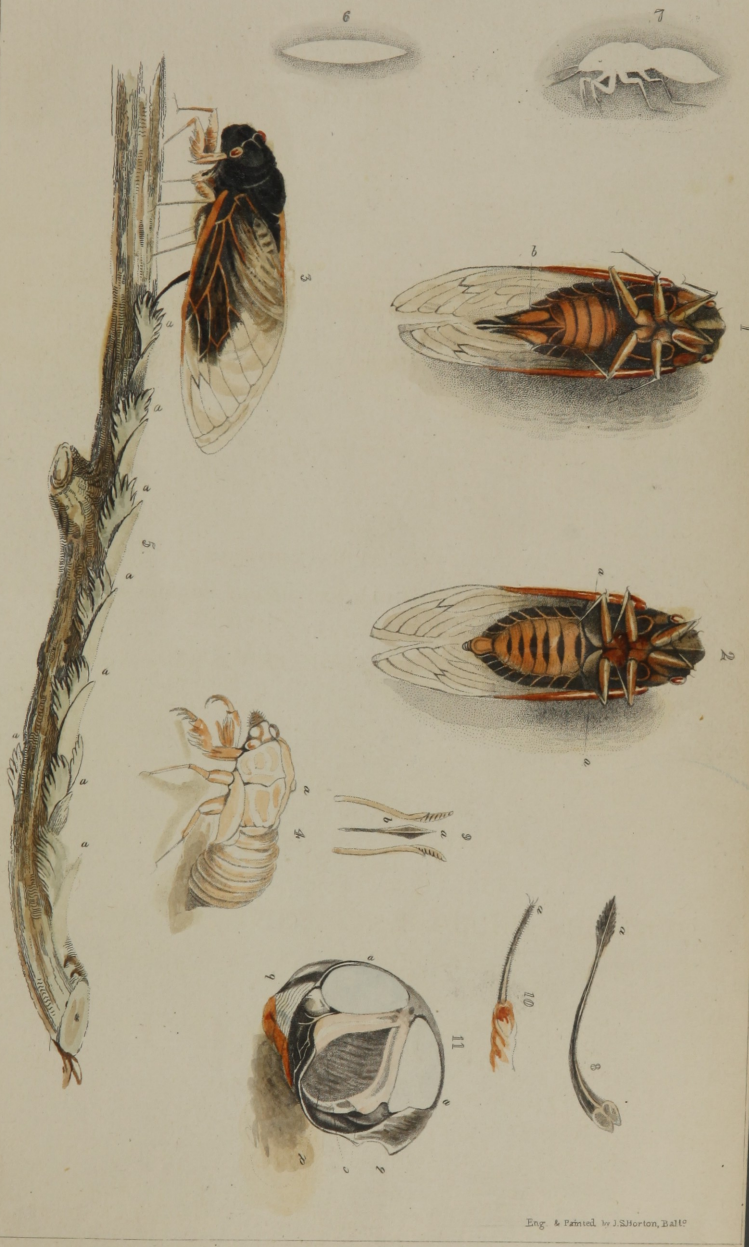
Potter (Kath L.)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Eng. & Printed by J.S.Horton, Bath.

NOTES

ON THE

LOCUSTA

SEPTENTRIONALIS AMERICANÆ DECEM SEPTIMA.

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"Still the green soil with joyful, living things
Swarms: the wide air is full of joyous wings,
And myriads still are happy in their sleep."

BRYANT.

BALTIMORE:
PRINTED BY J. ROBINSON.

1839.

EXPLANATION OF THE PLATE.

Figure 1. Female of the natural size. *b*, The *ovipositor*.
Fig. 2. Male of the natural size. *a, a,* Scales covering the membranes of the large cavities
Fig. 3. *Side view* of the natural size.
Fig. 4. Shell of the pupa, as left by the perfect insect adhering to trees, &c. *a,* The opening in the back through which the insect escaped.
Fig. 5. A section of the Mock Orange limb, (Philadelphus coronasius,) with the excavations made by the female (*a, a, a, a, a, a,*) ; *b,* a part of the wood cut away so show the situation of the eggs.
Fig. 6. An egg magnified 1000 times.
Fig. 7. A young insect just from the egg, magnified 1000 times.
Fig. 8. Ovipositor, magnified 10 times, to show the saw teeth of the edges, (*a,*) and rasps of the blade.
Fig. 9. Parts of the ovipositor separated and magnified, showing the form of the saws and rasps, (*a,*) and of the oviduct, *b*.
Fig. 10. The Rostrum or Snout magnified, to show the capillaries, (*a,*) slightly protruded.
Fig. 11. A section of the chest of the male at the upper ring, showing the internal structure, and the external musical membranes, or drums. *a, a,* The posterior walls of the large cavities within the chest, being white silky membranes. *b, b,* The external musical membranes or drums. *c,* Two bundles of muscular fibres, connected together at the top, and to the sides of the chest at the bottom of each. *d,* The cavity of the chest, spanned by the two bundles of muscular fibres.

ERRATA.

Page 1. For Mosse, read *Moses*.
" 12. For of fasciculi, read *of the fascicule*.
" 17. For hybirnating, read *hybernating*.
" 22. For Thycides, read *Thyoides*.
" 24. For grass, read *gross*.

NOTES, &c.

The title of the following disquisition admonishes the reader, that he is not to expect a perfect analysis of a subject environed by so many difficulties, and that we cannot avoid some obscurity, and much repetition. The irregularity and promiscuous character of our notes, observations and experiments, will render it still more difficult to observe a lucid order.

As we are not the first who have essayed this difficult problem, a due respect for our predecessors requires us to notice their impressions.

The first account we have found, is from the state of Massachusetts, where every thing remarkable or interesting has been recorded for the benefit of the past, present and time to come. It is to be found in a work entitled New England's Memorial, written by Nathaniel Moreton, in 1669. He witnessed an ascension of the locust in 1663. He says very little of its character, but mentions an ancient tradition of the native Indians, which associated the ascension with the appearance of pestilential diseases. Both reason and experience shew that there can be no natural connexion between two occurrences, that must either be the offspring of imagination or accidental coincidence.

