

# **CHAPTER 12-8 TERRESTRIAL INSECTS: HOLOMETABOLA – MEGALOPTERA AND NEUROPTERA**

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# CHAPTER 12-8

## TERRESTRIAL INSECTS: HOLOMETABOLA – MEGALOPTERA AND NEUROPTERA



Figure 1. *Chauliodes pectinicornis* adult, a species that spends its pupal stage among mosses. Dorothy Pugh <[www.dpughphoto.com](http://www.dpughphoto.com)>, with permission.

### MEGALOPTERA – Alderflies, Dobsonflies and Fishflies

This is a small order and most are aquatic as larvae. Nevertheless, some members of the **Corydalidae** (dobsonflies) pupate under mosses, a stage lasting about two weeks (Needham *et al.* 1901). These species include *Chauliodes pectinicornis* (Figure 1-Figure 2), *C. rastricornis* (Figure 3-Figure 4), and *Nigronia serricornis* (Figure 5-Figure 6).



Figure 2. *Chauliodes pectinicornis* pupa, a stage that often develops among mosses. Photo by Patrick Coin, through Creative Commons.



Figure 3. *Chauliodes rastricornis* adult, a species that pupates under mosses. Photo by Seabrooke Leckie, through Creative Commons.



Figure 4. *Chauliodes rastricornis* adult male head showing large eyes and comb-like antennae. Photo by Seabrooke Leckie, through Creative Commons.



Figure 5. *Nigronia serricornis* larva, a species that pupates under mosses. Photo by Donald S. Chandler at <[www.Discoverlife.org](http://www.Discoverlife.org)>, with permission.



Figure 6. *Nigronia serricornis* adult, a species that pupates under mosses. Photo by Richard Orr <[www.marylandinsects.com](http://www.marylandinsects.com)>, with permission.

Barnard (1931) reported pupae of alderflies (**Sialidae**) from *Sphagnum* and other wet or aquatic mosses that grew near or in streams and waterfalls in South Africa. These alderflies required that the mosses be wet.

## NEUROPTERA – Lacewings

Not many members of Neuroptera use bryophytes, but Richards and Davies (1977) reported that lacewing larvae search for prey in mosses.

### Osmylidae

The larvae of *Osmylus* (Figure 7) live in the mosses on the banks of woodland streams (Elliott 1996). Even the adults are typically found near these small streams that have mossy banks suitable for larval development. In Great Britain, the larvae can be found in these mosses throughout the year. In the winter they migrate deep into the moss rhizoids where they hibernate.

The female *Osmylus fulvicephalus* (Figure 7) lays about 30 eggs 2-3 days after mating (Elliott 1996). These often are laid in small groups. When deposited on mosses they are laid singly or in pairs on the undersides of leaves and near the water (Lestage 1920; David 1936; Ward 1965). The eggs are cylindrical and slightly flattened. These white eggs darken to brown within a few days, making them less obvious than the white version. Eggs hatch in 4-22 days, depending on the temperature (Withycombe 1923; David 1936; Ward 1965).



Figure 7. *Osmylus fulvicephalus* larva, a moss dweller near woodland streams. Photo by Walter Pfliegler, with permission.

When the larvae of the giant lacewing, *Osmylus fulvicephalus* (Figure 7), emerge, they burrow into the mosses (Elliott *et al.* 1996) and live among damp mosses in the splash zones of river banks and streams (Plant 1994; Roper 2001). These larvae are only 5 mm when they hatch, but reach 15 mm by the third (final) instar from which they develop into pupae (Elliott 1996).

In this moss habitat *Osmylus fulvicephalus* (Figure 7) larvae are able to eat small arthropods (Elliott *et al.* 1996). They strike at movement and inject enzymes that paralyze the prey. When they hatch, the first instar larvae eat mites and **Collembola**, but second and third instars switch to

eating larvae of small **Diptera**. The common **Chironomidae** (midges) are paralyzed in 10 seconds by the enzymes. They then suck the contents out of the prey. The larvae may dive into the water to find prey, but if they are forced to remain submersed they die within 8-28 days (Ward 1965).

