Tribe 5. Stenorhynchina. Cutting-teeth conical; grinders more or less three-lobed, two front in each jaw single-rooted, the rest two-rooted. Muffle hairy to the edge and between the nostrils. Hind feet clawless. Antarctic Seas and South Pacific?

Stenorhynchus, Gray, *ibid.* 15, f. 5. Lower jaw strong, ramus erect; grinders with three cylindrical elongate lobes.

Ommatophoca, Gray, *ibid.* 33, f. 4. Lower jaw slender in front; grinders small, compressed, with a central incurved lobe and a very small one on each side.

Leptonyx, Gray, *ibid.* 11, f. 3. Lower jaw weak, ramus shelving backwards; grinders subcompressed, with small central and smaller posterior lobes.

Tribe 6. Cystophorina, Gray, *ibid.* 38. Lower cutting-teeth conical, unequal; grinders with small plaited crowns and large swollen simple roots. Muffle hairy, of male produced or inflated; whiskers waved.

Morunga, Gray, *ibid.* 38, f. 13. Nose of male produced into a trunk. Antarctic and North Pacific Oceans.

Cystophora, Gray, *ibid.* 40, f. 14. Nose of male with an inflated crest. North and, perhaps, South Atlantic.

XLII.—*On some points in the History and Relations of the Wasp* (Vespa vulgaris) *and* Rhipiphorus paradoxus. By Andrew Murray, F.L.S.

Every entomologist knows that *Rhipiphorus paradoxus* undergoes its transformations in the nest of *Vespa vulgaris* (the common wasp which makes its nest underground). But in what capacity it is present there, and what are its relations to its hosts, are still matters of dispute. Is it as a robber and a murderer that it appears, or simply as a guest? and if as a guest, is it as a cuckoo-guest usurping the place of the genuine offspring of its hosts, or as an inoffensive changeling innocently imposed on the unconscious parents, and merely filling up a place which (from the wasp point of view) might have been better supplied had it been left empty?

In support of the more truculent hypothesis, Mr. Stone records, in the 'Entomologist's Monthly Magazine' (i. p. 118), how he found a larva of *Rhipiphorus* "sticking to the larva of

a wasp," which it devoured, except skin and mandibles, in forty-eight hours. The milder supposition had the support of Latreille and most subsequent authors (at any rate prior to Mr. Stone's observation), who, although they always spoke in somewhat doubtful tones, yet on the whole inclined to the opinion that the *Rhipiphori* were bred by the wasps under the mistaken belief that they were their own progeny.

This still seems to me to be the true explanation; and it is supported by some observations which I have recently had the opportunity of making, through the kindness of Miss Eleanor Ormerod, Sedbury Park, Chepstow, a lady with more of the true spirit and genius of a naturalist than any other whom it has been my fortune to encounter. She has been kind enough to assist the Horticultural Society in an attempt they are now making to form a collection of what may be called Economic Entomology—a task for which their connexions give them peculiar advantages, and of which the commencement may be seen housed in the South-Kensington Museum.

The charge of the formation of this collection having been entrusted by the Society to me, Miss Eleanor Ormerod's contributions have consequently passed through my hands, and I have had the advantage of profiting by her talents for observation. Among numerous other illustrations, she lately sent a large wasps' nest, containing *Rhipiphori*; and it is the examination of this, and the picking out the larvæ and pupæ from the cells to fit it for preservation, which has supplied the facts I am about to mention.

In France the knowing mode of procuring specimens of *Rhipiphori*, as expounded to me long ago by my old friend M. Chevrolat, is to note in summer the *locale* of a large wasps' nest, and to return to it in winter, and then examine it. Miss Ormerod's dealings with the wasps are simpler, bolder, and, as will be presently seen, more instructive. The process will be found detailed more at length in her brother Dr. Ormerod's little book on wasps. Enveloping her head in a gauze bag, which is made to stand out from her face by a broad-brimmed hat, and is tied tightly round the neck, protecting her hands by long and stout gloves tied tightly above the wrists, she fearlessly handles, rifles, or removes the largest and most formidable nest. Her subsequent perseverance and patience are not behind her courage; she tells me that she has picked out 3000 larvæ and pupæ from the nest which is the subject of these observations; and the reader will presently see that the intelligence with which every point of interest was observed and noted during the process is equally remarkable.

