BioOne COMPLETE

The Wood-Feeding Genus Cryptocercus (Blattodea: Cryptocercidae), with Description of Two New Species Based on Female Genitalia

Authors: Wang, Zong-Qing, Li, Yang, Che, Yan-Li, and Wang, Jin-Jun

Source: Florida Entomologist, 98(1) : 260-271

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.098.0143

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

The wood-feeding genus *Cryptocercus* (Blattodea: Cryptocercidae), with description of two new species based on female genitalia

Zong-Qing Wang, Yang Li, Yan-Li Che and Jin-Jun Wang*

Abstract

Two new Chinese *Cryptocercus* **(**Blattodea: Cryptocercidae**)** species, *C. arcuatus* **sp. nov.** and *C. convexus* **sp. nov**., are described together with photographs. This description includes the external structure of the adults and structures of the female genitalia. A comparative study of female genitalia was based on the 5 Chinese species in the family Cryptocercidae. Significant differences in female genitalia of Cryptocercidae are summarized. A key to these 5 species and a checklist of the species of *Cryptocercus* worldwide are provided.

Key Words: Cryptocercidae; termite; genitalia; China

Resumen

Se describen y se proveen fotografías de dos nuevas especies de *Cryptocercus* **(**Blattodea: Cryptocercidae**)** de China, *C. arcuatus* **sp. nov**. y *C. convexus* **sp. nov**. Estas descripciones incluyen la estructura externa de los adultos y las estructuras de la genitalia de las hembras. Un estudio comparativo de la genitalia de las hembras fue en base de las 5 especies de la familia Cryptocercidae de China. Se resumen las diferencias significativas de la genitalia femenina de los Cryptocercidae. Se incluyen una clave de estas 5 especies y una lista de las especies de *Cryptocercus conocidas* en todo el mundo.

Palabras Clave: Cryptocercidae; termitas; genitalia; China

The genus *Cryptocercus* Blattodea: Cryptocercidae**)** is distinguished by the following characters: wingless and except for a brief dispersal stage as late-stage nymphs or young adults, their entire life cycle is spent within galleries chewed in rotten logs (Nalepa et al. 1997). Currently the genus comprises 12 species (Beccaloni 2007) found in East Asia and North America (Bey-Bienko 1950; Grandcolas 1999), whose distribution is amphiberingian (Grandcolas et al. 2005).

Because species in the genus *Cryptocercus* show slight interspecific variations in structure, researchers mainly use sequence divergence in the mitochondrial DNA (Nalepa et al. 1997; Burnside et al. 1999; Grandcolas et al. 2001; Grandcolas et al. 2005) in addition to some aspects of female genitalia (Grandcolas 2000; Aldrich et al. 2004; Grandcolas et al. 2005) and chromosome number (Kambhampati et al. 1996; Burnside et al. 1999) or bacterial endosymbionts (Clark et al. 2003) to distinguish species. Aldrich et al. (2004) indicated that the female genitalia exhibit consistent, species-specific variation and can be used to identify each of the 4 *Cryptocercus* species that occur in the Appalachian Mountains. However, the male genitalia proved to be too variable to have utility in species identification. Grandcolas et al. (2005) consider the morphological diversity of *Cryptocercus* species to be more pronounced in East Asia than among North American species in terms of pronotum shape, leg spines, size, and genitalic structure.

Therefore, in this study we chose 5 species of *Cryptocercus*, i.e., *C. primarius*, *C. hirtus*, *C. meridianus*, *C. arcuatus* **sp. nov.**, and *C. convexus* **sp. nov.** distributed in southern China to examine female genitalia for consistent interspecific variation with the aim of providing new information on east Asian species and verifying the results of molecular taxonomy.

Material and Methods

Specimens were collected by chopping logs and were preserved in 100% ethanol or pinned. Terminology used in this paper mainly follows McKittrick (1964). Adult males and females were examined under the microscope. The genital segments of the examined specimens were macerated in 10% NaOH and observed in glycerin jelly using a Motic K400 stereomicroscope. Specimens were photographed by a Canon 50D plus a Canon EF 100 mm f/2.8L IS USM macro lens with the aid of the Helicon Focus software. Photographs of the female genitalia of specimens were made by a Leica M205A microscope by a Leica DFC camera. Images were produced by the software version LAS (Leica Application Suite) V3.7. All specimens studied are deposited in the College of Plant Protection of Southwest University (SWU), Beibei, China.

Results

Genus *Cryptocercus* Scudder, 1862

Cryptocercus Scudder, 1862: 419; Bey-Bienko 1938: 237; Nalepa et al. 1997: 416; Burnside et al. 1999: 361; Grandcolas, 2000: 223; Grandcolas et al. 2001: 61; Aldrich et al. 2004: 443; Grandcolas et al. 2005: 725.

Body medium, glossy brown to dark brown with dorsal surface finely punctured. Pronotum coarse with peculiar shape, disc depressed with protuberances, also with a protruding fore margin. Both male and

Institute of Entomology, College of Plant Protection, Southwest University, Beibei, Chongqing 400716, China
*Corresponding author; E-mail: shirleyche2000@126.com

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

female wingless. All legs powerful and armed with stout, articulated spines; front femur Type D_3, D_4 or D_5, tarsus with pulvilli, tarsal claws symmetrical and unspecialized. Abdomen of female slightly fuller than the male. Tergite VII extending backwards and covering the remaining segments. Styli invisible (generally sheltered by tergite VII), female and male are difficult to distinguish. Genital segments of Cryptocercidae differ from other cockroaches: tergite VII expands backwards completely concealing tergites VIII, IX and X.

Key to species of *Cryptocercus* in China (females)

1. Pronotum blackish brown with feeble punctations 2

—. Pronotum blackish brown with strong punctations (Fig. 6) . . . . . *C. hirtus*

2. Tergite VII with posterior margin slightly truncate at middle 3

—. Tergite VII with posterior margin weakly concave at middle (Fig. 49) . . . . . *C. convexus* **sp. nov.**

3. Vestibular sclerite with anterior margin slightly concave at middle (Fig. 58), valvule II strongly protruding at base, lateral margins slightly sclerotized at middle (Fig. 61) . . . . . *C. arcuatus* **sp. nov.**

—. Vestibular sclerite with anterior margin arched, valvule II not protruding at base 4

4. Front femur type varied greatly, and laterosternites IX with 1 short protuberance(Fig. 45) . . . . . *C. meridianus*

—. Front femur type not varied greatly, and laterosternites IX without protuberance (Fig. 25) . . . . . *C. primarius*

Checklist of the species of *Cryptocercus*

Cryptocercus punctulatus Scudder, 1862 (USA: Virginia)

C. relictus Bey-Bienko, 1935 (China: Northeast region; Russia: Ussuri region; Korea: Jeolla Province)

C. primarius Bey-Bienko, 1938 (China: Sichuan Province)

C. clevelandi Nalepa et al., 1997 (USA: Oregon)

C. darwini Burnside et al., 1999 (USA: Alabama)

C. garciai Burnside et al., 1999 (USA: Georgia)

C. wrighti Burnside et al., 1999 (USA: North Carolina)

C. matilei Grandcolas, 2000 (China: Sichuan Province)

C. kyebangensis Grandcolas et al., 2001 (South Korea: Gangwon Province)

C. hirtus Grandcolas & Bellés, 2005 (China: Gansu Province)

C. meridianus Grandcolas & Legendre, 2005 (China: Yunnan Province)

C. parvus Grandcolas & Park, 2005 (China: Heilongjiang Province)

C. convexus **sp**. **nov**. (China: Sichuan Province)

C. arcuatus **sp**. **nov**. (China: Yunnan Province)

1. *Cryptocercus primarius* Bey-Bienko, 1938 (Figs. 1-3, 16-25)

Cryptocercus primarius Bey-Bienko, 1938: 237.

MEASUREMENTS

Male, pronotum: length × width: 6.0-6.5 × 8.0-9.0 mm, body length: 23.0 mm; female, pronotum: length × width: 5.9-6.0 × 8.0 mm, body length: 22.5-23.0 mm.

