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XLVI.—*Observations on the Parasitism of Rhipiphorus paradoxus*. By FREDERICK SMITH, Assistant in the Zoological Department of the British Museum.

EVERY entomologist will read Mr. Murray's paper on *Rhipiphorus* with great interest; I have certainly done so, because I had been obligingly informed by the author of the aim he had in view, that of proving the larva of *Rhipiphorus* to be, as the American entomologists have happily termed it, "a guest-insect" whose larva feeds upon the food supplied by the wasp, and not a parasite that preys upon its larva.

I had certainly considered that the habit of the larva of *Rhipiphorus* had been clearly established by Mr. Stone five years ago; I therefore looked forward to the publication of Mr. Murray's paper with great interest.

When I refer back to the correspondence which I possess from Mr. Stone, and refresh my memory by so doing, I at once confess myself satisfied as to the habit of *Rhipiphorus*, and still believe its larva to be a carnivorous parasite.

I had the pleasure to hold a most interesting correspondence with Mr. Stone relative to the habits of the wasp and its parasites, during a period of about six years, and so am satisfied as to his accuracy of observation, his most scrupulous adherence to facts, and facts alone; for he never indulged in theory; he was a plain straightforward observer, indefatigable in the search after truth, and unremitting in his attention to the most minute details in all his investigations.

It appears to me only necessary to read a single paragraph in a communication which I had the pleasure of laying before the Entomological Society, on Mr. Stone's behalf, to convince any person of the habit of *Rhipiphorus*; it is as follows:—

"On the 19th of August I was more fortunate; for on taking out a nest of *Vespa vulgaris*, and proceeding to open the closed-up cells, I found a larva of the parasite firmly attached to the full-grown larva of the wasp, the mouth of the former buried in the body of the latter just below the head, its neck bent over that of its victim, whose body appeared to be tightly compressed by that of its destroyer, showing the latter to be possessed of a considerable amount of muscular power. It was of minute size when discovered, and appeared to have only very recently fastened upon its victim; but so voracious was its appetite, and so rapid its growth, that in the course of the following forty-eight hours it attained its full size, having consumed every particle of its prey, with the exception of the skin and mandibles, which, from observations I have since been enabled to make, these creatures retain in their grasp

even after they have passed into the pupa state. They scarcely appear to cease eating, except now and then for a minute or so, from the time they first begin to feed till they have become full-grown."

Thus we learn that Mr. Stone's observation was not confined to that of the single larva "attached to the full-grown larva of the wasp;" on the contrary, from subsequent observations, he was enabled to ascertain that these creatures, in the pupa-state, retain in their grasp the skin of their victims.

Again, he says, "I took out thirteen more nests of *V. vulgaris*, which contained examples of *Rhipiphorus*, either in the larva-, pupa-, or perfect state. In one that had been destroyed by means of gas-tar a few days before, I was fortunate in discovering a small larva of *Rhipiphorus* firmly attached to its victim: both were dead, and had become partially dried; so that when immersed in spirits they did not separate, but remained attached just as they were before death.

"Another nest was taken out on the 2nd of September; and on a closed cell being opened, that was appropriated to a queen, a larva of *Rhipiphorus* was discovered; an adjoining cell contained a pupa; both these were about double the size of larvæ and pupæ found in cells of worker wasps."

Shortly after the publication of Mr. Stone's paper in the 'Zoologist,' vol. xxiii. (1865), that gentleman presented to me the whole of the collection he had made of larvæ and pupæ alluded to in his paper. I have before me a small phial containing the larva of the wasp that has that of its destroyer firmly attached to it, as mentioned above; I have also a phial that contains a number of pupæ extracted from worker-cells, together with one extracted from a queen's cell, showing how greatly these parasites differ in size; then I have larvæ of wasps only partially devoured, together with undergrown larvæ of *Rhipiphorus*. To myself such evidence is conclusive; and it only remains necessary that I examine how far Mr. Murray's discoveries are reconcilable with the apparently proved habit of the parasitism of *Rhipiphorus* as discovered by Mr. Stone.

Mr. Murray informs us that Miss Ormerod observed some cells with two eggs in each (about four in a score had two eggs); in others a young larva at the bottom, and an egg not yet hatched adhering to the cell higher up. Mr. Murray in these cases regards one of the eggs as that of *Rhipiphorus*; this is exactly what I should conclude would be the case; the egg of the parasite, since it feeds upon the full-grown larva of the wasp, after the latter has spun the silken covering to the cell, would remain undeveloped until the wasp-larva was full-

grown, and therefore not previously in a suitable condition for the larva of the parasite to feed upon.

The larva of *Rhipiphorus*, attached to that of the wasp which I possess, is about one-third of the size of the larva of its victim. In three instances Mr. Murray found a pupa of the wasp and also that of *Rhipiphorus* in the same cell, which is considered conclusive against the idea of one feeding upon the other; and it is assumed that they must have been hatched in the same cell, bred lovingly together, and have undergone their metamorphoses in the same cell.

