

Introduction to the Family Coniopterygidae (Neuroptera) with *Semidalis aleyrodiformis* (Stephens) from the Korean Peninsula

Seongkyun Lee¹, Seulki Kim¹, Jaechon Sohn² and Soowon Cho^{1*}

¹Dept. of Plant Medicine, Chungbuk National University, Cheongju, CB 361-763 Korea

²Dept. of Entomology, University of Maryland, College Park, MD 20742 U.S.A.

한반도에서 *Semidalis aleyrodiformis* (Stephens)가 속한 가루풀잡자리과(Coniopterygidae: Neuroptera)의 소개

이성균¹ · 김슬기¹ · 손재천² · 조수원^{1*}

¹충북 청주시 흥덕구 충북대학교 식물의학과, ²미국 메릴랜드대학교 곤충학과

ABSTRACT: The family Coniopterygidae belonging to Neuroptera with *Semidalis aleyrodiformis* (Stephens) is introduced from the Korean Peninsula in the present study. Taxonomic descriptions of the family and the species and illustrations of its wing and male genitalia are presented.

Key words: Coniopterygidae, dusty wings, *Semidalis aleyrodiformis*

초 록: 한반도에서 *Semidalis aleyrodiformis* (Stephens)가 속한 풀잡자리목(Neuroptera)의 가루풀잡자리과(Coniopterygidae)에 대해 소개하고, 과(family)와 종(species)의 형태적 특징, 날개 및 수컷생식기의 도해를 제공하였다.

검색어: 가루풀잡자리과, *Semidalis aleyrodiformis*, 흑응애가루풀잡자리

The dusty wings, Coniopterygidae of the order Neuroptera are minute predators, often less than 3 mm long, of small arthropods such as mites, aphids, scale insects and whiteflies. They are known to have a strong predator/prey associations with scale insects, about 17% (14 species) of the known species in America feed on coccoid insects (Miller *et al.*, 2004). They typically reside in trees and shrubs where their preys are found. The eggs are laid on bark or leaves, often singly and at the edges of the leaves (Withycombe, 2008). The common name was derived from their covering of a whitish powdery exudation, and it caused they are often mistaken for whiteflies (Arnett, 1993). The white wax is known to be produced mainly from the abdomen as tiny circled ribbon-like particles and the adults

use the particles to cover all parts of their body except their eyes (Nelson *et al.*, 2003).

Their wing venation is quite simple, being greatly reduced as compared with other species of Planipennia. However, the structural characters of the larvae strongly claims that these have to be neuropterous insects (Townsend, 1939). There are nearly 500 species in Coniopterygidae and many species have been also found as fossils around the world, dating back close to mid-Jurassic (Jepson and Penney, 2007). Cladistic analyses of Neuroptera (Aspöck *et al.*, 2001; Aspöck, 2002) suggested that this family is a sister group of another unusual family, Sisyridae, not known to exist in Korea, of which their larvae are aquatic, feeding on fresh-water sponge, and the two are within the group Hemerobiiformia, suggesting they are closely allied to Hemerobiidae and Mantispidae. However, a recent molecular evidence supported a Permian (299-251 million years ago)

*Corresponding author: chosoowon@gmail.com
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origin of the order with Coniopterygidae as the closest relative of all other neuropterans (Winterton and Wiegmann, 2009).

Meinander first revised Coniopterygidae of the world in 1972 and later produced a checklist of the species of the world, listing 423 recent and 11 fossil named species (Meinander, 1990). Since then, about 60 species have been added, including recent additions of four *Heteroconis* spp. from China (Liu *et al.*, 2004).

In Asia, both China and Japan have several or more species of Coniopterygidae described (Enderlein, 1907; Kuwayama, 1962; Liu and Yang, 2002) but it has never been taxonomically treated in Korea. In North Korea, the family was introduced as *ga-ru-jam-ja-ri-gwa* including *Coniopteryx pulverulenta* Enderlein (www.nktech.net), a synonym of *C. abdominalis* ("Coniopterygidae" 2005). On the other hand, the only record on coniopterygid species in South Korea was on a book titled as 'Natural Enemy Understanding & Utilizing' where only a species name *Semidalis albata*, a synonym of *S. aleyrodiformis*, was listed in a table as one of many natural enemies to the pest of mandarin oranges in Jeju-do [Is.] (Kim, 1998). No systematic or biological description was provided, and no further study has been done. Recently we found this species from Chungcheongbuk-do [province], and introduced this species with a brief taxonomic description of the family.