DESCRIPTION

Body medium, brown to dark brown (Fig. 1). Vertex pale brown, ocellar spot dark brown; head with strong punctation. Antenna brown, apex pale brown and scape gradually darker. Vertex with interocular space slightly less than distance between antennal sockets. Maxillary palps reddish brown and apical segment with tiny hairs (Fig. 2). Pronotum blackish brown with peculiar shape, disc depressed with 2 pairs of well delimited but feeble protuberances, the fore ones more or less sharp; also with a protruding fore margin (Fig. 3). Front femur Type D_4 (only 4 large spines), tarsus with pulvilli, tarsal claws symmetrical and unspecialized. Abdominal tergites brown, margins of tergites slightly upturned and sterna pale brown; both tergites and sterna punctured, tergite VII and sterna with minute hairs. Area between tergites II and III slightly depressed.

Tergite VII with anterior margin arched and posterior margin slightly truncate at middle (Fig. 19). Sternum VII produced at apical part, posterior margin truncate; with a conspicuous pair of intersternal shelves (ints.f.) at apex, which are slightly sclerotized at apex and highly sclerotized at base. Vestibular sclerite (vst.s.) broad, well delimited and unmusculated (Fig. 18). Tergite X rounded at apex; paraprocts (pp.) developed, whose apices extending beyond posterior margin of tergite X (Fig. 16).

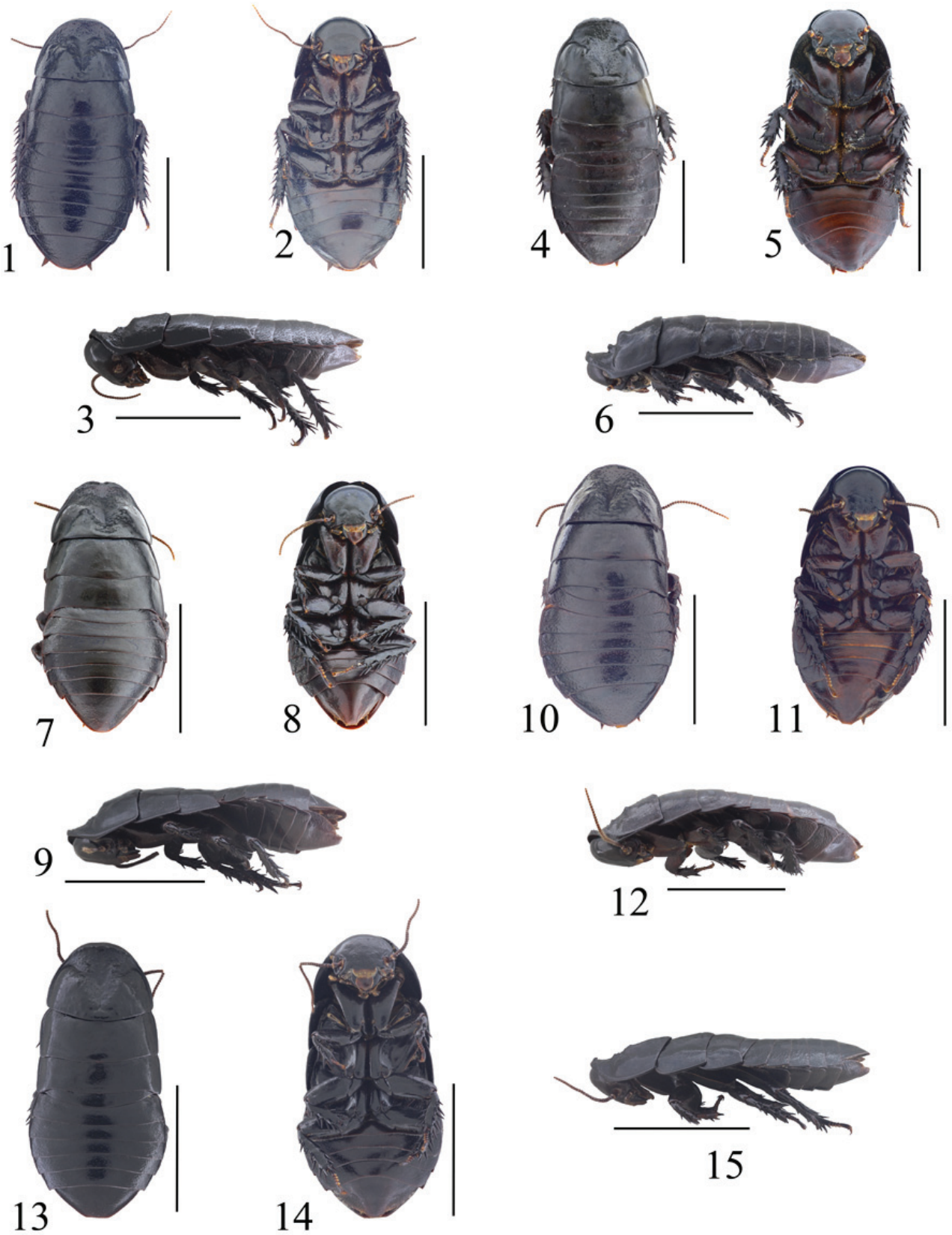
FEMALE GENITALIA

In the roof of the genital chamber, basivalvulae (bsv.) well-developed and elliptical; darker at apex and base, also highly sclerotized (Fig. 23). Spermatheca, sitting beyond the basivalvulae, fused with them. Valve I (v.I) bases situated posterior to the basivalvulae, but not fused with valvifers I (Fig. 20). Valvifers I (vlf.I) small and posterolateral to base of valve I, almost covered by inserted muscles; paratergites (pt.) long and slightly curved, situated between valvifers I and base of valve I (Fig. 25). Valvifer II ring (vlf.II) well sclerotized, located at the central apodeme (c.a.) that is well-developed. Anterior arch (a.a.) with punctures in the middle (Fig. 22). Laterosternites IX (ltst.IX) small and sheet-like, fused with the bases of paratergites (Fig. 25). Laterosternal shelf (ltst.sh.) large and translucent, nearly oblong; with dense spinules at apical half which are denser near the anterior margin (Fig. 24).

