Taxonomic Revision of the Genus *Chirosia* Rondani (Diptera: Anthomyiidae) in Korea

Sang Jae Suh*

Department of Environmental Horticulture, Kyungpook National University, Sangju 742-711, Korea

Received May 19, 2008 / Accepted August 23, 2008

In this paper, a total of 11 species of the genus *Chirosia* are treated. Among them, a species, *Chirosia flavipennis* (Fallen, 1823), is newly added to Korean fauna. The keys to Korean species, host plants and domestic localities are given. Some illustrations of male genitalic features are included. The cladistic analysis of the Korean species is performed using *Musca domestica* (Muscidae), *Scathophaga stercoraria* (Scathophagidae), *Delia platura* (Anthomyiidae) and *Anthomyia angulata* (Anthomyiidae) as outgroups.

Key words : Phylogeny, anthomyiidae, calyptratae, Diptera, Korea

Introduction

The genus *Chirosia* comprises over 30 species throughout the palaearctic region [12]. Rondani erected the genus based on a single species, *Aricia albitarsis* Zetterstedt, 1845 [9]. Subsequent authors assigned new genera, which were suppressed as synonyms for this genus. Among them, *Pycnoglossa* had been recognized as a distinct genus and often referred into different tribe from *Chirosia* only based on the frons width of the male for a long time. The larvae of some species in this genus are known to mine the leaves of ferns [2,12].

The first record of this genus from Korea was given by Chu and Hsia (1937) who recorded *Chirosia albimana* (= *Chirosia albitarsis*) in Korea along with Japanese species [2]. After then, Kwon and Suh described a new species, *Meliniella sobaeksana* (= *Chirosia sobaeksana*), based on the specimens collected from Sobaeksan with 2 species newly to Korean fauna [5]. Suwa also described a new species, *Chirosia inspirata* from Jirisan, and added 2 species to Korean fauna [13]. Again, Suh and Kwon added 3 species to Korean fauna [10,11]. Consequently, prior to the present study a total of 10 species have been reported as occurring correctly in Korea [4].

In this paper, we intend to add further a species hitherto unrecorded to Korean fauna. As a result, a total of 11 species are listed here to be occurred in Korea.

Materials and Methods

The studied material is deposited at the following in-

stitutions: School of Applied Biology and Chemistry, Kyungpook National University, Daegu (KPNU-D); Department of Environmental Horticulture, Kyungpook National University, Sangju (KPNU-S); Department of Natural Ecology, Ministry of Environment, Suwon, (MIEN).

In the cladistic analysis, Korean *Chirosia* species were included in the ingroup, using *Musca domestica* (Muscidae), *Scathophaga stercoraria* (Scathophagidae), *Delia platura* (Anthomyiidae) and *Anthomyia angulata* (Anthomyiidae) as outgroups. The choice of terminal taxa for the outgroup was based on previous phylogenetic hypotheses for Muscoidea in which Muscidae, Scathophagidae and Anthomyiidae are sister groups [1,6,8].

The analysis was based exclusively on male adult characters (Appendix 1), and all multistate characters (Appendix 2) were defined as unordered. The program NEXUS version 0.5.0 was used for data matrix editing and the cladistic analysis was carried out using the program PAUP version 4.0b10 [14]. The tree search was performed using the HSEARCH command, and character optimization using ACCTRAN.

The adult morphological terminology and classification system adopted and followed here is after Michelsen [7].

Results and Discussion

Systematic accounts

Genus *Chirosia* (Rondani, 1856)

Diagnosis. Interfrontal seta present; one or more fronto-orbital setae present; upper occipital setae present; haustellum robust and stout; scutellum usually bared on ventral surface; mid tibia often with 1 anterodorsal seta; hind tibia with 3 posterodorsal setae and apical anteroventral

*Corresponding author

Tel : +82-54-530-1235, Fax : +82-54-530-1239

E-mail : sjsuh@knu.ac.kr

and posteroventral setae, which easily distinguishable from adjacent setulae even if short.

***Chirosia albitarsis* (Zetterstedt, 1845)**

Material examined. [KPNU-D]: <GB> 2♂, Palgongsan, 18. VI. 1985, Y. Kwon.

Locality. South-GB: Palgongsan.

Distribution. Korea, Japan, China, Europe.

***Chirosia betuleti* (Ringdahl, 1935)**

Material examined. [KPNU-D]: <GW> 4♂, Odaesan, 24. V. 1989, Y. Kwon.

Locality. Central-GW: Odaesan.

Distribution. Korea, Japan, China, Europe.

Host. *Athyrium filix femina* [2].

