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Are Scale Insects in the Homoptera or Hemiptera; do they comprise a Superfamily or a Suborder?

Abstract - For some time, I have noted discrepancies in the titles of papers dealing with scale insects. For example articles listed in the March 2000 issue of *The Scale* included in their titles various higher category taxonomic names: e.g., Homoptera in 48 titles from 18 countries, and Hemiptera in 28 titles from 12 countries. In the March 2001 issue of *The Scale*, we found Homoptera in 85 titles from 25 countries and Hemiptera in 33 titles from 14 countries. It must be confusing for catalogers that encounter scale insects placed in either the superfamily Coccoidea or the suborder Coccinea within the same article titles. In the future, our successors may choose to adopt the already proposed order name Coccoidea. Are we going to keep Homoptera or Hemiptera, or abandon both and use only Sternorrhyncha or Rhynchoidea, already used by some, until this issue is scientifically clarified? It should be the responsibility of the public forum of ISSIS-IX to debate and attempt to standardize the nomenclature to be used in the future. The previous eight symposia brought us together in the co-operative spirit that has always allowed us to co-ordinate major projects to avoid duplication and has led to general progress in coccidology. Let's continue in that spirit.

Key words: Coccoidea, Coccinea, Coccoidea, Sternorrhyncha, nomenclature.

INTRODUCTION

The reason I have proposed to discuss this topic at this time is the present confusion in the printed literature on the use of different order, superfamily and suborder names for scale insects (Kosztarab, 2001). The results of my scale insect literature survey on this subject for the years 1999-2000 are given in the abstract.

Bibliographers and library cataloguers, as well as our entomologist peers have often asked the question: What is wrong with coccidologists that we cannot make up our minds? And, they are right! This is why we need to discuss our nomenclatural questions.

The species is probably the only taxonomic category that can be assessed by objective criteria. The coverage of the higher taxonomic categories has often changed. Diffe-

rent scientists have used different taxonomic characters and/or placed different weight on a series of taxonomic characters, and as a consequence, have arrived at different classifications.

ON THE VALIDITY OF THE ORDER NAMES HOMOPTERA AND HEMIPTERA

Linnaeus (1758), based on his limited knowledge of insects, recognized only Hemiptera and included all 17 species of scale insects known at that time in the genus *Coccus*. We have made significant progress during the past 242 years and that was reflected in our discussions.

In a comprehensive review of the Homoptera phylogeny, Evans (1963) divided Homoptera into nine distinctive superfamilies, one of which was Coccoidea. He never made it clear if Homoptera was treated as an order or as a suborder of Hemiptera.

Schaefer (1999) and Gullan (2001) pointed out that some major groups now included in the order Homoptera are paraphyletic and appear not to have had a common ancestor. The paraphyly that they and others discuss is with the Auchenorrhyncha and surely with the Coleorrhyncha. Both appear to be more closely related to Heteroptera than to Sternorrhyncha. I agree with their findings. So, why not remove these two groups from Homoptera and leave Sternorrhyncha alone in the Homoptera?

Sorensen *et al.* (1995) also suggested the non-monophyly for Auchenorrhyncha, therefore, the abandonment of this name. So, let the Auchenorrhyncha specialists worry about the proper placement of hoppers and cicadas in the future, but this should not affect the status of Homoptera with only the monophyletic Sternorrhyncha in it.

The term Homoptera, meaning uniform textured wings, well distinguishes them from the Heteroptera, meaning of differentiated wings. Therefore, I am proposing to replace the name with the synonymous term Rhynchota, currently in use by Porcelli (2001) and other specialists in the past.

The term Rhynchota is of Greek origin and refers to the presence of an extended mouth structure (proboscis or rostrum). Jointed sheaths are formed from the labium and enclose the mandibular and maxillary stylets for piercing and sucking. The adult mouthparts are vestigial in a few (e.g. Peloridiidae), or absent as in male scale insects. Because the presence of the rostrum is characteristic to all Heteroptera and Homoptera except some male scales, Rhynchota is an appropriate term to replace Hemiptera, especially if Sternorrhyncha are included.

The name Hemiptera, or half-winged, refers to the fact that the front wings have their basal portion thickened and the distal portion membranous, as in the Heteroptera. This is not true for any of the Sternorrhyncha now included by some authors in the Hemiptera. Therefore, I believe that there is no scientific justification for including scale insects and the other Sternorrhyncha in the Hemiptera.

All Sternorrhyncha feed on plant sap, while the Heteroptera have diverse food habits; besides plant sucking, some practice carnivory as well as feed on vertebrate blood. Heteroptera do not produce honeydew, as do many sternorrhynchans.

Both the morphological and recent molecular studies have proven the monophyly of Sternorrhyncha, therefore, we should treat them separately from the diverse Auchenorrhyncha and other "hemipterans" that include paraphyletic groups at present.

Weber (1930; 1968), a world-renowned Hemiptera specialist, in 1930 he used Hemiptera (Rhynchotha) as a superorder, with Heteroptera and Homoptera as orders. He found enough justification in their biologies and morphologies to treat the Psyllina, Aleurodina, Aphidina and Coccinea as suborders.

Recent molecular phylogenetic and cladistic analyses of "Hemiptera-Homoptera" by Sorensen et al (1995), resulted in separating the suborder Sternorrhyncha far from all other "Hemiptera" and placing the rest of the Hemiptera-Homoptera in three new suborders. They deleted Homoptera, the loss of which could impact stability in classification.

