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Scientific note

On the glowing and preying behaviour of lampyrid and pyrophorine larvae (Coleoptera: Lampyridae, Elateridae): An open subject for future research in Amazonia

by

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My contribution to the 90th birthday of Harald SIOLI, one of the pioneers of modern ecological Amazonas research, intends to be a stimulation for his scientific great-grandchildren. After the immense flood of quantitative eco-system analyses they are free to return to eco-etology where still inumerable diverting discoveries may be achieved. I returned with a notebook full of questions from my trips to Amazonia between 1956 to 1991. I selected the subject of glow worms on which I made some preliminary observations waiting to be verified by an in-depth study finally.

1. The glowing and preying behaviour of the semi-aquatic larvae of the lampyrid genus *Aspidosoma* inhabitating in glittering swarms the floating meadows of central and lower Amazonian floodplains.

During day they rest submerged on the edges of leaves extending some of their stalked stigmata into the air. At dusk activity starts. Their heads, provided with a crescent shaped sting and suctorial mandibles, stretch out in order to make orientation movements in the water. They prey upon watersnails especially for young ampullarids hatching in particular during the period of flooding.

The conspicuous element in the preying behaviour of *Aspidosoma* is the intermittently signaling with the abdominal glowing organs. The gleaming of these glow worms transforms a nocturnal visit to the floodplains to an unique experience, particularly on a clear starry night.

In 1974, I did some preliminary observations on the behaviour of these predators and their prey in the laboratory at INPA (National Institute for Amazonian Research) in Manaus. Similar to the glowing fungus gnat larvae of the genus *Arachnocampa* (=

*Dedicated to Prof. Dr. Harald Sioli on the occasion of his 90th anniversary.

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Bolitophila) inhabiting the ceilings of river caves in New Zealand which lure flying prey into their sticky nets by using their light, the *Aspidosoma* larvae likewise lure the small gliding ampillarids exploiting their apparently positive phototactic reaction. However, after gliding a few centimetres the positive phototactic reaction stops as a result of rapid adaptation to light and again the snails move on non-directionally. Apparently, this negative effect for the hunter is the reason_for the intermittently and not constantly glowing of the glow worms. Twenty to thirty seconds after the glowing organs are switched off the ampullarids show positive phototactic reaction again and start crawling towards the switched-on light again. And so, in successive stages they move towards the cunning predators which finally percieve their prey presumably mechano-sensorically, and then very quickly strike them with their mandible pincers.

However, seldomly this trapping reaction ends the encounter. The prey's lid quickly closing by reflex, usually prevent the predator from piercing the soft tissue. The predator holds the shell firmly but cannot yet suck up the snail's body. Now the second stage of the *Aspidosoma*'s trapping strategy starts: patiently they keep their prey till sun rise. They stretch out into the air and soon the snail is forced to open its lid because of heat and the lack of oxigen. The beetle larvae is protected from solar radiation at that time by the shade of the snail's shell. Protected by the vegetation while feeding the glow worms do not glow any more.

Occasionally, *Aspidosoma* larvae are found to have preyed on ants or other small inhabitants of the floating meadows. In these cases, it can likewise be assumed that the prey was lured by light to the predator.

Finally, the intermittent light production may serve territorial dispersion. The beetle larvae accelerate their glowing rhythm remarkably when moving too close to each other and ültimately one or both rivals switch off their light and crawl away. However, cannibalism is observed under laboratory conditions.

2. The glowing and preying behaviour of the terrestrial pyrophorine larvae of the genus *Hemirhipus* (Elateridae).

The pyrophorines which are common throughout the tropics, have long been known as flying fire beetles. The aduld beetles glow to attract a mate. The larvae inhabit holes in wood or earth (often hollow branches) and we may assume that the majority attempts to catch prey by using light.

In 1980, we found an abandoned termite nest in the Adolpho Ducke Forest Reserve ("Reserva Ducke" of INPA) near Manaus which appeared illuminated like a Christmas tree. It soon became clear that hundreds of *Hemirhipus* larvae were living in superficial holes lying in wait for crawling or flying small animals. I took a dozen of the larvae with me on a round-a-world trip, brought them hungry but well to Vienna and spent long nights studying their behaviour.

With their bristly and bright prothorax they worked as a perfect light and contact trap for nocturnally active flying and running insects. Presumably, their trapping behaviour is aimed at prey which lives in swarms. Because they do not consume their prey immediately, but merely demobilise it by several stings (purely mechanical) and by spitting digestive juices on it. After stuffing their prey into the enlarged end of their tube-like hole they reappear glowing yet more powerfully. In this way, they can hoard up to 12 *Drosophila* during the first half of the night, only to suck them up in the second half. Towards morning all chitin remains are deposited outside to the entrance of their hole. After moulting the same treatment is given to their own exuvie.

