Zootaxa 2735: 1–22 (2011)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

A review of *Ophthalmitis* Fletcher, 1979 in China, with descriptions of four new species (Lepidoptera: Geometridae, Ennominae)

NAN JIANG[1], DAYONG XUE[2] & HONGXIANG HAN[2,3]

[1]*Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Beijing 100101 China & Graduate University of Chinese Academy of Sciences, Beijing 100049 China. E-mail: jiangn@ioz.ac.cn*
[2]*Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Beijing 100101. E-mail: xuedy@ioz.ac.cn*
[3]*Corresponding author. E-mail: hanhx@ioz.ac.cn*

Abstract

The genus *Ophthalmitis* Oberthür in China is reviewed and four new species are described: *O. dissita* **sp. nov.**, *O. longiprocessa* **sp. nov.**, *O. brevispina* **sp. nov.**, and *O. tumefacta* **sp. nov.** Two subspecies of *O. albosignaria* -- *O. albosignaria juglandaria* and *O. albosignaria isophnia* -- are newly synonymized with the nominate subspecies. A key is provided to the Chinese *Ophthalmitis* and diagnoses for Chinese species. Illustrations of external features and genitalia are presented.

Key words: *Ophthalmitis*, taxonomy, new species, Geometridae, Lepidoptera

Introduction

Guenée established the genus *Ophthalmodes* with two species *Ophthalmodes herbidaria* Guenée, 1858 and *Ophthalmodes diurnaria* Guenée, 1858, without designating a type species. Moore (1887) subsequently designated the former as the type species of the genus. However, Wehrli (1941) treated *Ophthalmodes* as a subgenus of *Boarmia*. Fletcher subsequently discovered that the generic name was occupied by *Ophthalmodes* Fischer, 1834 (Orthoptera), and so proposed the replacement name of *Ophthalmitis* Fletcher, 1979.

Ophthalmitis is currently treated in the tribe Boarmiini within the subfamily Ennominae. The genus has some typical features of Boarmiini: the male forewing often has a fovea; the male abdomen generally has a setal patch on the third sternite, but sometimes it is absent; in the male genitalia, the uncus is almost triangular; the socii are usually absent; the terminal of the costa often bears a large area of setae; the valvae are usually modified; the juxta is often well-developed (Holloway 1994; Pitkin 2002; Young 2008).

The species of *Ophthalmitis* are widely distributed in eastern and southern Asia. Most species were identified in the nineteenth to twentieth centuries. For example, eight new species were described from India and Myanmar (Guenée 1858; Walker 1860; Felder & Rogenhofer 1875; Swinhoe 1891, 1893; Hampson 1902); eleven new species were described from Sundaland (Walker 1860, 1866; Warren 1897; Prout 1925; Holloway 1976, 1994; Sommerer & Stüning 1994); seven new species were described from China (Bremer & Grey 1853; Leech 1897; Oberthür 1913; Prout 1916; Wehrli 1924, 1941; Sato 1992). Parsons *et al.* (1999) summarized the previous works and listed 26 species and six subspecies. Later, Sato (2005) described one new species *O. ogatai* Sato, 2005 from Thailand. Two years later, Sato & Wang (2007) raised *O. lectularia siniherbida* (Wehrli, 1943) to species status and designated *O. lectularia* (Swinhoe, 1891) and *O. lushanaria* Sato, 1992 as junior synonyms of *O. irrorataria* (Bremer & Grey, 1853) and *O. sinensium* (Oberthür, 1913) respectively.

Until now, 26 species and four subspecies in the genus *Ophthalmitis* have been recognized, with ten species and four subspecies recorded in China (Bremer & Grey 1853; Leech 1897; Oberthür 1913; Prout 1915; Wehrli 1924; Wehrli 1941; Zhu 1981; Sato 1984, 1992; Xue 1992a, 1992b, 2001; Wang 1998; Kim *et al.* 2001; Han & Xue

Accepted by L. Gall: 29 Nov. 2010; published: 10 Jan. 2011

2002, 2005; Sato & Wang 2007). However, it has become apparent that, with the study of material obtained during recent expeditions and the re-examination of older specimens, new species need to be described, the taxonomy revised, and the Chinese *Ophthalmitis* fauna summarized. The purposes of this paper are as follows: to review all known Chinese *Ophthalmitis* species; to determine diagnostic characters; to construct a key for Chinese species; to provide illustrations of external features and genitalia; to describe four new species; and to synonymize *O. albosignaria juglandaria* (Oberthür, 1913) and *O. albosignaria isophnia* (Wehrli, 1943) with *O. albosignaria albosignaria* (Bremer & Grey, 1853). This will result in fourteen species and two subspecies of *Ophthalmitis* for the fauna of China.

Materials and methods

Specimens of *Ophthalmitis* were obtained from the Institute of Zoology, Chinese Academy of Sciences, Beijing, China (IZCAS); and Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK). Other museums where types are deposited are as follows: the Natural History Museum, London, United Kingdom (BMNH); the National Museum of Natural Science, Taichung, Taiwan (NMNS). Terminology for wing venation follows the Comstock-Needham System (Comstock 1918) as adopted for Geometridae by Scoble (1992) and Hausmann (2001); that for genitalia is based on Pierce (1914, reprint 1976), Sibatani *et al.* (1954), Klots (1970) and Nichols (1989). Photographs of moths were taken using a digital camera. Composite images were generated using Auto-Montage software version 5.03.0061 (Synoptics Ltd). The plates were compiled using Adobe Photoshop software.

Ophthalmitis Fletcher, 1979

Ophthalmitis Fletcher, 1979, *in* Nye (Ed.), *Generic Names Moths World*, 3: 146. Type species: *Ophthalmodes herbidaria* Guenée, 1858, by subsequent designation by Moore (1887). [Replacement name for *Ophthalmodes* Guenée, 1858.]

Ophthalmodes Guenée, 1858, *in* Boisduval & Guenée, *Hist. nat. Insectes* (Spec. gén. Lépid.), 9: 283. Type species: *Ophthalmodes herbidaria* Guenée, 1858. [Junior homonym of *Ophthalmodes* Fischer, 1834 (Orthoptera).]

Description Head. Antenna greyish white mixed with brown scales dorsally, partly to totally bipectinate, tapering, rami usually shorter in female. Frons rounded, not protruding. Labial palpus blackish brown, extending slightly beyond frons. Thorax. Patagium, tegula greyish white, pale green, or greyish green, blackish brown posteriorly. Centre of tegula blackish brown. Posterior mesonotum with pair of black spots. Metanotum posterior margin black. Two pairs hind tibial spurs in both sexes, usually not dilated, without hair-pencil except in males of *O. albosignaria*. Wings greyish white, greyish green, green, or pale yellowish brown, transverse lines greyish brown, brown, pale green or blackish brown. Forewing outer margin weakly protruded, hindwing rounded. Patterns of forewing: costa diffused with short longitudinal greyish brown flecks; antemedial, medial, postmedial, submarginal lines forming four black patches on costa; antemedial line wavy, sometimes indistinct; medial, postmedial lines serrate, sometimes indistinct, appearing as spots on veins, broadened at inner margin; postmedial line protruded outwards above CuA_1, protruded inwards below CuA_1, then paralleling to medial line; submarginal line appearing as series of small triangular patches between veins, sometimes only distinct between M_1 and M_3, near costal, inner margins; terminal line appearing as series of short strips between veins; fringes greyish white mixed with blackish brown or greyish green; discal spot stellate, pale-centered, ringed blackish brown. Hindwing medial line slightly wavy, sometimes appearing as spots on veins; broad dark band sometimes present between medial line, outer margin of discal spot, indistinct beyond cell; postmedial line stellate, sometimes indistinct, appearing as spots on veins; discal spot smaller than on forewing; submarginal, terminal lines, fringes similar to those of forewing. Venter, greyish white, greyish yellow or greyish black, diffused with small dots; transverse lines greyish brown, distinct; terminal bands present on both wings, discal spot large, distinct, forewing costa pale yellowish brown, diffused with dark flecks. Venation. Frenulum developed. Forewing: male with fovea at base between anal fold and 2A; Sc, R_1 usually long stalked, separate after cell, Sc+R_1, R_2 usually combined with short bar; R_2 and R_{3-5} separate, almost touching at base, diverging before anterior angle of cell; M_1 diverging from anterior angle of cell, not stalked with R_{3-5}; M_3 diverging from posterior angle of cell; CuA_1 diverging before posterior angle of cell. Hindwing: Sc+R_1 close to cell

less than one-half length of cell; Rs diverging before anterior angle of cell; M_1 diverging from anterior angle of cell; M_2 absent; M_3 diverging from posterior angle of cell; CuA_1 diverging before posterior angle of cell; 3A absent. Abdomen. Pairs of black dorsal spots on first to sixth abdominal segments. Spots on first abdominal segment small, on second to sixth segments relatively large and closer together. First abdominal segment pale grey, remaining segments pale green, yellowish green or greyish white. Third sternite of male abdomen without setal patch, except in *O. albosignaria* and *O. xanthypochlora* (Wehrli, 1924). Eighth sternite of male abdomen with cleft, flanked by sclerotized processes, except in *O. xanthypochlora*. Male genitalia. Uncus rounded or square terminally, length equal to basal width, usually with pair of lateral processes, but with two pairs of lateral processes in *O. pertusaria* (Felder & Rogenhofer, 1875) and *O. clararia* (Walker, 1866), or absent in *O. xanthypochlora*, *O. exemptaria* (Walker, 1860), *O. basiscripta* Holloway, 1993, *O. satoi* Holloway, 1993. Arms of gnathos connected medially, with median process rounded terminally, ratio of length to length of uncus variable. Valva blunt or squared distally; costa sclerotized, angled posteriorly medially, expanded, bearing a large area of long setae terminally; sacculus with dorsal margin strongly sclerotized band and/or with extension; ampulla usually present, spinulose, directed towards centre of costa. Saccus semicircular, with longitudinal arris apically in anterior half. Juxta weakly sclerotized, anterior margin usually concaved medially, posterior half narrower or weaker. Coremata developed. Aedeagus weakly sclerotized posteriorly, usually with a pair of sclerotized spines posteriorly; vesica usually without cornuti, except in *O. xanthypochlora*.

Female genitalia. Ovipositor not strongly sclerotized, covered densely with setae. Lamella postvaginalis sclerotized strongly, curved posteriorly, with three lobes below, wrinkled anteriorly. Ductus bursae occasionally sclerotized posteriorly, with colliculum. Corpus bursae oval or rounded, membranous, bearing signum; signum oval or rounded, with marginal spines, small central teeth.

Diagnosis. The genus *Ophthalmitis* resembles *Pseudalcis* Warren, 1897 in the bipectinate male antennae and the pale-centreed stellate discal spots. But *Ophthalmitis* differs from *Pseudalcis* in the following characters: the eighth abdominal sternite of the male usually has a cleft, absent in *Pseudalcis*; in the male genitalia, the costa of *Ophthalmitis* is angled posteriorly medially, and is expanded terminally and bears a large area of long setae terminally, whereas the costa is swollen in a bulbous manner, and bears a dense array of fine setae in *Pseudalcis*.

Distribution. China, Russia, Japan, North Korea, South Korea, India, Vietnam, Myanmar, Nepal, Thailand, Sundaland.

Biological notes. Most specimens from China have been recorded from 80 m to 2680 m elevation beteween April and December. Nakamura (2004) described the pupae and Sato (1976, 1984) and Sugi (1987) described the larvae of *O. albosignaria* and *O. irrorataria*. Singh (1953) described the characters of the type species larva, particularly the chaetotaxy. Larval host plants have been recorded from the families Ebenaceae, Flacourtiaceae, Juglandaceae, Lauraceae, Moraceae and Rosaceae (Holloway 1994; Sato 1984; Scoble 1992).