MATERIALS AND METHODS

We used light trap and sweeping net for collecting. For the study of genitalia, we first soaked the sample in 10% KOH for a few hours to a day, and saved it in 95% alcohol. For actual examination, the sample was soaked in glycerol and examined through a stereo light microscope, often with a 3D imaging computer system. The specimens examined were deposited in the Insect Collection of the Department of Plant Medicine, Chungbuk National University in Cheongju, Korea.

TAXONOMY

Coniopterygidae Burmeister, 1839

가루풀잡자리과(신칭)

Coniopterygidae Burmeister, 1839. Handbuch der Ento-

mologie 2: 771; Enderlein, 1906:173; Enderlein, 1930: 98; Tjeder, 1957: 98. (Type genus: *Coniopteryx* Curtis, 1834.)

Coniopterycidae Newman, 1853: 201.

Coniopterygides Rambur, 1942: 315.

A summarized description of the family is as follows. A much detailed description of the family can be found in Meinander's revisionary work on Coniopterygidae (1972).

Adults. Length of forewing not exceeding 5 mm. Body, wings and often legs covered with a whitish or light greyish waxy substance secreted by wax glands peculiar to the family; wax glands situated mainly on the abdomen and also on the dorsal surface of the head and thorax, secreting continuously after the emergence of the imago throughout the most of life.

Head hypognathous; head capsule strongly sclerotized and darkly pigmented. Ocelli absent. Compound eyes well developed and mostly very large. Clypeus very short but usually with long hairs. Genae small in Coniopteryginae and rather large in Aleuropteryginae. Number of antennal segments 16-57, often varying within certain limits in a species, even between left and right antennae of same specimen. Antennae of males and females of same species often with distinctive sexual dimorphism. Scape and pedicel bigger than flagellar segments. Flagellum rather short and moniliform, flagellar segments usually longer and narrower in females than in males. Labrum short. Mandibles rather small. Maxillae well-developed. Maxillary palpi very long, 5-segmented; third segment slightly longer than others and fifth segment swollen basally, often about twice as long as the third. Labium well developed; palpigers prominent; palpi 3-segmented. Ligula large, consisting of completely fused glossae. Paraglossae absent.

Prothorax short and usually faintly sclerotized. Mesothorax bigger than metathorax. Legs slender; tarsi 5-segmented. Wing venation reduced; wing membrane mostly unicoloured but in some species distinctly spotted.

Abdomen weakly sclerotized except for certain parts of genitalia. Wax glands present dorsally on tergites and laterally on sternites. In Aleuropteryginae, wax glands on tergites forming a narrow transverse line on each tergite while glands on sternites encircle the organs called plicaturae. In Coniopteryginae, glands on tergites forming a broad

band while glands on sternites a rather broad area laterally.

Genital structures very polymorphic, often difficult to identify homologous structures in different genera. The ninth tergite and sternite generally fused into a synscleritous well-sclerotized ring, often anteriorly strengthened by an apodeme; the tergite much reduced or incorporated into tenth tergite. The ninth coxopodites almost always fused into a structure called hypandrium. In most genera, the hypandrium incorporated into the ring of the ninth segment forming the ventral caudal part of the ring. The styli of the ninth coxopodites present in almost every genus; styli not articulating with hypandrium, rather articulating with an arcuate sclerite called gonarcus, a part of the ninth coxopodites, sometimes a separate structure or sometimes obliterate (Farris, 1940). Tenth tergite, usually incorporated into the ring of the ninth segment; ectoproct possibly formed not only with the tenth tergite but also with the ninth. The tenth sternite represented by a small plate between the anus and the parameres. Parameres present, usually elongated as a pair of long slender rods laterally of the aedeagus. The eleventh segment obliterate.

Eggs. The eggs laid on bark or leaves, usually singly but sometimes in twos or threes; oval and dorso-ventrally somewhat depressed. A small conical micropylar projection present at the anterior end. The chorion with polygonal depressions caused by the secretion of follicle cells.

Larvae. Almost all with three larval instars. The third-instar larva shortly fusiform, anteriorly swollen, being widest at thorax. Thorax and abdomen of about equal length. Head prognathous, small, often partly concealed within prothorax. Eyes just behind bases of antennae, composed of four or five ommatidia. Labrum projecting beyond head and covering the jaws, completely in Coniopteryginae, and partly in Aleuropteryginae. Antennae two-segmented. Two tarsal claws, between them a pad-like empodium. Malpighian tubules numbering six, although eight in all other Planipennia larvae.

Pupae. For pupation, a flat circular cocoon of white silk spun, consisting of two envelopes, more or less separated from each other. Pupa short and in profile somewhat square, with head bent over at an angle to thorax.