I confess to the difficulty of satisfactorily accounting for this; but it is a well-known fact that parasites do, in some instances, feed upon the larvæ of insects without destroying them; this is of course in cases where the nourishment required by the parasitic larva does not injure or destroy the vitality of the larva preyed upon. *Stylops* is an instance of this kind; and I have bred a species of *Tachina* and a perfect example of *Saperda populnea* from the same cell. Other instances of the kind might be readily adduced; and it may be possible that in the instances mentioned by Mr. Murray the larva of *Rhipiphorus* did not consume the whole of the wasp-larva, did not, indeed, destroy its vitality: these pupæ are described as being stunted; and such may be the explanation. Be this as it may, from some cause or other, parasites (I do not assert that all do so, but many species) vary in size most astonishingly. No better instance of this can be mentioned than that of the common ruby-tailed fly, *Chrysis ignita*: this parasite I have myself reared from cells of *Odynerus parietum* and *O. antilope*; I have also bred them from the nest of *Vespa vulgaris*; and I have bred them from the cells of *Osmia bicornis*. *Osmia parietina* has also a species of *Chrysis* parasitic upon it; I bred it myself. Now, unless we conclude that *Chrysis* is a general feeder, that at one time it is nourished upon lepidopterous larvæ stored up by *Odynerus*, then that it is fed by the social wasp *V. rufa*, and lastly that it feeds in the nests of *Osmia* upon pollen and honey, we must consider it to be a carnivorous parasite, and that it feeds upon the larvæ of the insects whose nests it infests.

Now, I repeat, I know of no parasite that differs more in size than *Chrysis*; and this must, I think, be attributable to variation in the amount of sustenance they obtain: this would certainly be very great in the instances I have enumerated of the larvæ of *Vespa*, *Odynerus*, and *Osmia*. I possess examples of *C. ignita* varying in length from $3\frac{3}{4}$ to 7 lines. I may also instance, as examples of parasites that differ greatly in size, the genera *Sitaris*, *Meloë*, and *Rhipiphorus*.

In one instance the larva of a wasp was found by Mr. Murray in a cell together with one of *Rhipiphorus*, both being stunted in growth; in this case I am led to believe that both died before the parasite was full-fed, the stunted state of the wasp-grub being just what would naturally result from such a catastrophe. The nest of the wasp was removed from its situation, and both perished in consequence; the two larvæ were found head to head, that of the wasp squeezed out of shape, the result, I imagine, of the dying struggles of the parasitic larva.

In cells in which *Rhipiphori* were reared, the débris of the skin of a wasp-larva was found, which Mr. Murray regards as the cast skin of the larva, such, in fact, as is occasionally found in the cells both of the wasp and hornet; but I am inclined to regard these skins as those of the larvæ upon which the *Rhipiphori* had been nourished, and from which they had extracted the entire contents.

The cells which contain *Rhipiphorus* will always be found lined and capped like those of the wasp, because, as Mr. Stone has shown, the larva of the parasite does not commence its attack until the wasp-larva is full-grown and has spun itself up. I have repeatedly watched the larvæ of wasps in the act of spinning these convex caps to the cells; and until the same is observed of the parasite, I cannot but doubt the possibility of the latter doing so.

The following observation in Mr. Murray's paper must, I think, be an inadvertency:—"I here assume, as I think is the general belief, that this lining and lid are spun by the pupæ." I scarcely think it possible that any one can have expressed such an opinion; I at least am not aware of a single instance, and conclude that for pupæ we should read larvæ.

There are other portions of the paper which I leave untouched; some because I am not able to suggest any satisfactory elucidation, and others that do not come within the scope of the object I have in view, that of endeavouring to account for some of the circumstances observed by Mr. Murray, and also of stating that five years ago Mr. Stone convinced me of the true parasitism of *Rhipiphorus*, and I have not since acquired any information that induces me to change my opinion.

The following extract from the Papers of the Ashmolean Society strongly supports Mr. Stone's account of the parasitism of *Rhipiphorus*. After an observation to the effect that no one had hitherto observed any parasite attacking the ant, wasp, humble-bee, or hive-bee, the Rev. E. Bigge, the author of the paper from which the extract is made, observes, "As regards the wasp, however, it seems that this exemption does

not exist; for though I myself have not been so fortunate as to find any specimens of ichneumon in their nests, one has been seen in them by Mr. Denison in several instances, and observed in all the stages of its growth. It is described by him as a fly, as large, or nearly as large, as the wasp itself; the head and fore part of the body black, the abdomen yellow, with a dark streak down the back; legs and wings black; upper wings dusky. This fly (*Rhipiphorus*) deposits its egg upon the grub of the wasp at the moment it assumes the pupa (*i. e.* spins or covers itself in the cell); as soon as the egg is hatched, it devours the grub of the wasp entirely, and itself assumes the pupa- and imago-form in the cell of the wasp."

XLVII.—*On certain nondescript Bones in the Skull of Osseous Fishes.* By GEORGE GULLIVER, F.R.S.

AFTER the much ado of late years about the osteology of the fish's head, it may seem surprising to announce undescribed cranial bones or ossicles in these animals. But that there are such pieces of the skull will probably be admitted by anatomists who may pay attention to the question.

A relation of the means by which these bones became known to me will show how and where they may be found; and this is the object of the present communication.

In separating and trying to put together again that segment of the fish's skull known as the frontal vertebra or prosencephalic arch, I have always found supernumerary bones—that is to say, besides all those usually given as composing that arch, a pair of neat ossicles, each of them thin, cup-shaped and subconical, somewhat triangular or subpyramidal, and measuring, in large codfish, about three-fourths of an inch across the base of the cone and in depth. The apex of each of the bones is rather obtusely pointed; and either of them, with its small end most deeply placed, occurs regularly, sunk into a pit, and easily separable therefrom in the boiled fish's head, at the hind part of each postfrontal.

The woodcut represents, of the natural size, one of these postfrontal ossicles, or *expostfrontals*, from a small codfish.



After a diligent search through the English books of comparative anatomy, I have been unable to discover any notice of the bones in question. And as they had so often puzzled me, I took them to London, on the 6th of August last, when and where they were compared with the admirable preparations of the skele-