



A review of *Jankowskia* Oberthür, 1884, with descriptions of four new species (Lepidoptera: Geometridae, Ennominae)

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Abstract

The genus *Jankowskia* Oberthür, 1884 is reviewed and four new species are described: *J. curva* **sp. nov.**, *J. acuta* **sp. nov.**, *J. improjecta* **sp. nov.**, and *J. obtusangula* **sp. nov.** *J. bituminaria raddensis* (Wehrli, 1941) is recorded for the first time from China. A key to all species of the genus is provided. The diagnoses for all species are given. Illustrations of adults and genitalia are presented.

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

Introduction

The genus *Jankowskia* Oberthür, 1884 is a genus of the tribe Boarmiini in the subfamily Ennominae. The species of *Jankowskia* are widely distributed in the East Asia area. This genus was established by Oberthür with the two species *Jankowskia athleta* Oberthür, 1884 and *Jankowskia thoracicaria* Oberthür, 1884, without designating a type species. *J. athleta* Oberthür, 1884 was subsequently designated as the type species of the genus by Fletcher (1979). *J. thoracicaria* Oberthür, 1884 was regarded as not a true *Jankowskia* and moved to *Biston* by Prout (1915). Djakonov (1926) described a monotypic genus *Pleogynopteryx* based on the species *Pleogynopteryx tenebricosa* Djakonov. *Jankowskia* and *Pleogynopteryx* were treated as two subgenera of *Boarmia* by Wehrli (1941) and two genera by Scoble (1999), until Kim *et al.* (2001) treated *Pleogynopteryx* as a junior synonym of *Jankowskia*.

Until now, five species and four subspecies in the genus *Jankowskia* were known. The species *Boarmia bituminaria* Lederer, 1853 was placed in the subgenus *Cleora* of *Boarmia* by Prout (1915), who treated numerous genera as subgenera of *Boarmia*. Wehrli (1941) placed this species in another subgenus *Pleogynopteryx* of *Boarmia* and designated *Pleogynopteryx tenebricosa* Djakonov as its synonym. The species *Boarmia fuscaria* Leech, 1891 was later transferred to the genus *Jankowskia* by the author himself (Leech, 1897). This species from Japan and China was mistakenly identified as *Jankowskia athleta* in Prout (1915). Wehrli (1929) described *Boarmia amurensis*, which was subsequently discovered to be preoccupied by *Boarmia amurensis* Staudinger, 1892. Wehrli (1941) proposed a replacement name *raddensis* for it and downgraded it to subspecies of *Boarmia* (*Pleogynopteryx*) *bituminaria*. Sato (1980) provided a revision of the genus *Jankowskia* for the first time. He described two new species, *J. taiwanensis* Sato, 1980 and *J. pseudathleta* Sato, 1980, and one new subspecies *J. fuscaria naitoi* Sato, 1980, together with the redescription of *J. athleta* and *J. fuscaria fuscaria* (Leech, 1891). He designated *Boarmia unmon* Sonan, 1934, *Boarmia* (*Jankowskia*) *athleta geloi* Wehrli, 1941 and *Boarmia* (*Jankowskia*) *athleta nanaria* Bryk, 1948 as new synonyms of *J. fuscaria fuscaria*. Sato (1980, 1984) also clarified that the record of *J. athleta* in Japan was a misidentification. The Japanese specimens partly belong to *J. fuscaria* and others belong to *J. pseudathleta*.

Two years later, the same author (Sato, 1986) added one species *J. viidaleppi* Sato, 1986 to *Jankowskia*, but the species was later considered as a junior synonym of *J. bituminaria raddensis* (Wehrli, 1941) by Kim *et al.* (2001).

Herein, we review all known species of *Jankowskia*; give descriptions of diagnostic characters for all species; describe four new species *J. curva* **sp. nov.**, *J. acuta* **sp. nov.**, *J. improjecta* **sp. nov.**, and *J. obtusangula* **sp. nov.**; first record of *J. bituminaria raddensis* (Wehrli, 1941) from China, and provide illustrations of adults and genitalia.

Material and methods

Specimens of *Jankowskia* were obtained from the Institute of Zoology, Chinese Academy of Sciences, Beijing, China (IZCAS) and Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK). Other cited museums where types are deposited are as follows: the Natural History Museum, London, United Kingdom (BMNH) and the National Science Museum, Tokyo, Japan (NSMT). Terminology for wing venation follows the Comstock-Needham System (Comstock, 1918) as adopted for Geometridae by Scoble (1992) and Hausmann (2001), and that for the genitalia was based on Pierce (1914), Klots (1970) and Nichols (1989). Photographs of adult moths and their genitalia were taken with digital cameras, and the plates compiled using Adobe Photoshop software.

Jankowskia Oberthür, 1884

Jankowskia Oberthür, 1884, *Études ent.*, 9: 25. Type species: *Jankowskia athleta* Oberthür, 1884, by subsequent designation by Fletcher, 1979.

Pleogynopteryx Djakonov, 1926, *Jahrb. Martj. Staatsmus. Minussinsk*, 4: 66, 70. Type species: *Pleogynopteryx tenebricosa* Djakonov, 1926 (= *Boarmia bituminaria* Lederer, 1853), by original designation.

Description. Head: Antenna greyish brown mixed with white scales dorsally, bipectinate in male, simple filiform at tip and in female. Frons blackish brown or greyish brown, smooth-scaled. Labial palpus blackish brown or greyish brown, short and stout, extending slightly beyond frons. Vertex greyish brown or blackish brown.

Thorax: Patagium and tegula blackish brown, suffused with grey scales. Dorsal side blackish brown, greyish black or greyish brown. Legs blackish brown mixed with yellow. Hind tibia with two pairs of spurs in both sexes, dilated, with or without hair-pencil in male. Wings blackish brown or grey, diffused with blackish grey small dots. Forewing with apex and anal angle rounded, outer margin almost straight or weakly protruded, anal margin straight. Hindwing rounded, with costa and anal margin straight, outer margin slightly wavy. Patterns of forewing: costa yellowish brown, diffused with short longitudinal greyish brown flecks; antemedial, medial, and postmedial lines forming three black patches on costa; antemedial line black, slightly wavy, distinct, protruded inwards below cell, then protruded outwards, extending to the wing base near anal margin; medial line black, distinct or indistinct; postmedial line black, wavy, distinct, protruded outwards between M_1 and M_2 , protruded inwards below M_2 , then paralleling to medial line; a yellowish brown patch outside postmedial line, a dull brown shadow in the middle of the patch; submarginal line greyish black, indistinct; terminal line black, appearing as series of small crenulate patches between veins; fringes greyish brown mixed with blackish brown; discal spot black, present as a strip or small dot, distinct or indistinct. Hindwing with basal area greyish brown, blackish brown or greyish black; medial line black, straight, distinct or indistinct, the width various between species; postmedial line black, distinct, wavy. Underside dull grey, greyish black or greyish white, transverse lines pale brown, a faint broad band usually present outside postmedial line, costa of forewing pale yellow or greyish yellow, diffused with fewer flecks, medial and postmedial lines often forming two black patches on costa of forewing.