***Chirosia bisinuata* (Tiensuu, 1930)**

Material examined. [KPNU-D]: <GW> 1♂, Odaesan, 24. V. 1999, Y. Kwon.

Locality. Central-GW: Odaesan.

Distribution. Korea, Japan, China, Finland, Sweden.

***Chirosia cinerosa* (Zetterstedt, 1845)**

Material examined. [KPNU-D]: <GG> 4♂, Myeongseongsan, 16. V. 1982, Y. Kwon; 1♂, Soyosan, 15. V. 1982, Y. Kwon; <GW> 2♂, Obongsan, 21. V. 1982, Y. Kwon; 2♂, Obongsan, 17. V. 1981, Y. Kwon; 1♂, Obongsan, 20. V. 1982, 2♂, Obongsan, 12. V. 1985, Y. Kwon; 1♂, Chiaksan, 22. V. 1982, Y. Kwon; <GB> 2♂, Sobaeksan, 10. V. 1985, Y. Kwon; 2♂, Palgongsan, 29. V. 1985, Y. Kwon; [KPNU-S]: <GB> 1♂, Bohyeonsan, 29. V. 1998, Y. Kwon; 1♂, Bakbongsan, 11. V. 2007, S. J. Suh; <JB> 1♂, Deogyusan, 20. V. 1999, S. J. Suh; [MIEN]: <GB> 2♂, Bohyeonsan, 29. V. 1998, Y. Kwon.

Locality. Central-GG: Myeongseongsan, Soyosan; GW: Chiaksan, Obongsan; South-GB: Bakbongsan, Bohyeonsan, Palgongsan, Sobaeksan; JB: Deogyusan.

Distribution. Korea, Japan, Europe, N.America.

Host. *Struthiopteris* sp. [12].

***Chirosia flavipennis* (Fallen, 1823) (Fig. 1)**

Diagnosis. Male. Black in ground color, with thin greyish pollen. Head about 14-1.5 times as high as long in profile. Frons at narrowest part nearly as wide as distance between posterior ocelli. Interfrontalia dark brown or dark, with a pair of proclinate cruciate interfrontal seta; parafrontalia dull with greyish pollen, with 2-3 frontal setae, and 1 slender fronto-orbital seta. Parafacialia and cheek brownish black, with grey pollen; parafrontal width about 0.5-0.6 times as wide as width of third antennal segment.

Fig. 1. *Chirosia flavipennis* (Fallen, 1823), Male. A. hypopygium, dorsal view; B. ditto, lateral view; C. fifth sternite, ventral view; D. ditto, lateral view; E. gonocoxal lobe, gonostylus and phallus, lateral view. Unit scale=0.1 mm.

Parafacialia narrowing toward level of lower margin of eye; cheek at narrowest part about as high as width of third antennal segment. Antenna black; third segment about 1.5-1.6 times as long as wide; arista distinctly plumose, the longest hair about twice as long as basal diameter of arista. Mentum of haustellum brownish black and stout. Palpus black with sparsely grey pollen, long and slender.

Thorax black in ground color, with brown pollen; mesonotum with paler brownish median vitta presuturally in anterior view; 5 pairs of presutural acrostichal setae, the distance of acrostichal rows about half as wide as distance between acrostichal and dorsocentral rows. Second posthumeral seta strong, about twice as long as anterior notopleural seta; posterior notopleural seta about 0.7-0.8 times as long as anterior notopleural seta; propleuron sunken, with 1 propleural seta. Mesopleuron with 2 prostigmatal setae.

Legs black; fore tibia with 1 anterodorsal seta, 1 anteroventral seta, 1 preapical anteroventral seta, apical anterodorsal seta and posterodorsal seta; mid tibia with 1 posterior seta, 3 posterodorsal setae, and strong apical anteroventral and posteroventral setae; hind tibia with 5 anterodorsal setae, 7 anteroventral setae, 5 posterodorsal setae, 7 posteroventral setae and apical anteroventral seta.

Wing faintly brownish tinged, denser basally; costal spine strong, about as long as humeral cross vein; m-m nearly straight. Calyptrate and knob of halter brown.

Abdomen pressed and short, with grey pollen and a black narrow median vitta.

Length. Body 4.8-5.0 mm, wing 5.8-5.9 mm.

Material examined. [KPNU-S]: <JB> 4♂2♀, Hupo-ri, Gochang-gun, 24. V. 2006, S. J. Suh.

Locality. South-JB: Hupo-ri.

Distribution: Korea (new record), Japan, Europe, North America.

