XXII. *Observations on the* Aphides *of* Linnæus, *by Dr.* William Richardson, *of* Ripon, Yorkshire: *Communicated by* William Heberden, *M. D. F. R. S.*

Read Mar. 14, 1771.

THE learned *Linnæus* by his unwearied application having reduced the various productions of nature into one regular system, and clearly distinguished the numerous tribe of insects into their distinct classes and subdivisions, seems to me to have laid a more solid foundation for the natural history of these minute animals, than any other writer who has gone before him. Difficult, however, as it is to lay so firm a foundation, the superstructure must still be esteemed a more arduous undertaking; as it is easier to distinguish the outward form, even of the minutest insects, than to discover their internal nature and disposition. This is a knowledge not to be attained by any single person, be his genius and diligence ever so great; but to bring it to any degree of perfection, will require the joint endeavours of the curious in all ages, and in all the different parts of the world. From which considerations, I am induced to throw in my mite towards promoting so useful an undertaking; by reducing my observations on this surprizing kind of insect, into a more concise and regular form.

Though the Aphides are diſtinguiſhed by Linnæus into more than thirty ſpecies; ſtill I am ſatisfied, from my own obſervation, the diſtinct ſpecies are even double that number: nor can I altogether agree with this ingenious author, that there are a greater variety of plants producing Aphides, than there are different ſorts of this inſect. Where plants are of a like nature, they are uſually frequented by the ſame inſects; but many of theſe plants will be found to ſupport two or more quite different ſorts. On the peach and nectarine indeed the Aphides are the ſame, nor do I find on theſe trees more than one ſort. The plum tree, on the other hand, has two ſorts, very diſtinct from each other: one of a yellowiſh-green, with a round ſhort body; the other of a bluiſh-green, as it were enameled with white, and the ſhape more oblong. On the gooſberry-buſh and currant the ſame Aphides may be found; but each of theſe is inhabited by two very different ſpecies: one being of a duſky green, with a ſhort plump body; the other of a paler green, the body more taper, and tranſverſly wrinkled. To theſe inſtances I muſt further add, that the roſe-tree ſupports not leſs than three diſtinct ſpecies: The largeſt of which is of a deep green, having long legs of a browniſh caſt, with the joints of a very dark brown, as are alſo the horns and antennæ; a ſecond ſort is paler green, has much ſhorter legs, and a more flat body; the third ſort is of a pale red, its body tranſverſly wrinkled, and is moſt frequently on the ſweet-brier. It not being, however, ſo much my intention to enumerate the different ſpecies of theſe inſects, as to give ſome inſight into their extraordinary

nary nature; the inſtances I have already produced will, I flatter myſelf, be thought ſufficient.

The great variety of ſpecies which occur in the inſects now under conſideration may indeed make an enquiry into their particular natures ſeem not a little intricate and perplexed; having them, however, ſkilfully reduced under their proper genus, the difficulty is by this means conſiderably diminiſhed. All the inſects comprehended under any diſtinct genus, we may reaſonably ſuppoſe to partake of one general nature; and, by diligently examining any of the particular ſpecies, may thence gain ſome inſight into the nature of all the reſt. With this view I have choſen, out of the various ſorts of Aphides, the largeſt of thoſe found on the roſe tree; not only as its ſize makes it the more conſpicuous, but as there are few others of ſo long a duration. This ſort, appearing early in the ſpring, continues late in the autumn; while ſeveral are limited to a much ſhorter term, in conformity to the different trees and plants from whence they drew their nouriſhment.

SECTION I.

If at the beginning of February the weather happens to be ſo warm, as to make the buds of the roſe tree ſwell and appear green; ſmall aphides are frequently to be found upon them, not larger than the young ones in ſummer, when firſt produced. But there being no old ones to be found at this time of the year, which in ſummer I had obſerved to be viviparous; I was formerly not a little perplexed by ſuch

ſuch different appearances, and almoſt induced to give credit to the old doctrine of equivocal generation. That the ſame kind of animal ſhould, at one time of the year be viviparous, and at another oviparous, was an opinion I could then by no means entertain. This, however, frequent obſervation has at laſt convinced me to be fact; having found thoſe Aphides, which appear early in the ſpring, to proceed from ſmall black oval eggs, which were depoſited on the laſt year's ſhoots in autumn: though, when it happens that thoſe inſects make too early an appearance, I have obſerved the greateſt part to ſuffer from the ſharp weather that uſually ſucceeds; by which means the roſe trees are ſome years in a manner freed from them.