The next in chronological order is to be found in a memorandum, left by the Reverend Andrew Sandel, Rector of the Sweedish Congregation, at Philadelphia, dated 1715. He scarcely alludes to the character of the insect, but states a fact known to all countries where the larger varieties of the cicadæ or locusts are known—that the natives use them as an article of diet. Doctor Pocock, and other travellers through Ægypt, mention the Gryllus Migratorius as a common article of consumption.

In Dosley's Annual Register for 1767, we have a more particular account by that excellent naturalist, Mosse Bartram, of Penn-

sylvania, in a letter addressed to Peter Collinson, Esq. of London. He gave a good account of the rise and progress, both as to habits and appearance, and only wanted the use of the microscope to have accomplished much more.

In the 10th volume of Silliman's Journal of Science and Arts, we have a contribution by Doctor S. P. Hildreth, of Marietta, dated 1829. It contains many useful facts and reflections, that have been corroborated by our observations and experiments; and if he had called to his aid the power of good glasses, he would have been led to important results.

In 1834, the date of the most material of our observations, James R. Williams, of this city, instituted an inquiry, and if he had been permitted to devote time enough to the pursuit, would have far surpassed his predecessors, as he availed himself of the use of the microscope, and discovered something of the anatomical character we afterwards demonstrated.

It would be useless to enumerate all the fugitive papers scattered through the ephemeral publications of the last and present century, as they contain nothing for which we have not credited those we have mentioned.

During the ascension of 1817, we entered into the investigation with all the enthusiasm it could inspire, and contemplated it in every aspect we could place it. When the time for observation had nearly expired, we were mortified to find that we were not much nearer a definite conclusion than we were in 1783, when the subject first attracted our attention. We now perceived the cause of our failure, and determined that, should there occur another ascension in our time, to avail ourselves of the power of magnifiers, and prosecute the inquiry under more favourable auspices.

As our professional avocations would not permit us to devote our whole time to the pursuit, it became necessary to call in the aid of a colleague whose knowledge of entomology, and industry could be relied on. These qualifications were found and well exemplified in Mr. Gideon B. Smith. Should our labours reflect any light on so obscure a subject, the credit is equally due to him.

As we have adopted the old Roman name *locusta*, and rejected the modern word *cicada*, it behoves us to assign our reasons for dissenting from modern naturalists. It must have occurred to the votaries of natural history, that they are often met by too great a propensity to generalise, and therefore to crowd incongruous articles into the same genus. While it seems to promote order and facilitate study, it sometimes operates at the expense of accuracy, leaving some varieties undefined or imperfectly described. If we are not deceived, the sequel will show that this remark applies emphatically to the locust. Although it is exclusively an *American insect*, it has been identified with a species of another genus that belongs to the *Eastern* and *Southern* continents. It has been unnaturally forced into the genus *Gryllus*, and thus associated with the numerous varieties of the *cicadæ*, to which it bears some analogies, while many of its principal characteristics are at variance with the whole tribe. It will therefore appear, upon a further investigation, that foreign naturalists, (who knew it only by tradition) have conceived a very imperfect conception of its true character.

An inquiry into its anatomy and physiology will shew, that we cannot run a parallel through the two genera, nor identify the locust with any one variety of either.

The genus *Gryllus* belongs to the *fifth class of animals, called Insecta.* It comprehends *those that breathe through lateral spiracles, and whose skins are bony, and covered with hair. They belong to the second order, Hemiptera, with semi-crustaceous wings, and snout inflected. The antennæ are cetaceous and bristle shaped, with legs formed for leaping.* This definition embraces the whole tribe of cicadæ, which consists of *grasshoppers*, *treehoppers* and *crickets;* and it is very natural (from a mere prima facie resemblance,) that naturalists should have coupled them together. Hence Linnæus denominated the American locust, *Cicada Septemdecima;* but Fabricius, sensible of some discrepancy he has not explained, proposed a *subgenus*, which he denominated *Tettigonia.* This only evades the difficulty, as it is the substitution of a Greek for a Latin

substantive; the word Τεττιξ being synonymous with cicada. Those great masters have been imitated by all their successors, and have taken the *Gryllus Migratorius*, the great architype of the *cicadæ*, as their pattern. This great monarch of the genus has given the law to all others, not only to his own subjects, but the whole science of entomology, where the faintest similitude can be found. In common parlance and scientific writings, we find the same error. His history presents a melancholy retrospect of national waste, and his return is held up in terror to the Eastern and Southern continents. His flights are marked through states and empires, by his devastations of the *vegetable kingdom*, and his name is coupled with pestilence and famine, two of the great scourges of the human race. He constituted one of the *seven plagues* of Ægypt, and was threatened as a vindictive visitation by the prophet Joel. The only atonement he has made for all the miseries he has inflicted, is the precarious subsistence he afforded (together with *wild honey*) to John the Baptist, in his journey through the wilderness.

It would not be possible at this remote period, to ascertain the precise sense in which the Romans entertained the words *locusta* and cicada. They employed both, but there is no word in the Greek synonymous with *locusta*, more than is conveyed by Τεττιξ; and they must either have intended to designate two different insects, or, with the moderns, applied the word *locusta* to the *larger*, and *cicada* to the *smaller* varieties of that numerous genus.

A brief comparison will so contract the two genera, that our reasons for separating them will, we think, be conclusive.

