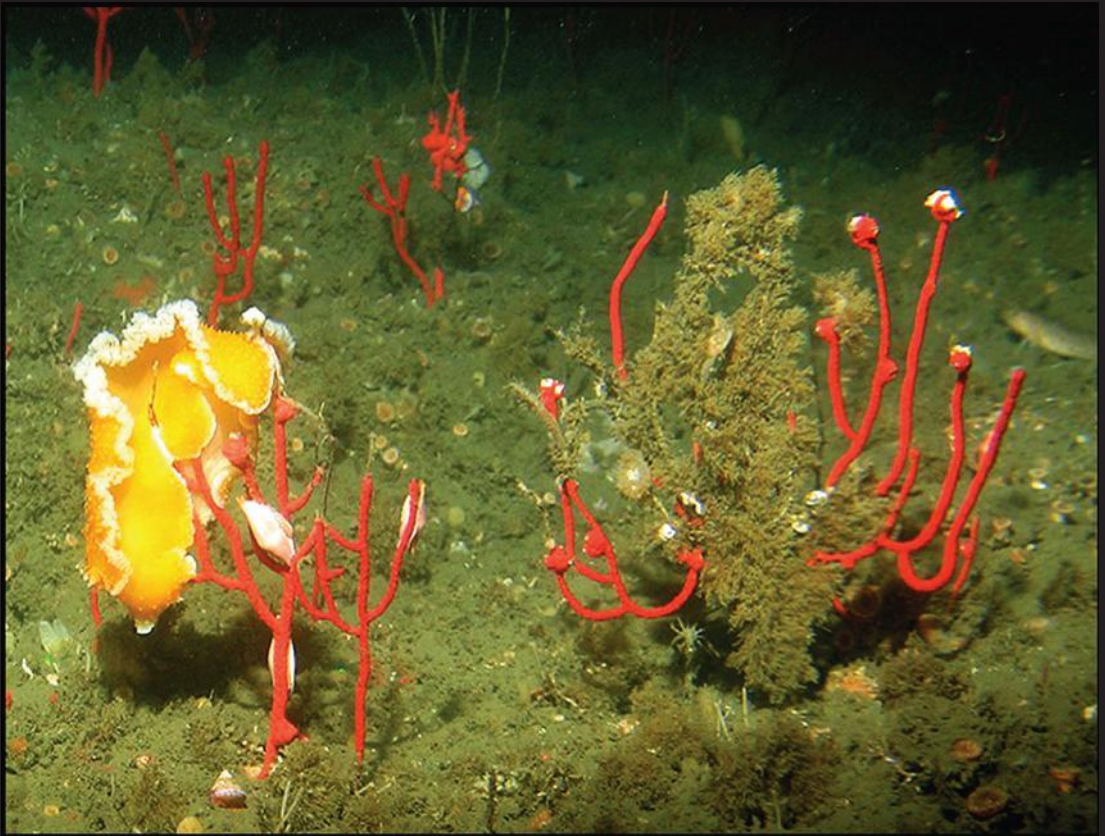


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COVER IMAGES

FRONT COVER: Figure 3 in Williams, p. 235, *Ecological Interactions*. Living colonies and associates *in situ* off San Mateo County, Monterey Bay NMS, 48 m, 2 August 2018; several gorgonian colonies *Chromoplexaura marki*, with the nudibranch *Tritonia tetraquetra*, ovulid snails *Simnia barbarensis*, and epizoic barnacles *Conopea* sp. Photograph courtesy NOAA and MARE.

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Inventory of the Carabid Beetle Fauna of the Gaoligong Mountains, Western Yunnan Province, China: Species of the Tribe Broscini (Coleoptera: Carabidae).

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Our study of 1,338 specimens of broscine carabid beetles collected during a ten-year biodiversity inventory project in the Gaoligong Shan region of western Yunnan Province, China, recognized fifteen different species representing four different genera. Eleven of the fifteen species are described as new: *Broscodera chukuai* sp. nov. (type locality: China, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, Chukuai Lake area); *B. gaoligongensis* sp. nov. (type locality: China, Yunnan, Lushui, Luzhang Township, Yaojiaping, 2500 m); *Broscosoma bicoloratum* sp. nov. (type locality: China, Yunnan, Gongshan County, Dulongjiang Township, NW slope of Heipu Yakou, 3350 m); *B. danzhuense* sp. nov. (type locality: China, Yunnan, Gongshan County, Cikai Township, Danzhu He drainage, 2720–2840 m); *B. furvum* sp. nov. (type locality: China, Yunnan, Fugong County, Lumadeng Township, second cirque S of Shibali Yakou at border post “31”, 3710 m); *B. gongshanense* sp. nov. (type locality: China, Yunnan, Gongshan County, Cikai Township, Heipu Yakou area); *B. holomarginatum* sp. nov. (type locality: China, Yunnan, Gongshan County, Dulongjiang Township, Kongdang); *B. parvum* sp. nov. (type locality: China, Yunnan, Fugong County, Lumadeng Township, 8.5 km W of Shibali on Shibali road, North Fork of Yamu He, 3100 m); *B. purpureum* sp. nov. (type locality: China, Yunnan, Gongshan County, Dulongjiang Township, Kongdang area, 1500 m); *B. resbecqi* sp. nov. (type locality: China, Yunnan, Gongshan County, Dulongjiang Township, Siran Wang, 0.2 km above confluence with Dulong Jiang, 1720 m); and *B. viridicollare* sp. nov. (type locality: China, Yunnan, Fugong County, Lishadi Township, 9.5–10.0 km W of Shibali on Shibali Road, 3195–3200 m). New evidence suggests that *Broscosoma ribbei rougeriei* Deuve should be considered as a synonym of *B. ribbei* Putzeys. We present a key for identification of adults of all species in the study area as well as nomenclatural data, diagnoses, illustrations of dorsal habitus, male genitalia and other diagnostic features. We also provide information about geographical, altitudinal, and habitat distributions within the study area and overall geographical distribution for each species. Geographical and altitudinal distributions of the species within the study area are compared and broader geographical range patterns are characterized.

KEYWORDS: *Broscosoma*, *Broscodera*, *Broscus*, *Eobroscus*, China, Yunnan, Gaoligong Shan, new species, distribution, biodiversity hotspot

The Gaoligong Shan (Gaoligong Mountains) of extreme western Yunnan Province, China (Fig. 1) represents the southeasternmost extension of the Transhimalaya (Akciz et al. 2008). The range extends for more than 600 km north to south and, in the central part of the range, its crest forms the border between China and Myanmar. It also separates and forms parts of the watersheds of two of Southeast Asia's major rivers, the Irrawaddy and the Salween (known in China as the Nujiang). Elevations within the region range from a low of about 650 m in the south to more than 5000 m in the north. Chaplin (2006) reviewed the physical geography of the region. Because of its geographic isolation and rugged topography, much of this area has remained less disturbed than most other parts of China. Previous biological exploration of the area over the past 150 years has revealed exceptionally high species richness, based mainly on records for vertebrates (e.g., Stattersfield et al. 1998) and vascular plants (Li et al. 2000). Because of these traits, two large nature reserves have been established in the area, and the region has been included in the Three Parallel Rivers of Yunnan World Heritage Site (UNESCO 2003).

In late 1997, the California Academy of Sciences was invited to participate in a joint project with the Kunming Institutes of Botany and Zoology of the Chinese Academy of Sciences to conduct a biodiversity inventory of the Gaoligong Mountains. Scientists from several additional institutions, including the Institute of Zoology, Beijing, and Royal Botanical Garden (Edinburgh) joined in the collaboration. Principal target groups for the inventory included bryophytes and vascular plants, all vertebrate groups, arachnids, myriapods and insects, especially the Neuropteroidea, Mecoptera, and Coleoptera (the Carabidae in particular). Multidisciplinary and multi-institutional teams carried out biotic sampling through more than 25 separate expeditions during the period 1998 to 2007. Numerous reports on the project have been published to date, including partial results for bryophytes, higher plants, birds, amphibians, fishes, spiders, and carabid beetles (see Deuve et al. 2016 for pertinent references).

This report, on the tribe Broscini, represents the fourth of an intended series of treatments on the carabid beetle fauna of the Gaoligong Shan region, each dealing with one or more tribes or genera represented in the fauna. The first three reports have dealt with the Zabini (Kavanaugh et al. 2014), Trechini (Deuve et al. 2016), and Omophronini (Kavanaugh et al. 2021) of the region. Subsequent reports will appear as taxonomic work on each group can be completed and not in any particular taxonomic or phylogenetic order.

The tribe Broscini Hope, 1838 is a modestly diverse taxon (Häckel et al. 2010), currently including about 340 described species arrayed in five subtribes (Roig-Juñent, 2000) and 33 genera. Three of the subtribes (Barypina Jeannel, 1941, Creobiina Jeannel, 1941, and Nothobroscina Roig-Juñent, 2000), include 248 (73% of the) species and 22 (67% of the) genera and are restricted to the Southern Hemisphere. Subtribe Axonyina Roig-Juñent, 2000 currently includes only four species arrayed two genera. *Broscodes* Bolivar y Peltain, 1914 includes three species (Wrase and Schmidt, 2017) and is distributed disjunctly along the southern edge of the Holarctic Region from eastern Turkey and Iran to Bhutan and Myanmar; and the monobasic genus, *Rawlinsius* Davidson and Ball (1998), is known only from the state of Guerrero in Mexico. Subtribe Broscina Hope is Holarctic in distribution, with one genus, *Zacotus* LeConte, 1869 restricted to western North America, six genera (*Broscosoma* Rosenhauer, 1846, *Broscus* Panzer, 1813, *Chaetobroscus* Semenov, 1900, *Craspedonotus* Schaum, 1863, *Eobroscus* Kryzhanovskij, 1951, and *Kashmirobroscus* Schmidt et al., 2013), restricted to Eurasia, and two genera (*Miscodera* Eschscholtz, 1830 and *Broscodera* Lindroth, 1961) with Holarctic distributions. *Miscodera* is represented by a single species with a subarctic circumpolar distribution. *Broscodera* currently includes four species arrayed in two subgenera: the nominate subgenus, represented by *B. insignis* (Mannerheim), 1852, endemic to northern North America, and subgenus *Sinobrosculus* Deuve, 1990, currently repre-

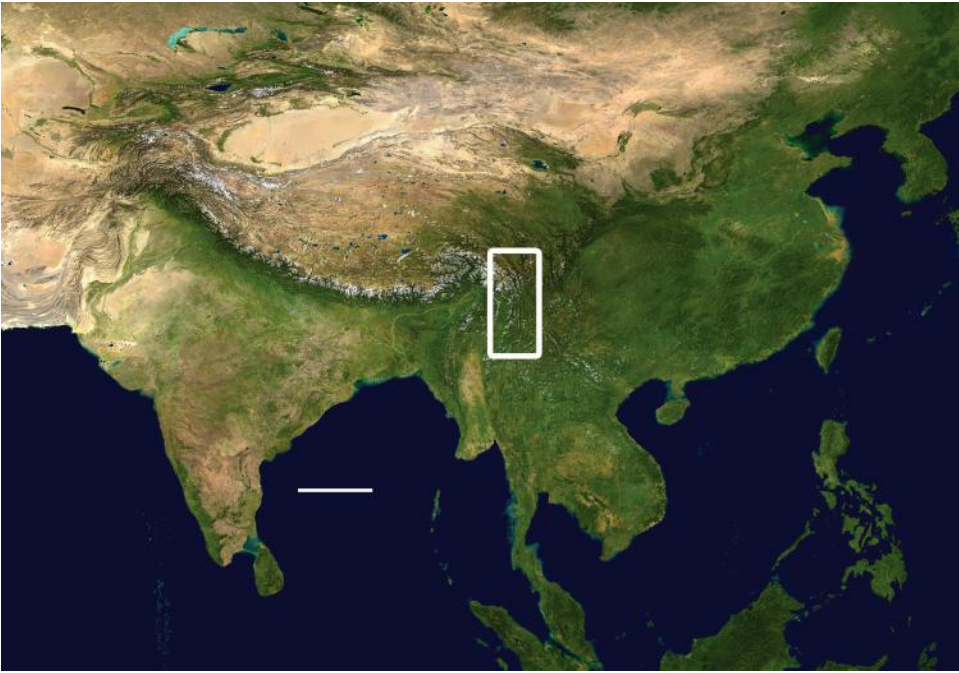


FIGURE 1. Map of Asia with study region outlined. Modified from Wikimedia Commons, World Atlas of the World, at URL: <http://upload.wikimedia.org/wikipedia/commons/8/8f/Whole_world_-_land_and_oceans_12000.jpg>. Scale line = 500 km.

sented by three species and two additional subspecies, each endemic to certain mountain ranges on the eastern margin of the Tibetan Plateau and the Greater Himalaya.

In the Palearctic Region, broscine taxa occupy a very broad range of habitats, including deserts, grasslands, coniferous forests, broadleaf evergreen and deciduous forests, montane riparian habitats, subalpine thickets, and subarctic steppe and treeline habitats (Häckel et al. 2010; Holdhaus 1954; Lindroth 1945; Schmidt and Arndt 2000). In the daytime, these beetles hide under stones, leaf litter or other debris on the soil surface or in mosses or in the soil itself. At night, they are active on the surface in wet, damp, or even dry areas, where they hunt for their small invertebrate prey.

As is the case with most other terrestrial arthropod groups, the broscine fauna of the study area has not been well documented previously. Only two species, *Brososoma ribbei* Putzeys, 1877 (as subspecies *B. r. rougeriei* Deuve and Tian, 2002) (see also Jiang et al. 2021) and *Brososoma gaoligongensis* Deuve and Wrase, 2015, have been recorded from the region. Based on our study of the material collected for the project and additional specimens from the region housed in other collections, we recognize a total of 15 broscine species, representing four genera, as occurring in the study area. We present here a key for identification of adults of these species, as well as nomenclatural data, diagnoses, illustrations of dorsal habitus, male genitalia, and other features, and information about geographical and habitat distributions within the study area and overall geographical distribution for each species. We also discuss geographical distributions of the species with respect to different parts of the study area (see below about “core areas”) and to each other, as well as the broader geographical range patterns and the altitudinal ranges of the species. In order to reach our taxonomic conclusions about the identities of the Gaoligong Shan species, we reviewed material representing the known Eurasian genera and most of the species, including type material wherever-

er possible. Among the 15 species represented in the fauna, we recognize 11 of them as new to science, including two new species of *Broscofera*, subgenus *Sinobrosculus*, and nine new species of *Broscosoma*.

MATERIALS AND METHODS

The natural physiographic limits of the study area for the project are as shown in Fig. 2 and include areas in eastern Myanmar and southern Xizang (Tibet); but we had permission to survey only those parts in Yunnan Province. Specialists for all taxonomic groups concentrated their efforts on seven core areas within the project region (Fig. 3), selected to facilitate comparisons of possible north to south and east to west spatial differences within the regional biota, as well as recognition of areas of local endemism. Other areas were sampled as time and opportunity permitted. The entomological team made a total of 13 expeditions to the Gaoligong region. Our sampling sites within the region are shown in Fig. 4. Habitats included in the study area range from subtropical lowland rainforest to the margin of glaciers and snowfields. In all, more than 35,000 carabid specimens were collected during the project by using a variety of collecting methods, including hand collecting both day and night, beating vegetation, sifting litter with subsequent extraction by hand or by mini-Winkler units, and Malaise flight traps and pitfall traps. All specimens were sorted to morphospecies (i.e., presumptive species units based on features of external structure and male and female genitalic traits) and detailed systematic studies of taxonomic groups are ongoing.

This study is based on the examination of 1,338 specimens of *broschine* species from the Gaoligong Shan region and hundreds of additional specimens from other regions, representing other broscine genera and species known to occur in Asia. Specimens acquired during our fieldwork have been divided among and are deposited in collections of our home institutions. Codens used throughout this report for collections in which specimens, including primary types, are deposited are as follows:

- CAS California Academy of Sciences, San Francisco, U.S.A.
- DWW David W. Wrase, Gusow-Platkow, Germany (working collection, part of Zoologische Staatssammlung München)
- IOZ National Zoological Museum of China, Institute of Zoology, Beijing, China
- MNHN Muséum National d'Histoire Naturelle, Paris, France
- NHMB Naturhistorisches Museum, Basel, Switzerland
- NSMT National Science Museum, Tokyo, Japan
- OUMNH Oxford University Museum of Natural History, Oxford, United Kingdom
- RBINS Royal Belgian Institute of Natural Sciences, Brussels, Belgium
- SCAU South China Agricultural University, Guangzhou, China

Measurements. The following measurements were recorded: body length (BL), measured longitudinally from the apex of the longer mandible to the apex of the longer elytron; pronotal length (PL), measured from anterior to posterior margin along midline; pronotal width (PW), measured transversely across the greatest pronotal width; elytral length (EL), measured along midline from the basal declivity to the apex of the longer elytron; elytral width (EW), measured transversely across the widest point of both elytra together; antennomere 3 length (A3); antennomere 5 length (A5); metepisternum length (ML), measured longitudinally along lateral margin; metepisternum width (MW), measured along the diagonal anterior margin. The following ratios were calculated using these measurements: A3/A5 (antennomere 3/ antennomere 5); EL/EW (elytral length/ elytral width); EL/PL (elytral length/ pronotal length); EW/PW (elytral width/ pronotal width); ML/MW (metasternum length/ metasternum width); and PL/PW (pronotal length/pronotal width). All measurements were taken with the aid of a calibrated ocular micrometer scale on a Wild M5 stereoscopic dissecting microscope.

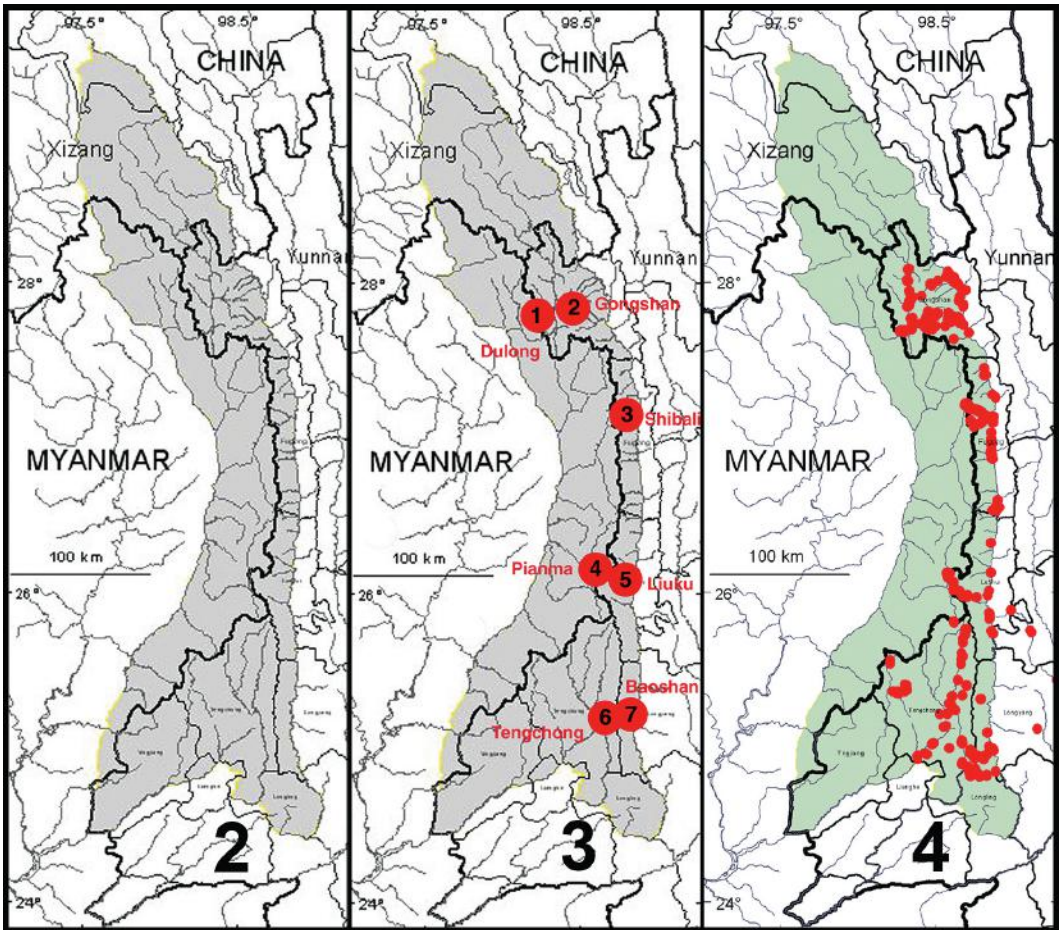


FIGURE 2–4. Fig. 2. Map showing natural extent of study area, colored in green (however, sampling was permitted only in those portions in Yunnan Province). Fig. 3. Map showing location of core sampling areas. Fig. 4. Map showing locations of all entomological sampling sites. Scale lines = 100 km.

Dissections of male genitalia were prepared from specimens relaxed in hot (near boiling) soapy water by severing the membranes between the genital capsule and tergite VII and sternite VII and extracting the capsule intact. The dissections were then cleared in warm 10% KOH and further dissected to separate the sclerotized parts enough to visualize structures to be compared. Following dissection, preparation and study, genitalia were placed in glycerine in microvials and pinned beneath the specimens from which they were extracted.

Illustrations. Digital images of whole specimens and particular structures were taken using a Leica imaging system including an M165C dissecting microscope, DFC550 video camera, and two KL1500 LCD light sources. Stacked images were captured and combined into single montage images using the Leica Application Suite V4.2.0. Plates of images were created using Adobe Photoshop CS5. Distribution maps for each species were generated from geographical coordinate data maintained in a Biota Version 3.0 database (Colwell 2012) using the ArcMap program in ArcGIS for Desktop Version 10.2 software from Esri.

Geographical Coordinate Data. All geographical coordinate data are presented in decimal degree format, with the first entry degrees North and the second degrees East, separated by “/”. Exceptions to this format include verbatim label data only.

Treatments for new species. For all new species, label data for all specimens of the type series are quoted verbatim (between quotation marks), with data for multiple labels separated by “/” and any editorial additions included between brackets (“[-]”).

TAXONOMY

Adult specimens of broscine species represented in the Gaoligong Shan region can be distinguished using the following key. It is provided only for distinguishing members of taxa (different genera or species) represented in this region and may not be appropriate for more general use. In each couplet, features that are most diagnostic for identification are listed first, followed by supporting supplementary features that can help to confirm identifications.

Key for identification of adults of broscine species of the Gaoligong Shan Region

- 1 Size large, BL of male or female greater than 15.0 mm 2
- 1' Size moderate, BL of male or female less than 13.0 mm 3
- 2(1) Head (Fig. 5a) with very deep, sharply defined and impunctate cleft on vertex between tempora; male with protarsomeres 1 and 2 and mesotarsomeres 1 and 2 with ventral pads of adhesive setae ... Genus *Eobrosicus* Kryzhanovskij *Eobrosicus bhutanensis* Morvan
- 2' Head (Fig. 5b) with shallower, broader, and distinctly punctate transverse sulcus between tempora; male protarsomeres 1 to 3 with ventral pads of adhesive setae, all male mesotarsomeres lacking ventral pads of adhesive setae ... Genus *Brosicus* Panzer . *Brosicus punctatus* (Dejean)
- 3(1') Pronotum (Figs. 5c-d) with basolateral setae present; antennomere 3 with sparse pubescence in apical one-third to one half, antennomere 4 pubescent; male protarsomeres and mesotarsomeres 1 and 2 with small ventral pads of adhesive setae ... Genus *Broscoдера* Lindroth subgenus *Sinobrosculus* Deuve 4
- 3' Pronotum (Figs. 6, 7) with basolateral setae absent; antennomeres 3 and 4 glabrous except for apical whorl of setae; male protarsomeres 1 to 3 with larger ventral pads of adhesive setae, mesotarsomeres 1 and 2 with larger ventral pads ... Genus *Brosocosoma* Rosenhauer 5
- 4 (3) Size larger, BL = 10.0 mm or more; body color piceous or dark brown; head (Fig. 5d) with eyes more convex and slightly larger, their diameter equal to length of tempora, vertex with post-temporal transverse sulcus densely, coarsely and, more widely punctate; hindwings full-sized, functional for flight; hind trochanter asetose (Fig. 8a); male genitalia as in Fig. 14
. *Broscoдера gaoligongensis* sp. nov.
- 4' Size smaller, BL = 9.5 mm or less; body color reddish brown; head (Fig. 5c) with eyes flatter and smaller, their diameter less than length of tempora, vertex with post-temporal transverse sulcus narrowly punctate only along bottom of sulcus; hindwings slightly reduced, non-functional for flight; hind trochanter unisetose (Fig. 8b); male genitalia as in Fig. 12
. *Broscoдера chukuai* sp. nov.
- 5 Elytral silhouette subparallel to subovoid, with humeri (shoulders) more (Figs. 24a, 28a, 32a) or less (Figs. 17a, 26a, 30a) distinct 6
- 5' Elytral silhouette ovoid, with humeri indistinct (Figs. 15a, 18a, 20a, 22a, 34a) 11
- 6 (5') Pronotum with lateral margination (lateral bead) complete (Fig. 9a) between apical and basal margins; dorsal surface with distinct blue or blue-green luster, legs pale rufous; elytral microsculpture distinct, comprised of isodiametric to slightly longitudinally stretched sculpti-

- cells, elytral striae distinctly punctate; male genitalia as in Fig. 25 *Brosocosoma holomarginatum* sp. nov.
- 6' Pronotum with lateral margination absent or incomplete (Figs. 9b-d) 7
- 7 (6') Pronotum with lateral margination complete anterior to midlateral seta, interrupted briefly in basal half (Fig. 9b); elytral humeri as in Fig. 30; dorsal surface of head and pronotum vivid metallic green, elytra darker blue-green, legs pale rufous; vertex with post-temporal transverse sulcus relatively shallow and broadly and densely punctate (Fig. 6d); elytral microsculpture effaced; metatrochanter aetose (Fig. 8c); male genitalia as in Fig. 29 *Brosocosoma resbecqi* sp. nov.
- 7' Pronotum with lateral margination absent, present only posterior to sub-basal constriction, or also present in area of midlateral seta (in a few specimens of *B. ribbei* extended almost to anterior margin (Fig. 9c), but these specimens have the metatrochanter unisetose) 8
- 8(7') Elytral microsculpture distinct, comprised of moderately impressed isodiametric sculpticells; metatrochanters unisetose (Fig. 9d) (except aetose unilaterally in some specimens); elytral silhouette as in Fig. 32a; size larger, BL = 8.9 mm or more; pronotum globose anterior to sub-basal constriction as in Fig. 6b, in most specimens with lateral margination present in region of midlateral seta (Fig. 9c) and also basal to sub-basal constriction and/or extended further anterior to midlateral seta in some specimens (absent entirely from a few specimens); vertex with post-temporal transverse sulcus relatively shallow and narrowly and sparsely punctate (Fig. 6b); entire dorsum of body bright metallic golden-green, green (Fig. 32a), or blue-green; male genitalia as in Fig. 33 *Brosocosoma ribbei* Putzeys
- 8' Elytral microsculpture faintly impressed or effaced; metatrochanters aetose (Fig. 8c) (although a few specimens of *B. purpureum* have one or both metatrochanters unisetose); size generally smaller, BL = 8.5 mm or less (except BL of *B. danzhuense* holotype = 9.3 mm); pronotum of different shape (Figs. 6c,e,f), with lateral margination absent or present only at or posterior to sub-basal constriction (Fig. 9d); dorsum of body bright metallic blue, blue-green, or darker and duller green 9
- 9 (8') Dorsum of body bright metallic blue or bluish-purple, head with greenish hue in some specimens, legs (including femora) pale rufous; elytral humeri distinct (Fig. 28a), angulate, elytral striae coarsely punctate, elytral microsculpture effaced; shape of pronotum as in Fig. 6c; male genitalia as in Fig. 29 *Brosocosoma purpureum* sp. nov.
- 9' Dorsum of body green or blue-green, legs with femora darker, reddish-brown to piceus; elytral humeri (Figs. 17a, 26a) less distinct, more rounded, elytral striae more finely punctate, elytral microsculpture faint but evident; shape of pronotum as in Figs. 6e,f 10
- 10 (9') Body larger, BL = 9.3 mm; elytral silhouette (Fig. 17a) with greatest width distinctly posterior to midlength; eyes (Fig. 6e) moderately convex; elytra with only stria 1 impressed, all other striae represented only by punctures diminishing in size and depth laterally and posteriorly, elytral intervals flat; entire dorsum of body dark green; male unknown *Brosocosoma danzhuense* sp. nov.
- 10' Body smaller, BL 8.5 mm or less; elytral silhouette (Fig. 26a) with greatest width at or near midlength; eyes (Fig. 6f) less convex, slightly flattened in some specimens; elytra with two or more striae impressed, all striae punctate with punctures diminishing in size and depth laterally and posteriorly, at least medial two or more elytral intervals very slightly to moderately convex; dorsum with head green, elytra blue-green and pronotum either green or blue-green; male genitalia as in Fig. 27 *Brosocosoma parvum* sp. nov.

- 11 (5') Metatrochanter unisetose (Fig. 8d) 12
- 11' Metatrochanter asetose (Fig. 8c) (except unilaterally unisetose in very few specimens of *B. bicoloratum*) 13
- 12 (11') Dorsum of body piceous, without any trace of metallic reflection (Fig. 18a); antennomeres 3 and 4 distinctly darker than antennomeres 1 and 2; pronotum anterior to sub-basal constriction (Fig. 7a) longitudinally slightly ovoid in dorsal view; genal ridge evident, extended from base of head to ventral margin of eye (Fig. 10a); male genitalia as in Fig. 19, with median lobe longer and more slender and with apical lamella distinctly expanded ventrally in lateral view *Broscosoma fuvum* sp. nov.
- 12' Dorsum of head and pronotum black or dark piceous, elytra with bright metallic green or blue-green reflection (Fig. 20a); antennomeres 1 through 4 concolorous, pale rufous; pronotum anterior to sub-basal constriction (Fig. 7d) globose in dorsal view; genal ridge evident basal to post-temporal constriction but extended only to or slightly anterior to the constriction (Fig. 10b); male genitalia as in Fig. 21, with median lobe slightly shorter and thicker and apical lamella more symmetrically rounded in lateral view ... *Broscosoma gaoligongense* Deuve and Wrase
- 13 (11') Head and pronotum black to piceous but with distinct metallic green band across anterior part of pronotum (Fig. 7b) anterior to anterior transverse impression; head with tempora slightly inflated, sharply convex or vaguely angulate; pronotum anterior to sub-basal constriction slightly to moderately longitudinally ovoid in dorsal view; elytral microsculpture distinct, comprised of moderately impressed isodiametric sculpticells; male genitalia as in Fig. 35, with median lobe slightly longer and apical lamella broader in lateral view *Broscosoma viridicollare* sp. nov.
- 13' Head and pronotum black to piceous, without metallic reflection (except a few specimens of *B. bicoloratum* have faint a metallic green band across anterior part of pronotum); head with tempora only slightly (Fig. 7e) or distinctly (Fig. 7c) convex; pronotum either globose or slightly longitudinally ovoid in dorsal view; elytral microsculpture indistinct, effaced or only extremely faintly evident in some areas 14
- 14 (13') Pronotum globose anterior to sub-basal constriction as in Fig. 7c; head with tempora distinctly convex behind eyes; male genitalia as in Fig. 16 ... *Broscosoma bicoloratum* sp. nov.
- 14' Pronotum anterior to sub-basal constriction slightly longitudinally ovoid in dorsal view (Fig. 7e); head with tempora straight or only slightly convex behind eyes; male genitalia as in Fig. 23 *Broscosoma gongshanense* sp. nov.

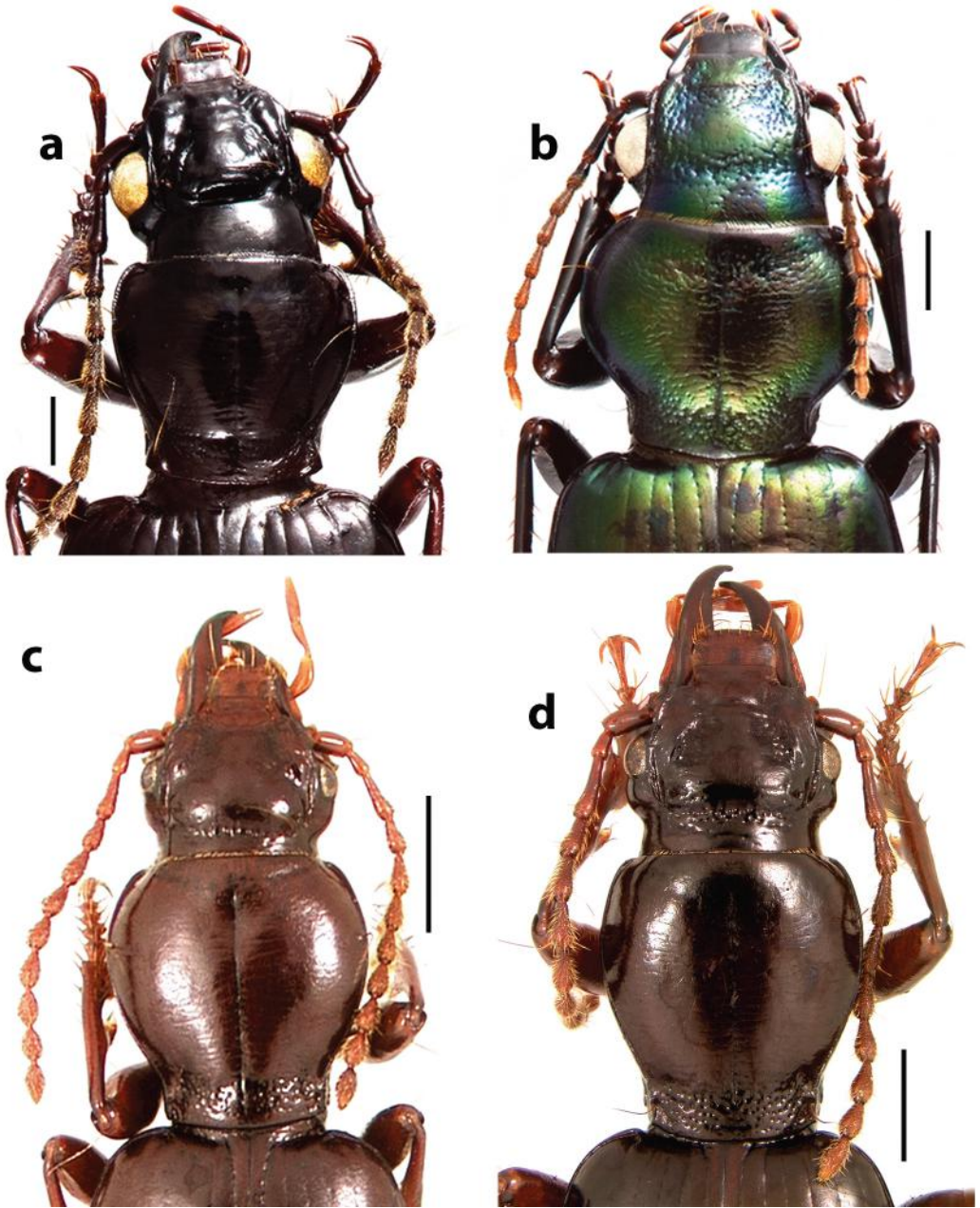


FIGURE 5. Forebody of broscine carabids, dorsal aspect. a. *Eoboscus bhutanensis* Morvan (CASENT1019340; Lishadi Township, Fugong County, Yunnan, China); b. *Broscus punctatus* (Dejean) (CASENT1011066; Heiwadi, Cikai Township, Gongshan County, Yunnan, China); c. *Broscodera chukuai* sp. nov. (CASENT1026168; NNE of Chukuai Lake, Bingzhongluo Township, Gongshan County, Yunnan, China); d. *Broscodera gaoligongensis* sp. nov. (CASENT1020104; South Fork of Yamu He, Lumadeng Township, Fugong County, Yunnan, China).