Thoſe which withſtand the ſeverity of the weather, ſeldom come to their full growth before the month of April; at which time they uſually begin to breed, after twice caſting off their exuviæ, or outward-covering. It then appears that they are all females, which produce each of them a very numerous progeny, and that without having intercourſe with any male inſect. As I obſerved before, they are viviparous; and what is equally uncommon, the young ones all come into the world backwards. When they firſt come from the parent, they are enveloped by a thin membrane, having in this ſituation the appearnce of an oval egg; which I apprehend muſt have induced Reaumur to ſuſpect that the eggs diſcovered by Bennet were norhing more than abortions. This egg-like appearance adheres by one extremity to the mother, while the young one therein contained extends the other; by that

means gradually drawing the ruptured membrane, over the head and body, to the hind feet. During this operation, and for ſome time after, by means of ſomething glutinous, the fore part of the head adheres to the vent of the parent. Being thus ſuſpended in the air, it ſoon frees itſelf from the membrane in which it was confined, and after its limbs are a little ſtrengthened, is ſet down on ſome tender ſhoot, and then left to provide for itſelf.

When the ſpring proves mild, and conſequently favourable to this kind of inſect, I have obſerved not only the roſe trees, but various kinds of fruit-trees, to be greatly injured by them. Hence I was firſt introduced to inveſtigate the nature of theſe inſects; in order to find out ſome expedient, whereby ſo great an evil might be prevented. To avoid being tedious by deſcending to particulars, I ſhall recommend the following general rule; *viz.* to lop off the infected ſhoots before theſe inſects are greatly multiplied; repeating the ſame operation before the time their eggs are depoſited. By the firſt pruning, you will prevent a very numerous preſent increaſe; and by the ſecond, may intirely cut off the next year's ſupply.

SECTION II.

In the ſpring months, there appear on the roſe tree but two generations of Aphides, including thoſe which immediately proceed from the laſt year's eggs; the warmth of the ſummer adds ſo much to their fertility, that no leſs than five generations ſucceed each other during that interval. One is produced

duced in May, which twice caſts off its covering; while the months of June and July each ſupply two more, which caſt off their coverings three or four times, according to the different warmth of the ſeaſon. This frequent change of the outward covering is the more extraordinary, as it is the oftenеſt repeated when the inſects come the ſooneſt to their growth; which I have ſometimes obſerved to happen in ten days, where warmth and plenty of nouriſhment have mutually conſpired. From which conſiderations, I am thoroughly convinced, that theſe various coverings are not connate with the inſect; but that they are like, the ſcarf-ſkin, ſucceſſively produced.

Early in the month of June, ſome of the third generation, which were produced about the middle of May, after caſting off their laſt covering, diſcover four erect wings, much longer than their bodies: and the ſame is obſervable in all the ſuceeding generations, which are produced during the ſummer months; without however diſtinguiſhing any diverſity of ſex, as is uſual in ſeveral other kinds of inſects. For ſome time before the Aphides come to their full growth, it is eaſy to diſcover which of them will have wings, by a remarkable fulneſs in the breaſt, which in the others is hardly to be diſtinguiſhed from the body. When the laſt covering is rejected, the wings, which were before folded up in a very narrow compaſs, gradually extend themſelves in a moſt ſurprizing manner, till their dimenſions are at laſt very conſiderable. But theſe winged ones have this further peculiarity, that the number of them does not ſeem ſo much to depend on their

original ſtructure, as on the quantity or quality of the nouriſhment wherewith they are ſupplied: it being frequently obſervable, that thoſe on a ſucculent ſhoot have few or none with wings among them; while others of the ſame generation, on a leſs tender branch, are moſt of them winged: as if the firſt rudiments of the wings were compoſed in the former, while nature thought proper to expand them in the latter, that they might be more at liberty to ſupply their wants.

