a large number of insects are guilty of the same offence. Reaumur tells us that having put into a glass vessel twenty caterpillars of the same species which he was careful to supply with their appropriate food, they nevertheless devoured each other until one only survived[a]; and De Geer relates several similar instances[b]. The younger larvæ of *Calosoma Sycophanta* often take advantage of the helpless inactivity into which the gluttony of their maturer comrades has thrown them, and from mere wantonness it should seem, when in no need of other food, pierce and devour them. A ferocity not less savage exists amongst the Mantes. These insects have their fore legs of a construction not unlike that of a sabre; and they

[y] Thiebaut de Berneaud's *Voyage to Elba*, p. 31.

[z] "Even Tyger fell and sullen Bear
Their likeness and their lineage spare.
Man only mars kind nature's plan,
And turns the fierce pursuit on Man!"

Scott's *Rokeby*, canto iii. I.

[a] Reaumur, ii. 413. [b] De Geer, i. 533. iii. 361. v. 400. vi. 91.

can as dexterously cleave their antagonist in two, or cut off his head at a stroke, as the most expert Hussar. In this way they often treat each other, even the sexes fighting with the most savage animosity. Rösel endeavoured to rear several specimens of *M. religiosa*, but always failed, the stronger constantly devouring the weaker[c]. This ferocious propensity the Chinese children have, according to Mr. Barrow, employed as a source of barbarous amusement, selling to their comrades bamboo cages containing each a Mantis, which are put together to fight. You will think it singular that both in Europe and Africa these cruel insects have obtained a character for gentleness of disposition, and even sanctity. This has arisen from the upright or sitting position, with the fore legs bent, assumed in watching for their prey, which the vulgar have supposed to be a praying posture, and hence adopted the belief that a child or traveller that had lost his road would be guided by taking one of these pious insects in his hands and observing what way it pointed. *Mantis fausta*, though not as some suppose worshipped by the Hottentots, is yet greatly esteemed by them, and they regard the person upon whom it alights as highly fortunate[d]. A similar unnatural ferocity is exhibited by *Acheta campestris*, of which having put the sexes into a box, I found on examining them that the female had begun to make her meal off her companion.—The malign aspect of the Scorpion leads us to expect from it unnatural cruelty, and its manners fulfil this expectation. Maupertuis put a hundred scorpions together,

[c] Rösel, iv. 96.   [d] Thunberg's *Travels*, ii. 66.

and a general and murderous battle immediately began. Almost all were massacred in the space of a few days without distinction of age or sex, and devoured by the survivors. He informs us also that they often devour their own offspring as soon as they are born[e]. Spiders are equally ferocious in their habits, fighting sanguinary battles, which sometimes end in the death of both combatants; and the females do not yield to the Mantes in their unnatural cruelty to their mates. Woe be to the male spider that after an union does not with all speed make his escape from the fangs of his partner! Nay, De Geer saw one that, in the midst of his preparatory caresses, was seized by the object of his attentions, enveloped by her in a web, and then devoured—a sight which, he observes, filled him with horror and indignation[f].

Such are the benefits which we derive from the insects that keep each other in check. Here it is the *destroyers* to which we are chiefly indebted: but we are in another point of view under nearly equal obligations to the *destroyed*; for it is insects, either wholly or in part, that form the food of some of our most esteemed fishes, and of birds that are not more valuable to us as articles for the table, than as the songsters that enliven our groves. But before proceeding to the details which this view of the subject involves, I ought not to omit pointing out to you that many quadrupeds, which though not all of direct utility to us are doubtless of importance in the scale of being, derive a considerable part of their subsistence from insects.

[e] De Geer, vii. 335. [f] Ibid. 180.

The harmless hedgehog and the mole, to begin at the lower end of the series, are both said to be insectivorous[g]; the latter devouring large quantities of the wire-worms. The greedy swine will root up whole acres in search of the grubs of cockchafers, of which they are very fond; and perhaps the good they do is greater than the harm, if their attack is confined to grass that having been undermined by these grubs would soon die: they also dig up the larvæ of the destructive *Tettigonia septendecim*, called the American Locust[h], on which, when in their perfect state, the squirrels are said to grow fat[i]. The badger, Lesser informs us, will eat beetles; and its kinsman the bear has the character of being very fond of ants and of honey; which last is also said to be a favourite article with the fox, who has sometimes the audacity to overturn bee-hives, and even to attack wasps' nests in search of it. He will also eat beetles.

Sparrman has given an amusing account of the Honey-ratel, (*Viverra mellivora*,) which has a particular instinct enabling it to discover bees, and attack them in their entrenchments. Near sun-set the ratel will sit and hold one of his paws before his eyes, in order to get a distinct view of the object of his pursuit; and when, in consequence of his peering about in this manner, he sees any bees flying, he knows that at this time of the day they are making for their habitations, whither he follows them, and so attains his end[j]. Another species of Viverra (*V. prehensilis*) is also re-

[g] Bingley, ii. 374.
[h] Ibid. iii: 27.
[i] Collinson in *Phil. Trans.* 1763.
[j] Sparrman, ii. 180.

puted to be an eager insect-hunter. The young Armadillos feed on a species of locust; but no quadruped can with more propriety be called insectivorous than the Ant-eaters (*Myrmecophaga*), which, as their name imports, live upon ants. The great Ant-eater, when he comes to an ant-hill, scratches it up with his long claws, and then unfolds his slender worm-like tongue, (which is more than two feet long, and wet with saliva,) and when covered with ants draws it back into his mouth and swallows thousands of them alive, renewing the operation till no more are to be found. He also climbs trees in search of woodlice and wild honey. Bats, as every one knows, are always flitting about in summer evenings, hawking for insects: and the Lemur and monkeys will also eat them.

Insects likewise afford a favourite kind of food to many reptiles: the tortoise; frogs and toads; and lizards too of different kinds. St. Pierre mentions a small and very handsome species in the island of Mauritius, that pursues them into the houses, climbs up the walls, and even walks over glass, watching with great patience for an opportunity of catching them[k]. The common snake also is said to receive part of its nutriment from them.

But to revert to insects as indirectly advantageous to us, by furnishing food to fishes and birds, beginning with the former..

Our rivers abound with *fish* of various kinds, which at particular seasons derive a principal part of their food from insects, as the numerous species of the sal-

[k] St. Pierre, *Voy.* 73.

mon and carp genus. These chiefly prey upon the various kinds of Phryganeæ, in their larva state called case or caddis-worms; and in their imago May-flies (though this last denomination properly belongs only to the *Sialis lutaria*, which generally appears in that month,) and Ephemeræ. Besides these, the waters swarm with insects of every order, as numerous in proportion to the space they inhabit, as those that fill the air, which form the sole nutriment of multitudes of our fish, and the partial support of almost all.

Reaumur has given us a very entertaining account of the infinite hosts of Ephemeræ that by myriads of millions emerge at a certain season of the year from some of the rivers in France, which, as it is well worth your attention, I shall abridge for you.

These insects in their first and intermediate state are aquatic: they either live in holes in the banks of rivers or brooks below the water, so that it enters into their habitations, which they seldom quit; or they swim about and walk upon the bed of the stream, or conceal themselves under stones or upon pieces of stick. Though their life, when they assume the perfect state, is usually extremely short, some being disclosed after sun-set, laying their eggs and dying before sun-rise; and many not living more than three hours; yet in their preparatory state their existence is much longer, in some one, in others two, in others even three years.

The different species assume the imago at different times of the year; but the same species appear regularly at nearly the same period annually, and for a certain number of days fill the air in the neighbourhood of the rivers, emerging also from the water at a certain hour of the day. Those which Swammerdam observed, began to fly about six o'clock in the evening, or about two hours before sun-set; but the great body of those noticed by Reaumur did not appear till after that time; so that the season of different harvests is not better known to the farmer, than that in which the Ephemeræ of a particular river are to emerge, is to the fishermen. Yet a greater degree of heat or cold, the rise or fall of the water, and other circumstances we are not aware of, may accelerate or retard their appearance. Between the 10th and 15th of August is the time when those of the Seine and Marne, which Reaumur described, are expected by the fishermen, who call them *Manna:* and when their season is come, they say "the Manna begins to appear, the Manna fell abundantly such a night;"—alluding, by this expression, either to the astonishing quantity of food which the Ephemeræ afford the fish, or to the large quantity of fish which they then take.

Reaumur first observed these insects in the year 1738, when they did not begin to show themselves in numbers till the 18th of August. On the 19th, having received notice from his fisherman that the flies had appeared, he got into his boat about three hours before sun-set, and detached from the banks of the river several masses of earth filled with pupæ, which he put into a large tub full of water. This tub, after staying in the boat till about eight o'clock without seeing any remarkable number of the flies, and being threatened with a storm, he caused to be landed and placed in his garden, at the foot of which ran the Marne. Before the people had landed it, an astonishing number of Ephemeræ emerged from it. Every piece of earth that was above the surface of the water was covered by them, some beginning to quit their slough, others prepared to fly, and others already on the wing; and every where under the water they were to be seen in a greater or less degree of forwardness. The storm coming on, he was obliged to quit the amusing scene; but when the rain ceased to fall he returned to it. As soon as the cloth with which he had ordered the tub to be covered was removed, the number of flies appeared to be greatly augmented, and kept continually increasing: many flew away, but more were drowned. Those already transformed, and continually transforming, would have been sufficient of themselves to have made the tub seem very full; but their number was soon very much enlarged by others attracted by the light. To prevent their being drowned, he caused the tub to be again covered with the cloth, and over it he held the light, which was soon concealed by a layer of these flies, that might have been taken by handfulls from the candlestick.

But the scene round the tub was nothing to be compared with the wonderful spectacle exhibited on the banks of the river. The exclamations of his gardener drew the illustrious naturalist thither; and such a sight he had never witnessed, and could scarcely find words to describe. "The myriads of Ephemeræ," says he, "which filled the air over the current of the river, and over the bank on which I stood, is neither to be expressed nor conceived. When the snow falls with the largest flakes, and with the least interval between them, the air is not so full of them as that which surrounded us was of Ephemeræ. Scarcely had I remained in one place a few minutes, when the step on which I stood was quite concealed with a layer of them from two to four inches in depth. Near the lowest step a surface of water of five or six feet dimensions every way was entirely and thickly covered by them; and what the current carried off was continually replaced. Many times I was obliged to abandon my station, not being able to bear the shower of Ephemeræ, which, falling with an obliquity less constant than that of an ordinary shower, struck continually, and in a manner extremely uncomfortable, every part of my face:—eyes, mouth and nostrils were filled with them. To hold the flambeau on this occasion was no pleasant office. The person who filled it had his clothes covered in a few moments with these flies, which came from all parts to overwhelm him.—Before ten o'clock this interesting spectacle had vanished. It was renewed for some nights afterwards, but the flies were never in such prodigious numbers. The fishermen allow only three successive days for the great fall of the Manna: but a few flies appear both before and after, their number increasing in one case, in the other diminishing. Whatever be the temperature of the atmosphere, whether it be cold or hot, these flies invariably appear at the same hour in the evening, that is, between a quarter and half-past eight: towards nine they begin to fill the air; in the following half-hour they are in the greatest numbers; and at ten there are scarcely any to be seen. So that in less than two hours this infinite host of flies emerge from their parent stream, fill the air, perform their appointed work, and vanish. A very large proportion of them falls into the river, when the fish have their grand festival and the fishermen a good harvest[l].

Under this head I may observe how much the patient angler is indebted to insects for some of his choicest baits, for the best opportunities of showing his skill, and for the most gratifying part of his diversion. The case-worm and several other larvæ are the best standing bait for many fish. The larva of the Ephemera, there called bait and bank-bait[m], is much used in some parts of Holland. The case-worms, and grubs (I suppose of flies) from the tallow-chandlers are in request with us for roach and dace; and I am told by an acute observer of these things, the Rev. R. Sheppard, that the larger Scarabæi and Melolonthæ are good baits for chub[n]. But to be an adept in fly-fishing, which requires the most skill and furnishes the best diversion, the angler ought to be conversant in entomology, at least sufficiently so to distinguish the different species of Phryganea, and to know the time of their appearance.—The angler is not only indebted to insects for some of his best baits, but also for the best material to fasten his hooks to, and even for making his lines for smaller fish—the so called gut or India grass, (termed in France *Cheveux de Florence*,) which is said to be prepared in China from the matter contained in the

[l] Reaum. vi. 479-487. [m] Swamm. *Bib. Nat.* i. c. 4. 106. b.

[n] In Col. Venable's *Experienced Angler*, a vast number of insects are enumerated as good baits for fish, under the names of *Bob*, *Cadbait*, *Cankers*, *Caterpillars*, *Palmers*, *Gentles*, *Bark-worms*, *Oak-worms*, *Colewort-worms*, *Flag-worms*, *Green flies*, *Ant flies*, *Butterflies*, *Wasps*, *Hornets*, *Bees*, *Humble-bees*, *Grasshoppers*, *Dors*, *Beetles*, *a great brown fly* that lives upon the oak like a *Scarabee*—(*Melolontha vulgaris or solstitialis?*) and *flies* (*i. e.* May-flies) of various sorts.

silk reservoirs of the silk-worm, but according to Latreille is the silk vessel itelf when dried[o].

One of the most important ends for which insects were gifted with such powers of multiplication, giving birth to myriads of myriads of individuals, was to furnish the feathered part of the creation with a sufficient supply of food. The number of birds that derive the whole or a principal part of their subsistence from insects is, as is universally known, very great, and includes species of almost every order.

Whether any of the *Accipitres* actually prey upon insects is not satisfactorily ascertained, it being probable that the Shrikes or Butcher birds (*Lanius excubitor* and *collurio*), so remarkable for impaling living insects upon thorns, may place them as baits to attract near to their haunts other birds upon which they prey, rather than for the purpose of eating them[p].

Amongst the *Picæ* or Pies the *Crotophaga*, called

[o] Anderson's *Recreations in Agricult.* &c., iv. 478. Latr. *Hist. Nat.* xiv. 154.

[p] It seems probable that each species of *Lanius* uses a different bait. *L. excubitor*, called in America the nine-killer, from an idea that it transfixes nine individuals daily, according to Mr. Heckewelder (*Trans. Am. Phil. Soc.* iv. 124.) treats in this manner *Grasshoppers* only; while *L. collurio* would seem to restrict itself chiefly to *Scarabæi*, two of which Mr. Sheppard once observed transfixed in a hedge that he knew to be the residence of this bird. Kugellan even thinks that it employs only *S. vernalis*, which he has often found transfixed, but never *S. stercorarius*. (Schneid. *Mag.* 259.) I must remark, however, that I last summer observed two *humble bees* quite alive, impaled on the thorns of a hedge near my house, which had most probably been so placed by this species, *L. excubitor* being rarely found except in mountainous wilds. (Bewick's *Birds*, i. 61.)

the Ani, which is a native of Africa and America, lives upon the locust and *Acarus ricinus*, which it picks in great numbers from the backs of cattle; but none are greater devourers of insects in this order than rooks. It is for the grubs of Melolontha, Tipula, &c., that they follow the plough; and they always frequent the meadows in which these larvæ abound, destroying them in vast numbers. Kalm tells us, that when the little crow was extirpated from Virginia at an enormous expense, the inhabitants would willingly have brought them back again at double the price[q]. The icteric Oriole is kept by the Americans in their houses for the sake of clearing them of insects; and the purple Grackle is so useful in this respect, that when, on account of their consuming grain, the American farmers in New England offered a reward of threepence a head for them, and they were in consequence nearly extirpated, insects increased to such a degree as to cause a total loss of the herbage, and the inhabitants were obliged to obtain hay for their cattle not only from Pennsylvania but even from Great Britain[r]. Of this order also is the Bee-cuckoo (*Cuculus indicator*) so celebrated for its instinct, by which it serves as a guide to the wild bees' nests in Africa. Sparrman describes this bird, which is somewhat larger than a common sparrow, as giving this information in a singular manner. In the evening and morning, which are its meal times, it excites the attention of the Hottentots, colonists, and honey-ratel, by the cry of *cherr*, *cherr*, *cherr*, and conducts them to the tree or spot in which the bees' nest is

[q] Stillingfl. *Tracts*, 175. *Linn. Trans.* v. 105. note b.
[r] Bingley, ii. 287-290.

concealed, continually repeating this cry. When arrived at the spot, it hovers over it, and then alighting on some neighbouring tree or bush, sits in silence, expecting to come in for its share of the spoil, which is that part of the comb containing the brood[s].—The wryneck and the woodpeckers, the nut-hatch and tree-creeper, live entirely upon insects which they pick out of decayed trees and out of the bark of living ones. The former also frequents grass-plats and ant-hills, into which it darts its long flexible tongue and so draws out its prey. The woodpecker also draws insects out of their holes by means of the same organ, which for this purpose is bony at the end and barbed, and furnished with a curious apparatus of muscles to enable them to throw it forwards with great force. Some species spit the insects on their tongue, and thus bring them into their mouth. In America, the tree-creeper is furnished with a box at the end of a long pole to entice it to build in gardens, which it is found to be particularly useful in clearing from noxious insects.

Amongst the *Grallæ* or Waders, many of the long-billed birds eat the larvæ of insects as well as worms: and they form also no inconsiderable part of the food of our domestic poultry, especially turkeys, which may be daily seen busily engaged in hunting for them, and, as well as ducks, will greedily devour the larger insects, as Melolonthæ, and in North America Tettigoniæ. The partridge takes her young brood to an ant-hill, where they feast upon the larvæ and pupæ, which Swammerdam informs us were sold at market in his

[s] Sparrman, ii. 186.

time to feed various kinds of birds[t]. Dr. Clarke also mentions having seen them, as well as the ants themselves, exposed to sale in the market at Moscow as a food for nightingales[u]. Latreille tells us that singing birds are fed in France with the larvæ of *Formica rufa*.

But the Linnean order of *Passeres* affords the greatest number of insectivorous birds; indeed almost all the species of this order, except perhaps the Columbæ and the crossbill, and other Loxiæ, more or less eat insects. Amongst the Thrush tribe, the blackbird, though he will have his share of our gooseberries and currants, assists greatly in clearing our gardens of caterpillars; and the locust-eating thrush is still more useful in the countries subject to that dreadful pest: these birds never appear but with the locusts, and then accompany them in astonishing numbers, preying upon them in their larva state. The common sparrow, though proscribed as a most mischievous bird, destroys a vast number of insects. Bradley has calculated that a single pair having young to maintain, will destroy 3360 caterpillars in a week[v]. They also prey upon butterflies and other winged insects. The Fly-catchers (*Muscicapa*) and the Warblers (*Motacilla*), which include our sweetest songsters, are almost entirely supported by insects; so that were it not for these despised creatures we should be deprived of some of our greatest pleasures, and half the interest and delight of our vernal walks would be done away. Our groves would no longer be vocal; our little domestic favourites the

[t] *Bib. Nat.* i. 126. b. [u] *Travels*, i. 110. [v] Reaum. ii. 408.

red-breast and the wren would desert us; and the heavens would be depopulated.—We should lose too some of the most esteemed dainties of our tables, one of which, the wheat-ear, is said to be attracted to our downs by a particular insect[w]. Lastly, insects are the sole food of swallows, which are always on the wing hawking for them, and their flight is regulated by that of their prey. When the atmosphere is dry and clear and their small game flies high, they seek the skies; when moist and the insects are low or upon the ground, they descend and just skim the surface of the earth and waters; and thus by their flight are regarded as prognosticating fair or wet weather. I was last summer much interested and amused by observing the tender care and assiduity with which an old swallow supplied her young with this kind of food. My attention was called to a young brood, that having left their nest before they were strong enough to take wing, were stationed on the lead which covers the bow window in my house. The mother was perpetually going and returning, putting an insect into the mouth first of one and then of the others in succession, all fluttering and opening their mouths to receive her gift. She was scarcely ever more than a minute away, and continued her excursions as long as we had time to observe her. When the little ones were satisfied they put their head under their wing and went to sleep. The number of insects caught by this tribe is inconceivable.

I shall close my list of the indirect benefits derived

[w] Bingley, ii. 374.

from insects, by adverting to the very singular apparent subserviency of some of them to the functions of certain vegetables.

You well know that some plants are gifted with the faculty of catching flies. These vegetable Muscicapæ, which have been enumerated by Dr. Barton of Philadelphia, who has lately published an ingenious paper on the subject[x], may be divided into three classes: First, those that entrap insects by the irritability of their stamina, which close upon them when touched. Under this head come *Apocynum androæsmifolium*, *Asclepias syriaca* and *curassavica*, *Nerium Oleander*, and a grass described by Michaux under the name of *Leersia lenticularis*. The second class includes those which entrap them by some viscosity of the plant, as many species of *Rhododendron*, *Kalmia*, *Robinia*, *Silene*, *Lythrum*, *Cucubalus otites*, *Populus balsamifera*, &c. And under the third class will arrange those which ensnare by their leaves, whether from some irritability in them, as in *Dionæa*, *Drosera*, &c., or merely from their forming hollow vessels containing water, into which the flies are enticed either by their carrion-like odour, or the sweet fluid which many of them secrete near the faux, as in *Sarracenia*, *Nepenthes*, *Aquarium*, &c., the tubular leaves of which are usually found stored with putrefying insects. In this last class may be placed the common *Dipsacus* of this country, the connate leaves of which form a kind of basin round the stem, that retains rain-water in which many insects are drowned. To these a fourth class might be added,

[x] *Philosoph. Mag.* xxxix. 107.

consisting of those plants whose flowers smelling like carrion (*Stapelia hirsuta*, &c.) entice flies to lay their eggs upon them, which thus perish.

The number of insects thus destroyed is prodigious. It is scarcely possible to find a flower of the *Muscicapæ Asclepiadeæ* that has not entrapped its victim, and some of them in the United States closely cover hundreds of acres together.

What may be the precise use of this faculty is not so apparent. Dr. Barton doubts whether the flowers that catch insects, being only temporary organs, can derive any nutriment from them; and he does not think it probable that the leaves of Dionæa, &c., which are usually found in rich boggy soil, can have any need of additional stimulus. As nothing however is made in vain, there can be little doubt that these ensnared insects are subservient to some important purpose in the economy of the plants which are endowed with the faculty of taking them, though we may be ignorant what that purpose is; and an experiment of Mr. Knight's, nurseryman in King's Road, London, seems to prove that in the case of Dionæa at least the very end in view, contrary to Dr. Barton's supposition, is the supplying the leaves with animal manure; for he found that a plant upon whose leaves he laid fine filaments of raw beef, was much more luxuriant in its growth than others not so treated[y]. Possibly the air evolved from the putrefying insects with which *Sarracenia purpurea* is sometimes so filled as to scent the atmosphere round it, may be in a similar manner favourable to its vegetation.

[y] *Elements of the Science of Botany*, 62.

Most of the insects which are found in the tubular leaves of this and similar plants enter into them voluntarily; but Dr. Smith mentions a curious fact, from which it appears that in some cases they are deposited by other species. One of the gardeners of the Liverpool Botanic Garden observed an insect, from the description one of the *Sphegiadæ* (*Sphex*, L.), which dragged several large flies to the *Sarracenia adunca*, and, having with some difficulty forced them under the lid or cover of its leaf, deposited them in its tubular part which was half filled with water: and on examination all the leaves were found crowded with dead or drowning flies[z]. What was the object of this singular manœuvre does not seem very obvious. At the first glance one might suppose that, having deposited an egg in the fly, it intended to avail itself of the tube of the leaf instead of a burrow. Yet we know of no such strange deviation from natural instinct, which would be the more remarkable because the insect was *European*, while the plant was *American* and growing in a hot-house. And at any rate it does not seem very likely that the insect would commit her egg to the tube without having previously examined it; in which case she must have discovered it to be half full of water, and consequently unfit for her purpose.—It is not so wonderful that many large flies should, as Professor Barton informs us, drop their eggs into the Ascidia furnished with dead carcases: and it seems very probable that Dytisci oviposit in them; for the Squilla which Rumphius found there was probably one of their larvæ, this being the old name for them[a].

[z] Dr. Smith's *Introduction to Botany*, 195.

[a] Mouffet, 319.

However problematical the agency of insects caught by plants as to their nutriment, there can be no doubt that many species perform an important function with regard to their impregnation, which indeed without their aid would in some cases never take place at all. Thus, for the due fertilization of the common Barberry (*Berberis vulgaris*) it is necessary that the irritable stamens should be brought into contact with the pistil by the application of some stimulus to the base of the filament; but this would never take place were not insects attracted by the melliferous glands of the flower to insinuate themselves amongst the filaments, and thus while seeking their own food unknowingly fulfil the intentions of nature in another department[b].

The agency of these little operators is equally indispensable in the beautiful tribe of Iris. In these, as appears from the observations of Kölreuter, the true stigma is situated on the upper side of a transverse membrane (*arcus eminens* of Haller) which is stretched across the middle of the under surface of the petal-like expansion or style-flag, the whole of which has been often improperly regarded as fulfilling the office of a stigma. Now as the anther is situated at the base of the style-flag which covers it, at a considerable distance from the stigma, and at the same time cut off from all access to it, by the intervening barrier formed by the *arcus eminens*, it is clear that but for some extraneous agency the pollen could never possibly arrive at the place of its destination. In this case the *Humble-bee* is the operator. Led by instinct, or, as the ingenious

[b] Smith's *Tracts*, 165. Kolreuter *Ann. of Bot.* ii. 9.

Sprengel supposes, by one of those honey-marks (*Saft-maal*) or spots of a different colour from the rest of the corolla, which, according to him, are placed in many flowers expressly to guide insects to the nectaries, she pushes herself between the stiff style-flag and elastic petal, which last, while she is in the interior, presses her close to the anther, and thus causes her to brush off the pollen with her hairy back, which ultimately, though not at once, conveys it to the stigma. Having exhausted the nectar she retreats backwards; and in doing this, is indeed pressed by the petal to the *arcus eminens*; but it is only to its lower or negative surface, which cannot influence impregnation. She now takes her way to the second petal, and insinuating herself under its style-flag, her back comes into close contact with the true stigma, which is thus impregnated with the pollen of the first visited anther: and in this manner migrating from one part of the corolla to another, and from flower to flower, she fructifies one with pollen gathered in her search after honey in another.—Mr. Sprengel found, that not only are insects indispensable in fructifying the different species of Iris, but that some of them, as *I. Xiphium*, require the agency of the larger humble-bees, which alone are strong enough to force their way beneath the style-flag: and hence, as these insects are not so common as many others, this Iris is often barren, or bears imperfect seeds[c].

Aristolochia clematitis, according to Professor Willdenow, is so formed, that the anthers of themselves

[c] Chr. Conr. Sprengel *Entdecktes Geheimniss*, &c. Berlin 1793, 4to. quoted in *Ann. of Bot.* i. 414.

cannot impregnate the stigma; but this important affair is devolved upon a particular species of Tipula (*T. pennicornis*). The throat of the flower is lined with dense hair, pointing downward so as to form a kind of funnel or entrance like that of some kinds of mouse-traps, through which the insects may easily enter but not return: several creep in, and, uneasy at their confinement, are constantly moving to and fro, and so deposit the pollen upon the stigma: but when the work intrusted to them is completed, and impregnation has taken place, the hair which prevented their escape shrinks, and adheres closely to the sides of the flower, and these little go-betweens of Flora at length leave their prison[d]. Dr. Smith supposes that it is for want of some insect of this kind that *Aristolochia Sipho* never forms fruit in this country.

Equally important is the agency of insects in fructifying the plants of the Linnean classes Monoecia, Dioecia and Polygamia, in which the stamens are in one blossom and the pistil in another. In exploring these for honey and pollen, which last is the food of several insects besides bees[e], it becomes involved in the hair, with which in many cases their bodies seem provided for this express purpose, and is conveyed to the germen requiring its fertilizing influence. Sprengel supposes

[d] *Grundriss der Kräuterkunde*, 353. A writer, however, in the *Annual Medical Review* (ii. 400.) doubts the accuracy of this fact, on the ground that he could never find *T. pennicornis*, though *A. clematitis* has produced fruit two years at Brompton.

[e] I have frequently observed *Dermestes flavescens*, Ent. Brit. eat both the petals and stamens of *Stellaria holosteum*; and *Mordellæ* will open the anthers with the securiform joints of their palpi to get at the pollen.

that with this view some plants have particular insects appropriated to them, as to the dioecious nettle *Catheretes Urticæ*, to the toad-flax *Catheretes gravidus*, &c. Whether the operations of *Cynips Psenes* be of that advantage in fertilizing the fig, which the cultivators of that fruit in the East have long supposed, is doubted by Hasselquist and Olivier[f], both competent observers, who have been on the spot. Our own gardeners, however, will admit their obligations to bees in *setting* their cucumbers and melons, to which they find the necessity of themselves conveying pollen from a male flower, when the early season of the year precludes the assistance of insects. Sprengel asserts, that apparently with a view to prevent hybrid mixtures, insects which derive their honey or pollen from different plants indiscriminately, will during a whole day confine their visits to that species on which they first fixed in the morning, provided there be a sufficient supply of it[g]; and the same observation was long since made with respect to bees by our countryman Dobbs[h].

Thus we see that the flowers which we vainly think are

> ———"born to blush unseen,
> And waste their fragrance on the desert air,"

unvisited by the lord of the creation, who boasts that they were made for him, have nevertheless myriads of insect visitants and admirers, who, though they pilfer their sweets, contribute to their fertility.

I am, &c.

[f] Hasselquist's *Travels*, 253. Latr. *Hist. Nat.* xiii. 204.
[g] Willd. *Grundriss*, 352. [h] *Phil. Trans.* xlvi. 536.

LETTER X.

BENEFITS DERIVED FROM INSECTS.

DIRECT BENEFITS.

My last letter was devoted to the indirect advantages which we derive from insects; in the present I shall enumerate those of a more *direct* nature for which we are indebted to them, beginning with their use as the food of man, in which respect they are of more importance than you may have conceived.

One class of animals which, till very lately, have been regarded as belonging to the entomological world, I mean the *Crustacea*, consisting principally of the genus *Cancer* of Linné, are universally reckoned amongst our greatest dainties; and they who would turn with disgust from a locust or the grub of a beetle, feel no symptoms of nausea when a lobster, crab, or shrimp is set before them. The fact is, that habit has reconciled us to the eating of these last, which, viewed in themselves with their threatening claws and many feet, are really more disgusting than the former. Had the habit been reversed, we should have viewed the former with appetite and the latter with abhorrence, as do the

Arabs, "who are as much astonished at our eating crabs, lobsters, and oysters, as we are at their eating locusts[i]." That this would have been the case is clear, at least as far as regards the former position, from the practice in other parts of the world, both in ancient and modern times, to which, begging you to lay aside your English prejudices, I shall now call your attention; first observing by the way, that the insects used as food, generally speaking, live on vegetable substances, and are consequently much more select and cleanly in their diet than the swine or the duck, which form a favourite part of ours.

Many larvæ that belong to the order Coleoptera are eaten in different parts of the world. The grub of the palm-weevil (*Calandra palmarum*), which is the size of the thumb, has been long in request in both the Indies. Ælian speaks of an Indian king, who, for a dessert, instead of fruit set before his Grecian guests a roasted worm taken from a plant, probably the larva of this insect, which he says the Indians esteem very delicious—a character that was confirmed by some of the Greeks who tasted it[j]. Madam Merian has figured one of these larvæ, and says that the natives of Surinam roast and eat them as something very exquisite[k]. A friend of mine, who has resided a good deal in the West Indies[l], where the palm-grub is called *Grugru*, informs me that the late Sir Thomas La Forey, who was somewhat of an epicure, was extremely fond of it when properly cooked.

[i] Walpole in Clarke's *Travels*, ii. 187.

[j] Ælian. *Hist.* l. xiv. c. 13. quoted in Reaum. ii. 343.

[k] *Ins. Sur.* 48.

[l] Robinson Kittoe, Esq.

The larvæ also of the larger species of the *Cerambycidæ* are accounted very great delicacies in many countries; and the Cossus of Pliny, which he tells us the Roman epicures fattened with flour[m], most probably belonged to this tribe. Linné indeed, following the opinion of Ray[n], supposes the caterpillar of the great goat-moth, the anatomy of which has been so wonderfully traced by the eye and pencil of the incomparable Lyonet, to be the Cossus. But there seems a strong reason against this opinion; for Linné's Cossus lives most commonly in the willow, Pliny's in the oak; and the former is a very disagreeable, ugly and fetid larva, not very likely to attract the Roman epicures. Probably they were the larvæ of *Prionus coriarius*, which I have myself extracted from the oak, or of one of its congeners[o]. The grub of *Cerambyx damicornis*, which is the thickness of a man's finger, is eaten at Surinam, in America, and in the West In-

[m] *Hist. Nat.* l. xvii. c. 24.

[n] *Wisdom of God*, 9th ed. 307. Ray first adopted the opinion here maintained, that the Cossi were the larvæ of some beetle; but afterwards, from observing in the caterpillar of *Bombyx Cossus* a power of retracting its prolegs within the body, he conjectured that the hexapod larva from Jamaica, (*Prionus damicornis ?*) given him by Sir Hans Sloane, might have the same faculty, and so be the caterpillar of a Bombyx.

[o] Amoreux has collected the different opinions of entomologists on the subject of Pliny's Cossus, which has been supposed the larva of *Calandra palmarum* by Geoffroy; of *Lucanus Cervus* by Scopoli; and of *Prionus damicornis* by Drury. The first and last, being neither natives of Italy nor inhabiting the oak, are out of the question. The larvæ of *Lucanus Cervus* and *Prionus coriarius*, which are found in the oak as well as in other trees, may each have been eaten under this name, as their difference would not be discernible either to collectors or cooks. Amoreux, 154.

dies, both by whites and blacks, who empty, wash, and roast them, and find them delicious[p]. Mr. Hall informs me, that in Jamaica this grub is called *Macauco*, and is in request at the principal tables. A similar insect is dressed at Mauritius under the name of *Moutac*, which the whites as well as Negroes eat greedily[q]. The larva of *C. cervicornis* is, according to Linné, held in equal estimation, and that of *Lamia Tribulus* when roasted forms an article of food in Africa[r]. It is probable that all the species of this genus might be safely eaten, as well as many other grubs of Coleoptera; and although I do not feel disposed to recommend with Reaumur[s], that the larvæ of *Oryctes nasicornis* should be sought for "*dans les couches de fumier*," yet I think with Dr. Darwin[t], that those of the cockchafer which feed upon the roots of grass, or the perfect insects themselves, which, if we may judge from the eagerness with which cats, and turkeys and other birds devour them, are no despicable *bonne bouche*, might be added to our *entremets*. This would be one means of keeping down the numbers of these occasionally destructive animals.

In the next order of insects, the Orthoptera, the Gryllus, or Locust tribe, as they are the greatest destroyers of food, so as some recompense they furnish a considerable supply of it to numerous nations. They are recorded to have done this from the most remote antiquity, some Ethiopian tribes having been named from this circumstance *Acridophagi* (Locust-eaters)[u].

[p] Merian *Ins. Sur.* 24. [q] St. Pierre, *Voy.* 72.
[r] Smeathman, 32. [s] Reaum. ii. 344. [t] *Phytol.* 364.
[u] Diod. Sic. l. iii. c. 29. Strabonis *Geog.* l. xvi. &c.

Pliny also relates that they were in high esteem as meat amongst the Parthians[v]. Hasselquist, in reply to some inquiries which he made on this subject with respect to the Arabs, was informed that at Mecca, when there was a scarcity of corn, as a substitute for flour they would grind locusts in their hand-mills, or pound them in stone mortars; that they mixed this flour with water into a dough, and made their cakes of it, which they baked like their other bread. He adds, that it is not unusual for them to eat locusts when there is no famine; but then they boil them first a good while in water, and afterwards stew them with butter into a kind of fricassee of no bad flavour[w]. Leo Africanus, as quoted by Bochart, gives a similar account[x]. Sparrman informs us that the Hottentots are highly rejoiced at the arrival of the locusts in their country, although they destroy all its verdure, eating them in such quantities as to get visibly fatter than before, and making of their eggs a brown or coffee-coloured soup. He also relates a curious notion which they have with respect to the origin of the locusts—that they proceed from the good will of a great master-conjurer a long way to the north, who, having removed the stone from the mouth of a certain deep pit, lets loose these animals to be food for them[y]. This is not unlike the account given by the divine author of the Apocalypse, of the origin of the symbolical locusts, which are said to ascend upon an angel's opening the pit of the abyss[z]. Clenard, in his letters quoted by Bochart, says that they bring waggon-loads of locusts to Fez, as a usual article

[v] *Hist. Nat.* l. xi. c. 29. [w] *Travels*, 232. [x] *Hieroz.* ii. l. 14. c. 7.
[y] Sparrman, i. 367. [z] *Rev.* ix. 2, 3.

of food[a]. Major Moor informs me, that when the cloud of locusts noticed in a former letter visited the Mahratta country, the common people salted and ate them. This was anciently the custom with many of the African nations, some of whom also smoked them[b]. They appear even to have been an article of food offered for sale in the markets of Greece[c]; and on a subject so well known, to quote no other writers, Jackson observes that, when he was in Barbary in 1799, dishes of locusts were generally served up at the principal tables and esteemed a great delicacy. They are preferred by the Moors to pigeons; and a person may eat a platefull of two or three hundred without feeling any ill effects. They usually boil them in water half an hour, (having thrown away the head, wings and legs,) then sprinkle them with salt and pepper, and fry them, adding a little vinegar[d].—From this string of authorities you will readily see how idle was the controversy concerning the locusts which formed part of the sustenance of John the Baptist, agreeing with Hasselquist[e], that they could be nothing but the animal locust, so common a food in the East; and how apt even learned men are to perplex a plain question, from ignorance of the customs of other countries.

In the hemipterous order of insects, none are more widely dispersed, or (if you will forgive me a pun) have made more noise in the world than the *Tettigonia* tribe. From the time of Homer, who compares the garrulity of age to the chirping of these insects[f], they

[a] *Hieroz.* ii. l. 4. c. 7. 492. [b] Pliny, *Hist. Nat.* l. vi. c. 30. [c] Ibid.
[d] Jackson's *Travels in Marocco*, 53. [e] *Travels*, 230.
[f] Hom. *Il.* γ. 150-4.

have been celebrated by the poets; and Anacreon, as you well know, has inscribed a very beautiful little ode to them. We learn from Aristotle, that these insects were eaten by the polished Greeks, and accounted very delicious. The worm (*larva*), he says, lives in the earth where it takes its growth; that it then becomes a *Tettigometra* (*pupa*), when he observes they are most delicious, just before they burst from their covering. From this state they change to the *Tettix* or *Cicada*, when the males at first have the best flavour; but after impregnation the females are preferred on account of their white eggs[g]. Athenæus also and Aristophanes mention their being eaten; and Ælian is extremely angry with the men of his age that an animal sacred to the Muses should be strung, sold, and greedily devoured[h]. Pliny tells us that the nations of the East, even the Parthians, whose wealth was abundant, use them as food[i]. The imago of the *Tettigonia septendecim* is still eaten by the Indians in America, who pluck off the wings and boil them[j]. This ancient Greek taste for Tettigoniæ seems now gone out of fashion, at least travellers do not notice it: but perhaps if it were revived in those countries where the insects are to be found, for they inhabit only warm climates, it would be ascertained that so polished a people did not relish them without reason.

