

THE MYTH OF SEMIAQUATIC PHASMIDS.

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With 2 figures in the text.

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Mr. R. W. PAINE, Government Entomologist at Fiji has recently brought home and presented to the British Museum two female specimens of a remarkable Phasmid, *Cotylosoma dipneusticum* WOOD-MASON. However, even more valuable than the specimens are the observations on the habits of this insect which Mr. PAINE has been able to make and which he very kindly allowed me to use. These observations supply a convincing proof that the specific name of the insect, implying its ability for both aerial and aquatic respiration, was based on nothing else than theoretical deductions from a superficial study of structure. The history of this error is of considerable interest, the more so that it is linked with the equally unjustified descriptions of similar habits in another Phasmid, occurring in South America.

Structural adaptations to semiaquatic life in Prisopus.

The story of the remarkable semiaquatic habits of the Brazilian *Prisopus flabelliformis* STOLL can be found in most standard book on entomology, where they are described as actually observed facts, and it is interesting to investigate the origin of these statements.

The observations on *Prisopus* are usually credited to MURRAY. From MURRAY's paper (1866) on the subject it can, however, be inferred that he had seen only a dead specimen of the insect. The specimen was received by him from ALEXANDER FRY in Brazil, who also had never seen the insect alive, but had obtained it from a third person, not named. That unknown person, apparently not a naturalist at all, told FRY that the insect was caught by him in the mountains of Brazil, and "its habits were to spend the whole of the day under water, in a stream or rivulet, fixed firmly to a stone in the rapid part of the stream; but on the approach of dusk to leave the water and to sally forth into the night air on its own affairs . . ."

MURRAY, having taken this fantastic description for scientifically established facts, proceeds to discuss in great detail various points in the structure of *Prisopus* which appeared to him as remarkable adaptations to this unusual mode of life. The following features are particularly mentioned:

1. Body is flattened and hollowed out on the ventral side, so that the insect can cling to a stone by exhausting the air between the body and the stone.

2. All the legs fit closely to the sides of the abdomen and are dentate and provided with a thick fringe of hair. "Moreover, at the knee-joint, where there is unavoidably an opening or unprotected space, it is provided with a flap or side knee-pan, a provision which occurs in no other insect with which I am acquainted. This flap hangs down, filling up the opening and is furnished, like the rest of the outer margins of the leg and body, with a supply of hair impervious to water". The flap is supposed to serve for closing the opening at the knee-joint, so that a vacuum can be created under the body. Actually, there are two flaps, one on each side of the base of the anterior tibia, though MURRAY apparently noticed only one.

3. The tegmina in other Phasmidae are usually short and narrow, while here they are as long as the body, and broad enough to cover the whole of the large underwings when folded.

4. The claws of the tarsi are strong, powerful and well adapted for clinging to a stone in rapidly running water.

In this description, the author's wish to find adaptations for aquatic life led him to make a number of misstatements and unwarranted conclusions. The shape of the body, very flat and hollowed out ventrally, can be observed in most Phasmids living on trunks and branches of trees. Moreover, it can also be seen in other *Orthoptera* of similar habits, such as Mantidae of the genera *Theopompa* and *Tarachodes* (particularly larvae), Tettigoniidae of the genera *Sathrophyllia* and *Cymatomera*, etc. In most of them, expansions on the sides of the abdominal segments and on the legs are observed, as well as the fringes of hair, supposed by MURRAY to exist in *Prisopus* only and for a highly special purpose. Tarsal claws in *Prisopus* are not particularly strong and powerful. As regards the elytra, their description is incorrect, since in *Prisopus* they are definitely shorter than the wings, and are not adapted to protect the latter from water; in fact, they are built exactly as in very many other Phasmid genera. The only peculiar feature of *Prisopus* are the pair of flap-like appendages on the knees, to which a highly special function is ascribed by MURRAY. These appendages are really very peculiar, but we will return to their discussion later on.

It will be seen that as far as *Prisopus* is concerned, there is nothing in its morphology to support the story of its semiaquatic life. No evidence whatever in support of the story came to light during nearly seventy years which elapsed since its publication, but nevertheless it is still repeated in modern books on entomology. There is little doubt that the first unknown author of the story has either invented it for FRY's benefit, or as suggested by my friend Mr. D. E. KIMMINS, he may have mistaken the Phasmid for a Perlid, for which such habits would be normal while a general resemblance of *Prisopus* to a large Perlid is very striking.

Cotyllosoma dipneusticum and its "tracheal gills".