The increaſe of theſe inſects in the ſummer time is ſo very great, that, by wounding and exhauſting the tender ſhoots, they would frequently ſuppreſs all vegetation, had they not many enemies which reſtrain them. To enumerate the variety of other inſects, that in their worm and fly ſtate are conſtantly deſtroying them, would exceed the bounds of my preſent deſign: there is one, however, ſo ſingular in the manner of executing its purpoſe, that I cannot paſs it by without ſome further notice. This is a very ſmall black ichneumon fly, with a ſlender body, and very long antennæ; which darts its pointed tail into the bodies of the Aphides, at the ſame time depoſiting an egg in each. This egg produces a worm, which feeds upon the containing inſect, till it has acquired its full growth; when it is uſually changed to that kind of fly from whence it had its origin. In this, however, it is ſometimes prevented by another ſort of ſmall black fly, which wounds this worm through its pearl-like habitation; and by laying one of its eggs therein, inſtead of the former fly, produces its own likeneſs.

I muſt however further obſerve, notwithſtanding theſe inſects have many enemies, they are not without friends; if we may conſider thoſe as ſuch, who are very officious in their attendance, for the good things they expect to reap thereby. The ant and the bee are both of this kind, collecting the honey in which the Aphides abound; but with this difference, that the ants are conſtant viſitors, the bee only when flowers are ſcarce. To which let me alſo add, that the ants will ſuck in the delicious nectar, while the Aphides are in the act of diſcharging it from the anus; but the bees only collect it from the leaves, on which this honey-dew has fallen.

SECTION III.

In the autumn, I find three more generations of Aphides to be produced; two of which make their appearance in the month of Auguſt, and the third uſually before the middle of September. As the two firſt differ in no reſpect from thoſe which we meet with in ſummer, it would be waſting time to dwell any longer upon them; but the third, differing greatly from all the reſt, demands our giving it a more ſerious attention. Though all the Aphides which have hitherto appeared were females, in this tenth generation are found ſeveral male inſects; not that they are by any means ſo numerous as the females, being only produced by a ſmall part of the former generation. To which I muſt further add, that I have obſerved thoſe which produce males, previouſly to have produced a number of females; which in all reſpects reſembling thoſe already deſcribed,

ſcribed, I ſhall decline taking into any further conſideration.

The females have at firſt altogether the ſame appearance with thoſe of the former generations; but in a few days their colour changes from a green to a yellow, which is gradually converted into an orange-colour, before they come to their full growth. They differ likewiſe in another reſpect, at leaſt from thoſe which occur in the ſummer, that all thoſe yellow females are without wings. The male inſects are however ſtill more remarkable; their outward appearance readily diſtinguiſhing them, from the females of this and all other generations. When firſt produced, they are not of a green colour like the reſt, but of a reddiſh brown; and have afterwards, when they begin to thicken about the breaſt, a dark line along the middle of the back. Theſe male inſects come to their full growth in about three weeks time, and then caſt off their laſt covering; the whole inſect being after this operation of a bright yellow, the wings only excepted. But they ſoon change to a darker yellow, and in a few hours to a very dark brown; if we except the body, which is ſomething lighter coloured, and has a reddiſh caſt. They are all of the winged ſort; and the wings, which are white at firſt, ſoon become tranſparent, and at length appear like very fine black gauze.

The males no ſooner come to maturity, than they copulate with the females; in which act they are readily diſcovered, as they remain in conjunction for a conſiderable time, and are not eaſily diſturbed. The commerce between them continues the whole month of October, and may be obſerved at all times

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of the day; though I have found it moſt frequent about noon, eſpecially when the weather is moderately warm, with the ſun overcaſt. The females, in a day or two after their intercourſe with the males, I have obſerved to lay their eggs; which they uſually do near the buds, when they are left to their own choice. Where there are a number crowded together, they of courſe interfere with each other; in which caſe, they will frequently depoſit their eggs on other parts of the branches, or even on the ſpines with which they are beſet. I do not however find that the eggs produced by theſe inſects bear any proportion to the number of young ones which proceed from the females of other generations; not having obſerved any one inſect to produce more than two or three, and that in appearance with great difficulty.