No insects are more numerous in this island than the caterpillars of Lepidoptera: if these could be used in aid of the stock of food in times of scarcity, it might

[g] Arist. *Hist. An.* l. v. c. 30.
[h] Vide Bochart, *Hieroz.* ii. l. 4. c. 7. 491.
[i] *Hist. Nat.* l. xi. c. 26.
[j] P. Collinson in *Phil. Trans.* 1763. n. x.

subserve the double purpose of ridding us of a nuisance and relieving the public pressure. Reaumur suggests this mode of diminishing the numbers of destructive caterpillars, speaking of that of *Noctua Gamma*, which did such infinite mischief in France in the year 1735[k]. If however we were to take to eating caterpillars, I should, for my own part, be of the mind of the red-breasts, and eat only the naked ones[l]. But you will see that there is some encouragement from precedent to make a meal of the caterpillars which infest our cabbages and cauliflowers. Amongst the delicacies of a Boshies-ma s table, Sparrman reckons those caterpillars from which butterflies proceed[m]. The Chinese, who waste nothing, after they have unwound the silk from the cocoons of the silk-worm, send the chrysalis to table: they also eat the larvæ of a *Sphinx*[n], some of which tribe, Dr. Darwin tells us, are, in his opinion, very delicious[o]: and lastly, the natives of New Holland eat the caterpillars of a species of moth of a singular new genus, to which my friend Alexander MacLeay, Esq., has assigned characters, and, from the circumstance of its larva coming out only in the night to feed, has called it *Nyctcrobia*.

The next order, the Neuroptera, will make us some amends for the meagerness of the last, as it contains the white ant tribe (*Termes*), which, in return for the mischief it does at certain times, affords an abundant supply of food to some of the African nations. The Hottentots eat them boiled and raw, and soon get into

[k] Reaum. ii. 341. [l] Ray's *Letters*, 135. [m] Sparrman, i. 201.
[n] Sir G. Staunton's *Voy.* iii. 246. [o] *Phytol.* 364.

good condition upon this food[p]. König, quoted by Smeathman, says that in some parts of the East Indies the natives make two holes in the nests of the white ants, one to the windward and the other to the leeward, placing at the latter opening a pot rubbed with an aromatic herb, to receive the insects driven out of their nest by a fire of stinking materials made at the former. Thus they catch great quantities, of which they make with flour a variety of pastry, that they can afford to sell cheap to the poorer people. Mr. Smeathman says he has not found the Africans so ingenious in procuring or dressing them. They are content with a very small part of those that fall into the waters at the time of swarming, which they skim off with calabashes, bring large kettles full of them to their habitations, and parch them in iron pots over a gentle fire, stirring them about as is done in roasting coffee. In that state without sauce or other addition they serve them up as delicious food, and eat them by handfuls as we do comfits. He has eaten them dressed in this way several times, and thought them delicate, nourishing and wholesome, being sweeter than the grub of *Calandra palmarum*, and resembling in taste sugared cream or sweet almond paste[q]. The female ant, in particular, is supposed by the Hindoos to be endowed with highly nutritive properties, and, we are told by Mr. Broughton, was carefully sought after and preserved for the use of the debilitated Surjee Rao, prime minister of Scindia chief of the Mahrattas[r].

[p] Sparmann, i. 363. [q] Smeathman, 31.
[r] *Letters written in a Mahratta Camp in* 1809.

The Hymenoptera order also furnishes a few articles to add to this head. I do not allude to the nectar which the bees collect for us. But perhaps you do not suspect that bees themselves in some places serve for food, yet Knox tells us that they are eaten in Ceylon[s]: —an ungrateful return for their honey and wax which I would on no account recommend. Piso speaks of yellow ants called *Cupia* inhabiting Brazil, the abdomen of which many used for food, as well as a larger species under the name of *Tama-joura*[t]; which account is confirmed by Humboldt, who informs us that ants are eaten by the Marivatanos and Margueritares, mixed with resin for sauce. Ants, I speak from experience, have no unpleasant flavour; they are very agreeably acid, and the taste of the trunk and abdomen is different; so that I am not so much surprised as Mr. Consett seems to have been at the avidity with which the young Swede mentioned by him sat down to the siege of an ants' nest[u]. This author states, that in some parts of Sweden ants are distilled along with rye, to give a flavour to the inferior kinds of brandy[v]. —Under this head may not improperly be mentioned several galls the product of different species of Cynips, particularly those found on some kinds of Sage, viz. *Salvia pomifera*, *S. triloba*, and *S. officinalis*, which are very juicy like apples, and crowned with rudiments of leaves resembling the calyx of that fruit. They are esteemed in the Levant for their aromatic and acid flavour, especially when prepared with sugar, and

[s] Knox's *Ceylon*, 25.
[t] Piso, *Ind.* l. v. c. 13. 291.
[u] *Travels in Sweden*, 118.
[v] *Ibid.*

form a considerable article of commerce from Scio to Constantinople, where they are regularly exposed in the market[w]. The galls of ground-ivy have also been eaten in France; but Reaumur, who tasted them, is doubtful whether they will even rank with good fruits[x].

To the Diptera order, as a source of food, man can scarcely be said to be under any obligation; the larva of *Musca putris*, which is so commonly found in cheese, being the only one ever eaten—a dainty as some think it, of whom you will perhaps say with Scopoli, "*quibus has delicias non invideo*[y]."

The order Aptera, now that the Crustacea are excluded, does not much more abound in esculent insects than the Diptera. The only species which have tempted the appetite of man in this order are the cheese-mite (*Acarus Siro*)—Lice, which are eaten by the Hottentots and natives of the western coast of Africa, who from their love of this game, which they not only collect themselves from their well stored *capital* pasture, but employ their wives in the chase, have been sometimes called Phthirophagi[z]—another tribe also, which you will think even more repulsive than the last, I mean spiders. These form an article in Sparrman's list of the Boshies-man's dainties[a]; and Labillardiere tells us that the inhabitants of New Caledonia seek for and eat with avidity large quantities of a spider nearly an inch long (which he calls *A. edulis*), and which they roast over the fire[b]. Even individuals

[w] Smith's *Introd. to Bot.* 346. Olivier's *Travels*, i. 139.
[x] Reaum. iii. 416.
[y] Scop. *Carniol.* 337.
[z] Lat. *Hist. Nat.* viii. 93.
[a] Sparrman, i. 201.
[b] *Voyage a la recherche de la Perouse*, ii. 240.

amongst the more polished nations of Europe are recorded as having a similar taste; so that, if you could rise above vulgar prejudices, you would in all probability find them a most delicious morsel. If you require precedents, Reaumur tells us of a young lady who when she walked in her grounds never saw a spider that she did not take and crack upon the spot[c]. Anna Maria Schurman, another female, used to eat them like nuts, which she affirmed they much resembled in taste, excusing her propensity by saying that she was born under the sign Scorpio[d]. If you wish for the authority of the learned, Lalande the celebrated French astronomer was, as Latreille witnessed[e], equally fond of these delicacies. And lastly, if not content with taking them seriatim you should feel desirous of eating them by handfulls, you may shelter yourself under the authority of the German immortalized by Rösel[f], who used to spread them upon his bread like butter, observing that he found them very useful, "*um sich auszulaxiren.*"—These edible aptera are all sufficiently disgusting; but we feel our nausea quite turned into horror when we read in Humboldt, that he has seen the Indian children drag out of the earth centipedes eighteen inches long and more than half an inch broad, and devour them[g].

After all I have said, you may perhaps still feel a prejudice against insects as food; but I think, when you recollect that Oberon and his queen Titania, that re-

[c] Reaum. ii. 342. [d] Shaw, *Nat. Misc.* [e] *Hist. Nat.* vii. 227.
[f] Rosel, iv. 257. [g] *Personal Travels*, ii. 205.

nowned personage Robin Goodfellow, "with all the fairy elves that be," number insects amongst their choicest cates, you will no longer be heretical in this article, but yield with a good grace; and as a reward I will copy out for you a beautiful poetical description of Oberon's feast, which was lately pointed out to me by a learned bibliographical friend, John Crosse, Esq. of Hull, in Herrick's *Hesperides*, 1658.

Shapcot, to thee the fairy state
I with discretion dedicate;
Because thou prizest things that are
Curious and unfamiliar.
Take first the feast: these dishes gone,
We'll see the fairy court anon.
A little mushroom table spread;
After short prayers, they set on bread,
A moon-parch'd grain of purest wheat,
With some small glitt'ring grit to eat
His choicest bits with: then in a trice
They make a feast less great than nice.
But, all this while his eye is serv'd,
We must not think his ear was starv'd;
But that there was in place to stir
His spleen, the chirring grasshopper,
The merry cricket, puling fly,
The piping gnat for minstrelsy:
And now we must imagine first
The elves present, to quench his thirst,
A pure seed pearl of infant dew,
Brought and besweeten'd in a blue
And pregnant violet; which done,
His kitling eyes begin to run

Quite through the table, where he spies
The horns of papery butterflies,
Of which he eats, and tastes a little
Of what we call the cuckow's spittle:
A little furze-ball pudding stands
By, yet not blessed by his hands,
That was too coarse; but then forthwith
He ventures boldly on the pith
Of sugar'd rush, and eats the sag
And well-bestrutted bee's sweet bag;
Gladding his palate with some store
Of emmets' eggs: what would he more?
But beards of mice, a newt's stew'd thigh,
A bloated earwig and a fly;
With the red-capp'd worm that's shut
Within the concave of a nut,
Brown as his tooth: a little moth
Late fatten'd in a piece of cloth;
With wither'd cherries; mandrakes' ears;
Moles' eyes; to these the slain stag's tears;
The unctuous dewlaps of a snail;
The broke heart of a nightingale
O'ercome in music;———

——— This done, commended
Grace by his priest, the feast is ended.—

Having considered insects as adding to the general stock of food, I shall next request your attention while I detail to you how far the medical science is indebted to them. Had I addressed you a century ago, I could have made this an ample history. Amongst scores of infallible panaceas, I should have recommended the woodlouse as a solvent and aperient; powder of silk-worm for vertigo and convulsions; millepedes against the jaundice; earwigs to strengthen the nerves; powdered scorpion for the stone and gravel; fly-water for disorders in the eyes; and the tick for erysipelas. I should have prescribed five gnats as an excellent purge; wasps as diuretics; lady-birds for the colic and measles; the cockchafer for the bite of a mad dog and the plague; and ants and their acid I should have loudly praised as incomparable against leprosy and deafness, as strengthening the memory, and giving vigour and animation to the whole bodily frame[h]. In short, I could have easily added to the miserably meager list of modern pharmacopœias, a catalogue of approved insect-remedies for every disease and evil

"that flesh is heir to!"

But these good times are long gone by. You would, I fear, laugh at my prescriptions notwithstanding the great authorities I could cite in their favour; and even doubt the efficacy of a more modern specific for tooth-ache, promulgated by a learned Italian professor[i], who assures us that a finger once imbued with the juices of *Curculio antiodontalgicus* will retain its power of curing this disease for a twelvemonth! I must content myself, therefore, with expatiating on the virtues of the very few insects to which the sons of Hippocrates and Galen now deign to have recourse. At the same time

[h] For this list of remedies, see Lesser *L.* ii. 171-3.

[i] Gerbi. The same virtues have been ascribed to *Coccinella septempunctata*, L.

I cannot help observing that their proscription of the remainder may have been too indiscriminate. Mankind are apt to run from one extreme to the other. From having ascribed too much efficacy to insect-remedies, we may now ascribe too little. Many insects emit very powerful odours, and some produce extraordinary effects upon the human frame; and it is an idea not altogether to be rejected, that they may concentrate into a smaller compass the properties and virtues of the plants upon which they feed, and thus afford medicines more powerful in operation than the plants themselves. It is at least worth while to institute a set of experiments with this view.

Medicine at the present day is indebted to the *Formica bispinosa* of Olivier (*fungosa*, F.) for a kind of lint collected by that insect from the Bombax and silk cotton-tree, which as a styptic is preferable to the puff-ball, and at Cayenne is successfully used to stop the blood in the most violent hæmorrhages[j]; and gum ammoniac, according to Mr. Jackson[k], oozes out of a plant like fennel, from incisions made in the bark by a beetle with a large horn. But with these exceptions, (in which the remedy is rather collected than produced by insects), and that of spiders' webs, which are said to have been recently administered with success in ague, the only insects which directly supply us with medicine are some species of Lytta and Mylabris.

[j] Latr. *Hist. Nat. des Fourmis*, 48. 134.

[k] Jackson's *Marocco*, 83. Some doubt however attaches to this statement, from the circumstance of the figure which Mr. Jackson gives of his beetle (*Dibben Fashook*) being clearly a mere copy of that of Mr. Bruce's *Zimb!*

These however amply make up in efficacy for their numerical insignificance; and almost any article could be better spared from the Materia Medica than one of the former usually known under the name of *Cantharides*, which is not only of incalculable importance as a vesicatory, but is now administered internally in many cases with very good effect. In Europe, the only insect used with this view is the *Lytta vesicatoria*; but in America the *L. cinerea* and *vittata* (which are extremely common and noxious insects, while the *L. vesicatoria* is sold there at sixteen dollars the pound,) have been substituted with great success, and are said to vesicate more speedily and with less pain, at the same time that they cause no strangury[l]: and in China they have long employed the *Mylabris Cichorei*, which seems to have been considered the most powerful vesicatory amongst the ancients, who however appear to have been acquainted with the common *Lytta vesicatoria* also, and to have made use of it, as well as of *Cetonia aurata* and some other insects mentioned by Pliny[m]. Another species of Mylabris has been described by Colonel Hardwicke in the *Asiatic Transactions*[n], plentiful in all parts of Bengal, Bahar, and Oude, which is fully as efficacious as the common Spanish fly.

But it is as supplying products valuable in the arts and manufactures, that we are chiefly indebted to insects. In adverting to them in this view, I shall not dwell upon the articles derived from a few species in

[l] Illiger *Mag.* i. 256. [m] *Hist. Nat.* l. xix. c. 4. [n] Vol. v. 213.

particular districts, and confined to these alone, such as the soap which in some parts of Africa is manufactured from a species of Carabus (*C. saponarius*, Oliv.[o]); the oil which Molina tells us is obtained in Chili from large globular cellules found upon the wild rosemary, and supposed to be produced by a kind of Cynips[p]; and the manure for which Scopoli informs us the hosts of Ephemeræ that annually emerge in the month of June from the Laz, a river in Carniola, are employed by the husbandmen, who think they have had a bad harvest unless every one has collected at least twenty loads[q].

Still less is it my intention to detain you in considering the purpose to which in the West Indies and South America the fire-flies are put by the natives, who employ them as lanterns in their journeys, and lamps in their houses;—or the use as ornaments to which some insects are ingeniously applied by the ladies, who in China embroider their dresses with the elytra and crust of a brilliant species of Buprestis (*B. vittata*); in Chili and the Brazils form splendid necklaces of the golden Chrysomelæ and Curculiones[r]; in some parts of the continent string together for the same purpose the burnished thighs of *Scarabæus stercorarius* &c.[s]; and in India, as I am informed by Major Moor, even have recourse to fire-flies, which they inclose in gauze and use as ornaments for their hair when they take their evening walks. I shall confine my details to the more important and general products which they supply to the arts, beginning with one in-

[o] Oliv. *Entom.* iii. 69. *t.* iii. *f.* 26. Compare *Philanthropist*, ii. 210.

[p] Molina's *Chili*, i. 174.

[q] *Ent. Carniol.* 264.

[r] Molina, i. 171. 285.

[s] Latr. *Hist. Nat.* x. 143.

dispensable to our present correspondence, and adverting in succession to the insects affording *dyes*, *lac*, *wax*, *honey*, and *silk*.

No present that insects have made to the arts is equal in utility and universal interest, comes more home to our best affections, or is the instrument of producing more valuable fruits of human wisdom and genius, than the product of the animal to which I have just alluded.—You will readily conjecture I mean the fly that gives birth to the gall-nut from which ink is made. How infinitely are we indebted to this little creature, which at once enables us to converse with our absent friends and connexions be their distance from us ever so great, and supplies the means by which, to use the poet's language, we can

> "———give to airy nothing
> A local habitation and a name!"

enabling the poet, the philosopher, the politician, the moralist, and the divine, to embody their thoughts for the amusement, instruction, direction and reformation of mankind.—The insect which produces the gall-nut is of the genus *Cynips* of Linné, but was not known to him or to Fabricius. Olivier first described it under the name of *Diplolepis gallæ tinctoriæ*[1]. The galls originate on the leaves of a species of oak (*Quercus infectoria*, Oliv.) very common throughout Asia Minor, in many parts of which they are collected by the poorer inhabitants and exported from Smyrna, Aleppo, and

[1] *Encyclop. Insect.* vi. 281. It had better, perhaps, as compound Trivial Names are bad, be called *Cynips Scriptorum.*

other ports in the Levant, as well as from the East Indies, whither a part of those collected are now carried. The galls most esteemed are those known in commerce under the name of *blue galls*, being the produce of the first gathering before the fly has issued from the gall. It will not be uninteresting to you to know, that from these when bruised may occasionally be obtained perfect specimens of the insect, one of which I lately procured in this way. The galls which have escaped the first searches, and from most of which the fly has emerged, are called *white galls*, and are of a very inferior quality, containing less of the astringent principle than the blue galls in the proportion of two to three[u]. The white and blue galls are usually imported mixed in about equal proportions, and are then called galls in sorts. If no substitute equal to galls as a constituent part of ink has been discovered, the same may be said of these productions as one of the most important of our dyeing materials constantly employed in dyeing black. It is true that this colour may be communicated without galls, but not at once so cheaply and effectually, as is found by their continued large consumption notwithstanding all the improvements in the art of dyeing. Other dyeing drugs are afforded by insects, the principal of which are *Kermes, the Scarlet Grain of Poland, Cochineal, Lac-lake and Lac-dye*, all of which are furnished by different species of *Coccus*.

The first of these, the *Coccus Ilicis*, L., found abundantly upon a small species of evergreen oak (*Quercus coccifera*, L.) common in the south of France, and

[u] Olivier's *Travels in Egypt*, &c. ii. 64.

many other parts of the world, has been employed to impart a blood red or crimson dye to cloth from the earliest ages, and was known to the Phœnicians before the time of Moses under the name of *Tola or Thola* (תולע), to the Greeks under that of *Coccus* (Κοκκος), and to the Arabians and Persians under that of *Kermes* or *Alkermes*; whence, as Beckmann has shown, and from the epithet *vermiculatum* given to it in the middle ages, when it was ascertained to be the produce of a worm, have sprung the Latin *coccineus*, the French *cramoisi* and *vermeil*, and our *crimson* and *vermilion*. It was most probably with this substance that the curtains of the tabernacle (Exodus xxvi. &c.) were dyed deep red (which the word scarlet, as our translators have rendered תולעת שני, then implied, not the colour now so called, which was not known in James the First's reign when the Bible was translated)—it was with this that the Grecians and Romans produced their crimson; and from the same source were derived the imperishable reds of the Brussels and other Flemish tapestries. In short, previous to the discovery of cochineal, this was the material universally used for dyeing the most brilliant red then known; and though that production of the New World has, in some respects undeservedly[v], supplanted it in Europe, where it is little attended to except by the peasantry of the provinces in which it is

[v] The colour communicated by Kermes with alum, the only mordant formerly employed, is blood red: but Dr. Bancroft found (i. 404.) that with the solution of tin used with cochineal it is capable of imparting a scarlet quite as brilliant as that dye, and perhaps more permanent. At the same time, however, as ten or twelve pounds contain only as much colouring matter as one of cochineal, the latter at its ordinary price is the cheapest.

found, it still continues to be employed in a great part of India and Persia[w].

The scarlet grain of Poland (*Coccus polonicus*, L.) is found on the roots of the perennial knawel (*Scleranthus perennis*, L. a scarce plant in this country, but abundant in the neighbourhood of Elvedon in Suffolk), and was at one time collected in large quantities for dyeing red in the Ukraine, Lithuania, &c. But though still employed by the Turks and Armenians for dyeing wool, silk and hair, as well as for staining the nails of women's fingers, it is now rarely used in Europe except by the Polish peasantry. A similar neglect has attended the Coccus found on the roots of *Poterium Sanguisorba*, L.[x], which was used by the Moors for dyeing silk and wool a rose colour; and the *Coccus Uva-ursi*, which with alum affords a crimson dye[y].

Cochineal, the *Coccus Cacti*, L., is doubtless the most valuable product for which the dyer is indebted to insects, and with the exception perhaps of indigo the most important of dyeing materials. Though the Spaniards found it employed by the natives of Mexico, where alone it is cultivated, on their arrival in that country in 1518, its true nature was not accurately ascertained for nearly two centuries afterwards. Acosta indeed as early as 1530, and Herrara and Hernandez subsequently, had stated it to be an insect. But led apparently by its external appearance, notwithstanding the conjectures of Lister and assertions of Pere Plumier

[w] Bochart, *Hierozoic.* ii. l. iv. c. 27. Beckmann's *History of Inventions*, Engl. Trans. ii. 171-205. Bancroft *on permanent Colours*, i. 393. See also Parkhurst's *Heb. Lexicon* under חלע and שנה.

[x] Rai. *Hist. Plant.* i. 401.

[y] Bancroft, i. 401.

to the contrary, it was believed by Europeans in general to be the seed of a plant, until Hartsoeker in 1694, Leeuwenhoek and De la Hire in 1704, and Geoffroy ten years later by dissections and microscopical observations incontrovertibly proved its real origin[z].

This insect, which comes to us in the form of a reddish shrivelled grain covered with a white powder or bloom, feeds on a particular kind of Indian fig, called in Mexico, where alone cochineal is produced in any quantity, Nopal, which has always been supposed to be the *Cactus cochinilifer*, L., but according to Humboldt is unquestionably a distinct species, which bears fruit internally white.

Cochineal is chiefly cultivated in the intendency of Oaxaca; and some plantations contain 50 or 60,000 nopals in lines, each being kept about four feet high for more easy access in collecting the dye. The cultivators prefer the most prickly varieties of the plant, as affording protection to the cochineal from insects; to prevent which from depositing their eggs in the flower or fruit, both are carefully cut off. The greatest quantity, however, of cochineal employed in commerce is produced in small nopaleries belonging to Indians of extreme poverty, called *Nopaleros*. They plant their nopaleries in cleared ground on the slopes of mountains or ravines two or three leagues distant from their villages; and when properly cleaned, the plants are in a condition to maintain the cochineal in the third year. As a stock, the proprietor in April or May purchases branches or joints of the *Tuna de Castilla*, laden with

[z] Bancroft, i. 413. Reaum. iv. 88.

small cochineal insects recently hatched (*Semilla*). These branches, which may be bought in the market of Oaxaca for about three francs the hundred, are kept for twenty days in the interior of their huts, and then exposed to the open air under a shed, where from their succulency they continue to live for several months. In August and September the mother cochineal insects, now big with young, are placed in nests made of a species of *Tillandsia* called *Paxtle*, which are distributed upon the nopals. In about four months the first gathering, yielding twelve for one, may be made, which in the course of the year is succeeded by two more profitable harvests. This period of sowing and harvest refers chiefly to the districts of Sola and Zimatlan. In colder climates the semilla is not placed upon the nopals until October or even December, when it is necessary to shelter the young insects by covering the nopals with rush mats, and the harvests are proportionably later and unproductive. In the immediate vicinity of the town of Oaxaca the Nopaleros feed their cochineal insects in the plains from October to April, and at the beginning of the remaining months, during which it rains in the plains, transport them to their plantations of nopals in the neighbouring mountains, where the weather is more favourable.

Much care is necessary in the tedious operation of gathering the cochineal from the nopals, which is performed with a squirrel or stag's tail by the Indian women, who for this purpose squat down for hours together beside one plant; and notwithstanding the high price of the cochineal, it is to be doubted if the cultivation would be profitable were the value of labour more considerable.

The cochineal insects are killed either by throwing them into boiling water: by exposing them in heaps to the sun; or by placing them in the ovens (*Temazcalli*) used for vapour-baths. The last of these methods, which is least in use, preserves the whitish powder on the body of the cochineal, which being thus less subject to the adulterations so often practised by the Indians, bears a higher price both in America and Europe[a].

The quantity at present annually exported from South America is said by Humboldt to be 32,000 arrobas, there worth 500,040*l.* sterling[b]—a vast amount to arise from so small an insect, and well calculated to show us the absurdity of despising any animals on account of their minuteness. So important is the acquisition of this insect, of which the Spanish government is extremely jealous, regarded, that the Court of Directors of the East India Company have offered a reward of 6000*l.* to any one who shall introduce it into India, where hitherto the Company have only succeeded in procuring from Brazil the wild kind producing the *Sylvestre* cochineal, which is of very inferior value.

Lac is the produce of an insect formerly supposed to be a kind of ant or bee[c], but now ascertained to be a

[a] Humboldt's *Political Essay on New Spain*, iii. 72-9.—Dr. Bancroft estimates the present annual consumption of cochineal in Great Britain at about 750 bags, or 150,000lbs.—worth at the present price 375,000*l.*

[b] Ibid. iii. 64.

[c] Lesser, *L.* ii. 165.

species of Coccus, whose history will be adverted to when I come to speak of the secretions of insects; and it is collected from various trees in India, where it is found so abundantly, that, were the consumption ten times greater than it is, it could be readily supplied. This substance is made use of in that country in the manufacture of beads, rings, and other female ornaments. Mixed with sand it forms grind-stones; and added to lamp- or ivory-black, being first dissolved in water with the addition of a little borax, it composes an ink not easily acted upon when dry by damp or water. In this country, where it is distinguished by the names *Stick-lac* when in its native state unseparated from the twigs to which it adheres; *Seed-lac* when separated, pounded, and the greater part of the colouring matter extracted by water; *Lump-lac* when melted and made into cakes; and *Shell-lac* when strained and formed into transparent laminæ;—it has hitherto been chiefly employed in the composition of varnishes, japanned ware and sealing-wax; but within these few years it has been applied to a still more important purpose, originally suggested by Dr. Roxburgh—that of a substitnte for cochineal in dyeing scarlet. The first preparations from it with this view were made in consequence of a hint from Dr. Bancroft, and large quantities of a substance termed *Lac-lake*, consisting of the colouring matter of stick-lac precipitated from an alkaline lixivium by alum, were manufactured at Calcutta and sent to this country, where at first the consumption was so considerable, that in the three years previous to 1810 Dr. Bancroft states that the sales of it at the India House equalled in point of colouring matter half a million of pounds weight of cochineal. More recently, however, a new preparation of lac colour, under the name of *Lac-dye*, has been imported from India, which has been substituted for the lac-lake, and with such advantage, that the East India Company are said to have saved in a few months 14,000*l.* in the purchase of scarlet cloths dyed with this colour and cochineal conjointly, and without any inferiority in the colour obtained[e].

Some other insects besides the Cocci afford dyes. Reaumur tells us, that in the Levant, Persia, and China, they use the galls of a particular species of Aphis for dyeing silk crimson, which he thinks might lead us to try experiments with those of our own country[f]. That dyes might be thus obtained seems probable from an observation of Linné's, in his Lapland Tour, upon the galls produced by *Aphis Pini* on the extremities of the leaves of the spruce-fir, which, he informs us, when arrived at maturity burst asunder, and discharge an orange-coloured powder which stains the clothes[g]. In fact, we are told that *Terminalia citrina*, a tree common in India, yields a species of galls, the product of an insect, which are sold in every market, being one of the most useful dyeing drugs known to the natives, who dye their best and most durable yellow with them[h]. A species of Trombidium (*T. tinctorium*—*Acarus*, L.), a native of Guinea and Surinam, is also employed as a dye; and it would be worth while to try whether our *T. holosericeum*, so remarkable for the dazzling bril-

[e] Bancroft *on permanent Colours*, ii. 20. 49.

[f] Reaum. iii. *Preface*, xxxi.

[g] *Lach. Lapp.* i. 258.

[h] *Trans. of the Soc. of Arts*, xxiii. 411.

liancy of its crimson and the beautiful velvet texture of its down, which seems nearly related to *T. tinctorium*, would not likewise afford a valuable tincture. It is not likely, perhaps, that many better and cheaper dyes than we now possess can be obtained from insects; but Reaumur has suggested, that water-colours of beautiful tints, not otherwise easily obtainable, might be procured from the excrements of the larvæ of the common clothes-moth, which retains the colour of the wool they have eaten unimpaired in its lustre, and mixes very well with water. To get a fine red, yellow, blue, green, or any other colour or shade of colour, we should merely have to feed our larvæ with cloth of that tint[i].

Wax, so valuable for many minor purposes, and deemed with us so indispensable to the comfort of the great, is of still more importance in those parts of Europe and America in which it forms a considerable branch of trade and manufacture, as an article of extensive use in the religious ceremonies of the inhabitants. Humboldt informs us, that not fewer than 25,000 arrobas, value upwards of 83,000*l.*, are annually exported from Cuba to New Spain, where the quantity consumed in the festivals of the Church is immense even in the smallest villages; and that the total export of the same island in 1803 was not less than 42,670 arrobas, worth upwards of 130,000*l.*[j] Nearly the whole of the wax employed in Europe, and by far the greater part of that consumed in America, is the produce of the common hive-bee; but in the latter quarter of the globe a quantity by no means trifling is

[i] Reaum. iii. 95. [j] *Political Essay*, iii. 62.

obtained from various wild species. According to Don F. de Azara, the inhabitants of Santiago del Estero gather every year not less than 14,000 pounds of a whitish wax from the trees of Chaco[k].

In China wax is also produced by another insect, which from the description of it by the Abbe Grosier seems to be a species of *Coccus*. With this insect the Chinese stock the two kinds of tree (*Kan-la-chu* and *Choni-la-chu*) on which alone it is found, and which always afterwards retain it. Towards the beginning of winter small tumours are perceived, which increase until as big as a walnut. These are the nests (abdomens of the females) filled with the eggs that are to give birth to the *Cocci*, which when hatched disperse themselves over the leaves, and perforate the bark under which they retire. The wax (called *Pe-la*, white wax, because so by nature,) begins to appear about the middle of June. At first a few filaments like fine soft wool are perceived, rising from the bark round the body of the insect, and these increase more and more until the gathering, which takes place before the first hoar frosts in September. The wax is carried to court, and reserved for the emperor, the princes, and chief mandarins. If an ounce of it be added to a pound of oil, it forms a wax little inferior to that made by bees. The physicians employ it in several diseases; and the Chinese, when about to speak in public and assurance is necessary, previously eat an ounce of it to prevent swoonings[l]; a use of it for which happily our less diffident orators have no call. This

[k] *Voyage dans l'Amer. Merid.* i. 162.

[l] Grosier's *China*, i. 439.

account is in the main confirmed by Geomelli Careri, except that he calls the wax-insect a *worm* which bores to the pith of certain trees; and says that it produces a sufficient supply for the whole empire, the different provinces of which are furnished from Xantung, where it is bred in the greatest perfection, with a stock of eggs[m]. A very different origin, however, is assigned to the *Pe-la* by Sir George Staunton, who informs us that it is produced by a species of *Cicada* (*C. limbata*), which in its larva state feeds upon a plant like the privet, strewing upon the stem a powder, which when collected forms the wax[n]. But as he merely states that this powder was "*supposed*" to form it, and does not himself appear to have made the experiment of dissolving it in oil; and as no Cicada yet known produces any similar secretion; it is most probable that his information was incorrect, and that Grosier's statement is the true one.

This probability is nearly converted into certainty by the fact that many Aphides and Cocci secrete a wax-like substance, and that a kind of wax very analogous to the *Pe-la*, and of the same class with bees-wax, only containing more carbon, is actually produced in India by a nondescript species of Coccus remarkable for providing itself with a small quantity of honey like our bees. This substance, for specimens of which I am indebted to the kindness of Sir Joseph Banks, was first noticed by Dr. Anderson, and called by him *White-lac*. It could be obtained in any quantity from the neighbourhood of Madras, and at a much

[m] Quoted in Southey's *Thalaba*, ii. 166. [n] *Embassy to China*, i. 400.

cheaper rate than bees-wax; but the experiments of Dr. Pearson do not afford much ground for supposing that it can be advantageously employed in making candles[o]. De Azara speaks of a firm white wax apparently similar, and the produce of an insect of the same tribe, which is collected in South America in the form of pearl-like globules from the small branches of the *Quabirámy'*, a small shrub two or three feet high[p].

Insects in some countries not only furnish the natives with wax but with *resin*, which is used in paying their ships. Molina informs us that, at Coquimbo in Chili, resin, either the product of an insect or the consequence of an insect's biting off the buds of a particular species of Origanum, is collected in large quantities. The insect in question is a small smooth red caterpillar about half an inch long, which changes into a yellowish moth with black stripes upon the wings (*Phal. ceraria*, Molina). Early in the spring vast numbers of these caterpillars collect on the branches of the *Chila*, where they form their cells of a kind of soft white wax or resin, in which they undergo their transformations. This wax, which is at first very white, but by degrees becomes yellow, and finally brown, is collected in autumn by the inhabitants, who boil it in water, and make it up into little cakes for market[q].

Honey, another well-known product of insects, has lost much of its importance since the discovery of sugar; yet at the present day, whether considered as a delicious article of food, or the base of a wholesome vinous

[o] *Phil. Trans.* 1794, xxi.

[p] *Voyage dans l'Amer. Merid.* i. 164.

[q] Molina's *Chili*, i. 174.

beverage of home manufacture, it is of no mean value even in this country; and in many inland parts of Europe, where its saccharine substitute is much dearer than with us, few articles of rural economy, not of primary importance, would be dispensed with more reluctantly. In the Ukraine some of the peasants have 4 or 500 bee-hives, and make more profit of their bees than of corn[r]; and in Spain the number of bee-hives is said to be incredible; a single parish priest was known to possess 5000[s].

The domesticated or hive-bee, to which we are indebted for this article, is the same according to Latreille in every part of Europe, except in some districts of Italy, where a different species (*Apis ligustica* of Spinola) is kept—the same probably that is cultivated in the Morea and the isles of the Archipelago[t]. Honey is obtained, however, from many other species both wild and domestic. What is called rock-honey in some parts of America, which is as clear as water and very thin, is the produce of wild bees, which suspend their clusters of thirty or forty waxen cells, resembling a bunch of grapes, to a rock[u]: and in South America large quantities are collected from the nests built in trees by *Trigona Amalthea*, and other species of this genus recently separated from Apis[v]; under which probably should be included the *Bamburos*, whose honey, honest Robert Knox informs us, whole

[r] *Communications to the Board of Agricult.* vii. 286.

[s] Mills *on Bees*, 77.

[t] Latr. in Humboldt and Bonpland, *Recueil d'Observations de Zoologie*, &c. (Paris, 1805) 300.

[u] Hill in *Swammerdam*, i. 181, note.

[v] Latr. *ubi supr.* 300.

towns in Ceylon go into the woods to gather[w]. According to Azara, one of the chief articles of food of the Indians who live in the woods of Paraguay, is wild honey[x]. One of the species that has probably been attended to ages before our hive-bee, is *Apis fasciata* of Latreille, a kind so extensively cultivated in Egypt, that Niebuhr states he fell in upon the Nile, between Cairo and Damietta, with a convoy of 4000 hives, which were transporting from a region where the season for flowers had passed, to one where the spring was later[y]. Columella says that the Greeks in like manner sent their bee-hives every year from Achaia into Attica; and a similar custom is not unknown in Italy, and even in this country in the neighbourhood of heaths. In Madagascar, according to Latreille, the inhabitants have domesticated *Apis unicolor*; *A. indica* is cultivated in India at Pondicherry and in Bengal; *A. Adansonii*, Latr. at Senegal[z]; and Fabricius thinks that *A. acraensis* (*Centris*, Syst. Piez.) *laboriosa* and others in the East and West Indies, might be domesticated with greater advantage than even *A. mellifica*[a].

The last, and doubtless the most valuable, product of insects to which I have to advert is *Silk*. To estimate justly the importance of this article, it is not sufficient to view it as an appendage of luxury unrivalled for richness, lustre, and beauty; and without which courts would lose half their splendour. We must consider it, what it actually is, as the staple article of cultiva-

[w] Knox's *Ceylon*, 25. [x] *Voy. dans l'Amer. Merid.* i. 162.
[y] Latr. *Hist. Nat.* xiv. 20.
[z] Latr. in Humboldt and Bonpland, *Recueil*, &c. 302.
[a] *Vorlesungen*, 324.

tion in many large provinces in the South of Europe, amongst the inhabitants of which the prospect of a deficient crop causes as great alarm as a scanty harvest of grain with us; and after giving employment to tens of thousands in its first production and transportation, as furnishing subsistence to hundreds of thousands more in its final manufacture; and thus becoming one of the most important wheels that give circulation to national wealth.

But we must not confine our view to Europe. When silk was so scarce in this country, that James the First, while king of Scotland, was forced to beg of the Earl of Mar the loan of a pair of silk stockings to appear in before the English ambassador, enforcing his request with the cogent appeal, "For ye would not, sure, that your king should appear as a scrub before strangers—" Nay, long before this period, even prior to the time that silk was valued at its weight of gold at Rome, and the Emperor Aurelian refused his empress a robe of silk because of its dearness—the Chinese peasantry in some of the provinces, millions in number, were clothed with this material; and for some thousand years to the present time, it has been both there and in India, where a class whose occupation was to attend silk-worms appears to have existed from time immemorial, being mentioned in the oldest Sanscrit books[b], one of the chief objects of cultivation and manufacture. You will admit, therefore, that when Nature

> "Set to work millions of spinning worms,
> That in their green shops weave the smooth-hair'd silk
> To deck her sons[c],"

[b] Colebrook in *Asiatic Researches*, v. 61.

[c] Milton's *Comus*.

she was conferring upon them a benefit scarcely inferior to that consequent upon the gift of wool to the fleecy race, or a fibrous rind to the flax or hemp plants; and that mankind is not under much less obligation to Pamphila, who, according to Aristotle, was the discoverer of the art of unwinding and weaving silk, than to the inventors of the spinning of those products[d].

It seems to have been in Asia that silk was first manufactured; and it was from thence that the ancients obtained it, calling it, from the name of the country whence it was supposed to be brought, Sericum. Of its origin they were in a great measure ignorant, some supposing it to be the entrails of a spider-like insect with eight legs, which was fed for four years upon a kind of paste, and then with the leaves of the green willow, until it burst with fat[e]; others, that it was the produce of a worm which built clay nests and collected wax[f]; Aristotle, with more truth, that it was unwound from the *pupa* of a large horned caterpillar[g]. Nor was the mode of producing and manufacturing this precious material known to Europe until long after the Christian æra, being first learnt about the year 550 by two monks, who procured in India the eggs of the silk-worm moth, with which, concealing them in hollow canes, they hastened to Constantinople, where they speedily multiplied, and were subsequently introduced into Italy, of which country silk was long a peculiar

[d] *Hist. Animal.* l. v. c. 19. [e] Pausanias, quoted by Goldsmith, vi. 80.

[f] Pliny *Hist. Nat.* l. xi. c. 22.

[g] Aristot. *ubi supra.* He does not expressly say the *pupa*, but this we must suppose. The *larva* he means could not be the common silk-worm, since he describes it as large, and having as it were horns.

and staple commodity. It was not cultivated in France until the time of Henry the Fourth, who, considering that mulberries grew in his kingdom as well as in Italy, resolved, in opposition to the opinion of Sully, to attempt introducing it, and fully succeeded.

