

## Antennal sensilla of Trichoptera and Lepidoptera: Phylogenetic considerations

By Michel J. FAUCHEUX

### Abstract

Most of the sensillar types found on the antennae of Lepidoptera already exist in Trichoptera. The sensilla auricillica are not specific to Lepidoptera. The sensilla placodea which are common in Trichoptera occur only in the more primitive lepidopterans Micropterigidae.

**Key words:** Trichoptera, Lepidoptera, antenna, sensilla, phylogeny.

### Résumé

La plupart des types sensillaires présents sur les antennes des Lépidoptères existent déjà chez les Trichoptères. Les sensilles auricilliformes ne sont pas particulières aux Lépidoptères. Les sensilles placoides qui sont communes chez les Trichoptères sont présentes seulement chez les lépidoptères les plus primitifs, les Micropterigidae.

**Mots-clefs:** Trichoptères, Lépidoptères, antenne, sensilles, phylogénèse.

The two orders Trichoptera and Lepidoptera are grouped together in the superorder Amphiesmenoptera, the relationship between the two orders is a genuine sistergroup relationship (KRISTENSEN, 1975, 1981). Numerous characters in the adult and larval ground plan are synapomorphic of Trichoptera and Lepidoptera. However, nothing is known as concerns the comparison between the antennal sensilla into two orders. The only reference appears to be that of HALLBERG & HANSSON (1999) who consider that "The ancestral ericraniids exhibit a sensillar pattern that more closely resembles the more primitive sistergroup Trichoptera than its more advanced relatives in the Lepidoptera". This affirmation is in fact based on false arguments (FAUCHEUX, 2004a).

For the study of sensilla, the antennae were dehydrated in absolute ethanol, mounted on specimen holders and coated with a thin layer of gold and palladium. Preparations were examined with a scanning electron microscope.

The structure of trichopteran antennal sensilla has only been described in a few studies (SLIFER & SEKHON, 1971; WELLS, 1984; DENIS, 1985). The study by Denis which concerns 18 families and 23 species offers most information. Thus, according to present terminology (ZACHARUK, 1985), the sensilla of Trichoptera described by Denis may be classed under the following types: uniporous sensilla chaetica ("sensilles trichoides cannelées"); aporous s. chaetica ("s. chaetica"); multiporous s. trichodea ("s. trichoides annelées"); multiporous s.

cœloconica ("s. cœloconica"); multiporous s. placodea ("s. placode discoïdale": Fig. 1); multiporous s. auricillica ("s. bicorne": Fig. 3, "s. bifide": Figs. 4, 5, "s. otoïde": Fig. 6, "s. placode": Fig. 7, "s. placode denticulée": Fig. 8, "s. placode sphérique", "s. placode cylindrique"); multiporous s. basiconica ("s. conique"); multiporous triforked sensilla ("s. trifides": Fig. 2); aporous s. squamiformia ("s. squamiformia"). The term "placode" used by Denis covers different types of sensilla.