Key to Chinese *Ophthalmitis* species and subspecies

1. Discal spots of both wings strip-like; the eighth sternite of male abdomen without cleft ..... *O. xanthypochlora*
   Discal spots of both wings stellate and pale-centred; the eighth sternite of male abdomen with a cleft 2
2. Wings greyish white 3
   Wings greyish green or pale green 6
3. Discal spots indistinct ..... *O. subpicaria*
   Discal spots distinct 4
4. Male genitalia dorsal margin of sacculus curved terminally ..... *O. prasinospila*
   Male genitalia dorsal margin of sacculus not curved terminally 5
5. Male genitalia dorsal margin of sacculus narrow ..... *O. albosignaria albosignaria*
   Male genitalia dorsal margin of sacculus broad ..... *O. albosignaria viridans*
6. Hindwing without dark band between medial line and outer margin of discal spot 7
   Hindwing with a broad dark band between medial line and outer margin of discal spot 9
7. Discal spots large; uncus with two pairs of lateral processes ..... *O. pertusaria*
   Discal spots small; uncus with a pair of lateral processes 8
8. Medial line on hindwing not close to inner margin of discal spot ..... *O. dissita*
   Medial line on hindwing close to inner margin of discal spot ..... *O. sinensium*
9. Postmedial line on forewing distinct and serrate 10
   Postmedial line on forewing indistinct and appearing as spots on veins 12
10. Areas inside postmedial lines of both wings diffused with blackish brown scale ..... *O. irrorataria*

Areas inside postmedial lines of both wings not diffused with blackish brown scales. 11
11. Rami of male antenna short. . . . . *O. herbidaria*
Rami of male antenna long . . . . . *O. siniherbida*
12. In the male genitalia lateral processes of uncus long . . . . . *O. longiprocessa*
In the male genitalia lateral processes of uncus short 13
13. Male genitalia dorsal margin of sacculus short, not extending into valvula . . . . . *O. brevispina*
Male genitalia dorsal margin of sacculus long, extending into valvula 14
14. Valva of male genitalia broad . . . . . *O. tumefacta*
Valva of male genitalia narrow . . . . . *O. cordularia*

Ophthalmitis albosignaria (Bremer & Grey, 1853)

Boarmia albosignaria Bremer & Grey, 1853, *Beitr. Schmett.-Fauna nord. China*: 21, pl. 9, fig. 6. Syntype(s), China (north).
Boarmia ocellata Leech, 1889, *Trans. ent. Soc. Lond*., 1889 (1): 143, pl. 9, fig. 11. Syntypes 1♂, 2♀, China: Yangzee River, Kiukiang. (BMNH)
Boarmia saturniaria Graeser, 1889, *Berl. ent. Z.*, 32 (2): 398. Syntypes 2♀, Russia: Amurlandes, Vladivostok.
Diastictis saturniaria: Meyrick, 1892, *Trans. ent. Soc. Lond.*, 1892: 104.
Ophthalmodes ocellata: Leech, 1897, *Ann. Mag. nat. Hist.*, (6) 19: 334.
Ophthalmodes ocellata juglandaria Oberthür, 1913, *Études Lépid. comp.*, 7: 292, pl. 175, fig. 1714. Syntype(s), Russia: Sidemi. **syn. nov.**
Ophthalmodes albosignaria: Prout, 1930, *Novit. Zool.*, 35: 331.
Boarmia (Ophthalmodes) albosignaria: Wehrli, 1943, *in* Seitz, *Gross-Schmett. Erde*, 4 (Suppl.): 530.
Boarmia (Ophthalmodes) albosignaria isorphnia Wehrli, 1943, *in* Seitz, *Gross-Schmett. Erde*, 4 (Suppl.): 530. Syntypes, China: Chekiang (Mokanshan, Tien-mu-shan); Hunan (Hong-shan), Jiangsu (Lungtan). (ZFMK) **syn. nov.**
Ophthalmitis albosignaria: Inoue, 1982, *in* Inoue *et al., Moths Jap*., 1: 545.

Ophthalmitis albosignaria albosignaria (Bremer & Grey, 1853)

Figs. 1–4, 45, 57, 69, 81, 91

Diagnosis. This species is easily distinguished from other congeners by the following external characters: the wing colour is greyish white; a broad greyish band is present between the submarginal line and the outer margin, which is interrupted between M_3 and CuA_1; the transverse lines are greyish brown, indistinct, only the discal spots are distinct, large, and broadly ringed; the terminal band on the underside of the both wings are interrupted in the middle; the hind tibia has a hair-pencil; the third sternite of the male abdomen has a setal patch. The male genitalia of the species are similar to that of *O. irroratari*a in: the dorsal margin of the sacculus is a sclerotized serrate band and spinulose terminally; the ampulla is a spinulose sclerotized bar; the sclerotized spines of the aedeagus are small. But it can be distinguished from *O. irroratari*a by the following characters: the dorsal margin of the sacculus is narrower, and the teeth on the margin are weaker; the juxta is narrower at middle and a little broadened terminally. In the female genitalia: the ductus bursae is shorter than that of *O. irroratari*a; the marginal spines of the signum are longer, the central teeth are distributed radially, while those of *O. irroratari*a are distributed in rows.

Material examined. CHINA: Kiangsu: Lungtan bei Nanking, VI.1933, coll. H. Höne, 1♂1♀, (Syntypes of *isorphnia*) (ZFMK); Heilongjiang: Wuchang, 10.VII.1970, coll. Song Shimei, 2♀ (IZCAS); Jilin: Changbaishan, 9.VII.1982, coll. Zhang Baolin, 1♂1♀ (IZCAS); Liaoning: Fengcheng, Sitaizi, 23.VII.1982, coll. Song Shimei, 1♂1♀ (IZCAS); Inner Mongolia: Dayangshu, 20.VI.1983, 1♂ (IZCAS); Beijing: Sanpu, 23.VIII.1972, coll. Zhang Baolin, 2♂2♀ (IZCAS); Henan: Xinyang, Jigongshan, 250 m, 20–21.VII.2002, coll. Han Hongxiang, 2♂1♀ (IZCAS); Shaanxi: Foping, Longcaoping, 1256 m, 3.VII.2008, coll. Liu Wangang, 1♂ (IZCAS); Gansu: Wenxian, Baohuju, 16.VII.2002, coll. Wang Hongjian, 1♂ (IZCAS); Anhui: Xuancheng, 28.VI.1980. coll. Li Liangzhen, 1♂ (IZCAS); Zhejiang: Taishun, Wuyanling, Fangcaoping, 930 m, 31.VII.2005, coll. Lang Songyun, 2♂ (IZCAS); Zhejiang: Lin'an, West Tianmushan, 400 m, 26–27.VII.2003, coll. Han Hongxiang, 1♂ (IZCAS); Hubei: Xuanen, 1240 m, 29.VII.1989, coll. Li Wei, 1♂ (IZCAS); Jiangxi: Lushan, 12.VI.1974, 3♂ (IZCAS); Hunan: Hengshan, 30.VIII.1979. coll. Zhang Baolin, 1♂ (IZCAS); Fujian: Wuyishan, Sangang, 700 m, 13–15.VIII.2006. coll. Wang Jiashe, 1♂ (IZCAS); Guangxi: Guilin, 16.VI.1980, coll. Song Shimei, 1♂ (IZCAS); Sichuan: Emeishan, Qingyinge, 800–1000 m, 29.IV.1957, coll. Huang Keren, 1♂ (IZCAS); Yunnan: Fugong, Lishadi, 1380 m, 17.V.1979, 1♂ (IZCAS).

Distribution. China (Heilongjiang, Jilin, Liaoning, Inner Mongolia, Beijing, Henan, Shaanxi, Gansu, Jiangsu, Anhui, Zhejiang, Hubei, Jiangxi, Hunan, Fujian, Guangxi, Sichuan, Yunnan), Russia (Amur, Ussuri), Japan, North Korea, South Korea.

Remarks. The three subspecies of *O. albosignaria*, *O. albosignaria albosignaria*, *O. albosignaria juglandaria*, *O. albosignaria isophnia* are very similiar in external and genital characters. They occur sympatrically in China. So, *O. albosignaria juglandaria* and *O. albosignaria isophnia* are considered to be synonyms of *O. albosignaria albosignaria*.

Ophthalmitis albosignaria viridans Sato, 1992

Ophthalmitis albosignaria viridans Sato, 1992, *Japan Heterocerists' J.*, 167: 296, figs 9–12, 19, 24, 25, 31, 35. Holotype ♂, Taiwan: Hualien Hsien, Hualuchi, 400 m. (NMNS)

Diagnosis. This subspecies is similar to the nominate subspecies in wing pattern and genital characters, but the dorsal margin of the sacculus is broader and more spinulose terminally (Sato 1992).

Distribution. China (Taiwan).

Ophthalmitis subpicaria (Leech, 1897)

Ophthalmodes subpicaria Leech, 1897, *Ann. Mag. nat. Hist.*, (6) 19: 335. Syntypes 2♂, 1♀, China (central and western): Omei-shan; Chang-yang. (BMNH)
Ophthalmitis subpicaria: Parsons *et al*., 1999, *Geometrid Moths of the World, a Catalogue*, 2: 670.

Diagnosis. The wing patterns of this species are similar to those of *O. albosignaria* in greyish white wing colour and a broad greyish band between the submarginal line and the outer margin, which is interrupted between M_3 and CuA_1, but the wings of *O. subpicaria* are distinct due to the brown transverse lines and more indistinct discal spots (Leech 1897).

Distribution. China (Hubei, Sichuan).

Ophthalmitis prasinospila (Prout, 1916)

Ophthalmodes prasinospila Prout, 1916, *Novit. Zool.*, 23: 55. Holotype ♂, China: Tibet, Vrianatong. (BMNH)
Ophthalmitis prasinospila: Sato, 1992, *Japan Heterocerists' J.*, 167: 296, figs 13–15, 21, 30.

Diagnosis. The external characters of this species are similar to those of *O. albosignaria*, but the pale green transverse lines, and indistinct terminal band on the underside of the hindwing are diagnostic. In the male genitalia (Sato 1992): the sclerotized dorsal margin of the sacculus is broader, and curved terminally, whereas it is narrower, almost straight terminally in *O. albosignaria*; the teeth on the margin of the sacculus are stouter than *O. albosignaria*.

Distribution. China (Tibet).

Ophthalmitis pertusaria (Felder & Rogenhofer, 1875)

Figs. 5–8, 46, 58, 70, 82, 92

Boarmia pertusaria Felder & Rogenhofer, 1875, *Reise öst. Fregatte Novara* (Zool.), 2 (Abt. 2): pl. 125, fig. 17. Syntype(s) ♂, India: Darjeeling. (BMNH)
Ophthalmitis pertusaria: Sato, 1993, *Tinea*, 13 (Suppl. 3): 16, pl. 36, fig. 6.

Diagnosis. The wing patterns of this species are similar to those of *O. albosignaria* as follows: the postmedial lines of both wings are serrate between the costa and M_1 and near the inner margin, and appearing as spots on the other veins; the discal spots are large and broad-ringed, and the dark band between the medial line and the outer margin

of the discal spot of hindwing is absent. But the species can be distinguished by the following characters: the wing colour is green, but greyish white in *O. albosignaria*; the terminal bands on the underside of both wings are broader. The most distinct differences are in the male genitalia, as follows: the uncus is wider, with two pairs of lateral processes, as in *O. clararia* (Sundaland, Philippines), whereas in *O. albosignaria*, the uncus has only one pair of lateral processes; the ampulla is not developed; the juxta is almost trapezoidal, whereas in *O. albosignaria*, it is markedly narrowed medially; the sclerotized spines of the aedeagus are larger than *O. albosignaria*. In the female genitalia: the ductus bursae is longer than that of *O. albosignaria*; the signum has more and shorter marginal spines, and some central teeth are fused.

Material examined. CHINA: Zhejiang: Qingyuan, Fengyangshan, Datianping, 1290 m, 6–10.VIII.2003, coll. Han Hongxiang, 1♂ (IZCAS); Hunan: Dayong, Zhushitou, 18.VIII.1988, coll. Chen Yixin, 2♀ (IZCAS); Fujian: Wuyishan, Sangang, 25–26.VII.2006, coll. Xie Juan, 1♂ (IZCAS); Hainan: Wuzhishan, Shuiman, 730–900 m, 10.V.2007, coll. Han Hongxiang, 1♂ (IZCAS); Guangxi: Miaoershan, 800 m, 2.VII.1985, coll. Wang Ziqing, 2♂ (IZCAS); Yunnan: Baoshan, Baihualing, 1520 m, 11–13.VIII.2007, coll. Lang Songyun, 5♂ (IZCAS); Tibet: Mêdog, Aniqiao, 1060 m, 12–13.VIII.2006, Lang Songyun, 1♂ (IZCAS).

Distribution. China (Zhejiang, Hubei, Hunan, Fujian, Hainan, Guangxi, Yunnan, Tibet), India, Nepal, Thailand.