***Chirosia griseifrons* (Seguy, 1923)**

Material examined. [KPNU-D]: <GG> 1♂, Ganhwado, 11. V. 1982, Y. Kwon; 12♂, Ganhwado, 8. V. 1983, Y. Kwon; 1♂, Ganhwado, 9. V. 1983, Y. Kwon; <GB> 6♂, Palgongsan, 26. V. 1985, Y. Kwon; 3♂, Sobaeksan, 10. V. 1985, Y. Kwon; <JB> 1♂, Maisan, 11. V. 1980; [KPNU-S]: <GB> 1♂, Bakbongsan, 11. V. 2007, S. J. Suh.

Locality. Central GG: Ganghwado; GW: Obongsan, Odaesan, Seoraksan; South GB: Bakbongsan, Palgongsan, Sobaeksan; GN: Jirisan; JB: Maisan.

Distribution. Korea, China, Japan, Europe.

***Chirosia grossicauda* (Strobl, 1899)**

Material examined. [KPNU-D]: <GB> 2♂, Palgongsan, 26. V. 1985, Y. Kwon; <JN> 1♂, Dolsando, 17. IV. 1986, Y. Kwon.

Locality. South-GB: Palgongsan; JN: Dolsando.

Distribution. Korea, Japan, Europe.

***Chirosia histricina* (Rondani, 1866)**

Material examined. [KPNU-S]: <GB> 1ex, Bohyeonsan, 11. V. 1998, S. J. Suh; <JB> 1ex, Deogyusan, 16. V. 1999, S. J. Suh.

Locality. South-GB: Bohyeonsan; JB: Deogyusan.

Distribution: Korea, Japan, Europe, North America.

Host plants: *Pteridium aquilinum*, *Asplenium*, *Athyrium*, *Blechnum*, *Cystopteris*, *Dryopteris*, *Polypodium*, *Osmunda*, *Polystichum* and *Struthiopteris* [12].

***Chirosia inspinata* (Suwa, 1983)**

Locality. South-GN: Jirisan.

Distribution. Korea.

***Chirosia nigripes* (Bezzi, 1895)**

Material examined. [KPNU-D]: <JN> 1♂, Dolsando, 17. IV. 1986, Y. Kwon; [KPNU-S] <JB> 3♂, Unjangan, 31. V. 1998, S. J. Suh.

Locality. South JB: Unjangan; JN: Dolsando.

Distribution. Korea, Japan, Italy.

***Chirosia sobaeksana* (Kwon et Suh, 1982)**

Material examined. [KPNU-D]: 1♂, Sobaeksan, 15. V.

1981, Y. Kwon.

Locality. South GB: Sobaeksan.

Distribution. Korea.

Key to the species of Korean *Chirosia*

1. Prealar seta longer or as long as second notopleural seta 2
- Prealar seta shorter than second-notopleural seta 6
2. Notopleuron with a few accessory setulae *bisinuata* (Tiensuu)
- Notopleuron without accessory setulae 3
3. Hind tibia without apical-anteroventral seta *sobaeksana* (Kwon & Suh)
- Hind tibia with apical-anteroventral seta 4
4. Interfrontal seta fine or often vestigial; larger species *griseifrons* (Seguy)
- Interfrontal seta strong; smaller species 5
5. Fore tarsus wholly black *histicina* (Rondani)
- First and second segments of fore tarsus whitish tinged *albitarsis* (Zetterstedt)
6. Arista plumose *flavipennis* (Fallen)
- Arista pubescent 7
7. Frons with 3 fronto-orbital setae *grossicauda* Strobl
- Frons with 1 fronto-orbital seta 8
8. Eyes markedly separated from each other 9
- Eyes contiguous 10
9. Frons with 3 fronto-orbital setae *nigripes* Bezzi
- Frons with 1 fronto-orbital seta *inspinata* Suwa
10. Middle femur with strong anteroventral seta *cinerosa* (Zetterstedt)
- Middle femur without strong anteroventral seta *betuleti* (Ringdahl)

Cladistics

The analysis using all characters, equally weighted, resulted in one of the most parsimonious cladogram with length=61 steps, consistency index (CI)=0.4262, homoplasy index (HI)=0.5738, retention index (RI)=0.5570, and re-scaled consistency index (RC)=0.2374. In the unrooted tree rooted using outgroup method, *Chirosia* appeared as a monophyletic group which included all species in a large polytomic clade with no internal resolution (Fig. 2).

Monophyly of *Chirosia* was supported by three synapomorphies and two homoplasies: strong interfrontal seta

Fig. 2. The most parsimonious cladogram resulting from analysis with character optimization. Tree length=61, consistency index (CI)=0.4262, homoplasy index (HI)=0.5738, retention index (RI)=0.5570, rescaled consistency index (RC)=0.2374. Numeric numbers are synapomorphic and homoplastic characters.

present (character 2); haustellum robust and stout (character 6); surstylus enlarged at apex in profile (character 18); dichoptic eyes (character 1); and ventral surface of scutellum bare (character 10).