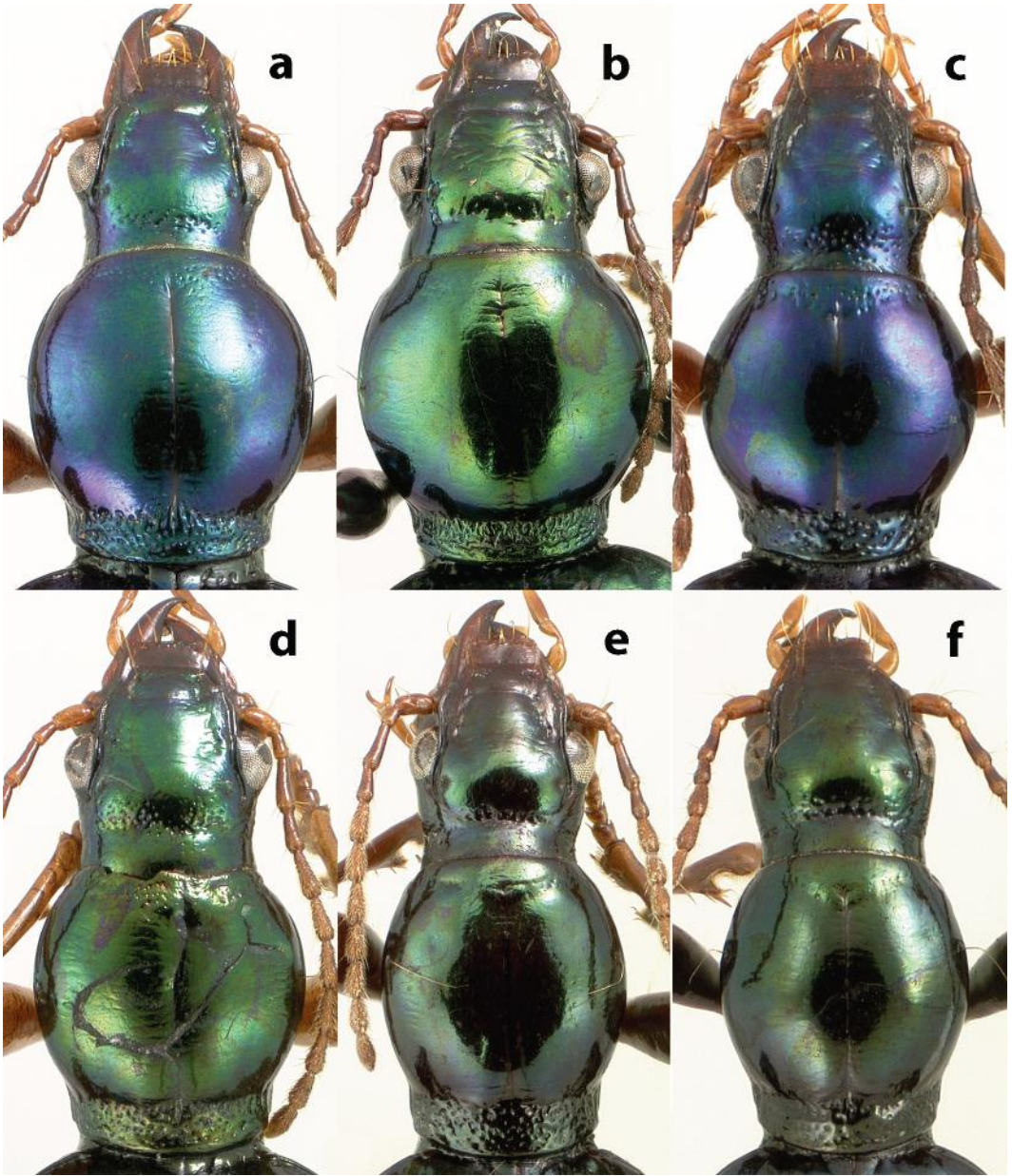


FIGURE 6. Forebody, *Broscosoma* species, dorsal aspect. a. *B. holomarginatum* sp. nov. (CASENT1015162; 0.5 km N of Kongdang, Dulongjiang Township, Gongshan County, Yunnan, China); b. *B. ribbei* Putzeys (CASENT1025337; 0.5 km WSW of Maku village, Dulongjiang Township, Gongshan County, Yunnan, China); c. *B. purpureum* sp. nov. (CASENT1015338; 0.5 km N of Kongdang, Dulongjiang Township, Gongshan County, Yunnan, China); d. *B. resbecqi* sp. nov. (Holotype; Siran Wang, Dulongjiang Township, Gongshan County, Yunnan, China); e. *B. danzhuense* sp. nov. (Holotype; Danzhum He drainage, Cikai Township, Gongshan County, Yunnan, China); f. *B. parvum* sp. nov. (CASENT1023565; 11.5 km above Shibali, Lishadi Township, Fugong County, Yunnan, China).

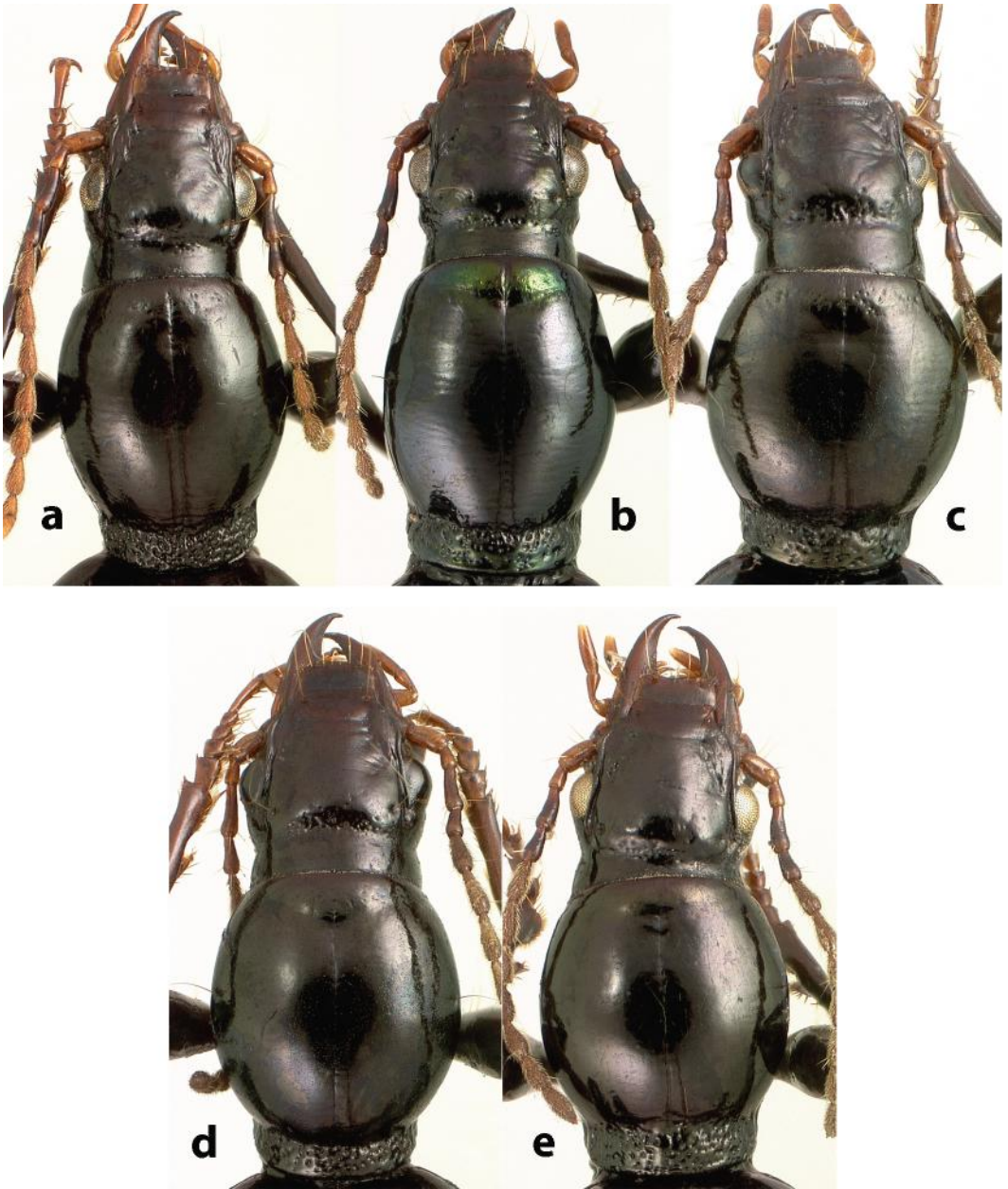


FIGURE 7. Forebody, *Broscosoma* species, dorsal aspect. a. *B. furvum* sp. nov. (CASENT1020001; first cirque S of Shibali Yakou, Fugong County, Yunnan, China); b. *B. viridicollare* sp. nov. (CASENT1022787; 8.5 km above Shibali, Lishadi Twonship, Fugong County, Yunnan, China); c. *B. bicoloratum* sp. nov. (CASENT1026704; slope NW of Heipu Yakou, Dulongjiang Township, Gongshan County, Yunnan, China); d. *B. gaoligongense* Deuve and Wrase (CASENT1027285; just W of Fenxue Yakou, Pianma Township, County, Yunnan, China); e. *B. gongshanense* sp. nov. (CASENT1008139; Dongshaofang area, Gongshan County, Yunnan, China).

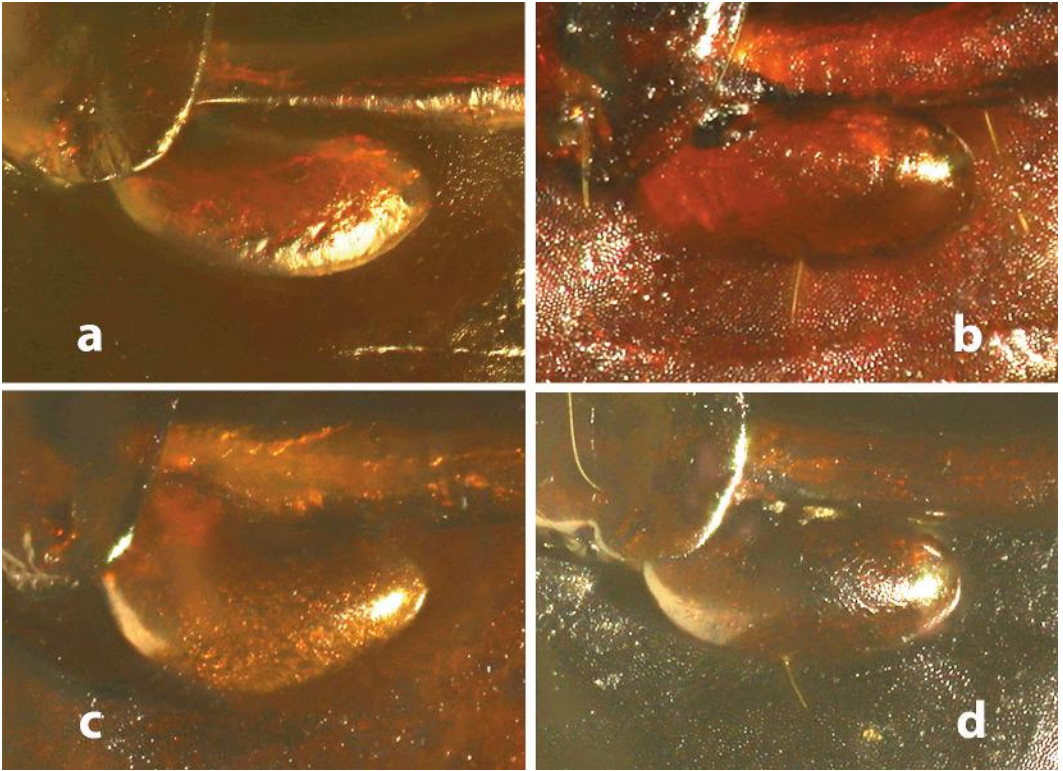


FIGURE 8. Left metatrochanter, broscine species, ventral aspect. a. *Broscodera gaoligongensis* sp. nov. (Yaojiaping, Lushui County, Yunnan, China); b. *Broscodera chukuai* sp. nov. (CASENT1026771; Chukuai Lake, Bingzhongluo, Gongshan County, Yunnan, China); c. *B. bicoloratum* sp. nov. (CASENT1034187; Qiqi-Dulong Yakou, Cikai Township, Gongshan County, Yunnan, China); d. *B. ribbei* Putzeys (CASENT1000578; Nankang Yakou, Longyang County, Yunnan, China).

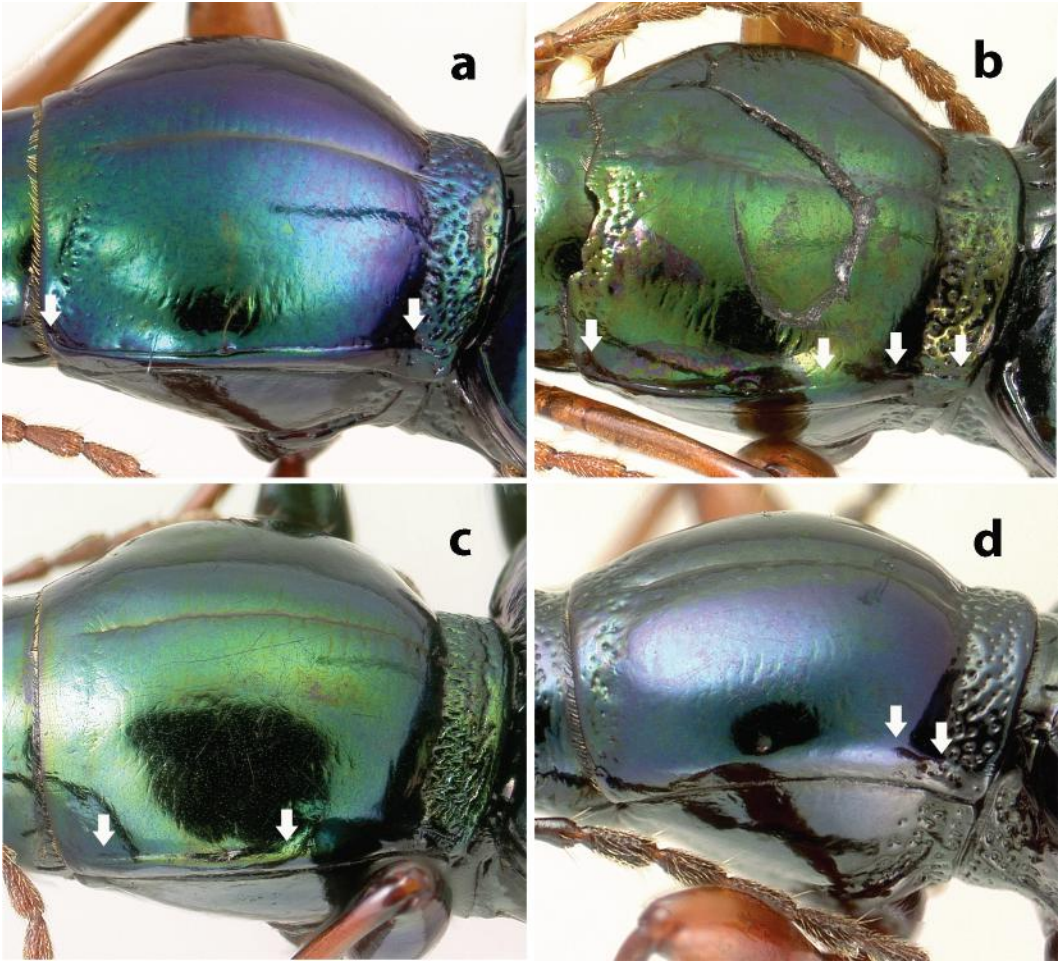


FIGURE 9. Prothorax, *Broscosoma* species, oblique left lateral aspect. a. a. *B. holomarginatum* sp. nov. (CASENT1016746; 0.5 km N of Kongdang, Dulongjiang Township, Gongshan County, Yunnan, China); b. *B. resbecqi* sp. nov. (Holotype; Siran Wang, Dulongjiang Township, Gongshan County, Yunnan, China); c. *B. ribbei* Putzeys (CASENT1025337; 0.5 km WSW of Maku village, Dulongjiang Township, Gongshan County, Yunnan, China); d. *B. purpureum* sp. nov. (CASENT1015871; Moqie Wang, Dulongjiang Township, Gongshan Yunnan, China). White arrows denote end points of lateral margination.

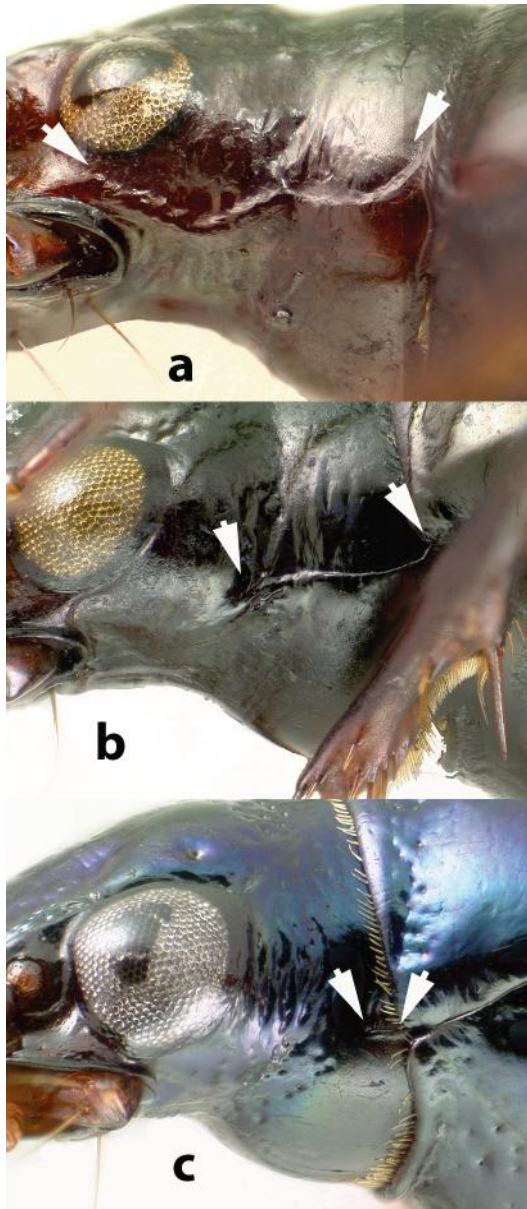


FIGURE 10. Head, *Broscosoma* species, lateral aspect. a. *B. furvum* sp. nov. (CASENT1020001; first cirque S of Shibali Yakou, Fugong County, Yunnan, China); b. *B. gaoligongense* Deuve and Wrase (CASENT1027285; just W of Fenxue Yakou, Pianma Township, County, Yunnan, China); c. *B. purpureum* sp. nov. (CASENT1015871; Moqie Wang, Dulongjiang Township, Gongshan Yunnan, China). White arrows denote endpoints of genal ridge.

Genus *Broscodera* Lindroth, 1961

Broscodera Lindroth, 1961:150. Type species: *Miscodera insignis* Mannerheim, 1852:296.

Sinobrosculus Deuve, 1990:186. Type species: *Sinobrosculus dreuxi* Deuve, 1990:187.

Diagnosis. Members of this genus can be distinguished from those of other broscine genera in the region by the following combination of character states: body small to moderate in size (BL<13.0 mm); body surface without metallic reflection; head with post-temporal transverse sulcus moderately deep and broadly or narrowly punctate; genal ridge present, extended from posterior region of head to ventral margin of eye; maxillae with three setae on eustipes, stipes with dorso-basal setae distinctly less than half as long as ventrobasal setae; mentum with one or two pairs of setae present, paramedial region deeply foveate; submentum with three or four pairs of setae; antennae with antennomere 3 with sparse pubescence in apical one-third to one half, antennomere 4 pubescent; pronotum with lateral margination (lateral bead) present and complete from apical margin to pronotal base, one pair of basolateral setae present; elytra with parascutellar seta absent, discal setae absent, umbilicate setal series comprised of one post-humeral and three preapical setae; male pro- and mesotarsi each with small pads of adhesive setae on tarsomeres 1 and 2 only.

Taxonomic notes. Members of the nominate subgenus (*Broscodera insignis*) have only one pair of setae on the mentum, those of subgenus *Sinobrosculus*, including those of both species described below, have two pairs of setae (Deuve 1990; Roig-Juñent 2000).

Diversity and geographical distribution. At present, this genus includes only four described species and two additional subspecies arrayed in two subgenera. *Broscodera* s. str. includes a single western North American species, and subgenus *Sinobrosculus* includes three described species and two additional subspecies. These previously described species of *Sinobrosculus* are recorded from Gansu and Sichuan Provinces, China and Nepal. The two new species described here represent the first species recorded from Yunnan Province.

1. *Broscodera (Sinobrosculus) chukuai* Kavanaugh and Liang, sp. nov.

Figures 5c, 8b, 11, 12, 40, 48-50

Type material. Holotype, a male, in IOZ, labeled: “CASENT 1026170”/ “CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.3 km NNE of Chukuai Lake, N27.98393°/E098.47491°”/ “3745 m, 19 August 2006, Stop #DHK-2006-081 D.H. Kavanaugh, J.A. Miller & D.Z. Dong collectors”/ “HOLOTYPE *Broscodera (Sinobrosculus) chukuai* Kavanaugh & Liang sp. nov. designated 2021” [red label]. Paratypes (a total of 31): three males and ten females (CAS, IOZ) labeled: same as holotype except first label: “CASENT 1026167” to “CASENT 1026169” and “CASENT 1026171” to “CASENT 1026180”, respectively; three males and four females (CAS, IOZ) labeled: “CASENT 1026771” to “CASENT 1026773” and “CASENT 1026774” to “CASENT 1026777”, respectively/ “CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan at Chukuai Lake, 3720 m,”/ “N27.98121°/E098.47580°, 18 August 2006, Stop #DHK-2006-079 D.H. Kavanaugh, J.A. Miller, D.Z. Dong & Y. Liu collectors”; two males (CAS, IOZ) labeled: “CASENT 1024860” and “CASENT 1024861”, respectively/ “CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, on slope NE of Chukuai Lake, 3950 m,”/ “N27.98206°/E098.48027°, 20 August 2006, Stop #DHK-2006-086 Y. Liu, P. Hu, D.Z. Dong & J. Wang collectors”; one male and two females (CAS, IOZ) labeled: “CASENT 1024904” and “CASENT 1024905” to “CASENT 1024906”, respectively/ “CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.8 km N of Chukuai Lake, N27.98785°/E098.47322°”/ “3920 m, 20 August 2006, Stop #DHK-2006-088 D.H. Kavanaugh,

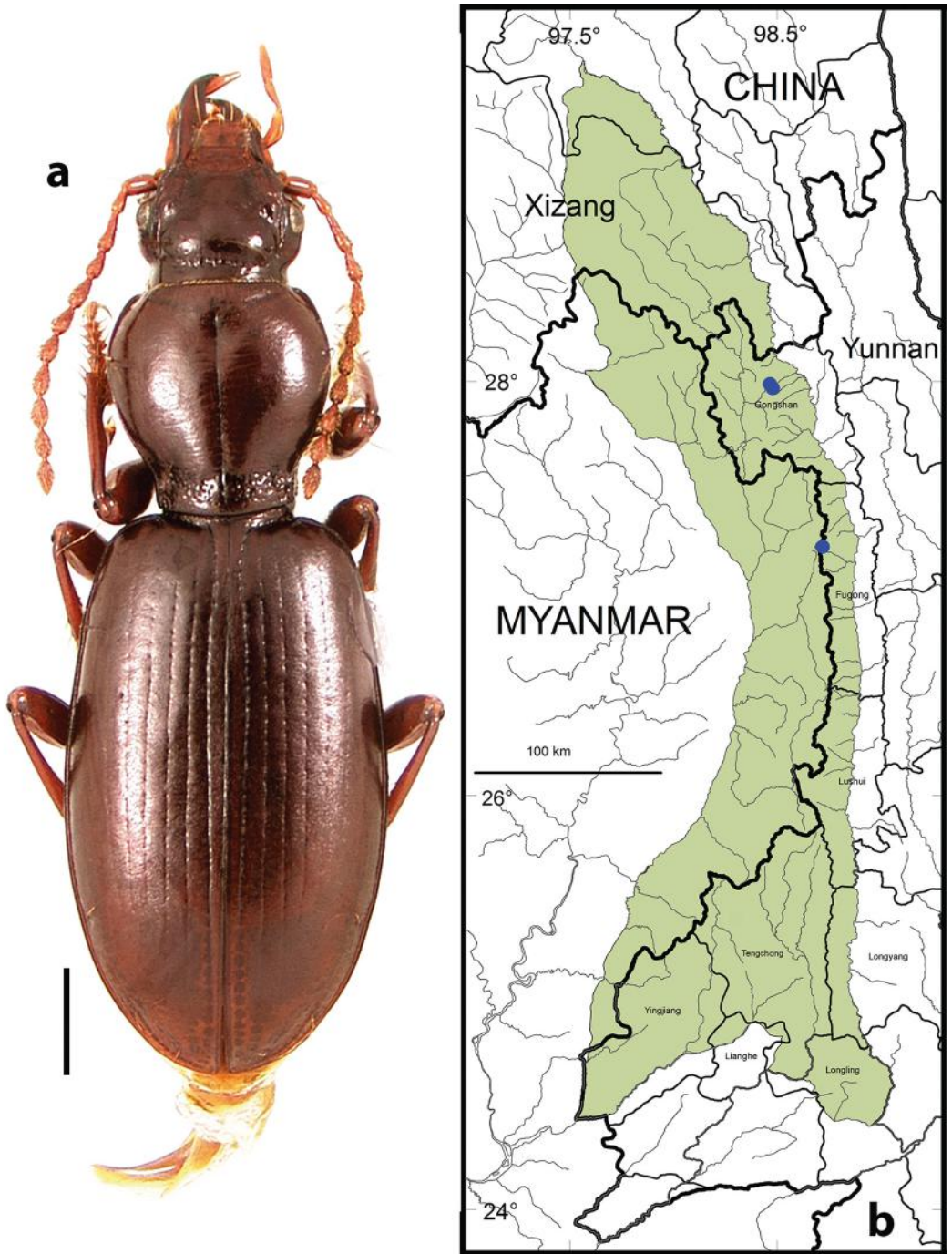


Figure 11. *Broscodera chukuai* sp. nov. a. Habitus (CASENT1026168; NNE of Chukuai Lake, Bingzhongluo, Gongshan County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

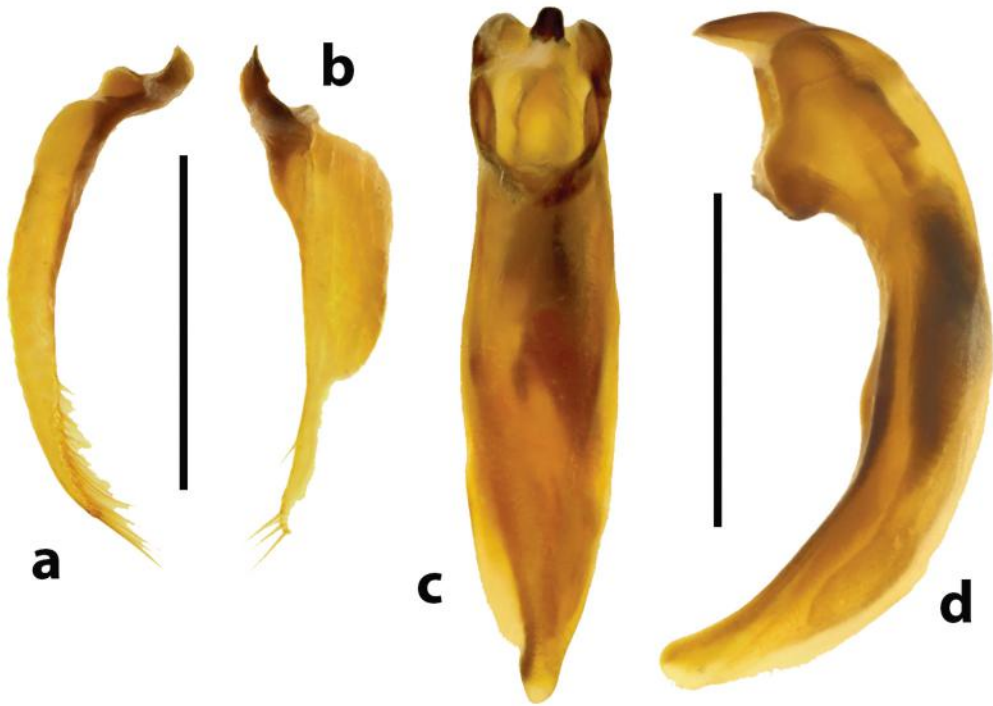


FIGURE 12. Male genitalia, *Broscodera chukuai* sp. nov. (CASENT1026169; NNE of Chukuai Lake, Bingzhongluo, Gongshan County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

J.A. Miller, J. Xiong, & C.H. Li collectors"; one male (CAS) labeled: "CASENT 1025034"/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpur Shan, 0.9 km N of Chukuai Lake,"/ "27.99005°/E098.47518°, 4035 m, 21 August 2006 Stop #DHK-2006-090 D.H. Kavanaugh collector"; one male and one female (CAS, IOZ) labeled: "CASENT 1025823" and "CASENT 1025824", respectively/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpur Shan, 0.3 km SW of Chukuai Lake at campsite, N27.97686°/E098.47799°"/ "3750 m, 19 August 2006, Stop #DHK-2006-082 Y. Liu collector; two females (CAS, IOZ) labeled: "CASENT 1017826" and "CASENT 1017827", respectively/ "CHINA, Yunnan, Fugong County, Lumadeng Township, second cirque S of Shibali Yakou at border post "31", N27.20333°/E098.69303°"/ "3710 m, 17 August 2005, Stop #DHK-2005-095, H.B. Liang, D.Z. Dong, & J.F.Zhang collectors"; one female (IOZ) labeled: "CASENT 1018367"/ "CHINA, Yunnan, Fugong County, Lishadi Township, headwaters of North Fork Yamu He just E of Shibali Yakou, 3450 m,"/ "N27.21034°/E098.70141°, 7 August 2005, Stop# LHB-05-52, H.B. Liang & J.F.Zhang collectors. All paratypes also bear the following label: "PARATYPE *Broscodera* (*Sinobrosculus*) *chukuai* Kavanaugh & Liang, sp. nov. designated 2021" [yellow label].

Type locality. China, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpur Shan, Chukuai Lake area.

Derivation of species name. The species epithet, *chukuai*, is a noun in apposition and derived from the name of a lake on the southwestern slope of Kawakarpur Shan, in the vicinity of which most of the specimens of the type series were found.

Diagnosis. Adults of this species (Fig. 11a) can be distinguished from those of other species in the region by the following combination of character states: size small, BL male = 8.0–8.8 mm, female = 7.8–9.5 mm; body color reddish-brown; head (Fig. 5c) with eyes small, only slightly convex, their diameter slightly less than length of tempora; frontal furrows deeply impressed, smooth and impunctate; vertex with post-temporal transverse sulcus deep, sharply impressed and only narrowly punctate along bottom of sulcus; gula smooth, without transverse grooves; antennomere 3 with pubescence on apical half; pronotum with posterior transverse impression shallow and vaguely delineated; elytra with lateral margins slightly arcuate, microsculpture comprised of distinct and deeply impressed isodiametric meshes; hindwings slightly reduced; prosternum, proepisternum, metasternum, and metepisternum smooth or faintly punctulate; hind trochanter unisetose; abdominal sternite VI of female with two pairs of apicoparamedial setae. Male genitalia as in Fig. 12; median lobe with ventral surface moderately concave with ventrolateral edges elevated and distinctly flanged near mid-length, especially on right edge; apex of apical lamella evenly rounded in lateral view.

Description. Fig. 11a. Size small, BL male = 8.0–8.8 mm, female = 7.8–9.5 mm, ratio EL/PL = 2.2–2.4. Body color reddish brown, all appendages reddish brown.

Head. Fig. 5c. Eyes small, only slightly convex, their diameter slightly less than length of tempora. Frontal furrows deeply impressed, narrow, smooth, impunctate. Vertex with post-temporal transverse sulcus deep, sharply impressed and only narrowly punctate along bottom of sulcus. Tempora roundly subangulate. Gula without transverse grooves.

Pronotum. Markedly cordate, moderately convex, narrowed posteriorly, widest distinctly anterior to middle of discal region; apical margination absent; lateral margination present, narrow, distinctly delineated throughout pronotal length; basal margination absent; anterior transverse impression absent or shallow and indistinct; median longitudinal impression moderately impressed; posterior transverse impression shallow and vaguely delineated; anterior region smooth, or faintly and sparsely rugulose; pronotal base coarsely punctate and rugulose; one pair of midlateral pronotal setae present at anterior one-third to one-fourth, one pair of basolateral pronotal setae present slightly anterior to basal angles.

Elytra. Elytral silhouette symmetrically subovoid, widest at or just behind middle, ratio EL/EW = 1.5–1.7, greatest elevation above lateral margin (in lateral view) posterior to middle; humeri distinctly present, roundly obtuse; lateral margins slightly arcuate; parascutellar striole present, short, distally merged in a distinct jog with free base of stria 1. Nine striae present; stria 1 moderately deeply and sharply impressed; striae 2 to 3, 4, or 5 moderately impressed in basal two-thirds and successively more shallowly impressed in apical third, striae 3 to 8 successively more shallowly impressed laterally and apically; stria 9 divergent medially from lateral groove in apical half; stria 1 moderately or finely punctate at least in basal half; striae 2 to 8 shallowly and sparsely punctate in basal two-thirds and successively more shallowly and sparsely punctate in apical third. Parascutellar setiferous pore absent, discal setae absent, umbilicate series comprised of one subhumeral and three subapical setae. Elytral microsculpture comprised of distinct and deeply impressed isodiametric sculpticells.

Hindwings. Slightly reduced, incapable of supporting flight.

Thoracic venter. Prosternum and proepisternum smooth or faintly punctulate, mesosternum and mesepisternum coarsely but sparsely punctate, metasternum and metepisternum smooth or faintly punctulate. Metepisternum ratio ML/MW = 2.0–2.1.

Legs. Hind trochanter unisetose. Tarsomeres with sparse long setae dorsally; tarsomere 5 with a single subapical pair of setae ventrally; male pro- and mesotarsi each with small pads of adhesive setae on tarsomeres 1 and 2.

Abdomen. Sternite VI of male with one pair of apicoparamedial setae, female with two pairs. Male genitalia. As in Fig. 12.

Comments. Members of this species can be distinguished from those of *B. gaoligongensis* by the features listed above in the key and diagnosis. They differ from members of all three subspecies of *B. dreuxi* from Sichuan Province, China in having a lighter body color (reddish-brown rather than dark brown to piceous), head with impunctate (rather than punctate) frontal furrows and the post-temporal transverse sulcus only narrowly (rather than more broadly) punctate, the elytral striae only finely (rather than more coarsely) punctate, and the median lobe of the male genitalia shorter, thicker, and slightly more arcuate in lateral view compared with the illustration provided by Deuve (1998:228). They differ from members of *Broscodera morvani* Deuve, 2004 from Gansu Province, China in having the eyes smaller, their diameter less than the length of the tempora (rather than greater than the temporal length), the antennae with antennomere 2 (the pedicel) longer, antennomere 3 with pubescence in its apical half (rather than without pubescence in addition to the apical setal whorl), the pronotum relatively longer and with a single midlateral seta on each side (rather with than two or three such setae), the elytral silhouette elongate-subovoid with the lateral margins less rounded (rather than shorter, more ovoid, and with more markedly rounded lateral margins), and the median lobe of the male genitalia shorter, thicker, and more arcuate in lateral view (compared with the illustration provided for *B. morvani* (Deuve 2004, Fig. 3). Members of *B. chukuai* differ from those of *Broscodera holzschuhi* Wrase, 1995 from Nepal in having smaller eyes, their diameter less than the length of the tempora (rather than greater than the temporal length), the pronotum relatively shorter and broader and widest distinctly anterior to mid-length (rather than closer to mid-length), and the elytral silhouette relatively shorter, broader, laterally more evenly curved throughout, and widest at or closer to midlength (rather than laterally nearly straight in basal half and more curved posteriorly and widest near two-thirds elytral length). We have not examined a male of *B. holzschuhi* for comparison of the genitalia.

Habitat distribution. Members of this species have been found under stones on open slopes above treeline, under deeply embedded stones on organic substrate in alpine tundra areas and near snow patches (Fig. 40a), and under stones on the upper banks of meltwater streams and on adjacent tundra flats. Specimens collected in Fugong County near Shibali Yakou were found under stones on organic soil along a small stream and in bamboo thickets (Fig. 40b). Within the Gaoligong Shan region, this species occurs at relatively high elevations, with our records documenting its occurrence in the 3450 to 4035 m range (Fig. 49).

Geographical distribution within the Gaoligong Shan. Fig. 11b. We examined a total of 32 specimens (12 males and 20 females) from the northern to the northcentral part of the Gaoligong Shan in Fugong and Gongshan Counties. Our records from Gongshan and Fugong Counties are on the eastern side of the range (in Core Areas 2 and 3, respectively (Fig. 48) (see Type material above for exact collection data).

Overall geographical distribution. This species currently is known only from the northern to northcentral part of the Gaoligong Shan, in western Yunnan Province, China.

Geographical relationships with other *Broscodera* species. As noted below for *B. gaoligongensis*, the known geographical range of that species partially overlaps with that of *B. chukuai*, but they have not been found together (Fig. 50) and appear to occupy non-overlapping altitudinal ranges. No other described species of *Broscodera* has been recorded from Yunnan Province.

2. *Broscodera (Sinobrosculus) gaoligongensis* Kavanaugh and Liang, sp. nov.

Figures 5d, 8a, 13, 14, 41, 48-50

Type material. Holotype, a male, in IOZ, labeled [in Chinese]: Yunnan, Lushui, Yaojiaping, 2500 m, Chinese Academy of Sciences"/ "1981.VI.1, Liao Subai coll."/ "HOLOTYPE *Broscodera (Sinobrosculus) gaoligongensis* Kavanaugh & Liang sp. nov. designated 2021" [red label]. Paratypes (a total of 16): four females (IOZ) labeled [in Chinese]: same as holotype; two females (IOZ) labeled [in Chinese]: same first label same as holotype, second label "1981.VI.2, Wang Shuyong coll."; one male (IOZ) labeled [in Chinese]: same first label as holotype, second label "1981.VI.4, Wang Shuyong coll."; one male and three females (CAS, IOZ) labeled [in Chinese]: same first label as holotype, second label "1981.VI.6, Liao Subai coll."; two females (IOZ) labeled [in Chinese]: same first label as holotype, second label "1981.VI.6, Zhao Jianming coll."; one female (IOZ) labeled: "Yunnan, Lushui, Pianma, 2300 m, Chinese Academy of Sciences"/ "1981.V.29, Wang Shuyong coll."; one male (CAS) labeled: "CASENT 1020104"/ "CHINA, Yunnan, Fugong County, Lumadeng Township, South Fork Yamu He, 1.3 km E of Lao Shibali, 2250 m, N27.08180°/E98.78670°,"/ "15 August 2005, Stop# DHK-2005-087, D.H. Kavanaugh, H.B. Liang, & J.F. Zhang collectors; one female (CAS) labeled: "CASENT 1001456"/ "CHINA, Yunnan Province, Gaoligong Shan, Nujiang Prefecture, Gongshan County, Danzhu He drainage, 13.5-15.7 airkm SSW of Gongshan [Cikai], 2700-3100 m,"/ "N27.63063°/E98.62074° to N27.62705°/E98.59204°, 30 June – 5 July 2000, Stop#00-17A, D.H. Kavanaugh, C.E. Grosword [sic], Liang H.-B., D. Ubick, & Dong D.-Z. collectors". All paratypes also bear the following label: "PARATYPE *Broscodera (Sinobrosculus) gaoligongensis* Kavanaugh & Liang, sp. nov. designated 2021" [yellow label].