The cicadæ are herbivorous, voracious and highly destructive, while the locust can scarcely be said to subsist on vegetable matter. They have *no teeth* nor *mandibles*, and in the proper sense, *no mouth*. It imbibes its aliment by an apparatus that belongs to none of the cicadæ. The cicadæ have *jaws* and *teeth* which arm them with the power of destruction to the vegetable kingdom. We were lately favoured with a fine opportunity of comparing the great monarch of the cicadæ with our locust. A perfect specimen, male and female, of the Gryllus Migratorius, brought from Ægypt

by Mr. Mendez I. Cohen, was furnished for inspection by Doctor Joshua I. Cohen, and minutely compared. They are perfect cicadæ on the largest scale, with large, long wings that cover their whole body, like a long frock coat, which enable them to fly rapidly, and to a great distance. Their legs are powerful, and they can leap also to a long distance, while the spindle shanks of the locust do not permit such an action, and it is obliged to elevate itself principally by its wings, having no lever legs to raise it perpendicularly. While the cicadæ elevate themselves in a perpendicular line quickly, the locust can only raise itself slowly, horizontally.

The cicadæ breed *annually:* the locust once in *seventeen years.*

The imaginary resemblance of the *notes* of the cicadæ and locust, have led some to identify them. Such a notion (if it be drawn from a comparison with the cicadæ of Greece) is too metaphorical for a rationale. While it is admitted there is a resemblance in the construction of their vocal organs, we cannot claim for the American songster a note that can be dignified with the epithet musical. The cicadæ of Greece must have been highly gifted with musical powers, to have been celebrated by Homer, who compares the strains of his orators to the sweetness of their notes. How differently would the ear of the imperial poet have decided, if he had been condemned to listen to the monotonous, protracted twang of the American locust! He would have been as much pleased with the scraping of a scissor grinder, or the grating of a file. There are a few of our cicadæ whose notes do not fall ungratefully on the ear, but most of them, compare literally with the *rauca cicada* of Virgil, which could not have been intended for a compliment.

The male only issues a note, which is the signal of adult age, and is immediately followed by flight, in search of a mate. It has been variously and very erroneously represented, both as to its suavity and compass. If we except a slight variation, when the insect is disturbed or driven from its place, (when it is louder and more obstreperous,) it is single, but rises and falls through the gradations; *crescendo, minuendo et cadendo.* It has been likened to

the sounds of several musical instruments, but cannot be identified with any. *A duet, with the bass of a small organ, and a Jewsharp,* (or rather *Jawsharp*, as there was probably no such instrument among the Jews,) is the best imitation we can conceive.

The note can be heard, in a clear, calm atmosphere, *three* or *four hundred yards*, but is not so astounding as it has been represented, scarcely interrupting colloquial intercourse. When thousands unite in the same choir, the universal din seems to compose a musical atmosphere, upon which all other sounds float unmolested. The note is never heard between the setting and rising sun. High winds and cloudy weather repress, but do not silence it. A damp air lessens its shrillness, and the number of songsters. Heavy or long continued rains put a period to the whole process; but it is resumed at the return of the rays of the sun; and no sooner is the water evaporated from the earth and surrounding foliage, than the whole choir is heard in full glee. While the note is issuing, a minute inspection perceives a tremblous motion of the body, vibrating under the impulse of the air in the musical cavities, and if the body be touched it is still more evident. This will be better understood when the whole apparatus shall have been described.

The external appearance of the full grown locust bears a strong resemblance to the common *horsefly*.* It is from *an inch and a quarter to an inch and three quarters long, and from three eighths to half an inch in diameter, at the largest part of the body, and, including the wings, from an inch and a half to an inch and five eighths.*

The body is black, except the four rings that run transversely over it, two large and two smaller, *all tipped with orange.*

The *shape of the head is a good miniature picture of the head of the elephant.*

The *eyes are red*, though a few are *black*, and *very prominent*, which increases their visual power, while it contracts its sphere, which is limited to less than *two feet*, as may be demonstrated by removing them beyond that distance from any object to which they

* Hyppobosca Equina.

are attached. Probably we have given them more power than they possess, and we think it will be found they cannot see so far. Their capacity for keen vision is vastly increased by the almost incalculable number of lenses, with which the eye is supplied; and those so convex that objects invisible, unless through a microscope that magnifies *a hundred and fifty thousand*, is clear to them. With *one* that magnified *four hundred and ninety thousand*, we counted the lenses with sufficient accuracy, and after repeated trials, came to the conclusion, that there were *ten thousand two hundred*, not many more or less. This mechanism gives the power of seeing in all possible directions, and we will presently perceive how important it is to the economy of the insect.

We have already alluded to the peculiar mechanism of the instruments by which the locust imbibes its aliment, so different from those of the cicadæ. They are exceedingly minute, and on a superficial view, unappropriated; but with a fine glass, their office is designated at once.

They seek nourishment that is always present and ready, prepared for the instruments through which they are to receive it. *The exhalation from vegetable barks* forms their entire subsistence. This they probably could not find without exquisitely keen vision, as they have no olfactory nerves, that can be demonstrated. We are, nevertheless, not to infer positively that they can neither hear nor smell. We must search for another apparatus to find the conduit of their nutriment. The antennæ, we have remarked, are bristle shaped, standing between the eyes and the rostrum or beak which furnishes the avenue through which the nourishment is conveyed. It is in this sense only that the locust can be said to have a mouth. There are *three exquisitely fine hairs* appended to its extreme points, by which, through a high magnifying power, we see them distinctly feeding on the dewy exhalation of vegetable barks—a material that may be compared to the insensible perspiration of the animal body; the insensible perspiration of the vegetable skin. Although we cannot demonstrate that they are tubular, they probably act by capillary attraction. The exquisite

tenuity of the exhalation from tender vegetable barks is such, that the imagination can scarcely paint, and never could dream of it, without the finest glasses. If it were possible, it might bear some faint resemblance to the fracture of a diamond of the first water, bespangled into myriads of chrystals!

There are *two varieties* of the decem septima, but only as to size or magnitude. The minor tribe constitutes about a hundredth part of the whole race. We find the smaller at the same time and in the same places with the larger variety, and all their organs and habits the same. As we very seldom find any of an intermediate size, it may be a question whether there is any sexual intercourse between them? The negative would seem to argue the violation of a law of nature. They are about seven eighths of an inch long, and five tenths in diameter.