The whole of the silk produced in Europe, and the greater proportion of that manufactured in China, is obtained from the common silk-worm; but in India considerable quantities are procured from the cocoons of the larvæ of other moths. Of these the most important species known are the Tusseh and Arindy silk-worms, of which an interesting history is given by Dr. Roxburgh in the *Linnean Transactions*[h]. These insects are both natives of Bengal. The first (*Phal. Attacus Paphia*, L.) feeds upon the leaves of the *Jugube tree* or *Byer* of the Hindoos, and of the *Terminalia alata glabra*, Roxburgh, the *Asseen* of the Hindoos, and is found in such abundance as from time immemorial to have afforded a constant supply of a very durable, coarse, dark-coloured silk, which is woven into a cloth called *Tusseh-doothies*, much worn by the Brahmins and other sects; and would doubtless be highly useful to the inhabitants of many parts of America and of the South of Europe, where a light and cool, and at the same time cheap and durable dress, such as this silk furnishes, is much wanted. The durability of this silk is indeed astonishing. After constant use for nine or ten years it does not show many signs of decay. These insects are thought by the natives of so much consequence, that they guard them by day to preserve them from crows

[h] vii. 33-48. Compare Lord Valentia's *Travels*, i. 78.

and other birds, and by night from the bats.—The Arrindy silk-worm (*Phal. Cynthia*, Drury), which feeds solely on the leaves of the *Palma Christi*, produces remarkably soft cocoons, the silk of which is so delicate and flossy, that it is impracticable to wind it off: it is therefore spun like cotton; and the thread thus manufactured is woven into a coarse kind of white cloth of a loose texture, but of still more incredible durability than the last, the life of one person being seldom sufficient to wear out a garment made of it. It is used not only for clothing, but for packing fine cloths, &c. Some manufacturers in England to whom the silk was shown, seemed to think that it could be made here into shawls equal to any received from India.

Other species, as may be inferred from an extract of a letter given in Young's *Annals of Agriculture*[i], are known in China, and have been recently introduced into India. "We have obtained," says the writer, "a monthly silk-worm from China, which I have reared with my own hands, and in twenty-five days have had the cocoons in my basins, and by the twenty-ninth or thirty-first day a new progeny feeding in my trays. This makes it a mine to whoever would undertake the cultivation of it."

Whether it will ever be expedient to attempt the breeding of the larvæ of any European moths, as *Noctua pacta*, *Sponsa*, &c. proposed with this view by Fabricius[j], seems doubtful, though certainly many of them afford a very strong silk, and might be readily propagated; and I have now in my possession some

[i] xxiii. 235. [j] *Vorlesungen*, 325.

thread more like cotton than silk spun by the larva of a moth, which when I was a very young Entomologist I observed (if my memory does not deceive me) upon the Euonymus, and from the twigs of which (not the cocoon) I unwound it. It is even asserted that in Germany a manufacture of silk from the cocoons of *Bombyx Pavonia* has been established[k]. There seems no question, however, that silk might be advantageously derived from many native silk-worms in America. An account is given in the *Philosophical Transactions* of one found there, whose cocoon is not only heavier and more productive of silk than that of the common kind, but is so much stronger that twenty threads will carry an ounce more[l]. Don Luis Neé observed on *Psydium pomiferum* and *pyriferum* ovate nests of caterpillars eight inches long, of gray silk, which the inhabitants of Chilpancingo, Tixtala, &c. in South America, manufacture into stockings and handkerchiefs[m]. Great numbers of similar nests of a dense tissué, resembling Chinese paper, of a brilliant whiteness, and formed of distinct and separable layers, the interior being the thinnest and extraordinarily transparent, were observed by Humboldt in the provinces of Mechoacan and the mountains of Santarosa at a height of 10,500 feet above the level of the sea, upon the *Arbutus Madroño* and other trees. The silk of these nests, which are the work of the social caterpillars of a Bombyx (*B. Madroño*, H.), was an object of commerce even in the time of Montezuma, and the ancient Mexicans pasted together the interior layers, which may be written upon without preparation, to form a white glossy pasteboard. Handkerchiefs are

[k] Latr. *Hist. Nat.* xiv. 150.
[l] Pullein in *Phil. Trans.* 1759. 54.
[m] *Annals of Botany*, ii. 104.

still manufactured of it in the intendency of Oaxaca[n]. And according to M. B. de Lozieres, large quantities of a very beautiful silk, of dazzling whiteness, may be collected from the cocoons even of the Ichneumons that destroy the larvæ of some moth in the West Indies which feed upon the indigo and cassada[o].

It is probable, too, that other articles besides silk might be obtained from the larvæ which usually produce it, particularly cements and varnishes of different kinds, some hard, others elastic, from their gum and silk reservoirs, from which it is said the Chinese procure a fine varnish, and fabricate the so called Indian grass used by anglers[p]. The diminutive size of the animal will be thought no objection, when we recollect that the very small quantity of purple dye afforded by the Purpura of the ancients did not prevent them from collecting it.

I now conclude this long series of letters on the injuries caused by insects to man, and the benefits which he derives from them; and I think you will readily admit that I have sufficiently made good my position, that the study of agents which perform such important functions in the economy of nature must be worthy of attention. Our subsequent correspondence will be devoted to the most interesting traits in their history, as their affection to their young, their food and modes of procuring it, habitations, societies, &c.

I am, &c.

[n] *Political Essay on N. Spain*, iii. 59. [o] *American Phil. Trans.* v. 325.

[p] Anderson's *Recreations in Agriculture*, &c. iv. 399.

LETTER XI.

ON THE AFFECTION OF INSECTS FOR THEIR YOUNG.

AMONGST the larger animals, every observer of nature has witnessed with admiration that love of their offspring which the beneficent Creator, with equal regard to the happiness of the parent and the progeny, has interwoven in the constitution of his creatures. Who that has any sensibility but has felt his heart dilate with gratitude to the giver of all good, in observing amongst the domestic animals which surround him, the effects of this divine *storge*, so fruitful of the most delightful sensations? Who that is not a stock or a stone has read unmoved the anecdote recorded in books of natural history, of the poor bitch, which in the agonies of a cruel dissection, licked with parental fondness her new-born offspring;—or the affecting account of the she-bear related in Phipps's *Voyage to the North Pole*, which, herself severely wounded by the same shot that killed her cubs, spent her last moments in tearing and laying before them the food she had collected, and died licking their wounds?

These feelings you must have experienced, but it has scarcely occurred to you that you would have any room for exercising them in your new pursuit. You have not, I dare say, suspected that any similar example could have been adduced amongst insects, to which at the first glance there seems even something absurd in attributing any thing like parental affection. An animal not so big perhaps as a grain of wheat, feel love for its offspring—how preposterous! we are ready to exclaim. Yet the exclamation would be very much misplaced. Nothing is more certain than that insects are capable of feeling quite as much attachment to their offspring as the largest quadrupeds. They undergo as severe privations in nourishing them; expose themselves to as great risk in defending them; and in the very article of death exhibit as much anxiety for their preservation. Not that this can be said of all insects. A very large proportion of them are doomed to die before their young come into existence. But in these the passion is not extinguished. It is merely modified, and its direction changed. And when you witness the solicitude with which they provide for the security and sustenance of their future young, you can scarcely deny to them love for a progeny they are never destined to behold. Like affectionate parents in similar circumstances, their last efforts are employed in providing for the children that are to succeed them.

Observe the motions of that common white butterfly which you see flying from herb to herb. You perceive that it is not food she is in pursuit of; for flowers have no attraction for her. Her object is the discovery of a plant that will supply the sustenance appropriated by providence to her young, upon which to deposit her eggs. Her own food has been honey drawn from the nectary of a flower. This, therefore, or its neighbourhood, we might expect would be the situation she would select for them. But no: as if aware that this food would be to them poison, she is in search of some plant of the cabbage tribe. But how is she to distinguish it from the surrounding vegetables? She is taught of God! Led by an instinct far more unerring than the practised eye of the botanist, she recognises the desired plant the moment she approaches it, and upon this she places her precious burthen: yet not without the further precaution of ascertaining that it is not preoccupied by the eggs of some other butterfly! Having fulfilled this duty, from which no obstacle short of absolute impossibility, no danger however threatening, can divert her, the affectionate mother dies.

This may serve as one instance of the solicitude of insects for their future progeny. But almost every species will supply examples similar in principle, and in their particular circumstances even more extraordinary. In every case the parent unerringly distinguishes the food suitable for her offspring[q], however dissimilar to her own; and invariably places her eggs, often defended from external injury by a variety of admirable contrivances, in the exact spot where when hatched the larvæ can have access to it. The dragon-fly is an inhabitant of the air, and could not exist in water: yet in this element, which is alone adapted

[q] Reaumur however observes (ii. 93.) that Lepidoptera do not always lay their eggs on the plant the larva feeds upon.

for her young, she ever carefully drops her eggs. The larvæ of the gad-fly (*Oestrus Equi*), whose history has been before described to you[r], are destined to live in the stomach of the horse. How shall the parent, a two-winged fly, convey them thither? By a mode truly extraordinary. Flying round the animal, she curiously poises her body for an instant while she glues a single egg to one of the hairs of his skin, and repeats this process until she has fixed in a similar way many hundred eggs. These after a few days, on the application of the slightest moisture attended by warmth, hatch into little grubs. Whenever therefore the horse chances to lick any part of his body to which they are attached, the moisture of the tongue discloses one or more grubs, which adhering to it by means of the saliva are conveyed into the mouth, and thence find their way into the stomach. But here a question occurs to you. It is but a small portion of the horse's body which he can reach with his tongue: what, you ask, becomes of the eggs deposited on other parts? I will tell you how the gad-fly avoids this dilemna; and I will then ask you if she does not discover a provident forethought, a depth of instinct, which almost casts into shade the boasted reason of man? She places her eggs only on those parts of the skin which the horse is able to reach with his tongue; nay, she confines them almost exclusively to the knee or the shoulder, which he is sure to lick. What could the most refined reason, the most precise adaptation of means to an end, do more[s]?

Not less admirable is the parental instinct of that vast

[r] P. 145 &c. [s] Clark in *Linn. Trans.* iii. 304.

tribe of insects already introduced to you by the name of Ichneumons, whose young are destined to feed upon the living bodies of other insects. These, as you know, are so numerous, that scarcely an insect exists, but is in its larva state exposed to the attacks of one or other of them; and even the pupæ, nay the very eggs of these animals are not safe from their insidious manœuvres. The size of the different species varies in proportion to that of the bodies which are to be their food; some being so inconceivably small, that the egg of a butterfly not bigger than a pin's head is of sufficient magnitude to nourish two of them to maturity[1]; others so large, that the body of a full grown caterpillar is not more than enough for one. It is the larvæ of these Ichneumons which make such havoc of our pygmy tribes: the perfect insect is a four-winged fly, which takes no other food than a little honey; and the great object of the female is to discover a proper nidus for her eggs. In search of this she is in constant motion. Is the caterpillar of a butterfly or a moth the appropriate food for her young? You see her alight upon the plants where they are most usually to be met with, run quickly over them, carefully examining every leaf, and, having found the unfortunate object of her search, insert her sting into its flesh and there deposit an egg. In vain her victim, as if conscious of its fate, writhes its body, spits out an acid fluid, menaçes with its tentacula, or brings into action the other organs of defence with which it is provided. The active Ichneumon braves every danger, and does not desist until her courage and address have ensured

[1] Bonnet, ii. 344.

subsistence for one of her future progeny. Perhaps, however, she discovers by a sense the existence of which we perceive, though we have no conception of its nature, that she has been forestalled by some precursor of her own tribe, that has already buried an egg in the caterpillar she is examining. In this case she leaves it, aware that it would not suffice for the support of two, and proceeds in search of some other yet unoccupied.—The process is of course varied in the case of those minute species of which several, sometimes as many as 150, can subsist in a single caterpillar. The little Ichneumon then repeats her operations until she has darted into her victim the requisite number of eggs.

The larvæ hatched from the eggs thus ingeniously deposited, find a delicious banquet in the body of the caterpillar, which is sure eventually to fall a victim to their ravages. So accurately, however, is the supply of food proportioned to the demand, that this event does not take place until the young Ichneumons have attained their full growth; when the caterpillar either dies, or, retaining just vitality enough to assume the pupa state, then finishes its existence; the pupa disclosing not a moth or a butterfly, but one or more full grown Ichneumons.

In this strange and apparently cruel operation one circumstance is truly remarkable. The larva of the Ichneumon, though every day perhaps for months it gnaws the inside of the caterpillar, and though at last it has devoured almost every part of it except the skin and intestines, carefully all this time *avoids injuring the vital organs*, as if aware that its own existence depends on that of the insect on which it preys! Thus the caterpillar continues to eat, to digest, and to move, apparently little injured, to the last, and only perishes when the parasitic grub within it no longer requires its aid. What would be the impression which a similar instance amongst the race of quadrupeds would make upon us?—If, for example, an animal—such as some impostors have pretended to carry within them—should be found to feed upon the inside of a dog; devouring only those parts not essential to life, while it cautiously left uninjured the heart, arteries, lungs, and intestines,—should we not regard such an instance as a perfect prodigy, as an example of instinctive forbearance almost miraculous?

Some Ichneumons, instead of burying their eggs in the body of the larvæ that are to serve their young for food, content themselves with gluing them to the skin of their prey, which the young grubs pierce as soon as hatched. Another tribe, whose activity and perseverance are equally conspicuous, which includes the beautiful genus Chrysis and many other hymenopterous insects, imitating the insidious cuckoo, contrive to introduce their eggs into the nests in which bees and other insects have deposited theirs. With this view they are constantly on the watch, and, the moment the unsuspecting mother has quitted her cell for the purpose of collecting a store of food or materials, glide into it and leave an egg, the germe of a future assassin of the larva that is to spring from that deposited by its side.

The females of the insects of which we have been speaking, in providing for their offspring, are saved the trouble of furnishing them with any habitation. Either they occupy that of another insect, or find a convenient abode within the body of that on which they feed. But upon the maternal affection of another large tribe chiefly belonging to the Linnean genus *Sphex*, whose young in like manner feed on other insects, is imposed the arduous task not merely of collecting a supply of food, but of inclosing it along with their eggs in cells or burrows often of considerable depth, and dug with great labour in sand or the solid earth.

The general economy of these insects is similar. Having first dug a cylindrical cavity of the requisite dimensions, and deposited an egg at the bottom, they inclose along with it one or more caterpillars, spiders, or other insects, each particular species for the most part selecting a distinct kind, as a provision for the young one when hatched, and sufficiently abundant to nourish it until it becomes a pupa. Many thus furnish several cells. This process, however, is varied by different species, some of whose operations are worthy of a more detailed description.

One of the most early histories of the procedure of one of these (probably *Ammophila vulgaris*, Kirby) is left us by the excellent Ray, who observed it along with his friend Willughby. On the 22d June 1667, he tells us, they noticed this insect dragging a green caterpillar thrice as big as itself, which after thus conveying about fifteen feet, it deposited at the entrance of a hole previously dug in the sand. Then removing a pellet of earth from its mouth, it descended into the cavity, and, presently returning, dragged along with it the caterpillar. After staying awhile it again ascended, then rolled pieces of earth into the hole, at intervals scratching the dust into it like a dog with its fore feet, and entering it as if to press down and consolidate the mass; flying also once or twice to an adjoining fir tree, possibly to procure resin for agglutinating the whole. Having filled the burrow to a level with the surrounding earth so as to conceal the entrance, it took two fir leaves lying at hand, and placed them near the orifice as if to mark the place.—Such is the anecdote left on record by our illustrious countryman, of whose accuracy of observation there can be no doubt. Who that reads it can refrain from joining in the reflection which it calls from him, "*Quis hæc non mihi miretur et stupeat? Quis hujusmodi opera meræ machinæ possit attribuere*[u]*?*"

I myself, when walking with a friend some months ago, observed nearly similar manœuvres performed by a species of Pompilus (*Sphex*, L.), which attracted our attention as it was dragging a spider to its cell. The attitude in which the spider was carried, namely with its feet constantly upwards; its singular mode of walking, which was backwards, except for a foot or two when it went forwards, moving by jerks and making a sort of pause every few steps; and the astonishing agility with which, notwithstanding its heavy burthen, it glided over or between the grass, weeds, and other numerous impediments in the rough path along which it passed—together formed a spectacle which we contemplated with admiration. The distance which we thus observed it to traverse was not less than twenty-seven feet, and great part of its jour-

[u] Rai. *Hist. Ins.* 254.

ney had probably been performed before we saw it. Once or twice, when we first noticed it, it laid down the spider, and making a small circuit returned and took it up again. But for the ensuing twenty or twenty-five feet it never stopped, but proceeded in a direct line for its hole with the utmost speed. When opposite the hole, which was in a sand bank by the way side, it made a sharp turn, as evidently aware of being in the neighbourhood of its abode, but when advanced a little further laid down its burthen and went to reconnoitre. At first it climbed up the bank, but, as if discovering that this was not the direction, soon returned, and, after another survey perceiving the hole, took up the spider and dragged it in after it.

In the two instances above given, one dead caterpillar or spider only was deposited in each hole. But an insect described by Reaumur under the name of the mason-wasp (*Epipone spinipes*, Latr.), very common in some parts of England, after having excavated a burrow, with an ingenuity to which on a future occasion I shall draw your attention, places along with its egg as food for the future young about twelve little green grubs without feet, which it has carefully selected full grown and conveyed without injuring them. You will inquire, Why this difference of procedure? With regard to the choice of a number of small grubs rather than of one large caterpillar, what I have said in a former letter on the subject of different species of this tribe being appointed to prey upon and thus keep within due limits the larvæ of different kinds of insects, will be a sufficient answer. But one circumstance creditable to the talents of the mason-wasp as a skilful purveyor should not be omitted, namely, that the number of grubs laid up is not always the same, but is exactly proportioned to their size, eleven or twelve being stored when they are small, but only eight or nine when larger. With respect however to the caution of the wasp in selecting full grown grubs and conveying them uninjured to her hole, a satisfactory explanation may be given. If those that are but partly grown were chosen, they would die in a short time for want of food, and putrefying would destroy the inclosed egg, or the young one which springs from it. But when larvæ of any kind have attained their full size, and are about to pass into the pupa state, they can exist for a long period without any further supply. By selecting these, therefore, and placing them uninjured in the hole, however long the interval before the egg hatches, the disclosed larva is sure of a sufficiency of fresh and wholesome nutriment.—To prevent the possibility of any injury to its egg from the motions or voracity of this living prey, the wasp is careful to pack the whole so closely, each grub being coiled above the other in a series of rings, and to consolidate the earth so firmly above them, that they have not the slightest power of motion[v].—Those which select more powerful caterpillars, or revenge the injuries of their insect brethren by devoting spiders to the destruction they have so often caused, take care to sting them in such a manner as, without killing them outright, will incapacitate them from doing any injury.

Zeal and activity in providing for the well-being

[v] Reaum. vi. 252.

of their future progeny, not inferior to what are exhibited by the tribe of Ichneumons, Spheges, and wasps, though less cruelly exerted, is also shown by the various species of wild-bee, of which we have in this country above two hundred. Having first excavated a proper cell with a dexterity and persevering labour never enough to be admired, they next deposit in it an egg, which they cover with a mass of pollen or honey collected with unwearied assiduity from a thousand flowers. As soon as the grub is hatched, it finds itself enveloped in this delicious banquet provided for it by the cares of a mother it is doomed never to behold; and so accurately is the repast proportioned to its appetite and its wants, that as soon as the whole is consumed it has no longer need of food: it clothes itself in a silken cocoon, becomes a pupa, and after a deep sleep of a few days bursts from its cell an active bee.

No circumstance connected with the *storge* of insects is more striking than the herculean and incessant labour which it leads them cheerfully to undergo. Some of these exertions are so disproportionate to the size of the insect, that nothing short of ocular conviction could attribute them to such an agent. A wild bee or a Sphex, for instance, will dig a hole in a hard bank of earth some inches deep and five or six times its own size, and labour unremittingly at this arduous undertaking for several days, scarcely allowing itself a moment for eating or repose. It will then occupy as much time in searching for a store of food; and no sooner is this task finished, than it will set about repeating the process, and before it dies will have completed five or six similar cells or even more. If you would estimate this industry at its proper value, you should reflect what kind of exertion it would require in a man to dig in a few days out of hard clay or sand, with no other tools than his nails and teeth, five or six caverns twenty feet deep and four or five wide—for such an undertaking would not be comparatively greater than that of the insects in question.

Similar laborious exertions are not confined to the bee or Sphex tribe. Several beetles in depositing their eggs exhibit examples of industry equally extraordinary.—The common dor or clock, (*Scarabæus stercorarius*, L.) which may be found beneath every heap of dung, digs a deep cylindrical hole, and lays its eggs at the bottom.—And many of the species of the genus *Ateuchus* roll together wet dung into round pellets, deposit an egg in the midst of each, and when dry push them backwards by their hind feet to holes of the surprising depth of three feet, which they have previously dug for their reception, and which are often several yards distant. Frequently the road lies across a depression in the surface, and the pellet when nearly pushed to the summit rolls back again. But our patient Sisyphi are not easily discouraged. They repeat their efforts again and again, and in the end their perseverance is rewarded by success. The attention of these insects to their eggs is so remarkable, that it was observed in the earliest ages, and is mentioned by ancient writers, but with the addition of many fables, as that they were all of the male sex, that they became young again every year, that they rolled the pellets containing their eggs from sun-rise to sun-set every day for twenty eight days without intermission[w], &c. It is one of this tribe of beetles (*A. sacer*) whose image is so often met with amongst the hieroglyphics of the Egyptians, with whom it was a symbol of the world, of the sun, and of a courageous warrior. Of the world, as P. Valerianus supposes, on account of the orbicular form of its pellets of dung, and the notion of their being rolled from sun-rise to sun-set; of the sun, because of the angular projections from its head resembling rays, and the thirty joints of the six tarsi of its feet answering to the days of the month; and of a warrior, from the idea of manly courage being connected with its supposed birth from a male only[x]. It was as symbolical of this last that its image was worn upon the signets of the Roman soldiers; and as typical of the sun, the source of fertility, it is yet, as Dr. Clarke informs us, eaten by the women to render them prolific[y].

These beetles, however, in point of industry must yield the palm to one (*Necrophorus Vespillo*, F.) whose singular history was first detailed by M. Gleditsch in *the Acts of the Berlin Society* for 1752. He begins by informing us that he had often remarked that dead moles when laid upon the ground, especially if upon loose earth, were almost sure to disappear in the course of two or three days, often of twelve hours. To ascertain the cause, he placed a mole upon one of the beds in his garden. It had vanished by the third morning; and on digging where it had been laid, he

[w] Mouffet, 153.
[x] J. Pierii Valeriani *Hieroglyphica*, 93-5. Mouffet, 156.
[y] *Travels*, ii. 306.

found it buried to the depth of three inches, and under it four beetles which seemed to have been the agents in this singular inhumation. Not perceiving any thing particular in the mole, he buried it again; and on examining it at the end of six days he found it swarming with maggots apparently the issue of the beetles, which M. Gleditsch now naturally concluded had buried the carcase for the food of their future young. To determine these points more clearly, he put four of these insects into a glass vessel half filled with earth and properly secured, and upon the surface of the earth two frogs. In less than twelve hours one of the frogs was interred by two of the beetles: the other two ran about the whole day as if busied in measuring the dimensions of the remaining corpse, which on the third day was also found buried. He then introduced a dead linnet. A pair of the beetles were soon engaged upon the bird. They began their operations by pushing out the earth from under the body so as to form a cavity for its reception; and it was curious to see the efforts which the beetles made by dragging at the feathers of the bird from below to pull it into its grave. The male having driven the female away continued the work alone for five hours. He lifted up the bird, changed its place, turned it and arranged it in the grave, and from time to time came out of the hole, mounted upon it and trod it under foot, and then retired below and pulled it down. At length, apparently wearied with this uninterrupted labour, it came forth and leaned its head upon the earth beside the bird without the smallest motion as if to rest itself, for a full hour, when it again crept under the earth. The next day in the morning the bird was an inch and a half under ground, and the trench remained open the whole day, the corpse seeming as if laid out upon a bier, surrounded with a rampart of mould. In the evening it had sunk half an inch lower, and in another day the work was completed and the bird covered.—M. Gleditsch continued to add other small dead animals, which were all sooner or later buried; and the result of his experiment was, that in fifty days four beetles had interred in the very small space of earth allotted to them twelve carcases: viz. four frogs, three small birds, two fishes, one mole, and two grasshoppers, besides the entrails of a fish, and two morsels of the lungs of an ox. In another experiment a single beetle buried a mole forty times its own bulk and weight in two days[z]. It is plain that all this labour is incurred for the sake of placing in security the future young of these industrious insects along with a necessary provision of food. One mole would have sufficed a long time for the repast of the beetles themselves, and they could have more conveniently fed upon it above ground than below. But if they had left thus exposed the carcase in which their eggs were deposited, both would have been exposed to the imminent risk of being destroyed at a mouthful by the first fox or kite that chanced to espy them.

At the first view I dare say you feel almost inclined to pity the little animals doomed to exertions apparently so disproportioned to their size. You are ready to exclaim that the pains of so short an existence, en-

[z] Gleditsch *Physic. Bot. Oecon. Abhandl.* iii. 200-227.

grossed with such arduous and incessant toil, must far outweigh the pleasures. Yet the inference would be altogether erroneous. What strikes us as wearisome toil, is to the little agents delightful occupation. The kind Author of their being has associated the performance of an essential duty with feelings evidently of the most pleasurable description; and like the affectionate father whose love for his children sweetens the most painful labours, these little insects are never more happy than when thus actively engaged. "A Bee," as Dr. Paley has well observed, "amongst the flowers in spring, (when it is occupied without intermission in collecting farina for its young or honey for its associates,) is one of the cheerfullest objects that can be looked upon. Its life appears to be all enjoyment: so busy and so pleased[a]."

Of the sources of exquisite gratification which every rural walk will open to you, while witnessing in the animals themselves those marks of affection for their unseen progeny of which I have endeavoured to give you a slight sketch, it will be none of the least fertile to examine the various and appropriate instruments with which insects have been furnished for the effective execution of their labours. The young of a little four-winged fly, known by the generic name of *Tenthredo*, is destined to feed upon the leaves of rose-trees and various other plants. Upon the branches of these the parent fly deposits her eggs in cells symmetrically arranged; and the instrument with which she forms them is a saw, somewhat like ours but far more ingenious

[a] *Natural Theology*, 497.

and perfect, being toothed on each side to cut both ways at once, and double; so that it is in fact composed of two saws applied to each other, which play alternately, and is thus at the same time a file and a wimble!—The *Cicada*, so celebrated by the poets of antiquity, which lays its eggs in dry wood, requires a stronger instrument of a different construction. Accordingly it is provided with an excellent double auger, the sides of which play alternately and parallel to each other, and bore a hole of the requisite depth in very hard substances without ever being displaced.

The construction of the sting or ovipositor with which the different species of Ichneumon are provided, is not less nicely adapted to its various purposes. In those which lay their eggs in the bodies of caterpillars that feed exposed on the leaves of plants it is short, often in very large species not the eighth of an inch long: having free access to their victims, a longer sting would have been useless. But a considerable number oviposit in larvæ which lie concealed where so short an instrument could not possibly approach them. In these, therefore, the sting is proportionably elongated, so much so that in some small species it is three or four times the length of the body. Thus in *Ichneumon manifestator*, whose economy has been so pleasingly illustrated by Mr. Marsham[b], and which attacks the larva of a wild bee (*Apis maxillosa*) lying at the bottom of deep holes in old wood, the sting is nearly two inches long: and it is not much shorter in the more minute *I. Strobilellæ*, which lays its eggs in larvæ con-

[b] *Linn. Trans.* iii. 23.

cealed in the interior of fir cones, which without such an apparatus it would never be able to reach.

The tail of the females of many moths whose eggs require to be protected from too severe a cold and too strong a light, is furnished, evidently for application to this very purpose, with a thick tuft of hair. But how shall the moth detach this non-conducting material and arrange it upon her eggs? Her ovipositor is provided at the end with an instrument resembling a pair of pincers, which for this purpose are as good as hands. With these, having previously deposited her eggs upon a leaf, she pulls off her tuft of hairs, with which she so closely envelops them as effectually to preserve them of the required temperature: and having performed this last duty to her progeny she expires.

The ovipositor of the *Cerambyx* tribe (I mean of Linne) is a flattened retractile tube, of a hard substance, by means of which it can introduce its eggs under the bark of timber, and so place them where its progeny will find their appropriate food[c]. The auger used by certain species of Oestrus, to enable them to penetrate the hides of oxen or deer and form a nidus for their eggs, has been before described[d].—But to enumerate all the varieties of these instruments would be endless.

The purpose which in the insects above mentioned is answered by their anal apparatus, is fulfilled in the numerous tribes of Curculios by the long slender snout with which their head is provided. It is with this that *Curc. nucum* pierces the shell of the nut, and the wee-

[c] See Kirby in *Linn. Trans.* v. 254. *t.* 12. *f.* 15. [d] See above, 149.

vil (*Calandra granaria*) the skin of the grains of wheat, in which they respectively deposit their eggs, prudently introducing one only into each nut or grain, which is sufficient, but not more than sufficient, for the nourishment of the grub that will inhabit it.

Hitherto I have adverted to those insects only which perish before their young come into existence, and can therefore evince their affection for them in no other way than by placing the eggs whence they are to spring in secure situations stored with food; and these include by far the largest portion of the race. A very considerable number, however, extend their cares much further: they not only watch over their eggs after depositing them, but attend upon their young, when excluded, with an affectionate assiduity equal to any thing exhibited amongst the larger animals, and in the highest degree interesting. Of this description are some solitary insects, as several species of the Linnean genus Sphex, earwigs, field-bugs, and spiders: and those insects which live in societies, namely, ants, bees, wasps, and Termites: the most striking traits of whose history in these respects I shall endeavour to lay before you.

You have seen that the greater number of the Linnean Spheges, (*Sphex*, *Bembex*, F.) after depositing their eggs in cells stored with a supply of food, take no further care of them. Some, however, adopt a different procedure. One of these, called by Bonnet the *Mason-wasp*, not only incloses a living caterpillar along with its egg in the cell, which it carefully closes, but at the expiration of a few days, when the young grub has appeared and has consumed its provision, re-opens the nest, incloses a second caterpillar, and again shuts the mouth: and this operation it repeats until the young one has attained its full growth[e]. A similar mode, according to Rolander, is followed by *Ammophila vulgaris* (*Sphex*, L.) as well as by the yellowish wasp of Pennsylvania, described by Bartram in the *Philosophical Transactions*[f], and by a Sphex? observed by Duhamel[g]; both of which, however, instead of caterpillars, supply their larvæ with a periodical provision of living flies.

What a crowd of interesting reflections are these most singular facts calculated to excite! With what foresight must the parent insect be endowed, thus to be aware at what period her eggs will be hatched into grubs, and how long the provision she has laid up will suffice for their support! What an extent of judgement, thus in the midst of various other occupations to know the precise day when a repetition of her cares will be required! What an accuracy of memory, to recollect with such precision the entrance to her cell, which the most acute eye could not discover; and without compass or direction unerringly to fly to it, often from a great distance and after the most intricate and varied wanderings! If we refer the whole to instinct, and to instinct doubtless it must in the main if not wholly be referred, our admiration is not lessened. Instinct, when simple and directed to one object, is less astonishing; but such a complication of instincts, applied to actions so varied and dissimilar, is beyond our conception. We can but wonder and adore!

[e] Bonnet. ix. 398. [f] liii. 37. [g] Reaum. vi. 269.

We are indebted to De Geer for the history of a field-bug (*Cimex griseus*), a species found in this country, which shows marks of affection for her young such as I trust will lead you, notwithstanding any repugnant association that the name may call up, to search upon the birch tree, which it inhabits, for so interesting an insect. The family of this field-bug consists of thirty or forty young ones, which she conducts as a hen does her chickens. She never leaves them ; and as soon as she begins to move all the little ones closely follow, and whenever she stops assemble in a cluster round her. De Geer having had occasion to cut a branch of birch peopled with one of those families, the mother showed every symptom of excessive uneasiness. In other circumstances such an alarm would have caused her immediate flight ; but now she never stirred from her young, but kept beating her wings incessantly with a very rapid motion, evidently for the purpose of protecting them from the apprehended danger[h].—As far as our knowledge of the economy of this tribe of insects extends, there is no other species that manifests a similar attachment to its progeny ; but such may probably be discovered by future observers.

It is De Geer also that we have to thank for a series of interesting observations on the maternal affection exhibited by the common Earwig. This curious insect so unjustly traduced by a vulgar prejudice,—as if the Creator had willed that the insect world should combine within itself examples of all that is most remarkable in every other department of nature,—still more nearly approaches the habits of the hen in her care of

[h] De Geer, iii. 262.

her family. She absolutely sits upon her eggs as if to hatch them—a fact which Frisch appears first to have noticed—and guards them with the greatest care. De Geer, having found an earwig thus occupied, removed her into a box where was some earth, and scattered the eggs in all directions. She soon however collected them one by one with her jaws into a heap, and assiduously sat upon them as before. The young ones, which resemble the parent except in wanting elytra and wings, and, strange to say, are as soon as born larger than the eggs which contained them, immediately upon being hatched creep like a brood of chickens under the belly of the mother, who very quietly suffers them to push between her feet, and will often, as De Geer found, sit over them in this posture for some hours[1]! This remarkable fact I have myself witnessed, having found an earwig under a stone which I accidentally turned over, sitting upon a cluster of young ones just as this celebrated naturalist has described.

We are so accustomed to associate the ideas of cruelty and ferocity with the name of spider, that to attribute parental affection to any of the tribe seems at first view almost preposterous. Who indeed could suspect that animals which greedily devour their own species whenever they have opportunity should be susceptible of the finer feelings? Yet such is the fact. There is a spider common under clods of earth (*Aranea saccata*, L.) which may at once be distinguished by a white globular silken bag about the size of a pea, in which she has deposited her eggs, attached to the ex-

[1] De Geer, iii. 548.

tremity of her body. Never miser clung to his treasure with more tenacious solicitude than this spider to her bag. Though apparently a considerable incumbrance, she carries it with her every where. If you deprive her of it, she makes the most strenuous efforts for its recovery; and no personal danger can force her to quit the precious load. Are her efforts ineffectual? A stupefying melancholy seems to seize her, and when deprived of this first object of her cares, existence itself appears to have lost its charms. If she succeeds in regaining her bag, or you restore it to her, her actions demonstrate the excess of her joy. She eagerly seizes it, and with the utmost agility runs off with it to a place of security. Bonnet put this wonderful attachment to an affecting and decisive test. He threw a spider with her bag into the cavern of a large ant-lion, a ferocious insect which conceals itself at the bottom of a conical hole constructed in the sand for the purpose of catching any unfortunate victim that may chance to fall in. The spider endeavoured to run away, but was not sufficiently active to prevent the ant-lion from seizing her bag of eggs, which it attempted to pull under the sand. She made the most violent efforts to defeat the aim of her invisible foe, and on her part struggled with all her might. The gluten, however, which fastened her bag, at length gave way, and it separated: but the spider instantly regained it with her jaws, and redoubled her efforts to rescue the prize from her opponent. It was in vain: the ant-lion was the stronger of the two, and in spite of all her struggles dragged the object of contestation under the sand. The unfortunate mother might have preserved her own life from the enemy: she had but to relinquish the bag, and escape out of the pit. But, wonderful example of maternal affection! she preferred allowing herself to be buried alive along with the treasure dearer to her than her existence; and it was only by force that Bonnet at length withdrew her from the unequal conflict. But the bag of eggs remained with the assassin; and though he pushed her repeatedly with a twig of wood, she still persisted in continuing on the spot. Life seemed to have become a burthen to her, and all her pleasures to have been buried in the grave which contained the germe of her progeny[j]! The attachment of this affectionate mother is not confined to her eggs. After the young spiders are hatched, they make their way out of the bag by an orifice, which she is careful to open for them, and without which they could never escape[k]; and then, like the young of the Surinam toad (*Rana pipa*), they attach themselves in clusters upon her back, belly, head, and even legs; and in this situation, where they present a very singular appearance, she carries them about with her and feeds them until their first moult, when they are big enough to provide their own subsistence. I have more than once been gratified by a sight of this interesting spectacle; and when I nearly touched the mother, thus covered by hundreds of her progeny, it was most amusing to see them all leap from her back and run away in all directions.

A similar attachment to their eggs and young is manifested by many other species of the same tribe, particularly of the genera *Lycosia* and *Dolomeda*, Walck.

[j] Bonnet, ii. 435. [k] De Geer, vii. 194.

Aranea holosericea, L. (*Clubiona*, Walck.) was found by De Geer in her nest with fifty or sixty young ones, when manifesting nothing of her usual timidity, so obstinately did she persist in remaining with them, that to drive her away it was necessary to cut her whole nest in pieces[1].

I must now conduct you to a hasty survey of those insects which live together in societies and fabricate dwellings for the community, such as Ants, Bees, Wasps, and Termites, whose great object (sometimes combined indeed with the storing up of a stock of winter provisions for themselves) is the nutrition and education of their young. Of the proceedings of many of these insects we know comparatively nothing. There are, it is likely, some hundreds of distinct species of bees which live in societies, and form nests of a different and peculiar construction. The constitution of these societies is probably as various as the exterior forms of their nests, and their habits possibly curious in the highest degree; yet our knowledge is almost confined to the economy of the hive bee and some species of humble bees. The same may be said of wasps, ants, and termites, of which, though there is a vast variety of different kinds, we are acquainted with the history of but a very few. You will not therefore expect more than a sketch of the most interesting traits of affection for their young, manifested by the common species of each genus.

One circumstance must be premised with regard to

[1] De Geer, vii. 268.

the education of the young of most of those insects which live in society, truly extraordinary, and without parallel in any other department of nature: namely, that this office, except under particular circumstances, is not undertaken by the female which has given birth to them, but by the workers, or neuters as they are sometimes called, which, though bound to the offspring of the common mother of the society by no other than fraternal ties, exhibit towards them all the marks of the most ardent parental affection, building habitations for their use, feeding them and tending them with incessant solicitude, and willingly sacrificing their lives in defence of the precious charge. Thus sterility itself is made an instrument of the preservation and multiplication of species; and females too fruitful to educate all their young, are indulged by Providence with a privilege without which nine tenths of their progeny must perish.

The most determined despiser of insects and their concerns—he who never deigned to open his eyes to any other part of their economy—must yet have observed, even in spite of himself, the remarkable attachment which the inhabitants of a disturbed nest of ants manifest towards certain small white oblong bodies with which it is usually stored. He must have perceived that the ants are much less intently occupied with providing for their own safety, than in conveying off these little bodies to a place of security. To effect this purpose the whole community is in motion, and no danger can divert them from attempting its accomplishment. An observer having cut an ant in two, the poor mutilated animal did not relax in its affectionate exertions. With that half of the body to which the head remained attached, it contrived previously to expiring to carry off ten of these white masses into the interior of the nest! You will readily divine that these attractive objects are the young of the ants in one of the first or imperfect states. They are in fact not the eggs, as they are vulgarly called, but the pupæ, which the working ants tend with the most patient assiduity. But I must give you a more detailed account of their operations, beginning with the actual eggs.

These, which are so small as to be scarcely visible to the naked eye, as soon as deposited by the queen ant, who drops them at random in her progress through the nest, are taken charge of by the workers, who immediately seize them and carry them in their mouths, in small parcels, incessantly turning them backwards and forwards with their tongue for the purpose of moistening them, without which they would come to nothing. They then lay them in heaps, which they place in separate apartments[m], and constantly tend until hatched into larvæ; frequently in the course of the day removing them from one quarter of the nest to another, as they require a warmer or cooler, a moister or drier atmosphere; and at intervals brooding over them as if to impart a genial warmth[n]. Experiments have been made to ascertain whether these assiduous nurses could distinguish their eggs if intermixed with particles of salt and sugar, which to an ordinary observer they very much resemble: but the result was constantly in favour of the sagacity of the

[m] Huber, 69. [n] De Geer, ii. 1099.

ants. They invariably selected the eggs from whatever materials they were mixed with, and re-arranged them as before°.