In 1878 WATERHOUSE showed WOOD-MASON a Phasmid in the British Museum collection with curious laminate appendages on the



Fig. 1. *Cotyllosoma dipneusticum*
W.-M., ♀.

sides of the metathorax. WOOD-MASON, obviously under the influence of MURRAY'S description of semiaquatic habits of *Prisopus*, did not hesitate to ascribe the same mode of life to the new insect. He gave it the appropriate name of *Cotyllosoma dipneusticum* (fig. 1), but only a very sketchy description. According to WOOD-MASON "the insect in question is closely related to the *Prisopi*, but is even more profoundly modified for an aquatic life; for it breathes not only in the ordinary fashion amongst insects by means of tracheae opening by stigmata on the exterior of the body, but also by the structures known as tracheal gills. From each side of the body, in fact, along the lower margins of the sides of the metathorax, there stand straight out five equal small but conspicuous ciliated oval plates, which, when the insect is submerged and its stigmata are closed, doubtless serve to bring the air that is thus shut up within the body into such intimate relation either with the oxygen dissolved in, or with the air in mechanical mixture with, the water as to render diffusion and consequently respiration possible. The only other insect known to me in which during adult life ordinary aerial respiration and respiration by

tracheal gills co-exist is *Pteronarcys regalis*, one of the *Orthoptera Amphibiotica*".

It was not until 1895 that WATERHOUSE returned to *Cotyllosoma* and published a good figure of it. As regards WOOD-MASON'S most positive statements on the function of the metathoracic appendages, WATERHOUSE says: "There is nothing in the form of the lateral plates of the metathorax to show definitely that they are 'tracheal gills', although I would not, on the other hand, say that they are not."

SHARP (1895) and REDTENBACHER (1908) are definitely of the opinion that the metathoracic appendages in *Cotyllosoma* are not tracheal gills, although no one apparently has studied these structures in detail. It is

curious that both these authors nevertheless continue to believe MURRAY'S account of the habits of *Prisopus*.

The nature and probable physiological role of the metathoracic appendages can be studied very imperfectly on dry material only. My friend Mr. W. E. CHINA has kindly made a preparation and drawing

(fig. 2) of one appendage, after boiling in water one of the females brought by Mr. PAINE. The appendage is flat, with strongly chitinised walls, which at once suggest that it cannot possibly act as a gill. Moreover, it is supplied only with a very small tracheal branch, which is only slightly divided inside the appendage. The trachea obviously serves only to bring in oxygen necessary for the organ. The true tracheal gills are, of course, served by a large trachea which is divided into numberless small branches coming in contact with the very fine walls of the gill. Even this superficial study of the appendage reveals its absolute lack of adaptation for the respiratory function. The knee appendage of *Prisopus* has an exactly similar structure.

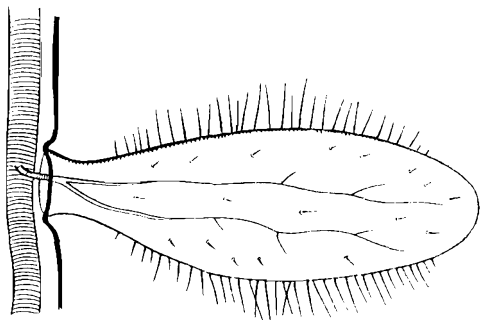


Fig. 2. *Cotylosoma dipneusticum* W.-M.,
a metathoracic appendage.

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Habits of Cotylosoma dipneusticum.

Mr. PAINE has kindly supplied me with the following notes on the two specimens collected by him in Fiji:

"The specimen with the broken off legs etc. was taken in the forest — on the ground — at 1,100' on the west side of Taveuni, Fiji in January 1934. It was crawling on the ground some way from any water in such a manner as to leave no doubt that it did not habitually frequent streams, as was formerly suggested. This female laid several eggs during the 6 days it was kept alive in captivity, but it never fed on any of the things provided for it — leaves of the tree (*Lauraceae*, Gen. undetermined) near to the trunk of which the specimen was found, sundry mosses, lichens and ferns from the floor of the forest in the locality where the insect was taken. The eggs were kept for more than 4 months, but none hatched; and on dissection showed no sign of embryonic development. They appeared to be infertile. The other specimen — also a female — was brought to me by a planter (in June 1934) who captured it in the forest at about 400' above sea level on the west side of Taveuni. Apart from the fact that it was crawling about in the forest I could get no very exact information regarding the exact situation in which it was found.