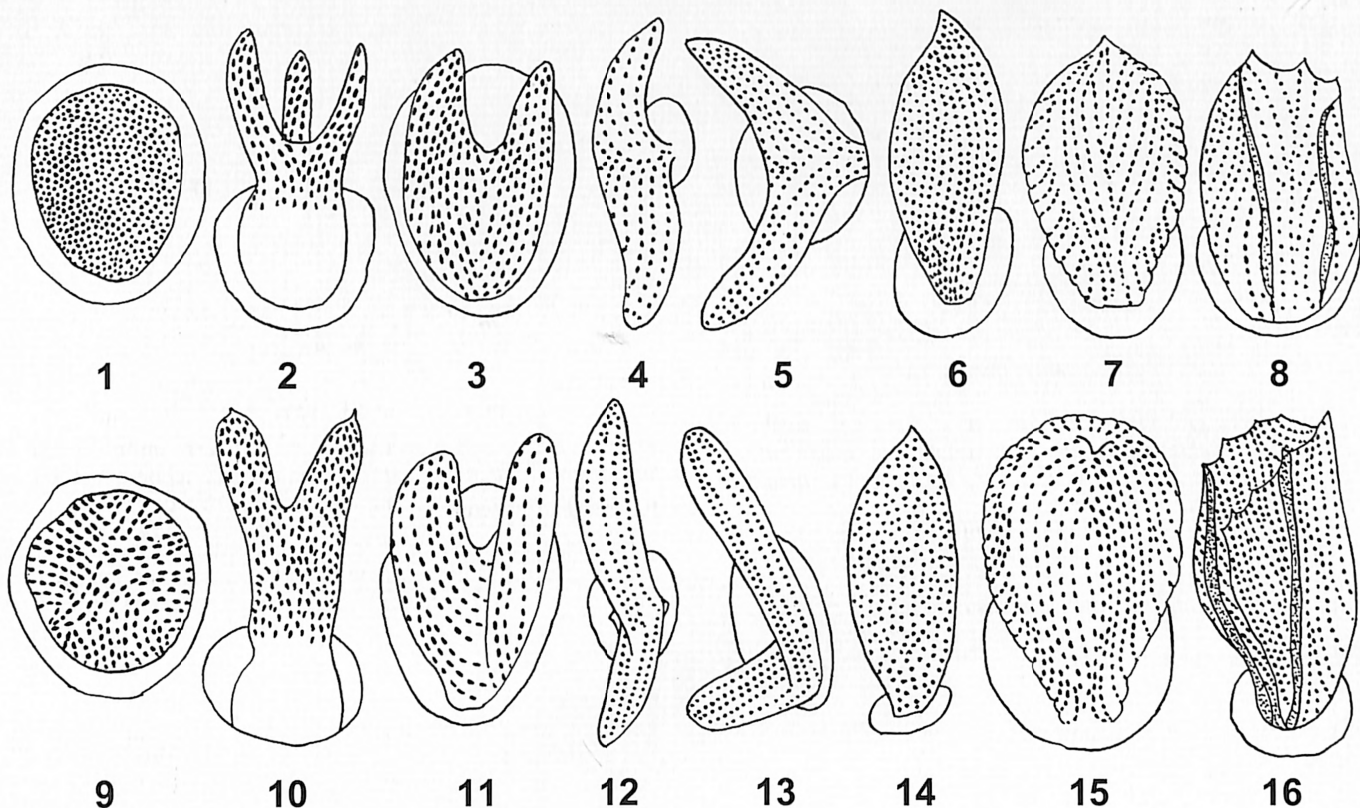
The antennal sensilla of Lepidoptera have been the subject of a great many publications (review in FAUCHEUX, 1987; 1999). Figures 9 to 16 represent sensilla bearing a surprising resemblance to those of Trichoptera. The comparison between the sensory equipment of the two orders permits several conclusions.

Sensilla placodea in Trichoptera are an important sensillar type, whose sexual dimorphism is manifested in a higher number of sensilla in the males, and which cover entirely one of the two faces of the segments (SLIFER & SEKHON, 1971; DENIS, 1985). They exist in Rhyacophilidae, Glossosomatidae, Hydroptilidae, Ecnomidae, Molannidae. The three first families are considered as the most primitive of Trichoptera (DESPAX, 1951). Now, sensilla placodea in Lepidoptera only exist in the suborder Zeugloptera, with the family Micropterigidae (FAUCHEUX, 1997). In the micropterigid moths, they are present in small numbers, 1 to 2 per segment, and they do not exhibit any sexual dimorphism.

The triforked sensilla of *Sericostoma galeatum* (Fig. 2) resemble short biforked sensilla basiconica of the limacodid *Latoia thamia* (Fig. 10). They possess together a basal stylus and a sensory cone, bi- or triforked. Until now, the biforked sensilla basiconica have been discovered only in *L. thamia* (FAUCHEUX, 1999).

The sensilla bifida of *Micropterna sequax* (Fig. 3) are similar to certain long biforked sensilla basiconica of *Agathiphaea queenslandensis* (FAUCHEUX, 1990a; 2004b). In this moth, this sensillar type is polymorphic and some sensilla with flattened branches must be classed with the "auricillicum" type. In Lepidoptera, these sensilla are present only in the suborder Aglossata which consists only of the Agathiphagidae family.