Venation: Frenulum developed. Forewing: male with a fovea between anal fold and 2A; R_1 and R_2

separate, almost parallel or shortly stalked, diverging before anterior angle of cell in male, anastomosing in female; R_{3+4} and R_5 longly stalked; R_{3-5} diverging from or before anterior angle of cell in male, always diverging before anterior angle in female; 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 1/2 length of cell; R_s diverging before anterior angle of cell; M_1 diverging from anterior angle of cell, M_2 absent, M_3 and CuA_1 from posterior angle; 3A absent.

Abdomen: First abdominal segment with pale grey dorsal band, remaining segments blackish brown or greyish brown. Sternite 3 of male abdomen without setal patch.

Male genitalia: Uncus triangular, length equal to basal width. Tegumen with or without a pair of posterior processes, its length varying, with or without (maybe lost during preparation) a bundle of long setae apically. Gnathos connected at middle, with median process small, the shape and the ratio of its length to the basal width various. Valva terminally blunt, bearing a large area of long setae; one or two clusters of long setae near center; ventral margin of valva sometimes protruded outwards at middle. Costa almost straight. Saccus small, rounded. Juxta symmetrical in *J. athleta*, *J. pseudathleta* and *J. improjecta*, or asymmetrical with an apical process at the left side in other members of the genus, the shape, length and degree of sclerotization of the processes various. Aedeagus short and stout, weakly sclerotized. Vesica with cornuti shaped as a bundle of spines.

Female genitalia: Ovipositor heavy elongated. Apophyses posteriores much longer than apophyses anteriores. Sterigma with central part almost rounded or quadrate, with a pair of sclerotized lateral lobes. Ductus bursae weakly or strongly sclerotized, wrinkled. Corpus bursae oval or round, membranous, bearing an almost flat signum with marginal spines, the shape of signum various.

Diagnosis. On the wing patterns, the genus *Jankowskia* resembles *Phthonosema* Warren, 1894 in the postmedial line usually protruded outwards between M_1 and M_2 , protruded inwards below M_2 , then paralleling to the medial line. But *Jankowskia* differs from *Phthonosema* in having a yellowish brown patch outside the postmedial line on forewing; in the male genitalia, *Jankowskia* has a fairly simple valva, while in *Phthonosema* the sacculus is separated from the valva.

Distribution. China, Russia (South Siberia and South of Far East), Mongolia, Japan, North Korea, South Korea, Thailand.

Biological notes. Adult are mostly active at night. Most specimens from China have been recorded from 230 m to 2400 m elevation between June and October. The pupa was described in Nakamura and Masanao (2004) and Sato (1984). The larva were described and illustrated in Sato (1984). Larval host plants (Sato & Nakajima, 1975; Nakajima, 1975; Sato, 1976; Sato, 1980; Sato, 1984; Scoble, 1999) have been recorded from the families Aquifoliaceae, Fagaceae, Lauraceae, Rosaceae, Salicaceae, Theaceae.

Remarks. Sato (1980) stated in his description of the genus *Jankowskia* that the tegumen possesses a pair of posterior processes in the male genitalia. Later, Kim *et al.* (2001) considered *Pleogynopteryx* as a generic synonym of *Jankowskia* although *J. bituminaria* lacks the tegumen posterior processes. Herein, the length of tegumen posterior processes of the four new species is varying from almost absent without long setae apically (in *J. obtusangula*) to short, triangular with or without a bundle of long setae apically (*J. curva*, *J. acuta* and *J. improjecta*). So, these new species could be a series of transitional forms between *J. bituminaria* and other species of *Jankowskia*, and support the synonymization of *Pleogynopteryx* to *Jankowskia*.

Key to *Jankowskia* species

1. Outer margin of forewing almost straight..... 2
 - Outer margin of forewing weakly protruded 8
2. Medial line on hindwing more than thrice width of postmedial line..... *J. taiwanensis*
 - Medial line on hindwing less than or about twice width of postmedial line 3
3. Postmedial line on forewing broadened below M_3 *J. curva* **sp. nov.**
 - Postmedial line on forewing not broadened below M_3 4
4. Tegumen posterior processes short and triangular.....*J. acuta* **sp. nov.**

- Tegumen posterior processes long and digitiform..... 5
- 5. Medial line on hindwing indistinct; juxta almost symmetrical 6
- Medial line on hindwing distinct; juxta asymmetrical..... 7
- 6. Hindwing basal area pale greyish brown; valva broadened terminally *J. athleta*
- Hindwing basal area dull greyish brown; valva not broadened terminally *J. pseudathleta*
- 7. Postmedial line on hindwing protruded inwards below M_3 ; tegumen posterior processes long *J. fuscaria fuscaria*
- Postmedial line on hindwing almost straight; tegumen posterior processes short *J. fuscaria naitoi*
- 8. Transverse lines indistinct; juxta with median dorsal process..... *J. improjecta* **sp. nov.**
- Transverse lines distinct; juxta left side with process..... 9
- 9. Postmedial line weak and brown on both wings underside; juxta left process stick-like..... 10
- Postmedial line strong and black on both wings underside; juxta left process hook-like
..... *J. obtusangula* **sp. nov.**
- 10. Postmedial line on forewing slightly protruded outwards between M_1 and M_3 *J. bituminaria bituminaria*
- Postmedial line on forewing strongly protruded outwards between M_1 and M_3 *J. bituminaria raddensis*

Jankowskia athleta Oberthür, 1884

Figs. 1–2, 23, 31

Jankowskia athleta Oberthür, 1884, *Études ent.* 9: 25, pl. 2, fig. 7. Syntypes, [Russia]: Sidemi. (ZFMK)
Boarmia (Jankowskia) athleta: Wehrli, 1941, in Seitz, *Gross-Schmett. Erde* 4 (Suppl.): 469, pl. 41: e, f.

Diagnosis. This species is similar to *J. taiwanensis* and *J. fuscaria* in: the forewing outer margin is straight, the postmedial line is strongly protruded outwards between M_1 and M_2 ; the hindwing basal area is pale greyish brown; the tegumen posterior processes of male genitalia are digitiform, each with a bundle of long setae apically; the valva is broadened terminally, bearing two cluster of long setae near center, extending dorsally and ventrally respectively. But from the wing patterns, *J. athleta* can be distinguished by the indistinct and narrower medial line on hindwing. In the male genitalia, the tegumen posterior processes are very long, about four-fifths length of the uncus; the gnathos median process is shorter and broader, almost flat apically, about one-half length of the basal width; the juxta is almost symmetrical, with a small slightly sclerotized central process. In the female genitalia (Sato, 1980), the ductus bursae is shorter; the signum is almost hexagon.

Distribution. China (Heilongjiang, Jilin, Henan, Shaanxi, Hubei, Jiangxi, Guangdong, Guizhou), Russia (Ussuri, Amur), North Korea, South Korea.

Remarks. *Boarmia (Jankowskia) athleta geloi* was recorded in Jiangsu, Zhejiang and Hunan provinces of China, by the description of Wehrli (1941). Later, Zhu (1981) considered these three provinces as the distribution of *J. athleta*. However, *Boarmia (Jankowskia) athleta geloi* was designated as a junior synonym of *J. fuscaria fuscaria* by Sato (1980). Thus, *J. athleta* is not reported from Jiangsu, Zhejiang and Hunan provinces of China in our study.