Ophthalmitis sinensium (Oberthür, 1913)

Figs. 9–12, 47, 59, 71, 83, 93

Ophthalmodes sinensium Oberthür, 1913, *Études Lépid. comp*., 7: 292, pl. 175, fig. 1713. Type(s), China: Tien-Tsuen. (ZFMK)
Boarmia (Ophthalmodes) sinensium: Prout, 1915, *in* Seitz, *Macrolepid. World*, 4: 376.
Boarmia (Ophthalmodes) sinensium var. *abundantior* Wehrli, 1943, *in* Seitz, *Gross-Schmett. Erde*, 4 (Suppl.): 529. Syntypes 2♂, China: North Kwangtung, Lienping. (ZFMK)
Boarmia (Ophthalmodes) sinensium hypophayla Wehrli, 1943, *in* Seitz, *Gross-Schmett. Erde*, 4 (Suppl.): 529. Syntypes 2♂, China: Lienping; Canton. (ZFMK)
Ophthalmitis lushanaria Sato, 1992, *Japan Heterocerists' J.*, 167: 298, figs 5, 6, 18, 24, 29. Holotype ♂, Taiwan: Natou Hsien, Lushan Spa, 1200 m. (NMNS)
Ophthalmitis sinensium: Parsons *et al*., 1999, *Geometrid Moths of the World, a Catalogue*, 2: 670.

Diagnosis. The external characters of this species are similar to those of *O. pertusaria*, but it can be distinguished from that species by the following differences: the discal spots are smaller; the hindwing medial line is close to the inner margin of the discal spot, whereas it is distal from the discal spot in *O. pertusaria*; the cleft of the eighth sternite of the male abdomen is tapered, while it is rounded in *O. pertusaria*. The most characteristic features of this species lie in the male genitalia: the uncus has only one pair of lateral processes; the extension of the sacculus is a short digitiform process, with an acuted apex adorned with several tiny spines, directed dorsally, while in *O. pertusaria*, there is no extension of the sacculus; the anterior margin of the juxta is relatively more concaved and its terminal half is more abruptly narrowed. In the female genitalia, the colliculum is longer and broader; the signum is smaller and has fewer marginal spines and five separate central teeth.

Material examined. CHINA: Kwangtung: Lienping, 1♂ (Syntype of *sinensium* var. *abundantior*) (ZFMK); Kwangtung: Lienping, 18.VII.1923, 1♂ (Syntype of *sinensium hypophayla*) (ZFMK); Sichuan: Tien-Tsuen, 1♂ (Type of *sinensium*) (ZFMK); Henan: Baotianman, Baohuqu, 1407 m, 10–11.VIII.2008, coll. Jiang Nan, 1♂ (IZCAS); Gansu: Kangxian, Qinghe, Linchang, 1400 m, 8.VII.1999. coll. Yao Jian & Zhu Chaodong, 2♂1♀ (IZCAS); Anhui: Yuexi, Baojiaxiang, 600–1200 m, 12–20.VIII.2008, Ding Liang, 1♂ (IZCAS); Zhejiang: Lin'an West Tianmushan, 400 m, coll. Han Hongxiang, 1♂ (IZCAS); Hubei: Lichuan, Xingdoushan, 800 m, 22.VII.1989, coll. Li Wei, 1♂ (IZCAS); Hunan: Tianpingshan, 7.VI.1981, 1♂ (IZCAS); Guangdong: Shixing, Chebaling, 365–400 m, 22–26.VII.2008, coll. Chen Fuqiang, 1♂ (IZCAS); Guangxi: Miaoershan, Jiuniutang, 1150 m, 7.VIII.1985, coll. Fang Chenglai, 1♂1♀ (IZCAS); Sichuan: Qingchengshan, 1000 m, 25.V.1989. coll. Gao Ping, 1♂ (IZCAS); Yunnan: Baoshan, Baihualing, 1520 m, 11–13.VIII.2007, Wu Chunguang, 1♂ (IZCAS); Tibet: Mêdog, Aniqiao, 1060 m, 12–13.VIII.2006, coll. Lang Songyun, 1♂ (IZCAS).

Distribution. China (Henan, Gansu, Anhui, Zhejiang, Hubei, Hunan, Taiwan, Guangdong, Guangxi, Sichuan, Yunnan, Tibet), India, Vietnam, Thailand.

Remarks. After examining the types of *Boarmia (Ophthalmodes) sinensium* var. *abundantior* Wehrli, 1943 and *Boarmia (Ophthalmodes) sinensium hypophayla* Wehrli, 1943, we suspect that these two subspecies are possible synonyms of *O. siniherbida*, not of *O. sinensium*. However, we did not examine the male genitalia of those type specimens further study for deciding the clear systematic position of the two subspecies is needed.

***Ophthalmitis dissita* Jiang, Xue & Han sp. nov.**
Figs. 13–14, 48, 60, 72

Description. Head. Antenna about 2/5 length of forewing, partly bipectinate, length of longest ramus about three times diameter of male antennal shaft. Frons pale yellowish, rounded, not protruding, with pair of medial pale yellowish brown dots. Labial palpus blackish brown, extending slightly beyond frons, second segment with greyish white hair-like scales. Vertex pale green. Thorax. Dorum pale green. Patagium pale green, blackish brown distally. Tegula pale green, blackish brown medially. Posterior part of mesonotum with pair of black spots. Posterior margin of metanotum black. Two pairs hind tibia spurs in male, not dilated, without hair-pencil. Forewing: Length: male 26–29 mm. Forewing outer margin weakly protruded, hindwing rounded. Wings pale green, transverse lines blackish brown. Patterns of forewing: costa diffused with short longitudinal greyish brown flecks; antemedial, medial, postmedial, submarginal lines forming four black patches on costa; antemedial line wavy, indistinct; medial line serrate, only distinct near inner margin; postmedial line serrate, only distinct between costa and M_1, near inner margin, appearing as spots on other veins, slightly protruded outwards above CuA_1, distinctly protruded inwards below CuA_1, then paralleling to medial line; submarginal line appearing as series of small triangular patches between veins, distinct between M_1 and M_3, near costal, inner margins; terminal line appearing as series of short strips between veins; fringes greyish white mixed with greyish green, darker between veins; discal spot small, stellate, pale-centered, ringed blackish brown. Hindwing: Medial line slightly wavy, indistinct, distal from discal spot; postmedial line indistinct, appearing as spots on veins; discal spot, submarginal, terminal lines, fringes similar to those of forewing. Venter greyish white, transverse lines greyish brown, terminal band of hindwing indistinct, discal spot large and distinct, costa of forewing pale yellowish brown, diffused with flecks. Abdomen. Pairs of black dorsal spots on first to sixth abdominal segments. Spots on first abdominal segment small, on second to sixth segments relatively large, closer together. First abdominal segment pale grey, remaining segments pale green. Third sternite of male abdomen without setal patch. Eighth sternite of male abdomen with tapered cleft, apical sclerotized processes rounded. Male genitalia. Uncus rounded terminally, length equal to basal width, with a pair of short lateral processes. Gnathos with median process rounded terminally, four-fifths length of uncus. Valva relatively narrow, about three times as long as basal width; costa sclerotized, angled dorsally medially, expanded, bearing large area of long setae terminally; extension of sacculus short digitiform, broadened distally, apex with several tiny spines, directed to medially; ampulla absent. Saccus semicircular, about one-half length of basal width, with longitudinal arris apically in anterior half. Juxta with anterior margin concaved medially, about one and half times as long as basal width. Coremata developed. Aedeagus sclerotized anteriorly, with one large, another tiny sclerotized spines posteriorly. Vesica without cornuti.

Diagnosis. The external characters of this species are similar to those of *O. sinensium*, but can be distinguished by the following differences: the hindwing medial line is not close to the discal spot; the cleft of the eighth sternite of the male abdomen is broader than that of *O. sinensium*, and the sclerotized processes are rounded, but square in *O. sinensium*. In the male genitalia, the lateral processes of the uncus are more acute distally; the extension of the sacculus is more broadened distally; the anterior half of the juxta is short and not so markedly narrowed; the aedeagus has one large and apical tiny posterior spines, whereas, *O. sinensium* has two tiny spines.

Material examined. Holotype ♂, CHINA: Hainan: Wuzhishan, Shuiman, 900 m, 1.IV.2008, coll. Lang Songyun (IZCAS). Paratypes, 1♂, Hainan: Ledong, Jianfengling, Tianchi, 982 m, 26.XI.2008, coll. Li Jing (IZCAS); 1♂, Hainan: Yinggeling, Ziranbaohuqu, 950–1000 m, 27.VIII–12.IX.2005, coll. Liu Chunxiang (IZCAS).

Etymology. The specific name is from the Latin word *dissitus*, which means distant. This refers to the distance between the hindwing medial line and the distal spot.

Distribution. China (Hainan).

FIGURES 1–12. Adults of *Ophthalmitis*, habitus. 1–4. *O. albosignaria albosignaria*. 1, male, upperside; 2, male, underside; 3, female, upperside; 4, female, underside; 5–8. *O. pertusaria*. 5, male, upperside; 6, male, underside; 7, female, upperside; 8, female, underside; 9–12. *O. sinensium*. 9, male, upperside; 10, male, underside; 11, female, upperside; 12, female, underside. Scale bar = 1 cm.

FIGURES 13–30. Adults of *Ophthalmitis*, habitus. 13–14. *O. dissita* **sp. nov.**, holotype. 13, male, upperside; 14, male, underside. 15–18. *O. irrorataria*. 15, male, upperside; 16, male, underside; 17, female, upperside; 18, female, underside; 19–22. *O. herbidaria*. 19, male, upperside; 20, male, underside; 21, female, upperside; 22, female, underside; 23–26. *O. siniherbida*. 23, male, upperside; 24, male, underside; 25, female, upperside; 26, female, underside; 27–30. *O. cordularia*. 27, male, upperside; 28, male underside; 29, female, upperside; 30, female, underside. Scale bar = 1 cm.

FIGURES 31–44. Adults of *Ophthalmitis*, habitus. 31–34. *O. longiprocessa* **sp. nov.** 31, male, holotype, upperside; 32, male, holotype, underside; 33, female, paratype, upperside; 34, female, paratype, underside; 35–38. *O. brevispina* **sp. nov.** 35, male, holotype, upperside; 36, male, holotype, underside; 37, female, paratype, upperside; 38, female, paratype, underside. 39–42. *O. tumefacta* **sp. nov.** 39, male, holotype, upperside; 40, male, holotype, underside; 41, female, paratype, upperside; 42, female, paratype, underside. 43–44. *O. xanthypochlora*. 43, male, upperside; 44, male, underside. Scale bar = 1 cm.

Ophthalmitis irroratariа (Bremer & Grey, 1853)

Figs. 15–18, 49, 61, 73, 84, 94–95

Boarmia irroratariа Bremer & Grey, 1853, *Beitr. Schmett.-Fauna nord. China*: 20, pl. 9, fig. 5. Syntype(s), China (north).
Boarmia senex Butler, 1878, *Ann. Mag. nat. Hist.*, (5) 1: 396. Syntype(s), Japan: Yokohama; Hakodaté. (BMNH)
Boarmia hedemanni Christoph, 1881, *Bull. Soc. imp. Nat. Moscou*, 55 (3): 79. Syntypes ♂, ♀, Russia: Chingan; Askold.
Ophthalmodes lectularia Swinhoe, 1891, *Trans. ent. Soc. Lond.*, 1891 (4): 489, pl. 19, fig. 4. Holotype ♂, India: Khasi Hills. (BMNH)
Boarmia (Ophthalmodes) irroratariа: Prout, 1915, *in* Seitz, *Macrolepid. World*, 4: 376.
Ophthalmodes irroratariа: Prout, 1930, *Novit. Zool.*, 35: 331.
Boarmia (Ophthalmodes) irroratariа episcia Wehrli, 1943, *in* Seitz, *Gross-Schmett. Erde*, 4 (Suppl.): 530. Lectotype ♂, China, Yunnan (north). (ZFMK)
Boarmia (Ophthalmodes) irroratariа specificaria Bryk, 1949, *Ark. Zool.*, 41A (1): 209, pl. 7, fig. 12. Holotype ♂, Korea: Myokosan.
Ophthalmitis irroratariа: Inoue, 1982, *in* Inoue *et al., Moths Jap.*, 1: 545; pl. 93: 15–17.

Diagnosis. The wing patterns of this species are similar to those of *O. sinensium*, but the postmedial lines on both wings are more deeply serrate and distinct, the areas inside the postmedial lines on both wings are diffused with blackish brown scales; a broad dark band is present between the medial line and the outer margin of the discal spot on the hindwing; the cleft of the eighth sternite of the male abdomen is shallower and the apical processes are less pointed and less strongly sclerotized. The most distinct differences between the two species are in the male genitalia and are as follows: *irroratariа* lacks the digitiform extension of the sacculus, present in *sinensium* and instead, in the former species, the dorsal margin of the sacculus is a sclerotized serrate band, and has spinulose terminal, extending to the base of the ampulla; the ampulla, present as a spinulose sclerotized bar in *O. irroratariа*, is absent in *O. sinensium*; the pair of sclerotized spines of the aedeagus are relatively smaller. In the female genitalia: the colliculum is shorter and narrower; the signum has more central teeth.