I killed this specimens, and dissected out the stomach to see if the contents of the gut would throw any light on its normal habitat and food. The gut contained bitten off fragments of a green dicotyledonous leaf (unidentifiable) and some rather pulpy yellowish plant matter, possibly fruit skin or dead leaf (probably the leaf veins or petiole, which in many forest plants on Taveuni are yellowish in colour). Also some interesting coffin-shaped, white objects of varying sizes — the longest about $1\frac{1}{2}$ mm. long. They resembled diminutive and much attenuated hymenopterous cocoons with a pupa inside, but I do not know what they were.

There is no doubt whatever in my mind that *C. dipneusticum* is not an aquatic insect. It appears to be an exceedingly uncommon insect, because it has only been found in Fiji on the island of Taveuni and apart from the two specimens I got last year I have seen only one other specimen before — a somewhat battered female in the Government collection in Suva.

But, on the other hand, it had been supposed by entomologists resident in Fiji that the insect frequented the beds of streams and for that reason no very thorough search has been made for it on forest trees. Furthermore, comparatively little collecting of a general nature has been done in the Fiji forests by resident or visiting entomologists. I have searched many stream beds on Taveuni primarily for mosquitoes; but I always kept an eye open for *Cotylosoma*. My failure to find it there does not now surprise me.

It is mentioned by SHARP that the describer of the species considered it probable that the curious leaf-like projections from the ventral side of the metathorax were tracheal gills. I have no idea what the function of these organs is, unless they assist in the general protective form of the species, which in colour and shape closely resembles certain lichens amongst which it may very possibly rest on the trunk of a forest tree. But the ventral position of the organs seem to suggest that they have some other significance than that of protective body pattern.

As far as I am aware the male of this insect has never been found; but it seems likely that this sex exists, because the eggs laid by the female captured in January 1934 did not hatch, and it would appear that the parent female had not mated or else had depleted her supply of spermatozoa by the time the eggs were laid in captivity."

Mr. PAINÉ's notes leave no doubt as to the true habits of *Cotylosoma*. Confirmatory evidence in support of this view can be found in a note accompanying MCGILLIVRAY's description (1860) of *Prisopus carlottae* from the New Hebrides, which also belongs to *Cotylosoma*. According to that author "it is said to be found on the trunks of trees". All morphological features of *Cotylosoma*, such as the flattened body, with expanded margins, laminate and wavy margins of legs, fringes of hairs, etc., are most typical of an insect living on tree trunks covered with lichens and certainly would be most unusual in an aquatic insect.

The only structures for which it is not easy to account are the metathoracic appendages. We have seen that they cannot possibly be respiratory organs, and Mr. PAINE must be right in his suggestion that they cannot represent outgrowths of the body intended to produce a closer imitation of lichens. Indeed, they are not particularly lichen-like in their appearance. Moreover, they are not mere expansions of chitin, but definite organs, connected with the body by a joint. It is very interesting that exactly similar organs are found in species of the genus *Prisopus* where they are represented by jointed "knee-flaps" (MURRAY) of the same shape and structure as the metathoracic appendages of *Cotylosoma*. It would be futile to speculate on the possible physiological role of these peculiar organs, until these insects are studied alive, and the histology of the organs is investigated on fresh, or suitably fixed, material. It would be particularly interesting to study their innervation as they may most likely represent some sense organs.

Systematic notes on the genus Cotylosoma.

REDTENBACHER (1908) considered *Cotylosoma* a synonym of *Nisyrus*, a genus described by STAL (1877) to include a Fijian species, *N. spinulosus*. There is no doubt, however, that the two genera are sufficiently distinct. In *Nisyrus* the whole body is much more spinose; femora and tibiae are provided with flattened margins; but, they are not broadly foliaceous as is the case in *Cotylosoma*; metatarsi of all legs are not expanded; foliaceous lobes of abdomen are small, not overlapping; female cerci small, not expanded apically.

The following four species are true *Cotylosoma*: *C. dipneusticum* W.-M., Tavuni, Fiji. *C. amphibius* ST., Tonga. *C. godffroyi* REDT., Tongatabu. *C. carlottae* MCGILL., New Hebrides.

REDTENBACHER (l. c.) quotes *C. amphibius* and *C. carlottae* from Fiji, as well, which suggests that the presumed specific characters are of doubtful value.

All known species have been described from the female sex alone, and resident entomologists of Oceania should try to discover the males. Now that the true habitat of these insects is known, it will be easier to find them and to throw more light on their habits.

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