Type locality. China, Yunnan, Lushui, Luzhang Township, Yaojiaping, 2500 m.

Derivation of species name. The species epithet, *gaoligongensis*, is derived from the name of the mountain range, the Gaoligong Shan, in which all specimens of the type series were collected, and the Latin suffix, *-ensis*, denoting place.

Diagnosis. Adults of this species (Fig. 13a) can be distinguished from those of other species in the region by the following combination of character states: size medium, BL male = 10.0–11.2 mm, female 10.2–11.2 mm; body color dark brown to piceous; head (Fig. 5d) with eyes small but moderately convex, their diameter about equal to length of tempora; frontal furrows moderately impressed, shallowly punctate; vertex with post-temporal transverse sulcus deep, sharply but slightly more broadly impressed, more densely, coarsely, and widely punctate; gula with shallow, vaguely defined transverse grooves; antennomere 3 with sparse pubescence mainly in apical one-third; pronotum with posterior transverse impression moderately deep, but vaguely delineated; elytra with lateral margins moderately arcuate, microsculpture comprised of distinctly but shallowly impressed isodiametric meshes; hindwings full-sized; prosternum, proepisternum, metasternum, and metepisternum coarsely but sparsely punctate; hind trochanter asetose; abdominal sternite VI of female with one pair of apicoparamedial setae. Male genitalia as in Fig. 14; median lobe with ventral surface faintly concave and with ventrolateral edges only faintly elevated and without distinct flange near mid-length; apex of apical lamella slightly asymmetrical and slightly pointed in lateral view.

Description. Fig. 13a. Size medium, BL male = 10.0–11.2 mm, female 10.2–11.2 mm, ratio EL/PL = 2.4–2.5. Body color piceous, or dark brown, all appendages reddish brown.

Head. Fig. 5d. Eyes small, moderately convex, their diameter about equal to length as tempora. Frontal furrows moderately impressed, narrow, distinctly divergent posteriorly, shallowly punctate. Vertex with post-temporal transverse sulcus deep, sharply impressed and densely and coarse-

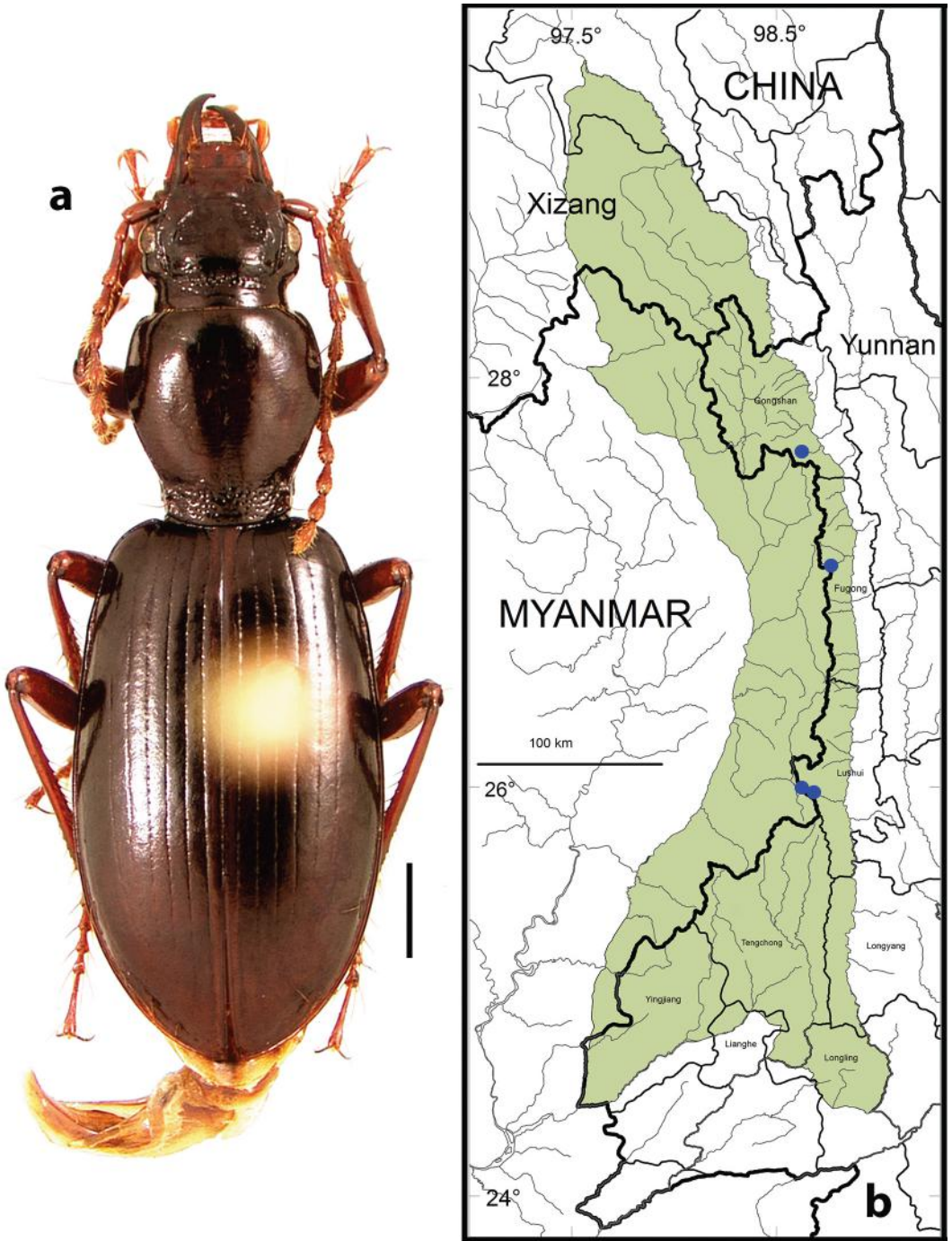


FIGURE 13. *Broscodera gaoligongensis* sp. nov. a. Habitus (CASENT1020104; South Fork of Yamu He, Lumadeng Township, Fugong County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

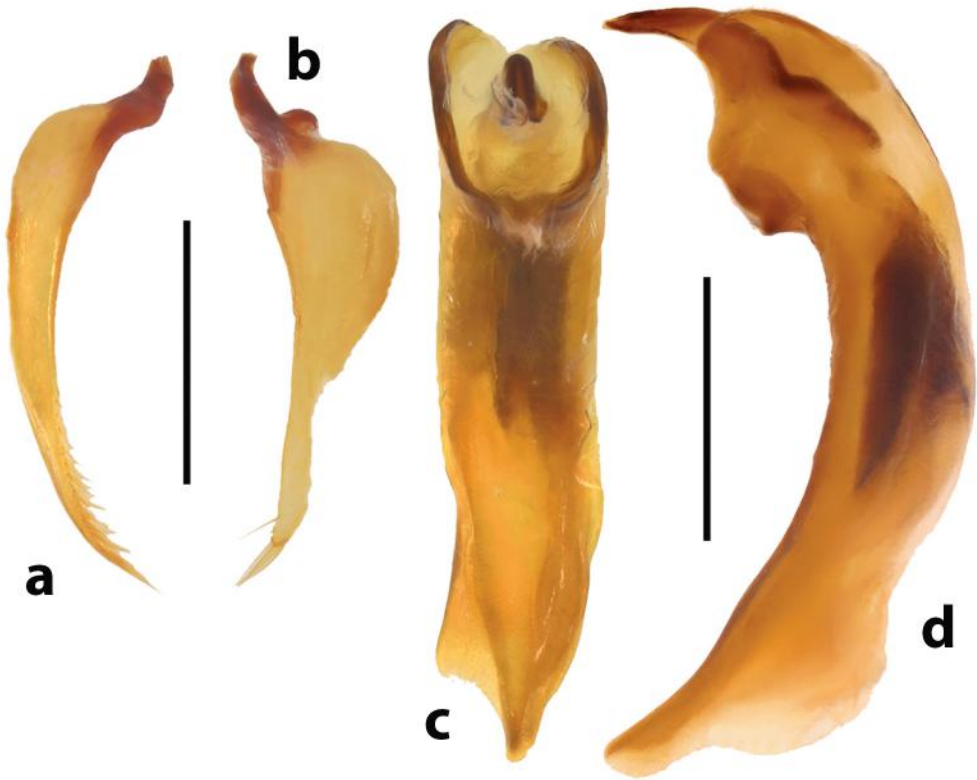


FIGURE 14. Male genitalia, *Broscodera gaoligongensis* sp. nov. (Yaojiaping, Lushui County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

ly punctate. Tempora slightly swollen, roundly subangulate. Gula with shallow, vaguely defined transverse grooves.

Pronotum. Markedly cordate, moderately convex, narrowed posteriorly, widest distinctly anterior to middle of discal region; apical margination absent; lateral margination present, narrow, distinctly delineated throughout pronotal length; basal margination absent; anterior transverse impression absent or shallow and indistinct; median longitudinal impression moderately impressed; posterior transverse impression moderately deep, but vaguely delineated; anterior region of disk smooth; pronotal base coarsely punctate and rugulose; one pair of midlateral setae present at anterior one-third to one-fourth of discal region; one pair of basolateral setae present slightly anterior to basal angles.

Elytra. Elytral silhouette symmetrically subovoid, ratio EL/EW = 1.7, widest at or just behind middle, greatest elevation above lateral margin (in latateral view) posterior to middle; humeri distinctly present, roundly obtuse; lateral margins moderately arcuate; parascutellar striole present, short, distally merged in a distinct jog with free base of stria 1. Nine striae present; stria 1 moderately deeply and sharply impressed (more shallowly impressed in some specimens), striae 2 to 3, 4, or 5 sharply and deeply impressed in basal two-thirds and successively more shallowly impressed in apical third, striae 3 to 8 successively more shallowly impressed laterally and apically, stria 9 divergent medially from lateral groove in apical half; stria 1 moderately punctate at least

in basal half, striae 2 to 8 successively more shallowly and sparsely punctate both laterally and apically. Parascutellar setiferous pore absent, discal setae absent, umbilicate series comprised of one subhumeral and three subapical setae. Elytral microsculpture comprised of distinctly but shallowly impressed isodiametric meshes.

Hindwings. Full-sized, functional.

Thoracic venter. Prosternum, proepisternum, mesosternum and mesepisternum, metasternum, and metepisternum coarsely but sparsely punctate. Metepisternum ratio ML/MW = 2.1–2.2.

Legs. Hind trochanters asetose (one seta found unilaterally in one specimen). Tarsomeres with sparse long setae dorsally; tarsomere 5 with a single subapical pair of setae ventrally. Male pro- and mesotarsi each with small pads of adhesive setae on tarsomeres 1 and 2.

Abdomen. Sternite I coarsely and sparsely punctate. Sternite VI of both males and females with one pair of apicoparamedial setae.

Male genitalia. As in Fig. 14.

Comments. Members of this species can be distinguished from those of *B. chukuai* by the features listed above in the key and diagnosis. They differ from members of all three subspecies of *B. dreuxi* in having the eyes more convex and the tempora more swollen and roundly angulate (rather than more smoothly rounded), the elytral striae only finely (rather than more coarsely) punctate, and the median lobe of the male genitalia shorter, thicker, and slightly more arcuate in lateral view compared with the illustration provided by Deuve (1998:228). They differ from members of *B. morvani* in having the eyes smaller, their diameter about equal to the length of the tempora (rather than greater than the temporal length), the antennae with antennomere 2 (the pedicel) longer, antennomere 3 with pubescence in at least its apical one-third (rather than without pubescence in addition to the apical setal whorl), the pronotum relatively longer and with a single mid-lateral seta on each side (rather with than two or three such setae), the elytral silhouette elongate-subovoid with the lateral margins less rounded (rather than shorter, more ovoid, and with more markedly rounded lateral margins), and the median lobe of the male genitalia shorter, thicker, and more arcuate in lateral view (compared with the illustration provided for *B. morvani* (Deuve 2004, Fig. 3). They differ from members of *B. holzschuhi* in having smaller eyes, their diameter about equal to the length of the tempora (rather than greater than the temporal length), the tempora more swollen and roundly angulate (rather than more smoothly rounded), the pronotum relatively shorter and broader and widest distinctly anterior to mid-length (rather than closer to mid-length), and the elytral silhouette relatively shorter, broader, laterally more evenly curved throughout, and widest at or closer to midlength (rather than laterally nearly straight in basal half and more curved posteriorly and widest near two-thirds elytral length). Again, we have not examined a male of *B. holzschuhi* for comparison of the genitalia.

Habitat distribution. Members of this species have been found under large stones along roadcuts at the base of cutbanks (Fig. 41b) and on the rocky banks of small to moderate-sized streams (Fig. FX41a). Within the Gaoligong Shan region, this species occurs at moderate elevations, with our records documenting its occurrence in the 2300 to 3100 m range (Fig. 41b).

Geographical distribution within the Gaoligong Shan. Fig. 13b. We examined a total of 17 specimens (six males and 11 females) from the northern to the southcentral part of the Gaoligong Shan in Fugong, Gongshan and Lushui Counties. Our records from Gongshan and Fugong Counties are on the eastern side of the range (in Core Areas 2 and 3, respectively) but those from Lushui County are from both western and eastern slopes (Core Areas 4 and 5, respectively) (Fig. 48) (see Type material above for exact collection data).

Overall geographical distribution. This species currently is known only from the northern to southcentral part of the Gaoligong Shan, in western Yunnan Province, China.

Geographical relationships with other *Broscodera* species. The northern and northcentral part of the geographical range of this species overlaps with that of *Broscodera chukuai*. However, we have not found the two species together (syntopic) (Fig. 50) and our records suggest that they occupy non-overlapping altitudinal ranges and therefore are unlikely to co-occur. *Broscodera gaoligongensis* appears to be restricted to elevations below 3100 m and mainly well below that level, whereas *B. chukuai* has been found only at elevations above 3400 m (Fig. 49). The ranges of the other described species do not include Yunnan Province.

Genus *Broscosoma* Rosenhauer, 1846

Broscosoma Rosenhauer, 1846:1. Type species: *Broscosoma baldense* Rosenhauer, 1846:4.

Diagnosis. Members of this genus can be distinguished from those of other broscine genera in the region by the following combination of character states: body small to moderate in size (BL >13.0 mm); body surface with or without metallic reflection; head with post-temporal transverse sulcus moderately deep and broadly or narrowly punctate; genal ridge present, but varied in extent; maxillae with two setae on eustipes, stipes with dorsobasal setae at least half as long as ventrobasal setae; mentum with one pair of setae present, paramedial region moderately to deeply foveate; submentum with one to three pairs of setae; antennae with antennomeres 3 and 4 glabrous except for apical whorl of fixed setae; pronotum with basolateral setae absent; elytra with parascutellar seta present, umbilicate setal series comprised of one post-humeral and two preapical setae; male pro-tarsi with pads on adhesive setae ventrally on tarsomeres 1 to 3, and mesotarsi with pads of adhesive setae on tarsomeres 1 and 2.

Taxonomic notes. The generic diagnosis presented above properly applies only among those species occurring in the study area. Members of some species of the genus occurring elsewhere present exceptions to several of the character states listed. Even the features most widely applied as characteristic of the genus are subject to exceptions, including among species of the study area. Roig-Juñent (2000) distinguished *Broscosoma* species from *Miscodera arctica* (Paykull), 1798 principally on differences in the lateral margination of the pronotum (present in *Miscodera* and absent from *Broscosoma*) and paramedial foveae on the mentum (present in *Miscodera* and absent from *Broscosoma*). However, we have found lateral margination of the pronotum present in at least some form (Figs. 9a-d) in several of the species occurring in the study area and fully present in members of one species. Similarly, we have found that members of most *Broscodera* species in the study area have at least shallow paramedial foveae on the mentum, and one species has foveae comparably deep to those of *M. arctica* members. Other features listed by Roig-Juñent in his description of the genus are also subject to greater variation among *Broscosoma* species in the study area than was represented in his sample of only three species. Among these are development of the genal (or “temporal”) ridge (Figs. 10a-d), number of pairs of setae on the submentum, and pubescence on antennomere 4.

Since Sciaky and Facchini (2005) presented their excellent key to the *Broscosoma* species of China, the number of species known from that country has more than tripled, from eight to 26, not including any of the species newly described herein. Clearly, a new key to Chinese species is needed; but new species continue to be discovered (see Jiang et al. 2020 and Jiang et al. 2021 for the most recent additions) at such a rate as to make creating such a key a rapidly ‘moving target’, which we plan to attempt, nonetheless, in the near future.

Diversity and geographical distribution. To date, 43 species and an additional five subspecies of *Broscosoma* have been described. The genus is strictly Palearctic in distribution, with a range extended from the Alps of northern Italy eastward to Japan and Taiwan, but with wide dis-

junctions apparent. The main distributional gaps occur between (1) northern Italy and the Caucasus Mountains, (2) the Caucasus and the Himalaya in central Nepal, and (3) Chongqing and Shaanxi Provinces and Fujian Province, Taiwan, and Japan.

3. *Broscosoma bicoloratum* Kavanaugh and Liang, sp. nov.

Figures 7c, 8c, 15, 16, 42, 48-50

Type material. Holotype, a male, in IOZ, labeled: “CASENT 10265704”/ “CHINA, Yunnan, Gongshan County, Dulongjiang Township, NW slope of Heipu Yakou, 3350m” N27.77437°/E098.44793°”/ “13 August 2006, Stop # DHK-2006-075, D.H. Kavanaugh & J.A. Miller collectors”/ “HOLOTYPE *Broscosoma bicoloratum* Kavanaugh & Liang, CH-04 Kavanaugh & Liang sp. nov. designated 2021” [red label]. Paratypes (a total of 29): two males and one female (CAS, IOZ) labeled: same as holotype except first label: “CASENT 10265703” and “CASENT 10265705” and “CASENT 10265706”, respectively; three males and five females (CAS, IOZ) labeled: “CASENT 1006243”, “CASENT 1006245”, “CASENT 1008140” and “CASENT 1008141” to “CASENT 1008145”, respectively/ “CHINA, Yunnan Province, Gaoligong Shan, Nujiang Prefecture, Nujiang State Nature Reserve, Dulong/Gongshan Yakou area, 21 airkm W of Gongshan”/ “3300-3680m, 16-17 July 2000, Stop #00-24C, D.H. Kavanaugh, C.E. Griswold, H.-B. Liang, D. Ubick & D.-Z. Dong collectors”; one female (IOZ) labeled: “CASENT 1025606”/ “CHINA, Yunnan, Gongshan County, Cikai Township, southeastern slope of Heipu Yakou, 3365m” /N27.77032°/E098.44674°”/ “11 August 2006, Stop # DHK-2006-069B, D.H. Kavanaugh, D.Z. Miller, D.-Z. Dong & Y. Liu collectors”; one male and two females (CAS, IOZ) labeled: “CASENT 1025709” to “CASENT 1025710” to “CASENT 1025711”, respectively/ “CHINA, Yunnan, Gongshan County, Cikai Township, southeastern slope of Heipu Yakou, 3365m”/ “N27.77032°/E098.44674°” “11 August 2006, Stop # DHK-2006-072, Y. Liu collectors”; two males and three females (CAS, IOZ) labeled: “CASENT 1026544” to “CASENT 1026545” and “CASENT 1026546” and “CASENT 10265548”, respectively/ “CHINA, Yunnan, Gongshan County, Cikai Township, southeastern slope of Heipu Yakou, 3365m” /N27.77032°/E098.44674°”/ “13 August 2006, Stop # DHK-2006-074, D.-Z. Dong & Y. Liu collectors”; one male and one female (CAS, IOZ) labeled: “CASENT 1033874” and “CASENT 1033875”, respectively/ “CHINA, Yunnan, Gongshan County, Cikai Township, headwaters South Fork Qiqi He on SE slope below Qiqi-Dulong Yakou, 3570 m,”/ “N27.69490°/E098.45646°, 27 September 2007, Stop# 2007-053, D.H. Kavanaugh, H.B. Liang, & H.L. Shi collectors”; one male (IOZ) labeled: “CASENT 1033984”/ “CHINA, Yunnan, Gongshan County, Cikai Township, Qiqi Trail SE of Qiqi-Dulong Yakou, 3525 m, N27.69367°/E098.46004°,”/ “29 September 2007, Stop# 2007-057, D.H. Kavanaugh & H.B. Liang collectors”; three males and one female (CAS, IOZ) labeled: “CASENT 1034174” to “CASENT 1034176” and “CASENT 1034177”, respectively/ “CHINA, Yunnan, Gongshan County, Cikai Township, Qiqi-Dulong Yakou, 3675 m, N27.69659°/E098.45398°,”/ “27 September 2007, Stop# HBL-2007-05A, H.B. Liang, H.L. Shi, & X.J. Feng collectors”; one male (IOZ) labeled: “CASENT 1033899”/ “CHINA, Yunnan, Gongshan County, Cikai Township, Qiqi-Dulong Yakou, 3675 m, N27. 69653°/E098.45393°, 27-29 September 2007,”/ Stop# 2007-054, D.H. Kavanaugh, H.B. Liang, & H.L. Shi collectors, in pitfall trap”; one male (IOZ) labeled: “CASENT 1034187”/ “CHINA, Yunnan, Gongshan County, Cikai Township, Qiqi-Dulong Yakou, 3675 m, N27.70401°/E098.45398°, 27-29 September 2007,”/ Stop# HBL-2007-05B, H.B. Liang, H.L. Shi, & X.J. Feng collectors, in pitfall traps”. All paratypes also bear the following label: “PARATYPE *Broscosoma bicoloratum* Kavanaugh & Liang, sp. nov. designated 2021” [yellow label].

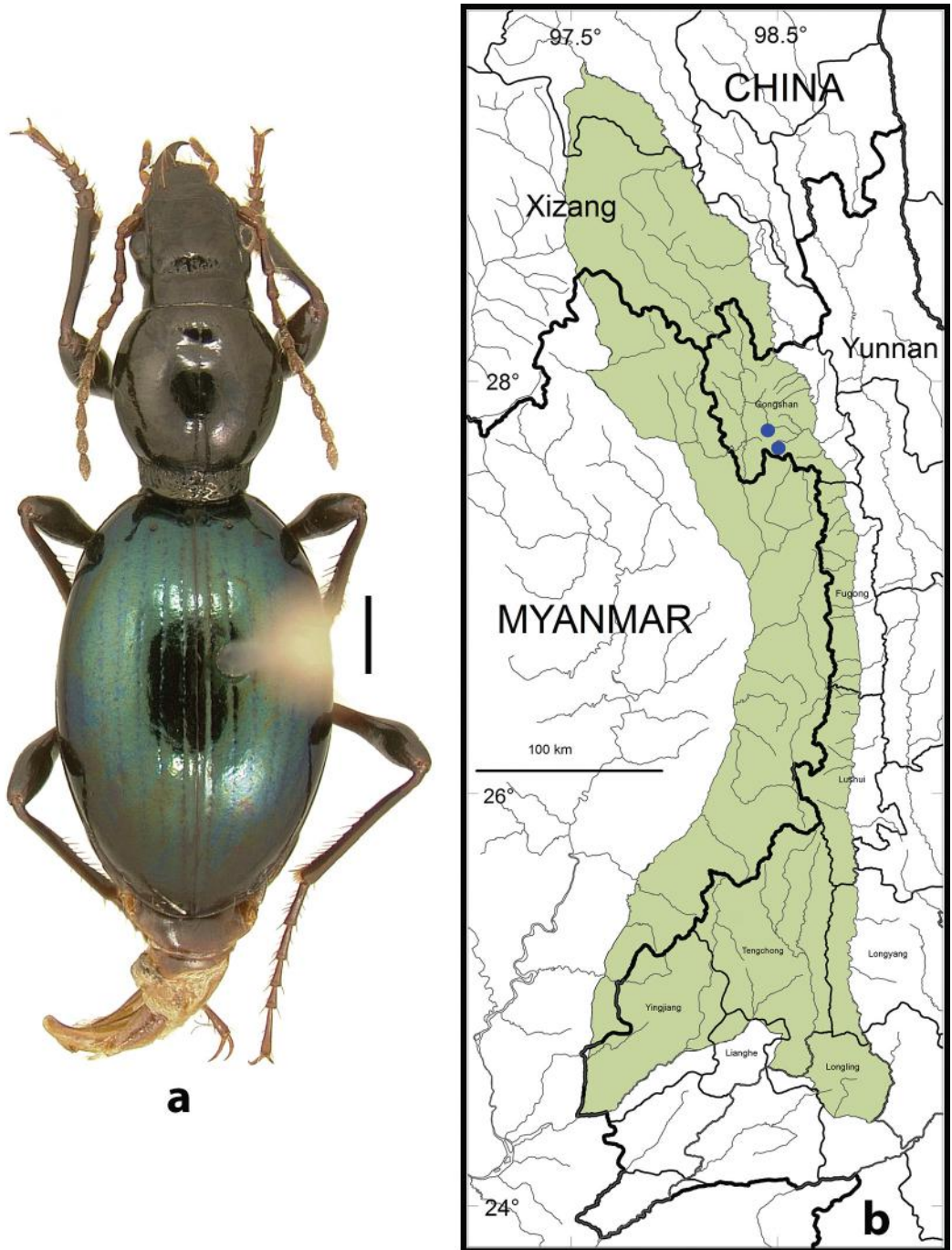


FIGURE 15. *Broscosoma bicoloratum* sp. nov. a. Habitus (CASENT1026704; slope NW of Heipu Yakou, Dulongjiang Township, Gongshan County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

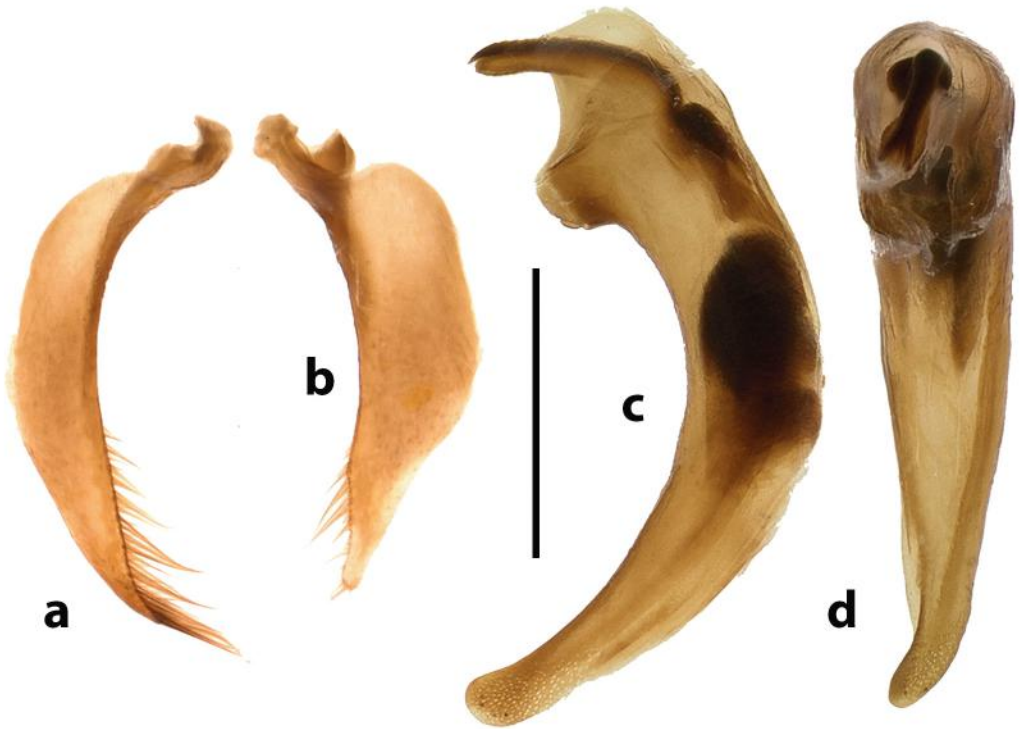


FIGURE 16. Male genitalia, *Broscosoma bicoloratum* sp. nov. (CASENT1025709; southeast slope of Heipu Yakou, Cikai Township, Gongshan County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

Type locality. CHINA, Yunnan, Gongshan County, Dulongjiang Township, NW slope of Heipu Yakou, 3350 m.

Derivation of species name. The species epithet, *bicoloratum*, is an adjective derived from the Latin words, *bis*, meaning two, and *coloratus*, meaning colored. The name refers to the distinct color difference in dorsal view between the forebody (black) and the elytra (metallic green or bluish-green) in members of this species.

Diagnosis. Adults of this species (Fig. 15a) can be distinguished from those of other species in the region by the following combination of character states: size moderate, BL = 9.6 to 10.8 mm; head and pronotum black to piceous, without metallic reflection (except a few specimens with a faint metallic green band across anterior part of pronotum anterior to the anterior transverse impression); head with tempora distinctly convex behind eyes (Fig. 7c); genal ridge varied, extended from base of head to just anterior to temporal constriction or to below ventral margin of eye; antennomeres 3 and 4 glabrous except for apical whorl of setae; pronotum globose anterior to sub-basal constriction (Fig. 7c), lateral margination absent, basolateral setae absent; elytral silhouette ovoid, with humeri indistinct, elytral microsculpture effaced or extremely faintly impressed; meta-trochanters asetose (except unisetose unilaterally in very few specimens); male protarsi with tarsomeres 1 to 3 with ventral pads of adhesive setae; male genitalia as in Fig. 16.

Description. Fig. 15a. Size medium, BL male = 10.3–10.8 mm, female = 9.6–10.8 mm, ratio EL/PL of male and female = 2.1–2.2. Body color black or dark piceous, last visible abdominal sternite dark brown or rufous brown, antennae with all antennomeres rufous brown, femora black, dark

piceous, or reddish brown, tibiae and tarsi reddish brown. Head and pronotum without metallic reflection (except a few specimens with a faint metallic green band across anterior part of pronotum anterior to the anterior transverse impression), elytra with distinct green or greenish-blue metallic reflection, venter without metallic reflection.

Head. Fig. 7c. Eyes medium-sized, their diameter equal to or slightly greater than length of tempora. Frontal furrows deeply impressed, narrow to broad, arcuate, slightly convergent anteriorly and posteriorly, long, extended posteriorly beyond middle of eyes, rugulose, impunctate. Vertex with post-temporal sulcus deep, sharply defined, very sparsely and finely punctate to moderately punctate. Tempora obliquely convex. Genal ridges present, extended from base of head anteriorly to slightly beyond the post-temporal constriction or to the ventral margins of the eyes. Clypeus with one pair of setae. Supraorbital setae present, one pair. Eustipes of maxilla with two setae, the dorsobasal seta distinctly more than half as long as ventrobasal seta. Mentum with tooth present, simple, paramedial region shallowly foveate, one pair of mental setae present. Glosal sclerite (ligula) with one pair of setae. Submentum with one or two pairs of setae. Gula without transverse grooves. Antennomeres 3 and 4 without pubescence, ratio $A3/A5 = 1.1-1.2$.

Pronotum. Fig. 7c. Globose anterior to sub-basal constriction with base distinctly pedunculate, widest at middle of discal region, ratio $PL/PW = 1.1-1.2$, disk markedly convex; apical, lateral, and basal margination absent; anterior transverse impression shallow, broad and vaguely delineated, coarsely punctate both at bottom and on slopes of depression; median longitudinal impression moderately impressed; posterior transverse impression deep, sharply delineated; anterior region sparsely to densely punctate and rugulose; pronotal base coarsely punctate and rugulose; one pair of midlateral pronotal setae present at mid-length of discal region; basolateral pronotal setae absent.

Elytra. Elytral silhouette ovoid, short, widest at middle, ratio EL/EW male = 1.5–1.6, female = 1.5, greatest elevation above lateral margin (in lateral view) posterior to middle; humeri narrow, sloped, indistinct; lateral margins markedly arcuate, or markedly arcuate and faintly angulate sub-basally; parascutellar striole present, short, distally merged in a distinct jog with free base of stria 1. Eight elytral striae present; stria 1 moderately deeply and sharply impressed, striae 2 to 3, 4, or 5 moderately or shallowly impressed in basal two-thirds of striae and successively more shallowly impressed in apical third and laterally, lateral striae indistinct in some specimens, striae 8 merged with lateral groove throughout its length or nearly so; stria 1 moderately punctate at least in basal half, striae 2 to 8 moderately to coarsely punctate in basal half and successively more finely and sparsely punctate in apical half and laterally. Elytral microsculpture effaced or only very faintly impressed. Parascutellar seta present at base of stria 2 in most specimens, on base of interval 3 or near base of stria 3 in a few specimens, discal setae absent, umbilicate series of elytral setae comprised of one post-humeral and two preapical setae.

Hindwings. Vestigial, incapable of supporting flight.

Thoracic venter. Metepisternum ratio $ML/MW = 1.5-1.7$.

Legs. Hind trochanter asetose. Tarsomeres without dorsal pubescence; tarsomere 5 with two or more pairs of setae ventrally; male protarsi with pads of adhesive setae on tarsomeres 1 to 3 ventrally, male mesotarsi with pads of adhesive setae on tarsomeres 1 and 2 ventrally.

Abdomen. Sternite VI of male with one to three pairs of apicoparamedial setae, of female with one pair of setae.

Male genitalia: As in Fig. 16.

Comments. This is one of four species in the study area members of which have the elytra with distinct metallic reflection but the forebody (head and pronotum) without metallic reflection or with that reflection confined to the pronotal area anterior to the anterior transverse impression.

Most members of *B. bicoloratum* have the pronotum without a trace of metallic reflection, but a few specimens have that anterior area with a faint metallic green band. That green band is found elsewhere only in all members of *B. viridicollare*, which are generally larger, have the elytral microsculpture moderately distinctly impressed (effaced or nearly so in *B. bicoloratum*), and median lobe of the male genitalia longer, slightly less arcuate, and with the apical lamella slightly broader (Fig. 35c). *Brosocosoma gaoligongense* members also have the forebody without metallic reflection, but they have the parascutellar setiferous pore inserted near the base of stria 3 (near base of stria 2 in most *B. bicoloratum* specimens), have the metatrochanter unisetose (asetose in most specimens of *B. bicoloratum*, but with a seta present unilaterally in a few specimens) and the eyes (Fig. 7d) slightly less convex (more convex in *B. bicoloratum*). Members of the fourth species, *Brosocosoma gongshanense*, have the eyes less convex (Fig. 7e), the tempora shorter and nearly straight (tempora longer and distinctly more convex in *B. bicoloratum*), and the discal portion of the pronotum very slightly more elongate. The male genitalia of these two species are quite similar but differ in the shapes of the sclerites of the internal sac of the median lobe.

Among *Brosocosoma* species known from outside the study area, members of only one species, *Brosocosoma monticola* Habu, 1973, from Nepal, have the forebody without metallic reflection and markedly contrasting with the very distinct metallic reflection seen on the elytra in most specimens. However, *B. monticola* members have the genal ridge confined to the region from the post-temporal groove to the base of the head (extended anteriorly to ventral margin of eye in most *B. bicoloratum* specimens) and the median lobe of the male genitalia with a large protuberance on the ventral margin (see Habu 1973, fig. 6), which is absent from the median lobe of *B. bicoloratum* males.

Habitat distribution. In daytime, members of this species have been found under stones in moist alpine meadow areas (Fig. 42a) and along roadcuts and trails through bamboo and *Rhododendron* thickets (Fig. 42b). The beetles are active on the surface at night in the same areas, particularly in areas with a cover layer of mosses. Our records document occurrence of this species at moderately high elevations in the 3300 to 3675 m range (Fig. 49).

Geographical distribution within the Gaoligong Shan. Fig. 15b. We examined a total of 30 specimens (16 males and 14 females) from the northern part of the Gaoligong Shan in Gongshan County. Our records are all from the crest of the range and adjacent western and eastern slopes (in Core Areas 1 and 2, respectively (Fig. 48) (see Type material above for exact collection data).

Overall geographical distribution. This species has been recorded only from the crest of the Gaoligong Shan in Gongshan County in western Yunnan Province China.

Geographical relationships with other *Brosocosoma* species. Members of this species have been found together only with those of *Brosocosoma gongshanense* (described below) at one or more sites (Fig. 50). *Brosocosoma ribbei* occurs in the same general area but mainly at lower elevations.

4. *Brosocosoma danzhuense* Kavanaugh and Liang, sp. nov.

Figures 6e, 17, 43, 48-50

Type material. Holotype, a female, in IOZ, labeled: "CASENT 1004637"/"CHINA, Yunnan Province, Gaoligong Shan, Nujiang Prefecture, Gongshan County, Danzhu He drainage, 13.5-13.8 airkm SSW of Gongshan [Cikai], 2720-2840 m,"/ "N27.63267°/E98.60861° to"/ "N27.63331°/E98.60356°, 30 June – 5 July 2000, Stop#00-17E, D.H. Kavanaugh, C.E. Grosword [sic], Liang H.-B., D. Ubick, & Dong D.-Z. Collectors"/ "HOLOTYPE *Brosocosoma danzhuense* Kavanaugh & Liang sp. nov. designated 2021" [red label].

Type locality. China, Yunnan, Gongshan County, Cikai Township, Danzhu He drainage 2720-2840 m.