I managed to get some larvae to pupate in their plastic containers in Vienna and three of them finally hatched into pretty imagines.
On a student excursion in 1985 from Vienna to the Peruvian rain forest site Panguana, Ms. Michaela Peterka (now Hemmer) intended to observe *Hemirhipus* larvae further. However, there she found only larvae of other related pyrophorines almost exclusively living in wooden tubes, under the bark of rotten branches and tree trunks, in the bark of living trees, or in the stems of fallen leaves. At night all emerged with their anterior body, spread their mandibles and glowed with their prothorax. Generally, they glowed continually until around midnight. Ms. Peterka's feeding attempts produced the following prey spectrum: various ants, flies, mites and beetles. In an experiment using water filled cup traps buried around the inhabited tubes, 84 springtails, 29 ants, 10 flies, 5 beetles, 2 spiders, 1 wood louse and 4 other arthropods were found. We may be sure that a representative portion of these would have been caught by the mandibles of Hemirhipus larvae.

These two examples sketched in short, together with the widely diverging literature, demonstrate a wide field of zoological studies where still much specific and nearly all the basic research is to be done. Following the tradition of Harald SIOLI, particularly in the Amazonian rain forest, a complex sector of life history studies remain to be examined with all its sensory physiological and eco-ethological aspects.

1. In the case of *Aspidosoma*, the complete glow behaviour has to be quantitatively and qualitatively monitored and analysed. The prey spectrum remains to be investigated and the assumed repetition of positive phototaxis must be verified. The question concerning the role of mechano-reception in catching prey needs to be enlightened. The population density and population dynamics of *Aspidosoma* larvae should be studied. Furthermore, the matter of intraspecific competition for space and prey needs to be clarified.

2. In the case of *Hemirhipus* and other pyrophorine larvae it is also necessary to document and elucidate by experiments the whole glow behaviour, to determine the prey spectrum of flying and running animals and to differentiate possible interference and synergies of photo-sensoric and mechano-sensoric stimuli patterns. The significance and function of the thorax sensilla ought to be studied. The digging and building behaviour of the various larvae species and instars must be described. And finally, the question of the "food stock" built up by *Hemirhipus* in the laboratory would seem to be particularly interesting.

Finally, it may be pointed out that the life history and behaviour of the imagines of these glow worms as well should be included in the open questions about the eco-ethology of these animals, above all their largely unknown mating and reproductive biology. These fire flies are such a characteristic element in the Amazonian ecosystem that in conclusion the following statement shall be made again: the thorough investigation of these animals is more than just a contribution to the knowledge about any specific element of the Amazonian fauna, it is a step towards a deeper understanding of the environment to which Harald SIOLI drew our attention more than 50 years ago as a pinoneer in the field of comparative tropical biology.

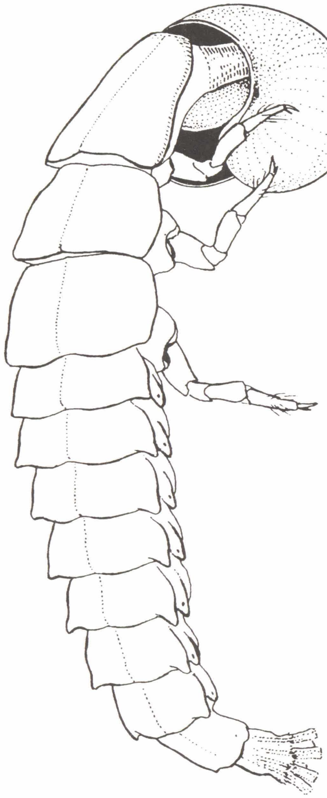

Figure 1

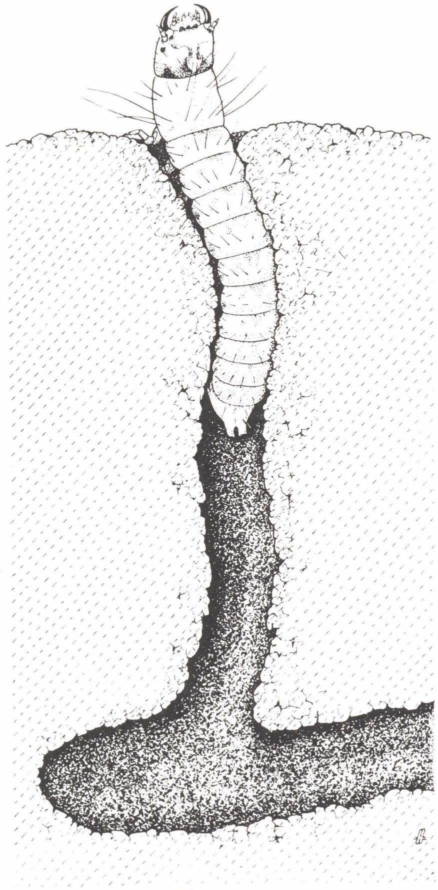

Figure 2

Fig. 1:
Larva of Amazonian fire fly, *Aspidosoma* sp. (Lampyridae) sucking on a young watersnail, *Ampullaria* sp. (drawn by Prof. Maria Mizzaro).

Fig. 2:
Larva of *Hemirhipus* sp. (Pyrophorinae, Elateridae) in glow and lurk position (drawn by Prof. Maria Mizzaro).