Having now traced their progreſs through the different ſeaſons of the year, and obſerved the various metamorphoſes which they ſucceſſively undergo; I cannot help ſuſpecting the inſufficiency of human reaſon, in ſetting any ſcheme to which the different changes of inſects may be accurately reduced. Though the indefatigable Swammerdam ſeems to have been fully convinced that there is no inſect, whoſe changes may not be reduced to one or other of the four orders he has deſcribed; ſtill the inſect now under conſideration, having at different ſeaſons quite different appearances, cannot, I think, with ſtrictneſs be confined to any of them. In the ſpring they ſeem in ſome meaſure to coincide with the firſt order, though in ſummer thoſe with wings more properly belong to the ſecond; but in autumn,

autumn, the males may ſeem to come under one order, and the females under another; or, I ſhould rather think theſe inſects are not clearly reducible to any order.

SECTION IV.

Some of the inſects now under conſideration continuing to lay their eggs till the beginning of November, I chooſe to defer giving a more particular account of them, till the ſeaſon for which they ſeem by nature to have been deſigned. Theſe eggs are of a regular oval figure, being about the tenth part of an inch in length, and the twentieth in breadth; which, though it may ſeem a very inconſiderable bulk, is certainly large for ſo minute an inſect. When they are firſt produced, their colour is green, but in a few days turns to brown, and by degrees becomes quite black. The covering of the eggs may be called thick, if compared with its ſmall ſize; which at firſt is rather of a yielding nature; but, after being expoſed to the air, ſoon contracts a greater firmneſs. If this covering is wounded, there iſſues forth a mucilaginous fluid, which is very tranſparent, and in appearance of a uniform conſiſtence. Theſe eggs adhere firmly to the branches on which they are depoſited, by means of ſomething glutinous wherewith they are beſmeared, and in a moſt ſurprizing manner reſiſt all the ſeverity of the winter.

Though I have juſt now obſerved, the contents of the eggs to have the appearance of an uniform fluid; that this cannot in reality be the caſe, ſufficiently appears from the Aphides they produce in the

the ſpring, without any other aid than the warmth of the ſeaſon. Nor is a ſingle inſect to be eſteemed the whole product of an egg, ſince it has been clearly ſhewn, that ten generations ſucceed each other; the firſt rudiments of which muſt have been originally in the egg, as the females have no communication with the males but in autumn. The wonder however becomes ſtill greater, when we conſider the number of individuals in each generation; this being, I am fully convinced, at a medium, not leſs than fifty. Whoever pleaſes to multiply by fifty, nine times over, may by this means form ſome notion of the great number of inſects produced from a ſingle egg; but will at the ſame time find that number ſo immenſe, as to exceed all comprehenſion, and indeed to be little ſhort of infinity. How far this can be reconciled with any theory of generation which the ingenuity of man has hitherto invented, may be a contemplation not altogether unworthy our curioſity, though I fear it will not turn out much to the credit of our reaſoning faculties.

The ancient doctrine of equivocal generation, as alſo that from an admixtion of the ſeminal matter of both ſexes, being now quite rejected by all modern naturaliſts; two other opinions ſeem to have ſprung up in their ſtead. While one party aſſerts, that the original organization of the fœtus exiſts in the ovary of the female, and that it is vivified by a ſubtile ſpirit in the ſpermatic fluid of the male; the other lays it down for a certainty, that the eggs of the female are only to be conſidered as a proper nidus, provided for the reception of thoſe minute animalcules, with which the male ſemen is found to

abound. As the former opinion does not appear to have any certain fact to ſupport it, we may well ſuſpect an inſufficiency in the cauſe to produce the effect aſſigned; but, ſuppoſing it adequate to the production of one generation, who can conceive a ſubtile ſpirit to remain in force for ten generations, and that through all the various ſeaſons of the year? With regard to the latter, I muſt obſerve, that the animalcules of Leeuwenhock being compared with Malpighi's firſt rudiments of the chick, their reſemblance is not ſo ſtriking as to afford me the leaſt conviction: but ſhould we allow theſe animalcules requiſite to produce the firſt generation, how then are the ſubſequent nine generations produced without them? Not being able to anſwer theſe queries myſelf, nor expecting them to be readily anſwered by others; it ſeems moſt prudent to obſerve with diligence what nature does, without being over anxious to diſcover by what means. Let us reſt ſatisfied in admiring the wonderful effects of generation, while we refer the primary efficient cauſe to the eternal will and power of an Almighty Creator.

XXIII. *Me-*