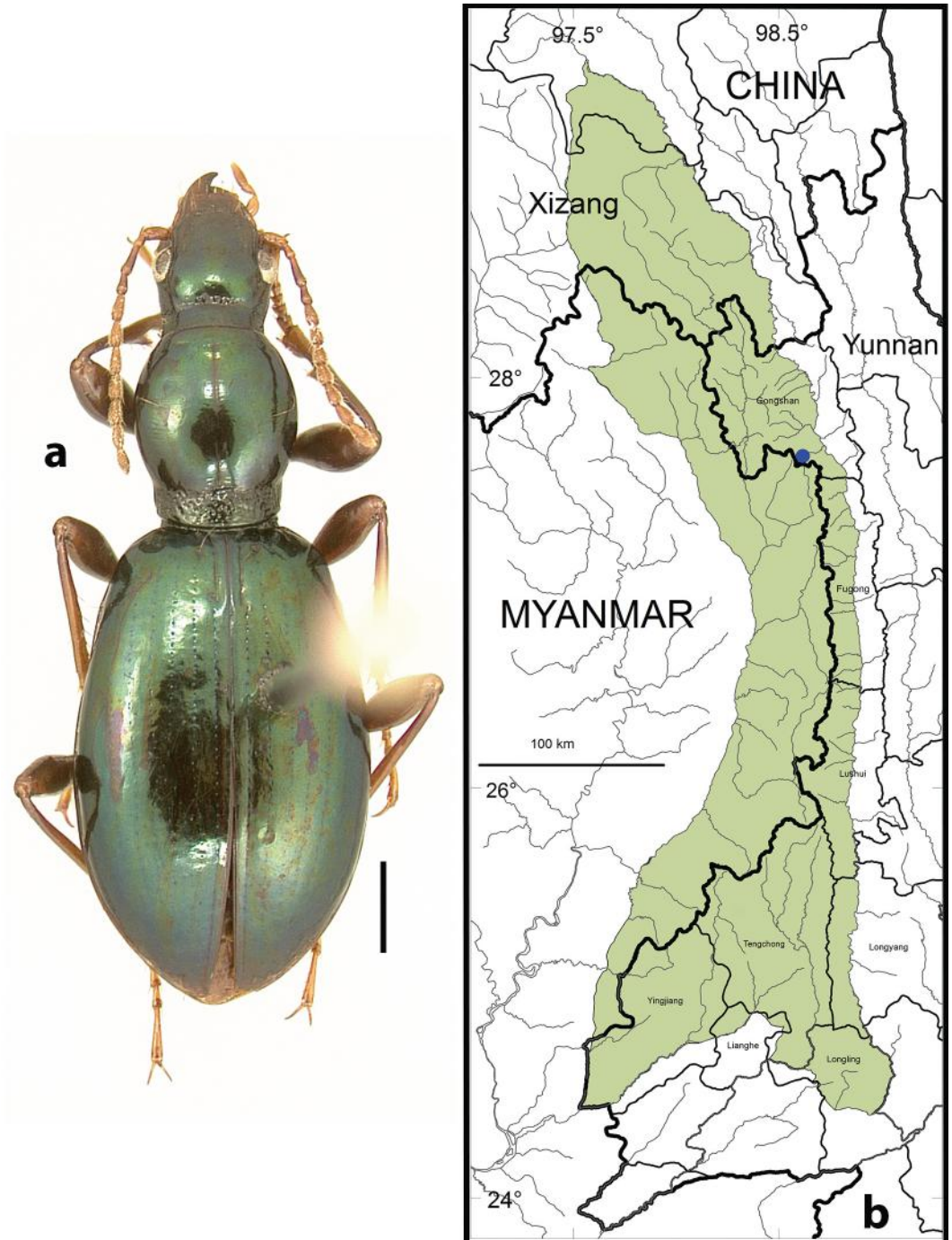


FIGURE 17. *Broscosoma danzhuense* sp. nov. a. Habitus (Holotype; Danzhum He drainage, Cikai Township, Gongshan County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

Derivation of species name. The species epithet, *danzhuense*, is derived from the name of the river valley in which the type specimen was collected, and the Latin suffix, *-ensis*, denoting place.

Diagnosis. Adults of this species (Fig. 17a) can be distinguished from those of other species in the region by the following combination of character states: size moderate, BL female = 9.3 mm; entire dorsum of body dark green, legs with femora darker (brown to piceous) than tibiae (reddish-brown); antennomeres 3 and 4 glabrous except for apical whorl of setae; eyes (Fig. 6e) moderately convex; pronotum with lateral margination absent, basolateral setae absent; elytral silhouette subovoid, greatest width distinctly posterior to midlength, with humeri rounded yet slightly evident, elytral microsculpture faintly impressed but evident, only striae 1 impressed, all other elytral striae represented only by punctures diminishing in size and depth laterally and posteriorly, elytral intervals flat; metatrochanters asetose.

Description. Fig. 17a. Size medium, BL female = 9.3 mm, ratio EL/PL = 2.3. Body color piceous. Last visible abdominal sternite dark or rufous brown, antennae with all antennomeres rufous brown, femora brown or piceous, tibiae and tarsi reddish brown. Head, Pronotum, elytra with distinct green metallic reflection, venter without metallic reflection.

Head. Fig. 6e. Eyes small, their diameter slightly less than length of tempora. Frontal furrows deeply impressed, narrow, arcuate, slightly convergent anteriorly and posteriorly, long, extended posteriorly beyond middle of eyes, faintly rugulose, impunctate. Vertex with post-temporal transverse sulcus deep, sharply and narrowly defined, narrowly punctulate only along bottom of sulcus. Tempora nearly straight, subparallel. Genal ridges present, restricted to head region distinctly behind post-temporal constriction. Clypeus with one pair of setae. Supraorbital setae present, one pair. Eustipes of maxilla with two setae, the dorsobasal seta distinctly more than half as long as ventrobasal seta. Mentum with tooth present, simple, paramedial region shallowly foveate, one pair of mental setae present. Glosal sclerite (ligula) with one pair of setae. Submentum with two or three pairs of setae. Gula without transverse grooves. Antennomeres 3 and 4 without pubescence, ratio A3/A5 = 1.3.

Pronotum. Fig. 6e. Discal region anterior to sub-basal constriction slightly longitudinally ovoid, slightly narrowed anteriorly with base distinctly pedunculate, widest slightly posterior to middle of discal region, ratio PL/PW = 1.2, disk markedly convex; apical, lateral, and basal margination absent; anterior transverse impression shallow, narrowly delineated, punctate in bottom of impression only; median longitudinal impression distinct, but fine and shallowly impressed; posterior transverse impression deep, sharply delineated; anterior region smooth; pronotal base coarsely and densely punctate; one pair of midlateral pronotal setae present, inserted slightly anterior to mid-length of discal region; basolateral pronotal setae absent.

Elytra. Elytral silhouette subovoid, slightly narrowed in basal half, widest distinctly posterior to middle, ratio EL/EW = 1.6, greatest elevation above lateral margin (in lateral view) posterior to middle; humeri distinctly present, roundly obtuse; lateral margins moderately arcuate and nearly straight in anterior half sub-basally; parascutellar striole present, short, distally merged in a distinct jog with free base of stria 1. Eight elytral striae present; stria 1 moderately deeply and sharply impressed, striae 2 to 8 indistinct, obliterated or represented by extremely fine and shallow linear depressions, successively less evident laterally and apically, striae 8 merged with lateral groove throughout its length or nearly so; stria 1 moderately punctate at least in basal half, striae 2 to 8 successively more finely and sparsely punctate or impunctate laterally and apically. Elytral microsculpture effaced. Parascutellar seta at base of stria 2, discal setae absent, umbilicate series comprised of one post-humeral and two preapical setae.

Hindwings. Slightly reduced, incapable of supporting flight.

Thoracic venter. Metepisternum ratio ML/MW = 2.4.

Legs. Hind trochanter asetose. Tarsomeres without dorsal pubescence; tarsomere 5 with two or more pairs of setae ventrally.

Abdomen. Female sternite VI with one pair of apicoparamedial setae.

Male genitalia. Male unknown.

Comments. This is one of six species in the study area members of which have the elytral humeri rounded or slightly angulate but distinct and both the forebody and the elytra with distinct metallic reflection. In two of these, *B. holomarginatum* and *B. purpureum*, the reflection is mainly blue or purple in color, respectively, with some greenish tinges in most specimens of *B. holomarginatum*. In addition to *B. danzhuense*, three species have the full dorsum of the body with green metallic reflection. *Brosocosoma parvum* members are smaller in size, have eyes that are less convex (Fig. 6f), and have the elytral silhouette slightly narrower across the humeri and the greatest width at or very near midlength (distinctly posterior to midlength in *B. danzhuense*). *Brosocosoma resbecqi* members have the pronotum with the discal portion relatively shorter and more globose (Fig. 6d) and lateral margination present and nearly complete, interrupted only briefly near basal two-thirds length (Fig. 9b) (absent from *B. danzhuense*), the elytra with their greatest width at or very near midlength, and femora pale rufous (darker in *B. danzhuense*). *Brosocosoma ribbei* members have the eyes distinctly more convex, the post-temporal transverse sulcus not or more sparsely punctate, the pronotum with the discal portion relatively shorter and more globose (Fig. 6b) and lateral margination incomplete but present in most specimens, at least in the vicinity of the mid-lateral setae and more extensively in some specimens, elytral microsculpture distinct, deeply to moderately impressed (effaced in *B. danzhuense*), and the metatrochanters unisetose, unilaterally asetose in a few specimens (asetose in *B. danzhuense*).

Among *Brosocosoma* species known from outside the study area, only two species, *Brosocosoma montreuili* Deuve, 2006 and *Brosocosoma tiani* Deuve, 2006 have members in which the elytral humeri are at least faintly evident (although in both they are less evident than in *B. danzhuense*) and the entire dorsum exhibits metallic green reflection. In members of *B. montreuili*, the forebody is a darker, less vividly metallic green than the elytra (both parts equally vivid in *B. danzhuense*), and in both *B. montreuili* and *B. tiani* members the discal portion of the pronotum is more globose (slightly narrower and more elongate in *B. danzhuense*), the elytra are widest at or near midlength and with striae 2 to 8 more faintly defined and finely punctate, and the femora are darker (lighter piceous or brown in *B. danzhuense*).

Habitat distribution. The unique specimen of this species was found under a stone at the edge of a moderate-sized cascading stream descending through mixed coniferous/ broadleaf evergreen forest and shaded during much of the day. The site of collection was at some point within the moderate elevational range of 2720 to 2840 m (Fig. 49), but the precise elevation was not recorded.

Geographical distribution within the Gaoligong Shan. Fig. 17b. This species is known only from the type locality in Gongshan County (see Type material above for exact collection data) on the eastern slope of the range in the southern part of Core Area 2 (Fig. 48).

Overall geographical distribution. This species currently is known only from the northern part of the Gaoligong Shan, in western Yunnan Province, China.

Geographical relationships with other *Brosocosoma* species. No other *Brosocosoma* species was found syntopic with the type of this species, although *B. ribbei* occurs in the same general area. *Eobrosocus bhutanensis* also has been found in the same area and habitat as *B. danzhuense* (Fig. 50).

5. *Brosocosoma furvum* Kavanaugh and Liang, sp. nov.

Figures 7a, 10a, 18, 19, 40b, 48-50

Type material. Holotype, a male, in IOZ, labeled: "CASENT 1017819"/ "CHINA, Yunnan,

Fugong County, Lumadeng Township, second cirque S of Shibali Yakou at border post “31”, N27.20333°/E098.69303°/ “3710m, 17 August 2005, Stop #DHK2005-095, H.B. Liang, D.Z. Dong & J.F. Zhang collectors”/ HOLOTYPE *Brosocosoma furvum* Kavanaugh & Liang sp. nov. designated 2021” [red label]. Paratypes (a total of 13): five males and seven females (CAS, IOZ) labeled: same as holotype except first label “CASENT 1017818”, “CASENT 1017820” to “CASENT 1017823” and “CASENT 1017811” to “CASENT 1017817”, respectively/ “CHINA, Yunnan, Fugong County, Lumadeng Township, second cirque S of Shibali Yakou at border post “31”, N27.20333°/E098.69303°/ “3710m, 17 August 2005, Stop #DHK2005-095, H.B. Liang, D.Z. Dong & J.F. Zhang collectors”; one male (CAS) labeled: “CASENT 1020001”/ “CHINA, Yunnan, Fugong County, Lumadeng Township, first cirque S of Shibali Yakou, 3725m”/ “N27.20520°/E098.69590”, 17 August 2005, Stop #DHK2005-094, D.H. Kavanaugh collector”. All paratypes also bear the following label: “PARATYPE *Brosocosoma furvum* Kavanaugh & Liang, sp. nov. designated 2021” [yellow label].

Type locality. China, Yunnan, Fugong County, Lumadeng Township, second cirque S of Shibali Yakou at border post “31”, 27.20333°/98.69303°, 3710m.

Derivation of species name. The species epithet, *furvum*, is an adjective derived from the Latin word, *furvus*, meaning dark or dusky. The name refers to the dark brown to black dorsal body color, with no trace of metallic reflection, of members of this species.

Diagnosis. Adults of this species (Fig. 18a) can be distinguished from those of other species in the region by the following combination of character states: size moderate, BL = 10.6 to 11.1 mm; dorsum of body piceous, without any trace of metallic reflection; antennomeres 3 and 4 glabrous except for apical whorl of setae, distinctly darker than antennomeres 1 and 2; genal ridge evident, extended from base of head to ventral margin of eye (Fig. 10a); pronotum anterior to sub-basal constriction (Fig. 7a) longitudinally slightly ovoid in dorsal view, basolateral setae absent; elytral silhouette ovoid, with humeri indistinct; metatrochanters unisetose; male protarsi with tarsomeres 1 to 3 with ventral pads of adhesive setae; male genitalia as in Fig. 19, with median lobe longer and more slender and with apical lamella distinctly bent ventrally in lateral view.

Description. Fig. 18a. Size medium, BL male = 10.6–11.1 mm, female = 10.6–10.9 mm, ratio EL/PL male = 2.2, female = 2.2–2.3. Body color black or piceous, last visible abdominal sternite black, piceous, or dark brown, antennae with antennomeres 3 and 4 slightly darker brown than antennomeres 1 and 2 and 5 to 11, femora, tibiae, and tarsi dark brown or tarsi lighter brown in some specimens. Head, pronotum, elytra, and venter without metallic reflection.

Head. Fig. 7a. Eyes medium-sized, their diameter slightly greater than length of tempora. Frontal furrows deeply impressed, narrow, short, linear, and distinctly divergent posteriorly, or medium length, arcuate, and slightly convergent anteriorly and posteriorly, extended posteriorly to middle of eyes or less, faintly rugulose, impunctate. Vertex with post-temporal transverse sulcus deep, sharply defined, smooth and impunctate or very sparsely and finely punctate. Tempora obliquely convex. Genal ridges distinctly present, extended from base of head to ventral margins of eyes. Clypeus with one pair of setae. Supraorbital setae present, one pair. Eustipes of maxilla with two setae, the dorsobasal seta distinctly more than half as long as ventrobasal seta. Mentum with tooth present, simple, paramedial region shallowly foveate, one pair of mental setae present. Glosal sclerite (ligula) with one pair of setae. Submentum with one or two pairs of setae. Gula without transverse grooves. Antennomeres 3 and 4 without pubescence, ratio A3/A5 = 1.0–1.1.

Pronotum. Fig. 7a. Disc anterior to sub-basal constriction slightly longitudinally ovoid in dorsal view with base distinctly pedunculate, widest at middle of discal region, ratio PL/PW = 1.2–1.3, disk markedly convex; apical margination absent; lateral margination present, narrow, delineated only on pronotal base; basal margination absent; anterior transverse impression shallow,

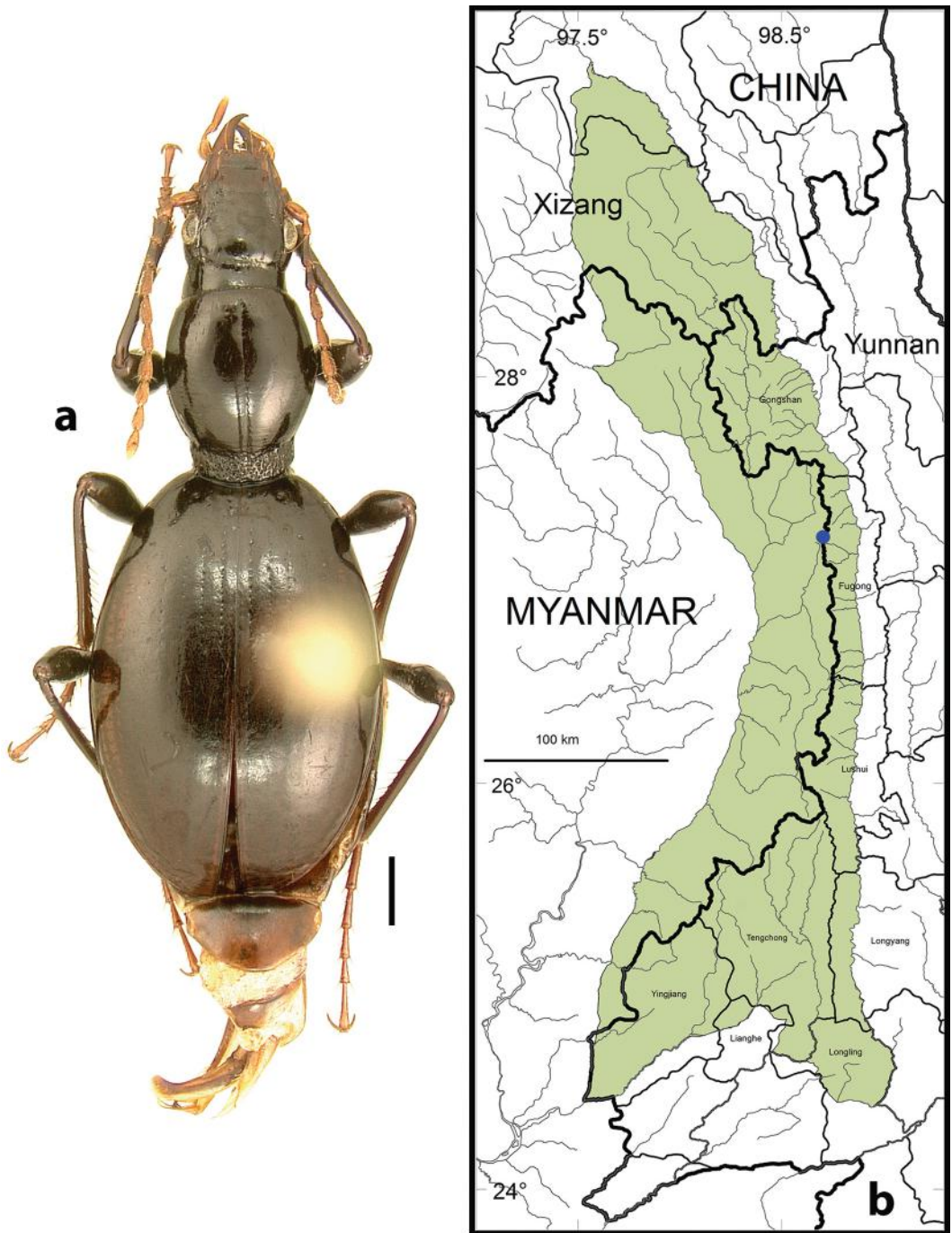


FIGURE 18. *Broscosoma furvum* sp. nov. a. Habitus (CASENT1020001; first cirque S of Shibali Yakou, Fugong County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 k.

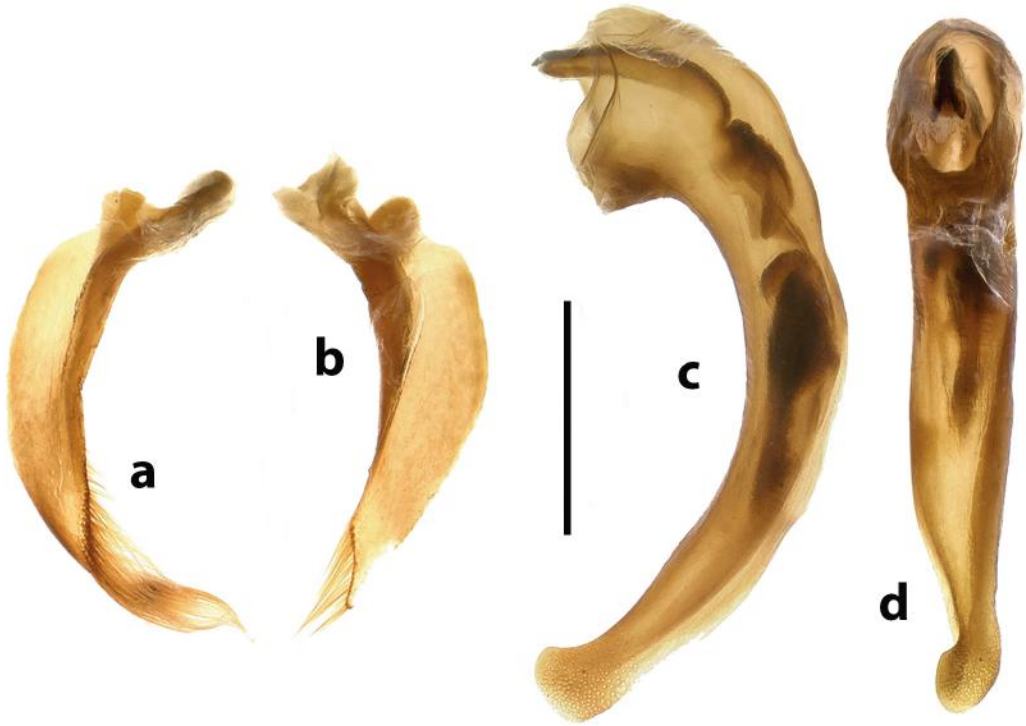


FIGURE 19. Male genitalia, *Broscosoma furvum* sp. nov. (CASENT1023548; 1.0 km E of Shibali Yakou, Lishadi Township, Fugong County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

broad and vaguely delineated, smooth; median longitudinal impression distinct, but finely and shallowly impressed or moderately impressed; posterior transverse impression deep, sharply delineated; anterior region faintly and sparsely rugulose; pronotal base coarsely and densely rugulose; one pair of midlateral pronotal setae present at mid-length of discal region; basolateral pronotal setae absent.

Elytra. Elytral silhouette ovoid, short, widest at middle, ratio EL/EW male = 1.5, female = 1.5–1.6, greatest elevation above lateral margin (in lateral view) posterior to middle; humeri narrow, sloped, indistinct; lateral margins markedly arcuate; parascutellar striole present, short, distally merged in a distinct jog with free base of stria 1. Eight striae present; stria 1 moderately deeply and sharply impressed, striae 2 to 3, 4, or 5 shallowly impressed in basal two-thirds of striae and successively more shallowly impressed to indistinct in apical third, striae 3 to 8 successively more shallowly impressed to indistinct laterally and apically (striae striae 3 or 4 to 8 obliterated or nearly so in some specimens), striae 8 merged with lateral groove throughout its length or nearly so; stria 1 moderately punctate at least in basal half, striae 2 to 3, 4, or 5 moderately punctate in basal two-thirds and successively more shallowly and sparsely punctate in apical third, striae 3 to 8 successively more shallowly and sparsely punctate laterally and apically. Elytral microsculpture evident, comprised of finely impressed isodiametric sculpticells. Parascutellar seta present near base of stria 3 in most specimens (near base of stria 2 in a few specimens), discal setae absent, umbilicate series comprised of one post-humeral and two preapical setae.

Hindwings. Vestigial, incapable of supporting flight.

Thoracic venter. Metepisternum ratio ML/MW = 1.4–1.5.

Legs. Hind trochanters unisetose. Tarsomeres without dorsal pubescence; tarsomere 5 with two or more pairs of setae ventrally; male protarsi with pads of adhesive setae on tarsomeres 1 to 3 ventrally, male mesotarsi with pads of adhesive setae on tarsomeres 1 and 2 ventrally.

Abdomen. Sternite VI of both male and female with one pair of apicoparamedial setae.

Male genitalia. As in Fig. 19.

Comments. This is the only *Broskosoma* species in the study area members of which have the full dorsum of the body without a trace of metallic reflection. Its members are also among the largest of any of the species in the area, overlapping in size only with those of *B. viridicollare* and the largest members of *B. bicoloratum* and *B. ribbei*, all of which have at least the elytra distinctly metallic green or bluish-green.

Among *Broskosoma* species known from outside the study area, only four have members with similar or larger body size and without dorsal metallic reflection at least in most members. The known body size ranges for three of these, *Broskosoma dostali* Deuve, 2006, *Broskosoma herculeaneum* Deuve, 2011, and *Broskosoma mourzinei* Deuve, 2011, all known only from Sichuan, are larger and non-overlapping with the size range of *B. furvum* specimens. Members of *B. dostali* also have the eyes and tempora more convex, the pronotum shorter and more globose (more elongate in *B. furvum*), and the median lobe of male genitalia with the apical lamella narrower and more symmetrical in lateral aspect (see Deuve 2006, fig. 9) (broader and distinctly expanded ventrally in *B. furvum*). Members of *B. herculeaneum* have the head more generally punctate, the submentum with three pairs of setae (one or two pairs in *B. furvum*), the pronotum with the medial impression distinctly impressed but not extended to the pronotal base (deep and extended well onto the pronotal base in *B. furvum*), the elytra with only stria 1 impressed, the others effaced and represented only by punctures (at least two striae impressed on center of elytral disc in *B. furvum*), and the median lobe of the male genitalia with the apical lamella narrower and slightly less expanded ventrally (see Deuve 2011a, fig. 61). Members of *B. mourzinei* have the eyes less convex and smaller, their diameter about equal to length of the tempora (eyes slightly more convex and their diameter slightly greater than the length of the tempora in *B. furvum*), the submentum with three pairs of setae, the pronotal base finely and densely punctate (base more coarsely punctate in *B. furvum*), the elytra with only stria 1 impressed, and the median lobe of the male genitalia of similar shape except with the apical lamella slightly narrower and more symmetrical in lateral aspect (see Deuve 2011b, fig. 16). Members of the fourth species, *Broskosoma rolex* Morvan, 1995, known from Nepal, are of similar size to *B. furvum* members but have the elytral silhouette more slender (slightly broader in *B. furvum*), elytra with slight metallic reflection in some specimens, and the median lobe of male genitalia distinctly thicker subapically and with the apical lamella narrower and more symmetrically rounded in lateral aspect (see Morvan 1995, fig. 7).

Habitat distribution. Members of this species were collected under large stones on the crest of the range and on the east-facing slope just below it in an area of scattered *Rhododendron* and bamboo thickets interspersed with moist herbaceous meadow vegetation and stabilized talus (Fig. 40b). This species has been found only at high elevation, with our records documenting its occurrence in the 3710 to 3725 m range (Fig. 49).

Geographical distribution within the Gaoligong Shan. Fig. 18b. We examined a total of 14 specimens (seven males and seven females), all from the northcentral part of the Gaoligong Shan in Fugong County on the eastern side of the range in Core Area 3 (Fig. 48) (see Type material above for exact collection data).

Overall geographical distribution. This species currently is known only from the northcentral part of the Gaoligong Shan, in western Yunnan Province, China.

Geographical relationships with other *Broscosoma* species. Members of this species have been found syntopic only with those of *Broscosoma viridicollare* at the type locality (Fig. 50).

6. *Broscosoma gaoligongense* Deuve and Wrase, 2015

Figures 7d, 10b, 20, 21, 44a, 48-50

Broscosoma gaoligongense Deuve and Wrase, 2015:29. Holotype, a male, deposited in DWW. Type locality: China, Yunnan, Gaoligong Shan, pass [Fengxue Yakou] 21 km NW of Liuku, 3150 m, 25.97281°/98.68339°.

Diagnosis. Adults of this species (Fig. 20a) can be distinguished from those of other species in the region by the following combination of character states: size moderate, BL male = 9.0–10.0 mm, female = 9.6–10.2 mm; dorsum of head and pronotum black or dark piceous, elytra with bright green or blue-green metallic reflection; genal ridge evident basal to post-temporal constriction but extended only to or slightly anterior to the constriction (Fig. 10b); antennomeres 3 and 4 glabrous except for apical whorl of setae, antennomeres 1 through 4 concolorous, pale rufous; pronotum anterior to sub-basal constriction (Fig. 7d) globose in dorsal view, basolateral setae absent; elytral silhouette ovoid, with humeri indistinct; metatrochanters unisetose; male protarsi with tarsomeres 1 to 3 with ventral pads of adhesive setae; male genitalia as in Fig. 21, with median lobe slightly shorter and thicker and apical lamella more symmetrically rounded in lateral view.

Comments. As noted in the Comments section for *B. bicoloratum*, this is one of four species in the study area members of which have the elytra with distinct metallic reflection but the forebody (head and pronotum) without metallic reflection or with that reflection confined to the pronotal area anterior to the anterior transverse impression. Specimens of *B. gaoligongense* can be distinguished from those of *B. viridicollare* in having the pronotum globose and without a trace metallic reflection (pronotum more elongate and with the area anterior to the anterior transverse impression with a distinct metallic green reflection in *B. viridicollare*), the elytral microsculpture effaced (finely impressed but distinct in *B. viridicollare*), the parascutellare pore puncture inserted near the base of stria 3 (stria 2 in *B. viridicollare*), and the median lobe of the male genitalia shorter and more evenly arcuate (Fig. 21c) (longer and less arcuate in apical third (Fig. 35c) in *B. viridicollare*). They differ from specimens of *B. bicoloratum* in having the metatrochanters unisetose (asetose in most *B. bicoloratum*, but one seta present unilaterally in a few specimens), the parascutellar setiferous pore inserted near the base of stria 3 (near base of stria 2 in most *B. bicoloratum* specimens), the eyes (Fig. 7d) slightly less convex (more convex in *B. bicoloratum* (Fig. 7c)), and the median lobe of male genitalia slightly narrower and with the apical lamella slightly more expanded apically (median lobe slightly thicker and with a slightly narrower apical lamella (Fig. 16c) in *B. bicoloratum*). They differ from members of *B. gongshanense* in having the elytra with a distinct metallic green reflection (metallic reflection distinctly more bluish in *B. gongshanense*), the parascutellar seta inserted at the base of stria 3 (stria 2 in *B. gongshanense*), and the metatrochanter unisetose (asetose *B. gongshanense*).

As noted above in the Comments section for *B. bicoloratum*, among *Broscosoma* species known from outside the study area, only *B. monticola* has members with the forebody lacking metallic reflection and the elytra with markedly metallic reflection as is seen in *B. gaoligongense* specimens. They also also have the parascutellar seta inserted near the base of stria 3; but they have the femora slightly paler and the median lobe of the male genitalia with a large protuberance on the ventral margin (see Habu 1973, fig. 6), which is absent from the median lobe of *B. gaoligongense* males.

Habitat distribution. A few members of this species were found under stones on organic substrate along the edges of the roadcut through bamboo and *Rhododendron* thickets (Fig. 44a) on both

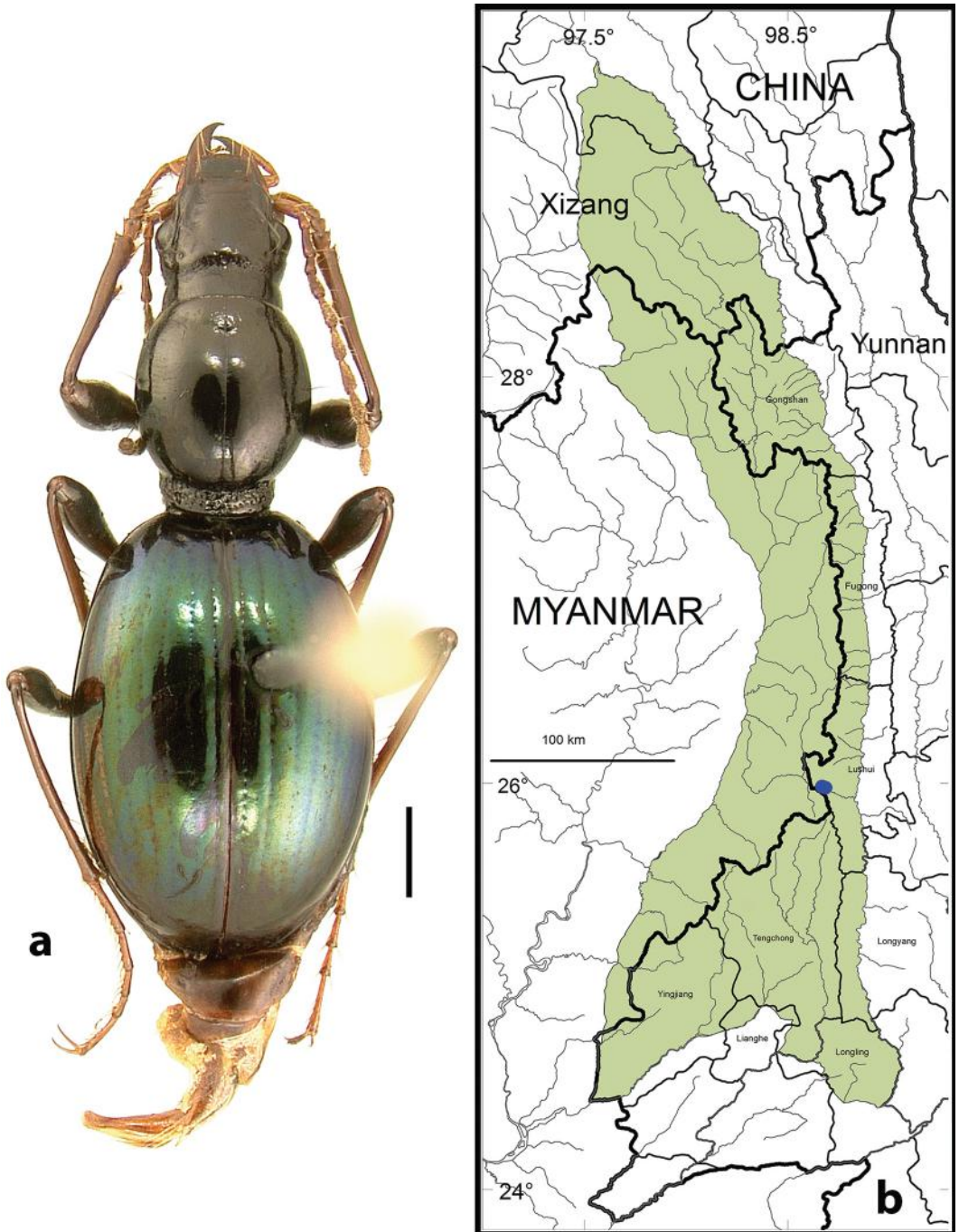


FIGURE 20. *Broscosoma gaoligongense* Deuve and Wrase. a. Habitus (CASENT1027285; just W of Fenxue Yakou, Pianma Township, County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.



FIGURE 21. Male genitalia, *Broscosoma gaoligongense* Deuve and Wrase. (CASENT1027154; just W of Fengxue Yakou, Pianma Township, County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

sides of the pass (Fengxue Yakou) during the day. The majority of specimens were collected at night, with the aid of headlamps, where they were found active on the surface of the ground, especially on mosses, in thickets and on the banks of the roadcut. This species is found at moderately high elevations, with our records documenting its occurrence in the 3120 to 3150 m range (Fig. 49).

Geographical distribution within the Gaoligong Shan. Fig. 20b. We examined a total of 35 specimens (23 males and 12 females) from the following localities: **Lushui County:** Luzhang Township (Pianma road at Fengxue Yakou, 25.97228°/098.68336°, 3150m, 11 May 2005, D.H. Kavanaugh, H.B. Liang, C.E. Griswold, D.Z. Dong & K.J. Guo collectors [one male; CAS]; Fengxue Yakou to 0.5 km E on Pianma Road, 25.97288°/98.68336° to 25.97347°/98.68780°, 3130-3150 m, 17 May 2005, D. Kavanaugh, C.E. Griswold, H.B. Liang, & D.Z. Dong collectors [one female, IOZ]); Pianma Township (Fengxue Yakou to 0.6 km W on Pianma Road, 25.97228°/98.68336° to 25.974108°/98.67716°, 3120-3150 m, 17-19 May 2005, D. Kavanaugh, C.E. Griswold, H.B. Liang, D.Z. Dong & K.J. Guo collectors [22 males and 11 females; CAS, IOZ]).

Members of this species were collected only in Lushui County on the crest of the Gaoligong Shan in the southcentral part of the study area, an area that staddles Core Areas 4 and 5 (Fig. 48).

Overall geographical distribution. This species currently is known only from the type locality and its immediate environs in Lushui County on the crest of the southcentral part of the Gaoligong Shan, in western Yunnan Province, China.

Geographical relationships with other *Broscosoma* species. Members of this species have been found syntopic only with those of *Broscosoma ribbei* at and around the type locality (Fig. 50).

7. *Brosocosoma gongshanense* Kavanaugh and Liang, sp. nov.

Figures 7e, 22, 23, 42a, 48-50

Type material. Holotype, a male, in IOZ, labeled: “CASENT 1026430”/ “CHINA, Yunnan Province, Gongshan County, Cikai Township, 2.0 airm S Heipu Yakou in cirque at head of Pula valley, 3350m” / “N27.75442°/E098.45639°, 12 August 2006, Stop #DHK2006-070, D.H. Kavanaugh, J. A. Miller collectors”/ “HOLOTYPE *Brosocosoma gongshanense* Kavanaugh & Liang sp. nov. designated 2021” [red label]. Paratypes (a total of five): one male and two females (CAS, IOZ) labeled: same as holotype except first label “CASENT 1026439” and “CASENT 1026439” to “CASENT 1026439”, respectively; one male and one female (CAS, IOZ) labeled: “CASENT 1008139” and “CASENT 1006244”, respectively/ “CHINA, Yunnan Province, Gaoligong Shan, Nujiang Prefecture, Nujiang State Nature Reserve, Dulong/Gongshan Yakou area, 21 airm W of Gongshan” / “N27.69655°/E098.45389°, 3300-3680m, 16-17 July 2000, Stop #00-24C, D.H. Kavanaugh, C.E. Griswold, H.-B. Liang, D. Ubick & D.-Z. Dong collectors”. All paratypes also bear the following label: “PARATYPE *Brosocosoma gongshanense* Kavanaugh & Liang, sp. nov. designated 2021” [yellow label].

Type locality. China, Yunnan Province, Gongshan County, Cikai Township, Heipu Yakou area.

Derivation of species name. The species epithet, *gongshanense*, is an adjective derived from the name of the county, Gongshan, in which all members of the type series were collected, and the Latin suffix, *-ensis*, denoting place.