Jankowskia taiwanensis Sato, 1980

Figs. 3–4, 24, 32

Jankowskia taiwanensis Sato, 1980, *Tyô to Ga* 30 (3&4): 136, figs. 7, 8, 12, 17. Holotype ♂, [Taiwan]: Lushan, nantou. (NSMT)

Diagnosis. This species can be distinguished from *J. athleta* based on the following characters: larger than *J. athleta* (length of forewing: 25–27 mm in male); the forewing postmedial line is broader and is almost merging with the medial line near anal margin; the yellowish brown patch outside the postmedial line is indistinct; the hindwing medial line is distinct, very broad, more than thrice width of the postmedial line. In the male genitalia, the tegumen posterior processes are much shorter, less than half length of uncus; the gnathos median process is pointed apically, the length is about equal to the basal width; the juxta is asymmetrical, the left sclerotized process is digitiform, about one-fourth length of the juxta, the right side with

a short sclerotized process. In the female genitalia (Sato, 1980), the signum is oval, with 13–15 long and stout spines.

Distribution. China (Shaanxi, Zhejiang, Hubei, Fujian, Taiwan).



FIGURES 1–18. Adults of *Jankowskia*. 1–2. *J. athleta*. 1, male, upperside; 2, male, underside; 3–4. *J. taiwanensis*. 3, male, upperside; 4, male, underside; 5–8. *J. fuscaria fuscaria*. 5, male, upperside; 6, male, underside; 7, female, upperside; 8, female, underside; 9–10. *J. curva* **sp. nov.**, holotype. 9, male, upperside; 10, male, underside; 11–12. *J. acuta* **sp. nov.**, holotype. 11, male, upperside; 12, male, underside. 13–14. *J. improjecta* **sp. nov.**, holotype. 13, male, upperside; 14, male, underside; 15–18. *J. bituminaria raddensis*. 15, male, upperside; 16, male, underside; 17, female, upperside; 18, female, underside. Scale bar = 1 cm.

***Jankowskia fuscaria* (Leech, 1891)**

Boarmia fuscaria Leech, 1891, *Entomologist* 24 (Suppl.): 45. Syntypes 1♂2♀, [Japan]: Oiwake. (BMNH)

Jankowskia fuscaria: Leech, 1897, *Ann. Mag. nat. Hist.* (6) 19: 429.

Boarmia (Jankowskia) athleta: Prout, 1915, in Seitz, *Macrolepid. World* 4: 365, pl.20: d.

Boarmia unmon Sonan, 1934, *Kontyû* 8 (4–6): 212, fig. 1. Syntypes 2♀, [Japan]: Shizuoka Prefecture, Yudo-Mura, Abe-Gun.

Boarmia (Jankowskia) athleta geloia Wehrli, 1941, in Seitz, *Gross-Schmett. Erde* 4 (Suppl.): 469, pl. 41: e. Syntypes, [China]: South-east China, Lungtan near Nanking, Province Kiangsu; Mokanshan; Chekiang Province; Hunan Province, Hoeng-Shan. (ZFMK)

Boarmia (Jankowskia) athleta nanaria Bryk, 1948, *Arkiv Zool.* 41A (1): 200. Holotype ♂, Korea: Myokosan. (BMNH)

***Jankowskia fuscaria fuscaria* (Leech, 1891)**

Figs.5–8, 25, 33, 40, 43–45

Diagnosis. The wing patterns of this species are similar to that of *J. taiwanensis*, but can be distinguished by the following characters: smaller than *J. taiwanensis* (length of forewing: 18–21 mm in male; 21–26 mm in female); the hindwing medial line is narrower, about twice width of the postmedial line, the postmedial line strongly protrudes inwards below M_3 . In the male genitalia, the gnathos median process is broader and semicircular; the juxta is asymmetrical, the left sclerotized process is triangular, about one-fifth length of the juxta, the right side is slightly sclerotized. In the female genitalia, the ductus bursae is longer and slender, almost equal to the length of the corpus bursae, weakly sclerotized; the signum is oval, bigger, bearing 19–26 small spines.

Distribution. China (Henan, Gansu, Anhui, Zhejiang, Hubei, Jiangxi, Hunan, Fujian, Guangdong, Hainan, Guangxi, Sichuan, Chongqing, Guizhou, Yunnan), Japan, North Korea, South Korea, Thailand.

Remarks. The shape of the signum of the female genitalia is variable among the specimens from different localities. The signum of the specimens from Moka-shan, Zhejiang and Huangkengdeng, Fujian are more rounded than those from Xingshan, Hubei, but otherwise similar. There may be variation of the shape of signum among *J. fuscaria fuscaria* in different areas of China. However the number of specimens and collecting sites are too limited to solve this problem presently.

***Jankowskia fuscaria naitoi* Sato, 1980**

Jankowskia fuscaria naitoi Sato, 1980, *Tyô to Ga* 30 (3&4): 135, figs. 5–6, 14, 19. Holotype ♂, [Japan]: [Okinawa], Amami-ôshima Island, Mt. Yuwan-dake. (NSMT)

Diagnosis. This subspecies is similar to the nominate subspecies, but can be distinguished by the following characters: the hindwing medial line is broader, the postmedial line is almost straight. In the male genitalia (Sato, 1980), the tegumen posterior processes are shorter; the left process of the juxta is smaller, about one-sixth length of the juxta. In the female genitalia (Sato, 1980), the signum is smaller, with 8–13 spines, which are longer than that of the nominate subspecies.

Distribution. Japan.

***Jankowskia pseudathleta* Sato, 1980**

Jankowskia pseudathleta Sato, 1980, *Tyô to Ga* 30 (3&4): 136, figs. 9, 10, 15, 20. Holotype ♂, [Japan]: Hokkaido, Sapporo. (NSMT)

Diagnosis. This species is very similar to *J. athleta* in: the forewing outer margin is almost straight; the

tegumen posterior processes of the male genitalia are digitiform, each with a bundle of long setae apically; the juxta symmetrical. But it can be distinguished from that species by the forewing postmedial line which is less protruded outwards between M_1 and M_2 , and the hindwing basal area is dull blackish brown. In the male genitalia (Sato, 1980), the tegumen posterior processes are much shorter; the valva is even in width, not broadened terminally, one cluster of long setae is present near center, extending dorsally. In the female genitalia (Sato, 1980), the ductus bursae is longer; the signum is irregularly shaped, with 4–6 long spines.

Distribution. Russia (Amur, Ussuri, South Kuriles), Japan, South Korea.

***Jankowskia curva* sp. nov.**

Figs. 9–10, 26, 34

Description. Head: Antenna bipectinate in male, the longest pectination about four times diameter of antennal shaft, filiform at tip. Frons yellowish brown suffused with sparse grey scales, smooth-scaled. Labial palpus greyish brown, short and stout, extending slightly beyond frons. Vertex greyish brown.

Thorax: Dorsal side blackish brown. Hind tibia in male without hair-pencil. Forewing length: male 23 mm. Wings blackish brown. Forewing with outer margin almost oblique; costa diffused with short longitudinal greyish brown flecks; antemedial line black, slightly protruded inwards below cell; medial line black, distinct; postmedial line black, protruded outwards between M_1 and M_2 , inwards below M_2 , then paralleling to medial line; both postmedial and medial lines broadened below M_3 ; a yellowish brown patch outside postmedial line, the dull brown shadow in the middle of the patch indistinct; discal spot black, strip-like, indistinct. Hindwing with basal area blackish brown; medial line black, indistinct, equal to postmedial line in width; postmedial line black, protruded outwards between M_1 and M_3 then strongly bent inwards below M_3 , thickened near anal margin; a yellowish brown patch outside postmedial line, the dull brown shadow in the middle of the patch more distinct than on forewing. Underside greyish black, transverse lines on hindwing more distinct than on forewing.