The nest which supplied our material in the present instance

was a very large one, containing six or seven large combs more than a foot in diameter. It was built in the ground, partly in a rough stone drain, and unusually deep and distant from the opening, being more than a yard from it, and fully a foot beneath the surface. The soil was very hard, so much so that it took a strong labourer nearly half an hour's work to get at it.

When the nest was raised out of its hole, after asphyxiating its inhabitants, a fully formed male and female *Rhipiphorus* were found, one lying dead among wasps at the bottom of the nest, and the other gone head foremost into one of the great cells (queens' cells) at the bottom.

No other *Rhipiphori* were found by Miss E. Ormerod in the lower or last-made tiers of comb—that is, in those composed of large cells (for male and female larvæ); all except the lowest two tiers of comb were composed of small or worker cells. She found no larvæ, but pupæ in every stage, from that almost resembling the larva in whiteness and form to the perfect insect, able, when the cap or seal of the cell was removed, to run out with such speed and dash down a neighbouring cell, that she could scarcely distinguish what it was. She mentions incidentally the stages she remarked in development were white, white with the black showing on the thorax, and coloured before the wings had developed. She noticed, too, that, in coming out, the pupæ did not cut the lid or cap nicely round, as the wasps do, but thrust their heads roughly through the middle of it, apparently only getting out by forcing their way slowly through the torn hole; but she did not see any specimen complete the operation of freeing itself.

All the specimens in the nest in question were of the common size; but two or three varied from the others in colour, as in having the abdomen black (or black with light rings) instead of yellow. From another nest, however, she took one of the large size mentioned by Prof. Westwood, in his 'Introduction to Entomology,' vol. i. p. 294, on Mr. Hope's authority, as being found only in the cells of the female wasps; the comb she took it from was full of nearly full-grown females of *Vespa vulgaris*.

Having picked the combs of the large nest pretty clean, Miss E. Ormerod sent it on to me, kindly leaving a portion of the cells unopened in all the combs, for me to have an opportunity of verifying her observations for myself. I found about fifty specimens of *Rhipiphorus* ready to come out, alive, not quite so active as described; but that was, no doubt, due to their not having reached their full term. I also found about a dozen pupæ less advanced. I did not distinguish any

difference in the proportions of the sexes in the combs which I examined: male and female seemed to come indifferently; and the cells in which they were placed seemed to be scattered indiscriminately over the combs in which they occurred, perhaps occurring a little more frequently towards the outer margin than the centre; and in the case of those near the outer margin, more of them seemed to lie near to each other. As already said, there were none in the queens' cells; but the greater part of them were as yet unoccupied.

In three instances I found two pupæ in the same cell, a wasp-pupa and a *Rhipiphorus*-pupa—a fact which seems to me to be conclusive against the idea of the one feeding on the other. They must have been hatched in the same cell, bred lovingly as larvæ in the same cell, and undergone their metamorphoses in the same cell. Both the pupæ in two of these instances are preserved in a phial of Canada balsam, and exhibited, along with the combs and sketches of their position, in the South-Kensington Museum. Their position was remarkable. In one of them the pupa of the wasp was next the mouth of the cell, but with its tail to the mouth, and the pupa of the *Rhipiphorus* further in, with its tail to the base of the cell, their heads thus meeting. The usual black saucer of droppings of the wasp-pupa was at the mouth of the cell. I shall return to it presently, but in the meantime stick to the *Rhipiphori*. Both pupæ were sufficiently developed, rather small and stunted perhaps, especially the *Rhipiphorus*, but all right, no lesion or distortion. In the next case there was distortion: the larva of the *Rhipiphorus* was uppermost, and I think (although I am not quite certain) that its head was towards the mouth of the cell. Its tail, or, to speak with absolute caution, its inner end (be it head or tail) rested on the head of the pupa of the wasp; and at first I thought the head of the latter had been eaten away, but, on closer examination, I found that it had merely been squeezed out of shape, leaving a discoloured depression where it should have been, and had dwindled into an unnatural small lump, in which, however, the eyes and mouth are to be distinguished. It was obviously nothing but the result of protracted pressure, which had begun to end in the destruction of the parts exposed to it. In the third case, the wasp-pupa was next the mouth of the cell, with its black deposit in the lid (preserved *in situ* at South Kensington), and the *Rhipiphorus* at the bottom in its natural position. Both were unhurt, but rather small.