New and more severe labours succeed the birth of the young grubs which are disclosed from the eggs after a few days. The working ants are now almost without remission engaged in supplying their wants and forwarding their growth. Every evening an hour before sunset they regularly remove the whole brood, as well as the eggs and pupæ, which in an old nest all require attention at the same time, to cells situated lower down in the earth, where they will be safe from the cold; and in the morning they as constantly remove them again towards the surface of the nest. If however there is a prospect of cold or wet weather, the provident ants forbear on that day transporting their young from the inner cells, aware that their tender frames are unable to withstand an inclement sky. What is particularly worthy of notice in this herculean task, the ants constantly regulate their proceedings by the sun, removing their young according to the earlier or later rising and setting of that luminary. As soon as his first rays begin to shine on the exterior of the nest, the ants that are at the top go below in great haste to rouse their companions, whom they strike with their antennæ, or, when they do not seem to comprehend them, drag with their jaws to the summit till a swarm of busy labourers fill every passage. These take up the larvæ and pupæ, which they hastily transport to the upper part of their habitation, where they leave

° Gould, 37.

them a quarter of an hour, and then carry them into apartments where they are sheltered from the sun's direct rays[p].

Severe as this constant and unremitted daily labour seems, it is but a small part of what the affection of the working ants leads them readily to undertake. The *feeding* of the young brood, which rests solely upon them, is a more serious charge. The nest is constantly stored with larvæ the year round, during all which time, except in winter when the whole society is torpid, they require feeding several times a day with a viscid half-digested fluid that the workers disgorge into their mouths, which when hungry they stretch out to meet those of their nurses. Add to which, that in an old nest there are generally two distinct broods of different ages requiring separate attention; and that the observations of Huber make it probable that at one period they require a more substantial food than at another. It is true that the youngest brood at first want but little nutriment: but still, when we consider that they must not be neglected, that the older brood demand incessant supplies, and in a well stocked nest amount to 7 or 8000; and that the task of satisfying all these cravings, as well as providing for their own subsistence, falls to the lot of the working ants, we are almost ready to regard the burthen as greater than can be borne by such minute agents; and we shall not wonder at the incessant activity with which we see them foraging on every side.

Their labour does not end here. It is necessary

[p] Huber, 74.

that the larvæ should be kept extremely clean; and for this purpose the ants are perpetually passing their tongue and mandibles over their body, rendering them by this means perfectly white[q]. After the young grubs have attained their full growth, they surround themselves with a silken cocoon and become pupæ, which, food excepted, require as much attention as in the larva state. Every morning they are transported from the bottom of the nest to the surface, and every evening returned to their former quarters. And if, as is often the case, the nest be thrown into ruins by the unlucky foot of a passing animal, in addition to all these daily and hourly avocations, is superadded the immediate necessity of collecting the pupæ from the earth with which they have been mixed, and of restoring the nest to its pristine state[r].

Nothing can be more curious than the view of the interior of a fully peopled ant's nest in summer. In one part are stored her eggs; in another the pupæ are heaped up by hundreds in spacious apartments; and in a third we see the larvæ surrounded by the workers, some of which feed them, while others keep guard, standing erect upon their hind legs with their abdomen

[q] Huber, 78.

[r] The Russian shepherds ingeniously avail themselves of the attachment of ants to their young, for obtaining with little trouble a collection of the pupæ, which they sell as a dainty food for nightingales. They scatter an ant's nest upon a dry plot of ground, surrounded with a shallow trench of water, and place on one side of it a few fir branches. Under these the ants, having no other alternative, carefully arrange all their pupæ, and in an hour or two the shepherd finds a large heap clean and ready for market. Anderson's *Recreations in Agriculture*, &c. iv. 158.

elevated in the position for ejaculating their acid, than which gunpowder would not be more formidable to the majority of their foes. Some again are occupied in cleaning the alleys from obstructions of various kinds; and others rest in perfect repose recruiting their strength for new labours.

Contrary to what is observed amongst other insects, even the extrication of the young ants from the silken cocoon which incloses them is imposed upon the workers, who are taught by some sensation to us incomprehensible, that the perfect insect is now ready to burst from the shroud, but too weak to effect its purpose unaided. When the workers discover that this period has arrived, a great bustle prevails in their apartment. Three or four mount upon one cocoon, and with their mandibles begin to open it where the head lies. First they pull off a few threads to render the place thinner; they then make several small openings, and with great patience cut the threads which separate them one by one, till an orifice is formed sufficiently large for extracting the prisoner; which operation they perform with the utmost gentleness. The ant is still enveloped in its pellicle: this the workers also pull off, carefully disengaging every member from its case, and nicely expanding the wings of such as are furnished with them. After thus liberating and afterwards feeding the new-born insects, they still for several days watch and follow them every where, teaching them to unravel the paths and winding labyrinths of the common habitation[s]; and when the males and

[s] Huber, 83.

females at length take flight, these affectionate step-mothers accompany them, mounting with them to the summit of the highest herbs, showing the most tender solicitude for them, (some even endeavour to retain them,) feeding them for the last time, caressing them; and at length, when they rise into the air and disappear, seeming to linger for some seconds over the footsteps of these favoured beings, of whom they have taken such exemplary care, and whom they will never behold again[t].

In the above account, exclusive of the bare fact of their laying the eggs, no mention is made of the female ants, the real parents of the republic. You are not from this to suppose that they never feel the influence of this divine principle of love for their offspring. When, indeed, a colony is established and peopled, they have enough to do to furnish it with eggs to produce its necessary supply of future females, males and workers; which, according to Gould, are laid at three different seasons[u]. This is the ordinary duty assigned to them by Providence. Yet at the first formation of a nest, the female acts the kind part, and performs all the maternal offices which I have just described as peculiar to the workers; and it is only when these become sufficiently numerous to relieve her that she resigns this charge and devotes herself exclusively to oviposition[v].

There is one circumstance occurring at this period of their history which affords a very affecting example of the self-denial and self-devotion of these admirable creatures. If you have paid any attention to what is

[t] Huber, 93. [u] p. 35. [v] Huber, 110.

going forward in an ant-hill, you will have observed some larger than the rest, which at first sight appear, as well as the workers, to have no wings, but which upon a closer examination exhibit a small portion of their base, or the sockets in which they were inserted. These are females that have cast their wings, not accidentally but by a *voluntary* act. When an ant of this sex first emerges from the pupa, she is adorned with two pair of wings, the upper or outer pair being larger than her body. With these, when a virgin, she is enabled to traverse the fields of ether, surrounded by myriads of the other sex, who are candidates for her favour. But when once connubial rites are celebrated the unhappy husband dies, and the widowed bride seeks only how she may provide for their mutual offspring. Panting no more to join the choir of aerial dancers, her only thought is to construct a subterranean abode in which she may deposit and attend to her eggs, and cherish her embryo young, till, having passed through their various changes, they arrive at their perfect state, and she can devolve upon them a portion of her maternal cares. Her ample wings, which before were her chief ornament and the instruments of her pleasure, are now an incumbrance which incommode her in the fulfilment of the great duty uppermost in her mind; she therefore, without a moment's hesitation, plucks them from her shoulders. Might we not then address females who have families, in words like those of Solomon, "Go to the ant, ye *mothers*, consider her ways and be wise?"

M. P. Huber was more than once witness to this proceeding. He saw one female stretch her wings with a strong effort so as to bring them before her head—she then crossed them in all directions—next she reversed them alternately on each side—at last, in consequence of some violent contortions, the four wings fell at the same moment in his presence. Another, in addition to these motions, used her legs to assist in the work[w].

Thus, from the very moment of the extrusion of the egg to the maturity of the perfect insect, are the ants unremittingly occupied in the care of the young of the society, and that with an ardour of affectionate attachment to which, when its intensity and duration are taken into the account, we may fairly say there is nothing parallel in the whole animal world[x]. Amongst birds and quadrupeds we have instances of affection as strong perhaps while it lasts, but how much shorter the period during which it is exerted! In a month or two the young of the former require no further attention; and if in a state of nature some of the latter give suck to their offspring for a longer period, it is on their parts without effort or labour: and in both cases the time given up to their young forms a very small part of the life of the animal. But the little insects in question not only spend a greater portion of time in the education of their progeny, but devote even the whole of their existence, from their birth to their death, to this one occupation!

[w] Huber, 109.—Gould had long before Huber observed that female ants cast their wings, pp. 59, 62, 64. I have frequently observed them, sometimes with only one wing, at others with only fragments of the wings; and again, at others they were so completely pulled off, that it could not be known that they formerly had them, only by the sockets in which they were inserted.

[x] Huber, 93.

The common hive-bee and the wasp in their attention to their young exhibit the same general features. Both build for their reception hexagonal cells, differing in size according to the future sex of the included grubs, which as soon as hatched they both feed and assiduously tend until their transformation into *pupæ*. There are peculiarities, however, in their modes of procedure, which require a distinct notice.

The economy of a nest of wasps differs from that of bees, in that the eggs are laid not by a single mother or queen, but by several; and that these mothers take the same care as the workers in feeding the young grubs: indeed those first hatched are fed entirely by the female which produced them, the solitary founder of the colony. The sole survivor probably of a last year's swarm of many thousands, this female, as soon as revived by the warmth of spring, proceeds to construct a few cells, and deposits in them the eggs of working wasps. The eggs are covered with a gluten, which fixes them so strongly against the sides of the cells, that it is not easy to separate them unbroken. These eggs seem to require care from the time they are laid, for the wasps many times in a day put their heads into the cells which contain them. When they are hatched, it is amusing to witness the activity with which the female runs from cell to cell, putting her head into those in which the grubs are very young, while those that are more advanced in age thrust their heads out of their cells, and by little movements seem to be asking for their food. As soon as they receive their portion, they draw them back and remain quiet. These she feeds until they become pupæ; and within twelve hours after being excluded in their perfect state, they eagerly set to work in constructing fresh cells, and in lightening the burthen of their parent by assisting her in feeding the grubs of other workers and females which are by this time born. In a few weeks the society will have received an accession of several hundred workers and many females, which without distinction apply themselves to provide food for the growing gtubs, now become exceedingly numerous. With this object in view, as they collect little or no honey from flowers, they are constantly engaged in predatory expeditions. One party will attack a hive of bees, a grocer's sugar hogshead, or other saccharine repository; or, if these fail, the juice of a ripe peach or pear. You will be less indignant than formerly at these audacious robbers now you know that self is little considered in their attacks, and that your ravaged fruit has supplied an exquisite banquet to the most tender grubs of the nest, into whose extended mouths the successful marauders, running with astonishing agility from one cell to another, disgorge successively a small portion of their booty in the same way that a bird supplies her young[y]. Another party is charged with providing more substantial aliment for the grubs of maturer growth. These wage war upon bees, flies, and even the meat of a butcher's stall, and joyfully return to the nest laden with the well-filled bodies of the former, or pieces of the latter as large as they can carry. This solid food they distribute in like manner to the larger grubs, which may be seen eagerly protruding

[y] See Willughby in Rai. *Hist. Ins.* 251. and Reaum.

their heads out of the cells to receive the welcome meal. As wasps lay up no store of food, these exertions are the task of every day during the summer, fresh broods of grubs constantly succeeding to those which have become pupæ or perfect insects; and in autumn, when the colony is augmented to 20 or 30,000, and the grubs in proportion, the scene of bustle which it presents may be readily conceived.

Though such is the love of wasps for their young, that if their nest be broken almost entirely in pieces they will not abandon it[z], yet when the cold weather approaches a melancholy change ensues, followed by a cruel catastrophe, which at first you will be apt to regard as ill comporting with this affectionate character. As soon as the first sharp frost of October has been felt, the exterior of a wasp's nest becomes a perfect scene of horror. The old wasps drag out of the cells all the grubs and unrelentingly destroy them, strewing their dead carcases around the door of their now desolate habitation. "What monsters of cruelty!" I hear you exclaim, "What detestable barbarians!" But be not too hasty. When you have coolly considered the circumstances of the case, you will view this seemingly cruel sacrifice in a different light. The old wasps have no stock of provisions: the benumbing hand of winter is about to incapacitate them from exertion; while the season itself affords no supply. What resource then is left? Their young must linger on a short period, suffering all the agonies of hunger, and at length expire. They have it in their power at least to shorten the

[z] Reaum. vi. 174.

term of this misery—to cut off its bitterest moments. A sudden death by their own hands is comparatively a merciful stroke. This is the only alternative; and thus, in fact, this apparent ferocity is the last effort of tender affection, active even to the end of life. I do not mean to say that this train of reasoning actually passes through the mind of the wasps. It is more correct to regard it as having actuated the benevolent Author of the instinct so singularly, and without doubt so wisely, excited. Were a nest of wasps to survive the winter, they would increase so rapidly, that not only would all the bees, flies, and other animals on which they prey, be extirpated, but man himself find them a grievous pest. It is necessary, therefore, that the great mass should annually perish; but that they may suffer as little as possible, the Creator, mindful of the happiness of the smallest of his creatures, has endowed a part of the society, at the destined time, with the wonderful instinct which, previously to their own death, makes them the executioners of the rest.

Wasps in the construction of their nests have solely in view the accommodation of their young ones; and to these their cells are exclusively devoted. Bees, on the contrary, (I am speaking of the common hive-bee,) appropriate a considerable number of their cells to the reception of honey intended for the use of the society. Yet the education of the young brood is their chief object, and to this they constantly sacrifice all personal and selfish considerations. In a new swarm the first care is to build a series of cells to serve as cradles; and little or no honey is collected until an ample store of *bee-bread*, as it is called, has been laid up for their food. This bee-bread is composed of the pollen of flowers, which the workers are incessantly employed in gathering, flying from flower to flower, brushing from the stamens their yellow treasure, and collecting it in the little baskets with which their hind legs are so admirably provided[a]; then hastening to the hive, and having deposited their booty, returning for a new load. The provision thus furnished by one set of labourers is carefully stored up by another, until the eggs which the queen-bee has laid have hatched[b]. With this bee-bread after it has undergone a conversion into a sort of whitish jelly by being received into the bee's stomach, where it is probably mixed with honey[c] and regurgitated, the young brood immediately upon their exclusion, and until their change into nymphs, are diligently fed by other bees, which anxiously attend upon them and several times a day afford a fresh supply. Different bees are seen successively to introduce their heads into the cells containing them, and after remaining in that position some moments, during which they replace the expended provision, pass

[a] Besides the fringe of incurved hairs at the sides and end of the posterior tibiæ, which help to form this basket, there is a row of straight hairs on the inner side, lying flatter against its concave surface, which may be said to constitute the bottom of the basket, and I imagine are very serviceable in retaining the masses of pollen. Kirby *Monogr. Ap. Angl.* i. *t.* 12. ** e. 1. *neut. f.* 19. *a b.*

[b] These are covered by a glutinous matter, which enables them to adhere, and are set nearly upright in the angle of the pyramidal bottom, or in one of those formed by the conflux of the sides of the rhombs. Reaum. v. 469.

[c] It is not unlikely that it may undergo some other alteration in the bee's stomach, which may possibly secrete some peculiar substance, as John Hunter discovered that the crop of the pigeon does.

on to those in the neighbourhood. Others often immediately succeed, and in like manner put in their heads as if to see that the young ones have every thing necessary; which being ascertained by a glance, they immediately proceed, and stop only when they find a cell almost exhausted of food. That the office of these purveyors is no very simple affair will be admitted, when it is understood that the food of all the grubs is not the same, but that it varies according to their age, being insipid when they are young, and, when they have nearly attained maturity, more sugary and somewhat acid. The larvæ destined for queen-bees, too, require a food altogether different from that of those of drones and workers. It may be recognised by its sharp and pungent taste.—They are not less careful with regard to the temperature of their charge, whether eggs or larvæ, imparting a genial warmth to them by brooding either singly or in clusters over the cells[d].

So accurately is the supply of food proportioned to the wants of the larvæ, that when they have attained their full growth and are ready to become nymphs, not an atom is left unconsumed. At this period, intuitively known to their assiduous foster-parents, they terminate their cares by sealing up each cell with a lid of wax, convex in those containing the larvæ of drones, and nearly flat in those containing the larvæ of workers, beneath which the inclosed tenants spin in security their cocoon.—In all these labours neither the queen nor the drones take the slightest share. They fall ex-

[d] Huber says, "At whatever time a hive is examined, neuters may always be seen with their head and thorax in the cells in which are eggs, and remain motionless several minutes in that position." 159.

clusively upon the workers, who, constantly called upon to tend fresh broods, as those brought to maturity are disposed of, devote nearly the whole of their existence to these maternal offices.

Humble-bees[e], which in respect of their general policy must, when compared with bees and wasps, be regarded as rude and untutored villagers, exhibit nevertheless marks of affection to their young quite as strong as their more polished neighbours. The females, like those of wasps, take a considerable share in their education. When one of them has with great labour constructed a commodious waxen cell, she next furnishes it with a store of pollen moistened with honey; and then having deposited six or seven eggs, carefully closes the orifice and minutest interstices with wax. But this is not the whole of her task. By a strange instinct, which however may be necessary to keep the population within due bounds, the workers, while she is occupied in laying her eggs, endeavour to seize them from her, and, if they succeed, greedily devour them. To prevent this violence her utmost activity is scarcely adequate; and it is only after she has again and again beat off the murderous intruders and pursued them to the furthest verge of the nest that she succeeds in her operation. When finished, she is still under the necessity of closely guarding the cell, which the gluttonous workers would otherwise tear open and devour the eggs. This duty she performs for six or eight hours

[e] Dr. Johnson was ignorant of the etymology of this word. It is clearly derived from the German *Hummel* or *Hummel Biene*, a name probably given it from its sound. Our English name would be more significant were it altered to *Humming-bee* or *Booming-bee*.

with the vigilance of an Argus, at the end of which time they lose their taste for this food, and will not touch it even when presented to them. Here the labours of the mother cease, and are succeeded by those of the workers. These know the precise hour when the grubs have consumed their stock of food, and from that time to their maturity regularly feed them with either honey or pollen, introduced in their proboscis through a small hole in the cover of the cell opened for the occasion and then carefully closed.

They are equally assiduous in another operation. As the grubs increase in size the cell which contained them becomes too small, and in their exertions to be more at ease they split its thin sides. To fill up these breaches as fast as they occur with a patch of wax, is the office of the workers, who are constantly on the watch to discover when their services are wanted; and thus the cells daily increase in size, in a way which to an observer ignorant of the process seems very extraordinary.

The last duty of these affectionate foster-parents is to assist the young bees in cutting open the cocoons which have inclosed them in the state of *pupæ*. A previous labour however must not be omitted. The workers adopt similar measures with the hive-bee for maintaining the young pupæ concealed in these cocoons in a genial temperature. In cold weather and at night they get upon them and impart the necessary warmth by brooding over them in clusters. Connected with this part of their domestic economy, M. P. Huber, a worthy scion of a celebrated stock, and an inheritor of the science and merits of the great Huber as well of his name, in his excellent paper on these insects in the sixth volume of the Linnean Transactions, from which most of these facts are drawn, relates a singularly curious anecdote.

In the course of his ingenious and numerous experiments, M. Huber put under a bell-glass about a dozen humble-bees without any store of wax, along with a comb of about ten silken cocoons so unequal in height that it was impossible the mass should stand firmly. Its unsteadiness disquieted the humble-bees extremely. Their affection for their young led them to mount upon the cocoons for the sake of imparting warmth to the inclosed little ones, but in attempting this the comb tottered so violently that the scheme was almost impracticable. To remedy this inconvenience, and to make the comb steady, they had recourse to a most ingenious expedient. Two or three bees got upon the comb, stretched themselves over its edge, and with their heads downwards fixed their fore-feet on the table upon which it stood, whilst with their hind feet they kept it from falling. In this constrained and painful posture, fresh bees relieving their comrades when weary, did these affectionate little insects support the comb for nearly three days! At the end of this period they had prepared a sufficiency of wax with which they built pillars that kept it in a firm position: but by some accident afterwards these got displaced, when they had again recourse to their former manœuvre for supplying their place, and this operation they perseveringly continued until M. Huber, pitying their hard case, relieved them by fixing the object of their attention firmly on the table[f].

It is impossible not to be struck with the reflection that this most singular fact is inexplicable on the supposition that insects are impelled to their operations by a blind instinct alone. How could mere machines have thus provided for a case which in a state of nature has probably never occurred to ten nests of humble-bees since the creation? If in this instance these little animals were not guided by a process of reasoning, what is the distinction between reason and instinct? How could the most profound architect have better adapted the means to the end—how more dexterously *shored* up a tottering edifice, until his beams and his props were in readiness?

With respect to the operations of the Termites in rearing their young I have not much to observe. All that is known is, that they build commodious cells for their reception, into which the eggs of the queen are conveyed by the workers as soon as laid, and where when hatched they are assiduously fed by them until they are able to provide for themselves.

In concluding this subject, it may not be superfluous to advert to an objection which is sometimes thrown out against regarding with any particular sympathy the affection of the lower animals to their young, on the ground that this feeling is in them the result of corporeal sensation only, and wholly different from that love which human parents feel for their offspring. It is true that the latter involves moral considerations

[f] *Linn. Trans.* vi. 247 &c.

which cannot have place in the brute creation; but it would puzzle such objectors to explain in what respect the affection which a mother feels for her new-born infant the moment it has seen the light, differs from that of an insect for its progeny. The affection of both is purely physical, and in each case springs from sensations interwoven by the Creator in the constitution of his creatures. If the parental love of the former is worthy of our tenderest sympathies, that of the latter cannot be undeserving of some portion of similar feeling.

I am, &c.

LETTER XII.

ON THE FOOD OF INSECTS.

INSECTS like other animals draw their *food* from the vegetable and animal kingdoms, but a very slight survey will suffice to show that they enjoy a range over far more extensive territories.

To begin with the vegetable kingdom.—Of this vast field the larger animals are confined to a comparatively small portion. Of the thousands of plants which clothe the face of the earth, when we have separated the grasses and a trifling number of herbs and shrubs, the rest are disgusting to them, if not absolute poisons. But how infinitely more plenteous is the feast to which Flora invites the insect tribes! From the gigantic banyan which covers acres with its shade, to the tiny fungus scarcely visible to the naked eye, the vegetable creation is one vast banquet at which her insect guests sit down. Perhaps not a single plant exists which does not afford a delicious food to some insect, not excluding even those most nauseous and poisonous to other animals—the acrid euphorbias, and the lurid henbane and nightshade. Nor is it a presumptuous supposition that a considerable proportion of these vegetables were created expressly for their entertainment and support. The common nettle is of little use either to mankind or the larger animals, but you will not doubt its importance to the class of insects, when told that at least fifty distinct species feed upon it[g]. But this is not all. The larger herbivorous animals are confined to a foliaceous or farinaceous diet. They can subsist on no other part of a plant than its leaves and seeds, either in a recent or dried state, with the addition sometimes of the tender twigs or bark. Not so the insect race; to different tribes of which every part of a plant supplies appropriate food. Some attack its roots; others select the trunk and branches; a third class feed upon the leaves; a fourth with yet more delicate appetite prefer the flowers; and a fifth the fruit or seeds. Even still further selection takes place. Of those which feed upon the roots, stem, and branches, of vegetables, some eat only the bark (larvæ of *Sphinx apiformis*, &c.), others the alburnum (*Tortrix Wœberana*), others the exuding resinous or other excretions (*Tinea Resinella*), a third class the pith (*Noctua Ochraceago*, Lep. Brit.), and a fourth penetrate into the heart of the solid wood (*Cerambyces*). Of those which prefer the leaves, some taste nothing but the sap which fills their veins (*Aphides*); others eat only the parenchyma, never touching the cuticle (larvæ of subcutaneous *Tineæ*), others only the lower surface of the leaf (many *Tortrices*), while a fourth de-

[g] Of the genus *Cimex* alone, Fallen tells us that thirty species are found upon the nettle. *Mon. Cimicum Sueciæ*, 16.

scription devour the whole substance of the leaf (most lepidopterous larvæ). And of the flower-feeders, while some eat the very petals (larvæ of *Noctua Verbasci*, *Linariæ*, &c.), others select the pollen which swells the anthers (Bees *Lepturæ* and *Mordellæ*), and a still larger class the honey secreted in the nectaries (most of the Lepidoptera, Hymenoptera, and Diptera).

Nor are insects confined to vegetables in their recent or unmanufactured state. A beam of oak when it has supported the roof of a castle five hundred years, is as much to the taste of some, (*Anobia*), as the same tree was in its growing state to that of others; another class (*Ptini*) would sooner feast on the herbarium of Brunfelsius, than on the greenest herbs that grow; and a third (*Tineæ*, *Termites*), to whom

> "——— a river and a sea
> Are a dish of tea,
> And a kingdom bread and butter,"

would prefer the geographical treasures of Saxton or Speed, in spite of their ink and alum, to the freshest rind of the flax plant.—The larva of a little fly (*Musca Cellaris?* L. *Oinopota Cellaris*, K.), whose economy, as I can witness from my own observations, is admirably described by Mentzelius[h], disdains to feed on anything but wine or beer, which like Boniface in the play it may be said both to eat and drink, though, unlike its toping counterpart, indifferent to the age of its liquor, which whether sweet or sour is equally acceptable.

[h] *Ephem. German. An.* xii. *Obs.* 58. Raij *Hist. Ins.* 261.

A diversity of food almost as great may be boasted by the insects which feed on animal substances. Some (Flesh flies, *Silphæ*, &c.) devour dead carcases only, which they will not touch until imbued with the *haut gout* of putridity. Others, like Mr. Bruce's Abyssinians, preferring their meat before it has passed through the hands of the butcher, select it from living victims, and may with justice pride themselves upon the peculiar freshness of their diet. Of these last, different tribes follow different procedures. The Ichneumons devour the flesh of the insects into which they have insinuated themselves. Some of the Oestri, fixed in a spacious apartment beneath the skin of an ox or deer, regale themselves on a purulent secretion with which they are surrounded. Others of the same tribe, partial to a higher temperature, attach themselves to the interior of the stomach of a horse, and in a bath of 102 degrees of Fahrenheit revel on the purest chyme. The various species of Tabanus and Stomoxys dart their sharp lancets into the veins of quadrupeds, and satiate themselves in living streams; while the gnat, the flea, the bug, and the louse, plunge their proboscis even into those of us lords of the creation, and banquet on "the ruddy drops which warm our hearts." Another numerous class kill their prey outright, either devouring its solid parts, as the *Carabidæ*, *Staphylinidæ*, &c., or imbibing its juices only, as the numerous hordes of the bug tribe. And the larvæ of Culex, Stratyomys, &c. the leviathans of the world of animalcules, swallow whole hosts of these minute inhabitants of aquatic situations at a gulp, causing with their oral apparatus a vortex in the water, down which myriads of victims are incessantly hurried into their destructive maw.

But not only animals themselves, almost every animal substance that can be named is the appropriate food of some insect. Multitudes find a delicious nutriment in excrements of various kinds. Matters apparently so indigestible as hair, wool, and leather, are the sole food of many moths in the larva state (*Tinea tapetzella*, *pellionella*, &c.). Even feathers are not rejected by others; and the larva of *Byrrhus Musæorum*, with powers of stomach which the dyspeptic sufferer may envy, will live luxuriously upon horn[i].

For the most part, insects feeding upon animal substances will not touch vegetables, and *vice versâ*. You must not however take the rule without exceptions. Many caterpillars (as those of *Noctua derasa*, *Delphini*, &c.), though plants are their proper food, will occasionally devour other caterpillars, and sometimes even their own species. *Gryllus viridissimus*, and probably others of the order, will eat smaller insects as well as its usual vegetable food[j]; and so also will the larvæ of many *Phryganeæ*. *Ptinus rubellus*, Ent. Brit. which ordinarily feeds upon wood, was, as I before mentioned, once found by Mr. Sheppard in great abundance living upon the dried Cantharides (*Lytta vesicatoria*) of the shops. On the other hand, *Necrophorus mortuorum*, which subsists on carcases, and many other carnivorous species, will make a hearty meal of a putrid fungus; *Ptinus fur* devours indifferently dried birds or plants, not refusing even tobacco; and from

[i] De Geer, iv. 210. [j] Brahm *Insekten Kalender*, i. 190.

the impossibility that one of a million of the innumerable swarms of gnats which abound in swampy places, particularly in regions which but for them would be lost to sensitive existence, should ever taste blood, it seems clear that they are usually contented with vegetable aliment. Indeed the males, as well as those of Tabanus of which even the females readily imbibed the sugared fluid offered to them by Reaumur[k], never suck blood at all ; so that they must either feed on vegetable matter, which in fact I have observed them to do, or fast during their whole existence in the perfect state.

Though insects, generally considered, have thus a much more extensive bill of fare than the larger animals, each individual species is commonly limited to a more restricted diet. Many both of animal and vegetable feeders are absolutely confined to one kind of food, and cannot exist upon any other. The larva of *Oestrus Equi* can subsist no where but in the stomach of the horse or ass, which animals therefore this insect might boast with some show of reason to have been created for its use rather than for ours, being to us useful only, but to it indispensable. The larvæ of *Syrphus Pyrastri* (*Musca*, L.) according to De Geer eat no other Aphis but that of the rose[l]. Most Ichneumons and Spheges prey each upon a single species of insect only, which therefore they would seem to have been formed for the express purpose of keeping within due limits. Reaumur mentions having once found in a parcel of decaying wood the nests of six different kinds

[k] Reaum. iv. 230. [l] De Geer, vi. 112.

of Sphex, each of which was filled with flies of a distinct and the same species[m]. *Cerceris auritus*, Latr. and *Philanthus lætus*, Panz., in the larva state feed solely on the Curculio tribe of Coleoptera, the latter being restricted even to the short-rostrum'd family, as *C. picipes*, *raucus*, &c.[n], while *Bembex rostrata* selects *Musca Cæsar*, &c.[o]

A very large proportion of species, however, are able to subsist on several kinds of food. Amongst the carnivorous tribes, it is indifferent to most of those which prey upon putrid substances from what source they have been derived: and the predaceous genera, such as *Libellula*, *Cantharis*, *Empis*, *Aranea*, &c. will attack most smaller insects inferior to them in strength, not excepting in many instances their own species. The wax-moth larva (*Galleria Cereana*) will for want of wax eat paper, wafers, wool, &c.[p]: another Tinea described by Reaumur, and before adverted to, attacks chocolate[q], which cannot have been its natural food, even selecting that most highly perfumed; and the Tineæ which devour dressed wool, but happily for the farmer and wool-stapler refuse it when unwashed, must have existed when no manufactured wool was accessible.—The vegetable feeders are under greater restrictions, yet probably the majority can subsist on different kinds of food. This is certainly true of most lepidopterous larvæ, several of which as well as many Coleoptera (*Haltica oleracea*, &c.) are polypha-

[m] Reaum. vi. 271.
[n] *Entomologische Bemerkungen* (Braunschweig 1799), p. 6.
[o] Latreille, *Obs. sur les Hymenopteres*, *Ann. de Mus.* xiv. 412.
[p] Reaum. iii. 257. [q] Ibid. iii. 277.

gous, eating almost every plant. It is worthy of remark, however, that when some of these have fed for a time on one plant they will die rather than eat another, which would have been perfectly acceptable to them if accustomed to it from the first[r]. Here too it must be borne in mind, that by far the greater part of insects feed upon different substances in their different states of existence, eating one kind of food in the larva and another in the imago state. This is the case with the whole order Lepidoptera, which in the former eat plants chiefly, in the latter nothing but honey; and the same rule obtains also in regard to most dipterous and hymenopterous insects. Those which eat one kind of food in both states, are chiefly of the remaining orders.

I have said that insects, like other animals, draw their subsistence from the vegetable or animal kingdoms. But I ought not to omit noticing that some authors have conceived that several species feed upon mineral substances. Not to dwell upon Barchewitz's idle tale of East Indian ants which eat iron[s], or on the stone-eating caterpillars recorded in the Memoirs of the French Academy[t], which are now known to erode the walls on which they are found solely for the purpose of forming their cocoons; Reaumur and Swammerdam have both stated the food of the larvæ of *Ephemeræ* to be earth, that being the only substance ever found in their stomachs and intestines which are filled with it. This supposition, which if correct renders invalid the definition by which Mirbel (and my

[r] Reaum. ii. 324. [s] Lesser, *L.* i. 259. [t] x. 458.

friend Dr. Alderson long before him) proposed to distinguish the animal and vegetable kingdoms, is certainly not inadmissible; for, though we might not be inclined to give much weight to Father Paulian's history of a flint-eater who digested flints and stone[u], the testimony of Humboldt seems to prove that the human race is capable of drawing nutriment from earth, which if the odious Ottomaques can digest and assimilate may doubtless afford support to the larvæ of Ephemeræ. Yet after all it is perhaps more probable that these insects feed on the decaying vegetable matter intermixed with the earth in which they reside, from which after being swallowed it is extracted by the action of the stomach; like the sand that, from being found in a similar situation, Borelli erroneously supposed to be the food of many *Testacea*, though in fact a mere extraneous substance.

The majority of insects, either imbibing their food in a liquid state, or feeding on succulent substances, require no aqueous fluid for diluting it. Water however is essential to bees, ants, and some other tribes, which drink it with avidity; as well as in warm climates to many Lepidoptera, which are there chiefly taken in court yards, near the margins of drains, &c. Even some larvæ which feed upon juicy leaves have been observed to swallow drops of dew; and one of them (*Bombyx potatoria*), which (according to Goedart) after drinking lifts up its head like a hen, has received its name from this circumstance. That it is not the mere want of succulency in the food which induces the ne-

[u] *Dictionnaire Physique.*

cessity of drink, is plain from those larvæ which live entirely on substances so dry that it is almost unaccountable whence the juices of their body are derived. The grub of an Anobium (*Ptinus*, L.) will feed for months upon a chair that has been baking before the fire for half a century, and from which even the chemist's retort could scarcely extract a drop of moisture; and will yet have its body as well filled with fluids as that of a leaf-fed caterpillar.

By far the greater part of insects always feed themselves. The young however of those which live in societies, as the hive- and humble-bees, wasps, ants, &c. are fed by the older inhabitants of the community, which also frequently feed each other. Many of these last insects are distinguished from the majority of their race, which live from day to day and take no thought for the morrow, by the circumstance of storing up food. Of those which feed themselves, the larger proportion have imposed upon them the task of providing for their own wants; but the tribe of Spheges, wild bees, and some others, are furnished in the larva state by the parent insect with a supply of food sufficient for their consumption until they have attained maturity.

As to their *time* of feeding, insects may be divided into three great classes: the day-feeders, the night-feeders, and those which feed indifferently at all times. You have been apt to think, I dare say, that when the sun's warmer beams have waked the insect youth, and

> "Ten thousand forms, ten thousand different tribes,
> People the blaze,"

you see before you the whole insect world. You are not aware that a host as numerous shun the glare of day, and, like the votaries of fashion, rise not from their couch until their more vulgar brethren have retired to rest. While the painted butterfly, the "fervent bees," and the quivering nations of flies, which sport

"Thick in yon stream of light, a thousand ways,
Upward and downward thwarting and convolved,"

love to bask in the sun's brightest rays, and search for their food amidst his noontide fervor, an immense multitude stir not before the sober time of twilight, and eat only when night has overshadowed the earth. Then only, the vast tribe of moths quit their hiding-places; "the shard-born[v] beetle with his drowsy hum," accompanied by numerous others of his order, sallies forth; the airy Tipulæ institute their dances; and the solitary spider stretches his net. All these retire into concealment at the approach of light.—Some few larvæ (*Noctua exclamationis*, &c.) have similar habits, and

[v] In the controversy between the commentators on Shakespeare, as to whether *shard* * means wing-cases, dung, or a fragment of earthenware, and whether *born* should be spelled with or without the *e*, it might have thrown some weight into the scale of those who contend for the orthography adopted above, and that the meaning of *shard* in this place is dung, if they had been aware that the beetle (*Scarabæus stercorarius*) is actually *born* amongst dung, and no where else; and that no beetle which makes a hum in flying can with propriety be said, as Dr. Johnson has interpreted the epithet in his Dictionary, "to be born amongst broken stones or pots." That Shakespeare alluded to the Beetle, and not to the Cockchafer (*Melolontha vulgaris*,) seems clear from the fact of the former being to be heard in all places almost every fine evening in the summer, while the latter is common only in particular districts, and at one period of the year.

* *Sharn* is the common name of cow-dung in the North: therefore Shakespeare probably wrote *sharn*-born. *Mr. Mac Leay.*

one singular genus before adverted to (*Nycterobius*) are remarkable for providing in the night a store of food which they consume in the day; but to the generality of these the period of feeding is indifferent, and most of them seem to eat with little intermission night and day.

Insects like other animals take in their food by the mouth, but there seems one exception to this rule. The singular *Acarus vegetans*, which is such a plague to some beetles, derives its nutriment from them by means of a filiform pedicle or umbilical cord attached to its anus; and what increases the singularity, sometimes several of these Acari form a kind of chain, of which the first only is fixed by its pedicle to the beetle, each of the remainder being similarly connected with the one that precedes it; so that the nutriment drawn from the beetle passes to the last through the bodies and umbilical cords of the individuals which are intermediate[w]. Some have regarded these bodies as true eggs; and their analogy with the pedunculated eggs of *Trombidium aquaticum*, which also seem to derive nourishment from the Notonectæ, &c. to which they are fixed, and still more the circumstance of their ultimately losing their pedicle and detaching themselves from the infested beetles, give plausibility to the idea. Yet these Acari are certainly furnished with feet, and have according to De Geer[x] a part resembling a mouth —characters which cannot be attributed to any egg.

[w] De Geer, vii. 123.

[x] Ibid. vii. 126. It is worthy of notice that the oral instruments of these, and also of the larvæ of many other orders, are quite different from those of the imago.

In the variety of their instruments of nutrition insects leave all other animals far behind. In common with them a vast number (the orders Coleoptera, Hymenoptera, and Orthoptera, and the larvæ of Lepidoptera, some Diptera, &c.) are furnished with jaws, but of very different constructions, and all admirably adapted for their intended services: some sharp, and armed with spines and branches for tearing flesh; others hooked for seizing, and at the same time hollow for suction; some calculated like shears for gnawing leaves; others more resembling grindstones, of a strength and solidity sufficient to reduce the hardest wood: and this singularity attends the major part of these insects, that they possess in fact two pairs of jaws, an upper and an under pair, both placed horizontally, not vertically, the former apparently in most cases for the seizure and mastication of their prey; the latter, when hooked, for retaining and tearing, while the upper comminute it previously to its being swallowed.

To the remainder of the class of insects, a mighty host, jaws would have been useless. Their refined liquid food requires instruments of a different construction, and with these they are profusely furnished. The innumerable tribes of moths and butterflies eat nothing but the honey secreted in the nectaries of flowers, which are frequently situated at the bottom of a tube of great length. They are accordingly provided with an organ exquisitely fitted for its office—a slender tubular tongue, more or less long, sometimes not shorter than three inches, but spirally convoluted when at rest, like the main spring of a watch, into a convenient compass. This tongue, which they have the power of instantly unrolling, they dart into the bottom of a flower, and, as through a syphon, draw up a supply of the delicious nectar on which they feed. A letter would scarcely suffice for describing fully the admirable structure of this organ. I must content myself therefore with here briefly observing, that it is of a cartilaginous substance, and apparently composed of a series of innumerable rings, which, to be capable of such rapid convolution, must be moved by an equal number of distinct muscles; and that, though seemingly simple, it is in fact composed of three distinct tubes, the two lateral ones cylindrical and entire, intended, as Reaumur thinks, for the reception of air; and the intermediate one, through which alone the honey is conveyed, nearly square, and formed of two separate grooves projecting from the lateral tubes; which grooves, by means of a most curious apparatus of hooks like those in the laminæ of a feather, inosculate into each other, and can be either united into an air-tight canal, or be instantly separated, at the pleasure of the insect[y].