Venation: Male forewing: R_1 and R_2 separate, almost parallel in male; R_{3+5} and M_1 diverging from anterior angle of cell.

Abdomen: First abdominal segment with pale grey band dorsally, remaining segments blackish brown.

Male genitalia: Uncus triangular, length about equal to basal width. Posterior processes of tegumen triangular, very short, about one-ninth length of uncus, without long setae apically. Gnathos with median process round, about half length of basal width. Valva even in width; blunt terminally, bearing a large area of long setae; one cluster of long setae near center, extending dorsally; ventral margin of valva not protruded outwards at middle. Saccus small, round. Juxta asymmetrical, left sclerotized process hook-like, long and slender, about half length of juxta. Spines bundle of cornuti about half length of aedeagus.

Female genitalia: unknown.

Diagnosis. This new species is similar to *J. fuscaria* in the wing shape and markings, but it can be distinguished from that species by the following differences: the forewing postmedial line is more strongly protruded outwards between M_1 and M_2 , broadened below M_3 . In the male genitalia, the tegumen posterior processes are triangular, not digitiform, much shorter, without long setae apically; the valva is even in width, not broadened terminally, the ventral margin of the valva is not protruded outwards at middle; the left process of juxta is hook-like, which is triangular in *J. fuscaria*; the spines bundle of cornuti is much longer, about half length of the aedeagus.

Material examined. Holotype, ♂, CHINA: Henan: Songxian Baiyunshan, 21.VI.2001, coll. Shen Xiaocheng (IZCAS). Paratypes: 1♂ (IZCAS), Shaanxi: Ningshan Huoditang, 1500–2000 m, 8.VII.2008, coll. Liu Wangang; 1♂ (IZCAS), Shaanxi: Zhouzhixian Houzhenzi, 1276 m, 1.VII.2008, coll. Li Wenzhu.

Etymology. The specific name is from the Latin word *curvus*, which means curvy.

Distribution. China (Henan, Shaanxi).

***Jankowskia acuta* sp. nov.**

Figs. 11–12, 27, 35

Description. Head: Antenna bipectinate in male, the longest pectination about six times diameter of antennal shaft, filiform at tip. Frons blackish brown, suffused with sparse grey scales, smooth-scaled. Labial palpus greyish brown, short and stout, extending slightly beyond frons. Vertex greyish brown.

Thorax: Dorsal side dull grey. Hind tibia in male without hair-pencil. Forewing length: male 22 mm. Wings grey. Forewing with outer margin straight; costa pale, diffused with short longitudinal greyish brown flecks; medial line and postmedial line black, paralleling to each other below CuA₁; a yellowish brown patch outside postmedial line, the dull brown shadow in the middle of the patch indistinct; discal spot black, indistinct. Hindwing with basal area grey; medial line black, distinct, equal to postmedial line in width; postmedial line black, protruded outwards between M₁ and M₃, then slightly protruded inwards below M₃. Underside greyish white, transverse lines weak, the faint broad band outside postmedial line indiscernible.

Venation: Male forewing: R₁ and R₂ separate and almost parallel; R₃₊₅ and M₁ diverging from anterior angle of cell.

Abdomen: First abdominal segment with pale grey band dorsally, remaining segments blackish brown.

Male genitalia: Uncus triangular, gradually tapered, length equal to basal width. Posterior processes of tegumen triangular, short, about one-seventh length of uncus, without long setae apically. Gnathos with median process semicircular. Valva even in width; blunt terminally, bearing a large area of long setae; one cluster of long setae near center, extending dorsally; ventral margin of valva slightly protruded outwards at middle; sacculus broadened basally. Saccus not elongate. Juxta asymmetrical, left sclerotized process hook-like, acute apically, about one-half length of juxta. Spines bundle of cornuti about one-third length of aedeagus.

Female genitalia: unknown.

Diagnosis. This new species is similar to *J. curva* on wing patterns. The main differences lie in that the hindwing postmedial line is less protruded inwards below M₃; the uncus is gradually tapered; the ventral margin of the valva is a little more protruded outwards at middle; the left sclerotized process of the juxta is differently shaped, shorter and stouter than in *J. curva*.

Material examined. Holotype, ♂, CHINA: Gansu: Kangxian Qinghe Linchang, 1450–1650 m, 15.VII.1998, coll. Zhang Xuezhong (IZCAS).

Etymology. The specific name is from the Latin word *acutus*, which means acute.

Distribution. China (Gansu).

Remarks. Due to the very poor condition of the type specimen, some characteristic features of the wing patterns are missing.

***Jankowskia improjecta* sp. nov.**

Figs. 13–14, 28, 36

Description. Head: Antenna bipectinate in male, the longest pectination about six times diameter of antennal shaft, filiform at tip. Frons blackish brown suffused with sparse grey scales, smooth-scaled. Labial palpus blackish brown, short and stout, extending slightly beyond frons. Vertex yellowish brown.

Thorax: Dorsal side greyish black. Hind tibia in male without hair-pencil. Forewing length: male 19–21 mm. Wings greyish black, transverse lines indistinct. Forewing with outer margin weakly protruded; costa diffused with dull short longitudinal greyish brown flecks; antemedial line black, strongly protruded inwards below cell; medial line black, indistinct, thickened near anal margin; postmedial line black, slightly protruded outwards between M₁ and M₂, protruded inwards below M₂, then paralleling to medial line; the yellowish brown patch outside postmedial line indistinct, the dull brown shadow in the middle of the patch indistinct; discal spot black, indistinct. Hindwing with basal area greyish black; medial line black, indistinct, equal to postmedial line in width; postmedial line black, slightly protruded outwards between M₁ and M₃, then slightly

protruded inwards below M_3 ; the yellowish brown patch outside postmedial line indistinct, the dull brown shadow in the middle of the patch more distinct than on forewing. Underside greyish black, transverse lines weak, the faint broad band outside postmedial line darker, costa of forewing greyish yellow.

Venation: Male forewing: R_1 and R_2 separate and almost parallel; R_{3-5} diverging before anterior angle of cell; M_1 diverging from anterior angle of cell.

Abdomen: First abdominal segment with pale grey band dorsally, remaining segments blackish brown.

Male genitalia: Uncus triangular, length equal to basal width. Posterior processes of tegumen triangular, short, about one-fifth length of uncus, each with a bundle of long setae apically. Median process of gnathos semicircular. Valva even in width; blunt terminally, bearing a large area of long setae; one cluster of long setae near center, extending dorsally; ventral margin of valva not protruded outwards at middle. Saccus small, round. Juxta symmetrical, with a wide tongue-like moderately sclerotized median dorsal process. Spines bundle of cornuti about two-fifth length of aedeagus.

Female genitalia: unknown.