MATERIAL EXAMINED

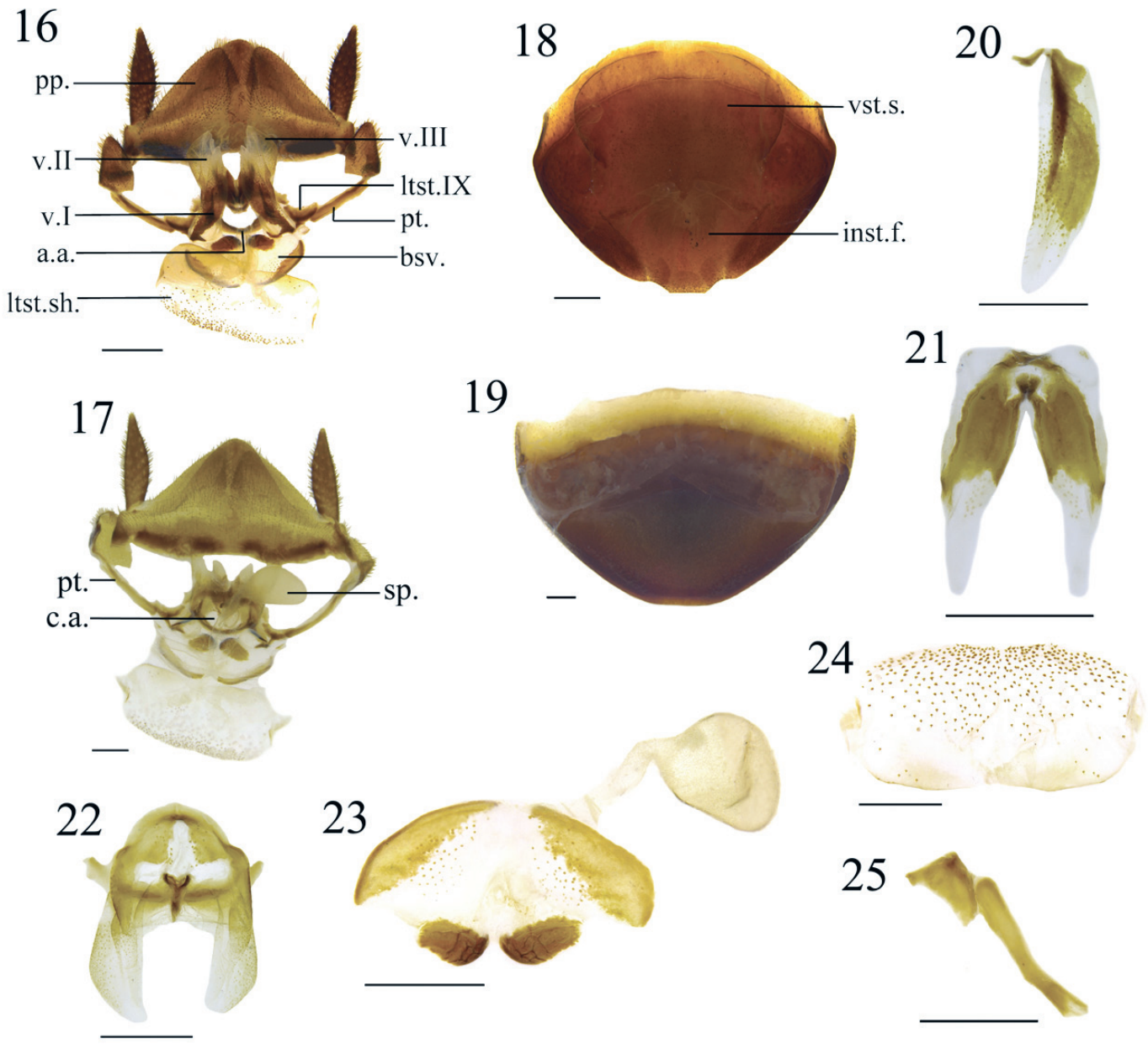
One male and 1 female, Sichuan Prov., Pingwu County, Wanglang, 2800m, 3-VIII-2011, host: Pine, coll. Dong Wang; 4 males and 1 female, Sichuan Prov., Pingwu County, Wanglang, 2800m, 3-VIII-2011, host: Pine, coll. Keliang Wu.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use



Figs. 1-15. 1-3. *Cryptocercus primarius* Bey-Bienko, 1938, female: (1) dorsal view; (2) ventral view; and (3) lateral view. 4-6 *Cryptocercus hirtus* Grandcolas & Belles, 2005, female: (4) dorsal view; (5) ventral view; and (6) lateral view. 7-9 *Cryptocercus meridianus* Grandcolas & Legendre, 2005, female: (7**)** dorsal view; (8) ventral view; and (9**)** lateral view. 10-12 *Cryptocercus convexus* **sp. nov.**, female: (10) Paratype, dorsal view; (11) same, ventral view; and (12) same, lateral view. 13-15 *Cryptocercus arcuatus* **sp. nov.**, female: (13) Paratype, dorsal view; (14) same, ventral view; (15) same, lateral view. (Scale bars = 1.0 cm). This figure is displayed in color in the online version.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use



Figs. 16-25. *Cryptocercus primarius* Bey-Bienko, 1938: (16) supraanal plate, ventral view; (17**)** supraanal plate, dorsal view; (18) subgenital plate, dorsal view; (19**)** tergite VII, dorsal view; (20) valvule I, ventral view; (21) valvule II, ventral view; (22) valvule III, ventral view; (23) basivalvula and spermatheca (1 absent), ventral view; (24) laterosternal shelf, dorsal view; and (25) laterosternite IX and paratergites, ventral view. (Scale bars = 1.0 mm). This figure is displayed in color in the online version.

REMARKS

Pronotum of this species has inconspicuous punctation similar to *C. convexus* **sp. nov.** and *C. arcuatus* **sp. nov.** (Figs. 3, 12, 15). Paraprocts with apices are nearly or slightly extending to the posterior margin of tergite X (Fig. 16).

2. *Cryptocercus hirtus* Grandcolas & Bellés, 2005 (Figs. 4-6, 26-35)

Cryptocercus hirtus Grandcolas & Bellés, 2005: 727.

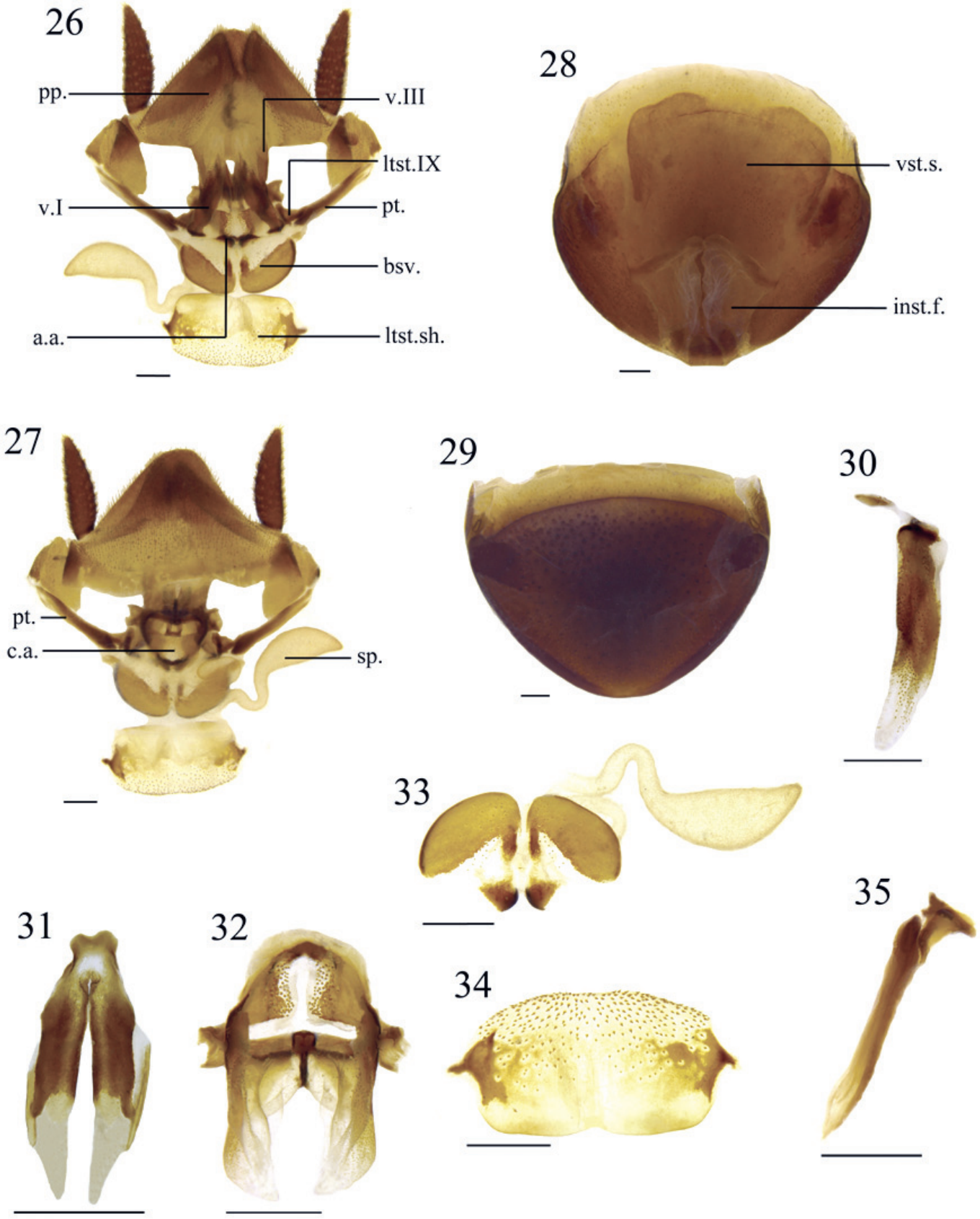
MEASUREMENTS

Male, pronotum: length × width: 7.0 × 9.5 mm, body length: 27.0 mm; female, pronotum: length × width: 6.6-8.0 × 9.3-10.0 mm, body length: 24.1-25.0 mm.