Although the locust has received its distinctive appellation from the singularity of its appearance *once in seventeen years*, and uniform experience confirms it, there are still some who fancy they have found exceptions to this law of nature. The want of observation, and too much credulity in popular rumour, has led them into this error.

They do not appear at the same time over the whole area of their nativity, but cover the whole ground by the same family once in seventeen years, comprising others that sometimes intervene, both having inhabited the same grounds since they were created. Although all the families are uniform in their ascension, in time and place, there may be *two generations* in the same place oftener than once in seventeen years, because they were so located originally. Such occurrences have confounded and deceived many, and made them sceptics. Some examples within our own observation (and we could adduce many more) will solve the problem. A part of Virginia and Maryland will be sufficient. Here two families occupy the same grounds on each side of the Potomac river—a part of Loudon county on the South, and a part of Montgomery on the north, or Maryland side, compose one section, while Fauquier county, in Virginia, that lies adjacent to Loudon, form part of ano-

ther section that runs into Loudon. It is for this reason that we find the locust twice in Loudon, at intervals of eight and nine years, because they form two distinct generations, and will probably remain so forever, each experiencing its own decem septennial ascension.

It would be as tedious as it would be unprofitable to detail the periods of ascension in every part of the continent, where they are known to have appeared; but as we desire to satisfy all who feel an interest in the matter, we will add a few examples of the chronology of their appearance in such places as we are properly advised of. Our inquiries on this head have not been as extensive as we could have desired, but as much so as are deemed necessary for our purpose. We give them in the promiscuous order we received them. They appeared in Louisiana in 1829. We have no accounts from Florida, where they must have been seen. They have not been found (that we are aware of) in Mexico, nor in any other South American province. They appeared at Galliopolis, in Ohio, in 1821, and in Muskingum in 1829—in part of South Carolina and Georgia in 1817 and 1834—in Middlesex county, in Jersey, in 1826—in parts of Pennsylvania, west of the mountains, in 1832—in Massachusetts, near Fall's River, in 1834—and in the greater part of Maryland in 1749, 1766, 1783, 1800, 1817 and 1834. We have no account from North Carolina, but they must have appeared there, as they have been found in all the adjacent states. We are at a still greater loss for information from the northern and eastern parts of the continent. We have none from the states of New York, Connecticut, Vermont, Maine, or New Hampshire, though they were first described in Massachusetts. It is most probable they pervade the whole continent, though it is possible the low temperature of the far north may draw a line beyond which they cannot exist. This remark, nevertheless, is rather intended to apply to the Canadas, New Brunswick and Nova Scotia, where, (if they ever were seen) there is no tradition. Future observations must decide the extent of their nativity.

It has been supposed that there are certain localities that the lo-

cust instinctively avoids, though they are sometimes seen there. This hypothesis supposes that such places are unfit for the purposes of propagation, and is true in part, but requires some explanation. Instinct always directs it to such places as are best adapted to its economy. We find it on the mountain tops, and in the plains, where there is a soil to rear trees and shrubs, without which there could be no place to deposite their eggs. They are equally repelled by a rocky and a sandy soil, in neither of which they could find subsistence, or construct their habitations. They do not burrow in a soil usually saturated with water, on the shores of water courses, nor the margins of meadows or marshes; though we have them down the declivities of hills, till they are repelled by a cold, damp soil.

As we have given some imperfect description of the note of the locust, we must attempt to describe the instruments by which it is produced—a task the more difficult because we cannot judge very accurately by comparing them with any thing. There is something in vocal music, the result of living animal matter, that art cannot aspire to, nor scarcely imitate.

If we view the body externally, we perceive, under the shoulders of the wings, *a small, delicate membrane, nearly triangular, and convex, with fine, long ridges, or ribs running over it.* It resembles a *small shell, and is stretched over a cavity, in the chest, like the head of a drum, each lower angle being intimately connected with a fasciculus of muscular fibres.* There are *two scales, one on each side of the thorax, firmly attached above and below.* By bending the body backwards, they are elevated, and expose *two larger cavities, covered by an exquisitely fine, silk-like membrane. Those cavities are connected with those under the musical membranes, and are the reservoirs of air, with which they are filled. The upper ends of fasciculi of muscular fibres, are tied down to the inner centre of the breast bone, and the lower ends pass through the sides of the posterior cavity of the chest, attached by a ligament, to the inferior angle of the musical membrane, forming together, a triangle, and span the chest like the rafters of a house.*

The musical process begins with the action of the muscular fibres, but they do not finish it. The motions of the fibres puts the membrane in motion while it is floating in air, constantly supplied by the reservoirs. The motions of the muscular fibres and membranes are almost inconceivably rapid, and may be compared to the wings of a fly, poised in air, which seem to stand still, because the naked eye cannot follow their velocity. Here the sense of touch discovers that which the eye cannot perceive. If we apply the point of a fine needle to the sides of the insect, a jarring sensation is felt, like that imparted by filing a thin plate of steel. By pressing on the fasciculi the notes cease. By cutting one of the fasciculi the music ceases on that side, but continues on the other. By dividing both fasciculi, we put an end to all sound. By pressing on the fasciculi the note ceases, and if we press the air out of of the reservoirs, the same effect is produced. There is still something wanted to perfect the musical process—an avenue to the external air. For this purpose there are two small apertures, one on each side, near the insertion of the inner wings, between them and the tympanum. They are capable of dilatation and contraction, at pleasure, and receive as much air as is necessary to fill and modulate the note.

When we were dissecting and separating the parts composing the musical apparatus, we were not aware that we had been anticipated by the celebrated Reamur, in his description of those of the cicadæ, which bear a strong resemblance to those of the locust.

The special economy and character of the locust next demand our consideration. We must trace it from its ascent to its death, when it is soon succeeded by a new generation.

