The Ecologic Relations of the Photogenic Function among Insects.

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Among the numerous interesting problems connected with the emission of light by living organisms are those which center around the usefulness of the light-producing power to the organisms themselves. For the great majority of luminous creatures no definite conclusions as to the utility of the luminosity can be reached, although there are good reasons for considering that it is probably defensive, alluring etc., in function, in various groups.

In at least two phyla, however, it has been possible to arrive at a definite explanation of the usefulness of the photogenic function during the life of the organisms:

Among the Annelids, Galloway (3) and Galloway and Welch (4) have shown that the luminosity serves as a mating adaptation in Odontosyllis enopla. Recently Potts (17) has called attention to the similar habits of Odontosyllis phosphorea, in which the luminosity appears to play a more subordinate part in mating. Lund (8) has also made observations on marine annelids.

It is among the insects, however, that we have the most definite cases of the application of the light-producing power to lives of the organisms. Among the Coleoptera there is the family Lampyridae, in which a very large number of the species possess the photogenic function. The surmises as to the usefulness of this function to these insects have embraced the protective, alluring and reproductive ideas, but it is now known that in at least certain of the genera of Lampyrids, the photogenic function serves, as in the Odontosyllids mentioned above, as a mating adaptation. Among the older writers, Spallanzani (18) and Rennie (19) both called attention to the attraction between the sexes apparently as the result of the luminosity, though the latter writer is inclined to interpret his observations as rather opposing the theory of the significance of the function for mating. Lubbock (7) notes a similar instance.

The first conclusive observations were made by Osten-Sacken (16), on the American species Photinus pyralis. Osten-Sacken found that the females of this species remained clinging to grass, leaves, etc., while the males flew above them, flashing at intervals. When the flash of a male was seen by a female, she answered by flashing, and upon the male seeing this answering flash, he alighted near the female, finally locating her definitely through subsequent flashes, and mating with her.

Next chronologically were the observations of Emery (2) upon Luciola italica. Emery watched the actions of the sexes in this species, and concluded that they depended upon the use of the luminous power for meeting and mating. He then tried a number of experiments, and found that females enclosed in a perforated opake box did not attract males, while those enclosed in glass vials did, thus excluding the effect of odors.

Osten-Sacken's paper was not well known until recently, and his observations were accordingly frequently overlooked, he records, however, what is probably the first definite establishment of the ecologic relations of the photogenic function in any species. Not knowing of
Osten-Sacken's work at the time, McDermott (11) recorded observations on the mating of Photinus pyralis very similar to those of Osten-Sacken. He found further that it was possible to cause light-emission from either sex by the proper operation of a small electric lamp in imitation of the opposit sex, or from the females by flashes of light from other sources, such as a match. A slight pause was found to intervene between the flash of the male and the answering flash of the female. McDermott (11, 12) extended his observations to Photinus consanguineus, P. scintillans, P. marginellus, P. castus and Lecontea lucifera.

In Photinus consanguineus the flash of the male, instead of being single, is composed of two distinct coruscations, while that of the female is a single flash like that of the female pyralis; the female consanguineus would answer only to a double flash. In P. scintillans and P. castus, both smaller species than P. pyralis, the flashes of the male and female are both single, and of rather shorter duration than that of pyralis; the ranges of the two species appear to overlap, though they were not found together. P. castus and P. marginellus were found in the same habitat; the manner of light-emission of the males of the two species differs only slightly, that of marginellus being a trifle sharper. The females, however, appear to distinguish between them readily, and the answering flashes of the two females are quite different. The flash of the female castus is a single flash, as described above, following the flash of the male by a very short pause; that of the female marginellus is a distinctly double flash, the two maxima following each other closely. With the idea of making these differences somewhat clearer, the accompanying diagram has been drawn, in which the abcissae represent time, one second to the centimeter, while the ordinates represent luminous intensity, one centimeter equalling approximately 0.02 candle-power.

Photinus castus was first described by Leconte as a separate species, but was later classed by him as a variety of marginellus. On account of the differences in light-emission, McDermott (13) has restored it to the position of a distinct species.

Green (6) has recently described the mating of Dioptoma adamsii; in this species the luminous organ of the female is, as usual, ventral, but the luminosity is rendered more effective by curling the abdomen over the dorsal, so as to expose the surface of the luminous apparatus upwards. The abdomen is returned to the normal position upon the approach of the male. In this case, as in Lampyris noctiluca, the female is larger and brighter than the male.