DESCRIPTION

Body medium, brown to dark brown (Fig. 4). Vertex pale brown, ocellar spot dark brown; head with strong punctation. Antenna brown, apex pale brown and scape gradually darker. Vertex with interocular space slightly less than distance between antennal sockets. Maxillary palps reddish brown and apical segment with tiny hairs (Fig. 5). Pronotum blackish brown with strong punctation, anterior margin elevated; disc depressed with 4 protuberances, the fore 2 small but sharp; protuberances also strongly depressed, and narrowing posteriorly to median incised line and terminating at short transverse groove (Fig. 6). Front femur Type D_4 (only 4 large spines), tarsus with pulvilli, tarsal claws symmetrical and unspecialized. Abdominal tergites brown, margins of each tergite slightly upturned, sterna pale brown. Both tergites and sterna punctured, tergite VII and sternum with minute hair; area between tergites II and III slightly depressed.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use



Figs. 26-35. *Cryptocercus hirtus* Grandcolas & Belles, 2005: (26) supraanal plate, ventral view; (27) supraanal plate, dorsal view; (28) subgenital plate, dorsal view; (29) tergum VII, dorsal view; (30) valvule I, ventral view; (31) valvule II, ventral view; (32) valvule III, ventral view; (33) basivalvula and spermatheca (1 absent), ventral view; (34) laterosternal shelf, dorsal view; (35) laterosternite IX and paratergites, ventral view. (Scale bars = 1.0 mm). This figure is displayed in color in the online version.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Tergite VII with anterior margin slightly truncate and posterior margin obtuse (Fig. 29). Sternum VII slightly produced at apex, posterior margin truncate; with a conspicuous pair of intersternal shelves (ints.f.) at apex which are slightly sclerotized at anterior margins. Vestibular sclerite (vst.s.) broad, clearly defined, with anterior margin slightly concave in the middle and unmusculated; membrane surrounding vestibular sclerite which is connected with tergite X (TX) (Fig. 28). Tergite X rounded at apex; paraprocts (pp.) developed with apices extending to the posterior margin of tergite X, with the gap between paraprocts narrow (Fig. 26).

FEMALE GENITALIA

In the roof of the genital chamber, the basivalvulae (bsv.) well-developed and divided into 2 parts which are symmetrical, left basivalvula nearly elliptical, apex slightly dilated on the left, and slightly narrow on the right, with 1 long and narrow prominence (Fig. 33). Spermatheca, sitting beyond the basivalvulae and fused with them. Valve I (v.I) bases situated posterior to the basivalvulae but not fused with valvifers I (Fig. 30). Valvifers I (vlf.I) small and posterolateral to bases of valve I, almost covered by inserted muscles; paratergites (pt.) slightly straight and situated between valvifers I and base of valve I (Fig. 35). Valvifer II ring (vlf.II) highly sclerotized, located at the central apodeme (c.a.) that is well-developed. Anterior arch (a.a.) dark, with punctures in the middle (Fig. 32). Laterosternites IX (ltst.IX) large and irregular, fused with the bases of paratergites (Fig. 35). Laterosternal shelf (ltst.sh.) large and translucent, nearly oblong, with dense spinules at apical half (Fig. 34).

MATERIAL EXAMINED

One male nymph, 4 female nymphs, Gansu Prov., Mt. Shimen, 20-VII-2012, coll. Jinjin Wang, Yang Li; 1 male,1 female and 1 male nymph, Shaanxi Prov., Mt. Taibaishan, 2,600 m, 15-VII-2011, host: White birch, coll. Chen Luo; 1 male and 1 male nymph, Shaanxi Prov., Mt. Taibaishan, 2600m, 15-VII-2011, host: White birch, coll. Dong Wang.

REMARKS

Pronotum of this species has conspicuous punctation, like that of *C. meridianus* (Figs. 6, 9). But tergite VII is obtuse at posterior margin (Fig. 29) and sternum VII is slightly produced at apex (Fig. 28). Valvule II of this species is highly scleritized at lateral margins, clearly forming 2 pale yellow stripes (Fig. 31).

3. *Cryptocercus meridianus* Grandcolas & Legendre, 2005 (Figs. 7-9, 36-45)

Cryptocercus meridianus Grandcolas & Legendre, 2005: 727.

MEASUREMENTS

Male, pronotum: length × width: 6.0 ×7.5 mm, body length: 25.0 mm; female, pronotum: length × width: 5.0 × 8.0 mm, body length: 19.9 mm.

DESCRIPTION

Body medium, brown to dark brown (Fig. 7). Vertex pale brown, ocellar spot dark brown, densely scattered with punctures. Antenna moniliform, brown, apex pale brown and scape gradually darker. Vertex with interocular space slightly more than distance between antennal sockets. Maxillary palps reddish brown and apical segment with tiny hairs (Fig. 8). Pronotum blackish brown with dense punctation, anterior margin elevated; disc depressed with faint protuberances, protuberances also strongly depressed and narrowing posteriorly to median incised line and terminating at short transverse groove (Fig. 9). Front femur Type D_4 (only 4 large spines) or D_5, males with different left and right front femur types; tarsus with pulvilli, tarsal claws symmetrical and unspecialized. Abdominal tergites brown, margins of each tergite slightly upturned, sterna pale brown. Both tergites and sterna punctured, the tergite VII and sternum with minute hair; area between tergites II and III slightly depressed.

Tergite VII with anterior margin slightly arched and posterior margin truncate, which is strongly extending backwards (Fig. 39). Sternum VII strongly produced at apex, posterior margin truncate; with a conspicuous pair of intersternal shelves (ints.f.) at apex, which are slightly sclerotized at anterior margins, dark and with punctures. Vestibular sclerite (vst.s.) broad, clearly defined, anterior margin arched, apex with dark and linear marks; the whole sclerite unmusculated, membrane surrounding vestibular sclerite which is connected with tergite X (TX) (Fig. 38). Tergite X rounded at apex; paraprocts (pp.) developed, triangular, with apices not extending to the posterior margin of tergite X, with the gap between paraprocts narrow (Fig. 36).

FEMALE GENITALIA

In the roof of the genital chamber, the basivalvulae (bsv.) well-developed and similar, nearly triangular or elliptic, anterior and posterior parts obscure and dark brown, anterior area sheet-like, and posterior area linear, both highly sclerotized (Fig. 43). Spermatheca, sitting beyond the basivalvulae and fused with them. Valve I (v.I) bases finger-like, highly sclerotized at base, situated posterior to the basivalvulae but not fused with the valvifers I (Fig. 40). Valvifers I (vlf.I) small and posterolateral to base of valve I, almost covered by inserted muscles; paratergites (pt.) weakly curved, situated between valvifers I and base of valve I (Fig. 45). Valvifer II ring (vlf.II) highly sclerotized, located at the central apodeme (c.a.) that is well-developed. Anterior arch (a.a.) dark, sheet-like in the middle (Fig. 42). Laterosternites IX (ltst.IX) large and irregular, fused with the bases of paratergites (Fig. 45). Laterosternal shelf (ltst.sh.) nearly oblong, with dense spinules at apical half (Fig. 44).

MATERIAL EXAMINED

Four males and 1 female, Yunnan Prov., Lijiang City, Mt. Yulongxueshan, 2-24-VII-2012, host: Pine, coll. Dong Wang and Lin Du.

REMARKS

Pronotum of this species has inconspicuous punctation (Fig. 9). Front femur type of this species is greatly varied, D_4 or D_5, and different types of left and right femur only exist in males.