It first appears at the surface of the earth, in the *pupa* or *grub form*, preparatory to the chrysalis state—almost defenceless and very imperfect. It is discovered in Maryland on or about the *tenth of April.* We found it on that day, at the four successive ascensions of 1783, 1800, 1817 and 1834. We do not assert that they do not appear sooner or later, nor that they arise at the same time in all other places. They are usually discovered by the hogs rooting

for them, and eating them with avidity; and hence we do not see them otherwise, unless we break the upper stratum of the soil. By removing it about a quarter of an inch deep, we discover a great number of *holes* about *five eighths of an inch* in diameter, resembling *auger holes*, six, eight, or ten inches apart, according to the facilities of entrance when the young were hatched, and extending downwards *six*, *eight*, *ten*, and sometimes *twelve inches*. Proceeding downwards, the pupa is found at the bottom, and appears to be well formed, though all its parts are not entirely unfolded. This is more remarkable in the *wings*, which look more like appendages than real wings, lying close to the body, and unfit for use. This imperfect state of the wings seems necessary to the safety of the body, as in a more developed form, they would operate as an impediment to the ascent, and accordingly, we find that, as soon as they emerge into a warmer and dryer atmosphere, they become harder and begin to expand. When the pupa first appears the body is fresh, soft, moist and so tender, that it is easily injured, while the extremities are hard and fit to work their upward course, and creep to such objects as they instinctively seek. The whole external appearance, as well as the occupation of the pupa, indicate a very material, recent change; that they have either sloughed or undergone some transformation preparatory to the chrysalis state, the next in order of completion. We have, moreover, other reasons for concluding that other important functional changes now follow. During its residence in the earth, the pupa is in a state of gradual, but slow growth, without any change, except its increment. They have been found, at various periods after their descent, covered with the *same brown shell* that always invests them, till the transformation they undergo, when they become pupæ. Mr. Samuel Feast, an intelligent gardener and naturalist, dug them from the earth, *one and two years* before the last ascension, in this form, but not completely grown. Mr. Ellis Thomas found them in this state in his garden *eight years* after their descent, nearly half grown. These facts clearly demonstrate that they require the whole time of their subterraneous existence to complete their

growth, and that the grub or pupa form is not assumed till a short time before they are found at the surface of the earth. While the insect is under ground, gradually acquiring its growth, it performs the functions of *digestion and excrementition*, we find it furnished with a strait intestinal tube, the upper part of which is expanded into a wider receptacle, and seems to answer for a stomach. When the pupa leaves the ground and the body is almost matured, these organs seem to be almost obliterated, as we find only a wasted membrane that can perform no function, a mere remnant of former vitality. As little or no growth is required after the pupa state, there is no necessity for a stomach, and during the fleeting existence of the insect in open air, no excrementitious matter can be found. The cavity occupied by the digestive organs is now filled by the seminal fluid in the male and the eggs in the female.

The time between the discovery of the pupa, and its final exit from the earth, is spent in maturing its skin, and acquiring strength to fit it for more active operations, to fulfil its destination.

During the warmer hours of the day, it is seen peeping from its cell, seeming to enjoy the warm, fresh air. At twilight, or if the temperature fall during the day, they retire to their chambers. In this imperfect state, their progress is slow, and they are unfit to inhabit the open air for eight or ten days. They then cast off their slough, which finishes the short-lived chrysalis state, and become perfect locusts in twenty four hours, and sometime sooner—their progress depending, in some degree, on the temperature of the atmosphere.

If we descend to the bottom of their chambers, we find them (as already remarked) six, eight, and sometimes ten or twelve inches deep; but as it is generally supposed that their residence is more profound, it is necessary to shew that this is an error, during their pupa state at least. To determine this question, and some others no better settled, we selected for our field of observation, *an ancient oak grove* of several acres. The upper stratum is a stiff loam, mixed with some gravel, and inclining, in places, to sand. At a depth of from two to three feet there is a stratum of pale blue

clay, rather compact, and well formed to retain any impression it might receive; and as the holes are always filled below with earth removed from above, through their whole course, their depth was easily ascertained. They were uniformly found filled to within six or eight inches of the top, with earth from which all vegetable matter had been extracted, and packed so hard that their depth could not be mistaken. In no case could we trace them to the blue stratum of clay below. From this fact it is clear that this is the utmost depth of their domicil in the latter stage of their subterraneous pilgrimage. All that seems to be required for the safety of the insect under ground is a temperature congenial to its degree of vitality; and although they descend deeper in search of aliment, previous to the assumption of the pupa state, it is clear there can be no necessity for it after it. The late Mr. William Patterson, of this city, saw them *three* feet below the surface of the earth, when they were very small, not quite three years old. The extent of the descent in this state is also confirmed by inspecting the bottom of their chambers, where we always find a certain quantity of refuse matter, hard and compact, in the form of a plug. This is neither of the consistence or colour of the surrounding soil, but fecal matter, strongly cemented, stiffer and more clay-like. It would appear, from these facts and reasoning, as a consequence, that the objection so often made to the superficial descent of the locust is futile. It has been remarked that the ground, during our cold winters, sometimes freezes below the depth of eight or ten inches. Before the chambers are constructed, they can descend as low as their instinct directs them to be agreeable, and certainly do, as we never find any diminution of numbers at any ascension after the hardest winters. If we examine the construction of the chambers which seem to be intended to protect them, in their most tender state, we find them ample and admirably formed for that purpose. The walls are thick and strong, cemented so firmly that water will not penetrate them, nor heat easily escape, preserving nearly a uniform temperature.

The superficial descent of the locust, and the construction of its

temporary dwelling, is analogous to the habits of other animals, especially the hybirnating, such as alligators, tortoises, frogs and others which immerse themselves beneath their natural element into a uniform temperature, merely high enough to be susceptible of excitement by the vernal return of heat. Although the locust does not lie torpid, instinct directs it to provide for its own preservation by insuring a steady temperature that answers all the purposes of its economy.

Is not the migration of birds regulated by the same principle? They instinctively seek more congenial climes to evade the sedative influence of cold.