Another numerous race, the whole of the order Hemiptera, abstract the juices of plants or of animals by means of an instrument of a construction altogether different—a hollow grooved beak, often jointed, and containing three bristle-formed lancets, which, at the same time that they pierce the food, apply to each other so accurately as to form one air-tight tube, through which the little animals suck up[z] their repast;

[y] For a full description of this instrument see Reaum. i. 125 &c.

[z] The mode, however, in which this is effected in all insects furnished with a proboscis can scarcely be by suction, strictly so called, or the abstraction of air, since the air-vessels of insects do not communicate with

thus forming a pump, which, more effective than ours, digs the well from which it draws the fluid.

A third description of insects, those of the order Diptera, comprising the whole tribe of flies, have a sucker formed on the same general plan as that last described, but of a much more complicated and varied structure. It is in like manner composed of a grooved case and several included lancets; but the case, although horny, rigid and beak-like in some, is in others fleshy, flexible, and more resembling the proboscis of an elephant, and terminates in two turgid liplets: and the accompanying lancets are themselves included in an upper hollow case, in connexion with which they probably compose an air-tight tube for suction. The number and form of these instruments is extremely various. In some genera (*Musca*) there is but one, which resembles a sharp lancet. Others (*Empis*, *Asilus*,) have three, the two lateral ones needle-shaped, that in the middle like a scymetar; together forming so keen an apparatus, that De Geer has seen an Asilus pierce with it the elytra of a Coccinella; and I have myself caught them with not only an *Elater* and *Curculio*, but even an *Hister*, in their mouths. In many Tabani we find four; two precisely resembling lancets, and two, even to the very handle, a buck-hafted carving-knife. The bloodthirsty gnat has five, some acutely lanced at the extremity, and others serrated on one side. The flea, the spider, the scorpion have all instruments for

their mouths: it is more probably performed in part by capillary attraction; and, as Lamarck has suggested, (*Syst. des Anim. sans Vertebres*, p. 193.) in part by a succession of undulations and contractions of the sides of the organ.

taking their food of a construction altogether different. But it is impossible here to attempt even a sketch of the variations in these organs which take place in the apterous genera, and in many of the dipterous larvæ. Suffice it to say that they all manifest the most consummate skill in their adaptation to the purposes of the insects which are provided with them, and which can often employ them not only as instruments for preparing food, but as weapons of offence and defence, as tools in the building of their nests, and even as feet.

Some insects in their perfect state, though furnished with organs of feeding, make no use of them, and consume no food whatever. Of this description are the moth which proceeds from the silk-worm, and several others of the same order; the different species of Oestrus and the Ephemeræ, insects whose history is so well known as to afford a moral or a simile to those most ignorant of natural history. All these live so short a time in the perfect state as to need no food.—Indeed it may be laid down as a general rule, that almost all insects in this state eat much less than in that of larvæ. The voracious caterpillar when transformed into a butterfly needs only a small quantity of honey; and the gluttonous maggot when become a fly contents itself with a drop or two of any sweet liquid.

While in the state of larvæ the quantity of food consumed by insects is vastly greater in proportion to their bulk than that required by larger animals. Many caterpillars eat daily twice their weight of leaves, which is as if an ox, weighing sixty stone, were to devour every twenty-four hours three quarters of a ton of grass —a power of stomach which our graziers may thank their stars that their oxen are not endowed with. A probable proximate cause for this voracity in the case of herbivorous larvæ has been assigned by John Hunter, who attributes it to the circumstance of their stomach not having the power of dissolving the vegetable matters received into it, but merely of extracting from them a juice[a]. This is proved both by their excrement, which consists of coiled-up and hardened particles of leaf, that being put into water expand like tea; and by the great proportion which the excrement bears to the quantity of food consumed. From experiments, with a detail of which he has favoured me, made by Colonel Machell on the caterpillars of *Bombyx Caja*, he ascertained that, though a larva weighing thirty-six grains voided every twelve hours from fifteen to eighteen grains weight of excrement, it did not increase in weight in the same period more than one or two grains. On the other hand, many carnivorous larvæ increase in weight in full proportion to the food consumed, and that in an astonishing degree. Redi found that the maggots of flesh-flies, of which twenty-five or thirty did not one day weigh above a grain, the next weighed seven grains each; having thus in twenty-four hours become about two hundred times heavier than before[b].

Some insects have the faculty of sustaining a long abstinence from all kinds of food. This seems to depend upon the nature of their habits. If the insect feeds on a substance of a deficiency of which there is

[a] *Obs. on the Animal Œconomy*, p. 221. Compare Reaum. ii. 167.

[b] Redi *de Insectis*, 39.

not much probability, as on vegetables, &c., it commonly requires a frequent supply. If, on the contrary, it is an insect of prey, and exposed to the danger of being long deprived of its food, it is often endowed with a power of fasting, which would be incredible but for the numerous facts by which it is authenticated. The ant-lion will exist without the smallest supply of food, apparently uninjured, for six months; though, when it can get it, it will devour daily an insect of its own size. Vaillant, whose authority may be here taken, assures us that he kept a spider without food under a sealed glass for ten months, at the end of which time, though shrunk in size, it was as vigorous as ever[c]. And Mr. Baker, so well known for his microscopical discoveries, states that he kept a beetle (*Blaps mortisaga*) alive for three years without food of any kind[d]. Some insects, not of a predaceous description, are gifted with a similar power of abstinence. Leeuwenhoek tells us that a mite, which he had gummed alive to the point of a needle and placed before his microscope, lived in that situation eleven weeks[e].

In some cases the very want of food, however paradoxical the proposition, seems actually to be a mean of prolonging the life of insects. At least one such instance has fallen under my own observation. The aphidivorous flies, such as *Syrphus Pyrastri*, &c. live in the larva state ten or twelve days, in the pupa state about a fortnight, and as perfect insects sometimes pos-

[c] *New Travels*, i. xxxix.

[d] *Phil. Trans.* 1740, p. 441. I confess, notwithstanding Mr. Baker's general accuracy, that I suspect some mistake here.

[e] Leeuw. *Op.* ii. 363.

sibly as long—the whole term of their existence in summer not exceeding at the very utmost six weeks. But one[f], which I put under a glass on the 2d of June 1811, when about half grown, and, after supplying it with Aphides once or twice, by accident forgot, I found to my great astonishment alive three months after; and it actually lived until the June following without a particle of food. It had therefore existed in the larva state more than eight times as long as it would have lived in all its states, if it had regularly undergone its metamorphoses—which is as extraordinary a prolongation of life as if a man were to live 560 years. It is true that its existence was not worth having even to the larva of a fly. For the last eight months it remained without motion, attached by its posterior pair of tubercles to the paper on which it was placed, manifesting no other symptoms of life than by moving the fore part of the body when touched, and replacing itself on its belly if turned upon its back. But this was quite enough to prove it still alive.—I can attribute this singular result to no other circumstance than its having been deprived of a sufficient quantity of food to bring it into the pupa state, though provided with

[f] Not having ever met with another specimen, I am unable to say of what precise species of aphidivorous fly it is the larva, nor can I find a figure of it, though it approaches near to one given by De Geer (vi. *t. f.* 6.). Its shape is oblong-oval, length about four lines, and colour pale red speckled with black. Each of the seven or eight segments which compose the body projects on each side into three serrated flat aculei or teeth; three or four similar but smaller aculei arm the head; and two, much larger than the rest, the anus, one on each side of the usual bifid protuberance which bears the respiratory plates. A bifid tubercular elevation is also placed in the middle of the back of each segment.

enough for the attainment of nearly its full growth as larva. Possibly the same remote cause might act in this case, as operates to prolong the term of existence of annual plants that have been prevented from perfecting their seed; and it would almost seem to favour the hypothesis of some physiologists, who contend that every organized being has a certain portion of irritability originally imparted to it, and that its life will be long or short as this is slowly or rapidly excited—no great consolation this for the advocates for fast-living, unless they are in good earnest in their affected preference of a "short life and a merry one:" though it must be admitted that they would have the best of the argument were the alternative such a state of torpid insensibility as that with which our larva purchased the prolongation of its existence.

After this general view of the food of insects, and of circumstances connected with it, I proceed to give you an account of some peculiarities in their modes of procuring it.

The vegetable feeders have for the most part but little difficulty in supplying their wants. In the larva state they generally find themselves placed by the parent insect upon the very plant or substance which is to nourish them; and in their perfect state their wings or feet afford a ready conveyance to the banquet to which by an unerring sense they are directed. All nature lies before them, and it is only when their numbers are extraordinarily increased, or in consequence of some unusual destruction of their appropriate aliment, that they perish for want. The description of their food renders unnecessary those artifices to which many of the carnivorous insects are obliged to have recourse; and none of them, if we except the Termites, whose cunning mode of insinuating themselves into houses in tropical climates has been detailed in a former letter, can be said to use stratagem in obtaining their food.

Of the carnivorous species, the greater proportion attack their prey by open violence, such as the *Cicindelæ*, *Carabidæ* and *Staphylinidæ*; the *Ichneumonidæ*, *Spheges* and *Vespæ*; the *Mantes*, *Cimicidæ*, *Libellulidæ*, &c.; which have been before adverted to. But a very considerable number, chiefly however of one tribe, that of spiders, provide their sustenance solely by artifice and stratagem, the singularity of which, and the admirable adaptation of the instruments by which they take their prey to the end in view, afford a most wonderful instance of the power and wisdom of the Creator, and have attracted admiration in all ages. A description of these, however, which will require a detailed survey, I must refer to another letter.

I am, &c.

LETTER XIII.

FOOD OF INSECTS CONTINUED.

STRATAGEMS EMPLOYED IN PROCURING IT.

The *stratagems* of insects in obtaining their food are now to engage our attention. I shall not dwell on those inartificial modes of surprising their prey, of which examples may be found amongst almost every order of insects, such as watching behind a leaf or other object affording concealment until its approach; but shall proceed to describe the various artifices of the race of spiders, of which there are several hundred distinct species differing essentially from each other both in characters and manners.

Many of these are constantly under our eyes; and were it not that we are accustomed to neglect what is the subject of daily occurrence, we should never behold a spider's web without astonishment. What, if we had not witnessed it, would seem more incredible than that any animal should spin threads; weave these threads into nets more admirable than ever fowler or fisherman fabricated: suspend them with the nicest judgement in the place most abounding in the wished-for prey; and there concealed watch patiently its approach? In this case, as in so many others, we neglect actions in minute animals, which in the larger would excite our endless admiration. How would the world crowd to see a fox which should spin ropes, weave them into an accurately-meshed net, and extend this net between two trees for the purpose of entangling a flight of birds? Or should we think we had ever expressed sufficient wonder at seeing a fish which obtained its prey by a similar contrivance? Yet there would, in reality, be nothing more marvellous in their procedures than in those of spiders, which, indeed, the minuteness of the agent renders more wonderful.

All spiders do not spin webs. A considerable number adopt other means for catching insects. Of these I shall speak hereafter. At present I shall endeavour to give you a clear idea of the operations of the weavers, explaining successively the instruments by which they spin—the mode of forming their nets, together with the various descriptions of them—and the manner in which they entrap and secure their prey.

The thread spun by spiders is in substance similar to the silk of the silk-worm and other caterpillars, but of a much finer quality. As in them, it proceeds from reservoirs, into which it is secreted in the form of a viscid gum; but in the mode of its extrication is very dissimilar, issuing not from the mouth but the hinder part of the abdomen. If you examine a spider, you will perceive in this part four little teat-like protuberances or spinners. These are the machinery through which, by a process more singular than that of rope-spinning, the thread is drawn. Each spinner is pierced like the plate of a wire-drawer with a multitude of holes, so numerous and so exquisitely fine, that a space often not bigger than a pin's point includes above a thousand. Through each of these holes proceeds a thread of an inconceivable tenuity, which immediately after issuing from the orifice unites with all the other threads from the same spinner into one. Hence from each spinner proceeds a compound thread; and these four threads, at the distance of about one-tenth of an inch from the apex of the spinners, again unite, and form the thread we are accustomed to see, which the spider uses in forming its web. Thus a spider's thread, even spun by the smallest species, and when so fine that it is almost imperceptible to our senses, is not, as we suppose, a single line, but a rope composed of at least four thousand strands. How astonishing! But to feel all the wonder of this fact we must follow Leeuwenhoek in one of his calculations on the subject. This renowned microscopic observer found by an accurate estimation that the threads of the minutest spiders, some of which are not larger than a grain of sand, are so fine that four millions of them would not exceed in thickness one of the hairs of his beard[g]. Now we know that each of these threads is composed of above 4000 still finer. It follows, therefore, that above sixteen thousand millions of the finest threads which issue from such spiders are not together thicker than a human hair! Of such tenuity it is utterly beyond the power of the imagination to conceive: the very idea over-

[g] Leeuw. *Op.* iii. 340.

whelms our faculties, and humbles us under a sense of their imperfection.—Of the probable accuracy of this calculation you may any day in summer convince yourself, by taking one of the largest field spiders, (as *Aranea diadema*, L.), and after pressing its abdomen against a leaf or other substance, so as to attach the threads to the surface—the same preliminary step which the spider adopts in spinning—drawing it gradually to a small distance. You will plainly perceive that the proper thread of the spider is formed of four smaller threads, and these again of threads so fine and numerous, that there cannot be fewer than a thousand issue from each spinner; and if you pursue your researches with the microscope, you will find that precisely the same takes place in the minutest species that spins.—You will inquire what can be the end of machinery so complex? One probable reason is, that it was necessary for drying the gum sufficiently to form a tenacious line, that an extensive surface should be exposed to the air; which is admirably effected by dividing it at its exit from the abdomen into such numerous threads. But the chief cause, perhaps, is the occasion (hereafter to be adverted to) which the spider sometimes has to employ its threads in their finer and unconnected state before they unite to form a single one.—The spider is gifted by her Creator with the power of closing the orifices of the spinners at pleasure, and can thus, in dropping from a height by her line, stop her progress at any point of her decent: and, according to Lister[h], she is also able to retract her threads within the abdomen;

[h] *Hist. Anim. Ang.* p. 8.

but this is doubted, and with apparent reason, by De Geer[i].

The only other instruments employed by the spider in weaving are her feet, with the claws of which she usually guides, or keeps separated into two or more, the line from behind; and in many species these are admirably adapted for the purpose, two of them being furnished underneath with teeth like those of a comb, by means of which the threads are kept asunder. But another instrument was wanting. The spider in ascending the line by which she has dropped herself from an eminence, winds up the superfluous cord into a ball. In performing this the pectinated claws would not have been suitable. She is therefore furnished with a *third* claw between the other two[j], and is thus provided for every occasion.

The situation in which spiders place their nets are as various as their construction. Some prefer the open air, and suspend them in the midst of shrubs or plants most frequented by flies and other small insects, fixing them in a horizontal, a vertical, or an oblique direction. Others select the corners of windows and of rooms, where prey always abounds; while many establish themselves in stables and neglected out-houses, and even in cellars and desolate places in which one would scarcely expect a fly to be caught in a month. It is with the operations of these last especially, that we are accustomed to associate the ideas of neglect and desertion by man—associations which both in painting and allegory have been often happily applied.

[i] De Geer, vii. 189.

[j] Leeuw. *Opusc.* iii. 317. f. 1.

Hogarth, when he wished to produce a speaking picture of neglected charity, clothed the poor's box in one of his pieces with a spider's web: and the Jews, in one of the fables with which they have disfigured the records of holy writ, have not less ingeniously availed themselves of the same idea. They relate that the reason why Saul did not discover David and his men in the cave of Adullam[k] was, that God had sent a spider which had quickly woven a web across the entrance of the hole that concealed them; which being observed by Saul, he thought it useless to investigate further a spot bearing such evident proofs of the absence of any human being[l].

The most incurious observer must have remarked the great difference which exists in the construction of spiders' webs. Those which we most commonly see in houses are of a woven texture similar to fine gauze, and are appropriately termed webs; while those most frequently met with in the fields are composed of a series of concentric circles united by *radii* diverging from the centre, the threads being remote from each other. These last, which in their simple state, or still more when studded with dew drops, you must have a thousand times admired, are with greater propriety termed *nets*; and the insects which form them proceeding on geometrical principles may be called *geometricians*, while the former can aspire only to the humbler denomination of *weavers*. I shall endeavour to describe the process followed in the construction of both, beginning with the latter.

[k] 1 Sam. xxiv. 4.   [l] Lesser, *L.* ii. 291.

The weaving spider which is found in houses, having selected some corner for the site of her web, and determined its extent, presses her spinners against one of the walls, and thus glues to it one end of her thread. She then walks along the wall to the opposite side, and there in like manner fastens the other end. This thread, which is to form the outer margin or selvage of her web, and requires strength, she triples or quadruples by a repetition of the operation just described; and from it she draws other threads in various directions, the interstices of which she fills up by running from one to the other, and connecting them by new threads until the whole has assumed the gauze-like texture which we see. Books of natural history, all copying from one another, have described these kinds of web as fabricated of a regular warp and woof, or of parallel longitudinal lines crossed at right angles by transverse ones glued to them at the points of intersection. This, however, is clearly erroneous, as you will see by the slightest examination of a web of this kind, in which no regularity of texture can be discovered.

The webs just described present merely a simple horizontal surface, but others more frequently seen in out-houses and amongst bushes possess a very artificial appendage. Besides the main web, the spider carries up from its edges and surface a number of single threads often to the height of many feet, joining and crossing each other in various directions. Across these lines, which may be compared to the tackling of a ship, and which from their fineness are probably invisible to an insect's eye, flies cannot avoid directing their flight.

The certain consequence is, that in striking against these ropes they become slightly entangled, and, in their endeavours to disengage themselves, rarely escape being precipitated into the net spread underneath for their reception, where their doom is inevitable.

But the net is still incomplete. It is necessary that our hunter should conceal her grim visage from the game for which she lies in wait. She does not therefore station herself upon the surface of her net, but in a small silken apartment constructed below it, and completely hidden from view. "In this corner," to use the quaint translation of Pliny by Philemon Holland, Doctor in Physic [m], "with what subtiltie doth she retire making semblance as though she meant nothing less than that she doth, and as if she went about some other business! nay, how close lieth she, that it is impossible to see whether any one be within or no!" But thus removed to a distance from her net and entirely out of sight of it, how is she to know when her prey is entrapped? For this difficulty our ingenious weaver has provided. She has taken care to spin several threads from the edge of the net to that of her hole, which at once inform her by their vibrations of the capture of a fly, and serve as a bridge on which in an instant she can run to secure it.

You will readily conceive that the geometrical spiders, in forming their concentric circled nets, follow a process very different from that just described, than which indeed it is in many respects more curious. As

[m] L. xi. c. 24.

the net is usually fixed in a perpendicular or somewhat oblique direction, in an opening between the leaves of some shrub or plant, it is obvious that round its whole extent will be required lines to which can be attached those ends of the *radii* that are furthest from the centre. Accordingly the construction of these exterior lines is the spider's first operation. She seems careless about the shape of the area which they inclose, well aware that she can as readily inscribe a circle in a triangle as in a square, and in this respect she is guided by the distance or proximity of the points to which she can attach them. She spares no pains, however, to strengthen and keep them in a proper degree of tension. With the former view she composes each line of five or six or even more threads glued together; and with the latter she fixes to them from different points a numerous and intricate apparatus of smaller threads. Having thus completed the foundations of her snare[n], she proceeds to fill up the outline. Attaching a thread to one of the main lines, she walks along it, guiding it with one of her hind feet that it may not touch in any part and be prematurely glued, and crosses over to the opposite side, where by applying her spinners she firmly fixes it. To the middle of this diagonal thread, which is to form the centre of her net, she fixes a second, which in like manner she conveys and fastens to another part of the lines encircling the area. Her work now proceeds rapidly. During the preliminary operations she sometimes rests, as though

[n] I am not certain whether the garden spider does not more frequently form one or two of the principal radii of the net, before she spins the exterior lines.

her plan required meditation. But no sooner are the marginal lines of her net firmly stretched, and two or three radii spun from its centre, than she continues her labour so quickly and unremittingly that the eye can scarcely follow her progress. The radii to the number of about twenty, giving the net the appearance of a wheel, are speedily finished. She then proceeds to the centre, quickly turns herself round, and pulls each thread with her feet to ascertain its strength, breaking any one that seems defective and replacing it by another. Next, she glues immediately round the centre five or six small concentric circles, distant about half a line from each other, and then four or five larger ones, each separated by a space of half an inch or more. These last serve as a sort of temporary scaffolding to walk over, and to keep the radii properly stretched while she glues to them the concentric circles that are to remain, which she now proceeds to construct. Placing herself at the circumference, and fastening her thread to the end of one of the radii, she walks up that one towards the centre to such a distance as to draw the thread from her body of a sufficient length to reach to the next. Then stepping across and conducting the thread with one of her hind feet, she glues it with her spinners to the point in the adjoining radius to which it is to be fixed. This process she repeats until she has filled up nearly the whole space from the circumference to the centre with concentric circles distant from each other about two lines. She always, however, leaves a vacant interval around the smallest first spun circles that are nearest to the centre, but for what end I am unable to conjecture. Lastly, she runs to the centre and bites away the small cotton-like tuft that united all the radii, which being now held together by the circular threads have thus probably their elasticity increased; and in this circular opening resulting from this procedure she takes her station and watches for her prey.

In the above description, which is from my own observations, I have supposed the spider to fix the first and main line of her net to points from one of which she could readily climb to the other, dragging it after her; and many of these nets are placed in situations where this is very practicable. They are frequently, however, stretched in places where it is quite impossible for the spider thus to convey her main line—between the branches of lofty trees having no connexion with each other; between two distinct and elevated buildings; and even between plants growing in water. Here then a difficulty occurs. How does the spider contrive to extend her main line, which is often many feet in length, across inaccessible openings of this description?

With the view of deciding this question, to which I could find no very satisfactory solution in books, I made an experiment, for the idea of which I am indebted to a similar one recorded by Mr. Knight[o], who informs us that if a spider be placed upon an upright stick having its bottom immersed in water, it will, after trying in vain all other modes of escape, dart out numerous fine threads so light as to float in the air, some one of which attaching itself to a neighbouring

[o] *Treatise on the Apple and Pear*, p. 97.

object furnishes a bridge for its escape. It was clear that if this mode is pursued by the geometric spiders, it would go considerably towards furnishing a solution of the difficulty in question. I accordingly placed the large garden spider upon a stick about a foot long, placed upright in a vessel containing water. After fastening its thread (as all spiders do before they move) at the top of the stick, it crept down the side until it felt the water with its fore feet, which seem to serve as antennæ: it then immediately swung itself from the stick (which was slightly bent) and climbed up by the thread to the top. This it repeated perhaps a score times, sometimes creeping down a different part of the stick, but more frequently down the very side it had so often traversed in vain. Wearied with this sameness in its operations, I left the room for some hours. On my return I was surprised to find my prisoner escaped, and not a little pleased to discover, on further examination, a thread extended from the top of the stick to a cabinet seven or eight inches distant, which thread had doubtless served as its bridge. Eager to witness the process by which the line was constructed, I replaced the spider in its former position. After frequently creeping down and mounting up again as before, at length it let itself drop from the top of the stick, not as before by a single thread but by *two*, each distant from the other about the twelfth of an inch, guided as usual by one of its hind feet, and one apparently smaller than the other. When it had suffered itself to descend nearly to the surface of the water, it stopped short, and, by some means which I could not distinctly see, broke off close to the spinners the smallest thread, which still adhering by the other end to the top of the stick floated in the air, and was so light as to be carried about by the slightest breath. On approaching a pencil to the loose end of this line, it did not adhere from mere contact. I therefore twisted it once or twice round the pencil, and then drew it tight. The spider, which had previously climbed to the top of the stick, immediately pulled at it with one of its feet, and, finding it sufficiently tense, crept along it, strengthening it as it proceeded by another thread, and thus reached the pencil[p].

That this therefore is one mode by which the geometric spiders convey the main line of their nets between distant objects, there can be no doubt, but that it is the *only* one is not so clear. If the position of the main line be thus determined by the accidental influence of the wind, we might expect to see these nets arranged with great irregularity, and crossing each other in every direction; yet it is the fact, that however closely crowded they may be, they constantly appear to be placed not by accident but design, com-

[p] Some time after making this experiment I stumbled upon a passage in Redi (*De Insectis*, p. 119.) from which it appears that Blancanus, in his *Commentaries upon Aristotle*, has related a series of observations which led him to precisely the same result. Lehmann, too, in a paper in the *Transactions of the Society of Naturalists at Berlin* (translated in the *Philosophical Magazine*, xi. 323.) has given an explanation somewhat similar of the operations of this very spider, but I am inclined to think erroneous in some particulars. He describes it as emitting *numerous* floating threads at the *commencement* of its descent. That he is mistaken in supposing these threads to be more than one, is proved by the fact which I have observed—that even that one sometimes breaks by the weight of the spider. How then could an insect almost as big as a gooseberry be supported by a line of the tenuity here attributed to it?

monly running parallel with each other at right angles with the points of support, and never interfering. Another objection too presents itself. From the experiment related, it is clear that the main line of the net can never be longer than the height of the object from which the spider dropped in forming it. But it is no uncommon thing to see nets in which these lines are a yard or two long, fastened to twigs of grass not a foot in height, and yet separated by obstacles effectually precluding the possibility of the spiders having *dragged* the lines from one to the other. Here therefore some other process must have been used.

Both these difficulties would be removed by adopting the explanation of an anonymous author in the *Journal de Physique*[q], founded as he asserts on actual observation. He says that he saw a small spider, which he had forced to suspend itself by its thread from the point of a feather, shoot out obliquely in opposite directions other smaller threads, which attached themselves in the still air of a room, without any influence of the wind, to the objects towards which they were directed. He therefore infers that spiders have the power of shooting out threads and directing them at pleasure towards a determined point, judging of the distance and position of the object by some sense of which we are ignorant. Something like this manœuvre I once myself witnessed in a male of the small garden spider (*Aranea reticulata*). It was standing midway on a long perpendicular fixed thread, and an appearance caught my eye of what seemed to be the emission

[q] *An.* vii. *Vendemiaire.* Translated in *Phil. Mag.* ii. 275.

of threads from its projected spinners. I therefore moved my arm in the direction in which they apparently proceeded, and, as I suspected, a floating thread attached itself to my coat, along which the spider crept. As this was connected with the spinners of the spider, it could not have been formed in the same way with the secondary thread of *A. diadema* above described.

Probably in this case, as in so many others, we bewilder ourselves by attempting to make nature bend to generalities to which she disdains to submit. Different spiders may lay the foundations of their net in a different manner; some on the plan adopted by *A. diadema*; others, as Lister long ago conjectured[r], by shooting out threads in the mode of the flying species as in the instances recorded by the anonymous observer, and Mr. Knight. Nor is it improbable that the same species has the power of varying its procedures according to circumstances.

How far these suppositions are correct it is impossible to determine without further experiments, which it is somewhat strange should not before now have been instituted. Pliny thought it nothing to the credit of the philosophers of his day, that while they were disputing about the number of heroes of the name of Hercules, and the site of the sepulchre of Bacchus, they should not have decided whether the queen bee had a sting or not[s]; but it seems much more discreditable to the Entomologists of ours, that they should yet be ignorant how the geometric spiders fix their nets. One excuse for them is, that these insects ge-

[r] *Hist. Anim. Ang.* p. 7. [s] Plin. *Hist. Nat.* l. xi. c. 17.

nerally begin their operations in the night, so that, though it is very easy to see them spinning their concentric circles, it is seldom that they can be caught laying the foundations of their snares. Yet doubtless the lucky moment might be hit by an attentive observer, and I shall be glad if my attempt to describe their more ordinary operations should induce you to aim at signalizing yourself by the discovery. If you failed in solving every difficulty, you would at least be rewarded by witnessing their industry, ingenuity, and patience.

For the latter virtue they have no small occasion. Incapable of actively pursuing their prey, they are dependent upon what chance conducts into their toils, which, especially those spread in neglected buildings, often remain for a long period empty. Even the geometrical spiders, which fix themselves in the midst of a well-peopled district in the open air, have frequently to sustain a protracted abstinence. A continued storm of wind and rain will demolish their nets, and preclude the possibility of reconstructing them for many days or sometimes weeks, during which not a single gnat regales their sharp-set appetites. And when at length formed anew or repaired, an unlucky bee or wasp, or an overgrown fly, will perversely entangle itself in toils not intended for insects of its bulk, and in disengaging itself once more leave the net in ruin.—All these trials move not our philosophic race. They patiently sit in their watching-place in the same posture, scarcely ever moving but when the expected prey appears. And however repeatedly their nets are injured or destroyed, as long as their store of silk is unexhausted, they repair or reconstruct them without loss of time.

The web of a house spider will, with occasional repairs, serve for a considerable period; but the nets of the geometric spiders are in favourable weather renewed either wholly, or at least their concentric circles every twenty-four hours, even when not apparently injured. This difference in the operations of the two species depends upon a very remarkable peculiarity in the conformation of their snares. The threads of the house spider's web are all of the same kind of silk, and flies are caught in them from their claws becoming entangled in the fine meshes which form the texture. On the other hand the net of the garden spider is composed of two distinct kinds of silk; that of the radii not adhesive, that of the circles extremely viscid. The cause of this difference, which, when it is considered that both sorts of silk proceed from the same instrument, is truly wonderful, may be readily perceived. If you examine a newly formed net with a microscope, you will find that the threads composing the outline and the radii are simple, those of the circles closely studded with minute dew-like globules, which from the elasticity of the thread are easily separable from each other. That these are in fact globules of viscid gum, is proved by their adhering to the finger and retaining dust thrown upon the net, while the unadhesive radii and exterior threads remain unsoiled. It is these gummed threads alone which retain the insects that fly into the net; and as they lose their viscid properties by the action of the air, it is necessary that they should be frequently renewed.

In this renewal, as above hinted, the geometrical spiders are constantly regulated by the future probable state of the atmosphere, of which they have such a nice perception, that M. Q. D'Isjonval, to whom we are indebted for the fact, has proposed them as most accurate barometers. He asserts that if the weather be about to be variable, wet and stormy, the main threads which support the net will be certainly short; but if fine settled weather be on the point of commencing these threads will be as invariably very long[t]. Without going the length with M. D'Isjonval of deeming his discoveries important enough to regulate the march of armies, or the sailing of fleets, or of proposing that the first appearance of these barometrical spiders in spring should be announced by the sound of trumpet, I have reason to suppose from my own observations that his statements are in the main accurate, and that a very good idea of the weather may be formed from attending to these insects.

The spiders which form geometrical nets differ from the weavers also with respect to the situation in which they watch for their prey. They do not conceal themselves under their net, but are placed in the centre with their head downwards, and retire to a little apartment formed on one side under some leaf of a plant, only when obliged by danger or the state of the weather. The moment an unfortunate fly or other insect touches the net, the spider rushes towards it, seizes it with her fangs, and if it be a small species at once carries it to her little cell, and, having there at

[t] Brez. *La Flore des Insectophiles*, 129.

leisure sucked its juices, throws out the carcase. If the insect be larger and struggle to escape, with surprising address she envelops it with threads in various directions, until both its wings and legs being effectually fastened, she carries it off to her den. If the captured insect be a bee or a large fly so strong that the spider is sensible it is more than a match for her, she never attempts to seize or even entangle it, but on the contrary assists it to disengage itself, and often breaks off that part of the net to which it hangs, content to be rid of such an unmanageable intruder at any price.—When larger booty is plentiful, these spiders seem not to regard smaller insects. I have observed them in autumn, when their nets were almost covered with the Aphides which filled the air, impatiently pulling them off and dropping them untouched over the sides, as though irritated that their meshes should be occupied with such insignificant game.—A species of spider described by Lister, (*A. conica*,) more provident than its brethren, suspends its prey in the meshes above and below the centre, and it is not uncommon to see its larder thus stored with several flies[u].

You must not infer that the toils of spiders are in every part of the world formed of such fragile materials as those which we are accustomed to see, or that they are every where contented with small insects for their food. An author in the *Philosophical Transactions* asserts, that the spiders of Bermudas spin webs between trees seven and eight fathoms distant, which are

[u] Lister, *Hist. An. Ang.* 32, tit. 4.

strong enough to ensnare a bird as large as a thrush[v]. And Sir G. Staunton informs us, that in the forests of Java, spiders' webs are met with of so strong a texture as to require a sharp cutting instrument to make way through them[w].

Nor must you suppose that all the spiders of this country which catch their prey by means of snares, follow the same plan in constructing them as the weavers and geometricians whose operations I have endeavoured to describe. The form of their snares and the situation in which they place them are so various, that it is impossible to enumerate more than a few of the most remarkable. *Aranea labyrinthica*, L. extends over the blades of grass a large white horizontal net, having at its margin a cylindrical cell, in the bottom of which, secure from birds and defended from the rays of the sun, the spider lies concealed, whence on the slightest movement of her net she rushes out upon her prey. *A. latens*, F., conceals itself under a small net spun upon the upper surface of a leaf, and thence seizes upon any insect that chances to pass over it. *A. 13-guttata*, F., forms under stones and in slight furrows in the ground a net consisting of threads spun without any regularity in all directions; and a similar inartificial snare of simple threads is often spun in windows by *A. bipunctata*, L. and several other species. *A. Senoculata* and its affinities conceal themselves in a long cylindrical straight silken tube, from the mouth of which they stretch out their six anterior feet, whose extremities rest upon as many di-

[v] *Phil. Tr.* 1668, p. 792. [w] *Embassy to China*, i. 343.

verging threads: thus, as soon as an insect walks across any of the threads (which are eight or ten inches long) the insect's toes give it warning of prey being at hand, when it rushes out and seldom fails to secure its victim.

> "The spider's touch how exquisitely fine!
> Feels at each thread, and lives along the line."

M. Homberg tells us that he has seen a vigorous wasp carried off and destroyed by one of these species.

The spiders hitherto adverted to seize their prey by means of webs or nets; but a very large number, though, like the former, they spin silken cocoons for containing their eggs, never employ the same material in constructing similar snares of which they make no use.

These may be separated into two grand divisions; the first comprising those which conceal themselves and lie in ambuscade for their prey, and sometimes run after it to a short distance; the second, those which are constantly roaming about in every direction in search of it, and seize it by open violence. The former Walckenaer, in his admirable work on spiders, has designated by the name of *Vagrants*, the latter by that of *Hunters*; terming those already adverted to which spin webs and nets, *Sedentaries*: if to which you add the *Swimmers*, or those species which catch their prey in the water, you will have an idea of the general manners of the whole race of spiders.

The artifices of that tribe which Walckenaer has named vagrants are various and singular. *A. holose-*

ricea and many other species conceal themselves in a little cell formed of the rolled-up leaf of a plant, and thence dart upon any insect which chances to pass; while *A. atrox* and its affinities select for their place of ambush a hole in a wall, or lurk behind a stone, or in the bark of a tree. *A. calycina* more ingeniously places herself at the bottom of the calyx of a dead flower, and pounces upon the unwary flies that come in search of honey; and *A. arundinacea* buries herself in the thick panicle of a reed, and seizes the luckless visitors enticed to rest upon her silvery concealment. Many of this tribe at times quit their habitations, and by various stratagems contrive to come within reach of their prey, as by pretending to be dead, hiding themselves behind any slight projection, &c. A white species I have often observed squatted in the blossom of the hawthorn or on the flowers of umbelliferous plants, and is thus effectually concealed by the similarity of colour.

Foremost amongst the spiders comprehended by Walckenaer under the general name of hunters, which search after and openly seize their prey, must be enumerated the monstrous *A. avicularia*, at least two inches long, which takes up its abode in the woods of South America, and does not hesitate to attack small birds, which it kills by a gripe of its poisonous fangs and then devours. This species, as well as another tropical one, *A. venatoria*, the European *A. cementaria*, and many others, construct in the ground very singular cylindrical cavities, and therein carry and devour their prey. These, being rather the habitations of insects than snares, I shall describe in a subsequent letter.

A. saccata, the species whose affection for its young I have before detailed, and not a few others of the same family, common in this country, in like manner seize their prey openly, and when caught carry it to little inartificial cavities under stones. *A. fimbriata*, L. hunts along the margins of pools; and *Lycosa piratica* of Walckenaer and its congeners not only chase their prey in the same situation, but, venturing to skate upon the surface of the water itself,

> "Bathe unwet their oily forms, and dwell
> With feet repulsive on the dimpling well."

The Rev. R. Sheppard has often noticed in the fen ditches of Norfolk a very large spider which actually forms a *raft* for the purpose of obtaining its prey with more facility. Keeping its station upon a ball of weeds about three inches in diameter, probably held together by slight silken cords, it is wafted along the surface of the water upon this floating island, which it quits the moment it sees a drowning insect—not, as you may conceive, for the sake of applying to it the process of the Humane Society, but of hastening its exit by a more speedy engine of destruction. The booty thus seized it devours at leisure upon its raft, under which it retires when alarmed by any danger.

The last of the tribe of hunters that it is necessary to particularize, are those which, like the tigers amongst the larger animals, seize their victims by leaping upon them. To this division belongs a very pretty small banded species, *A. scenica*, which in summer may be seen running on every wall.

To Walckenaer's *swimmers*, the last of his grand tribes of spiders, including *Aranea aquatica*, L. &c., the first line of the above quotation from Dr. Darwin is particularly applicable; for these actually seize their food by diving under the water, their bodies being kept unwet by a coating of air which constantly surrounds them.—Thus one single race of insects exemplify in miniature almost all the modes of obtaining food which prevail amongst predaceous quadrupeds—the audacious attacks of the lion; the wily spring of the tiger; the sedentary cunning of the sloth; and the amphibious dexterity of the otter.

This general view of the stratagems by which the spider tribe obtain their food, imperfect as it is, will, I trust, have interested you sufficiently to drive away the associations of disgust with which you, like almost every one else, have probably been accustomed to regard these insects. Instead of considering them as repulsive compounds of cruelty and ferocity, you will henceforward see in their procedures only the ingenious contrivance of patient and industrious hunters, who, while obeying the great law of nature in procuring their sustenance, are actively serviceable to the human race in destroying noxious insects. You will allow the poet to stigmatize them as

> ———" cunning and fierce,
> Mixture abhorred!"

but you will see that these epithets are in reality as unjustly applied to them (at least with reference to the mode in which they procure their necessary subsistence) as to the patient sportsman who lays snares for the birds that are to serve for the dinner of his family; and when you hear

> ———" the fluttering wing
> And shriller sound declare extreme distress,"

you will as little think it the part of true mercy to stretch forth "the helping hospitable hand" to the entrapped fly as to the captive birds. The spider requires his meal as well as the Indian: and, however to our weak capacity the great law of creation "eat or be eaten" may seem cruel or unnecessary, knowing as we do that it is the ordinance of a beneficent Being, who does all things well, and that in fact the sum of happiness is greatly augmented by it, no man who does not let a morbid sensibility get the better of his judgement will, on account of their subjection to this rule, look upon predaceous animals with abhorrence.