Certain sensilla bifida, placodea and "otoïdes" des Trichoptères (Figs. 4-8) are in fact sensilla auricillica, according to the terminology adopted in Lepidoptera (FAUCHEUX, 1999). Indeed, they show remarkable similarities with sensilla auricillica (Figs. 12-16). Moreover, the trichopteran *Neureclipsis bimaculata* possesses a variety of shape in these sensilla (Figs. 4-5) such as the lepidopteran *Trichophaga tapetzella* (Figs. 12-13). In one family of Trichoptera and of Lepidoptera, sensilla



Figs. 1-8 — Antennal sensilla of *Trichoptera*. 1 - “sensille placôide discoïdale” of *Ecnomus tenellus*, Ecnomidae; 2 - “sensille trifide” of *Sericostoma galeatus*, Sericostomatidae; 3 - “sensille bicorne” of *Micropterna sequax*, Limnephilidae; 4, 5 - “sensilles bifides” of *Neureclipsis bimaculata*, Polycentropidae; 6 - “sensille otoïde” of *Lepidostoma hirtum*, Lepidostomatidae; 7 - “sensille placôide” of *Leptodrusus budtzi*, Limnephilidae; 8 - “sensille placôide” of *Anabolia nervosa*, Limnephilidae. (Different magnifications. Drawn from Denis 1985, In Bulletin de la Société Scientifique de Bretagne).

Figs. 9-16 — Antennal sensilla of *Lepidoptera*. 9 - sensillum placodeum of *Micropterix calthella*, Micropterigidae; 10 - short biforked sensillum basiconicum of *Latoia thamia*, Limacodidae; 11, long biforked sensillum basiconicum of *Agathiphaga queenslandensis*, Agathiphagidae; 12-16 - sensilla auricillica: 12, 13 - *Trichophaga tapetzella*, Tineidae; 14 - *Tineola bisselliella*, Tineidae; 15 - *Heliothis armigera conferta*, Noctuidae; 16 - *Noctua pronuba*, Noctuidae. [Different magnifications. Drawn from Fauchaux 1999 (9, 10), 2004 b (11), 1989 (12, 13), 1987 (14), 1990b (16) and Flower & Helson 1971 (15)].

auricillica show the same degree of variation (Figs. 7, 8, 15, 16).

Sensilla cœloconica in Lepidoptera belong to two subtypes: naked and with a fringe of microtrichia. The first is considered as the most primitive and the second has only been described in the Lepidoptera. Now, the trichopteran insects possess the naked cœloconicum, i.e. *Micropterna sequax* while a hint of a fringe of microtrichia appears in *Rhyacophila fasciata* (DENIS, 1985).

Sensilla squamiformia are common to both Trichoptera and Lepidoptera. The uniporous sensilla chaetica, aporous sensilla chaetica and multiporous sensilla trichodea are ubiquitous types in Lepidoptera as in Trichoptera (“s. trichoïdes cannelées”, s. chaetica, “s. trichoïdes annelées”). The multiporous sensilla basiconica in Trichoptera have not been clearly defined by DENIS (1985) but were identified by SLIFER & SEKHON (1971)

who called them “thin-walled pegs”. They are always largely present in Lepidoptera.

Finally, we are for the moment the only person to have defined on two Lepidoptera, “cupuliform organs” comprising hemispherical dome pierced by circular orifice and including a cuticular formation; they are unobtrusive and few in number (FAUCHEUX, 1999). Similar organs possessing the same qualities have been found in Trichoptera where they are called “pores” by DENIS (1985) and “coelospherical sensilla” by WELLS (1984). In conclusion, most of the sensillar types found on the antenna of Lepidoptera already exist in Trichoptera. The sensilla auricillica are not specific to Lepidoptera as has often been claimed (FAUCHEUX, 1987). Certain types, such as sensilla placodea, which are common in Trichoptera, exist only in the more primitive Lepidoptera. Other types are characteristic of a suborder or of a family of Lepidoptera.

## References

DENIS, C., 1985. Étude comparée des microstructures antennaires des Trichoptères adultes. *Bulletin de la Société Scientifique de Bretagne*, 57: 103-114.