On examining the bottoms of the cells from which the *Rhipiphori* were taken (I mean those which had a cell to themselves) I found more than once the débris of the skin of a

wasp's larva, easily recognizable by its mandibles. At first sight this might seem to indicate that the *Rhipiphorus* had consumed a previous tenant of the cell, and recalled to my mind the way in which Mr. Stone speaks of his wasp-larva being devoured by a *Rhipiphorus*-larva, except "skin and mandibles," in forty-eight hours. But if any one will search the cells of the wasp-pupæ, and still more those of the hornet, they will constantly find the same thing, a shred of skin and mandibles, the skin of the mandibles being particularly noticeable in consequence of its greater strength, higher colour, and definite form. It is plainly the cast skin of the larva. It has all the look of a cast skin (every entomologist will recognize my meaning); and its occurrence in cells inhabited by *Rhipiphorus* is simply due to the *Rhipiphorus* having taken up its abode in a cell formerly inhabited by a wasp-pupa. Mr. Stone's observation, as it appears to me, must rest on a mistake in some way arising out of such a cast skin. The wasps, indeed, are said to clear out the cells which have been inhabited previously, before laying their eggs in them again. I have seen no indication of any such cleaning or redding up for a new tenant. The dégâts at the bottom are left all standing, and, from the size of this dung-heap (especially in the hornets' cells, where the quantity is naturally much greater), it is not difficult to distinguish those cells which have had more than one tenant from those which have been used only once. The silvery lining of the walls is all left, and, what we have specially to do with also, the cast skin of the previous larva. It is constantly to be seen in the cells; and that we do not see it always may be due to its sometimes decaying away or getting covered with additional rejectamenta; for it is plain that the digestive operations will continue after the insect has ceased to feed, and shut itself up, until the contents of its stomach are all voided. This, moreover, is proved by the black deposit having been found at the mouth of the cell in the case of the reversed specimen first above noticed. If it had been deposited prior to sealing up, it must have fallen out, not to speak of the barrier it would be to the larva in spinning itself up. The eggs of the wasps are not deposited, as by the bees, at the bottom of the cell, but about a third of the way up, so that this débris does not interfere with them.

In picking out some specimens of cells with eggs attached, Miss Eleanor Ormerod observed some with two eggs in the same cell. She sent me some of these combs, in which a tolerably large proportion (about four out of a score) had two eggs, either both in the state of eggs, or a young larva at the bottom and an egg not yet hatched adhering to the

angle of the cell higher up. I have tried my best to find a difference between the two eggs, but without success. I am not sufficiently acquainted with the economy of wasps and bees to know whether the queens often or ever commit the mistake of laying two eggs in the same cell: it may happen sometimes; but when it does happen, one would expect to find the mistake at long and wide intervals, not in a cluster or near each other, unless, indeed, we are to suppose that the queen only makes the mistake when she is in a stupid or absent frame of mind; for then the mistakes should all be near each other. This, however, seems less likely, because the exercise of instinct is not like that of pure mental effort. A man's instinct will lead him right when his reasoning fails him. Every one must be able to recall to his mind some time or other when he has instinctively found his way home although his mind has been so preoccupied as to take no note of external objects; and absence of mind would therefore be immaterial to an insect engaged on an operation of instinct. Now in the combs containing eggs the doubly employed cells were located near each other; and that I should be inclined to regard as a *primâ facie* presumption that one of the eggs was not that of the wasp, but of *Rhipiphorus*.

Should that be so, the points of resemblance in the economy of the *Rhipiphorus* to that of the wasp would become very striking. We should have:—

1. The egg of the same size, texture, shape, and transparency in both. (I am not quite positive about the enclosed undeveloped larva being quite the same. I have thought that in Canada balsam, which makes the shell transparent, the one seemed longer than the other; but this may have been due to state of advancement or imperfect observation.)

2. We should have the egg attached in the same way, at the same height in the cell, and in the same angle as it is placed by the wasps.

3. The larvæ must feed on the same food as the wasp-larvæ, and deposit similar black droppings; for these are found in the *Rhipiphori*-cells as well as in the wasps', and are undistinguishable from them, consisting of débris of digested insects, which might with care be often identified. In the hornet, where the fragments are larger, the identification of most of them can be made without much difficulty. Miss Eleanor Ormerod shrewdly remarks to me, however, that she has observed that, unlike the wasps, the dead pupæ of the *Rhipiphorus* keep well in their cells, and that this may be due to a difference of food. But we must remember that their texture is naturally harder and drier.