One more instance of the stratagems of insects in procuring their prey shall conclude this letter. Other examples might be adduced, but the enumeration would be tedious. This, from an order of insects widely differing from that which includes the race of spiders, is perhaps more curious and interesting than any of those hitherto recited. The insect to which I allude, an inhabitant of the south of Europe, is the larva of a species of *Myrmeleon*, a winged genus in many respects resembling the common dragon-flies, and from its singular manners has obtained the name of the ant-lion. When full grown its length is about half an inch: in shape it has a slight resemblance to a wood-louse, but the outline of the body is more triangular, the anterior part being considerably wider than the posterior: it has six legs, and the mouth is furnished with a forceps consisting of two incurved jaws, which give it a formidable appearance. If we looked only at its external conformation and habits, we should be apt to conclude it one of the most helpless animals in the creation. Its sole food is the juices of other insects, particularly ants, but at the first view it seems impossible that it should ever secure a single meal. Not only is its pace slow, but it can walk in no other direction than *backwards*; you may may judge, therefore, what would be such a hunter's chance of seizing an active ant. Nor would a stationary posture be more favourable; for its grim aspect would infallibly impress upon all wanderers the prudence of keeping at a respectful distance. What then is to become of our poor ant-lion? In its appetite it is a perfect epicure, never, however great may be its hunger, deigning to taste of a carcase unless it has previously had the enjoyment of killing it; and then extracting only the finer juices. In what possible way can it contrive to supply such a succession of delicacies, when its ordinary habits seem to unfit it for obtaining even the coarsest provision? You shall hear. It accomplishes by artifice what all its open efforts would have been unequal to. It digs in loose sand a conical pit, in the bottom of which it conceals itself, and there seizes upon the insects which, chancing to stumble over the margin, are precipitated down the sides to the centre. "How wonderful!" you exclaim: but you will be still more surprised when I have described the whole process by which it excavates its trap, and the ingenious contrivances to which it has recourse.

Its first concern is to find a soil of loose dry sand, in the neighbourhood of which, indeed, its provident mother has previously taken care to place it. This is necessary on two accounts: the prey most acceptable to it abounds there, and no other soil would suit for the construction of its snare. Its next step is to trace in the sand a circle, which, like the furrow with which Romulus marked out the limits of his new city, is to determine the extent of its future abode. This being done, it proceeds to excavate the cavity by throwing out the sand in a mode not less singular than effective. Placing itself in the inside of the circle which it has traced, it thrusts the hind part of its body under the sand, and with one of its fore-legs, that serves as a shovel, it charges its flat and square head with a load, which it immediately throws over the outside of the circle with a jerk strong enough to carry it to the distance of several inches. This little manœuvre is executed with surprising promptitude and address. A gardener does not operate so quickly nor so well with his spade and his foot, as the ant-lion with its head and leg.—Walking backwards, and constantly repeating the process, it soon arrives at the part of the circle from which it set out. It then traces a new one, excavates another furrow in a similar manner, and by a repetition of these operations at length arrives at the bottom of its cavity. One circumstance deserves remark—that it never loads its head with the sand lying on the *outside* of the circle, though it would be as easy to do this with the outward leg, as to remove the sand within the circle by the inner leg. But it knows that it is the sand in the interior of the circle only that is to be excavated, and it therefore constantly uses the leg next the centre. It will readily occur, however, that to use one leg as a shovel exclusively throughout the whole of such a toilsome operation, would be extremely wearisome and painful. For this difficulty our ingenious pioneer has a resource. After finishing the excavation of one circular furrow, it traces the next in an opposite direction; and thus alternately exercises each of its legs without tiring either.

In the course of its labours it frequently meets with small stones: these it places upon its head one by one, and jerks over the margin of the pit. But sometimes, when near the bottom, a pebble presents itself of a size so large that this process is impossible, its head not being sufficiently broad and strong to bear so great a weight, and the height being too considerable to admit of projecting so large a body to the top. A more impatient labourer would despair, but not so our insect. A new plan is adopted. By a manœuvre, not easily described, it lifts the stone upon its back, keeps it in a steady position by an alternate motion of the segments which compose that part; and carefully walking up the ascent with the burthen, deposits it on the outside of the margin. When, as occasionally happens, the stone is round, the labour becomes most difficult and painful. A spectator watching the motions of the ant-lion feels an inexpressible interest in its behalf. He sees it with vast exertion elevate the stone, and begin its arduous retrograde ascent: at every moment the burthen totters to one side or the other: the adroit porter lifts up the segments of its back to balance it, and has already nearly reached the top of the pit, when a stumble or a jolt mocks all its efforts, and the stone tumbles headlong to the bottom. Mortified, but not despairing, the ant-lion returns to the charge; again replaces the stone on its back; again ascends the side, and artfully avails himself, for a road, of the channel formed by the falling stone, against the sides of which he can support his load. This time possibly he succeeds; or it may be, as is often the case, the stone again rolls down. When thus unfortunate, our little Sisyphus has been seen six times patiently to renew his attempt, and was at last, as such heroic resolution deserved, successful. It is only after a series of trials have demonstrated the impossibility of succeeding that our engineer yields to fate, and, quitting his half-excavated pit, begins the formation of another.

When all obstacles are overcome, and the pit is finished, it presents itself as a conical hole about two inches deep, gradually contracting to a point at the bottom, and about three inches wide at the top. The ant-lion now takes its station at the bottom of the pit, and, that its gruff appearance may not scare the passengers which approach its den, covers itself with sand all except the points of its expanded forceps. It is not long before an ant on its travels, fearing no harm, steps upon the margin of the pit, either accidentally or for the purpose of exploring the depth below. Alas! its curiosity is dearly gratified. The faithless sand slides from under its feet; its struggles but hasten its descent; and it is precipitated headlong into the jaws of the concealed devourer. Sometimes, however, it chances that the ant is able to stop itself midway, and with all haste scrambles up again. No sooner does the ant-lion perceive this, (for, being furnished with six eyes on each side of his head, he is sufficiently sharp-sighted,) than, shaking off his inactivity, he hastily shovels loads of sand upon his head, and vigorously throws them up in quick succession upon the escaping insect, which, attacked by such a heavy shower from above, and treading on so unstable a path, is almost inevitably carried to the bottom. The instant his victim is fairly within reach, the ant-lion seizes him between his jaws, which are admirable instruments, at the same time hooked for holding, and hollow furnished with a lateral piston for sucking, and at his leisure extracting all the juices of the body, regales upon formic acid. The dry carcase he subsequently jerks out of his den, that it may not incumber him in his future contests, or betray the "horrid secrets of his prison-house:" and if the sides of the pit have received any damage, he leaves his concealment for awhile to repair it; which having done, he resumes his station.

In this manner in its larva state this insect lives nearly two years, during all which time it receives no food but what has been caught through the artifice above described. Though all living insects are equally acceptable to it, as the winged tribe can easily take flight from its pit should they chance to fall into it, its prey consists chiefly of apterous species, of which ants form by far the largest portion, with occasionally an unwary spider or wood-louse. When the full period of its growth is attained it retires under the sand;

spins with its anus a silken cocoon; remains a chrysalis a few weeks; and then breaks forth a four-winged insect resembling, as before observed, the dragon-fly both in appearance and manners, and preying in like manner on moths, butterflies, and other insects[x].

The *larva* of *Myrmeleon formicarius* is not the only insect which avails itself of a trap for obtaining its prey. A plan in most respects similar is adopted by that of a fly (*Rhagio Vermileo*, F.) in form somewhat resembling the common flesh maggot. This also digs a funnel-shaped cavity in loose earth or sand, but deeper in proportion to its width than that of *M. formicarius*, and excavated not by regular circles, but by throwing out the earth obliquely on all sides. When its trap is finished, it stretches itself near the bottom, remaining stiff and without motion like a piece of wood, and the last segment bent at an angle with the rest so as to form a strong point of support in the struggles which it often necessarily has with vigorous prey. The moment an insect falls into the pitfall, the larva writhes itself round it like a serpent, transfixes it with its mandibles, and sucks its juices at its ease. If the insect escapes, the larva casts above it jets of sand with surprising rapidity[y].

I am, &c.

[x] Reaum. vi. 333-78. Bonnet, ii. 380.

[y] Bonnet, ix. 414.

LETTER XIV.

HABITATIONS OF INSECTS.

In forming an estimate of the civilization and intellectual progress of a newly discovered people, we usually pay attention to their buildings and other proofs of architectural skill. If we find them, like the wretched inhabitants of Van Diemen's Land, without other abodes than natural caverns or miserable penthouses of bark, we at once regard them as the most ignorant and unhumanized of their race. If, like the natives of the South Sea Isles, they have advanced a step further, and enjoy houses formed of timber, thatched with leaves, and furnished with utensils of different kinds, we are inclined to place them considerably higher in the scale. When, as in the case of ancient Mexico, we discover a nation inhabiting towns containing stone houses, regularly disposed into streets, we do not hesitate without other inquiry to decide that it must have been civilized in no ordinary degree. And if it were to chance that some future Park in Africa should stumble upon the ruins of a large city, where, in addition to these proofs of science, every building was constructed on just geometrical and architectural principles; where the materials were so employed as to unite strength with lightness, and a confined site so artfully occupied as to obtain spacious symmetrical apartments, we should eagerly inquire into the history of the inhabitants, and sigh over the remains of a race whose intellectual advances we should infer with certainty were not inferior to our own.

Were we by the same test to estimate the sagacity of the different classes of animals, we should beyond all doubt assign the highest place to insects, which in the construction of their habitations leave all the rest far behind. The nests of birds, from the rook's rude assemblage of sticks to the pensile dwellings of the tailor-bird, wonderful as they doubtless are, are indisputably eclipsed by the structures formed by many insects; and the regular villages of the beaver, by far the most sagacious architect amongst quadrupeds, must yield the palm to a wasp's nest. You will think me here guilty of exaggeration, and that, blinded by my attachment to a favourite pursuit, I am elevating the little objects which I wish to recommend to your study to a rank beyond their just claim. So far, however, am I from being conscious of any such prejudice, that I do not hesitate to go further, and assert that the pyramids of Egypt, as the work of man, are not more wonderful for their size and solidity than are the structures built by some insects.

To describe the most remarkable of these is my present object; and that some method may be observed, I shall in this letter describe the habitations of insects living in a state of solitude, and built each by a single architect; and in a subsequent one, those of insects living in societies built by the united labours of many. The former class may be conveniently subdivided into habitations built by the parent insect, not for its own use, but for the convenience of its future young; and those which are formed by the insect that inhabits them for its own accommodation. To the first I shall now call your attention.

The solitary insects which construct habitations for their future young without any view to their own accommodation, chiefly belong to the order Hymenoptera, and are principally different species of wild bees. Of these the most simple are built by *M. succincta*, *fodiens*, and other species of the first family of the genus *Melitta*, Kirby (*Colletes*, Latr.). The situation which the parent bee chooses, is either the dry earth of a bank, or the vacuities of stone walls cemented with earth instead of mortar. Having excavated a cylinder about two inches in depth, running usually in a horizontal direction, the bee occupies it with three or four cells about half an inch long, and one-sixth broad, shaped like a thimble, the end of one fitting into the mouth of another. The substance of which these cells are formed is two or three layers of a silky membrane, composed of a kind of glue secreted by the animal, resembling gold-beater's leaf, but much finer, and so thin and transparent that the colour of an included object may be seen through them. As soon as one cell is completed, the bee deposits an egg within, and nearly fills it with a paste composed of pollen and honey; which having done, she proceeds to form another cell, storing it in like manner until the whole is finished, when she carefully stops up the mouth of the orifice with earth. Our countryman Grew seems to have found a series of these nests in a singular situation—the middle of the pith of an old elder-branch—in which they were placed lengthwise one after another with a thin boundary between each[z].

Cells composed of a similar membranaceous substance, but placed in a different situation, are constructed by *Apis manicata.* This gay insect does not excavate holes for their reception, but places them in the cavities of old trees, or of any other object that suits its purpose. Sir Thomas Cullum discovered the nest of one in the inside of the lock of a garden-gate, in which I have also since twice found them. It should seem, however, that such situations would be too cold for the grubs without a coating of some non-conducting substance. The parent bee, therefore, after having constructed the cells, laid an egg in each, and filled them with a store of suitable food, plasters them with a covering of vermiform masses, apparently composed of honey and pollen; and having done this, aware, long before Count Rumford's experiments, what materials conduct heat most slowly, she attacks the woolly leaves of *Stachys lanata*, *Agrostemma coronaria*, and similar plants, and with her mandibles industriously scrapes off the wool, which with her fore legs she rolls into a little ball and carries to her nest. This wool she sticks upon the plaster that covers her cells, and thus closely envelops them with a warm coat-

[z] Grew's *Rarities of Gresham Colledge*, 154.

ing of down impervious to every change of temperature[a].

The bee last described may be said to exercise the trade of a clothier. Another numerous family would be more properly compared to carpenters, boring with incredible labour out of the solid wood long cylindrical tubes, and dividing them into various cells. Amongst these, one of the most remarkable is the *Apis violacea*, L. (*Xylocopa*, F.), a large species, a native of Southern Europe, distinguished by beautiful wings of a deep violet colour, and found commonly in gardens, in the upright putrescent espaliers or vine-props of which, and occasionally in the garden seats, doors and window-shutters, she makes her nest. In the beginning of spring, after repeated and careful surveys, she fixes upon a piece of wood suitable for her purpose, and with her strong mandibles begins the process of boring. First proceeding obliquely downwards, she soon points her course in a direction parallel with the sides of the wood, and at length with unwearied exertion forms a cylindrical hole or tunnel not less than twelve or fifteen inches long and half an inch broad. Sometimes, where the diameter will admit of it, three or four of these pipes, nearly parallel with each other, are bored in the same piece. Herculean as this task, which is

[a] *Mon. Ap. Ang.* i. 173. From later observations I am inclined to think that these cells may possibly, as in the case of the humble bee, be in fact formed by the larva previously to becoming a pupa, after having eaten the provision of pollen and honey with which the parent bee had surrounded it. The vermicular shape, however, of the masses with which the cases are surrounded, does not seem easily reconcileable with this supposition, unless they are considered as the excrement of the larva.

the labour of several days, appears, it is but a small part of what our industrious bee cheerfully undertakes. As yet she has completed but the shell of the destined habitation of her offspring; each of which, to the number of ten or twelve, will require a separate and distinct apartment. How, you will ask, is she to form these? With what materials can she construct the floors and ceilings? Why truly God "doth instruct her to discretion and doth teach her." In excavating her tunnel she has detached a large quantity of fibres, which lie on the ground like a heap of saw-dust. This material supplies all her wants. Having deposited an egg at the bottom of the cylinder along with the requisite store of pollen and honey, she next, at the height of about three quarters of an inch, (which is the depth of each cell,) constructs of particles of the saw-dust glued together, and also to the sides of the tunnel, what may be called an annular stage or scaffolding. When this is sufficiently hardened, its interior edge affords support for a second ring of the same materials, and thus the ceiling is gradually formed of these concentric circles, till there remains only a small orifice in its centre, which is also closed with a circular mass of agglutinated particles of saw-dust. When this partition, which serves as the ceiling of the first cell and the flooring of the second, is finished, it is about the thickness of a crown-piece, and exhibits the appearance of as many concentric circles as the animal has made pauses in her labour. One cell being finished, she proceeds to another, which she furnishes and completes in the same manner, and so on until she has divided her whole tunnel into ten or twelve apartments.

Here, if you have followed me in this detail with the interest which I wish it to inspire, a query will suggest itself. It will strike you that such a laborious undertaking as the constructing and furnishing these cells, cannot be the work of one or even of two days. Considering that every cell requires a store of honey and pollen, not to be collected but with long toil, and that a considerable interval must be spent in agglutinating the floors of each, it will be very obvious to you that the last egg in the last cell must be laid many days after the first. We are certain, therefore, that the first egg will become a grub, and consequently a perfect bee, many days before the last. What then becomes of it? you will ask. It is impossible that it should make its escape through eleven superincumbent cells without destroying the immature tenants; and it seems equally impossible that it should remain patiently in confinement below them until they are all disclosed. This dilemma our heaven-taught architect has provided against. With forethought never enough to be admired she has not constructed her tunnel with one opening only, but at the further end has pierced *another* orifice, a kind of back-door, through which the insects produced by the first-laid eggs successively emerge into day. In fact, all the young bees, even the uppermost, go out by this road; for, by an exquisite instinct, each grub, when about to become a pupa, places itself in its cell with its head downwards, and thus is necessitated, when arrived at its last state, to pierce its cell in this direction[b].

[b] Reaum. vi. 39-50.

Ceratina albilabris of Spinola, who has given an interesting account of its manners, (*Prosopis*, F.) forms its cell upon the general plan of the bee just described, but, more economical of labour, chooses a branch of briar or bramble, in the pith of which she excavates a canal about a foot deep and one line, or sometimes more, in diameter, with from eight to twelve cells separated from each other by partitions of particles of pith glued together[c].

Such are the curious habitations of the carpenter bees. Next I shall introduce you to the not less interesting structures of another family which carry on the trade of masons, building their solid houses solely of artificial stone. The first step of the mother bee, *Apis muraria*, Oliv. (*Anthophora*, F.) is to fix upon a proper site for the future mansion of her offspring. For this she usually selects an angle, sheltered by any projection, on the south side of a stone wall. Her next care is to provide materials for the structure. The chief of these is sand, which she carefully selects grain by grain from such as contains some mixture of earth. These grains she glues together with her viscid saliva into masses the size of small shot, and transports by means of her jaws to the site of her castle[d]. With a number of these masses, which are the artificial stone of which her building is to be composed, united by a cement far preferable to ours, she first forms the basis

[c] *Ann. de Mus.* x. 236.

[d] Reaumur plausibly supposes that it has been from observing this bee thus loaded, that the tale mentioned by Aristotle and Pliny, of the hive-bee's ballasting itself with a bit of stone previously to flying home in a high wind, has arisen.

or foundation of the whole. Next she raises the walls of a cell, which is about an inch in length and half an inch broad, and before its orifice is closed in form resembles a thimble. This, after depositing an egg and a supply of honey and pollen, she covers in, and then proceeds to the erection of a second, which she finishes in the same manner, until the whole number, which varies from four to eight, is completed. The vacuities between the cells, which are not placed in any regular order, some being parallel to the wall, others perpendicular to it, and others inclined to it at different angles, this laborious architect fills up with the same material of which the cells are composed, and then bestows upon the whole group a common covering of coarser grains of sand. The form of the whole nest, which when finished is a solid mass of stone so hard as not to be easily penetrated with the blade of a knife, is an irregular oblong of the same colour as the sand, and to a casual observer more resembling a splash of mud than an artificial structure. These bees sometimes are more economical of their labour, and repair old nests, for the possession of which they have very desperate combats. One might have supposed that the inhabitants of a castle so fortified might defy the attacks of every insect marauder. Yet an Ichneumon and a beetle (*Clerus apiarius*, F.) both contrive to introduce their eggs into the cells, and the larvæ proceeding from them devour their inhabitants[e].

Other bees of the same family with that last described, use different materials in the construction of

[e] Reaum. vi. 57-88.

their nests. Some employ fine earth made into a kind of mortar with gluten. Another (*A. cærulescens*, L.), as we learn from De Geer, forms its nest of argillaceous earth mixed with chalk, upon stone walls, and sometimes probably nidificates in chalk-pits. *Apis bicornis* selects the hollows of large stones for the site of its dwelling; while others prefer the holes in wood.

The works thus far described require in general less genius than labour and patience: but it is far otherwise with the nests of the last tribe of artificers amongst wild bees, to which I shall advert—the hangers of tapestry or upholsterers—those which line the holes excavated in the earth for the reception of their young, with an elegant coating of flowers or of leaves. Amongst the most interesting of these is *Apis Papaveris*, (*Megachile*, Latr., *Anthophora*, F.) a species whose manners have been admirably described by Reaumur. This little bee, as though fascinated with the colour most attractive to our eyes, invariably chooses for the hangings of her apartments the most brilliant scarlet, selecting for its material the flowers of the wild poppy, which she dexterously cuts into the proper form. Her first process is to excavate in some pathway a burrow, cylindrical at the entrance but swelled out below, to the depth of about three inches. Having polished the walls of this little apartment, she next flies to a neighbouring field, cuts out oval portions of the flowers of poppies, seizes them between her legs and returns with them to her cell; and though separated from the wrinkled petal of a half-expanded flower, she knows how to straighten their folds, and, if too large, to fit them for her purpose by cutting off the superfluous parts. Beginning at the bottom, she overlays the walls of her mansion with this brilliant tapestry, extending it also on the surface of the ground round the margin of the orifice. The bottom is rendered warm by three or four coats, and the sides have never less than two. The little upholsterer, having completed the hangings of her apartment, next fills it with pollen and honey to the height of about half an inch; then, after committing an egg to it, she wraps over the poppy lining so that even the roof may be of this material: and lastly closes its mouth with a small hillock of earth[f]. What is worthy of remark, is the great depth of the cell compared with the space which the single egg and the accompanying food deposited in it occupy. This is not more than half an inch at the bottom, the remaining two inches and a half being subsequently filled with earth.—When you next favour me with a visit, I can show you the cells of this interesting insect as yet unknown to British entomologists, for which I am indebted to the kindness of M. Latreille, who first scientifically described the species[g].

Apis centuncularis, *A. Willughbiella*, and other species of the same family, like the preceding, cover the walls of their cells with a coating of leaves, but are content with a more sober colour, generally selecting for their hangings the leaves of trees, especially of the rose, whence they have been known by the name of the *leaf-cutter* bees. They differ also from *A. Papaveris* in excavating longer burrows, and filling them with several thimble-shaped cells composed of leaves so

[f] Reaum. vi. 139-148.

[g] Latr. *Hist. Nat. des Fourmis*, 297.

curiously convoluted, that, if we were ignorant in what school they have been taught to construct them, we should never credit their being the work of an insect. Their entertaining history, so long ago as 1670, attracted the attention of our countrymen Ray, Lister, Willughby, and Sir Edward King; but we are indebted for the most complete account of their procedures to Reaumur.

The mother bee first excavates a cylindrical hole eight or ten inches long, in a horizontal direction, either in the ground or in the trunk of a rotten willow tree, or occasionally in other decaying wood. This cavity she fills with six or seven cells wholly composed of portions of leaf, of the shape of a thimble, the convex end of one closely fitting into the open end of another. Her first process is to form the exterior coating, which is composed of three or four pieces of larger dimensions than the rest, and of an oval form. The second coating is formed of portions of equal size, narrow at one end but gradually widening towards the other, where the width equals half the length. One side of these pieces is the serrate margin of the leaf from which it was taken, which, as the pieces are made to lap one over the other, is kept on the outside, and that which has been cut within. The little animal now forms a third coating of similar materials, the middle of which, as the most skilful workman would do in similar circumstances, she places over the margins of those that form the first tribe, thus covering and strengthening the junctures. Repeating the same process, she gives a fourth and sometimes a fifth coating to her nest, taking care, at the closed end or narrow extremity of the cell, to bend the leaves so as to form a convex termination. Having thus finished a cell, her next care is to fill it to within half a line of the orifice, with a rose-coloured conserve composed of honey and pollen, usually collected from the flowers of thistles; and then having deposited her egg, she closes the orifice with three pieces of leaf so exactly circular, that a pair of compasses could not define their margin with more truth; and coinciding so precisely with the walls of the cell, as to be retained in their situation merely by the nicety of their adaptation. After this covering is fitted in, there remains still a concavity which receives the convex end of the succeeding cell; and in this manner the indefatigable little animal proceeds until she has completed the six or seven cells which compose her cylinder.

The process which one of these bees employs in cutting the pieces of leaf that compose her nest is worthy of attention. Nothing can be more expeditious: she is not longer about it than we should be with a pair of scissars. After hovering for some moments over a rose-bush, as if to reconnoitre the ground, the bee alights upon the leaf which she has selected, usually taking her station upon its edge so that the margin passes between her legs. With her strong mandibles she cuts without intermission in a curve line so as to detach a triangular portion. When this hangs by the last fibre, lest its weight should carry her to the ground, she balances her little wings for flight, and the very moment it parts from the leaf flies off with it in triumph; the detached portion remaining bent between her legs in a direction perpendicular to her body[h]. Thus without rule or compasses do these diminutive creatures mete out the materials of their work into portions of an ellipse, into ovals or circles, accurately accommodating the dimensions of the several pieces of each figure to each other. What other architect could carry impressed upon the tablet of his memory the entire idea of the edifice which he has to erect, and, destitute of square or plumb-line, cut out his materials in their exact dimensions without making a single mistake? Yet this is what our little bee invariably does. So far are human art and reason excelled by the teaching of the Almighty!

Other insects besides bees construct habitations of different kinds for their young, as various species of *Sphex*, *Scarabæus*, &c., which deposit their egg in cylindrical excavations that become the abode of the future larva. In the procedures of most of these, nothing worth particularizing occurs, but one species called by Reaumur the mason-wasp, (*Odynerus muraria*, Latr.) referred to in a former letter, works upon so singular a plan, that it would be improper to pass it over in silence, especially as these nests may be found in this country in most sandy banks exposed to the sun. This insect bores a cylindrical cavity from two to three inches deep, in hard sand which its mandibles alone would be scarcely capable of penetrating, were it not provided with a slightly glutinous liquor which it pours out of its mouth, that, like the vinegar with

[h] Reaum. vi. 97-124.

which Hannibal softened the hard Alpine rocks, acts upon the cement of the sand, and renders the separation of the grains easy to the double pickaxe with which our little pioneer is furnished. But the most remarkable circumstance is the mode in which it disposes of the excavated materials. Instead of throwing them at random on a heap, it carefully forms them into little oblong pellets, and arranges them round the entrance of the hole so as to form a circular wall, which, when the excavation is completed, is often not less than two or three inches high. For the greater part of its height this wall is upright, but towards the top it bends into a curve, always however retaining its cylindrical form. The little masses are so attached to each other in this cylinder, as to leave numerous vacuities between them, which gives it the appearance of filagree-work. You will readily divine that the excavated hole is intended for the reception of an egg, but for what purpose the external wall or tunnel is meant is not so apparent. One use, and perhaps the most important, would seem to be to prevent the incursions of the artful Ichneumons, *Chrysidæ*, &c. which are ever on the watch to insinuate their parasitic young into the nests of other insects: the tunnel may render their access to the nest more difficult; they may dread to enter into so long and dark a defile. I have seen however more than once a *Chrysis* come out of these tunnels. That its use is only temporary, is plain from the circumstance that the insect employs the whole fabric, when its egg is laid and store of food procured, in filling up the remaining vacuity of the hole; taking down the pellets, which are very conveniently at hand, and placing them in it until the entrance is filled[i].—Latreille informs us, that a nearly similar tunnel, but composed of grains of earth, is built at the entrance of its cell by a bee of his family of *pioneers*[k].

Under this head, too, may be most conveniently arranged the very singular habitations of the larvæ of the Linnean genus *Cynips*, though they can with no propriety be said to be *constructed* by the mother, who, provided with an instrument as potent as an enchanter's wand, has but to pierce the site of the foundation, and commodious apartments, as if by magic, spring up and surround the germ of her future descendants. I allude to those vegetable excrescencies termed *galls*, some of which resembling beautiful berries and others apples you must have frequently observed on the leaves of the oak, and of which one species, the Aleppo gall, as I have before noticed, is of such importance in the ingenious art "*de peindre la parole et de parler aux yeux*." All these tumours owe their origin to the deposition of an egg in the substance out of which they grow. This egg, too small almost for perception, the parent insect, a little four-winged fly, introduces into a puncture made by her curious spiral sting, and in a few hours it becomes surrounded with a fleshy chamber, which not only serves for shelter and defence but also for food; the future little hermit feeding upon its interior and there undergoing its metamorphosis. Nothing can be more varied than these habitations. Some are of a globular form, a bright red colour, and smooth fleshy consistence, resembling beautiful fruits, for which

[i] Reaum. vi. 251-7.

[k] Latr. *Fourmis*, 419.

indeed, as you have before been told, they are eaten in the Levant: others, beset with spines or clothed with hair, are so much like seed-vessels, that an eminent modern chemist has contended respecting the Aleppo gall, that it is actually a capsule[l]. Some are exactly round; others like little mushrooms; others resemble artichokes; while others again might be taken for flowers: in short, they are of a hundred different forms, and of all sizes from that of a pin's head to that of a walnut. Nor is their situation on the plant less diversified. Some are found upon the leaf itself; others upon the footstalks only; others upon the roots; and others upon the buds[m]. Some of them cause the branches upon which they grow to shoot out into such singular forms, that the plants producing them were esteemed by the old botanists distinct species. Of this kind is the *Rose-willow*, which old Gerard figures and describes as "not only making a gallant shew, but also yeelding a most cooling aire in the heat of summer, being set up in houses for the decking of the same." This willow is nothing more than one of the common species, whose twigs, in consequence of the deposition of the egg of a Cynips in their summits, then shoot out into numerous leaves totally different in shape from the other leaves of the tree, and arranged not much unlike those composing the flower of a rose, adhering to the stem even after the others fall off. Dr. Smith

[l] Aikin's *Dictionary of Chemistry*, i. 455. What have probably been taken by Mr. Aikin for "kernels," in the imperforated nuts, are the cocoons of the inhabitants of these galls in the pupa state, which often extremely resemble the seeds of a capsule, as Reaumur (iii. 429.) has remarked.

[m] Reaum. iii. 417 &c.

mentions a similar *lusus* on the Provence willows, which at first he took for a tufted lichen[n]. From the same cause the twigs of the common wild rose often shoot out into a beautiful tuft of numerous reddish moss-like fibres wholly dissimilar from the leaves of the plant, deemed by the old naturalists a very valuable medical substance, to which they erroneously gave the name of Bedeguar. None of these variations is accidental or common to several of the tribe, but each peculiar to the galls formed by a single and distinct species of *Cynips*.

How the mere insertion of an egg into the substance of a leaf or twig, even if accompanied, as some imagine, by a peculiar fluid, should cause the growth of such singular protuberances around it, philosophers are as little able to explain, as why the insertion of a particle of variolous matter into a child's arm should cover it with pustules of small-pox. In both cases the effects seem to proceed from some action of the foreign substance upon the secreting vessels of the animal or vegetable; but of the nature of this action we know nothing. Thus much is ascertained by the observations of Reaumur and Malpighi—that the production of the gall, which however large attains its full size in a day or two[o], is caused by the egg or some accompanying fluid; not by the larva, which does not appear until the gall is fully formed[p]; that the galls which spring from leaves almost constantly take their origin from nerves[q]; and that the egg, at the same time that it causes the growth of the gall, itself derives nourishment from the

[n] *Introd. to Botany*, 349.
[o] Reaum. iii. 474.
[p] Ibid. 479.
[q] Ibid. 501.

substance that surrounds it, becoming considerably larger before it is hatched than it was when first deposited[r].—When chemically analysed, galls are found to contain only the same principles as the plant from which they spring, but in a more concentrated state.

No productions of nature seem to have puzzled the ancient philosophers more than galls. The commentator on Dioscorides, Mathiolus, who agreeably to the doctrine of those days ascribed their origin to spontaneous generation, gravely informs us that weighty prognostications as to the events of the ensuing year may be deduced from ascertaining whether they contain spiders, worms, or flies. Other philosophers, who knew that except by rare accident no other animals are to be found in galls, besides grubs of different kinds which they rationally conceived to spring from eggs, were chiefly at a loss to account for the conveyance of these eggs into the middle of a substance in which they could find no external orifice. They therefore inferred that they were the eggs of insects deposited in the earth, which had been drawn up by the roots of trees along with the sap, and after passing through different vessels had stopped, some in the leaves, others in the twigs, and had there hatched and produced galls! Redi's solution of the difficulty was even more extraordinary. This philosopher, who had so triumphantly combated the absurdities of spontaneous generation, fell himself into greater. Not having been able to witness the deposition of eggs by the parent flies in the plants that produce galls, he took it for granted

[r] Reaum. iii. 479.

that the grubs which he found within them could not spring from eggs: and he was equally unwilling to admit their origin from spontaneous generation,—an admission which would have been fatal to his own most brilliant discoveries. He therefore cut the knot, by supposing that to the same *vegetative soul* by which fruits and plants are produced, is committed the charge of creating the larvæ found in galls[s]! An instance truly humiliating, how little we can infer from a man's just ideas on one point, that he will not be guilty of the most pitiable absurdity on another!

Though by far the greater part of the vegetable excrescencies termed galls, are caused by insects of the Linnean genus *Cynips*, they do not always originate from this tribe. Some are produced by beetles, as those on the roots of Kedlock (*Sinapis arvensis*), which I have ascertained to be inhabited by the larvæ of *Curculio contractus*, Ent. Brit., and *Cryptorhynchus (Curculio) simplex of* Hoffmansegg; and I have little doubt that the same insects or species allied to them cause the clubbing of the roots of cabbages, and the knob-like galls on turnips called in some places the *Anbury*. It seems to be a beetle of the same family that is figured by Reaumur[t], as causing the galls on the leaves of the lime tree. Others owe their origin to moths, as those resembling a nutmeg which Reaumur received from Cyprus[u]; and others again to two-winged flies, as the woody galls of the thistle caused by *Tephritis* (*Musca*, L.) *Cardui*[v], and the cottony galls found on ground-ivy, wild thyme, &c., as well as a very

[s] *De Insectis*, 233 &c.
[t] Reaum. iii. t. 38. f. 2, 3.
[u] Ibid. iii. 448.
[v] Ibid. 455.

singular one on the juniper resembling a flower, described by De Geer[w], all which are the work of minute *Cecidomyiæ* (*Tipulæ*, L.). Some of these last convert even the flowers of plants into a kind of galls, as *T. Loti* of De Geer[x], which inhabits the blossoms of *Lotus corniculatus*; and one which I have myself observed to render the flowers of *Erysimum Barbarea* like a hop-blossom. A similar monstrous appearance is communicated to the flowers of *Teucrium supinum* by a little field-bug, *Cimex* (*Tingis*) *Teucrii* of Host[y], and to another plant of the same genus by one of the same tribe described by Reaumur[z]. In these two last instances, however, the habitations do not seem strictly entitled to the appellation of galls, as they originate not from the egg, but from the larva, which, in the operation of extracting the sap, in some way imparts a morbid action to the juices, causing the flower to expand unnaturally: and the same remark is applicable to the gall-like swellings formed by many Aphides, as *A. Pistaciæ*, &c., which causes the leaves of different species of *Pistacia* to expand into red finger-like cavities; *A. Pini*, which converts the buds or young shoots of the fir into a very beautiful gall, somewhat resembling a fir-cone, or a pine-apple in miniature; and *A. Bursariæ*, which with its brood inhabits angular utriculi on the leafstalk of the black poplar, numbers of which I observed this year on those trees by the road-side from Hull to Cottingham.—For the most part each gall is inhabited by a single larva; but a few species contain several, as that of *Tephritis Cardui*.

[w] De Geer, vi. 409. [x] Ibid. 421.
[y] Jacquin *Collect.* ii. 255. [z] Reaum. iii. 427.

Having thus described the most remarkable of the habitations constructed by the parent insects for the accommodation of their future young, I proceed to the second kind mentioned, namely, those which are formed by the insect itself for its own use. These may be again subdivided into such as are the work of the insects in their larva state; and such as are formed by perfect insects.

Many larvæ of all orders need no other habitations than the holes which they form in seeking for, or eating, the substances upon which they feed. Of this description are the majority of subterranean larvæ, and those which feed on wood, as the *Bostrichi*, F. which make the curious pinnated labyrinths so often seen under the bark of decaying wood; the *Anobia*, F. which excavate the little circular holes frequently met with in ancient furniture and the wood-work of old houses; and many larvæ of other orders, particularly Lepidoptera. One of these last, the larva of *Bombyx Cossus*, differs from its congeners in fabricating for its residence during winter a habitation of pieces of wood lined with fine silk[a]. Under this division, too, come the singular habitations of the subcutaneous larvæ, so called from the circumstance of their feeding upon the parenchyma included between the upper and under cuticles of the leaves of plants, between which, though the whole leaf is often not thicker than a sheet of writing-paper, they find at once food and lodging. You must have been at some time struck by certain white zigzag or labyrinth-like lines on the leaves of the dandelion, lilac, and numerous other plants: the next time you

[a] Lyonet, *Anat. of Coss.* 9.

meet with one of them, if you hold it up to the light you will perceive that the colour of these lines is owing to the pulpy substance of the leaf having there been removed; and at the further end you will probably remark a dark-coloured speck, which, when carefully extricated from its covering, you will find to be the little miner of the tortuous galleries which you are admiring. Some of these minute larvæ, to which the parenchyma of a leaf is a vast country, requiring several weeks to be traversed by the slow process of mining which they adopt—that of eating the excavated materials as they proceed—are transformed into beetles (*Curculio Thapsus*, &c.); others into flies; and a still greater number into very minute moths of the genus *Tinea*, as *T. Wilkella*, *T. Clerkella*, &c. Many of these last are little miracles of nature, which has lavished on them the most splendid tints tastefully combined with gold, silver and pearl; so that, were they but formed upon a larger scale, they would far eclipse all other animals in richness of decoration.

Another tribe of larvæ, not very numerous, content themselves for their habitations with simple holes, into which they retire occasionally. Many of these are merely cylindrical burrows in the ground, as those formed by the larvæ of field-crickets, Cicindelæ and Ephemeræ. But the larvæ of the very remarkable lepidopterous genus (*Nycterobius* of Mr. MacLeay[b]) before alluded to[c], excavate for themselves dwellings of a more artificial construction; forming cylindrical

[b] In p. 299, this genus is called *Nycterobia* by mistake, Mr. Mac Leay's name being *Nycterobius* as here given.

[c] P. 299, 388.

holes in the trees of New Holland, particularly the different species of *Banksia*, to which they are very destructive, and defending the entrance against the attacks of the Mantes and other carnivorous insects by a sort of trap-door composed of silk interwoven with leaves and pieces of excrement, securely fastened at the upper end, but left loose at the lower for the free passage of the occupant. This abode they regularly quit at sunset, for the purpose of laying in a store of the leaves on which they feed. These they drag by one at a time into their cell until the approach of light, when they retreat precipitately into it, and there remain closely secluded the whole day, enjoying the booty which their nocturnal range has provided. One species lifts up the loose end of its door by its tail, and enters backward, dragging after it a leaf of *Banksia serrata*, which it holds by the footstalk[d].

A third description of larvæ, chiefly of the two lepidopterous genera *Tortrix* and *Tinea*, form into convenient habitations the leaves of the plants on which they feed. Some of these merely connect together with a few silken threads several leaves so as to form an irregular packet, in the centre of which the little hermit lives. Others confine themselves to a single leaf, of which they simply fold one part over the other. A third description form and inhabit a sort of roll, by some species made cylindrical, by others conical, resembling the papers into which grocers put their sugar, and as accurately constructed, only there is an opening left at the smaller extremity for the egress of the

[d] Lewin's *Prodromus Entomology* (sic !) p. 8.

insect in case of need. If you were to see one of these rolls, you would immediately ask by what mechanism it could possibly be made—how an insect without fingers could contrive to bend a leaf into a roll, and to keep it in that form until fastened with the silk which holds it together? The following is the operation. The little caterpillar first fixes a series of silken cables from one side of the leaf to the other. She next pulls at these cables with her feet: and when she has forced the sides to approach, she *fastens* them together with shorter threads of silk. If the insect finds that one of the larger nerves of the leaf is so strong as to resist her efforts, she weakens it by gnawing it here and there half through. What engineer could act more sagaciously? To form one of the conical or horn-shaped rolls, which are not composed of a whole leaf, but of a long triangular portion cut out of the edge, some other manœuvres are requisite. Placing herself upon the leaf, the caterpillar cuts out with her jaws the piece which is to compose her roll. She does not however entirely detach it: it would then want a base. She detaches that part only which is to form the contour of the horn. This portion is a triangular strap, which she rolls as she cuts. When the body of the horn is finished, as it is intended to be fixed upon the leaf in nearly an upright position, it is necessary to elevate it. To effect this she proceeds as we should with an inclined obelisk. She attaches threads or little cables towards the point of the pyramid, and raises it by the weight of her body[e].