Diagnosis. Adults of this species (Fig. 22a) can be distinguished from those of other species in the region by the following combination of character states: size moderate, BL = 9.5 to 9.9 mm; head and pronotum black to piceous, without a trace of metallic reflection; head with tempora straight or only slightly convex behind eyes; genal ridge evident, extended from base of head to ventral margin of eye (as in Fig. 10a); antennomeres 3 and 4 glabrous except for apical whorl of setae; pronotum anterior to sub-basal constriction slightly longitudinally ovoid in dorsal view (Fig. 7e), lateral margination absent or developed only posterior to sub-basal constriction, basolateral setae absent; elytral silhouette ovoid, with humeri indistinct, elytral microsculpture effaced; meta-trochanter asetose; male protarsi with tarsomeres 1 to 3 with ventral pads of adhesive setae; male genitalia as in Fig. 23.

Description. Fig. 22a. Size medium, BL male = 9.5–9.8 mm, female = 9.5–9.9 mm, ratio EL/PL male = 2.1, female = 2.2–2.3. Body color black or dark piceous, last visible abdominal sternite dark brown or rufous brown, antennae with antennomeres 3 and 4 black or piceous, antennomeres 1 and 2 and 5 to 11 rufous brown. Femora and tibiae piceous or dark brown, tarsi rufous brown. Head and pronotum without metallic reflection, elytra with distinct blue or greenish-blue metallic reflection, venter without metallic reflection.

Head. Fig. 7e. Eyes medium-sized, their diameter equal to or slightly greater than length of tempora. Frontal furrows deeply impressed, narrow, short, linear, distinctly divergent posteriorly, and extended posteriorly to middle of eyes, or medium length, arcuate, slightly convergent anteriorly and posteriorly, and extended posteriorly beyond middle of eyes, faintly rugulose, impunctate. Vertex with post-temporal transverse sulcus deep, sharply defined, moderately or sparsely and finely punctate. Tempora obliquely convex. Genal ridges distinctly present from posterior region of head to ventral margins of eyes. Clypeus with one pair of setae. Supraorbital setae present, one pair. Eustipes of maxilla with two setae, the dorsobasal seta distinctly more than half as long as ventrobasal seta. Mentum with tooth present, simple, paramedial region shallowly foveate, one pair of mental setae present. Glosal sclerite (ligula) with one pair of setae. Submentum with one or two

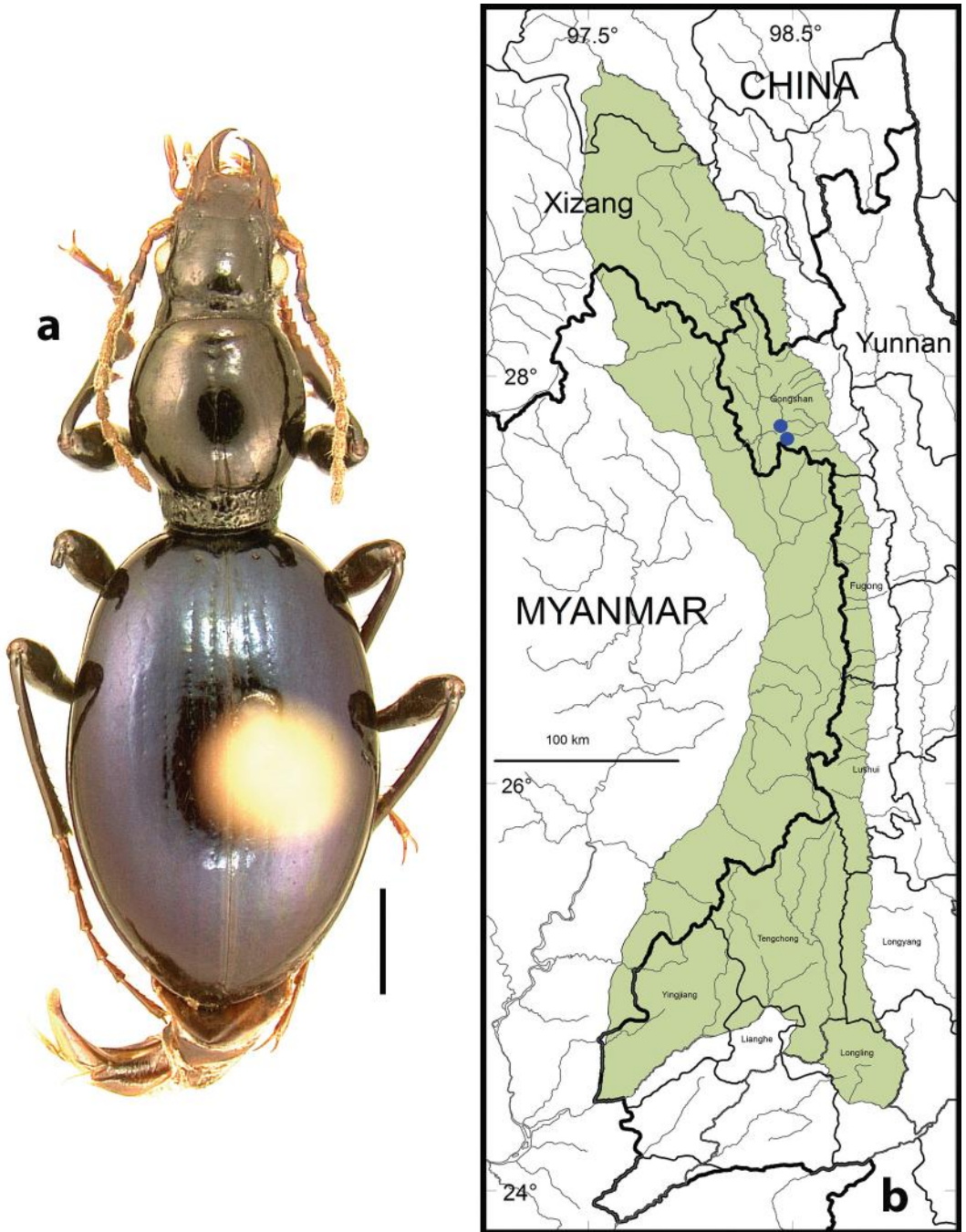


FIGURE 22. *Broscosoma gongshanense* sp. nov. a. Habitus (CASENT1008139; Dongshaofang area, Gongshan County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

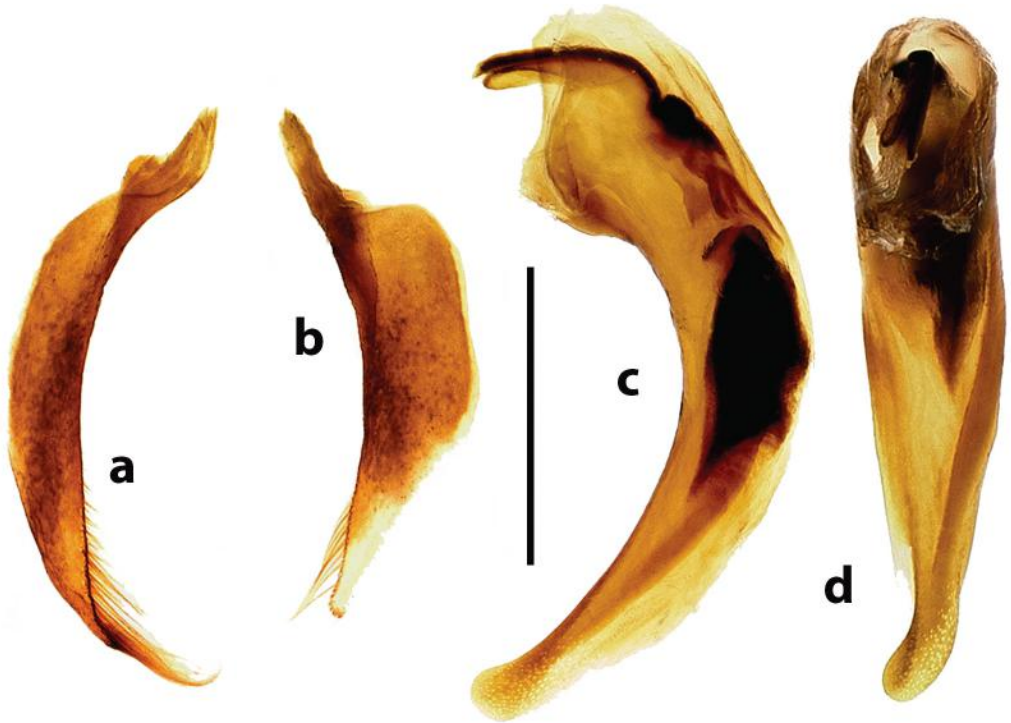


FIGURE 23. Male genitalia, *Broscosoma gongshanense* sp. nov. (CASENT1026429; 2.0 km S of Heipu Yakou, Cikai Township, Gongshan County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

pairs of setae. Gula without transverse grooves. Antennomeres 3 and 4 without pubescence, ratio $A3/A5 = 1.1-1.2$.

Pronotum. Fig. 7e. Globose anterior to sub-basal constriction with base distinctly pedunculate, widest at middle of discal region, ratio $PL/PW = 1.2-1.3$, disk markedly convex; apical margination absent, lateral margination present, narrow, delineated only on base; basal margination absent; anterior transverse impression absent or shallow and indistinct; median longitudinal impression distinct, but fine and shallowly impressed; posterior transverse impression deep, sharply delineated; anterior region smooth; pronotal base coarsely punctate and rugulose; one pair of midlateral pronotal setae present at mid-length of discal region; basolateral pronotal setae absent.

Elytra. Elytral silhouette ovoid, widest at middle, ratio EL/EW male = 1.4–1.5, female = 1.5–1.6, greatest elevation above lateral margin (in lateral view) posterior to middle; humeri narrow, sloped, indistinct; lateral margins markedly arcuate or markedly arcuate and faintly angulate sub-basally; parascutellar striole present, short, distally merged in a distinct jog with free base of stria 1. Eight striae present; stria 1 moderately deeply and sharply impressed, striae 2 to 3, 4, or 5 moderately impressed in basal two-thirds of striae and successively more shallowly impressed in apical third, striae 2 to 8 successively more shallowly impressed laterally and apically, striae obliterated apical and laterally in some specimens, striae 8 merged with lateral groove throughout its length or nearly so; stria 1 coarsely and moderately densely punctate, striae 2 and 3 or 4 moderately to coarsely punctate in basal half and successively more shallowly and sparsely punctate in

apical half, striae 4 or 5 to 8 successively more finely punctate or impunctate laterally and apically. Elytral microsculpture effaced. Parascutellar seta present at base of stria 2, discal setae absent, umbilicate series comprised of one post-humeral and two preapical setae.

Hindwings. Vestigial, incapable of supporting flight.

Thoracic venter. Metepisternum ratio ML/MW = 1.5–1.9.

Legs. Hind trochanter asetose. Tarsomeres without dorsal pubescence; tarsomere 5 with two or more pairs of setae ventrally; male protarsi with pads of adhesive setae on tarsomeres 1 to 3 ventrally, male mesotarsi with pads of adhesive setae on tarsomeres 1 and 2 ventrally.

Abdomen. Sternite VI of male with two or three pairs of apicoparamedial setae, female with one pair of setae.

Male genitalia. As in Fig. 23.

Comments. As noted in the Comments section for *B. bicoloratum*, this is one of four species in the study area members of which have the elytra with distinct metallic reflection but the forebody (head and pronotum) without metallic reflection or with that reflection confined to the pronotal area anterior to the anterior transverse impression. Its members can be distinguished from those of *B. viridicollare* in having smaller body size, the eyes less convex and tempora straight or faintly convex (distinctly convex, subangulate *B. viridicollare*), the pronotum without a trace of metallic reflection (band of metallic green reflection present anterior to anterior transverse impression *B. viridicollare*), the elytral microsculpture effaced (finely but distinctly impressed in *B. viridicollare*), and the median lobe of the male genitalia shorter and more evenly arcuate. They differ from members of *B. bicoloratum* in having the eyes less convex, the tempora shorter and nearly straight (tempora longer and distinctly more convex in *B. bicoloratum*), and the discal portion of the pronotum very slightly more elongate (more globose *B. bicoloratum*). They differ from members of *B. gaoligongense* in having the tempora slightly less convex, the parascutellar seta inserted near the base of stria 2 (stria 3 in most *B. gaoligongense*), the metatrochanter asetose (unisetose *B. gongshanense*), and the median lobe of the male genitalia relatively shorter and with sclerites of the internal sac of different shapes.

As noted above in the Comments sections for *B. bicoloratum* and *B. gaoligongense*, among *Broskosoma* species known from outside the study area, only *B. monticola* has members of similar size and with the forebody lacking metallic reflection and the elytral with markedly metallic reflection as is seen in *B. gongshanense* specimens. However, they have the parascutellar seta inserted near the base of stria 3 (stria 2 in *B. gongshanense*), the femora slightly paler, and the median lobe of the male genitalia with a large protuberance on the ventral margin (see Habu 1973, fig. 6), which is absent from the median lobe of *B. gongshanense* males.

Habitat distribution. Members of this species have been found under stones along trails through bamboo and *Rhododendron* thickets and in moist alpine meadow areas (Fig. 42a) at or near the crest of the range. Our records document occurrence of this species at moderately high elevations in the 3350 to 3680 m range (Fig. 49).

Geographical distribution within the Gaoligong Shan. Fig. 22b. We examined a total of six specimens (three males and three females), all from at or near the crest of the range in Gongshan County. We recorded this species only from the crest and adjacent slopes to the east in Core Area 2 (Fig. 48), but it probably also occurs on the western side at equivalent elevations in Core Area 1.

Overall geographical distribution. This species currently is known only from the northcentral part of the Gaoligong Shan, in western Yunnan Province, China.

Geographical relationships with other *Broskosoma* species. Members of this species have been found together only with those of *Broskosoma bicoloratum* at one or more sites (Fig. 50). *Broskosoma ribbei* occurs in the same general area but mainly at lower elevations.

8. *Brososoma holomarginatum* Kavanaugh and Liang, sp. nov.

Figures 6a, 9a, 24, 25, 44b, 47-50

Type material. Holotype: a male, in IOZ, labeled: “CASENT 1015162”/ “CHINA, Yunnan, Gongshan County, Dulongjiang Township, Kongdang, 1525 m, N27.87696°/E098.33587°,”/ “5 November 2004, Stop # LHB-2004-047, H.-B. Liang collector”/ “HOLOTYPE *Brososoma holomarginatum* Kavanaugh & Liang sp. nov. designated 2021” [red label]. Paratypes (a total of 19): two females (CAS, IOZ), labeled: same as holotype except first label: “CASENT 1015163” and “CASENT 1015164”, respectively; one female (IOZ) labeled: “CASENT 1016688”/ “CHINA, Yunnan, Gongshan County, Dulongjiang Township, 0.5km N of Kongdang, 1500m, N27.88111°/E098.34063°, 25 October 2004”/ “Stop #DHK-2004-057B, D.H. Kavanaugh, H.-B. Liang, & D.-Z. Dong collectors”; two males (CAS, IOZ) labeled: “CASENT 1014588” and “CASENT 1014589”, respectively/ “CHINA, Yunnan, Gongshan County, Dulongjiang Township, 0.5km N of Kongdang, 1500m, N27.88111°/E098.34063°, 25 October 2004”/ “Stop #DHK-2004-057C, D.H. Kavanaugh, Q.B. Hou, H.B. Liang, D.Z. Dong & G. Tang collectors”; one male and four females (CAS, IOZ) labeled: “CASENT 1016748” and “CASENT 1016744” to “CASENT 1016747”, respectively/ “CHINA, Yunnan, Gongshan County, Dulongjiang Township, 0.5km N of Kongdang, 1500m, N27.88111°/E098.34063°, 25 October 2004”/ “Stop #DHK-2004-057D, D.H. Kavanaugh, Q.B. Hou, H.B. Liang collectors”; one male (CAS) labeled: “CASENT 1025538”/ “CHINA, Yunnan, Gongshan County, Dulongjiang Township, Maku village along old road through village, N27.68804°/E098.30758°”/ “1615m, 3 September 2006, Stop DHK-2006-120, D.H. Kavanaugh, Y. Liu, S.Z Ma & P. Hu collectors”; four males and three females (CAS, IOZ) labeled: “CASENT 1000600” to “CASENT 1000603” and “CASENT 1000604” to “CASENT 1000606”, respectively/ “CHINA, Yunnan Province, Gaoligongshan Mountains, Nujiang Prefecture, Gangfang Sancha Lukou, 26°073'N/98°34.5'E”/ “1500m, 14-15 October 1998, Stop #98-117C, D.H. Kavanaugh, C.E. Griswold, C. Ferraris & C.-L. Long collectors”; one male (IOZ) labeled: “China, Tibet, Medog, 81.5km on Medog road, N29.65650, E95.49348”/ “2023m, 2020.9.17 N, Liang H.B, Xu Y. coll., Inst. Zool., Chinese Acad. Sci.”. All paratypes also bear the following label: “PARATYPE *Brososoma holomarginatum* Kavanaugh & Liang, sp. nov. designated 2021” [yellow label].

Type locality. CHINA, Yunnan, Gongshan County, Dulongjiang Township, Kongdang.

Derivation of species name. The species epithet, *holomarginatum*, is an adjective derived from the Greek word, *holos*, meaning whole or entire, and the Latin word, *marginatus*, meaning bordered or enclosed with a border. The name refers the complete lateral margination (or lateral bead) of the pronotum found in members of this species.

Diagnosis. Adults of this species (Fig. 24a) can be distinguished from those of other species in the region by the following combination of character states: size moderate, BL = 8.1 to 9.5 mm; dorsal surface with distinct blue or blue-green luster, legs pale rufous; antennomeres 3 and 4 glabrous except for apical whorl of setae; pronotum with lateral margination (lateral bead) complete between apical and basal margins (Fig. 9a), basolateral setae absent; elytral silhouette subparallel to subovoid, with humeri distinct, elytral microsculpture distinct, comprised of isodiametric to slightly longitudinally stretched sculpticells; male protarsi with tarsomeres 1 to 3 with ventral pads of adhesive setae; male genitalia as in Fig. 25.

Description. Fig. 24a. Size small to medium, BL male = 8.5–9.3 mm, female = 8.1–9.5 mm, ratio EL/PL male = 2.1–2.3, female = 2.1–2.3. Body color black or dark piceous, last visible abdominal sternite rufous brown, or rufous basally graded to pale yellow apically, antennae with all antennomeres pale rufous, femora, tibiae and tarsi pale rufous. Head with green, pronotum with blue or

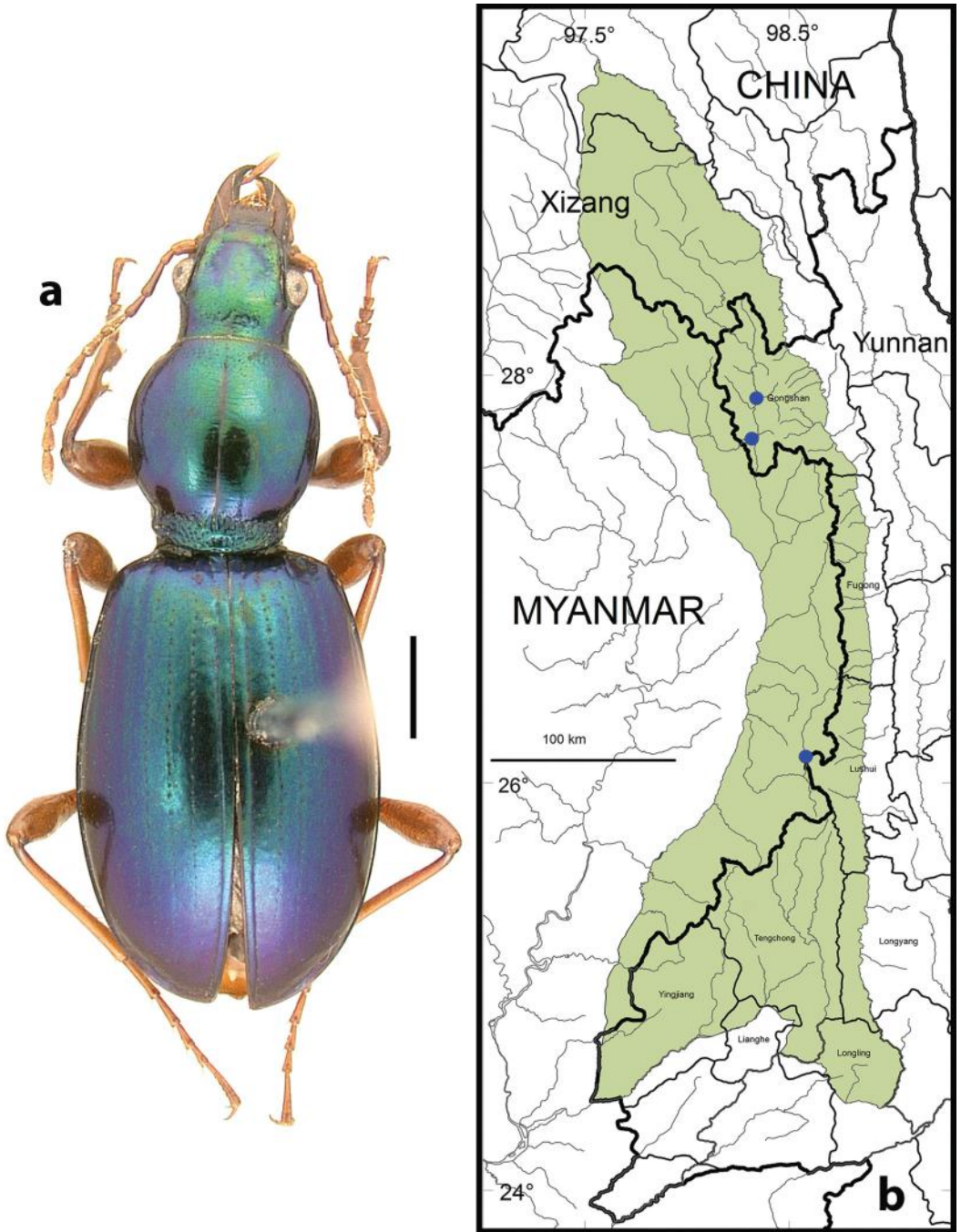


FIGURE 24. *Broscosoma holomarginatum* sp. nov. a. Habitus (CASENT1015162; 0.5 km N of Kongdang, Dulongjiang Township, Gongshan County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

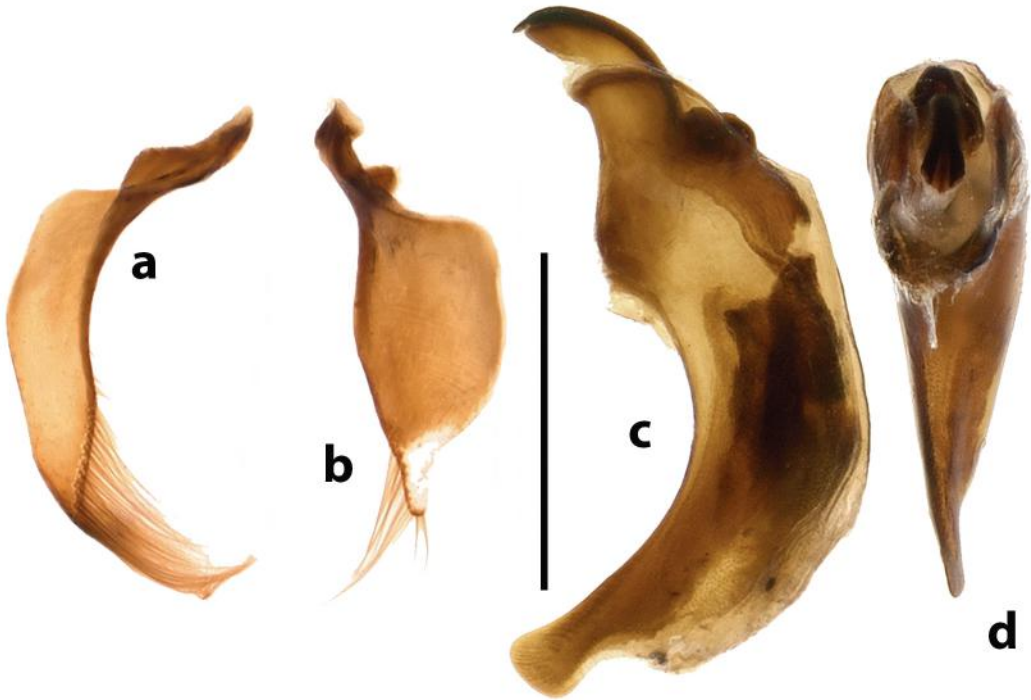


FIGURE 25. Male genitalia, *Broscosoma holomarginatum* sp. nov. (CASENT1016743; 0.5 km N of Kongdang, Dulongjiang Township, Gongshan County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

bluish-green, and elytra with marked blue metallic reflection, venter with metallic reflection absent or only faintly present.

Head. Fig. 6a. Eyes large, convex, their diameter slightly greater than length of tempora. Frontal furrows deeply impressed, narrow, arcuate, slightly convergent anteriorly and posteriorly, medium length, extended posteriorly to middle of eyes, rugulose and sparsely and coarsely punctate. Vertex with post-temporal transverse sulcus shallow, densely and coarsely punctate. Tempora straight, not convex. Genal ridges present, restricted to head region distinctly behind post-temporal constriction. Clypeus with one pair of setae. Supraorbital setae present, one pair. Eustipes of maxilla with two setae, the dorsobasal seta distinctly more than half as long as ventrobasal seta. Mentum with tooth present, simple, paramedial region shallowly foveate, one pair of mental setae present. Glossal sclerite (ligula) with one pair of setae. Submentum with one or two pairs of setae. Gula without transverse grooves. Antennomeres 3 and 4 without pubescence, ratio $A3/A5 = 1.2-1.3$.

Pronotum. Fig. 6a. Globose anterior to sub-basal constriction with base distinctly pedunculate, widest at middle of discal region, $PL/PW = 1.1$, disk markedly convex; apical margination absent; lateral margination present, narrow, distinctly delineated throughout pronotal length (Fig. FX09a); basal margination absent; anterior transverse impression shallow, broad and vaguely delineated, coarsely punctate both at bottom and on slopes of depression; median longitudinal impression moderately impressed; posterior transverse impression deep, sharply delineated; anterior region moderately to densely and coarsely punctate; pronotal base coarsely punctate and rugulose; one

pair of midlateral pronotal setae present at mid-length of discal region; basolateral pronotal setae absent.

Elytra. Elytral silhouette subovoid, slightly narrowed in basal half, widest at or slightly posterior to middle, ratio EL/EW in males = 1.5, in female = EL/EW 1.6, greatest elevation above lateral margin (in lateral view) posterior to middle; humeri distinctly present, roundly obtuse; lateral margins moderately arcuate and nearly straight in anterior half sub-basally; parascutellar striae present, short, distally merged in a distinct jog with free base of stria 1. Eight elytral striae present; stria 1 deeply and sharply impressed, striae 2 to 8 indistinct, obliterated or represented by extremely fine and shallow linear depressions, successively less evident laterally and apically, striae 8 merged with lateral groove throughout its length or nearly so; stria 1 moderately punctate at least in basal half, striae 2 to 8 densely and moderately punctate, but with punctures increasingly shallower and sparser laterally and apically. Elytral microsculpture comprised of distinct, deeply to shallowly impressed isodiametric sculpticells. Parascutellar seta present at base of stria 2, discal setae absent, umbilicate series comprised of one post-humeral and two preapical setae.

Hindwings. Full-sized, functional.

Thoracic venter. Metepisternum ratio ML/MW = 2.2–2.3.

Legs. Hind trochanter asetose. Tarsomeres without dorsal pubescence; tarsomere 5 with two or more pairs of setae ventrally; male protarsi with pads of adhesive setae on tarsomeres 1 to 3 ventrally, male mesotarsi with pads of adhesive setae on tarsomeres 1 and 2 ventrally.

Abdomen. Sternite VI of both male and female with one pair of apicoparamedial setae.

Male genitalia. As in Fig. 25.

Comments. This is apparently the only species in genus *Broskosoma* in which members have the pronotum with complete and well-defined lateral margination (Fig. 9a). Lateral margination is also present *B. resbecqi*, in which it is nearly complete but interrupted in the basal one-third of the discal region (Fig. 9b), and in most specimens of *B. ribbei*, in which it is present in the area of insertion of the midlateral seta and extended slightly anteriorly and posteriorly in some specimens (Fig. 9b). Members of both of these species have the dorsum with vivid green metallic reflection, whereas *B. holomarginatum* members are distinctly blue or greenish-blue dorsally. The left paramere of the male genitalia (Fig. 25b) is unusual for a *Broskosoma* species and similar only to that of *B. resbecqi* males among species of the region.

Habitat distribution. Within the study area, members of this species have been found under stones on the upper sandy beaches of rivers (Fig. 44b) and along roadcuts with sandy soil during daytime. Adults are active on the surface at night, along roadcuts on moist sandy substrate stabilized by mosses and on open, sandy river beaches, where they congregate near or on boulders surrounded by sand, especially on boulders covered with mosses. Most of these sandy flats have little cover under which these beetles can hide during the day, so it seems likely that many spend daylight hours burrowed in the sand itself. Within the Gaoligong Shan region, this species occurs at relatively low elevations, with our records documenting its occurrence in the 1500 to 1615 m range (Fig. 49). The record from Medog (Tibet) is from a slightly higher elevation of 2023 m.

Geographical distribution within the Gaoligong Shan. Fig. 24b. We examined a total of 20 specimens (ten males and ten females) from the northern and southcentral parts of the Gaoligong Shan in Gongshan and Lushui Counties. Our records from both areas are on the western side of the range (in Core Areas 1 and 4, respectively (Fig. 48) (see Type material above for exact collection data).

Overall geographical distribution. Fig. 47. This species has been recorded only from Gongshan and Lushui Counties in Yunnan and Medog County in Xizhang (Tibet). Its occurrence in the study area represents the southern part its geographical range.

Geographical relationships with other *Broscosoma* species. Within the study area, members of this species have been found together with those of *Broscosoma purpureum* (described below) and *B. ribbei* at one or more sites (Fig. 50). In Medog County, Xizang (Tibet), they have been found syntopic with members of *B. ribbei* and another (undescribed) *Broscosoma* species.

9. *Broscosoma parvum* Kavanaugh and Liang, sp. nov.

Figures 6f, 26, 27, 45a, 48-50

Type material. Holotype, a male, in IOZ, labeled: "CASENT 1022788"/ "CHINA, Yunnan, Fugong County, Lumadeng Township, 8.5 km above Shibali on Shibali road, North Fork of Yamu He" / "N27.18326°/E098.72002°, 3100m, 9 May 2004, Stop #DHK2004-042, D.H. Kavanaugh & H.B. Liang collectors"/ HOLOTYPE *Broscosoma furvum* Kavanaugh & Liang sp. nov. designated 2021" [red label]. Paratypes (a total of 6): one female (IOZ) labeled: same as holotype except first label "CASENT 1022789"; one male (CAS) labeled: "CASENT 1023771"/ "CHINA, Yunnan, Fugong County, Lumadeng Township, 8.5 km above Shibali on Shibali road, North Fork of Yamu He" / "N27.18326°/E098.72002°, 3100m, 7 May 2004, Stop #DHK2004-038B, D.H. Kavanaugh collectors"; one male and one female (CAS, IOZ) labeled: "CASENT 1019759" and "CASENT 1019754", respectively "CHINA, Yunnan, Fugong County, Lumadeng Township, 8.5 km W of Shibali on Shibali road, south bank of North Fork Yamu He" / "N27.18315°/E098.71921°, 3100-3200m, 16 August 2005, Stop #DHK2005-090, D.H. Kavanaugh & H.B. Liang collectors"; one female (CAS), "CHINA, Yunnan, Fugong County, Lumadeng Township, 8.5 km W of Shibali on Shibali road, south bank of North Fork Yamu He, N27.18326°/E098.72002°" / "3100m, 8 August 2005, Stop #DHK2005-067B, D.H. Kavanaugh & H.B. Liang, D.Z. Dong & J.F. Zhang collectors"; one male (CAS) labeled: "CASENT1023565"/ "CHINA, Yunnan, Fugong County, Lishadi Township, 11.5 km above Shibali on Shibali road, N27.20676°/E098.71763°" / "3290m, 6 May 2004, Stop #DHK-2004-036, D.H. Kavanaugh, C. E. Griswold, Liang H.-B., Li X.-Y. & Zhu B.-X. collectors". All paratypes also bear the following label: "PARATYPE *Broscosoma parvum* Kavanaugh & Liang, sp. nov. designated 2021" [yellow label].

Type locality. China, Yunnan, Fugong County, Lumadeng Township, 8.5 km W of Shibali on Shibali road, North Fork of Yamu He, 27.18326°/98.72002°, 3100m.

Derivation of species name. The species epithet, *parvum*, is an adjective derived from the Latin word, *parvus*, meaning small. The name refers to the relatively small body size of members of this species.

Diagnosis. Adults of this species (Fig. 26a) can be distinguished from those of other species in the region by the following combination of character states: size small, BL = 7.5 to 8.5 mm; dorsum with distinct metallic reflection, green on head, green or blue-green on pronotum, blue-green on elytra; antennomeres 3 and 4 glabrous except for apical whorl of setae; eyes (Fig. 6f) less convex, slightly flattened in some specimens; pronotum with basolateral setae absent; elytral silhouette ovoid, with greatest width at or near midlength, with humeri rounded yet slightly evident, two or more elytral striae impressed, all striae punctate with punctures diminishing in size and depth laterally and posteriorly, medial two or more elytral intervals very slightly to moderately convex; male protarsi with tarsomeres 1 to 3 with ventral pads of adhesive setae; male genitalia as in Fig. 27.

Description. Fig. 26a. Size small, BL male = 7.5-7.7 mm, female = 7.9-8.5 mm, ratio EL/PL male 2.2-2.4, female 2.3. Body color black or piceous, last visible addominal sternite dark brown or rufous brown, antennae with all antennomeres rufous brown, femora black or dark piceous, tibiae and tarsi rufous brown. Dorsum with distinct metallic reflection, green on head, green or blue-green on pronotum, and blue-green on elytra, venter without metallic reflection.

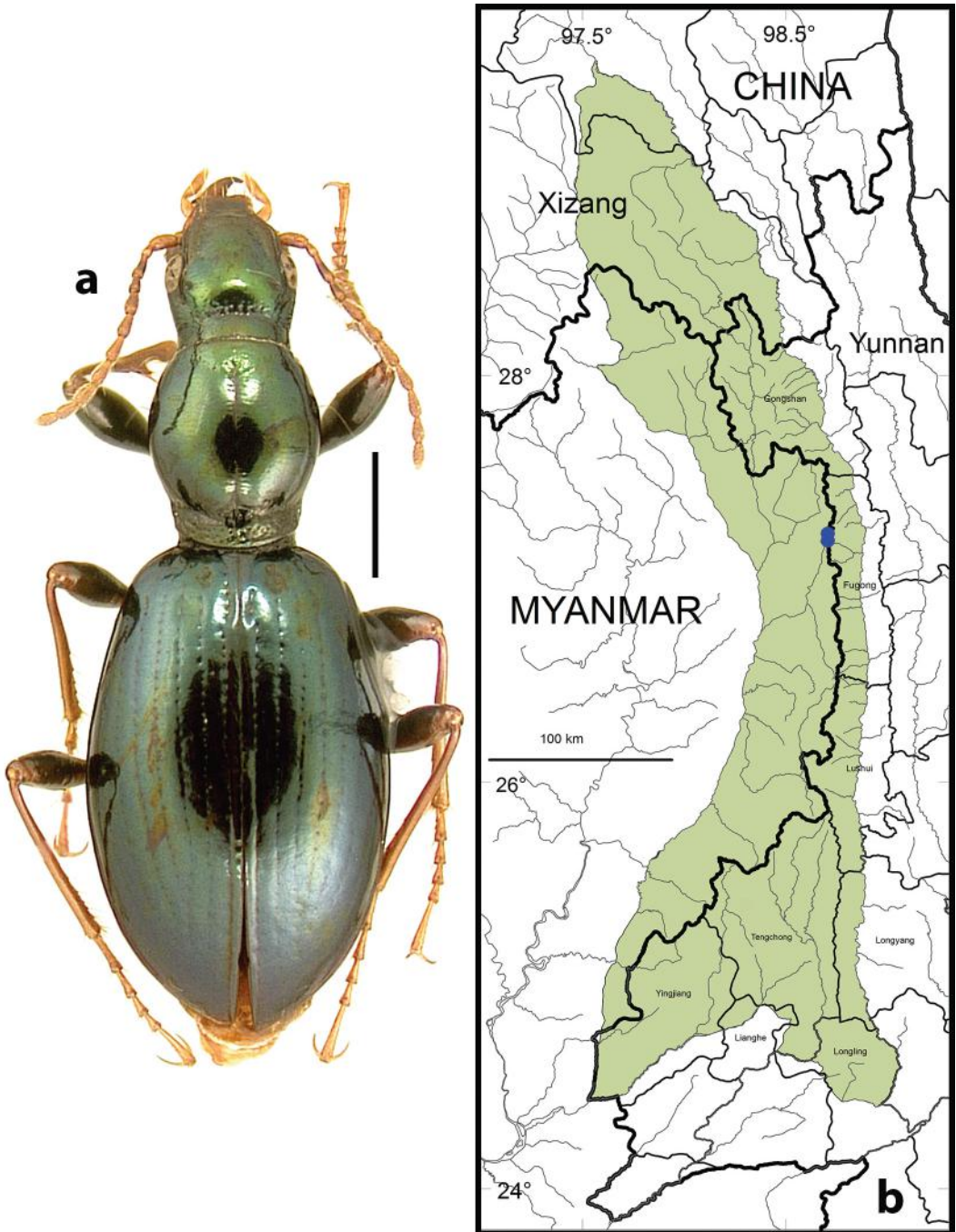


FIGURE 26. *Broscosoma parvum* sp. nov. a. Habitus (CASENT1020001; first cirque S of Shibali Yakou, Lumadeng Township, Fugong County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

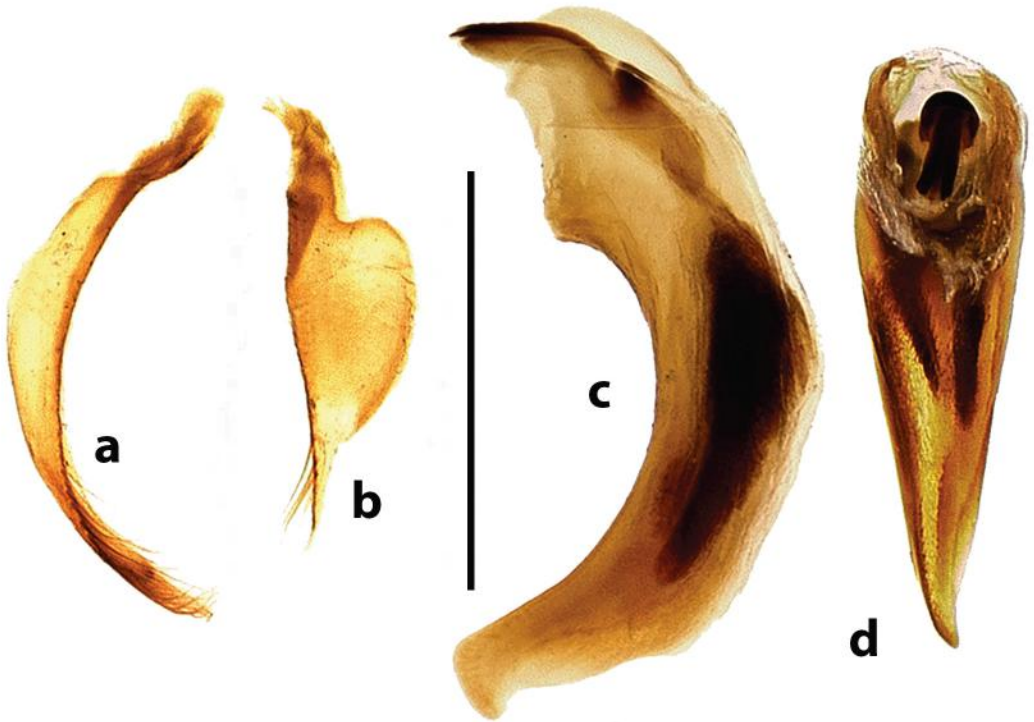


FIGURE 27. Male genitalia, *Broscosoma parvum* sp. nov. (CASENT1023565; 11.5 km above Shibali, Lishadi Township, Fugong County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

Head. Fig. 6f. Eyes only slightly convex, slightly flattened, small, their diameter slightly less than length of tempora. Frontal furrows deeply impressed, narrow, linear, slightly divergent posteriorly, medium length, extended posteriorly to middle of eyes, smooth or faintly rugulose, impunctate. Vertex with post-temporal transverse sulcus deep, sharply defined, moderately punctate. Tempora straight, oblique. Genal ridges absent or restricted to head region distinctly posterior to post-temporal constriction. Clypeus with one pair of setae. Supraorbital setae present, one pair. Eustipes of maxilla with two setae, the dorsobasal seta distinctly more than half as long as ventrobasal seta. Mentum with tooth present, simple, paramedial region deeply foveate, one pair of mental setae present. Glosal sclerite (ligula) with one pair of setae. Submentum with two or three pairs of setae. Gula without transverse grooves. Antennomeres 3 and 4 without pubescence, ratio $A3/A5 = 1.2$.