Lastly, it must pass into the pupa-state, and spin a cap or lid to the cell, and the membranaceous, thin, silvery, shiny-looking lining to the cell, all in the same way as the wasp-pupa; for the lids of the *Rhipiphori*-cells are identical with those of the wasp-cells and undistinguishable from them. I here assume, as I think is the general belief, that this lining and lid are spun by the pupa, although it does not present itself to my mind as absolutely free from difficulties. I am not a hymenopterist; that is, I do not make a specialty of that branch of entomology; I therefore may without loss of credit indulge in wonder not allowed to the better-informed specialist at some of the things which to my unsophisticated mind appear amazing and puzzling, but which to him are hackneyed and trite. The lid of these wasp-cells and the manner of their formation is one of these things. The authorities say the pupæ spin them; and that they are spun is demonstrable by examination of some of the less hard and complete lids. You can see the threads stretching across and interlacing each other in every direction. Moreover, plenty of observers have seen them doing it, and watched their heads going to and fro with the regular spinning motion, under a commenced lid; so that there can be no doubt up to that point. But we must go a step further. Can they do it with their tails? Two of the wasp-pupæ in the doubly employed cells were outermost, and in both cases tail to the mouth of the cell, and a black cap or deposit of its droppings lay just within the lid. Miss Eleanor Ormerod observed the same thing; but in her case, although there may have been two pupæ in the cell (and in my own mind, I have no doubt there were), she did not observe it, but was struck only by the reversed wasp-pupa. At that time we had not met with any cells containing two pupæ, and she may have overlooked a *Rhipiphorus*-pupa below it; but she marked the cell, and I searched it subsequently without finding any traces of double employ; but it was some days after before I looked, and by that time the pupa might have decayed or shrunk, so as under my manipulation to have become confounded with the débris at the bottom of the cell. The cells containing these reversed wasp-pupæ were in every respect the same as the surrounding cells. The spun lid was the same, and also the silvery lining and the strong base—no back door or any means of feeding or getting in from behind. Now I hold it to be impossible for the full-grown larva to turn in its cell—that is, to reverse its position. It can turn and turn on its side, turn about and wheel about on its pivot; but turn summersaults it cannot. If the larva then spins the lid, it must apparently be able to supply the silk or matter of the thread,

and to spin it equally well with its tail as its head. I do not say that it does not; but it seems a very unusual aggregation of gifts, an *accumulatio munerum* for which there is no precedent. Nature never provides for unnatural or exceptional events, but leaves the unhappy victim of them to meet its fate and die.

The explanation which has occurred to me is this—a little far-fetched, perhaps; but the difficulty seems to warrant a stretch. There are two difficulties, the supply of the material and the spinning. As to the first, it must be remembered that the position of the cell is mouth downwards; so that if the fluid silk or glue was ejected in quantity from the mouth of the larva, it would naturally flow down its body or along the walls to the mouth of the cell. I suppose that the grub at that stage of its existence is constantly expectorating some of this glue (if we touch its head at that period, it may be seen to eject from its mouth a bell of clear liquid like water, which I have no doubt is liquid silk), and that the slimy-looking stuff on the walls of the cell is part of it which has adhered to them. When the grub is ready to pass into the pupa-state, it spins it into the lid; and its weight, elasticity, and adhesive qualities make it take the cup-shaped form the lid bears. If we examine one half finished, we see the threads crossing the outside rough and somewhat woolly; but I suppose a quantity of glue poured out on it from within, after it has reached this stage, penetrates the interstices and gives the outside the glossy look which the finished lid bears. Suppose, then, the larva reversed, no change will take place so far as regards the glue on the walls; it flows down them and coats them as before; but when the larva begins to spin, the head being now uppermost (the mouth of the cell being downmost), the glue will fall back and flow past the grub to the mouth of the cell. This would explain why there is no lid in the middle between the two pupæ; the movement of the other larva would be sufficient to prevent its settling, and the matter would then by gravitation find its way downwards. If the larva then is restless and moves its tail (which, although used as a sucker, it can detach and move as it likes) from side to side, it would imitate the motion of spinning and prepare a sieve of sufficient fineness to retain any more liquid that flows down, and so complete the lid. The only difference from the usual process would then be, that, instead of the material being supplied from the pendent mouth, it streams backwards down its body. That the larva has enough of this glue streaming from its mouth to cover the whole body will be apparent to

any one who looks at an unexcluded pupa nearly mature, when he will see it is clothed in a hardened cake of it all over.