[e] Bonnet, ix. 188.

But even a greater degree of dexterity is manifested in fabricating the habitations of the larvæ of some other Tineæ which feed on the leaves of the rose-tree, apple, elm, and oak, on the under side of which they may in summer be often found. These form an oblong cavity in the interior of a leaf by eating the parenchyma between the two membranes composing its upper and under side, which, after having detached them from the surrounding portion, it joins with silk so artfully that the seams are scarcely discoverable even with a lens, so as to compose a case or horn, cylindrical in the middle, its anterior orifice circular, its posterior triangular. Were this dwelling cylindrical in every part, the form of the two pieces that compose it would be very simple; but the different shape of the two ends renders it necessary that each side should have peculiar and dissimilar curvatures; and Reaumur assures us, that these are as complex and difficult to imitate as the contours of the pieces of cloth that compose the back of a coat. Some of this tribe, whose proceedings I had the pleasure of witnessing a short time since upon the alders in the Hull Botanic Garden, more ingenious than their brethren, and willing to save the labour of sewing up two seams in their dwelling, insinuate themselves near the edge of a leaf instead of in its middle. Here they form their excavation, mining into the very crenatures between the two surfaces of the leaf, which, being joined together at the edge, there form one seam of the case, and from their dentated figure give it a very singular appearance, not unlike that of some fishes which have fins upon their backs. The opposite side they are necessarily forced to cut and sew up, but even in this operation they show an ingenuity and contrivance worthy of admiration. The Tineæ, which cut out their suit from the middle of the leaf, wholly detach the two surfaces that compose it before they proceed to join them together, the serrated incisions made by their teeth, which, if they do not cut as fast, in this respect are more effective than any scissars, interlacing each other so as to support the separated portions until they are properly joined. But it is obvious that this process cannot be followed by those Tineæ which cut out their house from the edge of a leaf. If these were to detach the inner side before they had joined the two pieces together, the builder as well as his dwelling would inevitably fall. They therefore, before making any incision, prudently *run* (as a sempstress would call it) loosely together in distant points the two membranes on that side. Then putting out their heads they cut the intermediate portions, carefully avoiding the larger nerves of the leaf; afterwards they sew up the detached sides more closely, and only intersect the nerves when their labour is completed[f].—The habitation made by a Tinea, which lives upon a species of *Astragalus*, is in like manner formed of the epidermis of the leaves, but of several corrugated pieces projecting over each other, so as to resemble the furbelows once in fashion[g].

Other larvæ construct their habitations wholly of silk. Of this description is that of a Tinea, whose abode, except as to the materials which compose it, is formed on the same general plan as that just described,

[f] Reaum. iii. 100-120. [g] Ibid. 145.

and the larva in like manner feeds only on the parenchyma of the leaf. In the beginning of spring if you examine the leaves of your pear-trees, you will scarcely fail to meet with some beset on the under surface with several perpendicular downy russet-coloured projections, about a quarter of an inch high, and not much thicker than a pin, of a cylindrical shape, with a protuberance at the base, and altogether resembling at first sight so many spines growing out of the leaf. You would never suspect that these could be the habitations of insects; yet that they are is certain. Detach one of them, and give it a gentle squeeze, and you will see emerge from the lower end a minute caterpillar with a yellowish body and black head. Examine the place from which you have removed it, and you will perceive a round excavation in the cuticle and parenchyma of the leaf, the size of the end of the tube by which it was concealed. This excavation is the work of the abovementioned caterpillar, which obtains its food by moving its little tent from one part of the leaf to the other, and eating away the space immediately under it. It touches no other part; and when these insects abound, as they often do to the great injury of pear-trees[h], you will perceive every leaf bristled with them, and covered with little withered specks, the vestiges of their former meals. The case in which the caterpillar resides, and which is quite essential to its existence, is composed of silk spun from its mouth almost as soon as it is excluded from the egg. As it increases in size, it enlarges its habitation by slitting it in two, and intro-

[h] Forsyth on *Fruit Trees*, 4to edit. 271.

ducing a strip of new materials. But the most curious circumstance in the history of this little Arab is the mode by which it retains its tent in a perpendicular posture. This it effects partly by attaching silken threads from the protuberance at the base to the surrounding surface of the leaf. But being not merely a mechanician, but a profound natural philosopher well acquainted with the properties of air, it has another resource when any extraordinary violence threatens to overturn its slender turret. It forms a *vacuum* in the protuberance at the base, and this as effectually fastens it to the leaf as if an air-pump had been employed! This vacuum is caused by the insect's retreating on the least alarm up its narrow case, which its body completely fills, and thus leaving the space below free of air. In detaching one of these cases you may easily convince yourself of the fact. If you seize it suddenly while the insect is at the bottom, you will find that it is readily pulled off, the silken cords giving way to a very slight force; but if, proceeding gently, you give the insect time to retreat, the case will be held so closely to the leaf as to require a much stronger effort to loosen it. As if aware that, should the air get admission from below, and thus render a vacuum impracticable, the strongest bulwark of its fortress would be destroyed, our little philosopher carefully avoids gnawing a hole in the leaf, contenting itself with the pasturage afforded by the parenchyma above the lower epidermis; and when the produce of this area is consumed, it gnaws asunder the cords of its tent, and pitches it at a short distance as before. Having attained its full growth, it assumes the pupa state, and after a while issues out of its confinement a small brown moth, with long hind legs, the *Phalæna Tinca Serratella* of Linné [i].

Some larvæ, which form their covering of pure silk, are not content with a single coating, but actually envelop themselves in another, open on one side and very much resembling a cloak; whence Reaumur called them "*Teignes à fourreau à manteau.*" What is very striking in the construction of this cloak, is, that the silk, instead of being woven into one uniform close texture, is formed into numerous transparent scales overwrapping each other, and altogether very much resembling the scales of a fish [j]. One of these I once had the pleasure of discovering.

Various substances besides silk are fabricated into habitations by other larvæ, though usually joined together either with silk or an analogous gummy material. Thus *Tinea Lichenum* forms of pieces of lichen a dwelling resembling one of the turrited *Helices*, many of which I observed in June 1812 on an oak in Barham. The larvæ of another Tinea, which also feeds upon lichens, instead of employing these vegetables in forming its habitation, composes it of grains of stone eroded from the walls of buildings upon which its food is found, and connected by a silken cement. These insects were the subject of a paper in the Memoirs of the French Academy [k], by M. de la Voye, who, from the circumstance of their being found in great abundance on mouldering walls, attributed to them the power of eating stone, and regarded them as the au-

[i] Goeze *Natur. Menschenleben und Vorsehung.* Anderson's *Recreations*, ii. 409. See above p. 16.

[j] Reaum. iii. 206. [k] x. 458.

thors of injuries proceeding solely from the hand of time: for the insects themselves are so minute, and the coating of grains of stone composing their cases is so trifling, that Reaumur observes they could scarcely make any perceptible impression on a wall from which they had procured materials for ages[l].—Another lepidopterous larva, but of a much larger size and different genus, the case of which is preserved in the cabinet of the President of the Linnean Society, who pointed it out to me, employs the spines apparently of some species of *Mimosa*, which are ranged side by side so as to form a very elegant fluted cylinder. A similar arrangement of pieces of small twigs is observable in the habitation of the females[m] of the larvæ of *Bombyx vestita*, F.; while *Tinea Viciella* of the *Wiener Verzeichniss* covers itself with short portions of the stems of grasses placed tranversely, and united by means of silk into a five or six-sided case. The habitation of a third larva of the same family, described and figured by Reaumur, is composed of squarish pieces of the *leaves* of grasss fastened only at one end, and overwrapping each other like the tiles of a house; and that of another noticed by the same author, of portions of the smallest twigs of broom arranged on the same plan[n].

The larvæ of *Clytra longimana* reside in oviform

[l] Reaum. iii. 183.

[m] The larvæ of the males intermix with the pieces of twigs, which are less closely and regularly arranged, bits of dried leaves and other light materials. See the excellent elucidation of the history of this tribe, whose mode of generation is so singular, by Von Scheven, in the *Naturforscher* Stk. xx. 61 &c.

[n] Reaum. iii. 148-9. T. 11. f. 10. 11.

cases apparently of a calcareous or earthy substance, joined by a gummy cement and covered with red hairs, the origin of which Hübner, who first discovered them, could not account for: and from the observations of Amstein and the French translator of Fuessly's *Archives*, it seems probable that the larvæ of all the species of *Clytra*, differing in this respect from all other known Coleoptera, live in moveable cases[o],—a sufficient ground, did not others equally strong exist, for separating this genus from *Cryptocephalus*, whose larvæ are naked.

Wax is the principal substance employed in the habitations of the larvæ occasionally so destructive to bee-hives. These insidious depredators, which are mentioned by Aristotle, tying together with silk grains of wax (which, and not honey, forms their food) construct galleries of a considerable length, and thus concealed from the sight, and protected from the stings of the armed people whom they have attacked, push their mines into the very heart of the fortress, and pursue their robberies in perfect safety[p].

As many of the habitations which I have been describing, fit the body of the insects as close as a coat, they might perhaps with more propriety be called *clothes*. This is certainly the most appropriate designation of the abodes of some species of Tineæ (the clothes' moths), which not only cover themselves with a coat, but employ the very same material in its composition as we do in ours, forming it of wool or hair curiously fitted together. Like us, they are born

[o] Fuessly, *Archiv.* 55.

[p] Reaum. iii. mem. 8.

naked, but not like us helpless at that period: scarcely have they breathed before they begin to clothe themselves; thus contradicting Dr. Paley's assertion, that "the *human* animal is the only one which is naked, and the only one which can clothe itself[q]:" and wisely inattentive to change of fashion, the same suit serves them from their birth to mature age. The shape of their dress is adapted to that of their body—a cylindrical case open at both ends. The stuff of which it is composed is the manufacture of the larva of the Tinea, which incorporates wool or hair artfully cut from our clothes or furniture, with silk drawn from its own mouth, into a warm and thick tissue: and as this would not be soft enough for its tender skin, it also lines the inside of its coat with a layer of pure silk. Since this suit of clothes during the earliest age of the insect accurately fits its body, you will readily conceive that it will frequently require enlarging. This the little occupant accomplishes as dexterously as any tailor. If the case merely requires lengthening, the task is easy. All that is needful is to add a new ring of hair or wool and silk to each end. But to enlarge it in width is not so simple an affair. Yet it sets to work precisely as we should, slitting the case on the two opposite sides, and then adroitly inserting between them two pieces of the requisite size. It does not, however, cut open the case from one end to the other at once: the sides would separate too far asunder, and the insect be left naked. It therefore first cuts each side about half way

[q] *Nat. Theol.* 230.

down, and then after having filled up the fissure proceeds to cut the remaining half: so that, in fact, four enlargements are made, and four separate pieces inserted.—The colour of the habit is always the same as that of the stuff from which it is taken. Thus, if its original colour be blue, and the insect previously to enlarging it be put upon red cloth, the circles at the end and two stripes down the middle will be red. If placed alternately upon cloths of different hues, its dress will be parti-coloured like that of a Harlequin.—The injury occasioned to us by these insects is not confined to the quantity of materials consumed in clothing and feeding themselves. In moving from place to place they seem to be as much incommoded by the long hairs which surround them, as we are by walking amongst high grass; and accordingly, marching scythe in hand, with their teeth they cut out a smooth road, from time to time reposing themselves, and anchoring their little case with small silken cables.

If, as I hope, you are induced to investigate the manners of these insects, you have but to leave an old coat for a few months undisturbed in a dark closet, and you may be pretty certain of meeting with an abundant colony.

Not merely wool or hair, but another substance analogous to one employed in our dress, is adopted for their clothing by other insects. The larva of a fly which lives on the seeds of willows, makes itself a very beautiful case of their cottony down, not only impervious to wet and cold, but serving, if accidentally blown into the water, which from the situation of these trees frequently happens, as a buoyant little barge which is wafted safely to the shore [r].

The habitations which we have hitherto been considering, are formed by larvæ that live on land, but others equally remarkable are constructed by aquatic species.—The larvæ of the various *Phryganeæ*, a tribe of four-winged insects which an ordinary observer would call moths, but which are even of a distinct order [s], not having their wings covered by the scales which adorn the lepidopterous race. If you are desirous of examining the insects to which I am alluding, you have only to place yourself by the side of a clear and shallow pool of water, and you cannot fail to observe at the bottom little oblong moving masses resembling pieces of straw, wood, or even stone. These are the larvæ in question, well known to fishermen by the title of *Caddis-worms*, and which, if you take them out of the water, you will observe to inhabit cases of a very singular construction. Of the larva itself, which somewhat resembles the caterpillars of many Lepidoptera, nothing is to be seen but the head and six legs by means of which it moves itself in the water, and drags after it the case in which the rest of the body is inclosed, and into which on any alarm it wholly retires. The construction of these habitations is very various. Some select four or five pieces of the leaves of grass, which they glue together into a shapely polygonal case; others employ portions of the stems of rushes, placed side by side so as to form

[r] Reaum. iii. 130.

[s] See Kirby in *Linn. Trans.* xi. 88, where it is proposed to call this order *Trichoptera*.

an elegant fluted cylinder; some arrange round them pieces of leaves like a spirally-rolled ribband; others inclose themselves in a mass of the leaves of any aquatic plants united without regularity; and others again form their abode of minute pieces of wood either fresh or decayed[t]. One, like the *Sabellæ*, forms a horn-shaped case composed of grains of sand, so equal in size, and so nicely and regularly gummed together, the sides throughout being of the thickness of one grain only, that the first time I viewed it I could scarcely persuade myself it could be the work of an insect. The case of *P. bimaculata*, which is less artificially constructed of a mixture of mud and sand, is pyriform, and has its end curiously stopped with a plate formed of grains of sand with a central aperture[u]. Other species construct houses which may be called alive, forming them of the shells of various aquatic snails of different kinds and sizes even while inhabited, all of which are immoveably fixed to it, and dragged about at its pleasure—a covering as singular as if a savage, instead of clothing himself with squirrels' skins, should sew together into a coat the animals themselves. However various may be the form of the case externally, within it is usually cylindrical and lined with silk; and though seldom apparently wider than just to admit the body of the insect, some species have the power of turning round in it, and of putting out their head at either end[v]. Some larvæ constantly make their cases of the same materials; others employ indifferently any that are at hand; and the new ones which they construct as they increase in size (for they have not the faculty,

[t] Reaum. iii. 156-9. [u] De Geer, ii. 564. [v] Ibid.

like the larva of the moth, of enlarging them) have often an appearance quite dissimilar to that of the old. Even those that are most careless about the nature of the materials of their house, are however solicitously attentive to one circumstance respecting them, namely, their specific gravity. Not having the power of swimming, but only of walking at the bottom of the water by aid of the six legs attached to the fore part of the body which is usually protruded out of the case, and the insect itself being heavier than water, it is of great importance that its house should be of a specific gravity so nearly that of the element in which it resides, as while walking neither to incommode it by its weight, nor by too great buoyancy; and it is as essential that it should be so equally *ballasted* in every part as to be readily moveable in any position. Under these circumstances our Caddis-worms evince their proficiency in hydrostatics, selecting the most suitable substances; and, if the cell be too heavy, glueing to it a bit of leaf or straw; or, if too light, a shell or piece of gravel. It is from this necessity of regulating the specific gravity, that to the cases formed with the greatest regularity we often see attached an apparently superfluous piece of wood, leaf, or the like.

A larva of one of the aquatic *Tipulidæ* lives in cases somewhat similar to those of some *Phryganeæ*. Several of these of a fusiform shape and brown colour, composed partly of silk and partly perhaps of fragments of leaves, and inhabited by a red larva apparently of a *Chironomus*, were found by Reaumur upon dead leaves in a pool of water in the Bois de Boulogne [w].

[w] Reaum. iii. 179.

In concluding this head I may observe, that here might have been described the various abodes which solitary larvæ prepare for themselves previously to assuming the pupa, and intended for their protection in that defenceless stage of existence; but as I shall have occasion again to refer to them in speaking of the larva state of insects, I shall defer their description to that letter, to which they more strictly belong.

From the next division of the habitations of insects—those formed by solitary *perfect* insects for their own accommodation—I shall select for description only two, both the work of spiders, and alluded to in a former letter, which indeed, with the exception of the inartificial retreats made by the *Achetæ*, *Cicindelæ*, and perhaps a few others, are the only ones properly belonging to it.

The habitation of one of these (*Mygale cæmentaria*, Latr., *Aranea Sauvagesii*, Dorthes) is subterraneous, not a mere shallow cavity, but a tube or gallery upwards of two feet in length and half an inch broad. This, for the size of the insect, vast tunnel it digs by means of its strong jaws in a steep bank of bare clay, so that the rain may readily run off without penetrating to its dwelling. Its next operation is to line the whole from top to bottom with a web of fine silk, which serves the double purpose of preventing the earth that composes the walls from falling in, and, by its connection with the door of the orifice, of giving information to the spider of what is passing above. You doubtless suppose that in saying *door* I am speaking metaphorically. It could never enter into your conception that any animal, much less an insect, could construct any thing really deserving of that name—any thing like our doors, turning upon a hinge, and accurately fitted to the frame of the opening which it is intended to close. Yet such a door, incredible as it may seem, is actually framed by this spider. It does not indeed, like us, compose it of wood, but of several coats of dried earth fastened to each other with silk. When finished, its outline is as perfectly circular as if traced with compasses; the inferior surface is convex and smooth, the superior flat and rough, and so like the adjoining earth as not to be distinguishable from it. This door the ingenious artist fixes to the entrance of her gallery by a hinge of silk, which plays with the greatest freedom, and allows it to be opened and shut with ease · and as if acquainted with the laws of gravity, she invariably fixes the hinge at the *highest* side of the opening, so that the door when pushed up shuts again by its own weight. She has not less sagaciously left a little ledge or groove at the top of the entrance upon which the door closes, and to which it fits with such precision, that it seems to make but one surface with it. Such is the astonishing structure of this little animal's abode; nor is its defence of its subterraneous cavern less surprising. If an observer adroitly insinuates the point of a pin under the edge of the door, and elevates it a little, he immediately perceives a very strong resistance.—What is its cause?—The spider, warned by the vibrations of the threads which extend from the door to the bottom of her gallery, runs with all speed to the door, fastens its legs to it on one side, and on the other to the walls, and turning upon its back, pulls with all its might. Thus the door is shut or opened alternately, as the exertions of the observer or of the spider prevail. It is easy to guess which will in the end conquer; and the spider, when it finds all resistance ineffectual, betakes itself to flight, and retreats. If, to make a further experiment, the observer fastens down the door so that it cannot be forced open, the next morning he will find a new entrance, with a new door formed at a small distance; or, if he take the door entirely away, another will be constructed in less than twelve hours.

The habitation thus singularly formed and defended is not at all used as a snare, but merely as a safe abode for the spider, which hunts its prey at night only; and, when caught, devours it in security at the bottom of its den, which is generally strewed with the remains of coleopterous insects[x].—From some curious observations of M. Dorthes on this species in the second volume of the Linnean Transactions, it appears that both the male and female spider and as many as thirty young ones occasionally inhabit one of these galleries.—*Aranea Sauvagesii* of Rossi, which is a distinct species found in Corsica, forms a similar habitation[y].

The galleries just described are the work of an European species not uncommon in the south of France; but similar ones, on a much larger scale, are fabricated by *Aranea venatoria*, an inhabitant of the West India islands, as well as by many other tropical species. I have seen one of these, which had been dug out of the earth, in the possession of Thomas Hall, Esq. F.L.S.,

[x] Sauvages *Hist. de l'Acad. des Sc. de Paris* 1758, p. 26.

[y] Latr. *Hist. Nat.* vii. 165.

that was nearly a yard in length and above an inch in diameter, forming a cylindrical bag of dark-coloured silk, closed at the bottom, and accurately fitted at the top by a door or lid.

The habitation of *Aranea aquatica*, the other spider to which I alluded, is chiefly remarkable for the element in which it is constructed and the materials that compose it. It is built in the midst of water, and formed in fact of air! Spiders are usually terrestrial, but this is aquatic, or rather amphibious; for though she resides in the midst of water, in which she swims with great celerity, sometimes on her belly but more frequently on her back, and is an admirable diver, she not unfrequently hunts on shore, and, having caught her prey, plunges with it to the bottom of the water. Here it is she forms her singular and unique abode. She would evidently have but a very uncomfortable time were she constantly wet, but this she is sagacious enough to avoid; and by availing herself of some well-known philosophical principles, she constructs for herself an apartment in which, like the mermaids and sea-nymphs of fable, she resides in comfort and security. The following is her process. First she spins loose threads in various directions attached to the leaves of aquatic plants, which may be called the frame-work of her chamber, and over them she spreads a transparent varnish resembling liquid glass, which issues from the middle of her spinners, and which is so elastic that it is capable of great expansion and contraction; and if a hole be made in it, it immediately closes again. Next she spreads over her belly a pellicle of the same material, and ascends to the surface. The precise mode in which she transfers a bubble of air beneath this pellicle is not accurately known; but from an observation made by the ingenious author of the little work from which this account is abstracted, he concludes that she draws the air into her body by the anus, which she presents to the surface of the pool, and then pumps it out from an opening at the base of the belly between the pellicle and that part of the body, the hairs of which keep it extended. Clothed with this aërial mantle, which to the spectator seems formed of resplendent quicksilver, she plunges to the bottom, and, with as much dexterity as a chemist transfers gas with a gas-holder, introduces her bubble of air beneath the roof prepared for its reception. This manœuvre she repeats ten or twelve times, until at length in about a quarter of an hour she has transported as much air as suffices to expand her apartment to its intended extent, and now finds herself in possession of a little aërial edifice, I had almost said an enchanted palace, affording her a commodious and dry retreat in the very midst of the water. Here she reposes unmoved by the storms that agitate the surface of the pool, and devours her prey at ease and in safety. Both sexes form these lodgings. At a particular season of the year the male quits his apartment, approaches that of the female, enters it, and enlarging it by the bubble of air that he carries with him, it becomes a common abode for the happy pair[z].—The spider which forms these singular habitations is one of the largest European species, and in some countries not uncommon in stagnant pools.

I am, &c.

[z] *Memoire pour servir a commencer l'Histoire des Araignees Aquatiques*, 12mo.

LETTER XV.

HABITATIONS OF INSECTS CONTINUED.

The habitations of insects which I shall next proceed to describe, are those formed by the united labour of several individuals.

The societies which thus combine their operations may be divided into two kinds: 1st, those of which the object is simply the conservation of the individuals composing them; and 2dly, those whose object is also the nurture and education of their young. To the last head belong bees, wasps, &c.: to the former the larvæ of some species of moths, whose labours being the most simple I shall first describe.

You cannot fail to have observed in gardens the fruit-trees disfigured, as you would probably think them, with what at first view seem very strong and thick spiders' webs. If you have bestowed upon these webs the slightest attention, you must have likewise remarked that they differ very materially in their construction from those spun by spiders, inclosing on every side an angular space, and being besides filled with caterpillars. These are the larvæ of *Bombyx chrysorrhœa*, and the web which contains them is spun by their united labour for the protection of the common society. As soon as the cluster of eggs deposited by the parent moth is hatched, the young caterpillars, to the number of three or four hundred, commence their operations. At first they content themselves by forming a sort of hammock of the single leaf upon which they find themselves assembled, covering it with a roof composed of a number of silken threads drawn from one edge to the other; and under one or more of these temporary habitations they reside for a few days, until they are become large and strong enough to undertake a more solid and spacious building sufficient to contain the whole society. In constructing this new habitation, they spin a close silken web round the end of two or three adjoining twigs and the leaves attached to them, so as to include the requisite space. They are not curious in giving any particular form to the edifice: sometimes it is flat, often roundish, but always more or less angular. The interior is divided by partitions of silk into several irregular apartments, to each of which there is purposely left an appropriate door. Within these the caterpillars retire at night, or in rainy weather, quitting the nest on fine days, and dispersing themselves over the neighbouring leaves, upon which they feed. Here too they repose during the critical period of the change of their skins. On the approach of winter the whole community shut themselves up in the nest, which, by the addition of repeated layers of silk, has at this time become so thick and strong as to be impervious to the wind and rain. They remain in a state of torpidity during the cold months, but towards the beginning of April are awakened to activity by the genial breath of spring, and begin to feed with greediness upon the young leaves that surround their habitation, which, as they soon greatly increase in size, they find it necessary to enlarge. One might fear that a structure formed of such materials would at this period be sadly damaged by the growth of the young shoots and leaves of the twigs which it incloses; but the inhabitants, as if to guard against such an accident, have gnawed off all the buds within their dwelling, and thus secured themselves from this inconvenience[a].

The nest of the larvæ of another species of moth, the *Bombyx processionea*, unfortunately not a native of this country, to which on account of their singular manners, that will be detailed to you in a subsequent letter, Reaumur has given the title of *processionary* caterpillars, is somewhat different in its construction from that just described, though formed of the same material. As the caterpillars which fabricate it, feed upon the leaves of the oak, it is always found upon this tree, attached not to the branches but the trunk, sometimes at a considerable height from the ground. In shape it resembles an irregular knot or protuberance, and the silk which composes it being of a gray colour, at a distance it would be taken for a mass of lichens. Sometimes this nest is upwards of eighteen inches long, and six broad, rising in the middle about four inches from the surface of the tree. Between the trunk and the silken covering, a single hole is left which serves

[a] Reaum. ii. 128.

for the entrance and exit of the inhabitants. These differ in their manners from those last mentioned. While very young they have no fixed habitation, contenting themselves with a succession of different temporary camps until they have attained two-thirds of their growth. Then it is they unite their labours in spinning the nest just described; and in this they continue to reside in harmony until they become perfect insects, assuming in it even the state of chrysalis[b].

Habitations similar, as to their general structure, to the above, though differing in several minute circumstances, are formed by the larvæ of several other moths, as of *Bombyx phæorrhea* of Curtis, *B. neustria*, &c. as well as those of *Papilio Io*, *P. Cinxia*, and some other butterflies; and even of some *Tenthrediadæ*, which, however, have each a separate silken covering. But as it would be tedious to describe these particularly, I pass on to the habitations formed by insects in their perfect state, which have in view the education of their young as well as self-preservation, describing in succession those of ants, bees, wasps, and *Termites*.

Of these the most simple in their structure are the nests of different kinds of ants, many of which externally present the appearance of hillocks more or less conical, formed of earth or other substances.

The nests of the large red ants (*F. rufa*, L.) which are common in woods, at the first aspect seems a very confused mass. Exteriorly it is a conical mount composed of pieces of straw, fragments of wood, little

[b] Reaum. ii. 179.

stones, leaves, grain; in short, of any portable materials within their reach. But however rude its outward appearance, and the articles of which it consists, interiorly it presents an arrangement admirably calculated at once for a protection against the excessive heat of the sun, and yet to retain a due proportion of genial warmth. It is wholly composed of numerous small apartments of different sizes, communicating with each other by means of galleries and arranged in separate stories, some very deep in the earth, others a considerable height above it; the former for the reception of the young in cold weather and at night, the latter adapted to their use in the day time. In forming these, the ants mix the earth excavated from the bottom of the nest with the other materials of which the mount consists, and thus give solidity to the whole. Besides the avenues which join the apartments together, other galleries varying in dimensions communicate with the outside of the nest at the top of the mount. These open doors would seem ill calculated for precluding the admission of wet or of nocturnal enemies: but the ants alter their dimensions continually according to circumstances; and they wholly close them at night, when all gradually retire to the interior, and a few sentinels only are left to guard the gates. On rainy days, too, they keep them shut, and when the sky is cloudy open them partially[c].

The habitations of these ants are much larger than those of any other species in this country, and sometimes as big as a small haycock; but they are mere

[c] Huber *Recherches sur les Mœurs des Fourmis*, p. 21-29.

molehills when compared with the enormous mounds which other species apparently of the same family, but much larger, construct in warmer climates. Malonet states, that in the forests of Guiana he once saw ant-hills which, though his companion would not suffer him to approach nearer than forty paces for fear of his being devoured, seemed to him to be fifteen or twenty feet high, and thirty or forty in diameter at the base, assuming the form of a pyramid, truncated at one-third of its height[d]: and Stedman, when in Surinam, once passed ant-hills six feet high, and at least one hundred feet in circumference[e].

The nest of *Formica brunnea*, Latr. is composed wholly of earth, and consists of a great number of stories, sometimes not fewer than forty, twenty below the level of the soil, and as many above, which last, following the slope of the ant-hill, are concentric. Each story, separately examined, exhibits cavities in the shape of saloons, narrower apartments, and long galleries which preserve the communication between both. The arched roofs of the most spacious rooms are supported by very thin walls, or occasionally by small pillars and true buttresses; some having only one entrance from above, others a second communicating with the lower story. The main galleries, of which in some places several meet in one large saloon, communicate with other subterranean passages which are often carried to the distance of several feet from the hill.—These insects work chiefly after sunset.—In building their nest they employ soft clay only,

[d] Huber *Recherches sur les Mœurs des Fourmis*, p. 168.

[e] Stedman's *Surinam*, i. 169.

scraped from its bottom when sufficiently moistened by a shower, which, far from injuring, consolidates and strengthens their architecture. Different labourers convey small masses of this ductile material between their mandibles, and with the same instruments they spread and mould it to their will, the antennæ accompanying every movement. They render all firm by pressing the surface lightly with their fore feet: and however numerous the masses of clay composing these walls, and though connected by no glutinous material, they appear when finished one single layer well united, consolidated, and smoothed. Having traced the plan of their structure, by placing here and there the foundations of the pillars and partition-walls, they add successively new portions; and when the walls of a gallery or apartment which are half a line thick are elevated about half an inch in height, they join them by springing a flattish arch or roof from one side to the other. Nothing can be a more interesting spectacle than one of these cities while building. In one place vertical walls form the outline, which communicate with different corridors by openings made in the masonry; in another we see a true saloon whose vaults are supported by numerous pillars; and further on are the cross ways or squares where several streets meet, and whose roofs, though often more than two inches across, the ants are under no difficulty in constructing, beginning the sides of the arch in the angle formed by two walls, and extending them by successive layers of clay till they meet: while crowds of masons arrive from all parts with their particle of mortar, and work with a regularity, harmony, and activity, which can never enough be admired. So assiduous are they in their operations, that they will complete a story with all its saloons, vaulted roofs, partitions and galleries, in seven or eight hours. If they begin a story, and for want of moisture are unable to finish it, they pull down again all the crumbling apartments that are not covered in[f].

Another species of ants (*F. fusca*, L.) are also masons. When they wish to heighten their habitations, they begin by covering the top with a thick layer of clay which they transport from the interior. In this layer they trace out the plan of the new story, first hollowing out little cavities of almost equal depth at different distances from each other, and of a size adapted to their purposes. The elevations of earth left between them serve for bases to the interior walls, which, when they have removed all the loose earth from the floors of the apartments, and reduced the foundations to a due thickness, they heighten, and lastly cover all in. Mr. Huber saw a single working ant make and cover in a gallery which was two or three inches long, and of which the interior was rendered perfectly concave, without assistance[g].

The societies of *F. fuliginosa*, Latr. make their habitations in the trunks of old oaks or willow-trees, gnawing the wood into numberless stories more or less horizontal, the ceilings and floors of which are about five or six lines asunder, black, and as thin as card, sometimes supported by vertical partitions, forming an infinity of apartments which communicate by small apertures;

[f] Huber, *Recherches*, &c. 30-40. [g] Ibid. 45.

at others by small light cylindrical pillars furnished with a base and capital which are arranged in colonnades, leaving a communication perfectly free throughout the whole extent of the story[h].

Two other tribes of carpenter ants (*F. æthiops* and *F. flava*, Latr.) use sawdust in forming their buildings. The former applies this material only to the building of walls and stopping up chinks: the latter composes whole stages or stories of it made into a sort of *papier mâché*, with earth and spiders' web[i].

Some ants form their nests of the leaves of trees. One of these was observed by Sir Joseph Banks in New South Wales, which was formed by glueing together several leaves as large as a hand. To keep these leaves in a proper position, thousands of ants united their strength, and if driven away, the leaves spring back with great violence[j].

THE most profound philosopher, equally with the most incurious of mortals, is struck with astonishment on inspecting the interior of a bee-hive. He beholds a city in miniature. He sees this city divided into regular streets, these streets composed of houses constructed on the most exact geometrical principles and the most symmetrical plan, some serving for storehouses for food, others for the habitations of the citizens, and a few, much more extensive than the rest, destined for the palaces of the sovereign. He perceives that the substance of which the whole city is built, is

[h] Huber *Recherches*, &c. 53. [i] Ibid. 61.
[j] Hawkesworth's *Cook's Voyages*, iii. 223.

one which man, with all his skill, is unable to fabricate; and that the edifices in which it is employed are such, as the most expert artist would find himself incompetent to erect. And the whole is the work of a society of insects! "*Quel abîme* (he exclaims with Bonnet) *aux yeux du sage qu'une ruche d'Abeilles! Quelle sagesse profonde se cache dans cet abime! Quel philosophe osera le fonder!*" Nor have its mysteries yet been fathomed. Philosophers have in all ages devoted their lives to the subject; from Aristomachus of Soli in Cilicia, who, we are told by Pliny, for fifty-eight years attended solely to bees, and Philiscus the Thracian, who spent his whole time in forests investigating their manners, to Swammerdam, Reaumur, Hunter, and Huber of modern times. Still the construction of a bee-hive is a miracle which overwhelms our faculties.

You are probably aware that the hives with which we provide bees are not essential to their labours, and that they can equally form their city in the hollow of a tree or any other cavity. In whatever situation it is placed, the general plan which they follow is the same. You have seen a honey-comb, and must have observed that it is a flattish cake, composed of a vast number of cells, for the most part hexagonal, regularly applied to each other's sides, and arranged in two strata or layers placed end to end. The interior of a bee-hive consists of several of these combs fixed to its upper part and sides, arranged *vertically* at a small distance from each other, so that the cells composing them are placed in a horizontal position, and have their openings in opposite directions—not the best position one would have thought for retaining a fluid like honey, yet the bees find no inconvenience on this score. The distance of the combs from each other is about half an inch, that is, sufficient to allow two bees busied upon the opposite cells to pass each other with facility. Besides these vacancies, which form the high roads of their community, the combs are here and there pierced with holes which serve as posterns for easy communication from one to the other without losing time by going round.

The arrangement of the combs is well adapted for its purpose, but it is the construction of the cells which is most admirable and astonishing. As these are formed of wax, a substance secreted by the bees in no great abundance, it is important that as little as possible of such a precious material should be consumed. Bees, therefore, in the formation of their cells have to solve a problem which would puzzle some geometers, namely, a quantity of wax being given, to form of it similar and equal cells of a determinate capacity, but of the largest size in proportion to the quantity of matter employed, and disposed in such a manner as to occupy in the hive the least possible space. Every part of this problem is practically solved by bees. If their cells had been cylindrical, which form seems best adapted to the shape of a bee, they could not have been applied to each other without leaving numberless superfluous vacuities. If the cells were made square or triangular, this last objection, indeed, would be removed; but besides that a greater quantity of wax would have been required, the shape would have been inconvenient to a cylindrical-bodied animal. All these difficulties are obviated by the adoption of hexagonal cells, which are admirably fitted to the form of the insect, at the same time that their sides apply to each other without the smallest vacant intervals.—Another important saving in materials is gained by making a common base serve for two strata of cells. Much more wax as well as room would have been required, had the combs consisted of a single stratum only. But this is not all. The base of each cell is not an exact plane, but is usually composed of three rhomboidal or lozenge-shaped pieces, placed so as to form a pyramidal concavity. From this form it follows that the base of a cell on one side or stratum of the comb is composed of portions of the bases of *three* cells on the other. You will inquire, Where is the advantage of this arrangement? First, a greater degree of strength; and secondly, precisely the same as results from the hexagonal sides—a greater capacity with less expenditure of wax. Not only has this been indisputably ascertained, but that the angles of the base of the cell are exactly those which require the smallest quantity of wax. It is obvious that these angles might vary infinitely; but by a very accurate admeasurement Maraldi found, that the great angles were in general 109° 28′, the smaller ones 70° 32′. Reaumur ingeniously suspecting that the object of choosing these angles from amongst so many was to spare wax, proposed to M. Kœnig, a skilful geometrician, who was ignorant of Maraldi's experiments, to determine by calculation what ought to be the angles of an hexagonal cell, with a pyramidal bottom formed of three similar and equal rhomboid plates, so that the least matter possible might enter into its construction. For the solution of this problem the geometrician had recourse to the infinitesimal calculus, and found that the great angles of the rhombs should be 109° 26′, and of the small angles 70° 34′[k]. What a surprising agreement between the solution of the problem and the actual measure[l]!

Besides the saving of wax effected by the form of the cells, the bees adopt another economical plan suited to the same end. They compose the bottoms and sides of wax of very great tenuity, not thicker than a sheet of writing-paper. But as walls of this thinness at the entrance would be perpetually injured by the ingress and egress of the workers, they prudently make the margin at the opening of each cell three or four times thicker than the walls. Dr. Barclay has recently discovered that though of such excessive tenuity, the sides

[k] Reaum. v. 390.

[l] Father Boscovisch observes, that all the angles that form the planes which compose the cell are equal, *i. e.* 120°; and he supposes that this equality of inclination facilitates much the construction of the cell, which may be a motive for preferring it, as well as economy. He shows that the bees do not economise the wax necessary for a flat bottom in the construction of every cell, near so much as MM. Kœnig and Reaumur thought.

MacLaurin says, that the difference of a cell with a pyramidal from one with a flat bottom, in which is comprised the economy of the bees, is equal to the fourth part of six triangles, which it would be necessary to add to the trapeziums, the faces of the cell, in order to make them right angles.

M. L'Huillier, professor of Geneva, values the economy of the bees at $\frac{1}{51}$ of the whole expense: and he shows that it might have been one-fifth if the bees had no other circumstances to attend to; but he concludes, that if it is not very sensible in every cell, it may be considerable in the whole of a comb, on account of the mutual setting of the two opposite orders of cells. Huber *Nouvelles Observations, &c.* ii. 34.

and bottom of each cell are actually *double*, or, in other words, that each cell is a distinct, separate, and in some measure an independent structure, agglutinated only to the neighbouring cells, and that when the agglutinating substance is destroyed, each cell may be entirely separated from the rest[m].

You must not imagine that all the cells of a hive are of precisely similar dimensions. As the society consists of three orders of insects differing in size, the cells which are to contain the larvæ of each proportionably differ, those built for the males being considerably larger than those which are intended for the workers. The abode of the larvæ of the queen bee differs still more. It is not only much larger than any of the rest, but of a quite different form, being shaped like a pear or Florence flask, and composed of a material much coarser than common wax, of which above one hundred times as much is used in its construction as of pure wax in that of a common cell. The situation, too, of these cells (for there are generally three or four, and sometimes many more, even up to thirty or forty, in each hive) is very different from that of the common cells. Instead of being in a horizontal they are placed in a vertical direction, with the mouth downwards, and are usually fixed to the lower edge of the combs, from which they irregularly project like stalactites from the roof of a cavern.—The cells destined for the reception of honey and pollen, differ from those which the larvæ of the males and workers inhabit, only by being deeper, and thus more capacious; in fact, the

[m] *Memoirs of the Wernerian Society*, ii. 259.

very same cells are successively applied to both purposes. When the honey is collected in great abundance, and there is not time to construct fresh cells, the bees lengthen the honey-cells by adding a rim to them.