Pronotum. Fig. 6f. Disc anterior to sub-basal constriction slightly narrow, slightly longitudinally ovoid in dorsal view with base distinctly pedunculate, widest at middle of discal region, ratio $PL/PW = 1.2-1.3$, disk markedly convex; apical, lateral, and basal margination absent; anterior transverse impression shallow, broad and vaguely delineated, impunctate or sparsely and coarsely punctate; median longitudinal impression moderately impressed; posterior transverse impression deep, sharply delineated; anterior region smooth; pronotal base coarsely and sparsely to densely punctate; one pair of midlateral pronotal setae inserted slightly anterior to mid-length of discal region; basolateral pronotal setae absent.

Elytra. Elytral silhouette subovoid, slightly narrowed in basal half, widest at or near middle, ratio EL/EW male and female = 1.6, greatest elevation above lateral margin (in lateral view) pos-

terior to middle; humeri faintly present, roundly obtuse; lateral margins moderately arcuate and nearly straight in anterior half sub-basally; parascutellar striae present, short, distally merged in a distinct jog with free base of stria 1. Eight striae present; stria 1 moderately deeply and sharply impressed, striae 2 to 3, 4, or 5 shallowly impressed in basal two-thirds of striae and successively more shallowly impressed to indistinct in apical third, striae 3 to 8 successively more shallowly impressed to indistinct or obliterated laterally and apically, striae 8 merged with lateral groove throughout its length or nearly so; stria 1 coarsely and moderately densely punctate at least in basal half, striae 2 to 3, 4, or 5 moderately punctate in basal two-thirds and successively more shallowly and sparsely punctate in apical third, striae 3 to 8 successively more shallowly and sparsely punctate laterally and apically. Elytral microsculpture comprised of very faintly impressed, nearly effaced isodiametric sculpticells. Parascutellar seta present at base of stria 2, discal setae absent, umbilicate series comprised of one post-humeral and two preapical setae.

Hindwings. Vestigial, incapable of supporting flight.

Thoracic venter. Metepisternum ratio ML/MW = 1.8–2.2.

Legs. Hind trochanters asetose. Tarsomeres without dorsal pubescence; tarsomere 5 with two or more pairs of setae ventrally; male protarsi with pads of adhesive setae on tarsomeres 1 to 3 ventrally, male mesotarsi with pads of adhesive setae on tarsomeres 1 and 2 ventrally.

Abdomen. Sternite VI of both male and female with one pair of apicoparamedial setae.

Male genitalia. As in Fig. 27.

Comments. Only four species in the study area have the full dorsum of the body with green metallic reflection. Members of *B. danzhuense* are larger in size, have eyes that are more convex (Fig. 6e), the elytral silhouette slightly broader across the humeri and their greatest width distinctly posterior to midlength (at or very near midlength in *B. parvum*), elytra striae that are more finely punctate, and elytral intervals that are flat (at least some intervals slightly convex in *B. parvum*). The holotype of *B. resbecqi* is larger and has the pronotum with the discal portion relatively shorter and more globose (Fig. 6d) and lateral margination present and nearly complete (Fig. 9b) (absent from *B. parvum*), the femora pale rufous (darker in *B. parvum*), and the median lobe of the male genitalia much thicker (Fig. 31c) and with the apical lamella short and tapered to a narrowly rounded tip in lateral aspect (median lobe much thinner and the apical lamella slightly hooked dorsally in *B. parvum*). Members of *B. ribbei* are generally much larger and have the eyes distinctly more convex, the pronotum with the discal portion relatively shorter and more globose (Fig. 6b) and lateral margination incomplete but present in most specimens, at least in the vicinity of the midlateral setae and more extensively in some specimens, elytral microsculpture distinct, deeply to moderately impressed (very faintly impressed or effaced in *B. parvum*), the metatrochanters unisetose (unilaterally asetose in a few specimens) (asetose in *B. parvum*), and the median lobe of the male genitalia much longer, thinner, and with the apical lamella more symmetrically rounded in lateral aspect.

As noted in the Comments section for *B. danzhuense*, only two *Brosocosoma* species known from outside the study area have members in which the elytral humeri are at least faintly evident (although in both they are less evident than in *B. parvum*) and the entire dorsum exhibits metallic green or bluish-green reflection. In members of *B. montreuili*, the forebody is a darker, less vivid metallic green than the elytra (both parts equally vivid or forebody lighter and more vivid in *B. parvum*), and in both *B. montreuili* and *B. tiani* body size is larger, the discal portion of the pronotum is more globose (narrower and more elongate in *B. parvum*), the elytra have striae 2 to 8 more faintly defined and finely punctate, and the median lobe of the male genitalia is longer, less arcuate and with the apical lamella either rounded apically or hooked ventrally (hooked dorsally in *B. parvum*).

Habitat distribution. Members of this species have been found under stones along small to medium-sized streams on moist organic substrate. Half of the specimens collected were found along a small snowmelt stream on a steep, north-facing slope (Fig. 45a). This species is found at moderately high elevations, with our records documenting its occurrence in the 3100 to 3290 m range (Fig. 49).

Geographical distribution within the Gaoligong Shan. Fig. 26b. We examined a total of seven specimens (four males and three females), all from the northcentral part of the Gaoligong Shan in Fugong County on the eastern side of the range in Core Area 3 (Fig. 48) (see Type material above for exact collection data).

Overall geographical distribution. This species currently is known only from the northcentral part of the Gaoligong Shan, in western Yunnan Province, China.

Geographical relationships with other *Broscosoma* species. Members of this species have been found together (syntopic) only with those of *B. viridicollare* at one or more sites (Fig. 50).

10. *Broscosoma purpureum* Kavanaugh and Liang, sp. nov.

Figures 6c, 9d, 10c, 28, 29, 45b, 48-50

Type material. Holotype, a male, in IOZ, labeled: "CASENT 1015338"/ "CHINA, Yunnan, Gongshan County, Dulongjiang Township, 0.5km N of Kongdang, 1500m, N27.88111°/E098.34063°,"/ "25 October 2004"/ "Stop #DHK-2004-057A, D.H. Kavanaugh collector"/ "HOLOTYPE *Broscosoma purpureum* Kavanaugh & Liang sp. nov. designated 2021" [red label]. Paratypes (a total of 52): one male and three females (CAS, IOZ) labeled: same as holotype except first label "CASENT 1015337" and "CASENT 1015339" to "CASENT 1015341", respectively; 18 males and eight females (CAS, IOZ) labeled: "CASENT 1014590" to "CASENT 1014602", "CASENT 1016705" to "CASENT 10116708" and "CASENT 10116730" and "CASENT 1014603" and "CASENT 1016709" to "CASENT 10116715", respectively/"CHINA, Yunnan, Gongshan County, Dulongjiang Township, 0.5km N of Kongdang, 1500m, N27.88111°/E098.34063°, 25 October 2004"/ "Stop #DHK-2004-057C, D.H. Kavanaugh, Q.-B. Hou, H.-B. Liang, D.-Z. Dong & G. Tang collectors"; three females (CAS, IOZ) labeled: "CASENT 1017017" to "CASENT 1017019", respectively/"CHINA, Yunnan, Gongshan County, Dulongjiang Township, 0.6 km N of Dizhengdang village on Dulong Jiang, N28.08442°/E098.32652°"/ "1880m, 29 October 2004, Stop #DHK-2004-061B, D.H. Kavanaugh, G. Tang & D.-Z. Dong collectors"; three males and three females (CAS, IOZ) labeled: "CASENT 1014626" to "CASENT 1014628" and "CASENT 1014629" to "CASENT 1014631", respectively/"CHINA, Yunnan, Gongshan County, Dulongjiang Township, Bapo, 1412m, N27.73902°/E098.34975°"/ "26 October 2004, Stop #LHB-2004-033, H.-B. Liang collector"; one female (IOZ) labeled: "CASENT 1015009"/ "CHINA, Yunnan, Gongshan County, Dulongjiang Township, Bapo, Mulangdang, 1355m, N27.75256°/E098.34745°"/ "4 November 2004, Stop #LHB-2004-046, H.-B. Liang collector"; three males and two females (CAS, IOZ) labeled: "CASENT 1016094" to "CASENT 1016096" and "CASENT 1016097" to "CASENT 1016098", respectively/"CHINA, Yunnan, Gongshan County, Dulongjiang Township, west bank of Dulongjiang at Elideng village, 1640m, N28.00287°/E098.32145°" / "3 November 2004, Stop #DHK-2004-073, D.H. Kavanaugh, G. Tang & D.-Z. Dong collectors"; two male and four females (CAS, IOZ) labeled: "CASENT 1015868" to "CASENT 1015869" and "CASENT 1015870" to "CASENT 10115874", respectively/"CHINA, Yunnan, Gongshan County, Dulongjiang Township, Moqie Wang at Gongshan/Dulongjiang Road Km 91, 1550m, N27.90085°/E098.34721°" / "6 November 2004, Stop #DHK-2004-077, D.H. Kavanaugh & H.-B. Liang collectors"; 1 male,

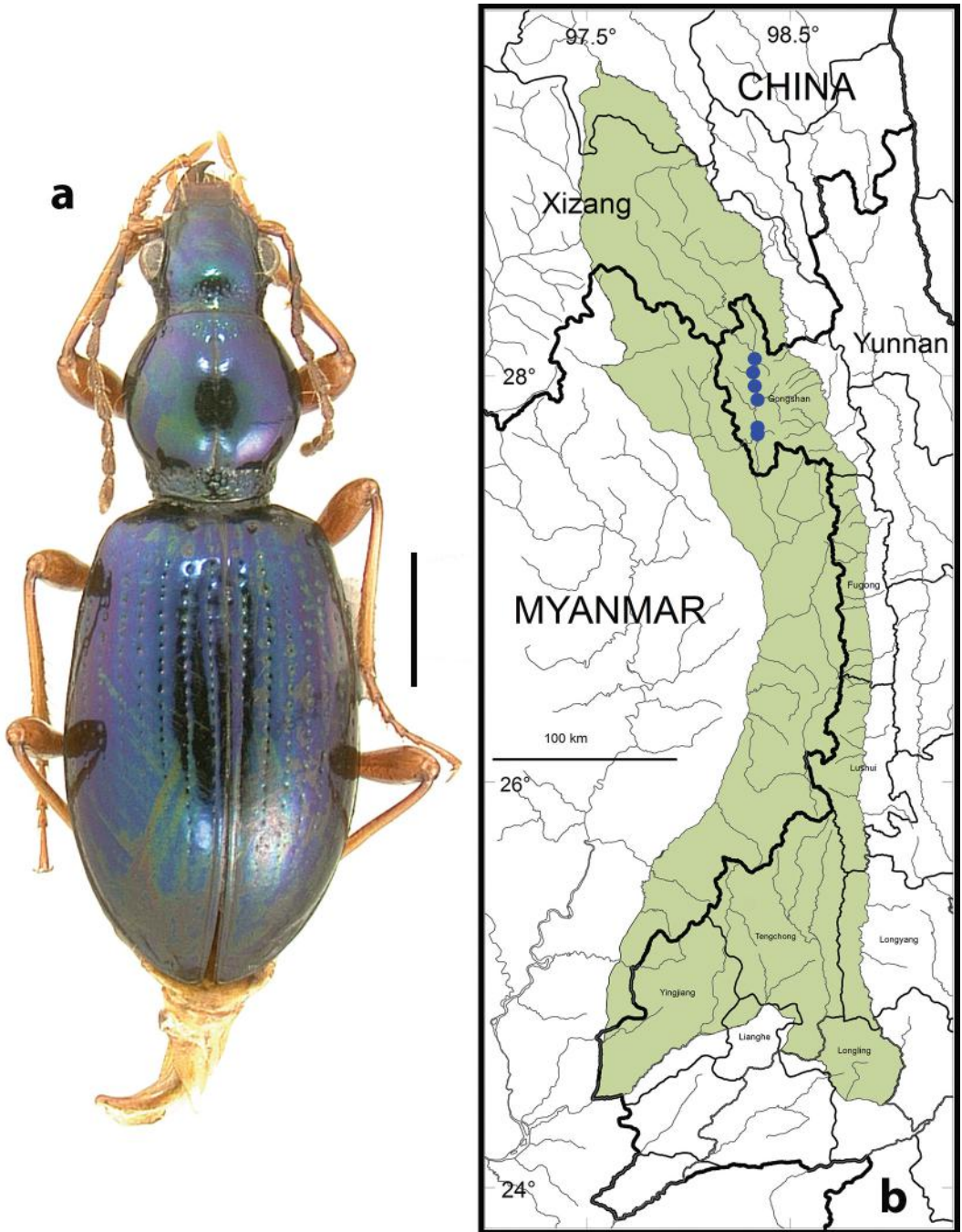


FIGURE 28. *Broscosoma purpureum* sp. nov. a. Habitus (CASENT1015338; 0.5 km N of Kongdang, Dulongjiang Township, Gongshan County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

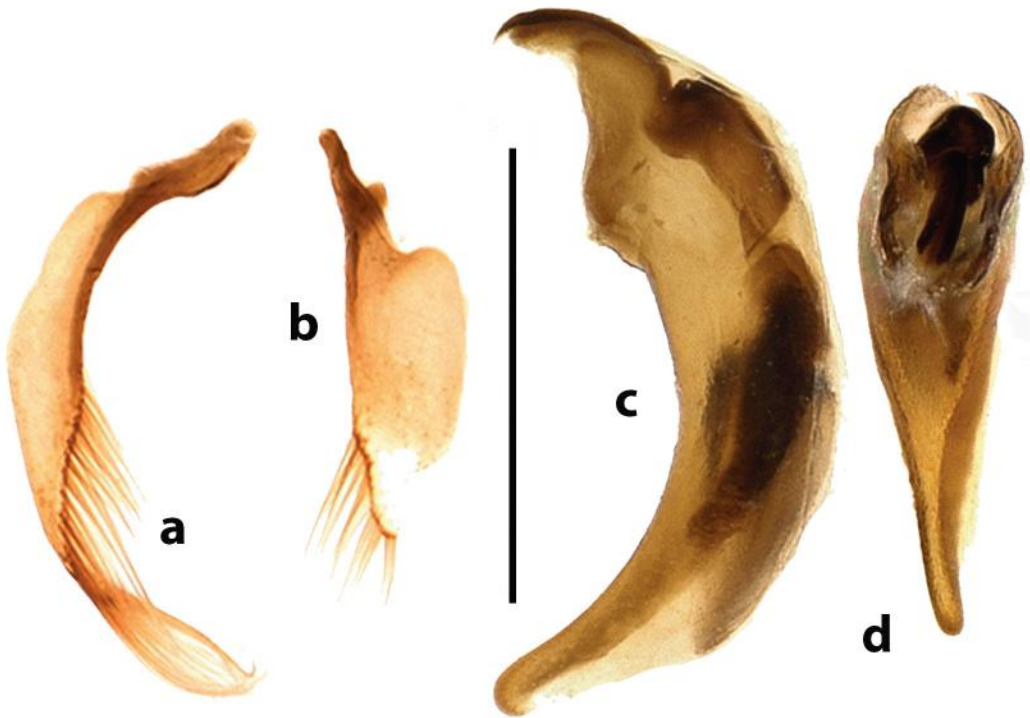


FIGURE 29. Male genitalia, *Broscosoma purpureum* sp. nov. (CASENT1015869; Moqie Wang, Dulongjiang Township, Gongshan Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

“CHINA, Yunnan, Gongshan County, Dulongjiang Township, Dulongjiang at Xianjiudang village, 1580m, N27.94092°/E098.33340°, 4 November 2004”/ “Stop #DHK-2004-074, D.H. Kavanaugh, M.A. Dixon, G. Tang & D.-Z. Dong collectors”. All paratypes also bear the following label: “PARATYPE *Broscosoma purpureum* Kavanaugh & Liang, sp. nov. designated 2021” [yellow label].

Type locality. China, Yunnan, Gongshan County, Dulongjiang Township, Kongdang area, 1500m.

Derivation of species name. The species epithet, *purpureum*, is an adjective derived from the Latin word, *purpureus*, meaning purple. The name refers to the purple or bluish-purple metallic reflection of the dorsum in members of this species.

Diagnosis. Adults of this species (Fig. 28a) can be distinguished from those of other species in the region by the following combination of character states: size small, BL = 7.4 to 8.1 mm; dorsal surface of body bright metallic blue or bluish-purple, head with greenish hue in some specimens, legs (including femora) pale rufous; antennomeres 3 and 4 glabrous except for apical whorl of setae; pronotum with lateral margination absent or present only at or posterior to sub-basal constriction (Fig. 9d), basolateral setae absent; elytral silhouette subparallel to subovoid, with humeri distinct, angulate, elytral microsculpture effaced, elytral striae coarsely punctate; metatrochanters asetose in most specimens (a few specimens with one or both metatrochanters unisetose); male pro-tarsi with tarsomeres 1 to 3 with ventral pads of adhesive setae; male genitalia as in Fig. 29.

Description. Fig. 28a. Size small, BL male = 7.4–8 mm, female = 7.9–8.1 mm, ratio EL/PL male = 2.4–2.5, female = 2.6. Body color black or dark piceous, last visible abdominal sternite

rufous basally graded to pale yellow apically, antennae with antennomeres 1 and 2 and base of 3 pale rufous, other antennomeres rufous brown, femora, tibiae, and tarsi pale rufous. Dorsum with bright blue or bluish-purple metallic reflection, head with greenish hue on some specimens, venter (except epipleurae) without metallic reflection.

Head. Fig. 6c. Eyes large, convex, their diameter twice the length of the tempora. Frontal furrows moderately impressed, broad or narrow, arcuate, slightly convergent anteriorly and posteriorly, long, extended posteriorly beyond middle of eyes, faintly rugulose, impunctate or sparsely punctate. Vertex with post-temporal transverse sulcus broadly defined, densely and coarsely punctate. Tempora obliquely convex. Genal ridges present, restricted to head region distinctly behind post-temporal constriction (Fig. 10c). Clypeus with one pair of setae. Supraorbital setae present, one pair. Eustipes of maxilla with two setae, the dorsobasal seta distinctly more than half as long as ventrobasal seta. Mentum with tooth present, simple, paramedial region shallowly foveate, one pair of mental setae present. Glosal sclerite (ligula) with one pair of setae. Submentum with one or two pairs of setae. Gula without transverse grooves. Antennomeres 3 and 4 without pubescence, ratio $A3/A5 = 1.1-1.2$.

Pronotum. Fig. 6c. Discal region anterior to basal constriction ovoid, slightly narrowed anteriorly with base distinctly pedunculate, widest at middle of discal region, ratio $PL/PW = 1.1$, disk markedly convex; apical, lateral, and basal margination absent; anterior transverse impression shallow, broad and vaguely delineated, coarsely and sparsely punctate; median longitudinal impression moderately impressed; posterior transverse impression deep, sharply delineated; anterior region sparsely punctate; pronotal base coarsely and densely punctate; one pair of midlateral pronotal setae present at mid-length of discal region; basolateral pronotal setae absent.

Elytra. Elytral silhouette subovoid, slightly narrowed in basal half, widest at middle, or slightly posterior to middle, ratio EL/EW male and female = 1.6–1.7, greatest elevation above lateral margin (in lateral view) posterior to middle; humeri distinctly present, roundly obtuse; lateral margins moderately arcuate and nearly straight in anterior half sub-basally; parascutellar striae present, short, distally merged in a distinct jog with free base of stria 1. Eight striae present; stria 1 moderately deeply and sharply impressed, striae 2 to 8 indistinct, obliterated or represented by extremely fine and shallow linear depressions between punctures, successively less evident laterally and apically, stria 8 merged with lateral groove throughout its length or nearly so; stria 1 coarsely and moderately densely punctate, striae 2 to 3, 4, or 5 coarsely and densely punctate in basal two-thirds and successively more shallowly and sparsely punctate in apical third, striae 3 to 8 successively more shallowly and sparsely punctate laterally and apically. Elytral microsculpture effaced. Parascutellar seta present at base of stria 2, discal setae absent, umbilicate series of elytral setae comprised of one post-humeral and two preapical setae.

Hindwings. Full-sized, functional.

Thoracic venter. Metepisternum ratio $ML/MW = 2.1-2.4$.

Leg. Hind trochanter asetose. Tarsomeres without dorsal pubescence; tarsomere 5 with two or more pairs of setae ventrally; male protarsi with small pads of adhesive setae on tarsomeres 1 to 3 ventrally, male mesotarsi with small pads of adhesive setae on tarsomeres 1 and 2 ventrally.

Abdomen. Sternite VI of both male and female with one pair of apicoparamedial setae.

Male genitalia. As in Fig. 29.

Comments. Members of this species and *B. parvum* have the smallest body size of any *Brosocosoma* species in the study area. In the field, they could be mistaken for a species of *Ardis-tomis*, a scaritine genus of the New World fauna. They can be distinguished from members of all other species in the region by their very shiny and brilliant purple or blue dorsum (although some individuals have the forebody greenish-blue rather than the purple or blue seen on the elytra), large

and convex eyes, pronotum without lateral margination, and elytra with elytral striae (especially striae 1-3) very coarsely punctate, at least at and anterior to midlength, and elytral microsculpture effaced. The only species with which *B. purpureum* might be confused is *B. holomarginatum*, members of which are larger, have complete lateral margination on the pronotum, slightly smaller eyes, and elytral microsculpture distinctly impressed.

Among *Broskosoma* species known from outside the study area, only three have some or all members with distinct blue metallic reflection on the dorsum. As noted above in the Comments section for *B. bicoloratum*, *B. monticola* members have the elytra with shiny blue metallic reflection, but the pronotum is black, without metallic reflection, the humeri are obliterated and hindwings reduced (humeri distinct, subangulate and hindwings full-sized and functional in *B. purpureum*), and the median lobe of the male genitalia has a large protuberance on the ventral margin. Members of *Broskosoma semenovi* Belousov and Kataev, 1990 from the Caucasus region also have the dorsum bright metallic blue and are similar in size to *B. purpureum* members, but they have the apical part of antennomere 4 pubescent (glabrous in *B. purpureum*), the pronotum more elongate, the elytra with the humeri obliterated and striae only faintly punctate, and the median lobe of the male genitalia with the apical lamella broader in lateral aspect (see Belousov and Kataev 1990, fig. 2). Some members of the third species, *Broskosoma sichuanum* Deuve, 1990 also have the dorsum of the body with metallic blue reflection. However, members of that species have the eyes much smaller and less convex, the elytra with humeri indistinct, only stria 1 distinctly impressed (two or more striae impressed in *B. purpureum*) and striatal punctures smaller, less coarse, the meta-trochanters unisetose (asetose *B. purpureum*, unisetose unilaterally in very few specimens), and the median lobe of the male genitalia more slender (see Deuve 1990, fig. 11).

Habitat distribution. Members of this species have been found under deeply embedded stones on the upper sandy beaches of rivers (Fig. 45b) and along roadcuts with sandy soil during daytime. Adults are active on the surface at night, along roadcuts on moist sandy substrate stabilized by mosses and on open, sandy river beaches, where they congregate near or on boulders surrounded by sand, especially on boulders covered with mosses. Most of these sandy flats have little cover under which these beetles can hide during the day, so it seem likely that many spend daylight hours burrowed in the sand itself. This species is restricted to relatively low elevations, with our records documenting its occurrence in the 1355 to 1880 m range (Fig. 49).

Geographical distribution within the Gaoligong Shan. Fig. 28b. We examined a total of 53 specimens (29 males and 24 females) from the northwestern part of the Gaoligong Shan in Gongshan County. Our records are all from the Dulong Jiang valley at the base of the western slope of the range in Core Area 1 (Fig. 48) (see Type material above for exact collection data).

Overall geographical distribution. This species has been recorded only from the northwestern part of the Gaoligong Shan in Gongshan County in western Yunnan Province China.

Geographical relationships with other *Broskosoma* species. Members of this species have been found together only with those of *Broskosoma holomarginatum* at one or more sites (Fig. 50). *Broskosoma ribbei* occurs in the same general area but has not been found syntopic with *B. purpureum*.

11. *Broskosoma resbecqi* Kavanaugh and Liang, sp. nov.

Figures 6d, 9b, 30, 31, 46a, 48-50

Type material. Holotype, a male, in IOZ, labeled: "CASENT 1016251"/ "CHINA, Yunnan, Gongshan County, Dulongjiang Township, Siran Wang, 0.2 km above confluence with Dulong Jiang, N28.01347°/ E098.32117°,"/ "1720 m, 1 November 2004, Stop # DHK-2004-066, D.H.

Kavanaugh & D.-Z. Dong collectors”/ “HOLOTYPE *Brosocosoma resbecqi* Kavanaugh & Liang sp. nov. designated 2021” [red label].

Type locality. China, Yunnan, Gongshan County, Dulongjiang Township, Siran Wang, 0.2. km above confluence with Dulong Jiang, 1720 m.

Derivation of species name. We take pleasure in naming this new species in honor of our colleague, known professionally as Thierry Deuve, but officially as Thierry de Resbecq, in recognition of his many contributions to our knowledge of the broscine fauna of Asia and for his help with this and other research projects. The species epithet, *resbecqi*, is the Latinized form of his surname (in the genitive case).

Diagnosis. Adults of this species (Fig. 30a) can be distinguished from those of other species in the region by the following combination of character states: size moderate, BL = 9.0 mm; dorsal surface of head and pronotum vivid metallic green, elytra darker blue-green, legs pale rufous; vertex of head with post-temporal transverse sulcus relatively shallow and broadly and densely punctate (Fig. 6d); antennomeres 3 and 4 glabrous except for apical whorl of setae; pronotum with lateral margination present but interrupted briefly in basal half (Fig. 9b), basolateral setae absent; elytral silhouette subovoid, with humeri rounded but evident, elytral microsculpture effaced; metatrochanter asetose; male protarsi with tarsomeres 1 to 3 with ventral pads of adhesive setae; male genitalia as in Fig. 31.

Description. Fig. 30a. Size medium. BL male = 9.0 mm, ratio EL/PL = 2.5. Body color black or dark piceous, last visible abdominal sternite dark rufous brown, all antennomeres, femora, tibiae, and tarsi pale rufous. Head and pronotum with brilliant green metallic reflection, elytra with darker bluish-green metallic reflection, venter without metallic reflection.

Head. Fig. 6d. Eyes medium-sized, their diameter slightly greater than length of tempora. Frontal furrows moderately impressed, narrow, arcuate, slightly convergent anteriorly and posteriorly, long, extended posteriorly beyond middle of eyes, rugulose and sparsely and coarsely punctate. Vertex with post-temporal transverse sulcus densely and coarsely punctate. Tempora straight, oblique. Genal ridges present, restricted to head region distinctly posterior to post-temporal constriction. Clypeus with one pair of setae. Supraorbital setae present, one pair. Eustipes of maxilla with two setae, the dorsobasal seta distinctly more than half as long as ventrobasal seta. Mentum with tooth present, simple, paramedial region shallowly foveate, one pair of mental setae present. Glosal sclerite (ligula) with one pair of setae. Submentum with two pairs of setae. Gula without transverse grooves. Antennomeres 3 and 4 without pubescence, ratio A3/A5 = 1.1.

Pronotum. Fig. 6d. Globose anterior to sub-basal constriction, with base distinctly pedunculate, widest at middle of discal region, PL/PW = 1.1, disk markedly convex; apical margination absent; lateral margination present, narrow, distinctly delineated from apical margin to just posterior of midlateral seta, thence slightly interrupted and then evident again at and posterior to the sub-basal constriction; basal margination absent; anterior transverse impression shallow, broad and vaguely delineated, coarsely punctate both at bottom and on slopes of depression; median longitudinal impression moderately impressed; posterior transverse impression deep, sharply delineated; anterior region sparsely punctate; pronotal base coarsely and densely punctate; one pair of midlateral pronotal setae present, inserted at mid-length of discal region; basolateral pronotal setae absent.

Elytra. Elytral silhouette subovoid, slightly narrowed in basal half, widest at middle, ratio EL/EW = 1.6, greatest elevation above lateral margin (in lateral view) posterior to middle; humeri distinctly present, roundly obtuse; lateral margins moderately arcuate and nearly straight in anterior half sub-basally; parascutellar striole present, short, distally merged in a distinct jog with free base of stria 1. Eight striae present; stria 1 moderately deeply and sharply impressed, striae 2 to 8

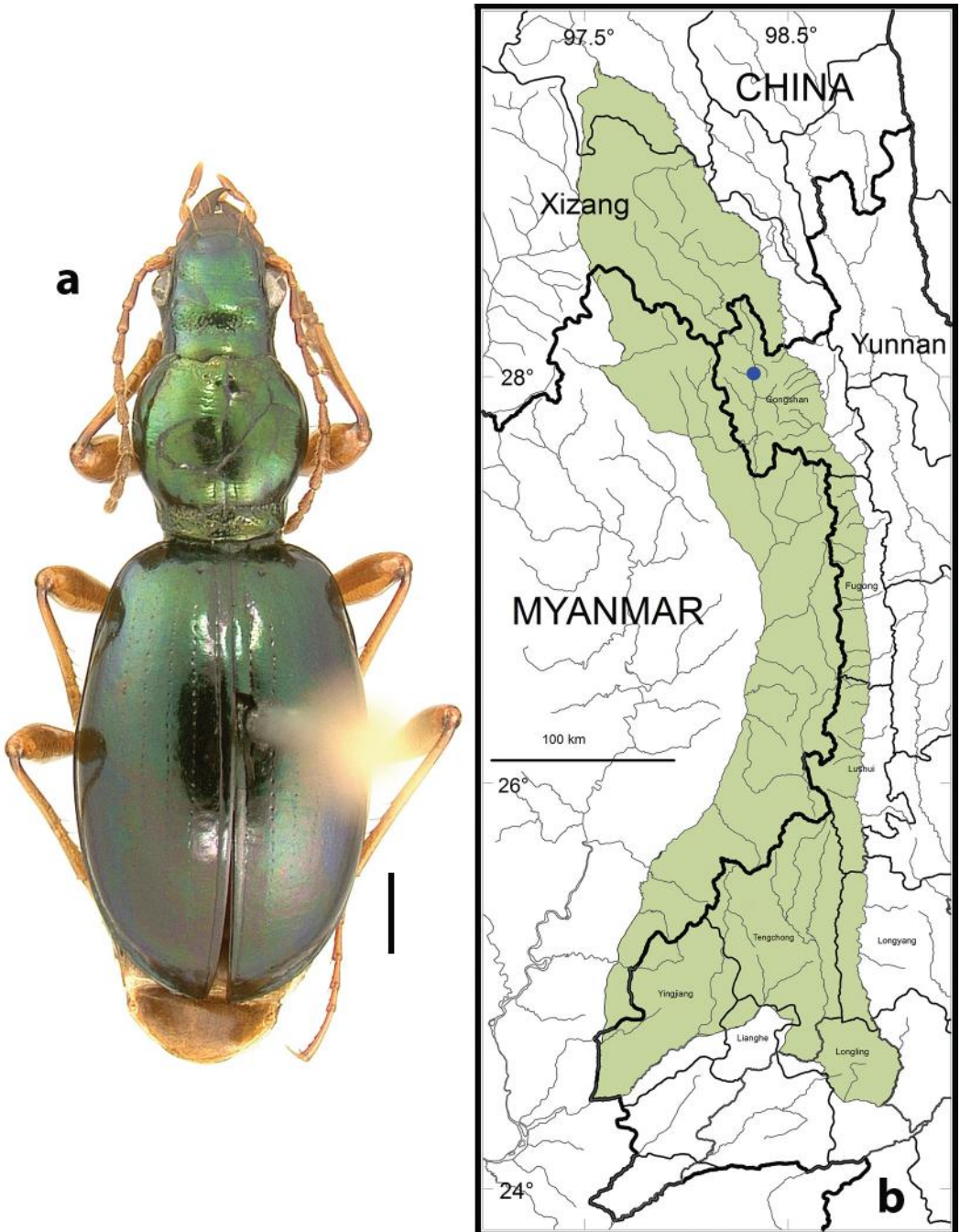


FIGURE 30. *Broscosoma resbecqi* sp. nov. a. Habitus (Holotype; Siran Wang, Dulongjiang Township, Gongshan County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

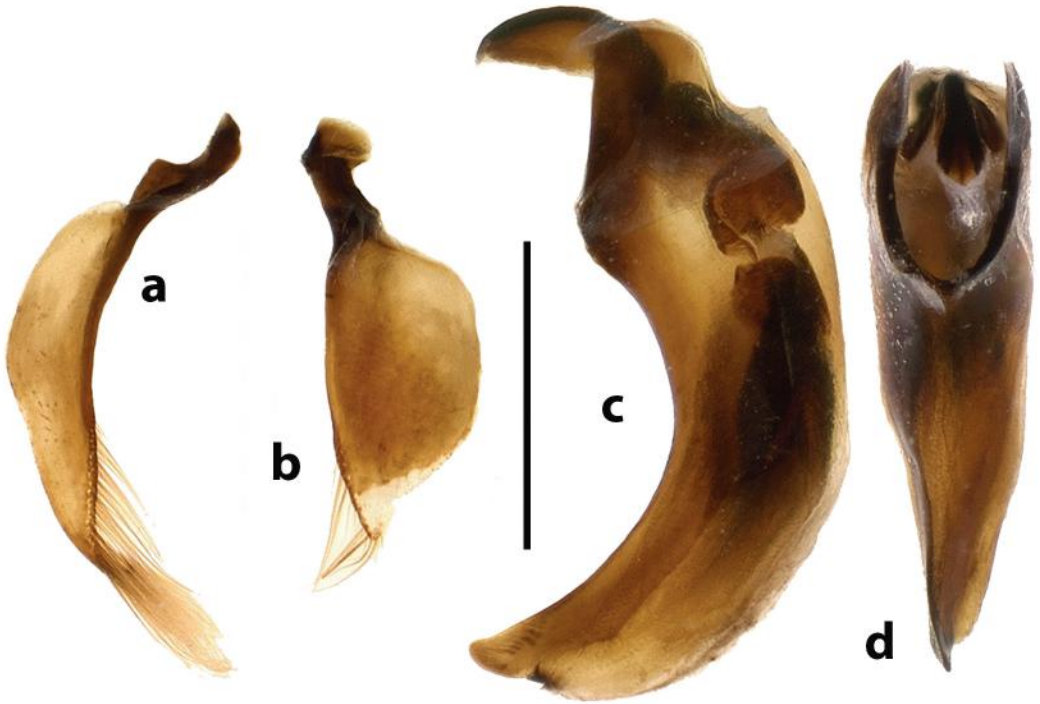


FIGURE 31. Male genitalia, *Broscosoma resbecqi* sp. nov. (Holotype; Siran Wang, Dulongjiang Township, Gongshan County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

indistinct, obliterated or represented by extremely fine and shallow linear depressions, successively less evident laterally and apically, stria 8 merged with lateral groove throughout its length or nearly so; stria 1 moderately punctate at least in basal half, stria 2 moderately punctate in basal two-thirds and successively more shallowly and sparsely punctate in apical third, striae 3 to 8 successively more shallowly and sparsely punctate laterally and apically. Elytral microsculpture effaced. Parascutellar seta present at base of stria 2, discal setae absent, umbilicate series of elytral comprised of one post-humeral and two preapical setae.