A more minute account of those apartments will shew how well they are adapted to the purposes of self-preservation, and how much better they are directed by instinct than they could have been by any contrivance human reason could invent.

On a first view of the external opening of the chambers we would suppose that they run in a perpendicular direction; but we find them deviating more or less: some running horizontally, others at obtuse or acute angles, while some form entire circles. All these varieties, and their modifications, are found where there is no impediment to a perpendicular ascent, which they meet sometimes. They come up occasionally under the roots of trees, floors, logs, stones and pavements laid since their descent. In such cases they pursue any course by which they can reach the surface; but they sometimes fail from the distance they have to travel. We found many that had perished under a brick pavement that had been laid over them after their descent.

The roofs of their tenements are neatly arched, and so firmly cemented that water is never found in them, though all the surrounding grounds are overflowed and perfectly saturated. This defence against an element that would be destructive, is to be attributed to the workmanship of the cells, the interior of which are varnished with a secretion that seals them hermetically, from bottom to top, and makes them water proof. The locust is not singular in this provision against inundation and drowning. The cray-

fish,* with other amphibious shellfish, and some insects, build houses along the margins of water courses, where the soil is too wet and cold, and rear them above tide water. They resemble small chimnies, and are so firmly cemented that water will not penetrate their walls. The glutinous secretion they employ resembles the slime on the bodies of snails, which seems to be used for the same purpose.

When the locust takes its final leave of its cell, it selects the stillest and most private hour, about day-break, to guard against the accidents to which it is liable in so weak and defenceless a state, till it can fly. Some cannot divest themselves of their sloughs under a cold damp atmosphere. Others ascend at so great a distance from any object by which they can climb up, that they perish before they can get the benefit of the sun. Great numbers are devoured by hogs, squirrels, all kinds of poultry and birds, which live and fatten on them.

No sooner has the pupa issued from the earth than we perceive a change which leads almost immediately to the divestment of its coat. It becomes browner and harder, more particularly on the back, between the head and wings. The latter are still more developed, but wear a delicate, silk-like appearance. The wings become amber, and the wing bones assume a bright orange colour.

The process by which they extricate themselves from the slough is slow at first, though soon finished. It is similar to the shedding of a crab, except the part through which the body is drawn from the shell. That of the crab open laterally at the side, opposite the eyes and mouth—the locust longitudinally, in the middle of the back. They are both disengaged by the muscles of their legs, with their claws constantly in motion till the process is finished.

We saw the first that had sloughed on the *eighteenth of May*, a few on the nineteenth, and from that time they multiplied almost incalculably, till the twenty fifth. From that day till the twenty third of June the numbers declined in the same ratio. On the fourth of July we found very few, and on the fifth one.

We found the first pair in sexual union *on the twenty fifth of May*,

* Cancer Astacus.

but this was considered precocious, as we could find no others till the first of June. On the third we saw a considerable number, which increased daily, and then declined. On the thirteenth we found only a solitary instance of the last melancholy note of an expiring race, to be heard no more for seventeen years.

On the *fourth of June* we found that a few boughs had been operated on by the female, and one on the first. The greatest deposite of eggs was on the *tenth*, and declined till the sixteenth, when we found only one.

The principal male organ of generation lies concealed in a *sheathe* at the lower extremity of the abdomen, from which it scarcely protrudes. When they come sexually together, the female embraces the male, and holds him in close contact, by means of a hook on each side, turned backwards, and he is immoveable till the process of impregnation is finished. The union continues from *fifteen* to *eighteen hours*. When they separate the female is frequently seen flying away with half the male, broken off in the middle region of his body.

The male and female survive only two or three days after they have performed their respective parts in the process of generation. The male dies first, and the female lives the same time after the deposition of her eggs. They emaciate rapidly, and at their death are skeletons as light and void of substance as the exuviæ cast off by the crysalis. The body is without muscular substance, the abdomen empty, and no moisture to be found but a little in the head and chest.

The most remarkable parts of this extraordinary insect are those of the female—the machinery by which she works in effecting a depository for her eggs. The *ovipositor* is lodged in a groove, and lies at *the terminating ring of the abdomen*, and the *oviduct* passes through its *centre*. When not in use, it is concealed, except a minute point at its lower extremity. It is composed of *three distinct pieces*, connected at the sides *by the nicest tongue and groove*, by which *the two side pieces play up and down upon the centre piece*. The material of these parts is similar in appearance to *tortoise*

shell, dark brown and elastic, but more brittle, and bent to a certain extent, fractures short, like a pipe stem. *The edges and points of the side pieces are serrated, forming perfect saws*, while their *flattened surfaces* form *rasps* equally perfect. When the instrument is protruded and examined by the microscope, the denticulations of the saws are clearly perceived. There are *fifteen teeth* on each side, symmetrically arranged, tapering away in fineness towards the point, where we find *three or four* more, so small that it is scarcely possible to determine, by the best glasses, whether there are *three* or *four*. In some there appeared to be three, in others four.

Previous to the application of the instruments, the female deposites a fluid on the part to be operated on. It seems to be intended as an emollient, and probably to mark the extent of her work. It is a secretion from the inner surface of the oviduct, so exquisitely fine that it is only to be seen by a fine glass. The practice of softening the place of deposite for eggs is not uncommon among insects and amphibious animals. Some of the tortoises use their urine to soften the surface of the ground, that they may excavate the hard soil with more ease, and deposite their eggs quicker.