Diagnosis. This new species is similar to *J. acuta* in the wing patterns, but can be distinguished from that species by the following differences: the forewing outer margin is protruded, but straight in *J. acuta*; the transverse lines are indistinct; the hindwing postmedial line is almost straight below M_3 , but remarkably protruded inwards in *J. acuta*. In the male genitalia, the tegumen posterior processes are longer, each with a bundle of long setae apically; the ventral margin of valva is not protruded outwards at middle; the juxta is symmetrical with median dorsal process, but asymmetrical, with an apical process at the left side in *J. acuta*.

Material examined. Holotype, ♂, **CHINA:** Shaanxi: Zhouzhixian Houzhenzi, 1276 m, 1.VII.2008, coll. Li Wenzhu (IZCAS). Paratypes, 1♂ (IZCAS), Gansu: Kangxian Qinghe Linchang, 1450–1650 m, 15.VII.1998, coll. Zhang Xuezhong.

Etymology. The specific name is from the Latin word *improjectus* which means without projecting.

Distribution. China (Shaanxi, Gansu).

Jankowskia bituminaria (Lederer, 1853)

Boarmia bituminaria Lederer, 1853, *Verh. zool. bot. Ver. Wien* 3 (Abh): 378, pl. 6, fig. 1. Syntypes 2, [Russia]: Siberia, [Eastern Ussuri], [Altai, Amur].

Boarmia (*Cleora*) *bituminaria*: Prout, 1915, in Seitz, *Macrolepid. World*, 4: 367, pl.25: h.

Pleogynopteryx tenebricosa Djakonov, 1926, *Ezheg. gosud. Muz. N. M. Mart'yanova* 4: 68, 71. Syntypes 2♂, 1♀, [Russia]: Minusinsk.

Boarmia (*Pleogynopteryx*) *bituminaria*: Wehrli, 1941, in Seitz, *Gross-Schmett. Erde* 4 (Suppl.): 470.

Pleogynopteryx bituminaria: Scoble, 1999, *Geometrid Moth of the World, a Catalogue* 2: 766.

Jankowskia bituminaria: Kim *et al.*, 2001, *Illustrated catalogue of Geometridae in Korea (Lepidoptera: Geometrinae, Ennominae)*: 97, pl. 21: 18.

Jankowskia bituminaria bituminaria (Lederer, 1853)

Diagnosis. This subspecies is similar to *J. improjecta* in: the forewing outer margin is protruded, the yellowish brown patch outside the postmedial line is faint; the hindwing medial line is equal to the postmedial line in width. But it can be distinguished by the following differences: wing colour is paler; the transverse lines are more distinct. In the male genitalia, the tegumen posterior processes are absent; the terminal half of valva is narrower than in *J. improjecta*; the left sclerotized process of juxta is stick-like, but lacking in *J. improjecta*.

Distribution. Russia (South Siberia).

***Jankowskia bituminaria raddensis* (Wehrli, 1941) (new to the fauna of China)**

Figs. 15–18, 29, 37, 41, 46

Boarmia (*Pleogynopteryx*) *bituminaria raddensis*: Wehrli, 1941, in Seitz, *Gross-Schmett. Erde* 4 (Suppl.): 470, pl. 41: g.
[Replacement name for *amurensis* Wehrli.]

Boarmia (*Pleogynopteryx*) *amurensis* Wehrli, 1929, *Ezheg. gosud. Muz. N. M. Mart'yanova* 6 (1): 24. Syntypes,
[Russia]: Amur; Radde; Pokroflka. (ZFMK)

Jankowskia viidaleppi Sato, 1986, *Tyô to Ga* 36 (4): 177, figs 1–4. Holotype ♂, [Russia]: S Ussuri, Primorye Territory,
Barabash-Levada. (NSMT)

Pleogynopteryx bituminaria raddensis: Scoble, 1999, *Geometrid Moth of the World, a Catalogue* 2: 766.

Jankowskia bituminaria raddensis: Kim *et al.*, 2001, *Illustrated catalogue of Geometridae in Korea (Lepidoptera: Geometrinae, Ennominae)*: 97, pl. 21: 18.

Redescription. Head: Antenna bipectinate in male, the longest pectination about five times diameter of antennal shaft, simple filiform in female. Frons greyish brown, smooth-scaled. Labial palpus blackish brown, short and stout, extending slightly beyond frons. Vertex greyish brown.

Thorax: Dorsal side greyish brown. Hind tibia in male without hair-pencil; with two pairs of spurs in both sexes. Forewing length: male 18–20 mm, female 19–21 mm. Wings pale grey. Forewing with outer margin weakly protruded; costa diffused with dull short longitudinal greyish brown flecks; antemedial line black, slightly protruded inwards below cell; medial line black, distinct; postmedial line black, slightly protruded outwards between M_1 and M_2 , protruded inwards below M_2 , then paralleling to medial line; a yellowish brown patch outside postmedial line, the dull brown shadow in the middle of the patch indistinct; discal spot black, distinct. Hindwing with basal area greyish brown; medial line black, distinct, equal to postmedial line in width; postmedial line black, slightly protruded outwards between M_1 and M_3 , then slightly protruded inwards below M_3 . Underside dull grey, postmedial line weak and indistinct, brown, forming black patch on costa of forewing.

Venation: Forewing: R_1 and R_2 separate and almost parallel in male, anastomosing in female; R_{3-5} diverging from before anterior angle of cell; M_1 diverging from anterior angle of cell.

Abdomen: First abdominal segment with pale grey band dorsally, remaining segments greyish brown.

Male genitalia: Uncus triangular, length equal to basal width. Tegumen posterior processes absent. Gnathos with median process about one-third length of basal width. Valva terminally blunt and slightly slender, bearing a large area of long setae; one cluster of long setae near center, extending dorsally; ventral margin of valva not protruded outwards at middle. Saccus small, round. Juxta asymmetrical, left sclerotized process stick-like, same length as juxta. Spines bundle of cornuti strong, about two-fifths length of aedeagus.

Female genitalia: Sterigma with central part round, lateral sclerotized lobes short. Ductus bursae about two-fifths length of corpus bursae, strongly sclerotized. Corpus bursae oval, signum irregularly shaped, with six big teeth and some small protrusions around margin.

Diagnosis. This subspecies is similar to the nominate subspecies, but the dull brown shadow is less distinct in the middle of the yellowish brown patch outside the postmedial line on both wings, and the forewing postmedial line is less protruded outwards between M_1 and M_3 .