Material examined. CHINA: Heilongjiang: Xiaoling, 10.VI, 1♂ (IZCAS); Jilin, 8.VII.1937, 1♂ (IZCAS); Beijing: Mentougou, Liyuanling, 22.VI.2001, coll. Xue Dayong, 2♂1♀ (IZCAS); Beijing: Huairou, Baiquanshan, 250 m, 26.VIII.2009, coll. Qi Feng, 1♀ (IZCAS); Hebei: Nanjiashan, 1981, coll. Jiao Yurong, 1♀ (IZCAS); Shaanxi: Luonan, Gucheng, 7.V.1981, coll. Xue Zhihua, 2♂ (IZCAS); Ningxia: Jingyuan, Hongxia, Linchang, 1998 m, 9.VII.2008, coll. Song Wenhui, 2♂1♀ (IZCAS); Gansu: Anzigou, 2100 m, 18.VII.2000, 1♀ (IZCAS); Zhejiang: Lin'an, West Tianmushan, 400 m, 30.VII.2003, coll. Xue Dayong, 1♂ (IZCAS); Hubei: Xingshan, Longmenhe, 700 m, 6.V.1994, coll. Li Wenzhu, 1♀ (IZCAS); Jiangxi: Dayu, 16.VIII.1985, coll. Wang Ziqing, 1♀ (IZCAS); Hunan: Tianpingshan, 6.VI.1981, 1♂ (IZCAS); Hunan: Yanling, Taoyuandong, 631 m, 4–8.VII.2008, coll. Chen Fuqiang, 1♀ (IZCAS); Fujian: Wuyishan, Sangang, 704 m, 11–14.VIII.2009, coll. Jiang Nan, 1♂1♀ (IZCAS); Guangxi: Fangcheng, Fulong, 300 m, 24.V.1992, coll. Yuan Decheng, 1♀ (IZCAS); Sichuan: Luding, Guzan, Jiangju, 1635 m, 21.V.2009, coll. Li Jing, 1♂ (IZCAS); Yunnan: Lijiang, Yushuizhai, 2680 m, 21.VI.2009, coll. Xue Dayong, 5♂1♀ (IZCAS); Yunnan: Lijiang, 23.V.1980, coll. Wang Linyao, 1♂ (IZCAS).

Distribution. China (Heilongjiang, Jilin, Beijing, Hebei, Shaanxi, Ningxia, Gansu, Zhejiang, Hubei, Jiangxi, Hunan, Fujian, Guangxi, Sichuan, Yunnan), Russia (Amur, Ussuri), Japan, India, North Korea, South Korea.

Remarks. The signum of the specimens from Ningxia, Sichuan and Yunnan (Fig. 95) are more rounded and smaller than those from Beijing, Gansu, Fujian, and Zhejiang (Fig. 94) but are otherwise similar. Thus, there appears to be variation in the shape of signum among *O. irroratariа* in different areas of China.

Ophthalmitis herbidaria (Guenée, 1858)

Figs. 19–22, 50, 62, 74, 85, 96

Ophthalmodes herbidaria Guenée, 1858, *in* Boisduval & Guenée, *Hist. nat. Insectes* (Spec. gén. Lépid.), 9: 283. Syntypes 1♂, 1♀, India (central). (BMNH)
Ophthalmodes pulsaria Swinhoe, 1891, *Trans. ent. Soc. Lond.*, 1891 (4): 489. Syntypes 3♂, India: Khasi Hills. (BMNH)
Boarmia herbidaria: Matsumura, 1931, *6000 Illust. Insects Japan-Empire*: 875.
Boarmia (Ophthalmodes) herbidaria: Wehrli, 1943, *in* Seitz, *Gross-Schmett. Erde*, 4 (Suppl.): 529.
Ophthalmitis herbidaria: Fletcher, 1979, *in* Nye (Ed.), *Generic Names Moths World*, 3: 146.

Diagnosis. This species is similar to *O. irrorataria* as follows: the postmedial lines on both wings are serrate and distinct; a broad dark band is present between the medial line and the outer margin of the discal spot on the hindwing. But it can be distinguished by the following characters: the discal spots of both wings are larger; greyish brown patches are usually present between the postmedial and submarginal lines, and between the submarginal and terminal lines; the areas inside the postmedial lines are not diffused with blackish brown scales; the terminal bands on the underside of both wings are broader; the cleft of the eighth sternite of the male abdomen is deeper and apical processes are pointed and more strongly sclerotized. The most distinct differences between these two species are in the male genitalia: the uncus is square distally, while it is rounded in *O. irrorataria*; the valva is relatively broader; the dorsal margin of the sacculus is long and curved, much broader than in *O. irrorataria*, but the marginal teeth are weaker relatively small; the ampulla is broader, terminating dorsally with a spur-like process; the sclerotized spines of the aedeagus are larger. In the female genitalia: the lamella postvaginalis is broader; the colliculum is longer and broader; the ductus bursae is shorter; the signum has fewer central teeth, and are positioned one side only.

Material examined. CHINA: Shaanxi: Liuba, Miaotaizi, 1350 m, 19.VII.1998, coll. Yao Jian, 1♂ (IZCAS); Shanghai, VIII.1930, 1♂ (IZCAS); Zhejiang: Lin'an, West Tianmushan, 400 m, 26–27.VII.2003, coll. Xue Dayong, 1♀ (IZCAS); Hubei: Zigui, Maoping, 80 m, 27.IV.1994, coll. Li Wenzhu, 1♀ (IZCAS); Jiangxi: Jiulianshan, 11.VI.1975, coll. Zhang Baolin, 1♀ (IZCAS); Hunan: Tongdao, 14.IV.1981, 1♂ (IZCAS); Fujian: Nanping, 14.IV.1981, 1♀ (IZCAS); Hainan: Jianfengling, 10.XI.1982, coll. Lin Youdong, 1♀ (IZCAS); Sichuan: Emeishan, Qingyinge, 800–1000 m, 15.VII.1957, coll. Huang Keren, 1♀ (IZCAS); Yunnan: Baoshan, Baihualing, 1520 m, 11–13.VIII.2007, coll. Wu Chunguang, 1♂ (IZCAS).

Distribution. China (Shaanxi, Shanghai, Zhejiang, Hubei, Jiangxi, Hunan, Fujian, Taiwan, Hainan, Sichuan, Yunnan), India.

Ophthalmitis siniherbida (Wehrli, 1943)

Figs. 23–26, 51, 63, 75, 86, 97

Boarmia (Ophthalmodes) herbidaria siniherbida Wehrli, 1943, *in* Seitz, *Gross-Schmett. Erde*, 4 (Suppl.): 529. Syntypes, 1♂, 1♀, China: Kwangtung, Lienping. (ZFMK)
Ophthalmitis lectularia siniherbida: Parsons *et al*., 1999, *Geometrid Moths of the World, a Catalogue*, 2: 670.
Ophthalmitis siniherbida: Sato & Wang, 2007, *Tinea*, 20 (1): 43, figs 12, 16, 28, 31, 40.

Diagnosis. The wing patterns of this species are similar to those of the *O. herbidaria*, but can be distinguished by the following characters: the rami of the male antenna are longer; the processes on the cleft of the eighth sternite of the male abdomen are rounded and less strongly sclerotized, whereas they are pointed in *O. herbidaria*. The most distinct differences between these two species are in the male genitalia: the lateral processes of the uncus are shorter, rounded distally, whereas they are longer, acute distally in *O. herbidaria*; the apex of the valva is relatively broader; the dorsal margin of the sacculus is very broad and densely serrate, extending to the base of the ampulla; the ampulla is broader and more longitudinally positioned, with dense teeth on dorsal margin and a large acute process on the anterior end. In the female genitalia: the lamella postvaginalis is narrower; the colliculum is shorter, with parallel sides; the central teeth of the signum are smaller.

Material examined. CHINA: Kwangtung: Lienping 1♂1♀, (Syntypes) (ZFMK); Zhejiang: Taishun, Wuyanling, Shuangkengkou, 680 m, 28.VII.2005, coll. Lang Songyun, 1♂ (IZCAS); Fujian: Wuyishan, Sangang, 704 m, 11–14.VIII.2009, coll. Xue Dayong, 1♂ (IZCAS); Fujian: Wuyishan, Sangang, 700 m, 29.V.2006, coll. Wang Jiashe, 1♀ (IZCAS); Guangdong: Shixing, Chebaling, 22–26.VII.2008, coll. Chen Fuqiang, 1♀ (IZCAS); Guangxi: Napo, Defu, 11.VI.2000, coll. Yao Jian, 1♂ (IZCAS).

Distribution. China (Zhejiang, Hunan, Fujian, Guangdong, Guangxi).

Ophthalmitis cordularia (Swinhoe, 1893)

Figs. 27–30, 52, 64, 76, 87, 98

Ophthalmodes cordularia Swinhoe, 1893, *Ann. Mag. nat. Hist*., (6) 12: 155. Holotype ♂, India: Khasi Hills. (BMNH)
Boarmia (Ophthalmodes) cordularia: Wehrli, 1943, *in* Seitz, *Gross-Schmett. Erde*, 4 (Suppl.): 530, pl. 45: f.
Ophthalmitis cordularia: Sato, 1992, *Japan Heterocerists' J.*, 167: 295, figs 7, 8, 17, 23, 28, 34.

Diagnosis. This species is similar to *O. siniherbida* as follows: the rami of the long male antenna and a broad dark band between the medial line and outer margin of the discal spot on the hindwing. But it can be distinguished from *O. siniherbida* on the following characters: the forewing postmedial line is indistinct and appears as spots on veins, but it is distinct and serrate in *O. siniherbida*; greyish brown patches are absent between the postmedial and submarginal lines, and between the submarginal and terminal lines, whereas they are present in *O. siniherbida*; the cleft of the eighth sternite of the male abdomen is rounded but tapered in *O. siniherbida*. The most distinct differences between these two species are in the male genitalia: the apex of the valva is truncated but rounded in *O. siniherbida*; the dorsal margin of the sacculus is very narrow, a little broadened and with dense teeth and a spinous bar apically; the ampulla is triangular and spinous, while in *O. siniherbida*, it is broader and has a serrate margin, forming an anterior spur-like process. In the female genitalia: the lamella postvaginalis is broader; the signum is larger, the central teeth are distributed radially.