You will be anxious to learn the process which these ingenious artificers follow in constructing their habitations: and on this head I am happy that the recent publication of a new edition of the celebrated Huber's *New Observations on Bees*, in which this subject is for the first time elucidated, will enable me to gratify your curiosity.

But in the first place you must be told of an important and unlooked-for discovery of this unrivalled detector of the hidden mysteries of Nature—that the workers or neuters, as they are called, of a hive consist of two descriptions of individuals, one of which he calls *abeilles nourrices* or *petites abeilles*, the other *abeilles cirieres*.—The former, or *nurse-bees*, are smaller than the latter; their stomach is not capable of such distention; and their office is to build the combs and cells after the foundation has been laid by the *cirieres*; to collect honey; and to feed the larvæ. The *abeilles cirieres* are the makers of wax, which substance Huber has now indisputably ascertained to be secreted, as John Hunter long ago suspected, beneath the ventral segments, from between which it is taken by the bees when wanted, in the form of thin scales. The apparatus in which the wax is secreted consists of four pair of membranous bags or *wax-pockets* situated at the base of each intermediate segment, one on each side, which can only be seen by pressing the abdomen so as to lengthen it, being usually concealed by the overlapping of the preceding segments. It should be observed that this discovery was nearly made by our countryman Thorley, who in his *Female Monarchy* (1744) says that he has taken bees with six pieces of wax within the plaits of the abdomen, three on each side. In these pockets the wax is secreted by some unknown process from the food taken into the stomach, which in the wax-making bees is much larger than in the nurse-bees, and afterwards transpires through the membrane of the wax-pocket in thin laminæ. The nurse-bees, however, do secrete wax, but in very small quantities.—When wax is not wanted in the hive, the wax-makers disgorge their honey into the cells.

The process of building the combs in a bee-hive, as observed by Huber, is as follows:

The wax-makers having taken a due portion of honey or sugar, from either of which wax can be elaborated, suspend themselves to each other, the claws of the fore-legs of the lowermost being attached to those of the hind pair of the uppermost, and form themselves into a cluster, the exterior layer of which looks like a kind of curtain. This cluster consists of a series of festoons or garlands, which cross each other in all directions, and in which most of the bees turn their back upon the observer: the curtain has no other motion than what it receives from the interior layers, the fluctuations of which are communicated to it.—All this time the *nurse-bees* preserve their wonted activity and pursue their usual employments.—The wax-makers remain immoveable for about twenty-four hours, during which period the formation of wax takes place, and thin laminæ of this material may be generally perceived under their abdomen. One of these bees is now seen to detach itself from one of the central garlands of the cluster, to make a way amongst its companions to the middle of the vault or top of the hive, and by turning itself round to form a kind of void, in which it can move itself freely. It then suspends itself to the centre of the space which it has cleared, the diameter of which is about an inch. It next seizes one of the laminæ of wax with a pincer formed by the posterior metatarsus and tibia[n], and drawing it from beneath the abdominal segment, one of the anterior legs takes it with its claws and carries it to the mouth. This leg holds the lamina with its claws vertically, the tongue rolled up serving for a support, and by elevating or depressing it at will, causes the whole of its circumference to be exposed to the action of the mandibles, so that the margin is soon gnawed into pieces, which drop as they are detached into the double cavity, bordered with hairs, of the mandibles. These fragments, pressed by others newly separated, fall on one side of the mouth, and issue from it in the form of a very narrow ribband. They are then presented to the tongue, which impregnates them with a frothy liquor like a *bouillie*. During this operation the tongue assumes all sorts of forms; sometimes it is flattened like a spatula; then like a trowel, which applies itself to the ribband of wax; at other times it resembles a pencil terminating in a point. After having moistened the whole of the ribband, the tongue pushes it so as to make it re-enter the mandibles, but in an opposite direction,

[n] Vide *Mon. Ap. Ang.* t. 12. ** e. 1. neut. fig. 19.

where it is worked up anew. The liquor mixed with the wax communicates to it a whiteness and opacity which it had not before; and the object of this mixture of *bouillie*, which did not escape the observation of Reaumur[p], is doubtless to give it that ductility and tenacity which it possesses in its perfect state.

The foundress-bee, a name which this first beginner of a comb deserves, next applies these prepared parcels of wax against the vault of the hive, disposing them with the point of her mandibles in the direction which she wishes them to take; and she continues these manœuvres until she has employed the whole lamina that she had separated from her body, when she takes a second, proceeding in the same manner. She gives herself no care to compress the molecules of wax which she has heaped together; she is satisfied if they adhere to each other. At length she leaves her work, and is lost in the crowd of her companions. Another succeeds, and resumes the employment; then a third; all follow the same plan of placing their little masses; and if any by chance gives them a contrary direction, another coming removes them to their proper place. The result of all these operations is a mass or little wall of wax with uneven surfaces, five or six lines long, two lines high, and half a line thick, which descends perpendicularly below the vault of the hive. In this first work is no angle nor any trace of the figure of the cells. It is a simple partition in a right line without any inflection.

The wax-makers having thus laid the foundation of

[p] Reaum. v. 424.

a comb, are succeeded by the nurse-bees, which are alone competent to model and perfect the work. The former are the labourers, who convey the stone and mortar; the latter the masons, who work them up into the form which the intended structure requires. One of the nurse-bees now places itself horizontally on the vault of the hive, its head corresponding to the centre of the mass or wall which the wax-makers have left, and which is to form the partition of the comb into two opposite assemblages of cells; and with its mandibles, rapidly moving its head, it moulds in that side of the wall a cavity which is to form the base of one of the cells to the diameter of which it is equal. When it has worked some minutes it departs, and another takes its place, deepening the cavity, heightening its lateral margins by heaping up the wax to right and left by means of its teeth and fore-feet, and giving them a more upright form. More than twenty bees successively employ themselves in this work. When arrived at a certain point, other bees begin on the yet untouched and opposite side of the mass; and commencing the bottom of *two* cells, are in turn relieved by others. While still engaged in this labour, the wax-makers return and add to the mass, augmenting its extent every way, the nurse-bees again continuing their operations.—After having worked the bottoms of the cells of the first row into their proper forms, they polish them and give them their finish, while others begin the outline of a new series.

The cells themselves, or prisms which result from the re-union and meeting of the sides, are next constructed. These are engrafted on the borders of the cavities hollowed in the mass. The bees begin them by making the contour of the bottoms, which at first is unequal, of equal height: thus all the margins of the cells offer an uniformly level surface from their first origin, and until they have acquired their proper length. The sides are heightened in an order analogous to that which the insects follow in finishing the bottoms of the cells; and the length of these tubes is perfectly proportioned that there is no observable inequality between them.—It is to be remarked, that though the general form of the cells is hexagonal, that of those first begun is *pentagonal*, the side next the top of the hive, and by which the comb is attached, being much broader than the rest; whence the comb is more strongly united to the hive than if these cells were of the ordinary shape. It of course follows that the base of these cells, instead of being formed like those of the hexagonal cells of three rhomboids, consists of one rhomboid and two trapeziums.

The form of a new comb is lenticular, its thickness always diminishing towards the edges. This gradation is constantly observable while it keeps enlarging in circumference; but as soon as the bees get sufficient space to lengthen it, it begins to lose this form and to assume parallel surfaces: it has then received the shape which it will always preserve.

The bees appear to give the proper forms to the bottoms of the cells by means of their antennæ, which extraordinary organs they seem to employ as directors by which their other instruments are instructed to execute a very complex work. They do not remove a single particle of wax until the antennæ have explored the surface that is to be sculptured. By the use of these organs, which are so flexible and so readily applied to all parts, however delicate, that they can perform the functions of compasses in measuring very minute objects, they can work in the dark, and raise those wonderful combs the first production of insects.

Every part of the work appears a natural consequence of that which precedes it, so that chance has no share in the admirable results witnessed. The bees cannot depart from their prescribed route, except in consequence of particular circumstances which alter the basis of their labour. The original mass of wax is never augmented but by an uniform quantity; and what is most astonishing, this augmentation is made by the wax-makers, who are the depositaries of the primary matter, and possess not the art of sculpturing the cells.

The bees never begin two masses for combs at the same time; but scarcely are some rows of cells constructed in the first, when two other masses, one on each side of it, are established at equal distances from it and parallel to it, and then again two more exterior to these. The combs are always enlarged and lengthened in a progression proportioned to the priority of their origin; the middle comb being constantly advanced beyond the two adjoining ones by some rows of cells, and they beyond those that are exterior to them. Was it permitted to these insects to lay the foundation of all their combs at the same time, they could not be placed conveniently nor parallel to each other. So with respect to the cells, the first cavity determines the place of all that succeed it.

A large number of bees work at the same time on the same comb; but they are not moved to it by a simultaneous but by a successive impulse. A single bee begins every partial operation, and many others in succession add their efforts to hers, each appearing to act individually in a direction impressed either by the workers who have preceded it, or by the condition in which it finds the work. The whole population of wax-makers is in a state of the most complete inaction till one bee goes forth to lay the foundations of the first comb. Immediately others second her intentions, adding to the height and length of the mass; and when they cease to act, a bee, if the term may be used, of another profession, one of the nurse-bees, goes to form the draught of the first cell, in which she is succeeded by others.

The diameters of the cells intended for the larvæ of workers is always $2\frac{2}{5}$ lines, that of those meant for the larvæ of the males or drones $3\frac{1}{3}$ lines. The male cells are generally in the middle of the combs, or in their sides; never in their upper part. They are never insulated, but form a corresponding group on both sides the comb. When the bees form male cells below those of neuters, they construct many rows of intermediate ones, the diameter of which augments progressively till it attains that of a male cell; and they observe the same method when they revert from male cells to those of neuters. It appears to be the oviposition of the queen which decides the kind of cells that are to be made: while she lays the eggs of workers, no male cells are constructed; but when she is about to lay the eggs of males, the neuters appear to know it and act accordingly.—When there is a very large harvest of honey, the bees increase the diameter and even the length of their cells. At this time many irregular combs may be seen with cells of twelve, fifteen, and even eighteen lines in length. Sometimes also they have occasion to shorten the cells. When they wish to lengthen an old comb, the tubes of which have acquired their full dimensions, they gradually diminish the thickness of its edges, gnawing down the sides of the cells till it assumes the lenticular form: they then engraft a mass of wax round it, and so proceed with new cells.

Variations, as has been already hinted, sometimes take place in the position and even form of the combs. Occasionally the bees construct cells of the common shape upon the wood to which the combs are fixed, without pyramidal bottoms, and from them continue their work as usual. These cells with a flat bottom, or rather with the wood for their bottom, are more irregular than the common ones; some of their orifices are not angular, and their dimensions are not exact, but all are more or less hexagonal. Once when disturbed, Huber observed them to begin their combs on one of the vertical sides of the hive instead of on the roof. When particular circumstances caused it, as, for instance, when glass was introduced, to which they do not like to fix their combs, he remarked that they constantly varied their direction; and by repeating the attempt, he forced them to form their combs in the most fantastic manner. Yet glass is an artificial substance, against which instinct merely cannot have provided them: there is nothing in hollow trees, their natural habitation, resembling it.—When they change the direction of their combs, they enlarge the cells of one side to two or three times the diameter of those of the other, which gives the requisite curve.

To complete the detail of these interesting discoveries of the elder Huber, I must lay before you the following additional observations of his son.

The first base of the combs upon which the bees work holds three or four cells, sometimes more.—The comb continues of the same width for three or four inches, and then begins to widen for three quarters of its length. The bees engaged at the bottom lengthen it downwards; those on the sides widen it to right and left; and those which are employed above the thickest part extend its dimensions upwards. The more a comb is enlarged below, the more it is necessary that it should be enlarged upwards to the top of the hive. The bees that are engaged in lengthening the comb, work with more celerity than those which increase its width; and those that ascend or increase its width upwards, more slowly than the rest. Hence it arises that it is longer than wide, and narrower towards the top than towards the middle.—The first formed cells are usually not so deep as those in the middle; but when the comb is of a certain height, they are in haste to lengthen these cells so essential to the solidity of the whole, sometimes even making them longer than the rest.—The cells are not perfectly horizontal; they are almost always a little higher towards their mouth than at their base, so that their axis is not perpendicular to the partition that separates the two assemblages. They sometimes vary from the horizontal line more than 20°, usually four or five. When the bees enlarge the diameter of the cells preparatory to the formation of male cells, the bottoms often consist of two rhomboids and two hexagons, the size and form of which vary, and they correspond with four instead of three opposite cells.—The works of bees are symmetrical less perhaps in minute details than considered as a whole. Sometimes, indeed, their combs have a fantastic form; but this, if traced, will be found to be caused by circumstances: one irregularity occasions another, and both usually have their origin in the dispositions which we make them adopt. The inconstancy of climate, too, occasions frequent interruptions, and injures the symmetry of the combs; for a work resumed is always less perfect than one followed up until completed.

At first the substance of the cells is of a dead white, semitransparent, soft, and though even not smooth; but in a few days it loses most of these qualities, or rather acquires new ones; a yellow tint spreads over the cells, particularly their interior surface; their edges become thicker, and they have acquired a consistence, which at first they did not possess. The combs also when finished are heavier than the unfinished ones: these last are broken by the slightest touch, whereas the former will bend sooner than break. Their orifices also have something adhesive, and they melt less readily; whence it is evident that the finished combs contain something not present in the unfinished ones. In examining the orifice of the yellow cells, their contour appeared to the younger Huber to be besmeared with a reddish varnish, unctuous, strongscented, and similar to, if not the same as, *propolis*. Sometimes there were red threads in the interior, which were also applied round the sides, rhombs, or trapeziums. This solder, as it may be called, placed at the point of contact of the different parts, and at the summit of the angles formed by their meeting, seemed to give solidity to the cells, round the axis of the longest of which there were sometimes one or two red zones. From subsequent experiments, M. Huber ascertained that this substance was actually *propolis*, collected from the buds of the poplar. He saw them take from the masses of propolis, which they carried with their fore-legs, a thread of this material, which they placed at the angles of the sides, &c., after having planished them. The yellow colour, however, is not given by the propolis, and it is not certain to what it is owing.—The bees sometimes mix wax and propolis and make an amalgam, which they use in rebuilding cells that have been destroyed, in order to strengthen and support the edifice[p].

HUMBLE-BEES are the only tribe besides the hive-bee, that in this part of the world construct nests by the united labour of the society. These, compared with the regular and populous cities of the latter, can but claim the rank of lowly villages. The habitations composing them are of a rude construction, and the streets are arranged with little architectural regularity. The number of inhabitants, too, is small, rarely

[p] *Nouvelles Observations sur les Abeilles, par* François Huber, ii. 101-288. I observed the bees collecting propolis this spring from the buds of *Populus balsamifera*.

exceeding two or three hundred, and often not more than twenty. The nests of some species, as of *Apis lapidaria*, *A. terrestris*, &c. are found under ground at the depth of a foot or more below the surface; but as the internal structure of these does not essentially differ from that of the more singular habitations of *A. muscorum*, and as some of the subterranean species occasionally adopt the same situation, I shall confine my description to the latter.

These nests, which do not exceed six or eight inches in diameter, are generally found in meadows and pastures, and sometimes in hedge-rows where the soil is entangled with roots. The lower half occupies a cavity in the soil, either accidentally found ready made, or excavated with great labour by the bees. The upper part or dome of the nest is composed of a thick felted covering of moss, having the interior ceiling coated with a thin roof of coarse wax for the purpose of keeping out the wet. The entrance is in the lower part, and is generally through a gallery or covered way, sometimes more than a foot in length and half an inch in diameter, by means of which the nest is more effectually concealed from observation. On removing the coping of moss, the interior presents to our view a very different scene from that witnessed in a bee-hive. Instead of numerous vertical combs of wax, we see merely a few irregular horizontal combs placed one above the other, the uppermost resting upon the more elevated parts of the lower, and connected together by small pillars of wax. Each of these combs consists of several groups of pale-yellow oval bodies of three different sizes, those in the middle being the largest, closely joined to each other, and each group connected with those next it by slight joinings of wax. These oval bodies are not, as you might suppose, the work of the old bees, but the silken cocoons spun by the young larvæ. Some are closed at the upper extremity; others, which chiefly occupy the lower combs, have this part open. The former are those which yet include their immature tenants; the latter are the empty cases from which the young bees have escaped. On the surface of the upper comb are seen several masses of wax of a flattened sphæroidal shape, and of very various dimensions; some above an inch and others not a quarter of an inch in diameter; which on being opened are found to include a number of larvæ surrounded with a supply of pollen moistened with honey. These, which are the true cells, are chiefly the work of the female, which after depositing her eggs in them furnishes them with a store of pollen and honey; and, when this is consumed, supplies the larvæ with a daily provision, as has been described in a former letter, until they are sufficiently grown to spin the cocoons before spoken of. Lastly, in all the corners of the combs, and especially in the middle, we observe a considerable number of small goblet-like vessels, filled with honey and pollen, which are not, as in the case of the hive-bee, the fabrication of the workers, but are chiefly the empty cocoons left by the larvæ. It falls to the workers, however, to cut off the fragments of silk from the orifice of the cocoon, which, after giving it a regular circular form, they strengthen by a ring or elevated tube of wax made in a different shape by different species; and to coat them internally with a lining of the same material. They even occasionally construct honey-pots entirely of wax[q].

The most curious circumstance in the construction of these nests, is the mode in which the bees transport the moss employed in forming the roof. When they have discovered a parcel of this material conveniently situated upon the ground, five or six insects place themselves upon it in a file, turning the hinder part of their bodies towards the quarter to which it is meant to be conveyed. The first takes a small portion, and with its jaws and fore-legs as it were felts it together. When the fibres are sufficiently entangled, it pushes them under its body by means of the first pair of legs; the intermediate pair receive the moss, and deliver it to the last, which protrude it as far as possible beyond the anus. When by this process the insect has formed behind it a small ball of well-carded moss, the next bee pushes it to the third, which consigns it in like manner to that behind it; and thus the balls are conveyed to the foot of the nest, and from thence elevated to the summit, much in the same way that a file of labourers transfer a parcel of cheeses from a vessel or cart to a warehouse[r]. It is easy to perceive that a vast saving of time must ensue from this well contrived division of labour; the structure rising much more rapidly than if every individual had been employed first in carding his materials, and then in transferring them to the spot.

WASPS, (*Vespa vulgaris*, L.) though ferocious and

[q] Huber, *Linn. Tr.* vi. 215-298. [r] Reaum. vi. 7-10.

cruel towards their fellow-insects, are civilized and polished in their intercourse with each other, and form a community whose architectural labours will not suffer on comparison even with those of the peaceful inhabitants of a bee-hive. Like these, the great object of their industry is the erection of a structure for their beloved progeny, towards which they discover the greatest tenderness and affection, and they even in like manner construct combs consisting of hexagonal cells for their reception; but the substance which they make use of is very dissimilar to the wax employed by bees, and the general plan of their city differs in many respects from that of a bee-hive.

The common wasp's nest, usually situated in a cavity under ground, is of an oval figure about sixteen or eighteen inches long by twelve or thirteen broad. Externally it is surrounded by a thick coating of numerous leaves of a sort of grayish paper, which do not touch each other, but have a small interval between each, so that, if the rain should chance to penetrate one or two of them, its progress is speedily arrested. On removing this external covering, we perceive that the interior consists of from twelve to fifteen circular combs of different sizes, not ranged vertically as in a bee-hive, but horizontally, so as to form so many distinct and parallel stories. Each comb is composed of a numerous assemblage of hexagonal cells formed of the same paper-like substance as the exterior covering of the nest, and, according to a discovery of Dr. Barclay, each, as in those of bees, a distinct cell, the partition walls being double[a]. These cells,

[a] *Memoirs of the Wernerian Society*, ii. 260.

which, as wasps do not store up any food, serve merely as the habitations of their young, are not, like those of the honey-bee, arranged in two opposite layers, but in one only, their entrance being always downwards: consequently the upper part of the comb, composed of the bases of the cells, which are not pyramidal but slightly convex, forms a nearly level floor, on which the inhabitants can conveniently pass and repass, spaces of about half an inch high being left between each comb. Although the combs are fixed to the sides of the nest, they would not be sufficiently strong without further support. The ingenious builders, therefore, connect each comb to that below it by a number of strong cylindrical columns or pillars, having according to the rules of architecture their base and capital wider than the shaft, and composed of the same paper-like material used in other parts of the nest, but of a more compact substance. The middle combs are connected by a rustic colonnade of from forty to fifty of these pillars; the upper and lower combs by a smaller number.

The cells, which in a populous nest are not fewer than 16,000, are of different sizes, corresponding to that of the three orders of individuals which compose the community; the largest for the grubs of females, the smallest for those of workers. The last always occupy an entire comb, while the cells of the males and females are often intermixed.—Besides openings which are left between the walls of the combs to admit of access from one to the other, there are at the bottom of each nest two holes, by one of which the wasps uniformly enter, and through the other issue from the nest, and thus avoid all confusion or interruption of their common labours. As the nest is often a foot and a half under ground, it is requisite that a covered way should lead to its entrance. This is excavated by the wasps, who are excellent miners, and is often very long and tortuous, forming a beaten road to the subterranean city, well known to the inhabitants though its entrance is concealed from incurious eyes. The cavity itself which contains the nest is either the abandoned habitation of moles or field-mice, or a cavern purposely dug out by the wasps, which exert themselves with such industry as to accomplish the arduous undertaking in a few days.

When the cavity and entrance to it are completed, the next part of the process is to lay the foundations of the city to be included in it, which, contrary to the usual custom of builders, wasps begin at the top, continuing downwards. I have already told you that the coatings which compose the dome are a sort of rough but thin paper, and that the rest of the nest is composed of the same substance variously applied. "Whence," you will inquire, "do the wasps derive it?" They are manufacturers of the article, and prepare it from a material even more singular than any of these which have of late been proposed for this purpose; namely, the fibres of wood[t]. These they detach by means of their jaws from window-frames, posts and rails, &c., and, when they have amassed a heap of the

[t] Reaumur says decaying wood, vi. 182, but White asserts (and my own observations confirm his opinion) that wasps obtain their paper from *sound* timber, hornets, only, from that which is *decayed*. *White's Nat. Hist.* by *Markwick*, ii. 228.

filaments, moisten the whole with a few drops of a viscid glue from their mouth, and, kneading it with their jaws into a sort of paste or *papier maché*, fly off with it to their nest. This ductile mass they attach to that part of the building upon which they are at work, walking backwards and spreading it into laminæ of the requisite thinness by means of their jaws, tongue, and legs. This operation is repeated several times, until at length, by aid of fresh supplies of the material and the combined exertions of so many workmen, the proper number of layers of paper that are to compose the roof are finished. This paper is as thin as that of the letter which you are reading; and you may form an idea of the labour which even the exterior of a wasp's nest requires, on being told that not fewer than fifteen or sixteen sheets of it are usually placed above each other with slight intervening spaces, making the whole upwards of an inch and a half in thickness. When the dome is completed, the uppermost comb is next begun, in which, as well as all the other parts of the building, precisely the same material and the same process, with little variation, are employed. In the structure of the connecting pillars there seems a greater quantity of glue made use of than in the rest of the work, doubtless with the view of giving them a superior solidity.—When the first comb is finished, the continuation of the roof or walls of the building is brought down lower; a new comb is erected; and thus the work successively proceeds until the whole is finished. As a comparatively small proportion of the society is engaged in constructing the nest, its entire completion is the work of several months: yet, though the fruit of such severe labour, it has scarcely been finished a few weeks before winter comes on, when it merely serves for the abode of a few benumbed females, and is entirely abandoned at the approach of spring; wasps never using the same nest for more than one season [u].

The nests of the hornet in their general construction resemble those of the common wasp, but the paper of which they are composed is of a much more rough texture; the columns which support the comb are higher and more massive; and that in the centre larger than the rest.

These last, as well as wasps, conceal their nest, suspending it in the corners of outhouses, &c.; but there are other species which construct their habitations in open day-light, affixing them to the branches of shrubs or trees.

One of these, described by Latreille, the work of *Vespa holsatica*, a species not uncommon with us, resembles in shape a cone of the cedar of Lebanon, and is composed of an envelope and the comb, the former consisting of three partial envelopes, each of the interior of which is longer than the preceding. The comb comprises about thirty hexagonal cells circularly arranged, those of the circumference being lower and smaller [v].

A vespiary somewhat similar to the above, but of a depressed globular figure, and composed of more numerous envelopes, so as to assume a considerable resemblance to a half-expanded Provence rose, is figured

[u] Reaum. vi. Mem. 6. [v] *Annales du Museum d'Hist. Nat.* i. 289.

by Reaumur[w]: and for a very beautiful specimen apparently of the same kind (except that it contains but one stage of cells), which was found in the garden at East-Dale, I am indebted to the kindness of Henry Thomson, esq. of Hull.

Another species (*Vespa Parietum*[x]?) attaches its small group of about twenty inverted crucible-like cells to a piece of wood without any covering[y].

But all these yield in point of singularity of structure to the habitation of *Polistes nidulans*, (*Vespa chartaria*, Oliv.) a native of Cayenne, which constructs its nests of a beautifully polished white and solid pasteboard, impenetrable by the weather. These are in shape somewhat like a bell, often a foot and a half long, and fixed by their upper end to the branch of a tree from which they are securely suspended. Their interior is composed of numerous concave horizontal combs, with the openings of the cells turned downwards, fastened to the sides without any pillars, and having a hole through each to admit of access to the uppermost[z].

I close my account of the habitations of insects with the description of those constructed by the *Termites*, a tribe alluded to in former letters.

The different species, which are numerous, build nests of very various forms. Some (*T. atrox* and *mordax*, Sm.) construct upon the ground a cylindrical turret of clay about three quarters of a yard high, surrounded by a projecting conical roof, so as in shape

[w] vi. t. 19. f. i. 2.
[x] Rosel Vesp. t. 7. f. 8.
[y] Rosel II. viii. 30.
[z] Reaum. vi. 224.

considerably to resemble a mushroom, and composed interiorly of innumerable cells of various figures and dimensions. Others, as *T. Destructor*, F. (*T. Arborum*, Sm.) prefer a more elevated site, and build their nests, which are of different sizes, from that of a hat to that of a sugar-cask, and composed of pieces of wood glued together, amongst the branches of trees, often seventy or eighty feet high. But by far the most curious habitations, and to which, therefore, I shall confine a minute description, are those formed by the *Termes fatalis* (*T. bellicosus*, Sm.), a species very common in Guinea and other parts of the coast of Africa, of whose proceedings we have a very particular and interesting account in the 71st volume of the *Philosophical Transactions*, from the pen of Mr. Smeathman.

These nests are formed entirely of clay, and are generally twelve feet high and broad in proportion, so that when a cluster of them, as is often the case, are placed together, they may be taken for an Indian village, and are in fact sometimes larger than the huts which the natives inhabit. The first process in the erection of these singular structures, is the elevation of two or three turrets of clay about a foot high, and in shape like a sugar-loaf. These, which seem to be the scaffolds of the future building, rapidly increase in number and height, until at length being widened at the base, joined at the top into one dome, and consolidated all round into a thick wall of clay, they form a building of the size above mentioned, and of the shape of a hay-cock, which when clothed, as it generally soon becomes, with a coating of grass, it at a distance very much resembles. When the building has assumed this its final form, the inner turrets, all but the tops, which project like pinnacles from different parts of it, are removed, and the clay employed over again in other services.

It is the lower part alone of the building that is occupied by the inhabitants. The upper portion or dome, which is very strong and solid, is left empty, serving principally as a defence from the vicissitudes of the weather and the attacks of natural or accidental enemies, and to keep up in the lower part a genial warmth and moisture necessary to the hatching of the eggs and cherishing of the young ones. The inhabited portion is occupied by the *royal chamber*, or habitation of the king and queen; the *nurseries* for the young; the *store-houses* for food; and innumerable galleries, passages, and empty rooms:—arranged according to the following plan.

In the centre of the building, just under the apex, and nearly on a level with the surface of the ground, is placed the royal chamber, an arched vault of a semi-oval shape, or not unlike a long oven; at first not above an inch long, but enlarged as the queen increases in bulk to the length of eight inches or more. In this apartment the king and queen constantly reside; and from the smallness of the entrances, which are barely large enough to admit their more diminutive subjects, can never possibly come out; thus, like many human potentates, purchasing their sovereignty at the dear rate of the sacrifice of liberty. Immediately adjoining the royal chamber, and surrounding it on all sides to the extent of a foot or more, are placed what Mr. Smeathman calls the *royal apartments*, an inextricable labyrinth of innumerable arched rooms of different shapes and sizes, either opening into each other or communicating by common passages, and intended for the accommodation of the soldiers and attendants, of whom many thousands are always in waiting on their royal master and mistress. Next to the royal apartments come the *nurseries* and the *magazines*. The former are invariably occupied by the eggs and young ones, and in the infant state of the nest are placed close to the royal chamber; but when the queen's augmented size requires a larger apartment, as well as additional rooms for the increased number of attendants wanted to remove her eggs, the small nurseries are taken to pieces, rebuilt at a greater distance a size bigger, and their number increased at the same time. In substance they differ from all the other apartments, being formed of particles of wood apparently joined together with gums. A collection of these compact, irregular, and small wooden chambers, not one of which is half an inch in width, is inclosed in a common chamber of clay sometimes as big as a child's head.—Intermixed with the nurseries lie the magazines, which are chambers of clay always well stored with provisions, consisting of particles of wood, gums, and the inspissated juices of plants.

These magazines and nurseries, separated by small empty chambers and galleries, which run round them or communicate from one to the other, are continued on all sides to the outer wall of the building, and reach up within it two-thirds or three-fourths of its height. They do not, however, fill up the whole of the lower part of the hill, but are confined to the sides, leaving an open area in the middle, under the dome, very much resembling the nave of an old cathedral, having its roof supported by three or four very large Gothic arches, of which those in the middle of the area are sometimes two and three feet high, but as they recede on each side rapidly diminish like the arches of aisles in perspective. A flattish roof, imperforated in order to keep out the wet, if the dome should chance to be injured, covers the top of the assemblage of chambers, nurseries, &c.; and the area, which is a short height above the royal chamber, has a flattish floor also water-proof, and so contrived as to let any rain that may chance to get in, run off into the subterraneous passages.

These passages or galleries, which are of an astonishing size, some being above a foot in diameter and perfectly cylindrical, lined with the same kind of clay of which the hill is composed, served originally, like the catacombs of Paris, as the quarries whence the materials of the building were derived, and afterwards as the grand outlets by which the Termites carry on their depredations at a distance from their habitations. They run in a sloping direction under the bottom of the hill to the depth of three or four feet, and then branching out horizontally on every side, are carried under ground, near to the surface, to a vast distance. At their entrance into the interior they communicate with other smaller galleries, which ascend the inside of the outer shell in a spiral manner, and, winding round the whole building to the top, intersect each other at different heights, opening either immediately into the dome in various places, and into the lower half of the building, or communicating with every part of it by other smaller circular or oval galleries of different diameters. The necessity for the vast size of the main underground galleries evidently arises from the circumstance of their being the great thoroughfares for the inhabitants, by which they fetch their clay, wood, water, or provision; and their spiral and gradual ascent is requisite for the easy access of the Termites, which cannot but with great difficulty ascend a perpendicular. To avoid this inconvenience in the interior vertical parts of the building, a flat path-way, half an inch wide, is often made to wind gradually, like a road cut out of the side of a mountain, by which they travel with great facility up ascents otherwise impracticable. The same ingenious propensity to shorten their labour seems to have given birth to a contrivance still more extraordinary. This is a kind of bridge of one vast arch, sprung from the floor of the area to the upper apartments at the side of the building, which answers the purpose of a flight of stairs, and must shorten the distance exceedingly in transporting eggs from the royal chambers to the upper nurseries, which in some hills would be four or five feet in the straightest line, and much more if carried through all the winding passages which lead through the inner chambers and apartments. Mr. Smeathman measured one of these bridges, which was half an inch broad, a quarter of an inch thick, and ten inches long, making the side of an elliptic arch of proportionable size, so that it is wonderful it did not fall over or break by its own weight before they got it joined to the side of the column above. It was strengthened by a small arch at the bottom, and had a hollow or groove all the length of the upper surface, either made purposely for the greater safety of the passengers, or else worn by frequent treading. It is not the least surprising circumstance attending this bridge, the Gothic arches before spoken of, and in general all the arches of the various galleries and apartments, that, as Mr. Smeathman saw every reason for believing, the Termites *project* their arches, and do not, as one would have supposed, excavate them.

Consider what incredible labour and diligence, accompanied by the most unremitting activity and the most unwearied celerity of movement, must be necessary to enable these creatures to accomplish, their size considered, these truly gigantic works. That such diminutive insects, for they are scarcely the fourth of an inch in length, however numerous, should, in the space of three or four years, be able to erect a building twelve feet high and of a proportionable bulk, covered by a vast dome, adorned without by numerous pinnacles and turrets, and sheltering under its ample arch myriads of vaulted apartments of various dimensions, and constructed of different materials—that they should moreover excavate, in different directions and at different depths, innumerable subterranean roads or tunnels, some twelve or thirteen inches in diameter, or throw an arch of stone over other roads leading from the metropolis into the adjoining country to the distance of several hundred feet—that they should project and finish the, for them, vast interior stair-cases or bridges lately described—and, finally, that the millions necessary to execute such Herculean labours, perpetually passing to and fro, should never interrupt or interfere with each other, is a miracle of Nature, or rather of the Author of nature, far exceeding the most boasted works and structures of man: for, did these creatures equal him in size, retaining their usual instincts and activity, their buildings would soar to the astonishing height of more than half a mile, and their tunnels would expand to a magnificent cylinder of more than three hundred feet in diameter; before which the pyramids of Egypt and the aqueducts of Rome would lose all their celebrity, and dwindle into nothings[a]. So that when in the commencement of my last letter I promised to introduce you to insects whose labours produced edifices more astonishing than those of the mightiest Egyptian monarchs, the pyramids, my promise, whatever you then thought of it, was the reverse of hyperbolical.

I am, &c.

[a] The most elevated of the pyramids of Egypt is not more than 600 feet high, which, setting the average height of man at only five feet, is not more than 120 times the height of the workmen employed. Whereas the nests of the Termites being at least twelve feet high, and the insects themselves not exceeding a quarter of an inch in stature, their edifice is upwards of 500 times the height of the builders; which, supposing them of human dimensions, would be more than half a mile. The shaft of the Roman aqueducts was lofty enough to permit a man on horseback to travel in them.

END OF THE FIRST VOLUME.

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EXPLANATION OF THE PLATES.

PLATE I.

Coleoptera.

Fig. 1. Calosoma Sycophanta.
2. Staphylinus cyaneus.
3. Siagonium quadricorne, Nov. Gen. *K.*
4. Malthinus.
5. Molorchus.
6. Meloe.

Dermaptera.

7. Forficula gigantea.

PLATE II.

Strepsiptera.

Fig. 1. Xenos Peckii. *Linn. Trans.*

Orthoptera.

2. Acheta Gryllotalpa.
3. Blatta germanica.

Hemiptera.

4. Ledra aurita
5. Cimex rufipes.

PLATE III.

Lepidoptera.

Fig. 1. Papilio dispar femina?
2. Sesia oestriformis.
3. Bombyx pulchella.

Trichoptera.

4. Phryganea varia?

Neuroptera.

5. Libellula cancellata.
6. Raphidia notata.

ERRATA.

Page.	Line.	
45	31	*for* for that *read* of that.
51	2	*for* continue *read* contrive.
64	5	*for* a butterfly *read* the butterfly.
122	ult.	*for* humour *read* tumour.
170	note [t]	and 206 antepenult. *for* Cecidomya *read* Cecidomyia.
255	16	*for* Amarophila *read* Ammophila.
256	16	*for* those *read* three
285	11	*for* androæsmifolium *read* androsæmifolium
299	23	*for* Nycterobia *read* Nycterobius.
313		note [*] *for* שנח *read* שנה.
319	9	*for* retains *read* retain.
	10	*for* mixes *read* mix.
395		note 3, *after* t *insert* 7.
408	5	*for* this *read* the.
440	29	*for* tribe *read* tube.
445	23	*for* then shoot out *read* there &c.
449	20	dele &c.
463	6	*After* species *dele* the period, and *for* The *read* the
474	27	*for* nests *read* nest.
490	8	*after* tubes is *insert* so.
503	12	*for* are *read* is.

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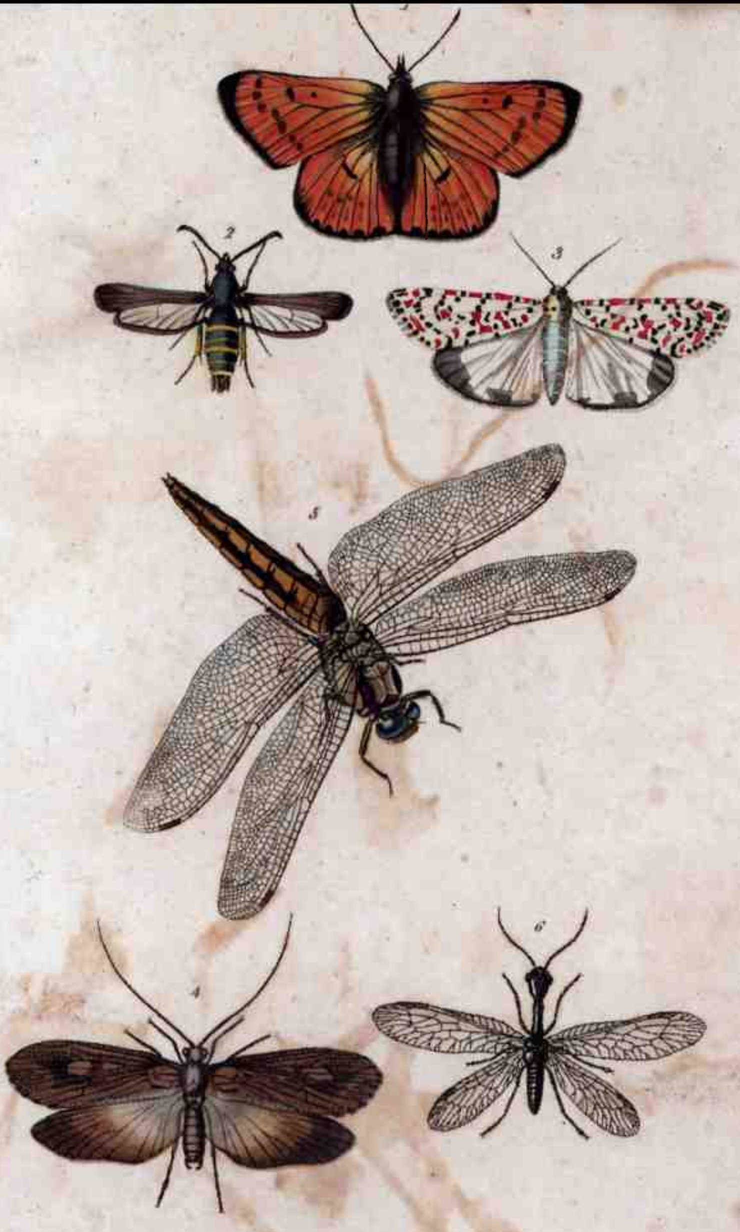

J. Curtis del. et sculp.

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