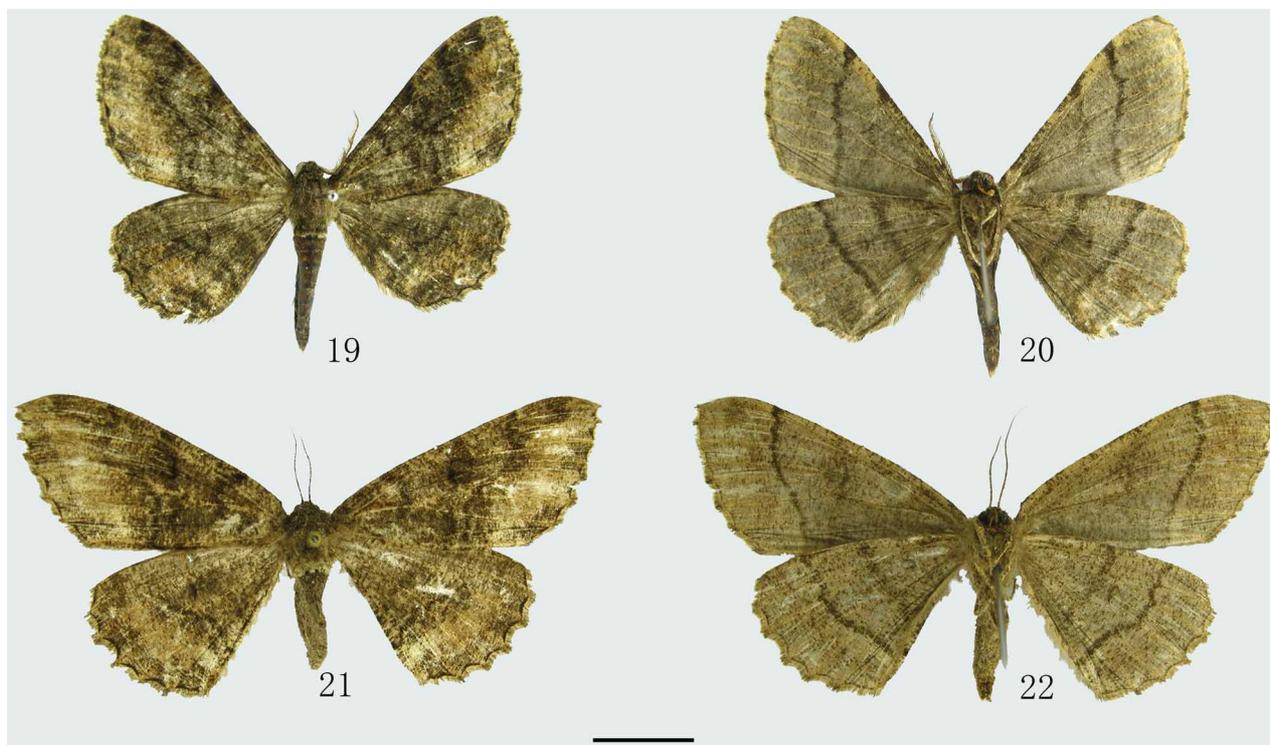
Material examined. CHINA: Beijing: Huairou Baiquanshan, 250 m, 26.VIII.2009, coll. Qi Feng, 1♂2♀ (IZCAS); Hebei: Chengde, 11.VI.1981, coll. Zhang Baolin, 1♀ (IZCAS); Shandong: Yishan, 20.VIII.1981, 1♀ (IZCAS); Ningxia: Jingyuan qiuqianjialinchang, 1822 m, 24.VI.2008, coll. Song Wenhui, 2♂ (IZCAS); Ningxia: Jingyuan Hongxialinchang, 1998 m, 9–10.VII.2008, coll. Song Wenhui, 1♂ (IZCAS); Gansu: Yongdeng Tulugou, 25–29.VII.1991, coll. Xue Dayong, 3♂7♀ (IZCAS). **MONGOLIA:** Bayandun, Dornod, 905 m, 4.VII.2009, coll. Chen Fuqiang, 1♂ (IZCAS).

Distribution. China (Beijing, Hebei, Shandong, Ningxia, Gansu), Russia (Amur, Ussuri), Mongolia, North Korea.

Jankowskia obtusangula sp. nov.

Figs. 19–22, 30, 38, 39, 42

Description. Head: Antenna bipectinate in male, the longest pectination about four times diameter of antennal shaft, simple filiform in female. Frons blackish brown suffused with sparse grey scales, smooth-scaled. Labial palpus greyish brown, short and stout, extending slightly beyond frons. Vertex greyish brown.



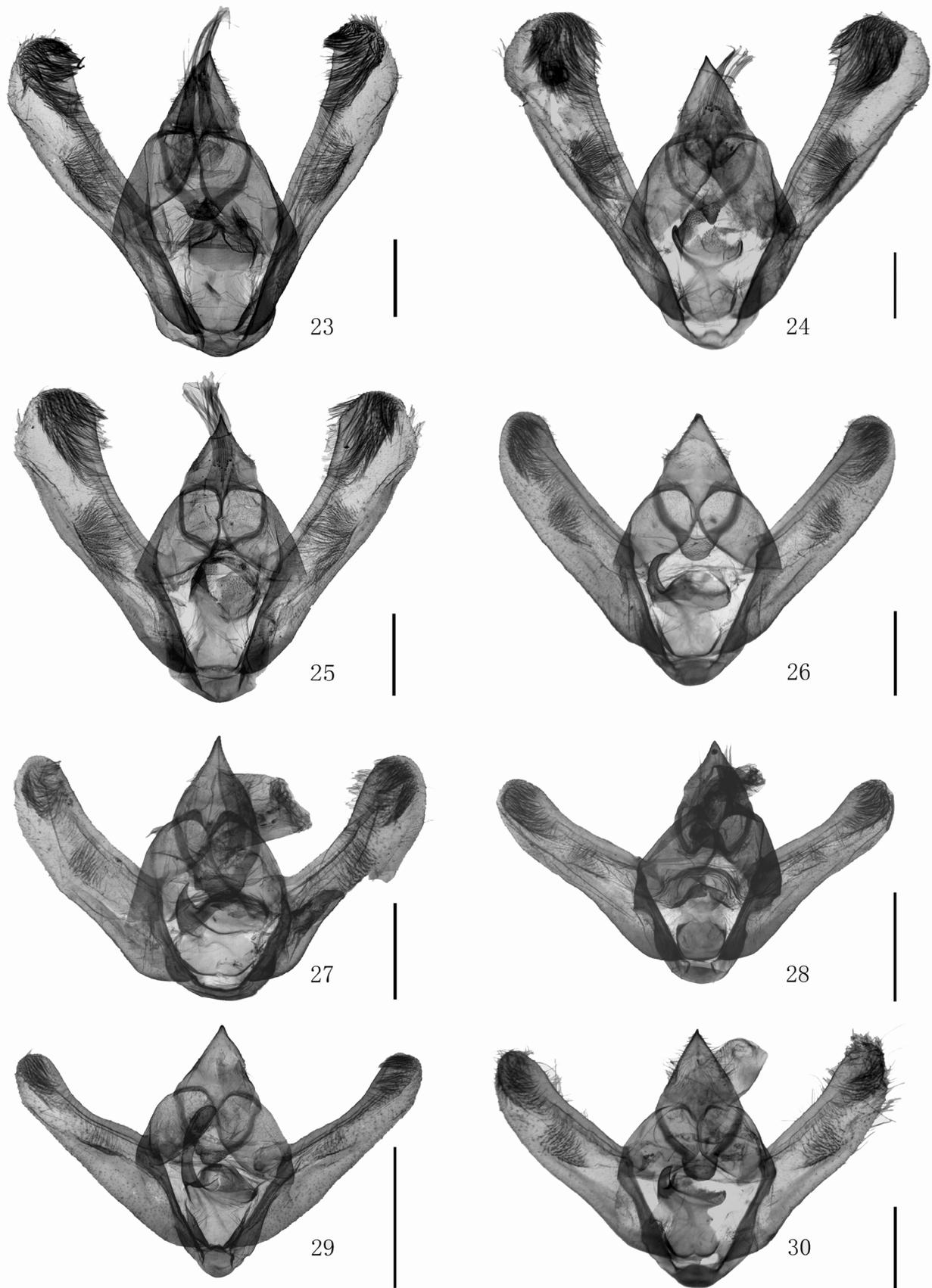
FIGURES 19–22. Adults of *Jankowskia*. 19–22. *J. obtusangula* sp. nov. 19, male, holotype, upperside; 20, male, holotype, underside; 21, female, paratype, upperside; 22, female, paratype, underside. Scale bar = 1 cm.