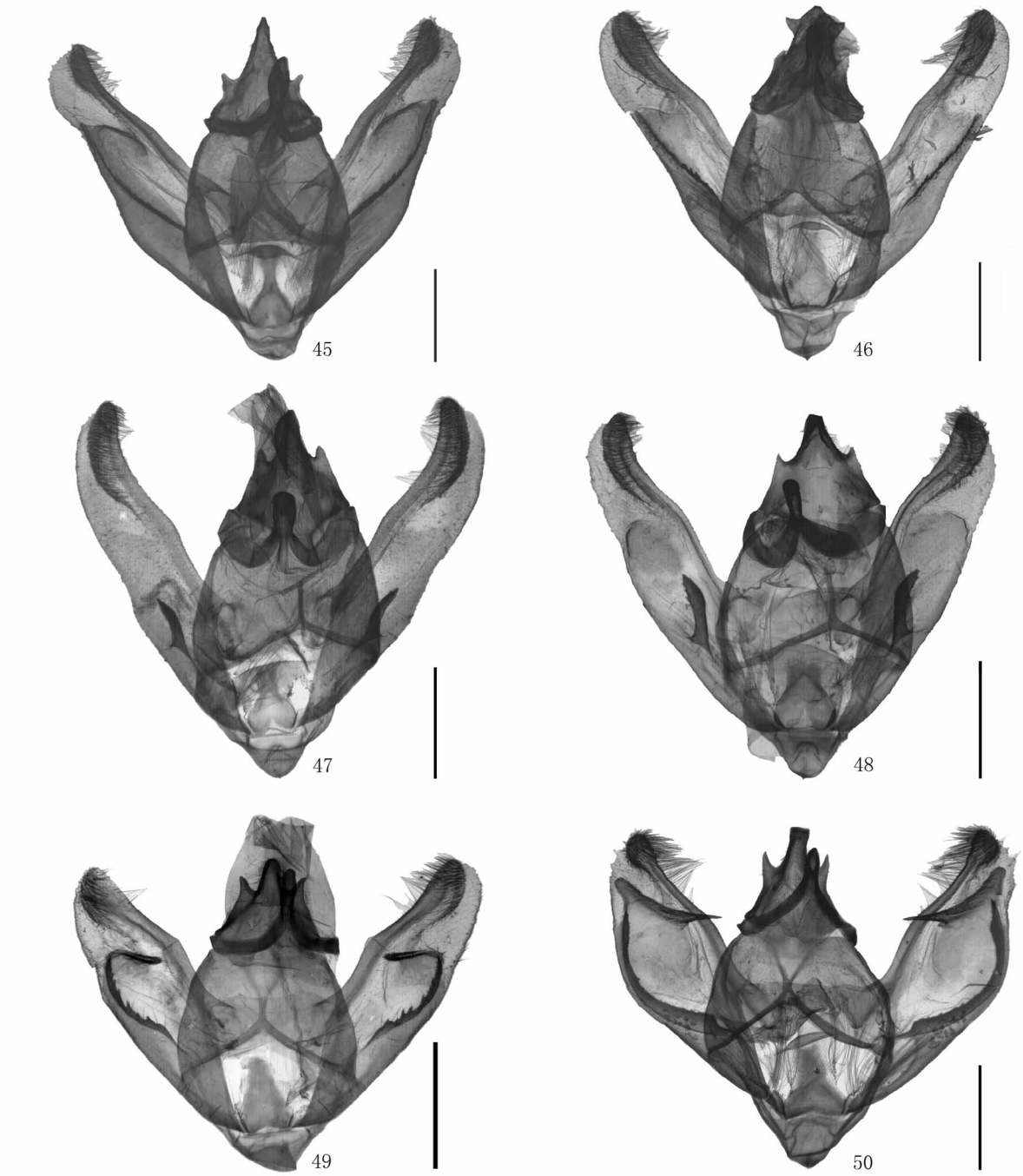
Material examined. CHINA: Henan: Baiyunshan, 1300 m, 9.VI.2001, coll. Shen Xiaocheng, 1♂ (IZCAS); Henan: Baiyunshan, 1400 m, 12.VII.2003, coll. Qiu Reng, 1♀ (IZCAS); Shaanxi: Zhouzhi, Houzhenzi, 1350 m, 25.VI.1999, coll. Yao Jian, 1♀ (IZCAS); Ningxia: Jingyuan, Erlonghe Linchang, 1984 m, 12.VII.2008, coll. Song Wenhui, 1♀ (IZCAS); Hubei: Xingshan, Xiaohekou, 700 m, 11.V.1994, coll. Li Wenzhu, 1♀ (IZCAS); Jiangxi: Doushui, 29.VI.1975, coll. Song Shimei, 1♀ (IZCAS); Hunan: Pingjiang, 31.VII.1981, 1♀ (IZCAS); Guangxi: Miaoershan, Jiuniuchang, 1150 m, 8.VII.1985, coll. Fang Chenglai, 1♀ (IZCAS); Sichuan: Wulong, 1000 m, 2.VII.1989, coll. Mai Guoqing, 1♂ (IZCAS) ; Yunnan: Yujinan, 2300 m, 22.VI.1980, 1♂ (IZCAS).

Distribution. China (Henan, Shaanxi, Ningxia, Hubei, Jiangxi, Hunan, Taiwan, Guangxi, Sichuan, Yunnan), India, Nepal.

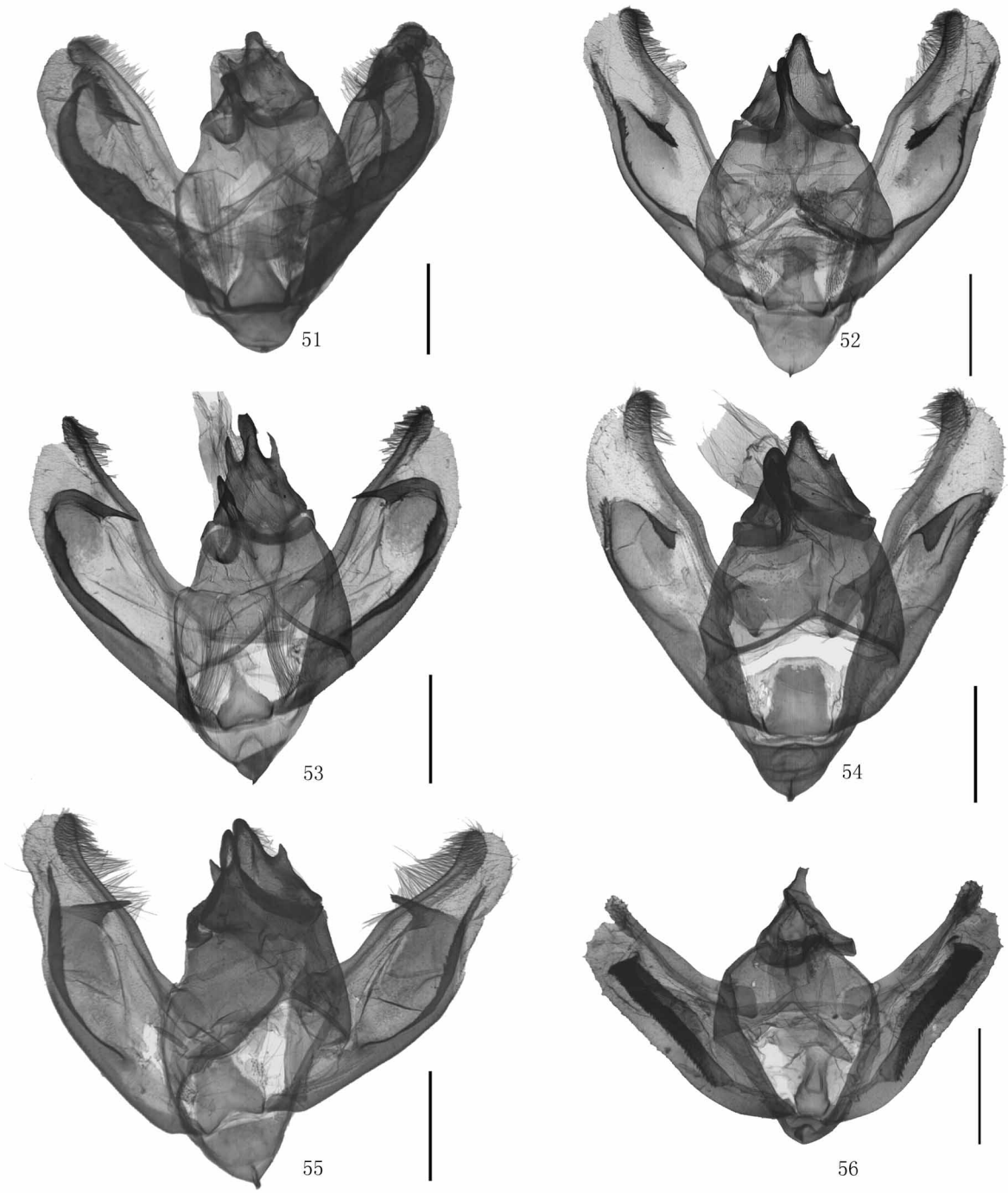
***Ophthalmitis longiprocessa* Jiang, Xue & Han sp. nov.**
Figs. 31–34, 53, 65, 77, 88, 99

Description. Head. Antenna about 2/5 length of forewing, bipectinate, tapering, length of longest ramus about eight and half times diameter of male antennal shaft, shortly bipectinate in female, length of longest ramus about three and half times diameter of female antennal shaft. Frons greyish white, rounded, not protruding, with pair of blackish brown dots medially. Labial palpus blackish brown, extending slightly beyond frons, second segment with greyish white hair-like scales. Vertex greyish green. Thorax. Dorsum greyish green. Patagium, tegula greyish green, blackish brown distally. Centre of tegula blackish brown. Posterior part of mesonotum with pair of black spots. Posterior margin of metanotum black. Two pairs hind tibia spurs in male, not dilated, without hair-pencil. Forewing: Length: male 26–27 mm; female 28–29 mm. Forewing outer margin weakly protruded, hindwing rounded. Wings greyish green, transverse lines blackish brown. Patterns of forewing: costa diffused with short longitudinal greyish brown flecks; antemedial, medial, postmedial, submarginal lines forming four black patches on costa; antemedial, medial lines indistinct; postmedial line weakly serrate, only distinct between costa and M_1, near inner margin, appearing as spots on other veins, diffused with brown between postmedial, medial lines at inner margin; submarginal line appearing as series of small triangular patches between veins, distinct between M_1 and M_3, near costal, inner margins; terminal line appearing as series of short strips between veins; fringes greyish white mixed with greyish green; discal spot stellate, pale-centered, ringed blackish brown. Hindwing: with broad dark band between medial line and outer margin of discal spot, indistinct beyond cell; postmedial line serrate, indistinct, appearing as spots on veins, discal spot smaller than that of forewing; submarginal lines unbroken; terminal line, fringes similar to those of forewing. Venter greyish white to greyish brown; terminal bands of both wings broad, unbroken, paler towards outer margin; discal spot large and distinct; costa of forewing pale yellowish brown diffused with flecks. Abdomen. Pairs of black dorsal spots on first to sixth abdominal segments. Spots on first abdominal segment small, on second to sixth segments relatively large, closer together. First abdominal segment pale grey, other segments yellowish green. Setal patch absent on third sternite of male abdomen. Eighth sternite of male abdomen with irregularly shaped cleft, apical processes weakly sclerotized, not pointed. Male genitalia. Uncus square apically, length equal to basal width, with pair of long lateral processes, about one-fourth length of uncus. Gnathos with median process acutely pointed terminally, three-fourths length of uncus. Valva blunt terminally, about three times as long as basal width; costa sclerotized, slightly angled dorsally medially, expanded, bearing large area of long setae terminally; sacculus gently curved; sacculus with sclerotized band, broadened and serrate

terminally, extending to base of ampulla. Ampulla broad, curved, with smooth margin, terminating with spur-like process. Saccus semicircular, about one-half length of basal width, with longitudinal arris apically in anterior half. Juxta with anterior margin concaved medially, length equal to basal width, terminal half triangular. Coremata developed. Aedeagus two-fifths weakly sclerotized posteriorly, with one tiny spine distally. Vesica without cornuti. Female genitalia. Ovipositor not strongly sclerotized, covered with dense setae. Lamella postvaginalis strongly sclerotized, curved posteriorly, with three lobes below, wrinkled anteriorly. Ductus bursae very long, about twice length of corpus bursae, not sclerotized; colliculum short, narrow. Corpus bursae small, rounded, membranous; signum large, rounded, with seventeen to nineteen marginal spines, several small asymmetrically distributed central teeth.



FIGURES 45–50. Male genitalia of *Ophthalmitis*. 45, *O. albosignaria albosignaria*; 46, *O. pertusaria*; 47, *O. sinensium*; 48, *O. dissita* **sp. nov.**; 49, *O. irrorataria*; 50, *O. herbidaria*. Scale bar = 1 mm.



FIGURES 51–56. Male genitalia of *Ophthalmitis*. 51, *O. siniherbida*; 52, *O. cordularia*; 53, *O. longiprocessa* **sp. nov.**; 54, *O. brevispina* **sp. nov.**; 55, *O. tumefacta* **sp. nov.**; 56, *O. xanthypochlora*. Scale bar = 1 mm.