Biology. Many species are associated with certain types of vegetation or a single species of bushes or trees. Both adults and larvae feed on small inactive arthropods, such as aphids and coccids. The adults fly at sunset and both sexes are attracted to light.

***Semidalis* Enderlein, 1905**

Semidalis Enderlein, 1905. Wiener Entomol. Zeitung 24: 197. (Type species: *Coniopteryx aleyrodiformis* Stephens, 1836 by original designation and monotypy.)

There are 60+ species worldwide except for the Australian region. At least five different species groups (*S. decipiens* group, *S. meridionalis* group, *S. vicina* group, *S. inconspicua* group, and *S. teneriffae* group) were recognized (Meinander, 1972, 1990).

***Semidalis aleyrodiformis* (Stephens, 1836)**

흑응애가루풀잡자리 (신칭)

(Fig. 1)

Aleyrodes gigantea Stephens, 1829:367 (listed); Hagen, 1866: 379 (listed). [nomen nudum]

Coniopteryx tineiformis Curtis. Curtis, 1834, pl. 528 nec text to pl. (wings)

Coniopteryx aleyrodiformis Stephens, 1836. Illustrations of British Entomology. Mandibulata VI: 116 (description).

Coniopteryx (Coniortes) tineiformis Curtis. Westwood, 1840: 49, f. 65: 1-8, f. 70: 1 (biology).

Semidalis curtisiana Enderlein, 1906: 212, f. 13, 62 (description).

Semidalis albata Enderlein, 1907: 5 (description).

Semidalis alpina Withycombe, 1925: 17, f. 15, 27 (description).

Semidalis poinciana Withycombe, 1925: 18, f. 16, 28 (description).

Head brown. Antennae rather dark brown, 18-21 segmented. Flagellar segments of male except basal ones slightly longer than broad.

Thorax brown with large blackish brown shoulder spots. Membrane of wings almost hyaline.

Length of forewing 2.1-2.7 mm, of hind wing 1.8-2.4 mm.

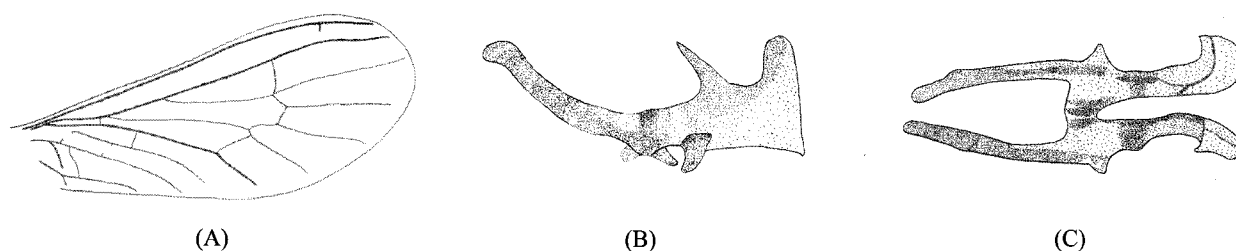


Fig. 1. *Semidalis aleyrodiformis* (Stephens) A. wing venation; B. internal genitalia of male, lateral view; C. ditto, ventral view.

Male genitalia. Outer process of ectoprocts long and slender. Process of inner angle of ectoprocts triangular in dorsal view, dentiform in lateral view. Hyandrium small and truncate. Parameres with two dorsal membraneous acute teeth, one at apex of parameres and the other near middle, slightly apicad; variable in shape among different specimens. Uncinus small and unguiform or almost absent; dorsum of parameres, withdrawn into abdomen, forming a transverse plate.

Specimen examined.

1 ♂: Chungbuk National Univ., Cheongju, S. K. Lee & S. K. Kim, Aug. 22. VIII. 2007; 1 ♂: Chungbuk National Univ., Cheongju, S. K. Kim, 3. V. 2008; 1 ♀: Weolag [Mt.], Jechoen, S. K. Lee & S. K. Kim, 21. VIII. 2008; 1 ♂: Chungbuk National Univ., Cheongju, S. K. Kim, 24. VI. 2009.

Biology.

Semidalis aleyrodiformis is mostly found on deciduous trees and bushes and the specimens found in Cheongju were from a persimmon tree and around.

Distribution.

India, Thailand, Palaeartic region (except North Africa) including Korea, Japan and China (Withycombe, 1925).

Remarks.