4. *Cryptocercus convexus* **sp. nov.** (Figs. 10-12, 46-55)

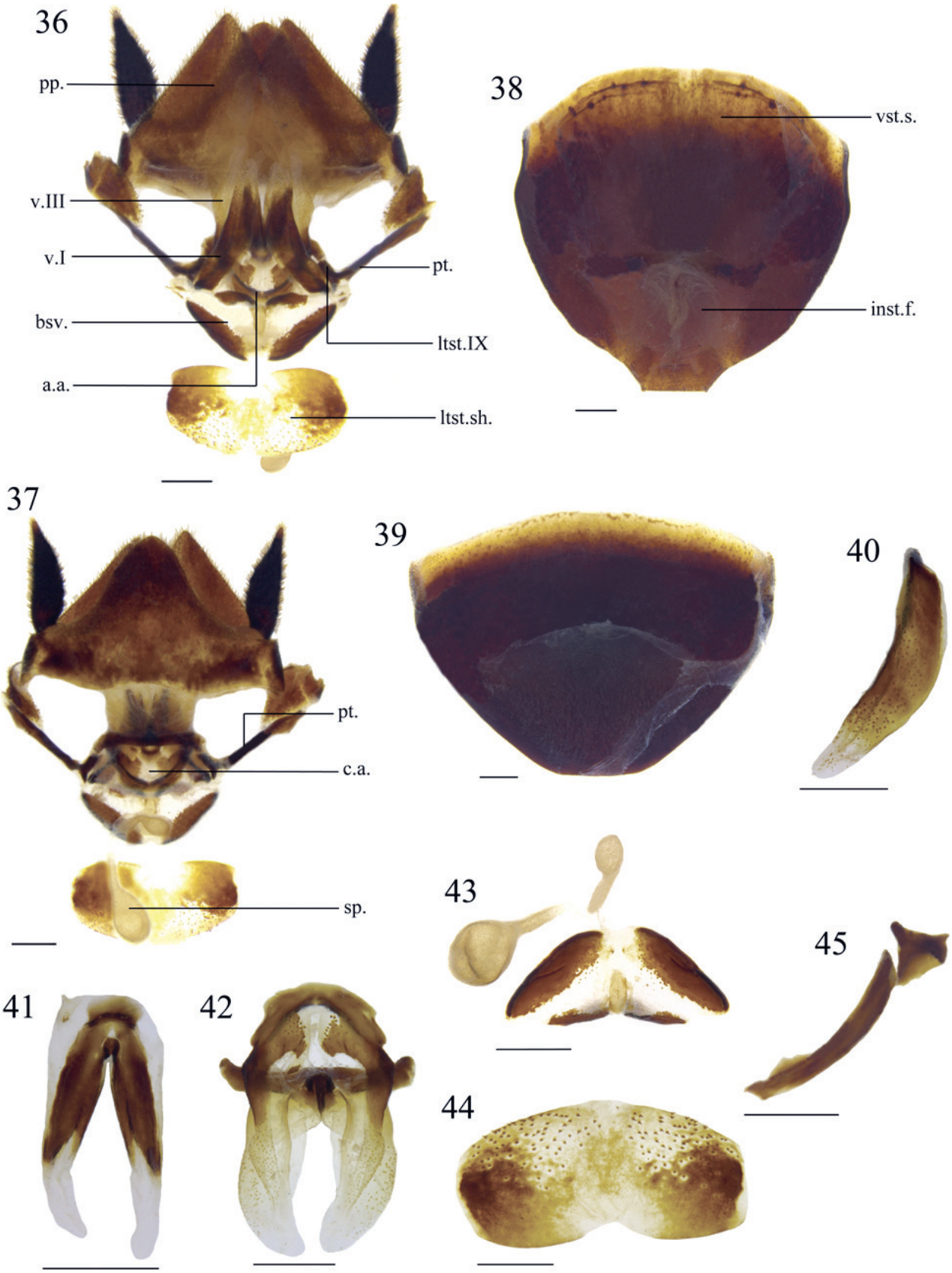
MEASUREMENTS

Male, pronotum: length × width: 6.5 ×9.5 mm, body length: 23.5 mm; female, pronotum: length × width: 6.0 × 8.0-9.5 mm, body length: 21.0-24.0 mm.

DESCRIPTION

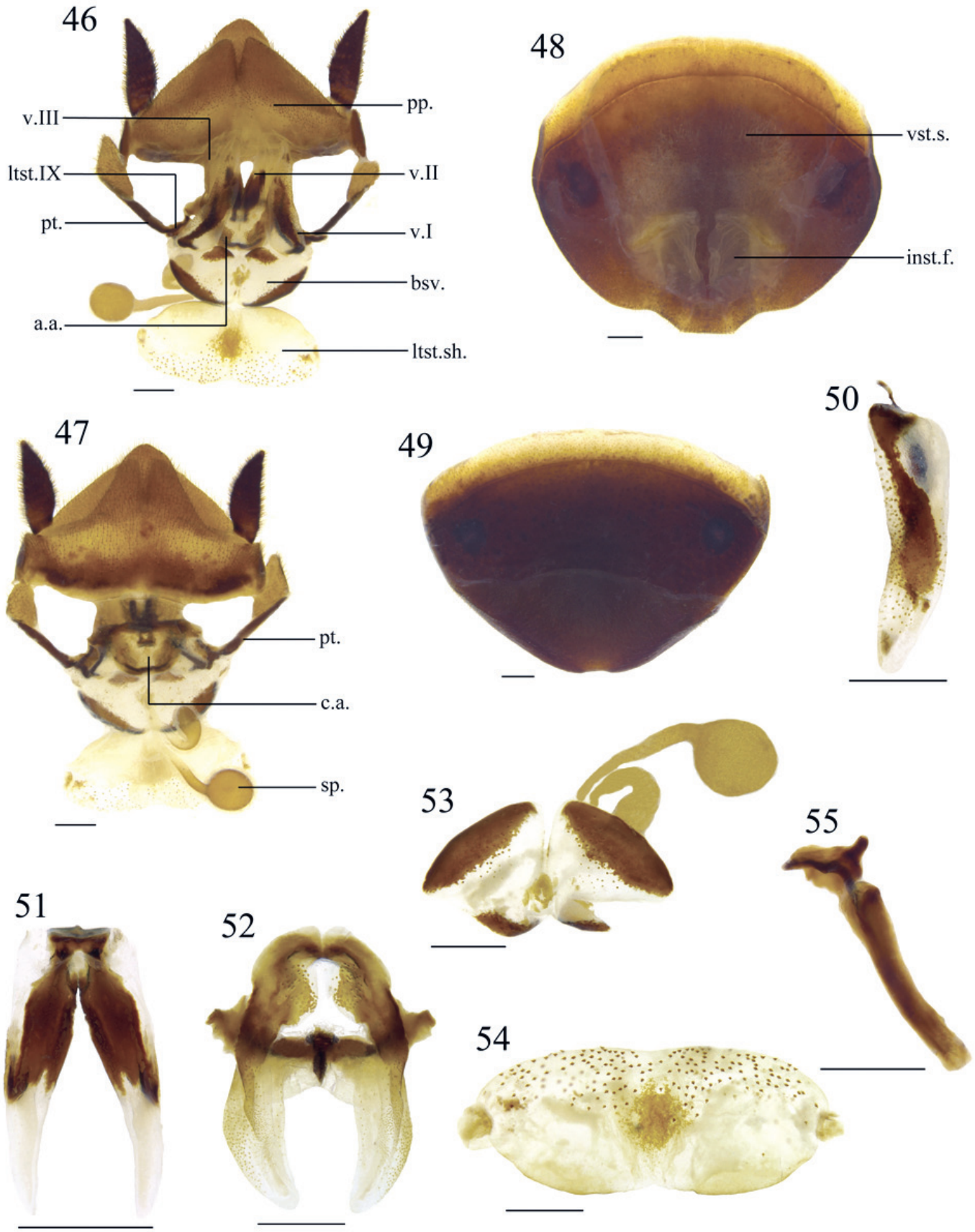
Body medium, brown to dark brown (Fig. 10). Vertex pale brown, ocellar spot dark brown, head with dense punctation. Antenna brown, apex pale brown and scape gradually darker. Vertex with interocular space slightly less than distance between antennal sockets. Maxillary palps reddish brown and apical segment with tiny hairs (Fig. 11). Pro-