Three major groups within the genus *Chirosia* were found. One large group including *C. albicansis*, *C. betuleti*, *C. cinerosa*, *C. flavipennis*, *C. histricina* and *C. inspinata*, was supported by four homoplastic traits: one fronto-orbital seta; prealar seta shorter than anterior notopleural seta; strong posteroventral seta on hind femur present; and surstylus in profile enlarged at apex and curved inward. In the eudicots, *C. betuleti* and *C. cinerosa* were linked the most closely by two traits: dichoptic eyes; and second post-humeral seta well developed as long as or longer than anterior notopleural seta. The small clade bearing *C. grossicauda* and *C. nigripes*, was supported by two homoplastic characters: three fronto-orbital setae present; and anterodorsal seta on fore tibia present. Three species, *C. sobaeksana*, *C. bisinuata* and *C. griseifrons*, which were treated the species in the genus *Melliniella* by Suwa (1976), were divided from the other *Chirosia* species by three characters: surstylus in profile enlarged at apex and curved outward (character 18); interfrontal seta fine (character 2); and lateral lobe of fifth sternite with a median process (character 20).

This analysis was well expounded at the internal relationships among *Chirosia* species, and was in accord with traditional view [7,12]. To obtain constant and reliable hypothesis on the relationships within the family Anthomyiidae, further high-level studies are required.

Acknowledgement

This study was supported by Kyungpook National University Grant (P&R-2008).

References

- Griffiths, G. C. D. 1972. The phylogenetic classification of Diptera Cyclorrhapha, with special reference to the structure of the male postabdomen. Dr. W. Junk N.V. Publishers, Hague, 340pp.
- Hennig, W. 1966. Anthomyiidae. *Flieg. Pal. Reg.* **63**, 47-96.
- Hwang, J. S., J. S. Lee, Y. S. Kim and Y. M. Seong. 1999. Molecular phylogenetics of silkworm (*Bombyx mori*) based on mariner-like elements (MLEs). *Korean J. life Science*, **9**, 176-181.
- Kwon, Y. J., J. H. Lee, S. J. Suh, S. L. An, E. Y. Huh and L. S. Lu. 1996. III. Invertebrate 2 (Insects and spiders): 93-292. In Lee et al. (eds): *List of biological species from Korea*. The Korean Natural Council for Conservation of Nature, Seoul. 505pp.
- Kwon, Y. J. and S. J. Suh. 1982. Classification of the Anthomyiidae from Korea (III). *Kor. J. Plant Prot.* **21**, 185-190.
- Nihei S. S. and C. J. B. Carvalho. 2004. Taxonomy, cladistics and biogeography of *Coenosopsia* Malloch (Diptera, Anthomyiidae) and its significance to the evolution of anthomyiids in the Neotropics. *Syst. Entomol.* **29**, 260-275.
- Michelsen, V. 1985. A revision of the Anthomyiidae (Diptera) described by J. W. Zetterstedt. *Steenstrupia* **11**, 37-65.
- Michelsen, V. 1991. Revision of the aberrant new world genus *Coenosopsia* (Diptera: Anthomyiidae), with a discussion of anthomyiid relationships. *Syst. Entomol.* **16**, 85-104.
- Rondani, C. 1856. Genera Italica ordinis dipterorum ordinatim disposita et distincta et in families et stirpes aggregata. *Dipt. Ital. Prodr.* 1-228.
- Suh, S. J. and Y. J. Kwon. 1986. Classification of the Anthomyiidae from Korea (V) (Diptera: Calyptratae). *Kor. Journ. Ent.* **16**, 157-162.
- Suh, S. J. and Y. J. Kwon. 2001. Two unrecorded species of the family Anthomyiidae (Diptera: Calyptratae) from Korea. *Korean J. Entomol.* **3**, 165-168.
- Suwa, M. 1974. Anthomyiidae of Japan (Diptera). *Ins. Mats. n.s.* **4**, 1-247.
- Suwa, M. 1983. Notes on Korean Anthomyiidae, with description of two new species and one new subspecies (Diptera). *Nat. & Life* **13**, 23-44.
- Swofford, D. L. 2003. PAUP: *Phylogenetic Analysis Using and Parsimony (* and other methods)*, Version 4.0b10. Sinauer Associates, Sunderland, Massachusetts.

Appendix 1. Characters and character states used in the cladistic analysis.