In conclusion, I suggest we keep Homoptera with the Sternorrhyncha in it to avoid future confusion in the processing of our articles (Kosztarab, 1987). As a temporary solution, we may use "Sternorrhyncha" in article titles dealing with scale insects, until the final status of the Hemiptera/Homoptera controversy is resolved.

Lois B. O'Brien (Fulgoroidea specialist), Carl Schaefer (heteropterist), Manya Stoetzel (aphidologist) and most coccidologists agree that further discussion on this subject in the near future is warranted.

ON THE CLASSIFICATION OF SCALE INSECTS

The Code of Zoological Nomenclature does not cover names higher than the superfamily. For the sake of brevity, I will not list here all the unique behaviors, biological, morphological and physiological attributes that make scales different from all other animals. Some obvious characters are unusual adaptations, defense mechanisms, multiple parthenogenesis, and holometabolous metamorphosis in males. Some, especially unique characteristics, are the occurrence of their specific endosymbionts, genetics including hermaphrodites and unique chromosome systems, neoteny in females, sperm ultrastructure and sperm-bundles, that no other animals, not even insects, share.

These important taxonomic characters may counteract the recent findings of some taxonomists who based their recommendations strictly on molecular genetics. Can scale insect DNA account for all the unique taxonomic characters that no other animal possesses?

CONCLUSIONS

For all the listed unique distinguishing taxonomic characters, I am convinced that scale insects, as previously proposed by researchers like the Hemiptera specialist (Weber, 1930), the scale paleontologists Koteja (1974) and by earlier coccidologists like Balachowsky, Bodenheimer and Borchsenius as well as the more recent works

done by Danzig (1980) and myself, Kosztarab (1996, 2001). A number of Russian paleontologists studying the fossils of scale insects and of the related groups like E.E. Bekker-Migdishova, I.A. Popov, A.P. Rasnitsyn, and D.E. Scherbakov came to the same conclusion that scale insects need to be treated in a suborder (Coccinea). I believe that after more studies have been completed on some poorly known groups such as Matsucoccini of margarodids, scales will be elevated into the new order Coccurea, as was previously proposed.

After taking the above insect paleontologists' findings into consideration as well as Weber's (1930) and Hennig's (1981) studies, I am proposing the following higher classification for all the Rhynchota (formerly "Hemiptera"):

Probable Phylogenetic Relationships among Rhynchota (Heteroptera/Homoptera)

Superorder: Rhynchota (Hemiptera of some authors)

I - Order: Coleorrhyncha (Peloriidiidae, with 20 spp.)

II - Order: Heteroptera (true bugs, also Auchenorrhyncha = cicadas and hoppers)

III - Order: Homoptera (all Sternorrhyncha in it)

Suborders (as in Weber 1930/1968):

1 - Psyllina

2 - Aleurodina

3 - Aphidina

4 - Coccina (or Coccinea)

Superfamilies:

(a) Orthezioidea

(b) Coccoidea

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REFERENCES

- DANZIG E.M., 1980 - Coccoids of the Far East USSR (Homoptera, Coccinea) with a phylogenetic analysis of the coccoid fauna of the world. - Publ. Nauka. Leningrad. 367 pp. [reprinted in English].
- EVANS J.W., 1963 - The phylogeny of the Homoptera. - Ann. Rev. Ent., 8: 77-94.
- GULLAN P.J., 2001 - Why the taxon Homoptera does not exist. Entomologica, 33 (1999): 101-104.
- HENNIG W., 1981 - Insect Phylogeny. - New York, John Wiley & Sons, 514 pp.
- KOSZTARAB M., 1996 - Scale Insects of Northeastern North America - Identification, Biology, and Distribution. - Virginia Museum of Natural History, Martinsville, VA. Spec. Publ. No. 3, 650 pp.
- KOSZTARAB M., 2001 - Hemiptera or Homoptera; Coccurea, Coccinea or Coccoidea? The Scale,

24: 2-3.

KOSZTARAB M.P., 1987 (1986) - Authors, have mercy on cataloguers. Boll. Lab. Ent. Agr. Filippo Silvestri 43 (Supl.): 19-21.

KOTEJA J., 1974 - On the phylogeny and classification of the scale insects (Homoptera, Coccinea) (discussion based on the morphology of the mouthparts). - Acta zool. Cracov., 19: 267-325.

LINNAEUS C., 1758 - Insecta Hemiptera – *Coccus*. Systema Naturae (Ed. 10): 455-457.

PORCELLI F., 2001 - On the term describing the post-embryonic development of Diaspididae (Rhynchota: Coccoidea). - Abstracts. IX International Symposium on Scale Insect Studies (Univ. of Padua). p. 17.

SCHAEFER C.W., 1999 - Hemiptera? Heteroptera? And what happened to "Homoptera"? (in Portuguese; English text from author). - Informativa da Soc. Do Brasil, 24(1): 1-5.

SORENSEN J.T., CAMPBELL C., GILL R.J., STEFFEN-CAMPBELL J.D., 1995 - Non-monophyly of Auchenorrhyncha ("Homoptera"), based upon 18S rDNA phylogeny: eco-evolutionary and cladistic implications within pre-Heteropterodea Hemiptera (S.L.) and a proposal for new monophyletic suborders. - Pan-Pacific Ent., 71(1): 31-60.

WEBER H., 1930/1968 - Biologie der Hemipteren. Eine Naturgeschichte der Schnabelkerfe. Berlin: Springer. [Reprint Amsterdam: Asher Co., 1968. 543 pp.]