Hindwings. Slightly reduced, incapable of supporting flight.

Thoracic venter. Metepisternum ratio ML/MW = 1.8.

Legs. Hind trochanter asetose. Tarsomeres without dorsal pubescence; tarsomere 5 with two or more pairs of setae ventrally; male protarsi with pads of adhesive setae on tarsomeres 1 to 3 ventrally, male mesotarsi with pads of adhesive setae on tarsomeres 1 and 2 ventrally.

Abdomen. Male sternite VI with one pair of apicolateral setae. Female unknown.

Male genitalia. As in Fig. 31.

Comments. As noted above, *B. resbecqi* is one of four species in the study area members of which have the entire dorsum of the body with metallic green reflection. Features distinguishing members of this species from those of *B. danzhuense* and *B. parvum* have been addressed above in the Comments sections for each of those species. At first glance, *B. resbecqi* could be mistaken for a small specimen of *B. ribbei*, but several features distinguish members of these taxa. The holotype of *B. resbecqi* has the metallic reflection of the elytra a darker bluish-green, contrasting with the

brighter green of the forebody, and the femora pale like the tibiae and tarsi. In *B. ribbei* members, the metallic reflection of the forebody and elytra are both a bright green, golden green, or blue-green and the femora are distinctly darker than the tibiae and tarsi. The eyes are more convex, the tempora longer and are less convex, and the post-temporal transverse sulcus more broadly and densely punctate in *B. resbecqi* (Fig. 6d) than in *B. ribbei* (Fig. 6b) members. The lateral margination of the pronotum in *B. resbecqi* (Fig. 6d) is better developed and nearly complete, whereas it is restricted to the area of the midlateral seta in most specimens *B. ribbei*, extended further anteriorly and posteriorly in some (Fig. 6b), and not at all distinct in a very few specimens. The metatrochanters are asetose in the *B. resbecqi* holotype but unisetose in most *B. ribbei* members, unilaterally asetose in a few. The median lobe of the male genitalia in much shorter, thicker, more arcuate and the apical lamella of very different shape in *B. resbecqi* (Fig. 31c) compared with that in *B. ribbei* males.

Among *Brosocosoma* species known from outside the study area, none have members with the lateral margination of the pronotum evident, so none can be confused with *B. resbecqi* members.

Habitat distribution. The unique specimen of this species was found under a stone about 4 m back from the edge of a moderate-sized, cold, and fast-flowing stream descending through mixed coniferous/ broadleaf evergreen forest (Fig. 46a). The banks of the stream were largely overgrown with vegetation and shaded during most if not all of the day. The site of collection was at the relatively low elevation of 1720 m (Fig. FX49).

Geographical distribution within the Gaoligong Shan. Fig. 30b. This species is known only from the type locality in Gongshan County (see Type material above for exact collection data) on the western slope of the range in Core Area 1 (Fig. 48).

Overall geographical distribution. This species currently is known only from the northwestern part of the Gaoligong Shan, in western Yunnan Province, China.

Geographical relationships with other *Brosocosoma* species. No other *Brosocosoma* species has been found syntopic with the unique type of this species (Fig. 50), although *Brosocosoma ribbei* occurs in the same general area.

12. *Brosocosoma ribbei* Putzeys, 1877

Figures 6b, 8d, 9c, 32, 33, 41b, 46b, 47-50

Brosocosoma ribbei Putzeys, 1877:100. Holotype, a male, deposited in RBINS. Type locality: India, West Bengal, Darjeeling.

Brosocosoma ribbei rougeriei Deuve and Tian, 2002:395. Holotype, a female, deposited in SCAU. Type locality: China, Yunnan, Ailao Shan, Fengshuiling Reserve, 2200 m. **NEW SYNONYMY**

Notes on nomenclature and types. Deuve and Tian (2002), Sciaky and Facchini (2005), and Jiang et al. (2021) have suggested that *B. ribbei* and *B. rougeriei* are conspecific, based on similar male genitalia and relatively minor differences in external features, and considered them as different subspecies. Indeed, specimens from central Yunnan (type area of *B. r. rougeriei*) exhibit a brighter green or golden-green metallic reflection compared with the darker blue-green or green reflection seen in most specimens from Nepal and northeastern India (type area for *B. ribbei* s. str.). They also tend to have very slightly larger eyes, slightly broader pronota, and more deeply impressed pronotal and elytral microsculpture than specimens of *B. ribbei* s. str. from its type area. Records available to these authors showed a disjunction of at least 600 km separating the ranges of these two nominal taxa, thus potentially supporting their taxonomic distinction.

We have compared more than 600 specimens from throughout the study area with good images of the holotypes of both *B. ribbei* and *B. rougeriei* and also with newly-acquired specimens from Medong and Cona counties in Xizang (Tibet), which serve to fill in the former geographical

gap region. Within this sample, we observed overlapping variation in all of the features previously cited as differentiating the two nominal taxa. Among these were dorsal coloration (metallic reflection), punctuation of the head and pronotum, pronotal shape and convexity, elytral shape, depth of impression of the elytral microsculpture, and depth and punctuation of the elytral striae. Although most specimens from the eastern and western extremes of the range of this species may differ slightly in some or all of these features, we conclude that no clear morphological or geographical distinction exists between these nominal taxa and treat them all simply as *B. ribbei*. Whether or not there is any phylogeographic structure within *B. ribbei* can only be established with appropriate analysis of DNA data, which remains a project for the future.

Diagnosis. Adults of this species (Fig. 32a) can be distinguished from those of other species in the region by the following combination of character states: size moderate, BL male = 9.3.0–11.8 mm, female = 8.9–11.9 mm; entire dorsum of body bright golden-green, green (Fig. 32a), or blue-green; vertex of head with post-temporal transverse sulcus relatively shallow and narrowly and sparsely punctate (Fig. 6b); antennomeres 3 and 4 glabrous except for apical whorl of setae; pronotum globose anterior to sub-basal constriction as in Fig. 6b, in most specimens with lateral margination present in region of midlateral seta and also basal to sub-basal constriction and/or extended further anterior to midlateral seta (Fig. 9c) in some specimens (absent entirely from a few specimens), basolateral setae absent; elytral silhouette subovoid, with humeri rounded by evident, elytral microsculpture distinct, comprised of moderately impressed isodiametric sculpticells; meta-trochanters unisetose (except asetose unilaterally in a few specimens); male protarsi with tarsomeres 1 to 3 with ventral pads of adhesive setae; male genitalia as in Fig. 33.

Comments. Features distinguishing members of this species from those of the three other species with evident elytral humeri and metallic green reflection over the entire dorsum (namely, *B. danzhuense*, *B. parvum*, and *B. resbecqi*) have been addressed above in the Comments sections for each of those species.

As noted in the Comments section for *B. danzhuense*, only two *Broscosoma* species known from outside the study area have members in which the elytral humeri are at least faintly evident (although in both they are much less evident than in *B. ribbei*) and the entire dorsum exhibits metallic green or bluish-green reflection. In members of *B. montreuili*, the forebody is a darker, less vivid metallic green than the elytra (both parts equally vivid in *B. ribbei*), the eyes less convex, the post-temporal transverse sulcus more densely punctate (not or only more sparsely punctate in *B. ribbei*), and the median lobe of the male genitalia has the apical lamella slightly narrower in lateral aspect (see Deuve 2006b, fig. 10). Members of *B. tiani* have the eyes more reduced in size and convexity, the tempora slightly longer and less convex, the post-temporal transverse sulcus more densely punctate, and the median lobe of the male genitalia with the apical lamella distinctly hooked ventrally in lateral aspect (see Deuve 2006b, fig. 9). We must also mention here *Broscosoma sehnali* Deuve, 2006a, also from Sichuan like these other two species. Although most members of this species are slightly smaller and have the humeri indistinct and the elytral microsculpture effaced (well impressed in *B. ribbei*), they nonetheless present a very similar habitus to that of *B. ribbei* specimens and have a generally similar form of the median lobe of the male genitalia (see Deuve 2006a, fig. 11).

Habitat distribution. Within the study area, members of this species are typically found in disturbed habitats, usually on bare or sparsely vegetated ground, at all elevations and within all vegetation types. They are found hiding under stones during daylight hours but are active on the substrate surface at night. Areas in which they are most easily found include forest clearings, road and trail cutbanks (Fig. 41b), dry meadows, and other types of waste areas (Fig. 46b). At night, they are also found on the mossy banks of roadcuts, but they appear to prefer bare granitic sandy sub-

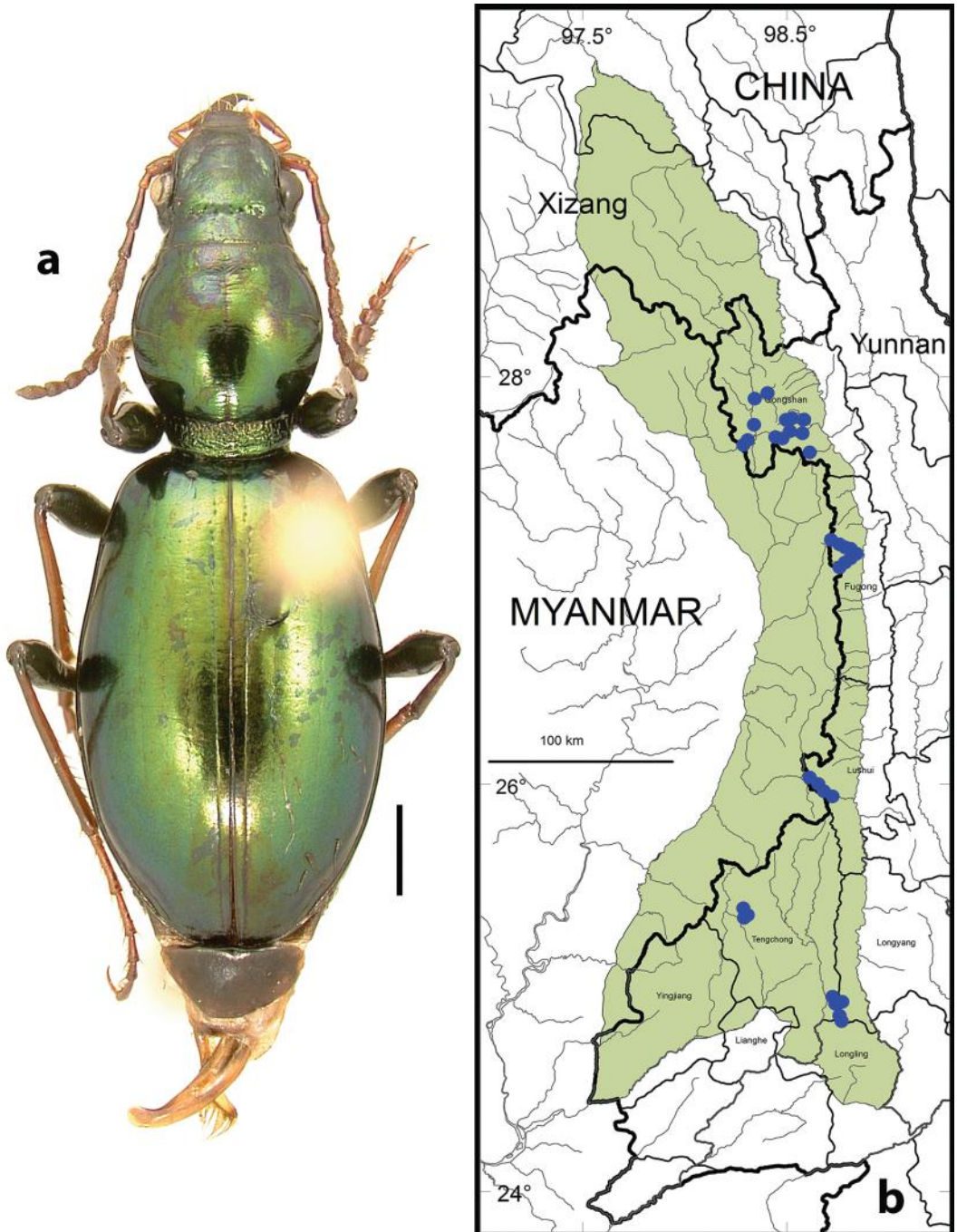


FIGURE 32. *Broscosoma ribbei* Putzeys. a. Habitus (CASENT1021037; 2.8 km above Shibali, Lishadi Township, Fugong County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

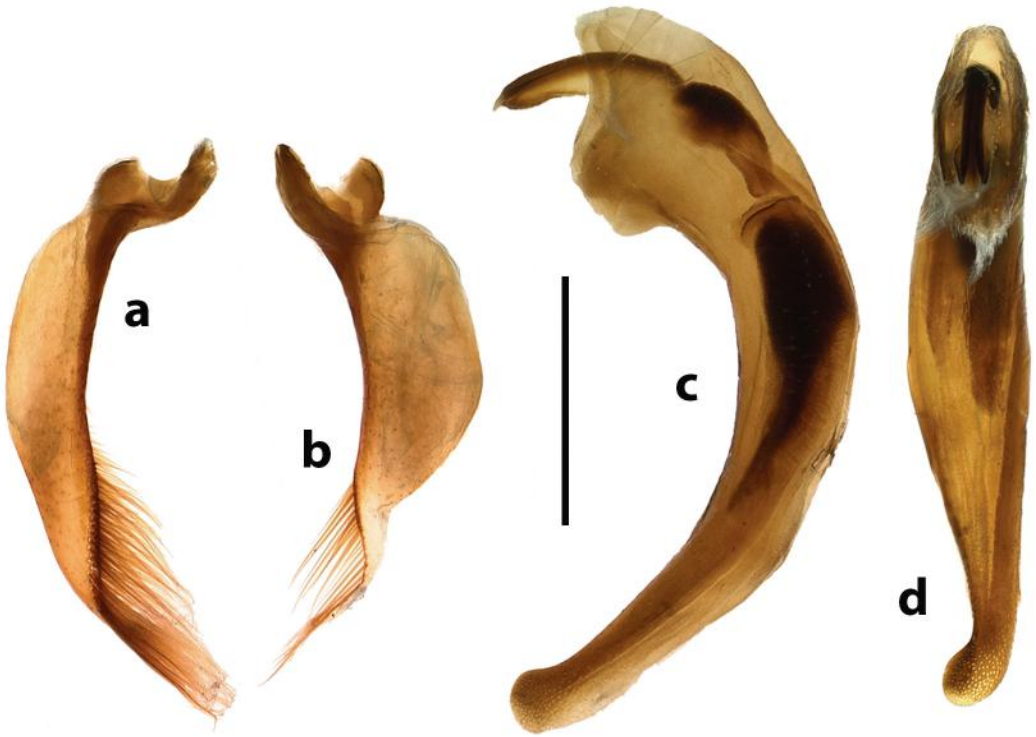


FIGURE 33. Male genitalia, *Broscosoma ribbei* Putzeys (CASENT1025422; 0.5 km WSW of Maku village, Dulongjiang Township, Gongshan County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

strate. They often occur in the company of a group of other carabid species, including *Paropisthius indicus* (Chaudoir), *Brosicus punctatus* (Dejean), *Nirmala odelli* Andrewes, *Aristochroa yuae* Kavanaugh & Liang, *Amara chalciope* (Bates) and *Xestopus cyaneus* Sciaky and Facchini. Within the Gaoligong Shan region, this species occupies a broad elevational range, with our records documenting its occurrence from 1500 to 3300 m (Fig. 49).

Geographical distribution within the Gaoligong Shan. Fig. 32b. We examined a total of 628 specimens (342 males and 285 females) from the following localities: **Fugong County:** Lishadi Township (Shibali area, 27.16536°/98.78003°, 2535 m, 4-5 August 2005, H.B. Liang collector [three males and four females; CAS, IOZ], 4-17 August 2005, D.H. Kavanaugh, H.B. Liang, P. Paquin, & D.Z. Dong collectors [seven males and six females; CAS, IOZ], 5-6 August 2005, D.H. Kavanaugh, H.B. Liang, P. Paquin, & D.Z. Dong collectors [24 males and 13 females; CAS, IOZ], 18 August 2005, D. H. Kavanaugh & P. Paquin collectors [four males; CAS, IOZ], 4-5 October 2007, D.H. Kavanaugh, H.B. Liang, & H.L. Shi collectors [two females; CAS, IOZ]), (Shibali Road at Shibali, 27.16786°/98.77741°, 2560 m, 1 May 2004, D.H. Kavanaugh & C. E. Griswold collectors [two males and four females; CAS, IOZ]), (1.0 km above Shibali on Shibali Road, 27.16791°/98.77655°, 2580 m, 2 May 2004, D.H. Kavanaugh & C. E. Griswold collectors [two males; CAS, IOZ]), (2.0 to 4.3 km above Shibali on Shibali Road, 27.17262°/98.76943° to 27.17772°/98.75485°, 2700-2826 m, 3 May 2004, D.H. Kavanaugh, H.B. Liang & C. E. Griswold collectors [21 males and 17 females; CAS, IOZ]), (11 km above Nu Jiang on Shibali Road at Shi-

mowa village, 27.13839°/98.82147°, 1850-1928 m, 25 April 2004, H.B. Liang collector [one female; IOZ]), (11 km W of Shibali on Shibali Road, 27.20654°/98.71772°, 3280 m, 6 August 2005, D. Z. Dong collector [two males; CAS, IOZ]), (1.5 km below Shibali on Shibali Road, 27.16284°/98.78989°, 2420 m, 2 May 2004, H.B. Liang & G.X. Peng collectors [one male and four females; CAS, IOZ]), (Shibali Road from Galadi village to 2.5 km W, 27.13863°/98.82174° to 27.14286°/98.82001°, 1845-1940 m, 9 August 2005, D.H. Kavanaugh, H.B. Liang, & D. Z. Dong collectors [eight males; CAS, IOZ]), (0 to 2 km W of Shibali on Shibali Road, 27.16536°/98.78003° to 27.16100°/98.79370°, 2300-2530 m, 18 August 2005, D. Z. Dong collector [three males and one female; CAS, IOZ]), (2.8 km W of Shibali on Shibali Road, 27.17405°/98.76722°, 2750 m, 6 August 2005, D. Garfield collector [one male; CAS], 9 August 2005, D. Z. Dong collector [eight males and eight females; CAS, IOZ]), (4.0 km W of Shibali on Shibali Road, 27.17740°/98.75490°, 2800 m, 16 August 2005, D. Z. Dong collector [three males and one female; CAS, IOZ]), (8.4 to 9.5 km W of Shibali on Shibali Road, 27.18740°/98.71936° to 27.19438°/98.71486°, 3160-3195 m, 14 August 2005, D.H. Kavanaugh, H.B. Liang, & D.Z. Dong collectors [one male; CAS]), (9.5 to 10.0 km W of Shibali on Shibali Road, 27.19438°/98.71486° to 27.19980°/98.71375°, 3195-3200 m, 12 August 2005, D.H. Kavanaugh, H.B. Liang, & D.Z. Dong collectors [two males; CAS, IOZ]), (4 km E of Shibali on Shibali Road, 27.15727°/98.79784°, 2280 m, 11 August 2005, D. Z. Dong collector [nine males and five females; CAS, IOZ]), (Shibali Road from confluence of North and South Forks of Yamu He to Galadi village, 27.13086°/98.83874° to 27.13863°/98.82174°, 1630-1845 m, 15 August 2005, D.H. Kavanaugh, H.B. Liang, P. Paquin, & D. Z. Dong collectors [three females; CAS, IOZ]); Lumadeng Township (Lao Shibali Road, 27.08263°/98.74621°, 3085 m, 13 August 2005, D.H. Kavanaugh & P. Paquin collectors [one female; CAS]), (Lao Shibali Yakou, 27.06429°/98.75123°, 3270 m, 13 August 2005, D.H. Kavanaugh, H.B. Liang, & D.Z. Dong collectors [one male; IOZ]), (South Fork of Yamu He, 1.6 km E of Lao Shibali on Lao Shibali Road, 27.08260°/98.78877°, 2240 m, 21 August 2005, D.H. Kavanaugh collector [one male; CAS]), (4 km E of Lao Shibali on Lao Shibali Road, 27.09700°/98.80570°, 2120 m, 21 August 2005, D. Z. Dong collector [two males; CAS, IOZ]), (1.5 km above confluence of North and South Forks of Yamu He on Lao Shibali Road, 27.11992°/98.83150°, 1825 m, 15 August 2005, H.B. Liang collector [one male; IOZ]). **Gongshan County:** Cikai Township (Danzhu He drainage, 13.5-15.7 airkm SSW of Cikai, 27.63063°/98.62074° to 27.62705°/98.59204°, 2700-3100m, 30 June- 5 July 2000, D.H. Kavanaugh, C.E. Griswold, H.B. Liang, D. Ubick, & D.Z. Dong collectors [seven males and 14 females; CAS, IOZ]), (Dong Shao Fang area, 18-20 airkm W of Cikai, 27.69504°/98.48433°, 3230-3300m, 16-17 July 2000, D.H. Kavanaugh, C.E. Griswold, H.B. Liang, D. Ubick, & D.Z. Dong collectors [four males and five females; CAS, IOZ]), (No. 12 Bridge Camp area, 16.3 airkm W of Cikai, 27.71503°/E98.50244°, 2775m, 15-19 July 2000, D.H. Kavanaugh, C.E. Griswold, H.B. Liang, D. Ubick, & D.Z. Dong collectors [ten males and one females; CAS, IOZ]), (Qiqi He, 27.75748°/98.66073°, 1500 m, 25 September 2007, H.B. Liang & H.L. Shi collectors [one male; IOZ]), (Qiqi area, 10.3 airkm W of Cikai, 27.71542°/98.56529°, 2010m, 9-14 July 2000, D.H. Kavanaugh, C.E. Griswold, Liang H.-B., D. Ubick, & D.Z Dong collectors [two males and one female; CAS, IOZ]), (Dabadi, 40 km W of Cikai on Dulong Valley Road, 27.79619°/ 98.51867°, 2900 m, 29 September 2002, H.B. Liang collector [three males and three females; CAS, IOZ]), (Dabadi, 41 km W of Cikai on Dulong Valley Road, 27.79655°/98.50562°, 3000 m, 27 September to 6 October 2002, D.H. Kavanaugh , P.E. Marek, H.-B. Liang, D.Z. Dong & X.C. Li collectors [eight males and 11 females; CAS, IOZ]), (Heiwadi, 16.8 km W of Cikai on Dulong Valley Road, 27.79584°/98.58443°, 2150 m, 10 October 2002, D. H. Kavanaugh , P.E. Marek, H.-B. Liang, &

D.-Z. Dong collectors [seven males and seven females; CAS, IOZ]), (Heiwadi Nature Reserve Managing Station, 15 km W of Cikai on Dulong Valley Road, 27.79433°/98.58908°, 4 October 2002, H.B. Liang & C.G. Jin collectors [four males and four females; CAS, IOZ]), (South Fork of Qiqi He, 27.70393°/98.49585°, 2975 m, 27-28 September 2007, H.B. Liang & H.L. Shi collectors [one male; IOZ]); Dulongjiang Township (Dulong Jiang, 2 km N of Bapo, 27.76000°/98.34611°, 1510 m, 16-17 July 2000, P. Thomas & Z.L. Wang collectors [two males and four females; CAS, IOZ]), (Kongdang, 0.5 km N, 7.88111°/98.34063°, 1500 m, 25 October 2004, D.H. Kavanaugh, Q.B. Hou & H.B. Liang collectors [one female; IOZ]), (Maku, 27.68553°/98.30425°, 1823 m, 2 November 2004, H.B. Liang collector [three males and one female; CAS, IOZ]), (Maku village, 27.68498°/98.30299°, 1800 m, 28 August 2006, D.H. Kavanaugh, J.A. Miller, & D.Z. Dong collectors [four males and four females; CAS, IOZ]), 27.67775°/98.29771°, 1815 m, 29 August 2006, D.Z. Dong & P. Hu collectors [11 males and four females; CAS, IOZ], 2 September 2006, Y. Liu & D. Z. Dong collectors [three males and four females; CAS, IOZ]), (0.5 airkm WSW of Maku village on trail to Maku Yakou, 27.68310°/98.30038°, 1845 m, 29 August 2006, D.H. Kavanaugh, J.A. Miller, D.Z. Dong & Y. Liu collectors [five males and eight females; CAS, IOZ]), (North Fork of Moqie Wang at Gongshan-Dulong Road Km 77, 27.90085°/98.34721°, 1550 m, 8 November 2004, D.H. Kavanaugh & M.A. Dixon collectors [one male; CAS]), (Xishaofang, 27.70400°/98.43864°, 3110 m, 30 October 2004, V. F. Lee collector [one male; CAS]). **Longling County:** Longjiang Township (small stream along road below Xiaoheishan Forest Reserve, Guchengshan, 24.82888°/98.76001°, 2020 m, 25 May 2005, D.Z. Dong & H.B. Liang collectors [two females; CAS, IOZ]). **Longyang County:** Lujiang Township (Baoshan-Tengchong Road Km 36-37, 24.93417°/98.76667°, 2150 m, 12 October 2003, H.B. Liang & X.C. Shi collectors [one female; IOZ]), (Baoshan-Tengchong Road Km 40-41, 24.92694°/98.75000°, 2404 m, 12 October 2003, H.B. Liang & X.C. Shi collectors, LHB-03-03 [three females; CAS, IOZ]), (Baoshan-Tengchong Road Km 41, 24.93194°/98.76111°, 2440 m, 15 October 2003, H.B. Liang & J. Yang collectors [one male and one female; CAS, IOZ]); Luoshuidong area (24.94833°/98.75667°, 2300 m, 26-31 October 1998, D.H. Kavanaugh, C.E. Griswold, C.-L. Long & H.X. He collectors [five males and two females; CAS, IOZ]), (Sancha He, 24.94849°/98.75699°, 2300 m, 3 June 2005, D.H. Kavanaugh, C.E. Griswold, H.B. Liang, D.Z. Dong & H.M. Yan collectors [three males and three females; CAS, IOZ]); Nankang Forest Station (24.82444°/98.76667°, 2085 m, 27 October 2003, H.B. Liang & X.C. Shi collectors [five males and six females; CAS, IOZ]), (Route S317 at KM 19.8, 24.82284°/98.78207°, 2060 m, 23 May 2005, D.H. Kavanaugh, C.E. Griswold, H.B. Liang, D.Z. Dong, H.M. Yan & K.J. Guo collectors [four males and three females; CAS, IOZ]); Nankang Yakou (24.83167°/98.76667°, 2130 m, 4-7 November 1998, D.H. Kavanaugh, C.E. Griswold, C.L. Long, R. Li & H.X. He collectors [31 males and 35 females; CAS, IOZ]), (24.82583°/98.76667°, 2130 m, 26 October 2003, H.B. Liang & X.C. Shi collectors [four males; CAS; IOZ], D.Z. Dong collector [one female; IOZ]), (24.82587°/98.76832°, 2148 m, 22 May 2005, H.B. Liang collector [four males and nine females; CAS, IOZ]), (Nankang Yakou, just N of pass, 24.83178°/98.76472°, 2180 m, 22 May 2005, D.H. Kavanaugh, C.E. Griswold & D.Z. Dong collectors [15 males and 16 females; CAS, IOZ], 25 May 2005, D.H. Kavanaugh & C.E. Griswold collectors [three males and one female; CAS, IOZ], 26 May 2005, D.Z. Dong & H.B. Liang collectors [one female; IOZ]). **Lushui County:** Luzhang Township (Fengxue Yakou to 0.5 km E on Pianma Road, 25.97288°/98.68336° to 25.97347°/98.68780°, 3130-3150 m, 17 May 2005, D.H. Kavanaugh, C.E. Griswold, H.B. Liang & D.Z. Dong collectors [seven males and three females; CAS, IOZ]), (Yaojiaping Forestry Station, 25.96911°/98.70713°, 2586 m, 18 May 2005, D.H. Kavanaugh & Y.H. San collectors [one male and two females; CAS, IOZ]), (Yaojiaping He at Pianma Road, 25.97722°/98.71091°, 2527 m, 20 May 2005, D.H. Kavanaugh & D.Z. Dong collectors

[one male and one female; CAS, IOZ]); Pianma Township (7 km N of Pianma at Gangfang Yakou, 26.03672°/98.62026°, 2250 m, 12 May 2005, H.B. Liang collector [one female; IOZ]), (9 km ESE of Pianma, 26.12167°/98.57500°, 2450 m, 15-18 October 1998, D.H. Kavanaugh, C.E. Griswold, C. Ferraris, & C.L. Long collectors [one male and one female; CAS, IOZ]), (9 km ESE of Pianma at Pianma Road bridge over Changyan He, 25.99414°/98.66336°, 2454 m, 14 May 2005, H.B. Liang collector [two males; CAS, IOZ]), (Fengxue Yakou to 0.6 km W on Pianma Road, 25.97288°/98.68336° to 25.97410°/98.67716°, 3120-3150 m, 19 May 2005, D.H. Kavanaugh, C.E. Griswold, H.B. Liang, D.Z. Dong & K.J. Guo collectors [seven males and nine females; CAS, IOZ]). **Tengchong County:** Houqiao Township (4.4 airkm NE of Houqiao near power station, N5.35746°/98.30364°, 1885 m, 28 May 2006, D.H. Kavanaugh, R.L. Brett, H.B. Liang, & Z.C. Liu collectors [five males and one female; CAS, IOZ]), (5.9 airkm NE of Houqiao near Guyong Forestry Station, 25.36562°/98.31610°, 2030 m, 27 May 2006, D.H. Kavanaugh, R.L. Brett, H.B. Liang, Z.C. Liu, & D.Z. Dong collectors [two males and two females; CAS, IOZ]), (8.5 airkm NNE of Houqiao at Gaoshidong, 25.39858°/98.30533°, 2580 m, 27 May 2006, D.H. Kavanaugh, R.L. Brett, & D.Z. Dong collectors [one male and two females; CAS, IOZ]); Nankang Yakou (5 km W, 24.83167°/98.765000°, 2100 m, 23 October 1998, D.H. Kavanaugh collector [three males and three females; CAS, IOZ]); Shangying Township (Baoshan-Tengchong Road Km 41-46 d, 24.95361°/98.73333°, 2290 m, 17 October 2003, H.B. Liang collector [31 males and 11 females; CAS, IOZ]), (Baoshan-Tengchong Road Km 42 km at Sanchawa, 24.93278°/98.75333°, 2300 m, 13 October 2003, H.B. Liang & X.C. Shi collectors [two females; CAS, IOZ]), (Baoshan-Tengchong Road Km 42-46, 24.95361°/98.73333°, 2290 m, 14 October 2003, H.B. Liang & X.C. Shi collectors [four females; CAS, IOZ]), (Baoshan-Tengchong Road Km 46-51, 24.95722°/98.73333°, 2220 m, 17 October 2003, H.B. Liang & X.C. Shi collectors [three males and two females; CAS, IOZ]), (Baoshan-Tengchong Road Km 48-51, 24.97556°/98.71667°, 2014 m, 18 October 2003, H.B. Liang collector [six males and three females; CAS, IOZ]), (Dahaoping, 24.96976°/98.3142°, 2040 m, 31 May 2005, D.Z. Dong & H.B. Liang collectors [one male; CAS]), (Dahaoping Forest Station, 24.97333°/98.72972°, 2014 m, 19 October 2003, G. Tang collector [two males and three females; CAS, IOZ]); Wuhe Township (Xiaodifang He at Km 24.7 on Route S317, 24.84868°/98.75913°, 2040 m, 26 May 2005, H.B. Liang collector [one male and one female; CAS, IOZ]), (Xiaoheishan Forest Station, 24.82889°/98.75000°, 2025 m, 29 October 2003, H.B. Liang collector [one male; IOZ]).

Members of this species have been collected throughout the Gaoligong Shan region, in all seven Core Areas. This is the only broscine species so widely recorded (Fig. 48).

Overall geographical distribution. Fig. 47. This species has been recorded from India (Sikkim, West Bengal), Nepal, and Xizang (Tibet) along the southern slope of the Himalaya and from the western half of Yunnan Province. We have not been able to confirm the record from Pakistan (Häckel et al. 2010). The occurrence of *B. ribbei* in the study area is near the southern and eastern limits of its geographical range.

Geographical relationships with other *Brososoma* species. Within the study area, members of this species have been found together (syntopic) with those of *B. gaoligongense* and *B. viridicollare* (described below) at one or more sites (Fig. 50). In Medog County, Xizang (Tibet), they have been found together with members of *B. holomarginatum*. They also have been found syntopic with specimens of *Broscofera gaoligongensis*, *Brosco punctatus* and *Eobrosco bhutanensis* in the study area.

13. *Broscosoma viridicollare* Kavanaugh and Liang, sp. nov.

Figures 7b, 34, 35, 40b, 48-50

Type material. Holotype, a male, in IOZ, labeled: “CASENT 1017935”/ “CHINA, Yunnan, Fugong County, Lishadi Township, 9.5-10.0 km W of Shibali on Shibali Road, N27.19438°/E098.71486° to N27.19807°”/ “E098.71375°, 3195-3200m, 12 August 2005, Stop #DHK2005-078, D.H. Kavanaugh, H.B. Liang, D.Z. Dong collectors”/ “HOLOTYPE *Broscosoma viridicollare* Kavanaugh & Liang sp. nov. designated 2021” [red label]. Paratypes (a total of 20): two males and one female (CAS, IOZ) labeled: same as holotype except first label “CASENT 1017933” to “CASENT 1017934” and “CASENT 1017936”, respectively; one female (IOZ) labeled: “CASENT 1018722” “CHINA, Yunnan, Fugong County, Lishadi Township, headwaters of North Fork Yamu He just E of Shibali Yakou, 3450m”/ “N27.21034°/E098.70141°, 7 August 2005, Stop #LHB-05-52, H.B. Liang & J.F. Zhang collectors”; one male and one female (CAS, IOZ) labeled: “CASENT 1018602” and “CASENT 1018603”, respectively/ “CHINA, Yunnan, Fugong County, Lishadi Township, headwaters of North Fork Yamu He just E of Shibali Yakou, 3450m”/ “N27.21034°/E098.70141°, 12 August 2005, Stop #LHB-05-54, H.B. Liang & J.F. Zhang collectors”; one male (CAS) labeled: “CASENT 1019520”/ “CHINA, Yunnan, Fugong County, Lishadi Township, 10.1 to 11.5 km above Shibali on Shibali road, N27.20049°/E098.71354° to N27.20676°/E098.71763°”/ “3225-3290m, 8 May 2004, Stop #DHK-2004-041, D.H. Kavanaugh, C. E. Griswold, Liang H.-B., Li X.-Y. & Zhu B.-X. collectors”; one male and two females (CAS, IOZ) labeled: “CASENT 1018889” and “CASENT 1018890” to “CASENT 1018891”, respectively/ “CHINA, Yunnan, Fugong County, Lishadi Township, Shibali Yakou, 3612m, N27.21231°/E098.69575°, 5 August 2005” / “Stop #DHK2005-060, D.H. Kavanaugh, H.B. Liang, P. Paquin, D.Z. Dong & J.F. Zhang collectors”; one male and one female (CAS, IOZ) labeled: “CASENT 1020868” and “CASENT 1020869”, respectively/ “CHINA, Yunnan, Fugong County, Lishadi Township, Shibali Yakou, 3612m, N27.21231°/E098.69575°, 7 August 2005”/ “Stop #DHK2005-066, D.H. Kavanaugh, H.B. Liang, P. Paquin & D.Z. Dong collectors”; one male and two females (CAS, IOZ) labeled: “CASENT 1021213” to “CASENT 1021214” and “CASENT 1021215”, respectively/ “CHINA, Yunnan, Fugong County, Lishadi Township, 0.5 km NE of Shibali Yakou, N27.21447°/E098.70064°” / “3460m, 12 August 2005, Stop #DHK2005-077, D.H. Kavanaugh, P. Paquin & D.Z. Dong collectors”; one male (CAS) labeled: “CASENT 1023548”/ “CHINA, Yunnan, Fugong County, Lishadi Township, 1.0 km E of Shibali Yakou on Shibali road, N27.20854°/E098.71174°” / “3506m, 6 May 2004, Stop #DHK2004-035, D.H. Kavanaugh, H.B. Liang, & C.E. Griswold collectors”; two males (CAS, IOZ) labeled: “CASENT 1022786” and “CASENT 1022787”, respectively/ “CHINA, Yunnan, Fugong County, Lumadeng Township, 8.5 km above Shibali on Shibali road, North Fork of Yamu He” / “N27.18326°/E098.72002°, 3100m, 9 May 2004, Stop #DHK2004-042, D.H. Kavanaugh & H.B. Liang collectors”; one male (CAS) labeled: “CASENT 1029941”/ “CHINA, Yunnan, Fugong County, Lumadeng Township, 8.5 km W of Shibali on Shibali road, south bank of North Fork Yamu He,”/ “N27.18315°/E098.71921°, 3100-3200m, 16 August 2005, Stop #DHK2005-090, D.H. Kavanaugh & H.B. Liang collectors”; one male (IOZ) labeled: “CASENT 1017824”/ “CHINA, Yunnan, Fugong County, Lumadeng Township, second cirque of Shibali Yakou at border post “31”, N27.20333°/E098.69303°”/ “3710m, 17 August 2005, Stop #DHK2005-095, D.H. Kavanaugh, H.B. Liang, D.Z. Dong & J.F. Zhang collectors”. All paratypes also bear the following label: “PARATYPE *Broscosoma viridicollare* Kavanaugh & Liang, sp. nov. designated 2021” [yellow label].

Type locality. CHINA, Yunnan, Fugong County, Lishadi Township, 9.5-10.0 km W of Shibali on Shibali Road, 3195-3200 m.

Derivation of species name. The species epithet, *viridicollare*, is an adjective derived from the Latin words, *viridis*, meaning green, and *collare*, meaning collar. The name refers the distinct band of metallic green reflection along the anterior border of the otherwise black pronotum in members of this species.