DESPAX, R., 1951. Ordre des Trichoptères. In: GRASSÉ, P.P. (Éditeur), *Traité de Zoologie X* (1<sup>er</sup> fasc.). Masson et C<sup>ie</sup>, Paris, pp. 125-173.

- FAUCHEUX, M.J., 1987. Recherches sur les organes sensoriels impliqués dans le comportement de ponte chez deux lépidoptères à larves kératinophages: *Tineola bisselliella* Humm. et *Monopis crocicapitella* Clem. (Tineidae). *Thèse de Doctorat es sciences*, Univ. Nantes, 511 pp.
- FAUCHEUX, M.J., 1989. Antennal sensilla in male and female carpet moth, *Trichophaga tapetzella* L. (Lepidoptera: Tineidae): a scanning electron microscopic study. *Annales de la Société entomologique de France (n.s.)*, 25: 83-93.
- FAUCHEUX, M.J., 1990a. Antennal sensilla in adult *Agathiphaga vitiensis* Duml. and *A. queenslandensis* Duml. (Lepidoptera: Agathiphagidae). *International Journal of Insect Morphology and Embryology*, 19: 257-268.
- FAUCHEUX, M.J., 1990b. External ultrastructure of sensilla on the male and female antennal flagellum of *Noctua pronuba* L. (Lepidoptera: Noctuidae). *Annales de la Société Entomologique de France (n.s.)*, 26: 173-184.
- FAUCHEUX, M.J., 1997. Sensory organs on the antennae of *Micropterix calthella* L. (Lepidoptera: Micropterigidae). *Acta Zoologica* (Stockholm), 78: 1-8.
- FAUCHEUX, M.J., 1999. Biodiversité et unité des organes sensoriels des Insectes Lépidoptères. Supplément hors-série du *Bulletin de la Société des Sciences Naturelles de l'Ouest de la France (n. s.)*, 296 pp.
- FAUCHEUX, M.J., 2004a. Sensilla placodea on the antennae of Lepidoptera. *Annales de la Société Entomologique de France (n.s.)*, 40: 105-107.
- FAUCHEUX, M.J., 2004b. Polymorphisme des sensilles basiconiques bifurquées de l'antenne de l'Agathiphage du Queensland, *Agathiphaga queenslandensis* Dumbleton, 1952 (Lepidoptera: Aglossata, Agathiphagidae). *Bulletin de la Société des Sciences Naturelles de l'Ouest de la France (n.s.)*, 26: 138-139.
- FLOWER, N.E. & HELSON, G.A.H., 1971. The structure of sensors on the antennae and proboscis of *Heliothis armigera conferta* Hubn. *New Zealand Journal of Science*, 14: 810-815.
- HALLBERG, E. & HANSSON, B.S., 1999. Arthropod sensilla: morphology and phylogenetic considerations. *Microscopy Research and Technique*, 47: 428-439.
- KRISTENSEN, N.P., 1975. The phylogeny of hexapod "orders". A critical review of recent accounts. *Zeitschrift für Zoologie, Systematik und Evolutionforschung*, 13: 1-44.
- KRISTENSEN, N.P., 1981. Phylogeny of insect orders. *Annual Review of Entomology*, 26: 135-157.
- SLIFER, E.H. & SEKHON, S.S., 1971. Structures on the antennal flagellum of a caddisfly, *Frenesia missa* (Trichoptera, Limnephilidae). *Journal of Morphology*, 135: 373-388.
- WELLS, A., 1984. Comparative studies of antennal features of adult Hydroptilidae (Trichoptera). *Proceedings of the 4<sup>th</sup> International Symposium on Trichoptera*, Clemson, South Carolina, pp. 423-440.
- ZACHARUK, R.Y., 1985. Antennae and sensilla. In: KERKUT, G.A. & GILBERT, L.I. (Editors), *Comprehensive Insect Physiology, Biochemistry and Pharmacology* (Vol. 6), Pergamon Press, Oxford, pp. 1-69.

Michel J. FAUCHEUX

Laboratoire d'Endocrinologie des Insectes Sociaux,  
Université de Nantes, 2 rue de la Houssinière,  
B.P. 92208, F-44322 Nantes Cedex 03, France.