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use



Figs. 36-45. *Cryptocercus meridianus* Grandcolas & Legendre, 2005: (36) supraanal plate, ventral view; (37) supraanal plate, dorsal view; (38) subgenital plate, dorsal view; (39) tergum VII, dorsal view; (40) valvule I, ventral view; (41) valvule II, ventral view; (42) valvule III, ventral view; (43**)** basivalvula and spermatheca (1 absent), ventral view; (44) laterosternal shelf, dorsal view; (45) laterosternite IX and paratergites, ventral view. (Scale bars = 1.0 mm). This figure is displayed in color in the online version.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use



Figs. 46-55. *Cryptocercus convexus* **sp. nov.**: (46) supraanal plate, ventral view; (47) supraanal plate, dorsal view; (48) subgenital plate, dorsal view; (49) tergum VII, dorsal view; (50) valvule I, ventral view; (51) valvule II, ventral view; (52) valvule III, ventral view; (53) basivalvula and spermatheca (1 absent), ventral view; (54) laterosternal shelf, dorsal view; (55) laterosternite IX and paratergites, ventral view. (Scale bars = 1.0 mm). This figure is displayed in color in the online version.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

notum blackish brown, trapezoid with dense punctation, anterior margin elevated; disc depressed with faint protuberances, protuberances also strongly depressed, and narrowing posteriorly to median incised line and terminating at short transverse groove (Fig. 12). Front femur Type D_3, D_4 or D_5, sometimes left and right femur type different; tarsus with pulvilli, tarsal claws symmetrical and unspecialized. Abdominal tergites brown, margins of each tergite slightly upturned, sterna pale brown. Both tergites and sterna punctured, the tergite VII and sternum with minute hairs; area between tergites II and III slightly depressed.

Tergite VII with anterior margin arched and posterior margin obtuse, weakly concave at middle (Fig. 49). Sternum VII distinctly produced at apex, posterior margin truncate; with a conspicuous pair of intersternal shelves (ints.f.) at apex which are slightly sclerotized at anterior margins. Vestibular sclerite (vst.s.) broad, clearly delimited and unmusculated; membrane surrounding vestibular sclerite, which is connected with tergite X (TX) (Fig. 48). Tergite X finely acute at apex; paraprocts (pp.) developed, with apices extending to the posterior margin of tergite X, with the gap between paraprocts narrow (Fig. 46).

FEMALE GENITALIA

In the roof of the genital chamber, the basivalvulae (bsv.) well-developed, elliptical, and similar, posterior parts obscure and dark brown, narrow margin of anterior area dark brown, both highly sclerotized (Fig. 53). Spermatheca, sitting beyond the basivalvulae, fused with them. Valve I (v.I) bases situated posterior to the basivalvulae, but not fused with valvifer I (Fig. 50). Valvifer I (vlf.I) small and posterolateral to the valve I base, almost covered by inserted muscles; paratergites (pt.) slightly curved, situated between valvifers I and base of valve I (Fig. 55). Valvifer II ring (vlf.II) highly sclerotized, located at the central apodeme (c.a.) that is well-developed. Anterior arch (a.a.) dark, with punctures in the middle (Fig. 52). Laterosternites IX (ltst.IX) small and irregular, fused with the bases of paratergites (Fig. 55). Laterosternal shelf (ltst.sh.) large and light yellow, nearly oblong, and brown at disc, with dense spinules at apical half (Fig. 54).

MATERIAL EXAMINED

HOLOTYPE, male, CHINA: Sichuan Prov., Yaan City, Baoxin Mt. Jiajinshan, 3,300m, 6-VIII-2011, coll. Dong Wang and Keliang Wu. PARATYPES, 3 males and 2 females, same data as holotype.

DISTRIBUTION

China (Sichuan).

ETYMOLOGY

The specific epithet "*convexus*" is derived from the Latin and refers to the hind margin inter-stylus being distinctly convex.

REMARKS

This species resembles other *Cryptocercus* species in structure, but can be distinguished as follows: pronotum of this species has inconspicuous punctation (Fig. 12); there are 3 main types of front femur, D_3, D_4 or D_5, and sometimes different types of left and right femur; tergite VII is weakly concave at posterior margin (Fig. 49) and tergite X is slightly acute at apex (Fig. 47).

5. *Cryptocercus arcuatus* **sp. nov.** (Figs. 13-15, 56-65)

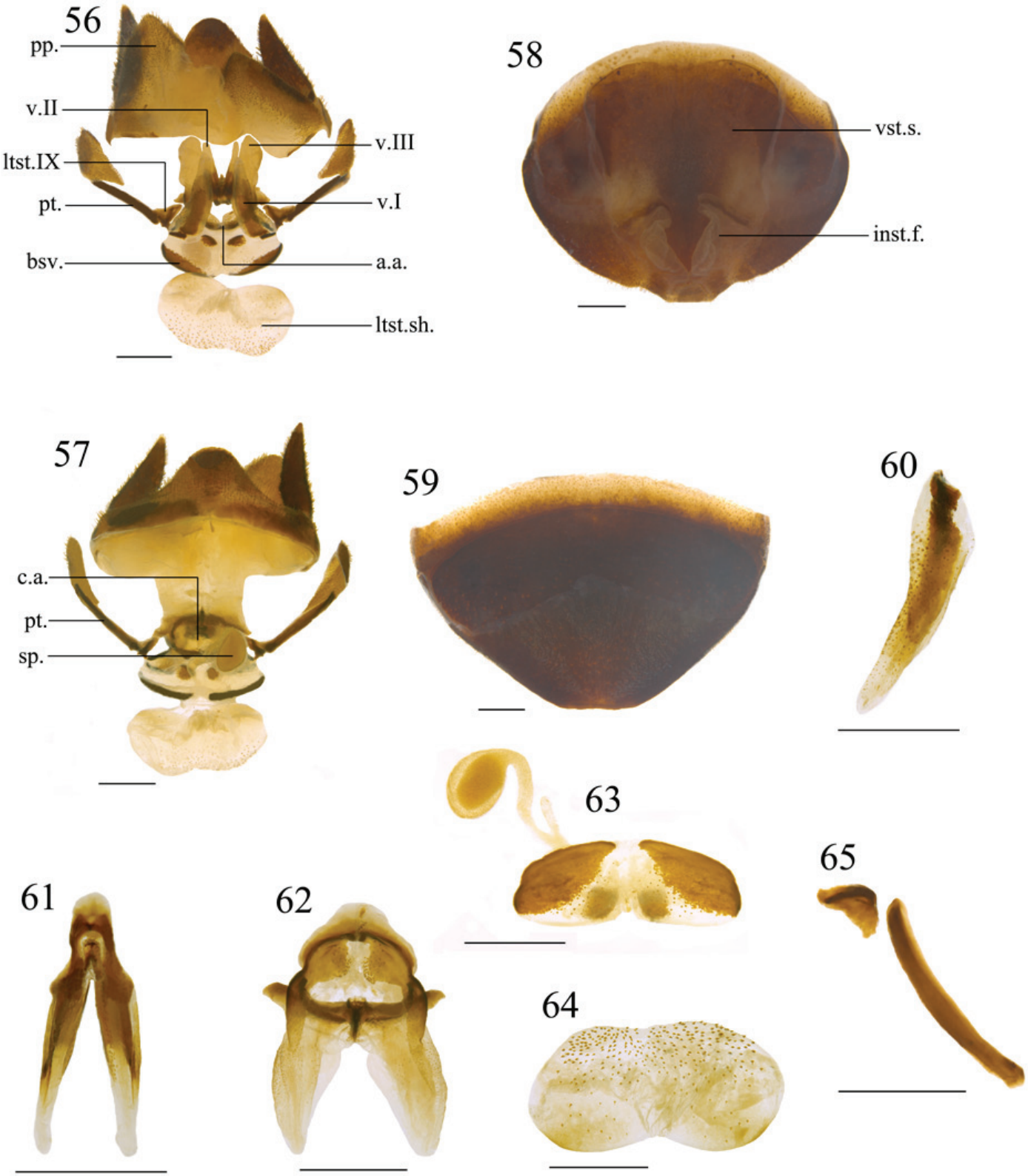
MEASUREMENTS

Male, pronotum: length × width: 6.0 × 9.0 mm, body length: 21.0 mm; female, pronotum: length × width: 6.0 × 9.0 mm, body length: 22.0 mm.