When the female selects a limb, she goes formally and industriously to work, and soon finishes it. She raises her body, extends the point of the instrument, and with her whole weight pierces the bark with the *upper point of the centre piece or chisel*, which is like the *flattened point of a thumb lancet*, making way for the side pieces or saws. Though the puncture is very minute, scarcely perceptible, it is sufficient for a place of entry, and a quick sawing motion now commences, and continues till the apertures are large enough to admit the other side piece, which follows with the like motion. As soon as the blade point is fairly inserted, say the twelfth of an inch, she presses on the part attached to her body, and then, by a lever, raises the ends of the divided fibre; she then adjusts the *three different parts* of the *instrument*, forming *two saws* by *its edges*, *two rasps* by *its flattened sides*, and a *perforator* or *chisel* by *its point*. The uses of the perforator and saws are easily per-

ceived, but the design of the rasps would not be discovered without seeing and closely observing the progress of the operation in its different stages. They seem to be intended to comminute and divide the rough ligneous fibres furrowed up by the saws, and thus prepare a softer and smoother bed for the eggs. While the female is sawing away the sides, and rasping up the ends of the fibres below, she withdraws the instrument occasionally and reinserts it, till she shall have penetrated the full length of the incision, in a direction obliquely downwards, towards the pith, which is never touched, because it would not be a proper nidus, and a deeper cut would weaken the ligneous fibre, and it would be easier broken. As soon as the opening is made deep enough, she enlarges it externally, by plying the saws along its sides and the rasps to the top and bottom. She now withdraws the instrument for a moment, and reinserts it to its full length, depositing *two eggs* in quick succession. She withdraws it again, reinserts it, and deposites two more, till she shall have laid from *ten* to *twenty*, but never an odd number. The number in a single fissure depends on the size of the perforation, and that on the bough which may be crooked, knotty, or otherwise defective, or occasionally rotten in the middle. The eggs are set *uniformly in two rows*, close together, their ends inclining downwards. They are one twelfth of an inch long, and one sixteenth in diameter, tapering to an obtuse point. They are of a pearl-like white. She is about *fifteen minutes* in preparing a single nidus and depositing the eggs; but it is not uncommon for her to make *fifteen* or *twenty* fissures in the same limb, more or less, according to its fitness. She frequently shifts from one limb to another, and from tree to tree, before she can deposite all her eggs, the whole number of which varies from *four* to *five hundred*. She seldom selects a limb more than a quarter of an inch in diameter, though often a smaller one. Both the upper and lower sides are sometimes perforated, but never directly opposite to each other. The age and texture of the wood seem to be disregarded. A thorny or abruptly crooked bough seems to annoy her in searching for a place of entry. We were amused by the maneouvres and apparent disappointment of several that had lighted upon a flourish-

ing *aurelia spinatu.* Three of them left it precipitately after lighting on ten or a dozen branches, which they inspected closely, till one more persevering than the rest, found a single fit place of deposite, finished her work and departed.

There are but few trees and shrubs not invaded, and the larger under vines are not exempted. The younger rose and raspberry bushes were frequently perforated immediately above the ground, where the stock was large enough. We found no forest tree untouched, except the pine, with the whole tiribinthenate class, except a few of the white cedar.*

We see the perfection of instinct in the selection of boughs of a small dimension. Those that are smaller are more tender and succulent, affording a milder and more copious nourishment for the embryo, while a larger size could not be well operated on on account of their larger growth and hardness. As a considerable force is required to introduce the instrument, it is necessary that the female should grasp the whole circumference of the limb, to steady herself, and concentrate her strength. If she were to attempt a larger limb, her legs would be so much distended that her muscular power would be diminished, and she could not take a firm hold with her claws.

The punctured branches decay and die after the young have left them, and we have some evidence of the injury they have received before that time. The leaves becomes yellow from the failure of a perfect circulation, the medium of which is cut off, or much impaired. They do not fall off immediately, unless broken by a heavy wind, but hang by the bark, which is more pliant and tougher than the liburnum in which the eggs are lodged.

The great number of dead boughs we perceive after an ascension, that give a chequered appearance to our groves and forests, only contrast living green with dead yellow, with little or no injury. Old forest trees and orchards suffer but little, and some of them that are very luxuriant seem to improve under the pruning knife of the locust. The younger articles of the nursery, and or-

* Cupressus Thycides.

namental shrubbery, are the principal sufferers. The grafts or buds of the last summer, grown only a few feet, with a single strait stem, are destroyed, or if, by chance, a bud be left beneath the wound, a year's growth is lost, and the beauty of its form spoiled.

We must now trace the progress of the embryo from its incubation till it descends to its long subterraneous abode, where we found it.

The time at which the eggs are fit for deposite is *forty eight hours* after impregnation, or within a fraction of that time. They are so transparent, that we can see indistinctly the features of the future insect through the shell, and with a good glass they are still more visible. The shell wears a pellucid, membranous appearance; but notwithstanding their apparent delicacy, they retain their contents longer than other eggs either of insects or birds. They hatch in *fifty two days*. We saw a deposite on the *fifth of June*, and marked the spot, and witnessed the parturient process on the *twenty eighth of July*. On the fifteenth day after the deposite we discovered a manifest change of *colour* and form in the eggs, which increased gradually till the embryo assumed the form of a *worm*, without legs, and a thicker cream colour succeeded to the shining, pearl-like white. Instead of the previous well-defined shape, it now becomes crooked, and the form of the head is obvious, while the body takes on the form of a *silk-worm* wrapped up, in a cream-coloured cocoon. The most distinct feature is now the eye, which is well defined *ten days* before the shell is broken. The *rings* of the body, and the legs are easily distinguished, laid close to the abdomen. Immediately before birth a distinct *motion* is to be observed in the insect in the *eggs*, resembling the *jerking of the tails of butterflies and moths*, in the chrysalis state, when they are *disturbed*. We took several nests from a bough marked for observation at the exact time of maturity, and soon perceived the signs of parturition. We placed some of the eggs between two scales of *mica*, and applied the microscope. The power of the glass brought upwards of *fifty* within its focus, and the whole process was clear and satisfactory. Temperature exerts a considerable influence on the pro-

cess. It is accelerated by heat, and retarded by a low temperature. Those we held in our hands hatched sooner than those on the limbs at the temperature of the air. The act of delivery differs but little from that of the chrysalis. A rupture of the fetal membrane covering the back is first effected by muscular motion. The insect draws its body upwards, and seems to swell, whilst it throws its lower extremities to and fro, labouring in all possible attitudes to extricate itself. It draws out its head slowly, disengages its fore legs, and in a few minutes its whole body. The moment it is set at liberty it begins to caper as if it were in a new state of existence, seeming to exult in its delivery. For a moment it seems to be at a loss what to do, till instinct begins to operate and directs it to its proper element. As soon as it is freed from its shell it falls to the ground. It does not run nor creep down the body of the tree, nor cast itself off precipitately; but runs to the side of the limb, loosens its claws, and falls to the ground by an instinctive rule, for from whatsoever height it may have descended, it sustains no injury. When it inters itself it descends by the side of some vegetable root, which is its first and only aliment under ground.