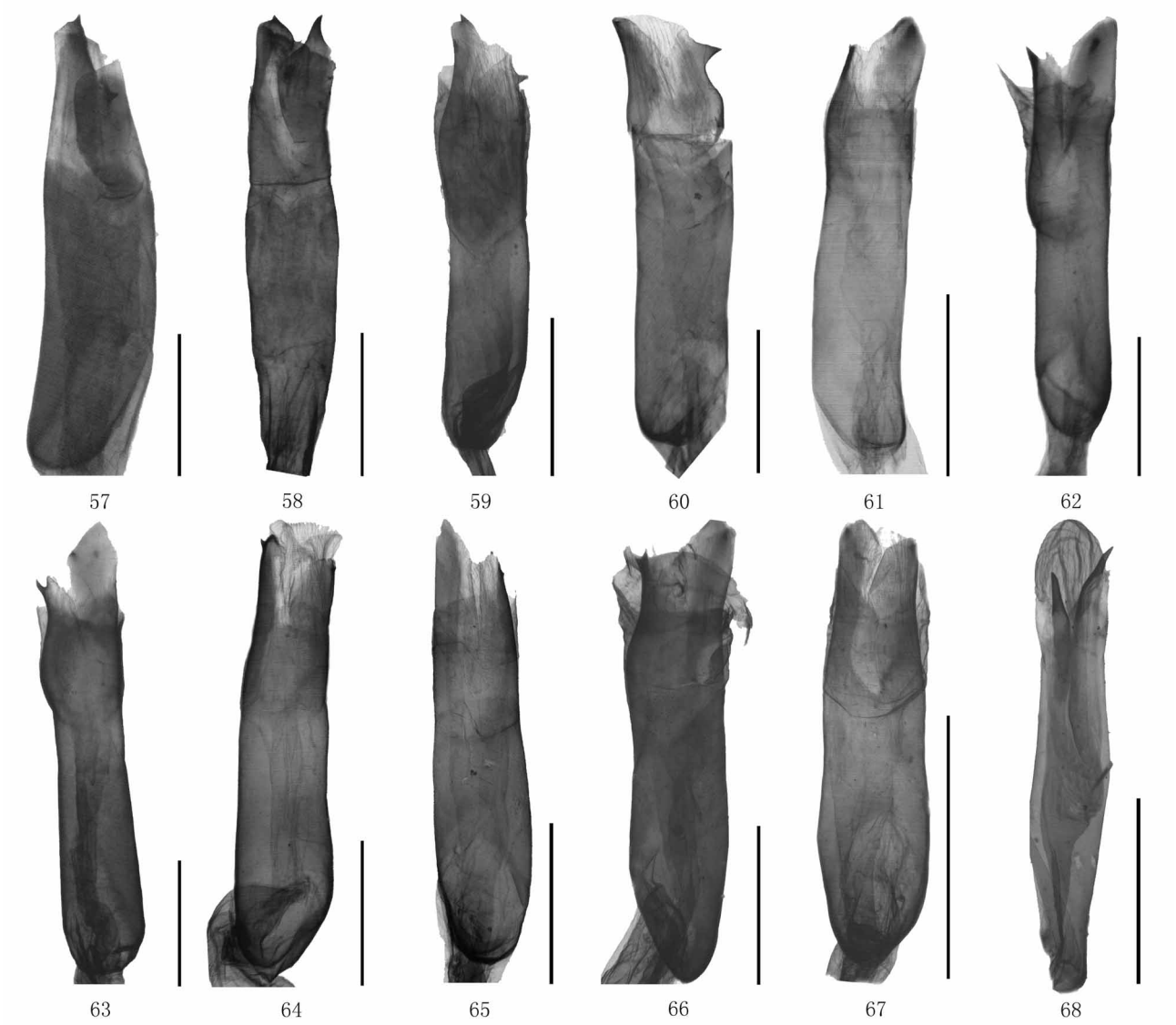
Diagnosis. The external characters of this species are similar to that of *O. cordularia*, but the rami of the male antennal are longer and the cleft of the eight sternite of the male abdomen is shallower. The most characteristic features of this species lie in the male genitalia: the uncus is square apically, but rounded in *O. cordularia*, the lateral processes of the uncus are longer than that of *O. cordularia*; the dorsal margin of the sacculus is much broader, and the dorsal margin of the sacculus is not forming a spinous bar terminally; the ampulla is broader, and forming a big spur-like process, while in *O. cordularia*, it is triangular; the aedeagus has only one tiny spine, but has a pair of spines in *O. cordularia*. In the female genitalia: the ductus bursae is longer; the central teeth of the signum are fewer and unevenly distributed, which are radially distributed in *O. cordularia*.

Material examined. Holotype, ♂, CHINA: Jiangxi: Doushui, 3.VII.1975, coll. Song Shimei (IZCAS). Paratypes, 1♂, Jiangxi: Doushui, 3.VII.1975, coll. Song Shimei (IZCAS); 2♀, Jiangxi: Jiulianshan, 9–11.VI.1975, coll.

Zhang Baolin (IZCAS); 1♀, Jiangxi: Jiulianshan, 28.VII.1975, coll. Song Shimei (IZCAS); 3♂, Guangdong: Shixing, Chebaling, 365–401 m, 22–26.VII.2008, coll. Chen Fuqiang (IZCAS); 1♂, Guangdong: Dinghushan, 11.VI.1973, coll. Zhang Baolin (IZCAS).

Etymology. The specific name is from the Latin prefix *long-* and the word *processus*, which means long process. This refers to the lateral processes of the uncus.

Distribution. China (Jiangxi, Guangdong).



FIGURES 57–68. Aedeagus of *Ophthalmitis*. 57, *O. albosignaria albosignaria*; 58, *O. pertusaria*; 59, *O. sinensium*; 60, *O. dissita* **sp. nov.**; 61, *O. irrorataria*; 62, *O. herbidaria*; 63, *O. siniherbida*; 64, *O. cordularia*; 65, *O. longiprocessa* **sp. nov.**; 66, *O. brevispina* **sp. nov.**; 67, *O. tumefacta* **sp. nov.**; 68, *O. xanthypochlora*. Scale bar = 1 mm.

***Ophthalmitis brevispina* Jiang, Xue & Han sp. nov.**

Figs. 35–38, 54, 66, 78, 89, 100

Ophthalmitis cordularia Han & Xue, 2005; *in* Yang, *Insect fauna Middle-West Qinling Range-South Mountains Gansu*: 621. (part) (*nec* Swinhoe, 1893)

Description. Head. Antenna about 2/5 length of forewing, bipectinate, tapering, length of longest ramus about five times diameter of antennal shaft. Frons greyish white, rounded, not protruding, with pair of blackish brown dots medially. Labial palpus blackish brown, extending slightly beyond frons, second segment with greyish white hair-

like scales. Vertex greyish green. Thorax. Dorsum greyish green. Patagium, tegula greyish green, blackish brown distally. Pair of black spots absent from mesonotum. Posterior margin of metanotum black. Hind tibia with two pairs of spurs in male, not dilated, without hair-pencil. Forewing: Length: male 26–27 mm; female 35 mm. Forewing outer margin of forewing weakly protruded, that of hindwing rounded. Wings greyish green, markings blackish brown to black. Patterns of forewing: costa diffused with short longitudinal flecks; antemedial, medial, postmedial, submarginal lines forming four black patches on costa; antemedial, medial lines indistinct, almost invisible; postmedial line serrate, only appearing as black serrations on veins, broadened to large black patch at inner margin; submarginal line appearing as series of small triangular patches between veins, distinct on costa, between M_1 and M_3, nearly continuous from CuA_2 to inner margin; blackish brown patch outside submarginal line between M_1 and M_3; terminal line series of short strips between veins; fringes greyish white mixed with greyish green, darker between veins; discal spot small, stellate, pale-centered, blackish brown ring, very narrow. Hindwing: with broad band between medial line, outer margin of discal spot black, very solid, distinct; postmedial line serrate, only appearing as black serrations on veins; discal spot smaller than that of forewing, black ring sometimes mixed with band; submarginal line more continuous than that of forewing; terminal line, fringes similar to those of forewing. Venter greyish white; transverse lines greyish brown; terminal band narrow, not reaching outer margin except between M_1 and M_3 of forewing, interrupted between M_3 and CuA_2 on both wings, between Rs and M_1 on hindwing; discal spot large, distinct, with the pale centre almost invisible; costa of forewing pale yellowish brown, diffused with dark flecks. Abdomen. Pairs of black dorsal spots on first to sixth abdominal segments. Spots on first abdominal segment small, on second to sixth segments relatively large, closer together. First abdominal segment pale grey, other segments yellowish green. Setal patch absent on third sternite of male abdomen. Eighth sternite of male abdomen with tapered cleft, apical processes weakly sclerotized, not pointed. Male genitalia. Uncus rounded apically, length equal to basal width, with pair of very short lateral processes. Gnathos with median process rounded terminally, equal to length of uncus. Valva blunt apically, about three times as long as basal width; costa sclerotized, weakly angled dorsally medially, expanded, bearing large area of long setae terminally; sacculus straight; dorsal margin of sacculus weak and short, almost absent at basal half, without serrate margin, ended with spinous process distally, extending to base of ampulla; ampulla triangular, spinulose. Saccus semicircular, about three-fifths length of basal width, with longitudinal arris medially, apically. Juxta sub-quadrate, anterior margin concaved medially, longer than the basal width. Coremata developed. Aedeagus with pair of sclerotized tiny spines posteriorly. Cornuti absent from vesica. Female genitalia. Ovipositor not strongly sclerotized, covered with dense hairs. Lamella postvaginalis strongly sclerotized, curved posteriorly, with three lobes below, wrinkled anteriorly. Ductus bursae about three-fourths length of corpus bursae, weakly sclerotized posteriorly; colliculum short. Corpus bursae rounded, membranous; signum large, round, with twenty-three marginal spines, many radially distributed small, central teeth.

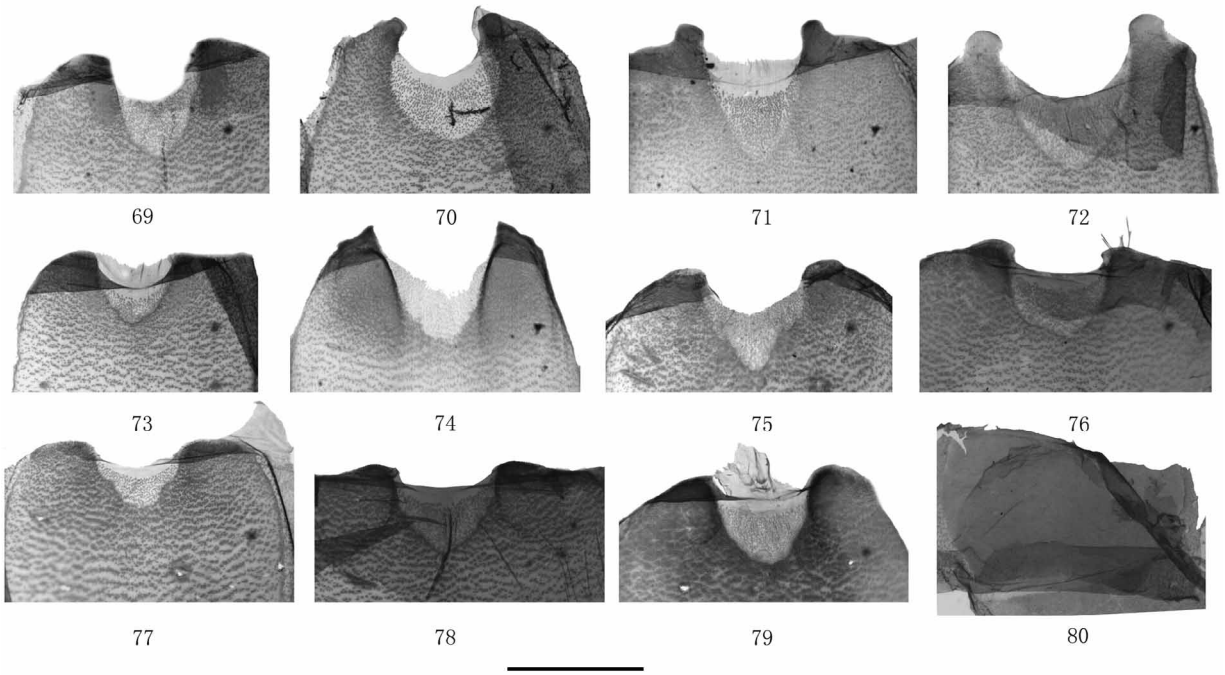
Diagnosis. This species is very similar to *O. cordularia*, but in *O. brevispina* the discal spots on both wings are smaller and the cleft of eight sternite of the male is tapered, whereas it is rounded in *O. cordularia*. In the male genitalia of *O. brevispina*, the median process of the gnathos is much thicker; the harpe is weak and narrow, the basal half is almost absent but present and strong in *O. cordularia*, the terminal process of the dorsal margin of the sacculus is much shorter in the present species. The ampulla is also differently shaped and less spinulose than in *O. cordularia*. In the female genitalia, the central teeth of the signum are smaller.

Material examined. Holotype, ♂, CHINA: Gansu: Wenxian, Qiujiaba, 2250–2350 m, 29.VI.1998, coll. Zhang Xuezhong. Paratypes, 1♀, Gansu: Tianshui, VI.1990 (IZCAS); 1♂, Beijing: Mentougou, Liyuanling, 22.VI.2001, coll. Xue Dayong (IZCAS).

Etymology. The specific name is from the Latin prefix *brevi-* and the word *spinus*, which means short and spinous, and refers to the apical processes of the dorsal margin of the sacculus.

Distribution. China (Beijing, Gansu).

Remarks. The number of marginal spines on the signum has not been quantified exactly, because we have only one female specimen of the species. This number is likely to vary intraspecifically.



FIGURES 69–80. Sternite 8 of male abdomen of *Ophthalmitis*. 69, *O. albosignaria albosignaria*; 70, *O. pertusaria*; 71, *O. sinensium*; 72, *O. dissita* **sp. nov.**; 73, *O. irroratoria*; 74, *O. herbidaria*; 75, *O. siniherbida*; 76, *O. cordularia*; 77, *O. longiprocessa* **sp. nov.**; 78, *O. brevispina* **sp. nov.**; 79, *O. tumefacta* **sp. nov.**; 80, *O. xanthypochlora*. Scale bar = 1 mm.