Table 1. Principal characters to distinguish the 5 Chinese *Cryptocercus* species.

	C. hirtus	*C. primarius*	*C. meridianus*	*C. convexus* **sp. nov.**	*C. arcuatus* **sp. nov.**
Protuberances of the pronotum	Strong, more or less tapered	Flat and obtuse	Flat and obtuse	Flat and obtuse	Flat and obtuse
Front femur type	D_4	D_4	D_4 and d_5	D_3, d_4 or d_5	D_4
Hind margin of Tergite VII	More or less arched	Truncate	Truncate	Concave	Truncate
Sternum X	Rounded at apex	Rounded at apex	Rounded at apex	Acute at apex	Rounded at apex
Sternum VII	Slightly produced at the apex	Protruded at apex	Protruded at apex	Protruded at apex	Protruded at apex
Valvulae II	Highly sclerotized lateral margins	Lateral margins not sclerotized	Lateral margins not sclerotized	Lateral margins not sclerotized	Slightly sclerotized lateral margins
Laterosternites IX	With long or short protuberance	Without protuberance	With long or short protuberance	With long or short protuberance	Without protuberance
Paratergites	Nearly straight	Weakly curved	Weakly curved	Weakly curved	Weakly curved
Paraprocts	Well beyond the posterior margin of tergite X	Nearly to or slightly beyond the posterior margin of tergite X	Does not extend to the posterior margin of tergite X	Does not extend to the posterior margin of tergite X	Does not extend to the posterior margin of tergite X
The anterior margins of the vestibular sclerites	Slightly concave at the middle	Distinctly arched	Distinctly arched	Distinctly arched	Slightly concave at the middle

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use



Figs. 56-65. *Cryptocercus arcuatus* **sp. nov.**: (56) supraanal plate, ventral view; (57) supraanal plate, dorsal view; (58) subgenital plate, dorsal view; (59) tergum VII, dorsal view; (60) valvule I, ventral view; (61) valvule II, ventral view; (62) valvule III, ventral view; (63) basivalvula and spermatheca (1 absent), ventral view; (64) laterosternal shelf, dorsal view; (65) laterosternite IX and paratergites, ventral view. (Scale bars =1.0 mm). This figure is displayed in color in the online version.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use



Figs. 66-68. (66) habitat of *Cryptocercus primarius* Bey-Bienko, 1938 (Sichuan Prov., Pingwu County, Wanglang) (67) *Cryptocercus primarius* Bey-Bienko, 1938 (1 is drilling) (68) gallery of *Cryptocercus primarius* Bey-Bienko, 1938 (Photographs by Dong Wang) This figure is displayed in color in the online version.

DESCRIPTION

Body medium, brown to dark brown (Fig. 13). Vertex pale brown, ocellar spot dark brown, head with dense punctation. Antenna brown, apex pale brown and scape gradually darker. Vertex with interocular space slightly less than distance between antennal sockets. Maxillary palps reddish brown and apical segment with tiny hairs (Fig. 14). Pronotum blackish brown with punctation indistinct, anterior margin elevated; disc depressed with faint protuberances, protuberances also strongly depressed, and narrowing posteriorly to median incised line and terminating at short transverse groove (Fig. 15). Front femur Type D_4 (only 4 big spines), tarsus with pulvilli, tarsal claws symmetrical and unspecialized. Abdominal tergites brown, margins of each tergite slightly upturned, sterna pale brown. Both tergites and sterna punctured, the tergite VII and sternum with minute hairs; area between tergites II and III slightly depressed.

Tergite VII with anterior margin arched, and posterior margin slightly truncate at middle (Fig. 59). Sternum VII distinctly produced at apex, posterior margin truncate; with a conspicuous pair of intersternal shelves (ints.f.) at apex, which are slightly sclerotized at anterior margins and highly sclerotized at base. Vestibular sclerite (vst.s.) broad, clearly delimited and unmusculated; membrane surrounding vestibular sclerite, which is connected with tergite X (TX) (Fig. 58). Tergite X rounded at apex; paraprocts (pp.) developed, with apices not extending to the posterior margin of tergite X, with the gap between paraprocts narrow (Fig. 56).

FEMALE GENITALIA

In the roof of the genital chamber, the basivalvulae (bsv.) well-developed, elliptical, obscure at apex and base, which are highly sclerotized (Fig. 63). Spermatheca sitting beyond the basivalvulae and fused with them. Valve I (v.I) bases situated posterior to the basivalvulae, but not fused with the valvifers I (Fig. 60). Valvifers I (vlf.I) small and posterolateral to the valve I bases, almost covered by inserted muscles; paratergites (pt.) slightly curved and situated between valvifers I and base of valve I (Fig. 65). Valvifer II ring (vlf.II) highly sclerotized, located at the central apodeme (c.a.) that is well-developed. Anterior arch (a.a.) dark, with punctures in the middle (Fig. 62). Laterosternites IX (ltst.IX) small and sheet-like, fused with the bases of paratergites (Fig. 65). Laterosternal shelf (ltst.sh.) very large and translucent, nearly oblong; with dense spinules at apical half, which are denser near the anterior margin (Fig. 64).

MATERIAL EXAMINED

HOLOTYPE, male, CHINA: Yunnan Prov., Xianggelila, Mt. Shikaxueshan, 3,756 m, 20-VII-2012, coll. Dong Wang and Lin Du. PARATYPES, 2 males and 1 female, same date as holotype.

DISTRIBUTION

China (Yunnan).

ETYMOLOGY

The specific epithet is derived from the Latin adjective "*arcuatus*" referring to the posterior margin between 2 styli being rounded.

REMARKS

The following characteristics make this new species distinctive and easily noticed. Firstly, the pronotum of this species has inconspicuous punctation (Fig. 15). Secondly, valvule II is strongly protruding at base and lateral margins are slightly scleritized at middle (Fig. 61).

Discussion

These 5 *Cryptocercus* species are closely similar in morphology and they are difficult to distinguish. The differences are in the protuberances of the pronotum and the front femur type, etc. (Table 1). *Cryptocercus hirtus* has strong protuberances on the pronotum, and these protuberances are towering and more or less tapered. However, the protuberances of *C. primarius*, *C. arcuatus* **sp. nov.**, *C. meridinus* and *C. convexus* **sp. nov**. are flat and obtuse, distinctly smaller and shorter than in the former species (Figs. 3, 6, 9, 12, 15). In addition, *C. meridinus* and *C. convexus* **sp. nov.** show wide variations in the front femur type. *Cryptocercus convexus* **sp. nov.** has 3 main types of front femur, D_3, D_4 or D_5; and sometimes a specimen has a different type of left femur than the right femur. *Cryptocercus meridinus* has 2 types of front femur, i.e., D_4 and D_5; and left and right femur differ only in males. However, the front femur type of the remaining 3 species is D_4.