In this state it is blind, and acts by the sense of touch, and feels its way downward by its *antennæ*. Although its eyes are prominent, they are covered by an opaque film, through which the rays of light cannot pass. What would be the use of vision to an insect destined to dwell in darkness *sixteen years and nine months?* Perfectly formed eyes would be an incumbrance, while the membrane that invests them defends them from injuries in passing through a grass-irritating medium. In this state the young insect shews, also, the rudiments of wings, but they are not unfolded, because they are not wanted. What would be their use when adult age, the only time they could use them, is almost as distant as that of a child born at the same time? While it has fit for use all the parts required beneath the soil, it is restrained in the use of others till it shall have passed through a *long infancy, a short adolescence*, and puts on the *toga virilis* at *seventeen.*

We must be indulged while we draw a further comparison between the newly born progeny and the pupa as we find it *sixteen years and nine months* after: the odd three months, from its appearance at the surface of the earth till its death in the adult and last state, completing the *whole circle.*

When the young emerge from their native place, they are *one sixteenth of an inch long*, apparently, on a superficial view, nearly perfect, but with some parts better developed than others. With *three pair of legs*, *one before and two behind*, the former resemble those of the pupa—are strong and muscular, armed with hard, sharp claws, while the latter are slender and more delicate, with their hooks reversed, being intended for pushing, while the fore legs are employed in pulling in the same direction, so that they work together, assisting each other.

The *antennæ are longer* in proportion than those of the pupa, and the whole body longer *in proportion* to its *diameter.* The whole body of the young locust is thickly covered with *hair*, which is more remarkable on the sides, tail and antennæ. This covering seems to furnish some defence against external impressions, and keeps them warm in their tender, infantile state. The prominences we find on the shoulders shew the rudiments of unfolded wings, as in the pupa. The eyes are of a deep orange red colour. The hooks of the claws incline to red. The *snout* is much longer in proportion than that of the pupa, and lies flat in the chest. The head seems longer, also, but this appearance is deceptive. It seems to project considerably, and this gives it the appearance of the ewer mouths of certain small fish, the upper lip only projecting, and is only an extension of the skin beyond the extreme point of the real head. This apparent deformity is subsequently adjusted by the perfect developement of the other parts of the body. The membraneous extension is found filled with a serous-like fluid that resembles the fluid under the cuticle vesicated by Cantharides.

We have seen the dangers to which the locust was exposed till it shook off its chrysalis form and was able to fly. They are few and inconsiderable compared to those to which the fetal state is

liable. It is probable that not one third of the eggs come to perfection, and were it not for the myriads that are laid, there would be a slender account of the next generation, and in not many more, the whole race would be extinct. Besides the great numbers of eggs and young picked from the boughs by *woodpeckers* and *other birds*, they are constantly infested by *legions of ants* before and after they are hatched. Even the little red species, the most diminutive of the race, will shoulder the eggs and the young, and bear them off to their cells. In all our researches we found them in battalions, systematically arrayed for wholesale plunder and devastation. They are probably the most numerous of all the insects on our globe, and are found in all nations and all latitudes.

The mode of subsistence in the earth, from the time the young descends till it appears at the surface in the pupa state, does not seem to have been conjectured. We have already suggested that the young, when it falls to the ground, descends by the side of a vegetable root. It seeks first a penetrable spot, and then the fibrous roots of vegetables that insure its means of subsistence. It moves along the particles of earth through those interstices that are found in all soils, and furnish a passage to any necessary depth. It does not dig a passage for which its tender limbs would be unfit, and which is unnecessary from the constitution of the soil, if we view it through a good glass. We find the particles loosely aggregated, resembling heaps of stone, through which mice and rats find their way with ease. The soil is more loosely connected by the insertion of numerous small roots with which it is every where intersected to a certain depth, and of which there are ten times as many as could be seen by the naked eye. In all places they are found attached to the tender fibrils of plants. When they are disturbed or driven from them, they seek for others the moment they are at liberty. This is their only aliment, not the substance of the roots of plants, which they cannot divide and comminute without teeth or jaws to use them, but the more aerial exhalation from their surface. This well established fact would seem to account for the slowness of their growth, and furnish a reason for so long a subterraneous residence.

We must devote a few words to popular credulity, which has circulated so many marvellous and idle tales of the venomous character of this poor, defenceless insect. The very organism of the locust refutes them all. It has no jaws, teeth, sting, or any other instrument by which it can injure or annoy the most diminutive insect—no weapon, offensive or defensive. It cannot defend itself against an ant or a fly. We have handled them, male and female, time after time. We have irritated and mutilated them, but never could provoke them to resentment.

As it is not probable that we shall witness the next ascension in 1851, we leave to our successors the task of filling up the void we have left, and correcting our errors. We expect from them what time and circumstance would not permit us to accomplish. We do not know exactly the increment of the body from the time the young descends into the earth till we discover the pupa at the surface of the soil; though, from the facts stated, we think it may be calculated without much inaccuracy. We have not had the means of defining distinctly the period at which they begin to construct their chambers, though it may be nearly approached by reasoning from the facts we have mentioned. It is certain that no animal builds a house for itself till it arrives at adult age. And, in fine, although nothing was made in vain, we know not what link the locust forms in the chain of animated nature.

Baltimore, November 19, 1834.