Thorax: Dorsal side greyish brown. Hind tibia in male without hair-pencil. Forewing length: male 24–27 mm, female 31–32 mm. Wings blackish brown. Forewing with outer margin weakly protruded; costa diffused with short longitudinal greyish brown flecks; antemedial line black, slightly protruded inwards below cell; medial line black, distinct; postmedial line black, slightly protruded outwards between M_1 and M_2 , protruded inwards below M_2 , then paralleling to medial line; a yellowish brown patch outside postmedial line, the dull brown shadow in the middle of the patch indistinct; discal spot black, strip-like, distinct. Hindwing with basal area greyish brown; medial line black, indistinct, equal to postmedial line in width; postmedial line black, almost straight between M_1 and M_3 , then slightly protruded inwards below M_3 ; a yellowish brown patch outside postmedial line, the dull brown shadow in the middle of the patch more distinct than on forewing. Underside greyish black, postmedial line strong and black on both wings, the faint broad band outside postmedial line indistinct, discal spot weak.

Venation: Forewing: R_1 and R_2 separate and almost parallel in male, anastomosing in female; R_{3-5} diverging before anterior angle of cell; M_1 diverging from anterior angle of cell, R_1 anastomosing with R_2 in female.

Abdomen: First abdominal segment with pale grey band dorsally, remaining segments blackish brown.

Male genitalia: Uncus triangular, length equal to basal width. Posterior processes of tegumen triangular, almost absent, without long setae apically. Gnathos with median process rounded apically, about two-thirds as long as basal width. Valva even in width, blunt terminally, bearing a large area of long setae; one cluster of long setae near center, extending dorsally; ventral margin of valva slightly protruded outwards at middle. Saccus small, round. Juxta asymmetrical, left sclerotized process hook-like, about two-fifths length of juxta. Spines bundle of cornuti about two-fifths length of aedeagus.



FIGURES 23–30. Male genitalia of *Jankowskia*. 23, *J. athleta*; 24, *J. taiwanensis*; 25, *J. fuscaria fuscaria*; 26, *J. curva* **sp. nov.**; 27, *J. acuta* **sp. nov.**; 28, *J. improjecta* **sp. nov.**; 29, *J. bituminaria raddensis*; 30, *J. obtusangula* **sp. nov.** Scale bar = 1 mm.



FIGURES 31–38. Aedeagus of *Jankowskia*. 31, *J. athleta*; 32, *J. taiwanensis*; 33, *J. fuscaria fuscaria*; 34, *J. curva* **sp. nov.**; 35, *J. acuta* **sp. nov.**; 36, *J. improjecta* **sp. nov.**; 37, *J. bituminaria raddensis*; 38, *J. obtusangula* **sp. nov.** Scale bar = 1 mm.

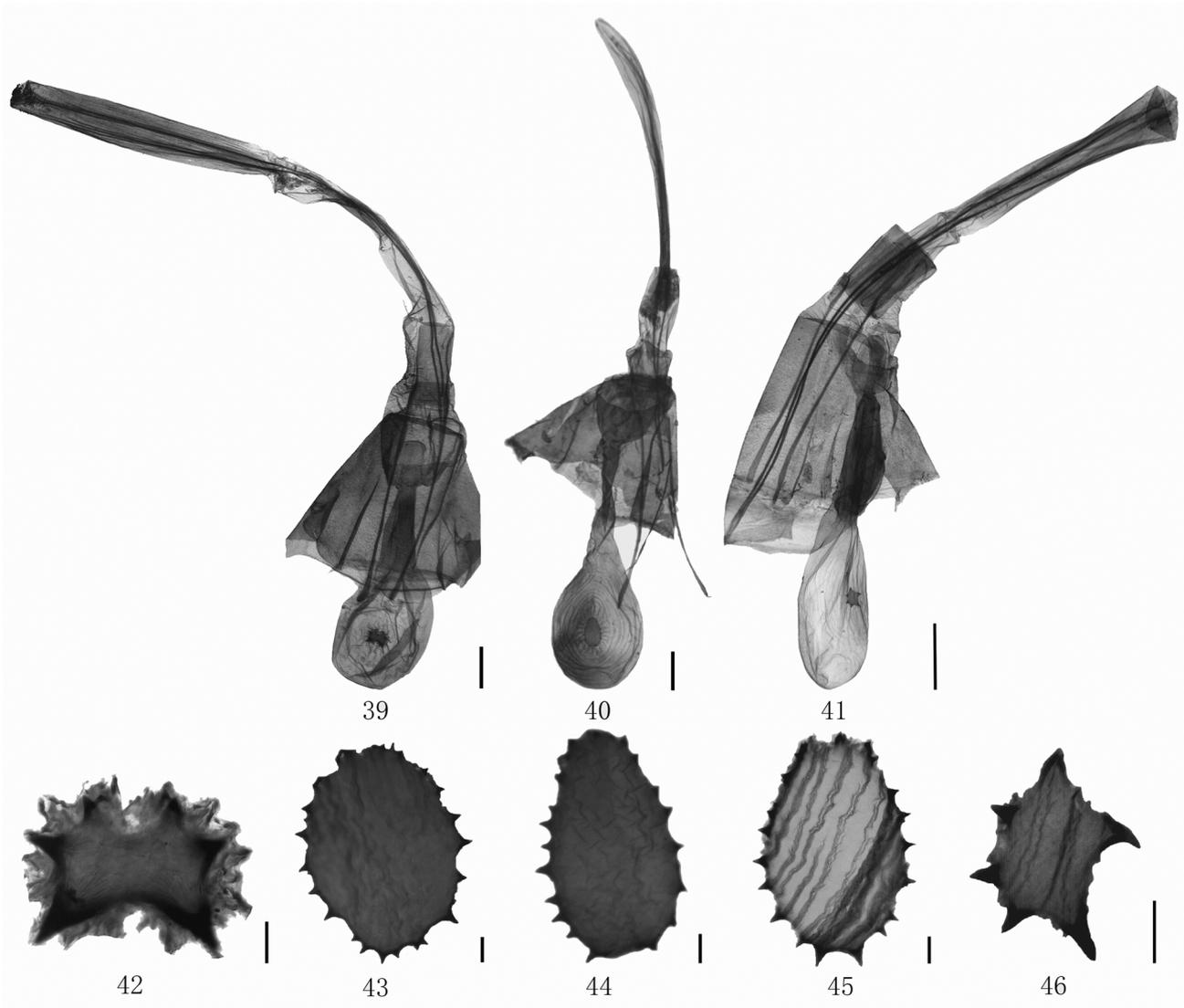
Female genitalia: Sterigma with central part quadrate, lateral sclerotized lobes very long, broadened terminally. Ductus bursae slightly sclerotized, about four-fifths length of corpus bursae. Corpus bursae oval. Signum almost hexagonal, concave anteriorly, with six big teeth and irregular small protrusions around margin, the anterior two teeth longer than the posterior four ones.