1. Eyes: (0) dichoptic; (1) holoptic.
2. Interfrontal seta: (0) absent; (1) present, fine; (2) present, strong.
3. Fronto-orbital seta: (0) present, 3 setae; (1) present, 1 seta; (2) absent.
4. Frontal seta: (0) more than 4; (1) 2-3 setae.
5. Arista: (0) plumose; (1) pubescent.
6. Haustellum: (0) slender; (1) stout.
7. Acrostical seta: (0) numerous; (1) 3-5 pairs.
8. Second posthumeral seta: (0) shorter than anterior notopleural seta; (1) as long as or longer than notopleural seta.
9. Prealar seta: (0) shorter than anterior notopleural seta; (1) as long as or longer than anterior notopleural seta.
10. Ventral surface of scutellum: (0) bare; (1) setulose.
11. Anterodorsal seta on fore tibia: (0) absent; (1) present.
12. Anteroventral seta on mid femur: (0) absent; (1) present, strong.
13. Posteroventral seta on hind femur: (0) present, strong; (1) absent.
14. Posteroventral seta on hind tibia: (0) absent; (1) present, 2-5 setae; (2) present, more than 5 setae.
15. Apical posteroventral seta on hind tibia: (0) present; (1) absent.
16. Apex of cercal plate: (0) not bifurcate; (1) bifurcate.
17. Surstylus: (0) simple slender; (1) with sunken margins on middle; (2) with a process.
18. Surstylus in profile: (0) simple slender; (1) enlarged at apex and curved inward; (2) enlarged at apex and curved outward.
19. Distiphallus: (0) cylindrical; (1) triangular.
20. Lateral lobe of fifth sternite: (0) small; (1) moderate; (2) with a process.

Appendix 2. Character state distribution of characters used in cladistic analysis (*: 0, 1, 2=character states; ?=missing data).

Taxon/Node	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
<i>Musca domestica</i>	0*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Scathophaga stercoraria</i>	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	0	0
<i>Delia platura</i>	1	0	2	0	1	0	1	0	1	1	1	1	0	2	0	0	0	0	1	1
<i>Anthomyia angulata</i>	1	2	1	0	1	0	1	0	1	1	0	0	1	2	1	0	2	0	1	2
<i>Chirosia albitarsis</i>	0	2	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1
<i>Chirosia betuleti</i>	1	2	1	0	1	1	1	1	0	0	1	0	1	2	0	1	1	1	1	1
<i>Chirosia bisinuata</i>	0	1	1	0	1	1	1	1	0	0	1	0	1	2	1	1	2	2	1	2
<i>Chirosia cinerosa</i>	1	2	1	1	1	1	1	1	0	0	0	1	0	2	0	0	1	1	1	1
<i>Chirosia flavipennis</i>	0	2	1	1	0	1	1	0	0	0	0	0	1	2	0	0	1	1	1	1
<i>Chirosia griseifrons</i>	0	1	1	0	1	0	1	0	1	1	1	0	1	2	1	0	2	2	1	2
<i>Chirosia grossicauda</i>	0	2	0	1	1	1	1	0	0	0	1	1	1	2	0	1	1	0	1	1
<i>Chirosia histricina</i>	0	2	1	0	1	1	1	0	0	0	0	0	1	1	0	0	1	1	1	1
<i>Chirosia inspinata</i>	0	2	1	1	1	1	1	0	1	0	0	1	1	1	?	0	2	0	1	1
<i>Chirosia nigripes</i>	0	2	0	1	1	1	1	0	1	0	1	0	0	1	1	1	1	1	1	1
<i>Chirosia sobaeksana</i>	0	2	1	1	1	0	1	0	0	0	?	?	1	1	1	1	2	2	1	1

초록 : 한국산 양치꽃파리속의 분류학적 재검토

서 상 재

(경북대학교 생명자원과학대학 환경원예학과)

한국산 양치꽃파리류는 현재까지 10종이 알려져 있으며, 새로이 1 한국미기록종, *Chirosia flavipennis* (짧은배양치꽃파리, 신칭)을 추가하고자 한다. 또한 한국산 양치꽃파리 11종에 대한 수컷외부 형질에 의한 계통학적 분석을 실시하였다. 군외군으로 선택한 꽃파리과(Anthomyiidae) 내의 씨고자리파리(*Delia platura*), 어리꽃파리(*Anthomyia angulata*)와 근연과인 집파리과(Muscidae)의 집파리(*Musca domestica*), 똥파리과(Scathophagidae)의 똥파리(*Scathophaga stercoraria*)와 비교 분석에서 전통적인 분류와 유사한 결과를 얻을 수 있었다.