Due to morphological variations within a species, we compared the DNA barcodes of the three specimens. Maximum 0.2% dissimilarity among the sequences confirmed they belong to one species. Kim *et al.* (1978) referred the name in the abstract of their paper as "*Semidalis albate*

E." which is a misspelled synonym, and we do not count it valid as the name of the species or the family was not mentioned at all in the text.

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Literature Cited

- Arnett, R.A. 1993. American Insects: A Handbook of the Insects of America North of Mexico. Sandhill Crane Press, Gainesville, USA.
- Aspöck, U. 2002. Phylogeny of the Neuropterida (Insecta: Holometabola). Zool. Scr. 31: 51-55.
- Aspöck, U., J.D. Plant, and H.L. Nemeschkal. 2001. Cladistic analysis of Neuroptera and their systematic position within Neuropterida (Insecta: Holometabola: Neuropterida: Neuroptera). Sys. Entomol. 26: 73-86.
- Burmeister, H.C.C. 1839. Neuroptera. In: Handbuch der Entomol. 2: 756-1050. Berlin.
- "Coniopterygidae" 2005. Encyclopedia. North Korean Science and Technology Network. [Accessed 10 Jul 2007] Available from URL: <http://www.nktech.net>.
- Enderlein, G. 1905. Ein neuer zu den Coniopterygiden gehörigen Neuropteren-Typus aus der Umgebung von Berlin. Wiener Entomol. Zeitung 24: 197-198.
- Enderlein, G. 1907. Die Coniopterygiden fauna Japans. Entomol. Zeitung Stettin 68: 3-9.
- Farris, G.F. 1940. The morphology of *Plega signata* (Hagen) (Neuroptera: Mantispidae). Microentomology 5: 33-56.
- Jepson, J.E. & D. Penny. 2007. Neuropteran (Insecta) palaeodiversity with predictions for the Cretaceous fauna of the Wealden. Palaeogeogr. Palaeoclimatol. 248: 109-118.
- Kim, H.S., D.Y. Moon, P.C. Lippold, Y.D. Chang and J.S. Park. 1978. Studies on the intergrated control of citrus pests. I. Bionomics of citrus red mite and natural enemies. Kor. J.

- Plant Prot. 17(1): 7-13.
- Kim, H.S. 1998. Biological control of coccids on tangerine trees. *In: Understanding and Use of Natural Enemy. Rural Development and Administration.* pp. 203-211.
- Kuwayama, S. 1962. A revisional synopsis of the Neuroptera in Japan. *Pac. Insects* 4: 325-412.
- Liu, Z.Q. and C.K. Yang. 2002. Coniopterygidae. *In: Huang, F.S. (ed.), Forest Insects of Hainan.* Science Press, Beijing. pp. 302-304.
- Liu, Z.Q., C.K. Yang and Z.R. Shen. 2004. A study of the genus *Heteroconis* Enderlein (Insecta: Neuroptera: Coniopterygidae) with four new species from mainland China. *Raffles B. Zool.* 52(2): 365-372.
- Meinander, M. 1972. A revision of the family Coniopterygidae (Planipennia). *Acta Zool. Fenn.* 136: 1-357.
- Meinander, M. 1990. The Coniopterygidae (Neuroptera, Planipennia). A check-list of the species of the world, descriptions of new species and other new data. *Acta Zool. Fenn.* 189: 1-95.
- Miller, G.L., J.D. Oswald and D.R. Miller. 2004. Lacewings and scale insects: A review of predator/prey association between the Neuropterida and Coccoidea (Insecta: Neuroptera, Raphidioptera, Hemiptera). *Ann. Entomol. Soc. Am.* 97(6): 1103-1125.
- Nelson, D.R., T.P. Freeman, J.S. Buckner, K.A. Hoelmer, C.G. Jackson and J.R. Hagler. 2003. Characterization of the cuticular surface was pores and the waxy particles of the dustywing, *Semidalis flinti* (Neuroptera: Coniopterygidae). *Comp. Biochem. Phys. B* 136: 343-356.
- Stephens, J.F. 1836. *Illustrations of British Entomology. Mandibulata VI.* 240pp. London.
- Townsend, L.H. 1939. Lacewings and their allies. *Sci. Mon.* 48(4): 350-357.
- Winterton, S.L. and B.M. Wiegmann. 2009. Lacewings (Neuroptera). pp. 290-292 *In: The Timetree of Life, S. B. Hedges and S. Kumar, Eds. Oxford Univ. Press.*
- Withycombe, C.L. 1925. A contribution towards a monograph of the Indian Coniopterygidae (Neuroptera). *Mem. Dept. Agr. India, Entomol. Ser.* 9:1-20.