***Ophthalmitis tumefacta* Jiang, Xue & Han sp. nov.**
Figs. 39–42, 55, 67, 79, 90, 101

Description. Head. Antenna about 2/5 length of forewing, bipectinate, tapering, length of longest ramus about five times diameter of male antennal shaft, rami shorter in female, length of longest ramus about four times diameter of female antennal shaft. Frons greyish white, rounded, not protruding, with pair of blackish brown dots medially. Labial palpus blackish brown, extending slightly beyond frons, second segment with hair-like scales. Vertex greyish green. Thorax. Dorsum greyish green. Patagium, tegula greyish green, blackish brown distally. Centre of tegula blackish brown. Posterior part of mesonotum with pair of black spots. Posterior margin of metanotum black. Two pairs hind tibia spurs in male, not dilated, without hair-pencil. Forewing: Length: male 26–28 mm; female 29–31 mm. Forewing outer margin weakly protruded, hindwing rounded. Wings greyish green, transverse lines blackish brown to black. Patterns of forewing: costa diffused with short longitudinal greyish brown flecks; antemedial, medial, postmedial, submarginal lines forming four black patches on costa; antemedial, medial lines indistinct, wavy, forming small black serrations on veins; postmedial line dentate, weak or invisible between veins, appearing as sharp black serrations on veins, broadened at inner margin; submarginal line appearing as series of small triangular patches between veins, distinct between M_1 and M_3, near costal, inner margins; two blackish brown patches between submarginal, terminal lines at veins M, anal angle; terminal line series of short strips between veins; fringes greyish white or green, darker between ends of veins; discal spot large, stellate, pale-centered, blackish brown ring rhomboid. Hindwing: with broad band between medial line and outer margin of discal spot brown, distinctly lighter than black discal spot ring; discal spot smaller than that of forewing; postmedial line more distinct than on forewing; submarginal line more continuous than that of forewing; terminal line, fringes similar to those of forewing. Venter yellowish grey; terminal band dark brown, broad, reaching outer margin; discal spot large, distinct, with thin central white line; costa of forewing pale yellowish brown, diffused with flecks. Abdomen. Pairs of black dorsal spots on first to sixth abdominal segments. Spots on first abdominal segment small, on second to the sixth segments relatively large, closer together. First abdominal segment pale grey, remaining segments yellowish green. Setal patch absent from third sternite of male abdomen. Eighth sternite of male abdomen with rounded cleft, apical processes round, weakly sclerotized. Male genitalia. Uncus rounded terminally, length equal to basal width, with pair of short lateral processes, about one-eighth length of uncus, acute distally. Gnathos with median process

rounded terminally, equal to length of uncus. Valva broad medially, blunt terminally, length about three times as long as basal width; costa sclerotized, angled dorsally medially, expanded, bearing large area of long setae terminally; sacculus slightly curved; dorsal margin of sacculus broad, serrate, forming spinous process distally, extending beyond base of ampulla; ampulla, spinulose spur-like process. Saccus semicircular, about three-fifths length of basal width, with longitudinal arris apically in anterior half. Juxta sub-trapezoidal, anterior margin deeply concaved medially, longer than basal width. Coremata developed. Aedeagus with pair of small sclerotized spines posteriorly. Vesica without cornuti. Female genitalia. Ovipositor not strongly sclerotized, covered with dense setae. Lamella postvaginalis strongly sclerotized, curved posteriorly, with three lobes below, wrinkled anteriorly. Ductus bursae broad, weakly sclerotized, about two-fifths length of corpus bursae, colliculum short. Corpus bursae rounded, membranous; signum large, rounded, with fifteen to eighteen marginal spines and many small radially distributed central teeth.

Diagnosis. This species is hard to distinguish from *O. cordularia* on external and female genitalia characters. However, it differs in the following male genitalia characters: the lateral processes of the uncus are longer; the valva is expanded medially; the dorsal margin of the sacculus is broader; and the ampulla is spur-like, while in *O. cordularia*, it is triangular.

Material examined. Holotype, ♂, CHINA: Zhejiang: Qingyuan, Baishanzu, Wulingkeng, 570 m, 12–13.VIII.2003, coll. Han Hongxiang (IZCAS). Paratypes, 1♀, Zhejiang: Qingyuan, Baishanzu, Wulingkeng, 570 m, 12–13.VIII.2003, coll. Han Hongxiang (IZCAS); 3♂, Zhejiang: Qingyuan, Fengyangshan, Datianping, 1290 m, 6–10.VIII.2003, coll. Han Hongxiang (IZCAS); 2♂3♀, Zhejiang: Taishun, Wuyanling, Shuangkengkou, 680 m, 28.VII–3.VIII.2005, coll. Lang Songyun (IZCAS); 1♂1♀, Zhejiang: Taishun, Wuyanling, Ankengqiao, 400 m, 1.VIII.2005, coll. Lang Songyun (IZCAS); 1♂, Zhejiang: Taishun, Siqianzhen, 250 m, 4.VIII.2005, coll. Lang Songyun (IZCAS); 1♂, Fujian: Chong'an, 14.VII.1980 (IZCAS); 1♂, Fujian: Wuyishan, Sangang, 740 m, 14.VII.1960, coll. Zhang Yiran (IZCAS); 1♂2♀, Fujian: Wuyishan, Sangang, 704 m, 11–14.VIII.2009, coll. Xue Dayong & Jiang Nan (IZCAS); 1♂, Fujian: Wuyishan, Sangang, 25–26.VII.2006, coll. Xue Dayong (IZCAS); 1♂, Fujian: Wuyishan, Huangxizhou, 500 m, 29.VII.2006, coll. Xie Juan (IZCAS); 1♂, Fujian: Wuyishan, 17.V.1983, coll. Song Shimei (IZCAS); 1♂, Fujian: Wuyishan, 12.IX.1982, coll. Zhang Baolin (IZCAS); 1♀, Fujian: Wuyishan, 14.IX.1982, coll. Zhang Baolin (IZCAS); 1♀, Fujian: Sanming, 16.VII.1981, coll. Xiao Hu (IZCAS); 1♂, Hainan: Ledong, Jianfengling, Mingfenggu, 983 m, 6.XII.2009, coll. Yang Chao (IZCAS).

Etymology. The specific name is from the Latin word *tumefactus*, which means expanded, and refers to the middle part of the valva.

Distribution. China (Zhejiang, Fujian, Hainan).

Ophthalmitis xanthypochlora (Wehrli, 1924)

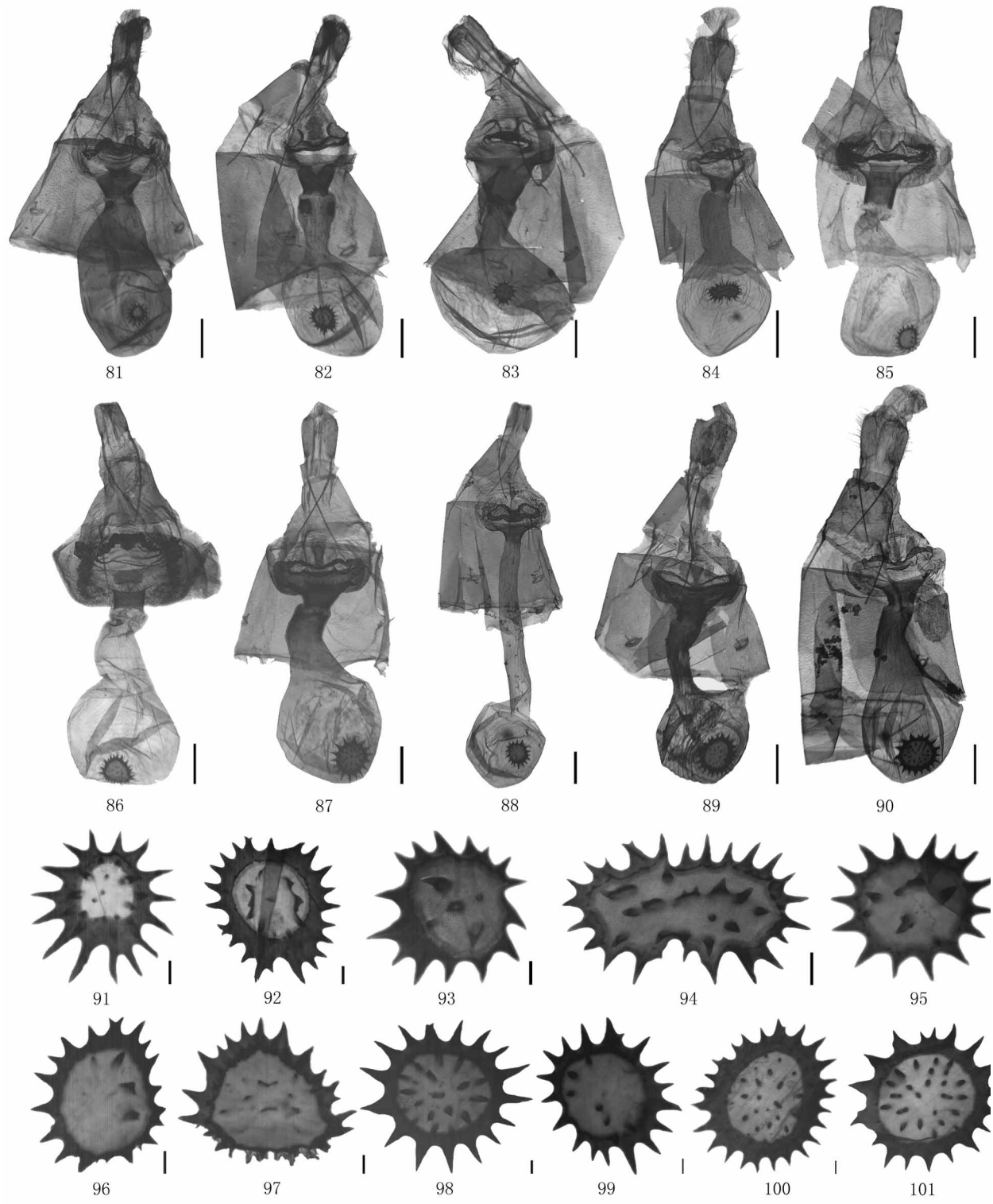
Figs. 43–44, 56, 68, 80

Boarmia xanthypochlora Wehrli, 1924, *Mitt. münch. ent. Ges.*, 14 (6–12): 140, pl. 1, fig. 24. Holotype ♀, China: Lienping. (ZFMK)

Boarmia (Ophthalmodes) xanthypochlora: Wehrli, 1943, *in* Seitz, *Gross-Schmett. Erde*, 4 (Suppl.): 531, pl. 44: a.

Ophthalmitis xanthypochlora: Parsons *et al*., 1999, *Geometrid Moths of the World, a Catalogue*, 2: 670.

Diagnosis. This species is different from other congeners in the following external characters: smaller than other congeners (length of forewing: 18–21 mm in male); the wing colour is pale yellowish brown, diffused with bluish black spots; area outside the postmedial line usually forms a bluish black dark band, which is interrupted between M_3 and CuA_1 of the forewing; the discal spots on both wings are strip-like, not stellate; the underside of the wings is greyish black, the transverse lines are similar to those on upperside, and the terminal band is absent; Sc is free, R_1 and R_2 are long stalked; the eighth sternite of the male abdomen does not have a cleft. There are also differences in the male genitalia: the uncus lacks lateral processes, as in *O. exemptaria* (Thailand, Borneo, Sumatra, Singapore, Peninsular Malaysia), *O. basiscripta* (Borneo, Peninsular Malaysia), and *O. satoi* (Borneo); the gnathos median process is shorter and rounded terminally; the costa is not angled dorsally and medially; the dorsal margin of the sacculus is a straight spinulose sclerotized band, which is of even width from the base to the end and covering on the same spinulose band-like ampulla; the juxta is long and narrow, its anterior margin not concaved medially. The aedeagus lacks sclerotized spines; the vesica has two large cornuti.



FIGURES 81–90. Female genitalia of *Ophthalmitis*. 81, *O. albosignaria albosignaria*; 82, *O. pertusaria*; 83, *O. sinensium*; 84, *O. irroratariа*; 85, *O. herbidaria*; 86, *O. siniherbida*; 87, *O. cordularia*; 88, *O. longiprocessa* **sp. nov.**; 89, *O. brevispina* **sp. nov.**; 90, *O. tumefacta* **sp. nov.** Scale bar = 1 mm.

FIGURES 91–101. Signum of female genitalia of *Ophthalmitis*. 91, *O. albosignaria albosignaria*; 92, *O. pertusaria*; 93, *O. sinensium*; 94–95, *O. irroratariа*; 96, *O. herbidaria*; 97, *O. siniherbida*; 98, *O. cordularia*; 99, *O. longiprocessa* **sp. nov.**; 100, *O. brevispina* **sp. nov.**; 101, *O. tumefacta* **sp. nov.** Scale bar = 0.1 mm.