The third (and final) larval instar overwinters in **diapause** and is able to withstand total immersion during flooding (Elliott *et al.* 1996). When spring arrives, the larvae make a cocoon, incorporating some of the moss in the cocoon, then pupate for 10-14 days before cutting their way out with their mandibles. They then emerge as adults (Figure 8) without further feeding. The adults fly about over the water surfaces in their woodland homes in the evening (**crepuscular**) (Elliott 1996).



Figure 8. *Osmylus fulvicephalus* adult, a species that lays its eggs on moss leaves. Photo from <[www.invertebradosdehuesca.com](http://www.invertebradosdehuesca.com)>, through Creative Commons.

## Chrysopidae

The modern **Chrysopidae** are not known to live among bryophytes, but they sometimes wear them. The larvae attach various pieces of debris, including bits of mosses and lichens, on their backs (Figure 9) (Skorepa & Sharp 1971; Slocum & Lawrey 1976; Eisner *et al.* 2002; Pérez-de la Fuente *et al.* 2012; Anonymous 2015; Newman *et al.* 2015). This cloak provides camouflage that hides them from both predators and prey.



Figure 9. **Chrysopidae** larva with cloak of debris and lichens. Note the head and large jaws at right. Photo by David Illig, through Creative Commons.

Larvae of the green lacewing *Leucochrysa pavid*a (Figure 10-Figure 13) (Slocum & Lawrey 1976) and the brown lacewing (Anonymous 2015) take their camouflage with them. They make packets of lichen fragments, bark, pollen grains, fungal spores, and moss fragments that they attach to spines on their backs (Slocum & Lawrey 1976). Likewise, immature brown lacewings use lichen and moss coverings to camouflage and protect them from predators and to disguise themselves from their prey (Insects 2014).



Figure 10. *Leucochrysa pavid*a larva with lichen back pack. This species also uses mosses. Photo by Jim McCormac, with permission.



Figure 11. *Leucochrysa pavid*a larva with lichen back pack, ventral view. Photo by Jim McCormac, with permission.



Figure 12. *Leucochrysa pavidana* larva with lichen back pack showing its camouflage against lichen-covered substrate. Photo by Jim McCormac, with permission.



Figure 13. *Leucochrysa pavidana* larva with lichen back pack, mandibles ready. Photo by Jim McCormac, with permission.

*Hallucinochrysa diogenesi* (Figure 14) is a fossil lacewing that attached plant fibers, bark, leaves, algae, mosses, snail shells, and corpses of its food prey on its back (Pérez-de la Fuente *et al.* 2012). These were held in place by the bristles on the backs of the larvae.



Figure 14. *Hallucinochrysa diogenesi*, representation of the fossil that attached mosses and other substances to its back. Photo by Jose Antonio Penas, through Creative Commons.

Fossil evidence suggests that some larvae of the **Chrysopidae** have been associated with liverworts (Liu *et al.* 2018). *Phyllochrysa huangi* larvae (Figure 15, Figure 16) from Burmese amber (Upper Cretaceous ~100 million years old) exhibit "distinctive foliate lobes" on the thorax and abdomen. This mimicry permits individuals to hide from prey (Figure 16) or to be ambush predators because the larvae are hard to distinguish from their background vegetation.

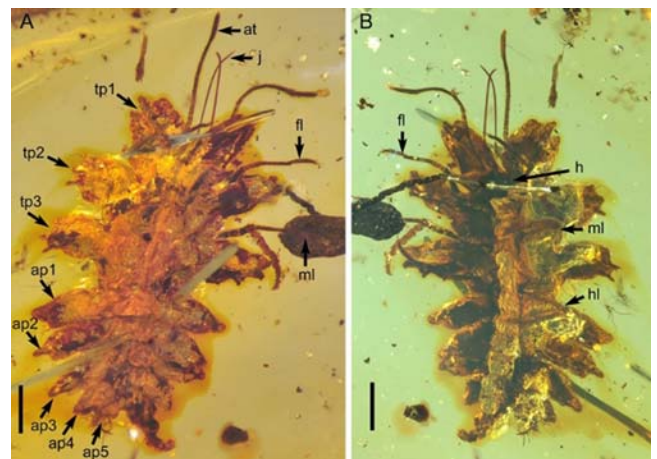


Figure 15. Chrysopid larvae, *Phyllochrysa huangi*, in Burmese amber. Image from Liu *et al.* 2018, with permission.