This may explain the spinning of the lids to the cells of reversed wasp-pupæ; but what shall we say to those of the *Rhipiphori*? Have they the same *fluida sericina*? I suppose they must; but we want observation on this point; and for the present I must content myself with having pointed out the want.

These reversed larvæ present other difficulties. How do they maintain their place in this unnatural position? Normally their position is head downmost (not in reference to the cell, but to the ground). The cell has its mouth downwards, and the head of the grub is at the mouth of the cell. In that position one would expect it to fall out; but it uses its tail as a sucker, and hangs on by it. When you pull them out of the cell, you have to give a tug to bring them away. Reverse it, and it might hang on like a sailor by the teeth for a little, but certainly could not do so for any length of time. It must in any event sometimes open its jaws to eat, and it would then fall out. I suppose it must hold on as usual by the tail; only, instead of fastening itself at the base of the cell, it will do so on the sides of the mouth of the cell. It would have the disadvantage of the weight of the body pressing on the tail, instead of hanging from it; but I can see no other way in which it could be done. In the pupa-state both the reversed specimens had the tail adhering as a sucker to the black saucer of débris lying in the lid of the cell.

The manner in which these reversed larvæ can have been fed is another puzzle. Miss Eleanor Ormerod suggests that it may have been through an opening towards the base in an adjoining cell; but I can find no such opening, and, moreover, all the surrounding cells were themselves tenanted. It somehow seems not quite so difficult to imagine how it could be done with two larvæ in the cell (the one at the mouth reversed and the other not) as it would be with only one, reversed. The grub in the latter would have its mouth so far in the cell that the wasp coming with food might not be able to reach it; but when there are two (arranged as supposed), the inner one, of course, both has its own head halfway to the opening, and directed towards it, and also prevents the other going so far into the cell, and its head must just meet that of the inner one. Thus, if the wasp gets at the mouth of the inner one to feed it, the upper reversed one must always have the opportunity of taking a share of what is given to it.

I feel rather inclined to suppose that the only case in which

we can find reversed pupæ is when there are two in the cell. It is only under such circumstances that one can conceive the grub taking the reversed position. In the ordinary case of only one grub in the cell, it is so small when it first comes out of the egg, that it can turn and shift its position as it likes; and of course the position it likes will be that with its mouth to the food-bringer. But when there are two, if the egg first evolved be lowest, or, what is the same thing, if the grub first out has taken its position at the base of the cell with its head to the mouth of the cell, when the last evolved breaks out of the egg, the latter will naturally turn its head down to that of the former when it receives its food, in order to partake of it, and will gradually settle into that position until it grows too big to have room to change it. I am also inclined to believe that the only case in which two pupæ are found in one cell is when one of them is a *Rhipiphorus*.

I have only, in conclusion, to say that evidence of the accuracy of all the facts above recorded is, I think, to be seen in the collection in the South-Kensington Museum. As already said, I have not sufficient acquaintance with the economy of wasps and bees to be sure that the occurrence of reversed pupæ and grubs, although new to me, is not perfectly well known to hymenopterists, and that all the points I have been boggling at have not been clearly and satisfactorily explained; but I know that if they have not been previously observed, they will have and ought to undergo the usual scrutiny of doubt and suspicion. To any one who shall feel so far interested in the subject as to wish to test them, I would recommend the little black saucer of droppings taken from the mouths of the cells of the reversed pupæ as a good "*pièce justificatif*." Its shape will tell that it did not come from the base of the cell, but must have come from the mouth. One of these is left actually *in situ* under the lid of the cell or cocoon; another is in a phial of Canada balsam (as to which, however, I may add the scarcely necessary caution that its position in relation to the pupa in the phial is not the natural one: when I put it in, its tail was still attached to it; but it became detached; and, in settling, it has wheeled round and its mouth come into contact with the black saucer; but no one knowing the nature of the saucer will mistake that for its natural position). The pupæ from these doubly tenanted cells are also there; and if there is anything I have overlooked, it is, I hope, unnecessary to say that I shall be happy to supply it to those who may wish to know more, if they will specify the points on which they desire information.