The conduct of the Lampyridae toward artificial light is of interest. Both McDermott (11, 12) and Mast (10) have shown that the species of Photinus may be deceived by small artificial lights operated in imitation of the opposit sex. They are, however, practically unaffected by ordinary continuous lights. The writer has seen a male Photinus pyralis fly past an open arc-light, within about 1.25 meter of the arc, without showing the least sign of attraction toward it. On one occasion a decided attraction toward an oil lamp was observed on the part of a male of Lecontea lucifera. Lund (8) has observed that the Jamaican species Photinus pallens shows a very slight attraction toward ordinary lights. On the other hand, the males of Lampyris noctiluca have long been
known to be attracted toward lights. Both sexes of *Photuris pennsylvanica*, a species whose mating has been observed only rarely, and in which the relation of the luminosity to mating is unknown, come to light quite frequently.

Mast (10) has shown that the orientation of the male *Photinus* to the female after her response, is extremely accurate, and takes place after the stimulus has ceased, in entire darkness, thus offering an objection to Loeb's theory of phototropism.

There appear to be two main or general types of expression of the photogenic function among the *Lampyridae*; these are (A), that in which the female emits light in flashes, and only in answer to a male (or to artificial stimulus), typified by *Photinus*; and (B), that in which the female exposes a continuous light until mated, typified by *Lampyris*. In A, the males are usually the more brightly luminous; in B, the females are usually the brighter and frequently apterous, while the males may be nearly or entirely non-luminous. The second type reaches its extreme development in *Phengodes*, e.g., *P. laticollis* (see Barber (1)). Gorham (5) and Olivier (14) have both called attention to the relations between the development of the photogenic apparatus and that of the eyes, antennae, etc., in the sexes. As a general rule the eyes of the males are larger and their antennae longer than those of the females, the extreme being represented by *Phengodes*.

Some species which in the adult stage are diurnal and have either no luminous apparatus, or organs which are non-functionating, in the larval stage possess organs as highly developed as have the larvae of the brightly luminous species; such are *Rileya (Lucidota) atra*, and it is said, *Ellychnia corrusca*. *Phosphaenus hemipterus* — apterous, diurnal, and faintly luminous in both sexes and in the larva — seems to be quite anomalous, and probably represents a degeneration.
Some interesting speculations as to the phylogenetic relations of the Lampyridae and other luminous insects presents themselves here, but we have so little evidence in any direction that even speculation seems hardly justified. Olivier (15) has called attention to the main features in the geographic distribution of the Lampyridae. The relatively immense number of species in South America — nearly half of the 1200 described species — is especially interesting and probably significant. The relatively scarcity in Africa is also noteworthy. On the whole the Lampyridae show the same peculiarities in dispersal as are found among other creatures; — e. g., the genus Ptilocladus, whose species are found only in South America and in Japan.

A second interesting group of luminous Coleoptera are the members of the Elaterid genera Pyrophorus and Photophorus. These two genera are very close, and while little is known as to the habits of Photophorus, it is not improbable that it will prove very much like Pyrophorus. Lund (S) and others have shown that Pyrophorus is strongly attracted to a moving light, and we are probably safe in assuming that in them the luminous power plays the part of an attraction between the sexes. Photophorus presents one of those remarkable peculiarities of geographic distribution, occurring as it does in the Fiji and nearby islands, some eight thousand kilometers from its nearest luminous relatives in South America.

Phengodes has already been referred to under the Lampyridae; the peculiar structures of these insects, the vast differences between the sexes in the adult stage, etc., has long made them a matter of considerable entomologic interest; with them stands, in this regard, Dioptoma adamsii, before referred to. The New Zealand Bolitophilus luminosus seems to be about the best known of the non-coleopterous luminous insects, and presents the only definitely known instance of proven self-luminosity in the entire order of Diptera.

It it probable that among all the brightly luminous members of the family Lampyridae, the luminosity serves as a means whereby the sexes may meet; it also seems very probable that this is the utility of the photogenic function in all luminous Coleoptera, and indeed in all self-luminous insects. Among others luminous forms, — Annelids, fish, crustaceans, etc., — this may sometimes be the ecologic relation of the function, though in particular instances the defensive and other relations may also enter in.

3. Galloway; A case of phosphorescence as a mating adaptation; School Sci. and Math, Decatur, Ill., May, 1908.
5. Gorham; The structure of the Lampyridae with reference to their phosphorescence; Trans. Ent. Soc. Lond., 1880, pp. 63—67.
7. Lubbock; Origin and metamorphoses of Insects; Lond., 1874, p. 17.
18. Spallanzani; Chimico esame sopra la luce delle Fosfora; Modena, 1776, pp. 128–129.

Kleinere Original-Beiträge,

Ueber einen Schmetterlingszug in Deutsch-Ostafrika.


Forstassessor Ludwig Schuster (Morogoro, Deutsch-Ostafrika).

Tephroleystia sinuosaria Ev.


Dr. Dannenberg (Köslin).

On the affinities of the subfamily Aphelininae.

This subfamily is now classed with the Eulophidae (chalcidoid Hymenoptera) but I have so frequently mistaken members of it for encrytid that it commences to seem doubtful to me whether it should be retained in its present position. I have described several genera of encrytid Paneostigmini resembling Aphelininae.