The shape of this larva is similar to that of bryophytes (Figure 16, Figure 17). Furthermore, its head is small and concealed under the anterior thoracic lobe (Figure 16) (PPI 2018). Antennae are extremely long with enlarged ends. The researchers found several amber fossil bryophyte species with similar morphologies (Figure 17), including size, leaf shape and arrangement, leaf folds, and lines.

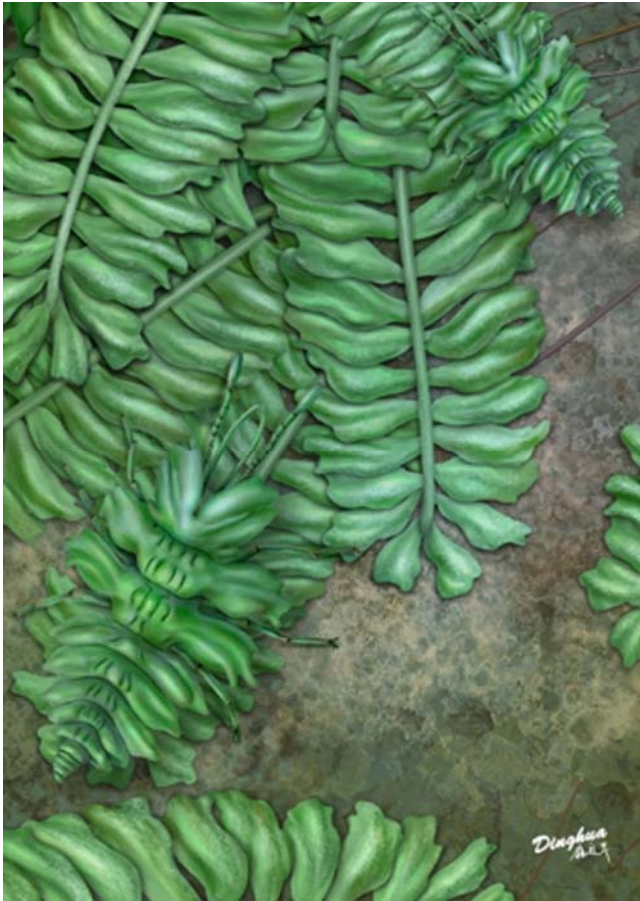


Figure 16. Models of *Phyllochrysa huangi* larvae and hypothetical liverworts. Image from Liu *et al.* 2018, with permission.

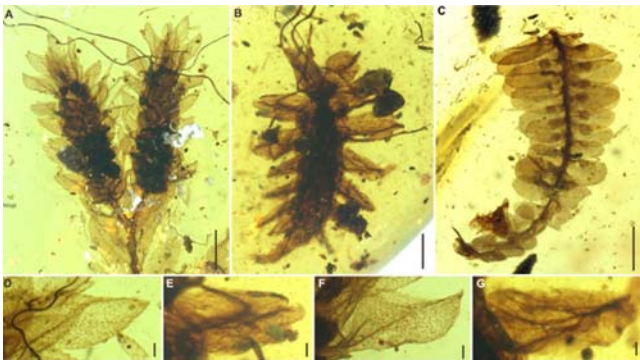


Figure 17. Burmese mosses (B, E, & G) and liverworts in amber – potential hosts for *Phyllochrysa huangi* larvae. Image from Liu *et al.* 2018 and PPI 2018, with permission.

## Summary

The **Megaloptera** and **Neuroptera** are small orders. Hence there are few bryophyte dwellers. Some members of **Megaloptera** pupate under mosses. In the **Neuroptera**, the best known bryophyte-dwelling genus is *Osmylus*. *Leucochrysa pavida* makes packets of camouflage that include moss fragments among other objects.

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Bernard Goffinet alerted me to the story on fossil *Phyllochrysa huangi* larvae that mimicked liverworts. Thank you to all the photographers who placed their images online with Creative Commons permission and to those who gave me permission to use their images.