The female genitalia of these 5 *Cryptocercus* species are similar. These 5 species differ in the shape of some sclerites. The hind margin of Tergite VII of *C. primarius*, *C. meridianus* and *C. arcuatus* **sp. nov.** is rather truncate (Figs. 19, 39, 59); but that of *C. convexus* **sp. nov.** is weakly concave (Fig. 49) and that of *C. hirtus* is more or less arched (Fig. 29). Sternum X of *C. convexus* is a little acute at apex (Fig. 47), but rounded at apex in the other 4 species (Figs. 17, 27, 37, 57). Paraprocts of all 5 species are developed and the gap between paraprocts is very narrow. The paraprocts of *C. primarius* have apices extending nearly to or slightly beyond the posterior margin of tergite X (Fig. 16), but the paraprocts of *C. meridianus*, *C. convexus* **sp. nov.** and *C. arcuatus* **sp. nov.** do not extend to the posterior margin of tergite X (Figs. 36, 46, 56), and those of *C. hirtus* extend well beyond the posterior margin of tergite X (Fig. 26). Sternum VII of *C. hirtus* is slightly produced at the apex (Fig. 28), but the sterna of *C. primarius*, *C. meridianus*, *C. convexus* **sp. nov.** and *C. arcuatus* **sp. nov.** protruded at apex (Figs. 17, 37, 47, 57). The intersternal shelves of all 5 species are developed and are sclerotized at the anterior margin (Figs. 18, 28, 38, 48, 58). The anterior margins of the vestibular sclerites of *C. hirtus* and *C. arcuatus* **sp. nov.** are slightly concave at the middle (Figs. 28, 58); however, those of the other 3

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

species are distinctly arched (Figs. 18, 38, 48). Valvulae I in these 5 species are finger-shaped and merely differ in the degree of sclerosis (Figs. 20, 30, 40, 50, 60). Valvulae II of the 5 species are all slender and long, those of *C. hirtus* have highly sclerotized lateral margins and clearly have the shape of 2 pale yellow stripes (Fig. 31), but the valvulae II of *C. arcuatus* **sp. nov.** have only slightly sclerotized lateral margins (Fig. 61). Except for *C. hirtus* and *C. primarius*, valvulae II of the remaining 3 species are upturned at the base (Figs. 41, 51, 61). Valvulae III of these 3 species are all broad and sheet-like, but those of some species are highly sclerotized and those of other species are slightly sclerotized (Figs. 22, 32, 42, 52, 62). Laterosternites IX of these 5 *Cryptocercus* species are sheet-like. Except for *C. primarius* and *C. arcuatus* **sp. nov.** (Figs. 25, 65), the laterosternites IX of the remaining 3 species have 1 long or short protuberance (Figs. 35, 45, 55). Paratergites of these 5 *Cryptocercus* species are slender and long, but those of *C. hirtus* are nearly straight, and those of the other 4 species weakly curved. It is worth mentioning that basivalvulae of *C. hirtus* (Fig. 33) differs greatly from the basivalvulae of the other 4 species (Figs. 23, 43, 53, 63). Laterosternal shelves are all nearly rectangular, but the distribution of marks and spinules is different (Figs. 24, 34, 44, 54, 64). In addition, these 5 *Cryptocercus* species each has a pair of spermathecae but they are shaped differently in the different species (Figs. 23, 33, 43, 53, 63).

As can be seen above, the female genitalia of different *Cryptocercus* species are uniformly structured, but the shape of the same structure across different species is notably different. Inward et al. (2007) found that Cryptocercidae has a close phylogenetic relationship with termites (Isoptera), even closer than with other Blattodea families. The structures of female genitalia of termites are also similar to those of Cryptocercidae (McKittrick 1964; Nalepa & Lenz 2000). Meanwhile, the results of Belyaeva & Dovgobrod (2006) showed that only the female genitalia of termites could be used to classify and identify termite species. However, the male genitalia of these 5 *Cryptocercus* species are not materially different. For example, the shape of the hind margins of subgenital plates and middle aedeagus vary but these differences also exist across individuals of the same species. So compared with the characteristics of external morphology and male genitalia, it can be concluded that features of female genitalia have greater value for the identification of each of the 5 *Cryptocercus* species from China. According to our results, the morphological diversity of *Cryptocercus* species is not more pronounced in East Asia than among North American species. And this conclusion is consistent with the results of Grandcolas et al. (2005).

In recent years, we have collected *Cryptocercus* species from the Provinces of Sichuan, Hubei, Gansu, Yunnan, Shaanxi, Henan and Chongqing City, China. They usually live in natural forests (Fig. 66) at a high altitude (1,200 m to 3,600 m), where in general there is abundant rainfall. Trees with high water content are more suitable for the survival of *Cryptocercus* species (Figs. 67-68). They are not selective for rotten or soft wood and a large number can be collected in hard wood (Z. Q. Wang, pers. obs.)

Acknowledgments

We are sincerely grateful to Prof. J. R. Schrock (Department of Biological Sciences, Emporia State University, USA) for reviewing this manuscript and providing valuable comments. This study is supported by the National Natural Sciences Foundation of China (NSFC-30900146, 31093430) and also partly by the Fundamental Research Funds for the Central Universities (XDJK2012B025, XDJK2013B013).

References Cited

Aldrich BT, Zolnerowich G, Kambhampati S. 2004. Interspecific morphological variation in the wood-feeding cockroach, *Cryptocercus* (Dictyoptera: Cryptocercidae). Arthropod Structure & Development 33: 443-451.

Beccaloni GW. 2007. Blattodea Species File Online. Version 5.0/5.0. World Wide Web electronic publication. <http://Blattodea.SpeciesFile.org> [accessed 20-X-2013].

Belyaeva NV, Dovgobrod IG. 2006. The genitalia of termites (Isoptera): possibilities of using in taxonomy. Entomological Review 86(5): 501-508.

Bey-Bienko G. 1935. Descriptions of six new species of Palaearctic Blattodea. Konowia 14: 117-134.

Bey-Bienko G. 1938. On some new or interesting Asiatic Blattodea. Annals and Magazine of Natural History 1: 230-238.

Bey-Bienko G. 1950. Fauna of the USSR. Insects. Blattodea. Institute of Zoology, Academy of Sciences of the URSS, Moscow 40: 1-343.

Burnside CA, Smith PT, Kambhampati S. 1999. Three new species of wood roach, *Cryptocercus* (Blattodea: Cryptocercidae), from the eastern United States. Journal of the Kansas Entomological Society 72: 361-378.

Clark JW, Kambhampati S. 2003. Phylogenetic analysis of blattabacterium, endosymbiotic bacteria from the wood roach, *Cryptocercus* (Blattodea: Cryptocercidae), including a description of 3 new species. Molecular Phylogenetics and Evolution 26: 82-88.

Grandcolas P. 1999. Systematics, endosymbiosis and biogeography of *Cryptocercus clevelandi* and *C. punctulatus* (Blattaria: Polyphagidae) from North America: A phylogenetic perspective. Annals of the Entomological Society of America 92(3): 285-291.

Grandcolas, P. 2000. *Cryptocercus matilei* n. sp., du Sichuan de Chine. Revue française d' Entomologie (N. S.) 22(4): 223-226.

Grandcolas P, Legendre F, Park YC, Bellés X, Murienne J, Pellens R. 2005. The genus *Cryptocercus* in East Asia: Distribution and new species (Insecta, Dictyoptera, Blattaria, Polyphagidae). Zoosystema 27(4): 725-732.

Grandcolas P, Park YC, Choe JC, Piulachs MD, Bellés X, d'Haese C, Farine JP, Brossut R. 2001. What does *Cryptocercus kyebangensis*, n. sp. from Korea reveal about *Cryptocercus* evolution? A study in morphology, molecular phylogeny and chemistry of tergal glands (Dictyoptera, Blattaria, Polyphagidae). Proceedings of the Academy of Natural Sciences of Philadelphia 151: 61-79.

Inward D, Beccaloni G, Eggleton P. 2007. Death of an order: a comprehensive molecular phylogenetic study confirms that termites are eusocial cockroaches. Biology Letters 3: 331-335.

Kambhampati S, Luykx P, Nalepa CA. 1996. Evidence for sibling species in *Cryptocercus punctulatus*, the woodroach, from variation in mitochondrial DNA and karyotype. Heredity 76: 485-496.

McKittrick FA. 1964. Evolutionary Studies of Cockroaches. Cornell University Agricultural Experiment Station Memoir 389: 1-197.

Nalepa CA, Byers GW, Bandi C, Sironi M. 1997. Description of *Cryptocercus clevelandi* (Dictyoptera: Cryptocercidae) from the northwestern United States, molecular analysis of bacterial symbionts in its fat body, and notes on biology, distribution and biogeography. Annals of the Entomological Society of America 90(4): 416-423.

Nalepa CA, Lenz M. 2000. The ootheca of *Mastotermes darwiniensis* Froggatt (Isoptera: Mastotermitidae): homology with cockroach oothecae. Proceedings of the Royal Society of London, B 267: 1809-1813.

Scudder SH. 1862. Materials for a monograph of North American Orthoptera. Boston Journal of Natural History 7: 409-480.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use