Diagnosis. This new species resembles *J. bituminaria* in the wing patterns, but can be distinguished from it by the following characters: larger than *J. bituminaria*; the yellowish brown patch outside postmedial line is more distinct; the postmedial line is stronger and black, not brown on both wings underside. In the male genitalia, the gnathos median process is longer and broader; the valva is even in width, not narrowed terminally; the left process of the juxta is hook-like, not stick-like as in *J. bituminaria raddensis*. In the female genitalia, the signum is almost hexagonal, but irregularly shaped in *J. bituminaria*; the ductus bursae is longer.

Material examined. Holotype, ♂, **CHINA:** Ningxia: Jingyuan Hongxialinchang, 1998 m, 10.VII.2008, coll. Song Wenhui (IZCAS). Paratypes, 1♂ (IZCAS), Ningxia: Jingyuan Erlonghelinchang, 1984 m, 12.VII.2008, coll. Song Wenhui; 1♂ (IZCAS), Gansu: Zhouqu Shatan Linchang, 2400 m, 14.VII.1999, coll. Yaojian; 1♀ (IZCAS), Hubei: Shennongjia Jiuhu Linchang, 1840 m, 16.VIII.1981, coll. Han Yinheng; 1♂ (IZCAS), Hainan: Changjiang Bawangling Pingdonger Linchang, 8.V.2007, coll. Chen Fuqiang; 1♀ (IZCAS), Sichuan: Wenchuan Wolong, 1670 m, 27.VII.1983, coll. Chai Huaicheng; 4♂ (IZCAS), same locality and collector, 1920 m, 29.VII.1983; 1♂ (IZCAS), same locality, 1920 m, 22.VII.1983, coll. Wang Shuyong.

Etymology. The specific name is form the Latin word *obtusangulus*, which means obtuse.

Distribution. China (Ningxia, Gansu, Hubei, Hainan, Sichuan).



FIGURES 39–41. Female genitalia of *Jankowskia*. 39, *J. obtusangula* sp. nov.; 40, *J. fuscaria fuscaria*; 41, *J. bituminaria raddensis*. Scale bar = 1 mm. **FIGURES 42–46.** Signum of female genitalia of *Jankowskia*. 42, *J. obtusangula* sp. nov.; 43–45, *J. fuscaria fuscaria*; 46, *J. bituminaria raddensis*. Scale bar = 0.1 mm.

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References

- Bryk, F. (1948) Zur Kenntnis der Großschmetterlinge von Korea. *Arkiv för Zoologi*, 41A (1), 154–216.
- Comstock, J.H. (1918) *The wings of insects*. Comstock Publishing Company, Ithaca, New York, 430 pp.
- Djakonov, A.M. (1926) Zur Kenntnis der Geometriden Fauna des Minussinsk-Bezirks (Sibirien, Ienissej Gouv.). *Ezhegodnik Gosudarstvennogo Muzeya imeni N. M. Martyanova*, 4, 1–78.
- Fletcher, D.S. (1979) Geometroidea. In: Nye, I.W.B. (Ed.). *The generic names of moths of the World* 3. British Museum, London, pp. 1–243.
- Han, H-X & Xue, D-Y. (2004) Lepidoptera geometridae. In: Yang X-K (Ed). *Insects from Mt. Shiwandashan Area of Guangxi*. China Forestry Publishing House, Beijing, pp. 467–482.
- Hausmann, A. (2001) Introduction. Archiarinae, Orthostixinae, Desmobathrinae, Alsophilinae, Geometrinae. In: Hausmann, A. (Ed.): *The Geometrid Moths of Europe*. Apollo Books, Stenstrup, 1, 282 pp.
- Inous, H., Sugi, S., Kuroko, H., Moriuti, S. & Kawabe, A. (Eds.) (1982) *Moths of Japan II*. Kodansha, Tokyo, 552 pp., 392 pls.
- 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.
- Lederer, J. (1853) Lepidopterologisches aus Sibirien. *Verhandlungen des Zoologisch-Botanischen Vereins in Wien*, 3 (Abh), 351–386.
- Leech, J.H. (1891) Description of new species of Geometridae from China, Japan and Corea. *Entomologist*, 24 (Suppl.), 42–56.
- Leech, J.H. (1897) On Lepidoptera Heterocera from China, Japan and Corea. *Annals and Magazine of Natural History*, (6) 19, 414–463.
- Nakajima, H. (1975) Notes on the larvae and food-plants of some Geometridae IX. *Yûgato, Niigata*, (62), 107–109.
- Nakamura, M. (2004) A morphological and phylogenetic study on the pupae of Geometridae (Insecta: Lepidoptera) from Japan. *Tinea*, 18 (Supplement 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. (1884) Lépidoptères du Thibet, de Mantschollrie d'Asie mineure et d'Algerie. *Études de Lépidoptérologie compare*, 9, 1–40.
- Pierce, N. (1914 [reprint 1967]) *The Genitalia of the Group Geometridae of the British Islands*. E. W. Classey Ltd, Middlesex, xxix + 88 pp., 48 pls.
- Prout L.B. (1915) The Palaearctic Geometrae. In: Seitz, A. (Ed.), *The Macrolepidoptera of the World*. Vol. 4, Verlag A. Kernen, Stuttgart, pp 1–479, pls. 1–25.
- Sato, R. & Nakajima, H. (1975) A list of the food-plants of the Japanese Geometridae I. Ennominae. *Japan Heterocerists' Journal*, (Supplement 2), 1–56.
- Sato, R. (1976) Notes on the larvae of Japanese Geometridae XXIV. *Yûgato, Niigata*, (63), 29–32.
- Sato, R. (1980) A revision of the genus *Jankowskia* Oberthür (Lepidoptera, Geometridae). *Tyô to Ga*, 30 (3&4), 127–139.
- Sato, R. (1984) Taxonomic study of the Genus *Hypomecis* Hübner and its allied genera from Japan (Lepidoptera:

- Geometridae: Ennominae). *Special Bulletin of Entomological Society*, 1, 1–213 pp.
- Sato, R. (1986) A new species of the genus *Jankowskia* from Ussuri and Northern Korean (Lepidoptera, Geometridae). *Tyô to Ga*, 36 (4), 177–179.
- Scoble, M.J. (1992) *The Lepidoptera, Form, Function and diversity*. Oxford University Press, Oxford, 404 pp.
- Scoble, M.J. (Ed.) (1999) *Geometrid Moths of the World: A Catalogue (Lepidoptera, Geometridae)*. CSIRO, Collingwood, Vols. 1–2, 1016 pp.
- Sonan, J. (1934) On three new species of the moths in Japan and Formosa. *Kontyû*, 8, 212–214.
- Wehrli, E. (1929) Beitrag zur Geometriden-Fauna von Minussinsk Sibirien, Gouv. Jenissej. *Ezhegodnik Gosudarstvennogo Muzeja imeni N. M. Martyanova*, 6 (1), 8–30.
- Wehrli, E. (1941) Subfamilie: Geometrinae. In: Seitz, A. (Ed.), *Die Grossschmetterlinge der Erde*. Vol. 4 (Supplement), Verlag A. Kernen, Stuttgart, pp. 254–766, Taf. 19–53.
- Zhu, H-F. (Ed.) (1981) *Iconographia Heterocerorum Sinicorum I*. Science Press, Beijing, iv + 134 pp + 22 pp (Index), 38 pls.