## Literature Cited

- Anonymous. 2015. The Wild, Wonderful World of Insects. Accessed 12 September 2015 at <<http://itc2.utk.edu/web/jgrant/InsectIntro/Neuroptera.htm>>.
- Barnard, K. H. 1931. The Cape alder-flies: (Neuroptera, Megaloptera.). Trans. Royal Soc. S. Afr. 19: 169-184.
- David, K. 1936. Beiträge zur Anatomie und Lebensgeschichte von *Osmylus chrysops* L. Z. Morph. Ökol. Tiere 31: 151-206.
- Eisner, T., Carrel, J. E., Tassel, E. Van, Hoebeke, E. R., and Eisner, M. 2002. Construction of a defensive trash packet from sycamore leaf trichomes by a chrysopterid larva (Neuroptera: Chrysopidae). Proc. Entomol. Soc. Wash. 104: 437-446.
- Elliott, J. M. 1996. British Freshwater Megaloptera and Neuroptera: A Key with Ecological Notes. Freshwater Biol. Assoc. Sci. Publ. 54: 1-69.
- Elliott, J. M., Kimmins, D. E., and Worthington, C. J. 1996. British Freshwater Megaloptera and Neuroptera: A Key with Ecological Notes. Freshwater Biological Association, 68 pp.
- Insects. 2014. The Wild, Wonderful World of Insects. Accessed 8 August 2014 at <<http://itc2.utk.edu/web/jgrant/InsectIntro/Differentinsects.htm>>.
- Lestage, J. A. 1920. La ponte et la larvule de l'*Osmylus chrysops* L. (Planipenne). Ann. Biol. Lacustre 10: 226-230.
- Liu, X., Shi, G., Xia, F., Lu, X., and Wang, B., and Engel, M. S. 2018. Liverwort mimesis in a Cretaceous lacewing larva. Current Biol. <<https://doi.org/10.1016/j.cub.2018.03.060>>.
- Needham, J. G., Betten, C., MacGillivray, A. D., Coquillett, D. W., and Ashmead, W. H. 1901. Aquatic Insects in the Adirondacks. N. Y. State Mus. Bull. 47: 1-612.
- Newman, K. M., Woolley, J., and Lacher, T. 2015. A Photographic Guide to the Neuroptera of Dominica, West Indies. Texas A & M University, College Station, TX, 11 pp. <[http://dominica.tamu.edu/student%20projects/Dominica%20Projects%20pdf%20copy/Newman\\_Kara\\_2011.pdf](http://dominica.tamu.edu/student%20projects/Dominica%20Projects%20pdf%20copy/Newman_Kara_2011.pdf)>.
- Pérez-de la Fuente, R., Delclòs, X., Peñalver, E., Speranza, M., Wierzchos, J., Ascaso, C., and Engel, M. S. 2012. Early evolution and ecology of camouflage in insects. Proc. Natl. Acad. Sci. USA 109: 21414-21419.
- Plant, C. W. 1994. Provisional Atlas of the Lacewings and Allied Insects (Neuroptera, Megaloptera, Raphidioptera and Mecoptera) of Britain and Ireland. Edited for the Biological Records Centre by P. T. Harding, B. C. Eversham, and H. R. Arnold. Biological Records Centre, Huntingdon.
- PPI (Plant Protection Institute). 2018. Professor Liu Xingyue of Plant Protection College reveals the mimicry of insects 100 million years ago from amber in Myanmar. Translated by Google. Accessed 27 April 2018 at <[http://news.cau.edu.cn/art/2018/4/27/art\\_10867\\_566332.html](http://news.cau.edu.cn/art/2018/4/27/art_10867_566332.html)>.
- Richards, O. W. and Davies, R. G. 1977. Imm's General Textbook of Entomology, 10th edn. Chapman and Hall, London.

- Roper, Patrick. 2001. A note on the two -winged flies (Diptera) associated with ghyll woodlands in Sussex. Accessed on 21 July 2008 at <<http://www.prassociates.co.uk/environmental/articles/ghyll.pdf>>.
- Skorepa, A. C. and Sharp, A. J. 1971. Lichens in "packets" of lacewing larvae (Chrysopidae). *Bryologist* 74: 363-364.
- Slocum, R. D. and Lawrey, J. D. 1976. Viability of the epizoic lichen flora carried and dispersed by green lacewing (*Nodita pavidata*) larvae. *Can. J. Bot.* 54: 1827-1831.
- Ward, P. H. 1965. A contribution to the knowledge of the biology of *Osmylus fulvicephalus*. *Entomol. Gaz.* 16: 175-182.
- Withycombe, C. L. 1923. Notes on the biology of some British Neuroptera (Plannipennia). *Trans. Royal Entomol. Soc. London* 1922: 501-594.