Material examined. CHINA: Guangdong: Lienping, 1♀ (Holotype) (ZMFK); Yunnan: Tengchong, Dahaoping, 2020 m, 5–7.VIII.2007, coll. Xue Dayong, 1♂ (IZCAS); Yunnan: Baoshan, Baihualing, 1520 m, 11–13.VIII.2007, coll. Xue Dayong, 1♂ (IZCAS); Tibet: Mêdog, Aniqiao, 1060 m, 12–13.VIII.2006, coll. Lang Songyun, 2♂ (IZCAS); THAILAND: Loei Province: Phu Luang Wildlife Sanctuary, 700–900m, 8–14.X.1984, coll. Karsholt, Lomholdt & Nielsen, 2♂ (ZMFK).

Distribution. China (Guangdong, Yunnan, Tibet), Thailand.

Remarks. This species is quite different from the other congeners in both the external and male genital characters. Further study to estbalish a clear systematic position of the species is needed.

Acknowledgments

We thank Dieter Stüning, the Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany, for his constant help on our work, and all the collectors whose contributions made our work possible. Yang Chao and Yan Keji helped prepare some specimens and photographs. The reviewers for this article offered valuable comments and corrections on a draft. This work was supported by the Key Project of Scientific Innovation of CAS (KSCX2-YW-Z-0909), the National Science Foundation of China (No. 30870320), the National Science Fund for Fostering Talents in Basic Research (NSFC-J0930004) and a grant from the Key Laboratory of the Zoological Systematics and Evolution of the Chinese Academy of Sciences (No. O529YX5105).

References

Bremer, O. & Grey, W. (1853) *Beiträge zur Schmetterlings-Fauna des nördlichen China*. St. Petersburg, 23 pp.

Bryk, F. (1949) Zur Kenntnis der Gross-Schmetterlinge von Korea, Pars II. *Arkiv för Zoologi*, 41A (1), 1–225.

Butler, A.G. (1878) Descriptions of new species of Heterocera from Japan. *Annals and Magazine of Natural History*, (5) 1, 392–419.

Christoph, H. (1881) Neue Lepidopteren des Amurgebietes. *Bulletin de la Société Impériale des Naturalistes de Moscou*, 55 (3), 33–124.

Comstock, J.H. (1918) *The Wings of Insects*. Comstock Publishing Company, Ithaca, New York, 430 pp.

Felder, R. & Rogenhofer, A.F. (1875) Lepidoptera. Heft V. Atlas der Heterocera, Geometridae Pterophorida. *Reise der österreichischen Fregatte Novara um die Erde* (Zoologischer Theil), 2 (2. Abt), pls. 121–140. Wien.

Fletcher, D.S. (1979) Geometroidea. *In* Nye, I.W.B. (Ed.). *The Generic Names of Moths of the World* 3. British Museum, London, 243 pp.

Graeser, L. (1889) Beitrage zur Kenntniss der Lepidopteren-Fauna des Amurlandes. *Berliner Entomologische Zeitschrift*, 32 (2), 309–414.

Guenée, A. (1858) Uranides et Phalénites 1. *In* Boisduval J.B.A.D. & Guenée A. (Eds.), *Histoire naturelle des Insectes* (Species général des Lépidoptères), 9, i–lvi, 1–514; 10, 1–584; Atlas, pls. 1–22.

Hampson, G.F. (1902) The moths of India. Supplementary paper to the Volumes in the Fauna of British India. Series II, Part v. *Journal of the Bombay Natural History Society*, 14 (3), 103–117.

Han, H-X. & Xue, D-Y. (2002) Lepidoptera: Geometridae. *In* Huang F-S (Ed.). *Forest insects of Hainan*. Science Press, Beijing, pp. 543–561.

Han, H-X. & Xue, D-Y. (2005) Lepidoptera: Geometridae. *In* Yang X-K (Ed.). *Insect fauna of Middle-West Qinling Range and South Mountains of Gansu Province*. Science Press, Beijing, pp. 588–627.

Hausmann, A. (2001) Introduction. Archiearinae, Orthostixinae, Desmobathrinae, Alsophilinae, Geometrinae. *In*: Hausmann, A. (Ed.): *The Geometrid Moths of Europe*. Apollo Books, Stenstrup, 1, 282 pp.

Holloway, J.D. (1976) *Moths of Borneo with special reference to Mount Kinabalu*. Malayan Nature Society, Kuala Lumpur, 264 pp., 727 fig., 31 pls.

Holloway, J.D. (1994) The Moths of Borneo: Family Geometridae, Subfamily Ennominae. *Malayan Nature Journal*, 47, 1–309.

Inoue, H. (1982) Geometridae. *In* Inoue H. *et al. Moths of Japan*. Kodansha, Tokyo, Japan, Vol. 1: 425–573; Vol. 2: 263–310, pls. 55–108, 228–229, 232, 314–344.

Kim, S.S., Beljaev, E.A. & Oh, S.H. (2001) Illustrated catalogue of Geometridae in Korea (Lepidoptera: Geometrinae, Ennominae). *In* Park, K.T. (Ed.), *Insects of Korea, Series 8*. Korea Research Institute of Bioscience and Biotechnology, Daejeon, 278 pp.

Klots, A.B. (1970) Lepidoptera. *In* Tuxen, S.L. (Ed.), *Taxonomist's Glossary of Genitalia in Insects*. Munksgaard, Copenhagen, pp. 115–130.

Leech, L.H. (1889) On a collection of Lepidoptera from Kiukiang. *Transactions of the Royal Entomological Society of London*, 1889 (1), 99–148, pls. 7–9.

Leech, L.H. (1897) On Lepidoptera Heterocera from China, Japan and Corea. *Annals and Magazine of Natural History*, (6) 19, 297–349, 414–463.

Matsumura, S. (1931) *6000 Illustrations of the Insects of the Japanese Empire*. Toukoushoin, Tokyo, 497 pp. + 191 pp. (index).

Meyrick, E. (1892) On the classification of the Geometrina of the European fauna. *Transactions of the Royal Entomological Society of London*, 1892, 53–140.
Moore, F. (1884–1887). *The Lepidoptera of Ceylon* 3. L. Reeve and Co., London, 578 pp.
Nakamura, M. (2004) A morphological and phylogenetic study on the pupae of Geometridae (Insecta: Lepidoptera) from Japan. *Tinea*, 18 (Suppl. 1), 1–227.
Nichols, S.W. (Ed.) (1989) *The Torre-Bueno Glossary of Entomology.* New York Entomological Society in cooperation with the American Museum of Natural History, New York, 840 pp.
Oberthür, C. (1913) *Études de Lépidoptérologie compare*. Fasc 7: 677 pp.
Parsons, M.S., Scoble, M.J., Honey, M.R., Pitkin, L.M. & Pitkin, B.R. (1999) The catalogue. *In* Scoble, M. J. (ed.). *Geometrid moths of the world: a Catalogue (Lepidoptera, Geometridae)*. CSIRO, Collingwood, 1016 pp.
Pierce, N. (1914, reprint 1976) *The Genitalia of the Group Geometridae of the British Islands.* E. W. Classey Ltd., Middlesex, xxix + 88 pp., 48 pls.
Pitkin, L.M. (2002) Neotropical ennomine moths: a review of the genera (Lepidoptera: Geometridae). *Zoological Journal of the Linnean Society*, 135, 121–401.
Prout, L.B. (1912–1916) The Palaearctic Geometrae. *In* Seitz, A. (Ed.), *The Macrolepidoptera of the World*. Vol. 4, Verlag A. Kernen, Stuttgart, pp. 1–479, pls. 1–25.
Prout, L.B. (1916) New species of indo-australian Geometridae. *Novitates Zoologicae*, 23, 1–77.
Prout, L.B. (1925) Geometrid descriptions and notes. *Novitates Zoologicae*, 32, 31–69.
Prout, L.B. (1930) On the Japanese Geometridae of the Aigner collection. *Novitates Zoologicae*, 35, 289–337.
Sato, R. (1976) Larvae of Japanese *Phthonosema* and *Ophthalmodes* (Lepidoptera: Geometridae: Ennominae). *Tinea*, 10 (8) 1976, 71–84.
Sato, R. (1984) Taxonomic study of the Genus *Hypomecis* Hübner and its allied genera from Japan (Lepidoptera: Geometridae: Ennominae). *Special Bulletin of Essa Entomological Society*, 1, 1–213, pls. 1–99.
Sato, R. (1992) The genus *Ophthalmitis* (Geometridae, Ennominae) of Taiwan, with dscriptions of one new species and one new subspecies. *Japan Heterocerists' Journal*, 167, 294–299.
Sato, R. (1993) Geometridae: Ennominae (part). *In* Haruta, T. (Ed.). Moths of Nepal, Part 2. *Tinea*, 13 (Suppl. 3), 5–30.
Sato, R. (2005) Records of the Boarmiini (Geometridae, Ennominae) from Thailand IV. *Transactions of the Lepidopterological Society of Japan*, 56 (1), 63–72.
Sato, R. & Wang, M. (2007) Records and descriptions of the Boarmiini (Geometridae, Ennominae) from Nanling Mts, S. China. part 4. *Tinea*, 20 (1), 33–44.
Scoble, M.J. (1992) *The Lepidoptera, Form, Function and diversity.* Oxford University Press, Oxford, 404 pp.
Sibatani, A., Ogata, M., Okada, Y. & Okagaki, H. (1954) Male genitalia of Lepidoptera morphology and nomenclature. II. Divisions of the valvae in Rhopalocera, Phalaenidae (=Noctuidae) and Geometridae. *Annals of the Entomological Society of America*, 47, 93–106.
Singh, B. (1953) Immature stages of Indian Lepidoptera. No. 8: Geometridae. *Indian Forest Records* (N.S.), 8 (7), 67–158.
Sommerer, M. & Stüning, D. (1994) Spolia Sumatrensia: a new *Ophthalmitis* (Lepidoptera: Geometridae, Ennominae). *Heterocera Sumatrana*, 7 (2), 257–260.
Swinhoe, C. (1891) New species of Heterocera from the Khasia Hills. Part I. *Transactions of the Royal Entomological Society of London*, 1891 (4), 473–495, pl. 19.
Swinhoe, C. (1893) On new Geometers. *Annals and Magazine of Natural History*, (6) 12, 147–157.
Sugi, S. (Ed.) (1987) *Larvae of Large Moths in Japan*. Tokyo: Kodansha, 453 pp.
Walker, F. (1860) *List of Specimens of Lepidopterous Insects in the Collection of the British Museum*. Part 21, London, Edward Newman. pp. 277–489.
Walker, F. (1866) *List of Specimens of Lepidopterous Insects in the Collection of the British Museum*. Part 35, London, Edward Newman. pp. 1535–2040.
Warren, W. (1897) New genera and species of Drepanulidae, Thyrididae, Epiplemidae, Uraniidae, and Geometridae in the Tring Museum. *Novitates Zoologicae*, 4, 195–262.
Wang, H-Y. (1998) *Geometer Moths of Taiwan*. Vol. 2. Taiwan Museum, Taipei, 399 pp.
Wehrli, E. (1924) Neue und wenig bekannte palaarktische und Sudchine-sische Geometriden-Arten und Formen. (Sammlung Hone.) II. *Mitteilungen der Münchener Entomologischen Gesellschaft* 14 (6–12), 130–142.
Wehrli, E. (1938–1954) Subfamilie: Geometrinae. *In* Seitz, A. (Ed.), *Die Grossschmetterlinge der Erde.* Vol. 4 (Supplement), Verlag A. Kernen, Stuttgart, pp. 254–766, taf. 19–53.
Xue, D-Y. (1992a) Lepidoptera: Geometridae. *In* Liu Y-Q (Ed.), *Iconography of Forest Insects in Hunan China*. Hunan Science and Technology Publishing House, Changsa, pp. 807–904.
Xue, D-Y. (1992b) Lepidoptera: Geometridae. In Huang F-S (Ed.), *Insects of Wuling Mountains area, Southwestern China.* Science Press, Beijing, pp. 463–477.
Xue, D-Y. (2001) Geometridae. *In* Huang B-K (Ed.), *Fauna of Insects in Fujian Province of China*. Vol. 5. Fujian Science and Technology Press, Fuzhou, pp. 320–360.
Young, C.J. (2008) Characterisation of the Australian Nacophorini using adult morphology, and phylogeny of the Geometridae based on morphological characters. *Zootaxa*, 1736, 1–141.
Zhu, H-F. (Ed.) (1981) *Iconocraphia Heterocerorum Sinicorum*. Vol. I. Science Press, Beijing, iv + 134 pp. + 22 pp. (Index), 38 pls.