Diagnosis. Adults of this species (Fig. 34a) can be distinguished from those of other species in the region by the following combination of character states: size moderate, BL = 10.0 to 12.7 mm; head and pronotum black to piceous but with distinct metallic green band across anterior part of pronotum (Fig. 7b) anterior to anterior transverse impression; head with tempora slightly inflated, sharply convex or vaguely angulate; antennomeres 3 and 4 glabrous except for apical whorl of setae; pronotum anterior to sub-basal constriction slightly to moderately longitudinally ovoid in dorsal view, basolateral setae absent; elytral silhouette ovoid, with humeri indistinct, elytral microsculpture distinct, comprised of moderately impressed isodiametric sculpticells; metatrochanter asetose; male protarsi with tarsomeres 1 to 3 with ventral pads of adhesive setae; male genitalia as in Fig. 35, with median lobe slightly longer and apical lamella broader in lateral view.

Description. Fig. 34a. Size medium, BL male = 10.1–12 mm, female = 10.0–12.7 mm, ratio EL/PL male = 2.2, female = 2.2–2.3. Body color black or dark piceous, last visible abdominal sternite dark brown or rufous brown, antennae with antennomeres 3 and 4 slightly darker brown than antennomeres 1 and 2 and 5 to 11, femora black or dark piceous, tibiae and tarsi rufous brown. Head black, pronotum black except for distinct green metallic reflection anterior to anterior transverse impression, elytra with bluish green metallic reflection, venter without metallic reflection.

Head. Fig. 7b. Eyes medium-sized, their diameter slightly greater than length of tempora. Frontal furrows moderately impressed, narrow, arcuate, distinctly divergent posteriorly, extended posteriorly to or slightly beyond middle of eyes, faintly rugulose, impunctate. Vertex with post-temporal transverse sulcus deep and well-defined, sparsely and moderately to coarsely punctate. Tempora slightly inflated, sharply convex or vaguely angulate. Genal ridges distinctly present posteriorly, extended anteriorly to anterior margin of post-temporal constriction and further extended as the edge of a vague depression anteriorly to ventral margins of eyes. Clypeus with one pair of setae. Supraorbital setae present, one pair. Eustipes of maxilla with two setae, the dorsobasal seta distinctly more than half as long as ventrobasal seta. Mentum with tooth present, simple, paramedial region shallowly foveate, one pair of mental setae present. Glosal sclerite (ligula) with one pair of setae. Submentum with one or two pairs of setae. Gula without transverse grooves. Antennomeres 3 and 4 without pubescence, ratio A3/A5 = 1.1–1.2.

Pronotum. Fig. 7b. Disc anterior to sub-basal constriction slightly to moderately longitudinally ovoid in dorsal view with base distinctly pedunculate, widest at or slightly posterior to middle of discal region, ratio PL/PW = 1.2–1.3, disk markedly convex; apical margination absent; lateral margination present, narrow, delineated only on base; basal margination absent; anterior transverse impression shallow, broad and vaguely delineated, smooth or finely and very sparsely punctate; median longitudinal impression moderately impressed; posterior transverse impression deep, sharply delineated; anterior region faintly and sparsely rugulose; pronotal base coarsely and sparsely to densely punctate; one pair of midlateral pronotal setae present at mid-length of discal region; basolateral pronotal setae absent.

Elytra. Elytral silhouette ovoid, short, widest at middle, ratio EL/EW male and female = 1.5, greatest elevation above lateral margin (in lateral view) posterior to middle; humeri narrow, sloped, indistinct; lateral margins markedly arcuate, or markedly arcuate and faintly angulate sub-basally; parascutellar striole present, short, distally merged in a distinct jog with free base of stria 1. Eight striae present; stria 1 moderately deeply and sharply impressed, striae 2 to 3, 4, or 5 moderately impressed in basal two-thirds of striae and successively more shallowly impressed in apical third,

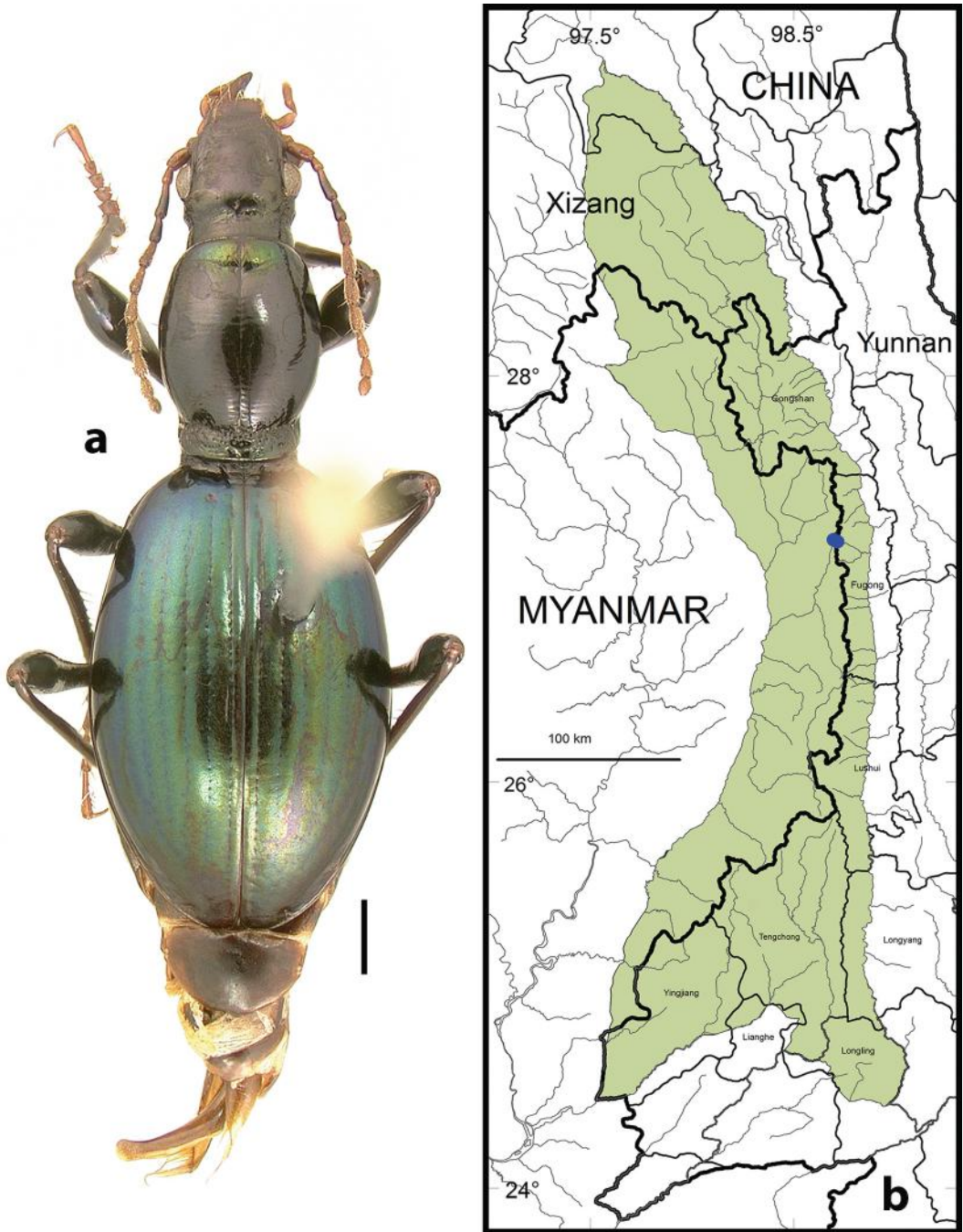


FIGURE 34. *Broscosoma viridicollare* sp. nov. a. Habitus (CASENT1022787; 8.5 km above Shibali, Lishadi Township, Fugong County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

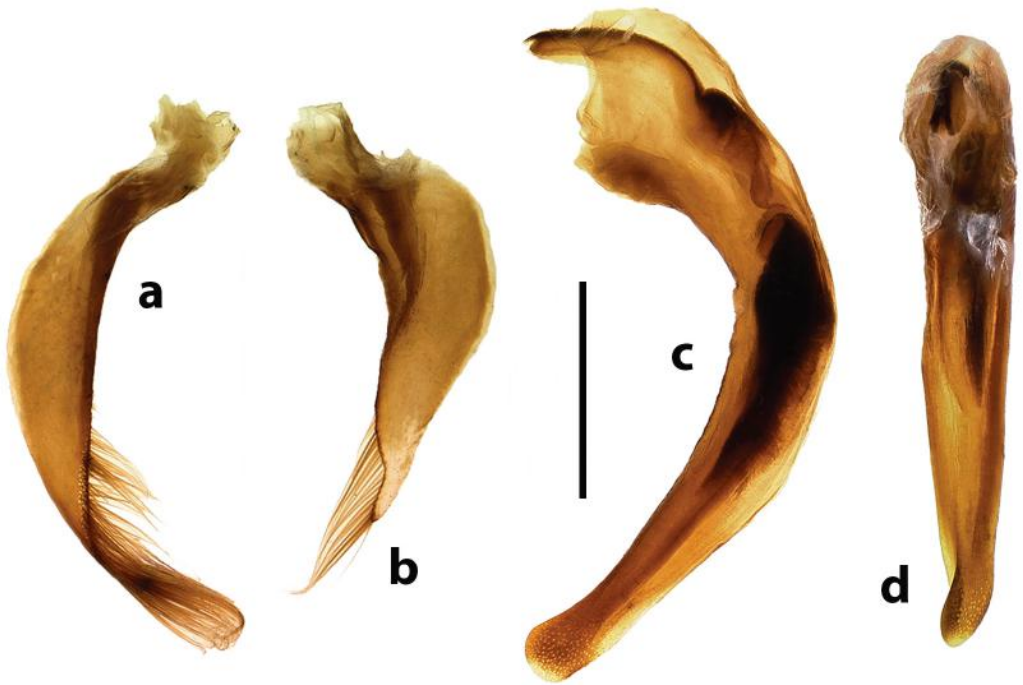


FIGURE 35. Male genitalia, *Broscosoma viridicollare* sp. nov. (CASENT1017820; second cirque S of Shibali Yakou, Lumadeng Township, Fugong County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

striae 3 to 8 successively more shallowly impressed laterally and apically, striae 8 merged with lateral groove throughout its length or nearly so; stria 1 moderately punctate at least in basal half, 2 to 3, 4, or 5 moderately punctate in basal two-thirds and successively more shallowly and sparsely punctate in apical third, striae 3 to 8 successively more shallowly and sparsely punctate laterally and apically. Elytral microsculpture distinct, comprised of moderately impressed isodiametric sculpticells. Parascutellar seta present at base of stria 2, discal setae absent, umbilicate series comprised of one post-humeral and two preapical setae.

Hindwings. Vestigial, incapable of supporting flight.

Thoracic venter. Metepisternum ratio ML/MW = 1.4–1.6.

Legs. Hind trochanters asetose. Tarsomeres without dorsal pubescence; tarsomere 5 with two or more pairs of setae ventrally; male protarsi with pads of adhesive setae on tarsomeres 1 to 3 ventrally, male mesotarsi with pads of adhesive setae on tarsomeres 1 and 2 ventrally.

Abdomen. Sternite VI of both male and female with one pair of apicoparamedial setae.

Male genitalia. As in Fig. 35.

Comments. Features distinguishing members of this species from those of the three others (namely, *B. bicoloratum*, *B. gaoligongense*, and *B. gongshanense*) with indistinct elytral humeri and distinct metallic reflection on the elytra but with the forebody (head and pronotum) without metallic reflection (or with that reflection confined to the pronotal area anterior to the anterior transverse impression) have been addressed above in the Comments sections for each of those species.

No *Broscosoma* species known from outside of the study area has members with a distinct band of green metallic reflection on the apical portion of an otherwise dark and non-metallic pronotum.

tum such as is seen in *B. viridicollare* members. This feature, in combination with their relatively large size, head with the tempora enlarged and subangulate, and elytral microsculpture finely impressed but distinct, distinguishes them from those of all other described species, including *B. montreuille* and *B. tiani*.

Habitat distribution. In daytime, members of this species have been found under stones along roadcuts and trails through bamboo and *Rhododendron* thickets (Fig. 40b), in scattered stands of *Abies* sp. with sparse understory, in moist alpine meadow areas and stable talus slopes, and along small to medium-sized streams. The beetles are active on the surface at night in the same areas. This species is found at moderately high elevations, with our records documenting its occurrence in the 3100 to 3710 m range (Fig. 49).

Geographical distribution within the Gaoligong Shan. Fig. 34b. We examined a total of 21 specimens (13 males and 8 females), all from the northcentral part of the Gaoligong Shan in Fugong County on the eastern side of the range in Core Area 3 (Fig. 48) (see Type material above for exact collection data).

Overall geographical distribution. This species currently is known only from the northcentral part of the Gaoligong Shan, in western Yunnan Province, China.

Geographical relationships with other *Broscosoma* species. Members of this species have been found together (syntopic) with those of *B. ribbei*, *B. furvum* and *B. parvum* at one or more sites (Fig. 50). They have been found syntopic also with specimens of *Broscoдера chukuai*.

Genus *Broscus* Panzer, 1813

Cephalotes Bonelli, 1810: Tabula Synoptica (junior homonym). Type species: *Carabus cephalotes* Linnaeus, 1758:414.

Broscus Panzer, 1813:62 (replacement name). Type species: *Carabus cephalotes* Linnaeus, 1758:414.

Nepalobrosclus Habu, 1973:85. Type species *Brosclus bipilifer* Andrewes, 1927:71

Diagnosis. Members of this genus can be distinguished from those of other broscine genera in the region by the following combination of character states: body size large, BL > 15.0 mm; head with one pair of supraorbital setae, vertex with shallower, broader, and distinctly punctate transverse sulcus between tempora; genal ridge present, extended from posterior region of head to ventral margin of eye; gula without deep transverse grooves on either side; maxillae with two setae on eustipes; mentum with one pair of setae; submentum with three pairs of setae; antennomere 3 with apical whorl of fixed setae only, antennomere 4 with or without pubescence on apical one-half; pronotum with basolateral setae present; elytra with parascutellar setae present; male protarsi with tarsomeres 1 to 3 with ventral pads of adhesive setae, all male mesotarsomeres lacking ventral pads of adhesive setae.

Diversity and geographical distribution. This genus includes 25 described species and two additional subspecies (Häckel et al. 2010). Its geographical range extends across the Palearctic Region, from the Canary Islands eastward to Japan. A single species, *B. cephalodes* (Linnaeus), is adventive in eastern North America (Cape Breton Island and Prince Edward Island in Canada) (Larochelle and Larivière 1989).

14. *Brosclus punctatus* (Dejean), 1828

Figures 5b, 36, 37, 46b, 47-50

Cephalotes punctatus Dejean, 1828:431. Holotype, a female, deposited in MNHN. Type locality: Egypt, Mt. Sinai.

Percus nepalensis Hope, 1831:21. Type deposited in OUMNH. Type locality: Nepal.

Brosclus limbatus Ballion, 1871:327. Type locality: Tajikistan, Mogol-Tau.

Brosicus davidianus Fairmaire, 1888:7. Types deposited in MNHN. Type areas: China, Yunnan and Hong Kong.

Brosicus batesi Semenov, 1891:276. Holotype, a female, deposited in ZIN. Type locality: India, Assam.

Diagnosis. Fig. 36a. Because *B. punctatus* is the only species of the genus in the region, the generic diagnosis serves also to distinguish members of this species.

Habitat distribution. Within the study area, members of this species were collected in day-time from under stones, logs and other cover in open roadside and disturbed waste areas, in heavily grazed meadows with scattered grasses and shrubs (Fig. 46b), at the edges of agricultural fields, including wet and dry rice paddies, and on the upper open sandy banks of large streams. At night, beetles were found active on the bare substrate surface in these same habitats.

Within the Gaoligong Shan region, this species occurs at relatively low to moderate elevations, with our records documenting its occurrence in the 1185 to 2506 m range (Fig. 49).

Geographical distribution within the Gaoligong Shan. Fig. 36b. We examined a total of 466 specimens (250 males and 216 females) from the following localities: **Fugong County:** Lumadeng Township (Nu Jiang at Yaping Bridge, 27.12957°/98.87596°, 1250 m, 30 April 2004, H.B. collector [one male and one female; CAS; IOZ]); Maji Township (Majimi village, 27.39828°/98.82650°, 1350 m, 23 April 2004, H.B. Liang, X.Y. Li & M. Xie collectors [two males; CAS, IOZ]); Pihe Township (Zhiziluo village, 26.54657°/98.915731° to 26.54415°/98.92677°, 1990-2285m, 20 August 2005, D.H. Kavanaugh & H.B. Liang collectors [one female; CAS]); Shangpa Township (west bank of Nu Jiang, 1185 m, 26.90668°/98.86339°, 13 October 2002, D. H. Kavanaugh, P. E. Marek, H.-B. Liang, & D.-Z. Dong collectors [one female; IOZ]), (Nu Jiang, along road on west bank south of vehicle bridge, 26.88952°/98.86539°, 1223 m, 22 April 2004, D.H. Kavanaugh & C. E. Griswold collectors [one female; CAS], 27 April 2004, D.H. Kavanaugh & C. E. Griswold collectors [one female; CAS], 12 May 2004, D.H. Kavanaugh collector [one male; CAS]); Shibali Road (above Shilajia village, North Fork of Yamu He, 27.13419°/98.82641° to 27.13947°/98.82184°, 1800-1900 m, 25 April 2004, D.H. Kavanaugh & C. E. Griswold collectors [one female; CAS]). **Gongshan County:** (10-20 May 2001, W.D. Ba collector [one male; IOZ]); Bingzhongluo Township (Bingzhongluo, 28.01986°/98.62297°, 1749 m, 7 October 2002, H.-B. Liang & W.-D. Ba collectors [one male and five females; CAS, IOZ]), (34 km N of Cikai at junction of Shuangla He and Nu Jiang, 27.96606°/98.66092°, 1550 m, 24 September 2002, H.-B. Liang & W.-D. Ba collectors [one male; IOZ], 25 September 2002, H.-B. Liang collector [one female; IOZ], 27.96918°/98.66198°, 1550 m, 9 October 2002, D. H. Kavanaugh, H.-B. Liang, & W.-D. Ba collectors [one male and two females; CAS; IOZ], 22 October 2004, D. H. Kavanaugh & D.-Z. Dong collectors [one female; CAS]), (Gongdangshenshan, 27.99725°/98.662003°, 2489 m, 12 November 2004, H.-B. Liang collector [one male; IOZ]), (Gongdong, 2506 m, 27.99858°/98.61933°, 9 October 2002, P. E. Marek & D.-Z. Dong collectors [one female; CAS]); Cikai Township (Heiwadi, 15 km W of Cikai on Dulong Valley Road, 2022 m, 27.79584°/98.58443°, 4 October 2002, H.-B. Liang, W.-D. Ba, & C.-G. Jin collectors [one male; IOZ], 10 October 2002, D. H. Kavanaugh, P.E. Marek, H.-B. Liang, & D.-Z. Dong [one male; CAS]), (15 km W of Cikai on Dulong Valley Road at Heiwadi Nature Reserve Managing Station, 2018 m, 27.79433°/98.58908°, 4 October 2002, H.-B. Liang & C.-G. Jin collectors [one female; IOZ]), (Heiwadi, 16.8 km W of Cikai on Dulong Valley Road, 27.79584°/98.58443°, 2020-2150 m, 23 September 2002, D. H. Kavanaugh, P.E. Marek, & D.-Z. Dong collectors [one male; CAS]), (Nu Jiang in Cikai, 27.73845°/98.67092°, 1430 m, 8-9 October 2002, D. H. Kavanaugh & P. E. Marek collectors [four males and three females; CAS, IOZ]), (Nu Jiang at Dashaba, 27.73845°/98.67092°, 1430 m, 10 November 2004, H.-B. Liang collector [one male; IOZ]), (Pula He, 3.0 airm N of Cikai, 1510 m, 27.76883°/98.65325°, 21 September 2002, H.-B. Liang collec-

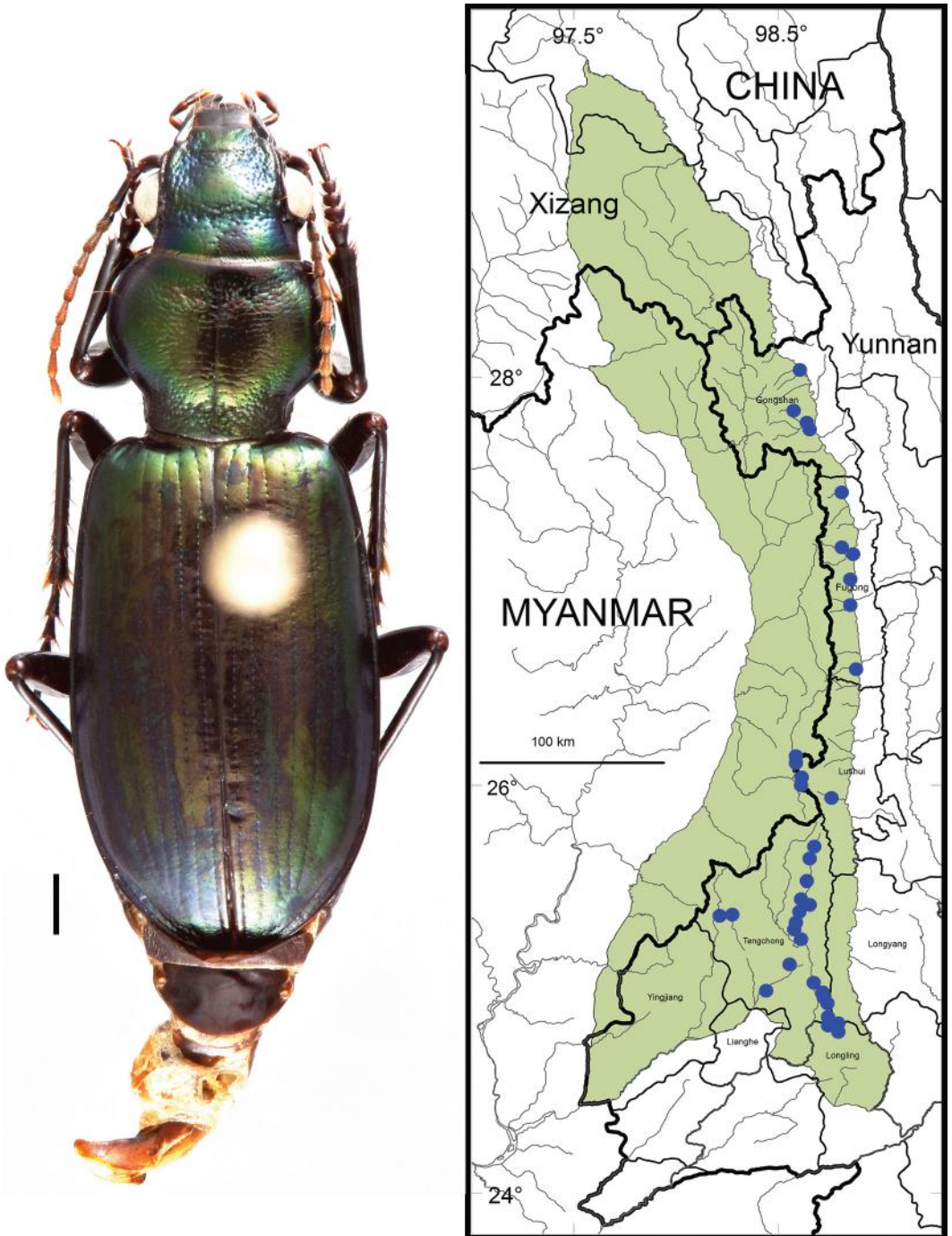


FIGURE 36. *Broscus punctatus* (Dejean). a. Habitus (CASENT1010276; Heiwadi, Cikai Township, Gongshan County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

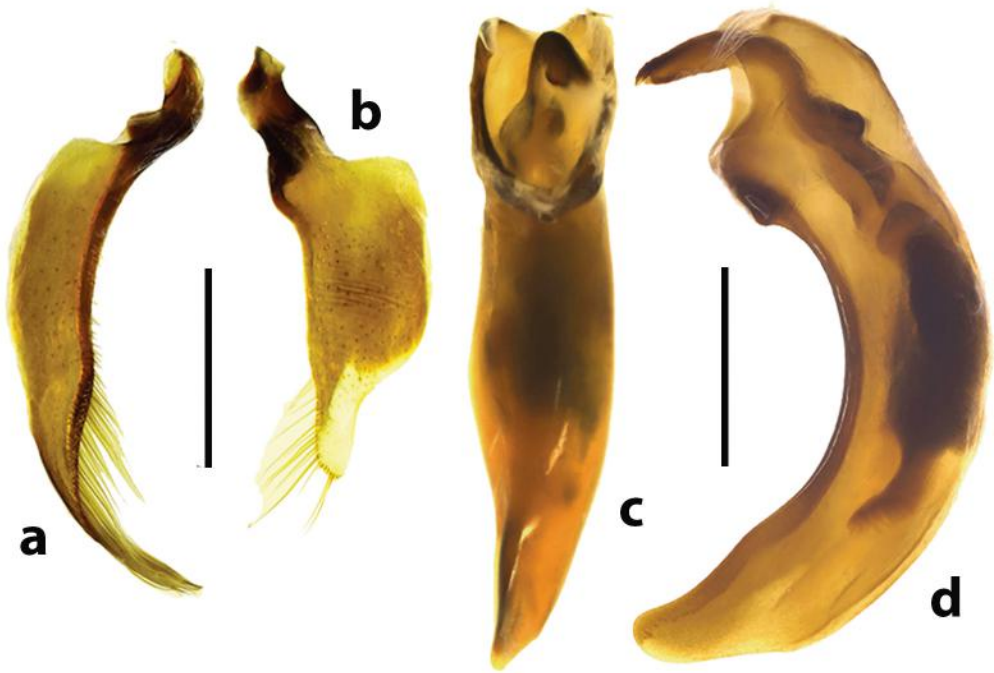


FIGURE 37. Male genitalia, *Broscus punctatus* (Dejean) (CASENT1011066; Heiwadi, Cikai Township, Gongshan County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. Median lobe, ventral aspect; scale line = 1.0 mm.

tor [one male; IOZ]), (Pula He just above Nu Jiang Road, 27.74861°/98.66675°, 1440 m, 23 October 2004, D.H. Kavanaugh, H.-B. Liang & D.-Z. Dong collectors [four males and two females; CAS, IOZ], 11 November 2004, D.H. Kavanaugh, G. Tang, H.-B. Liang & D.-Z. Dong collectors [one female; IOZ]). **Longling County:** Longjiang Township (Xiaoheishan Forest Reserve, Guchengshan, 24.82888°/98.76001°, 2020 m, 26 May 2005, D.H. Kavanaugh, C.E. Griswold & H.B. Liang collectors [three males and one female; CAS, IOZ], 27 May 2005, D.Z. Dong collector [six males and five females; CAS, IOZ]), (small stream along road below Xiaoheishan Forest Reserve, Guchengshan, 24.82888°/98.76001°, 2020 m, 25 May 2005, D.H. Kavanaugh, H.B. Liang & D.Z. Dong collectors [seven males and four females; CAS, IOZ]). **Longyang County:** Lujiang Township (Dasheyao Forestry Station, Km 39.9 on Baoshan-Tenchong Road, 24.92994°/98.75850°, 2325 m, 3 June 2005, D.H. Kavanaugh & D.Z. Dong collectors [two males and one female; CAS, IOZ], Km 40, 24.92944°/98.75861°, 2320 m, 6 June 2005, J.J. Yang collector [two males; CAS, IOZ]), (Baoshan-Tenchong Road Km 24, 24.83917°/98.75000°, 2008 m, 29 October 2003, N.D. Penny, T.S. Briggs, H.B. Liang, D.Z. Dong, R. Li, & G. Tang [three males and two females; CAS, IOZ]), (Baoshan-Tenchong Road Km 29-35, 24.92916°/98.75861°, 2000-2350 m, 12 October 2003, D.Z. Dong collector [one female; IOZ]), (Baoshan-Tenchong Road Km 36-37, 24.93417°/98.76667°, 2150 m, 12 October 2003, H.B. Liang & X.C Shi collectors [three males and two females; CAS, IOZ]), (Baoshan-Tenchong Road KM 40, 24.92944°/98.75861°, 2320 m, 16 October 2003, H.B. Liang & X.C Shi collectors [three males and one female; CAS, IOZ]), (Baoshan-Tenchong Road Km 40-41 (24.92694°/98.75000°, 2404 m, 12 October 2003, H.B. Liang & X.C Shi collectors [five males and three females; CAS, IOZ]), (Baoshan-Tenchong Road Km 41, 24.93194°/98.76111°, 2440 m, 15 October 2003, H.B. Liang & X.C Shi collectors [two males

and two females; CAS, IOZ]); Luoshuidong area (24.94833°/98.75667°, 2300 m, 26-31 October 1998, D.H. Kavanaugh, C.E. Griswold, C.-L. Long & H.X. He collectors [two females; CAS, IOZ], 30 May 2005, D.Z. Dong collector [two females; CAS, IOZ]), (24.93278°/98.75333°, 2300-2480 m, 13 October 2003, D.Z. Dong collector [one female; IOZ]), (Sancha He, 24.94865°/98.75193°, 2350 m, 30 May 2005, H.B. Liang & J.J. Yang collectors [two males and one female; CAS, IOZ]); Mangkuan Township (Baihualing Nature Reserve work station, 25.29560°/98.80298°, 1520 m, 9-12 October 2007, H. B. Liang collector [one female; IOZ]); Nankang Forest Station (24.82444°/98.77889°, 2085 m, 27 October 2003, H.B. Liang & X.C. Shi collectors [four males and one female; CAS, IOZ]), (24.82284°/98.78207°, 2060 m, 23 May 2005, D.H. Kavanaugh, C.E. Griswold, H.B. Liang, D.Z. Dong, H.M. Yan & K.J. Guo collectors [one female; CAS]); Nankang Yakou (24.83167°/98.76667°, 2130 m, 4-7 November 1998, D.H. Kavanaugh, C.E. Griswold, C.-L. Long, R. Li, & H.-X. He collectors [48 males and 33 females; CAS, IOZ]), (24.82583°/E098.77222°, 2130 m, 26 October 2003, H.B. Liang & X.C. Shi collectors [four males and two females; CAS; IOZ], 26 October 2003, D.Z. Dong collector [one male and two females; CAS, IOZ]), (24.81944°/98.77111°, 2130 m, 27 October 2003, D.Z. Dong collector [one male; IOZ], 31 October 2003, D.Z. Dong collector [one female; IOZ]), (24.82587°/98.76832°, 2148 m, 22 May 2005, H.B. Liang collector [four males and two females; CAS, IOZ]), (just N of Nankang Yakou, 24.83178°/98.76472°, 2180 m, 22 May 2005, D.H. Kavanaugh, C.E. Griswold & D.Z. Dong collectors [four males; CAS, IOZ]), (mountain near Nankang, 24.83250°/98.76667°, 2245 m, 27 October 2003, H.B. Liang & X.C. Shi collectors [one male and one female; CAS, IOZ]). **Lushui County:** Luzhang Township (Langbazhai, Lusai He, 25.96378°/98.770321°, 1873 m, 20 May 2005, D.Z. Dong & H.B. Liang collectors [five males and three females; CAS, IOZ]); Pianma Township (Gangfang village, 26.10403°/98.58059°, 1563 m, 13 May 2005, D.Z. Dong collector [two males and three females; CAS, IOZ]), (Gangfang He at Gulang village, 26.10321°/98.58094°, 1590 m, 13 May 2005, H.B. Liang & Y.H. San collectors [one male and two females; CAS, IOZ]), (Gangfang Yakou, 7 km N of Pianma, 26.03672°/98.62026°, 2250 m, 12 May 2005, H.B. Liang collector [two males; CAS, IOZ]), (Gangfang Sancha Lukou (26.12167°/98.57500°, 1500 m, 12 October 1998, D. H. Kavanaugh collector [three males; CAS, IOZ]; 14-15 October 1998, D.H. Kavanaugh, C.E. Griswold, C. Ferraris, & C.-L. Long collectors [14 males and seven females; CAS, IOZ]), (Gulang village, 26.09028°/98.58584°, 1535 m, 14 May 2005, D.Z. Dong, H.B. Liang & Y.H. San collectors [one male; IOZ]), (0 to 4.0 km E of Sancha Lukou, 26.12218°/98.57546° to 26.11750°/98.59509°, 1625-1785 m, 16 May 2005, D.H. Kavanaugh, C.E. Griswold, D.Z. Dong & K.J. Guo collectors [13 males and 15 females; CAS, IOZ]), (Xiapianma village, 26.01137°/98.61788°, 1850 m, 13 May 2005, H.B. Liang collector [one female; IOZ]). **Tengchong County:** Beihai Township (15.2 airkm NNE of Tengchong at Qing Hai (lake), 25.13408°/98.57144°, 1842 m, 7 June 2006, D.H. Kavanaugh, R.L. Brett, H.B. Liang, Z.C. Liu, & D.Z. Dong collectors [one male; CAS]); Houqiao Township (5.9 airkm NE of Houqiao near Guyong Forestry Station, 25.36562°/98.31610°, 2030 m, 27 May 2006, D.H. Kavanaugh, R.L. Brett, H.B. Liang, Z.C. Liu, & D.Z. Dong collectors [two males and two females; CAS, IOZ]), (3.5 airkm NW of Houqiao at Xiajie village, 25.34885°/98.25266°, 1720 m, 28 May 2006, D.Z. Dong collector [one male; IOZ]); Jietou Township (Dahetou Lingganjiao, 25.73947°/98.69630°, 2010 m, 14-15 May 2006, D.H. Kavanaugh, R.L. Brett, & H.B. Liang collectors [18 males and nine females; CAS, IOZ], 16 May 2006, D. H. Kavanaugh collector [seven males and three females; CAS, IOZ], 25.67125°/98.68016° to 25.73947°/98.69630°, 1838 - 2010 m, 14 May 2006, D.Z. Dong & X.P. Wang collectors [one male and one female; CAS, IOZ], along Longtang He, 25.73947°/98.69630°, 2010 m, 18 May 2006, D.H. Kavanaugh & R.L. Brett collectors [seven males and one female; CAS, IOZ], 19 May 2006, D.H. Kavanaugh, R.L. Brett, & D.Z. Dong collectors [four males and

seven females; CAS, IOZ]), (0.75 km N of Dahetou Lingganjiao at Longtang He, 25.74622°/98.69612°, 2030 m, 18 May 2006, D.H. Kavanaugh & R.L. Brett collectors [one female; CAS]), (0.3 km S of Dahetou Lingganjiao in valley of Longchuan Jiang, 25.73678°/98.69639°, 2005 m, 18 May 2006, D. Z. Dong collector [six males and 11 females; CAS, IOZ], 20 May 2006, D. Z. Dong collector [one female; IOZ]), (Datang Village, Maluchong, 25.58194°/98.67583°, 1740 m, 24 October 2003, H.B. Liang collector [one female; IOZ]), (Jietou, stream 0.7 km N, 25.43128°/98.64773°, 1564 m, 22 May 2006, D.H. Kavanaugh, R.L. Brett, H.B. Liang, & D.Z. Dong collectors [three females; CAS, IOZ]), (Shaba Village, 25.39639°/98.70000°, 1850 m, 23 October 2003, H.B. Liang & X.C. Shi collectors [one male and one female; CAS, IOZ], Cha He at Shaba village, 25.39256°/98.70488°, 1840 m, 25 May 2006, D.H. Kavanaugh, R.L. Brett, & D.Z. Dong collectors [one female; CAS]), (Shabadi, 25.39416°/98.64686°, 1500 m, 25 October 1998, D.H. Kavanaugh collector [one male; CAS]), (Yong'anqiao, 25.32556°/98.60944°, 1500 m, 22 October 2003, H.B. Liang & X.C. Shi collectors [two males and two females; CAS, IOZ]), (Zhoujiapo Village, 25.33222°/98.67611°, 1740 m, 24 October 2003, D.Z. Dong collector [one female; IOZ], 25.53476°/98.66897°, 1610 m, 13 May 2006, H.B. Liang, R.L. Brett, & D.Z. Dong collectors [one male and three females; CAS, IOZ]); Qushi Township (Longchuan Jiang at Longkou village, 25.28175°/98.59246°, 1500 m, 6 June 2006, D.H. Kavanaugh, R.L. Brett, H.B. Liang, & D.Z. Dong collectors [one male; CAS]), (Xiaojiangqiao, 25.23944°/98.62722°, 1445 m, 21 October 2003, H.B. Liang & X.C. Shi collectors [six males and two females; CAS, IOZ]; Shangying Township (Baoshan-Tenchong Road Km 42 at Sanchawa, 2300 m, 24.93278°/98.75333°, 14 October 2003, H.B. Liang & X.C. Shi collectors [two females; CAS, IOZ]), (Baoshan-Tenchong Road Km 42-46, 24.95361°/98.73333°, 2290 m, 14 October 2003, H.B. Liang & X.C. Shi collectors [five males and six females; CAS, IOZ], 17 October 2003, H.B. Liang collector [one male and six females; CAS, IOZ]), (Baoshan-Tenchong Road Km 46-51 near Dahaoping Forest Station, 24.95722°/98.73333°, 2220 m, 17 October 2003, H.B. Liang & X.C. Shi collectors [two males and three females; CAS, IOZ], D.Z. Dong collector [one female; IOZ], 18 October 2003, H.B. Liang & X.C. Shi collectors [one male; IOZ]), (Baoshan-Tenchong Road Km 63, 25.02917°/98.66667°, 1360 m, 19 October 2003, H.B. Liang X.C. Shi and G. Tang collectors, [one male; IOZ]), (Km 65, 25.04167°/98.66667°, 1335 m, 19 October 2003, H.B. Liang & X.C. Shi collectors [one male and one female; CAS, IOZ]), (small road near Dahaoping Forest Station, 24.95722°/98.73333°, 2170 m, 18 October 2003, H.B. Liang & X.C. Shi collectors [one male; IOZ]), (Longwen Bridge at Baoshan-Tengchong Road, 25.02222°/98.66667°, 1290 m, 19 October 2003, D.Z. Dong collector [four females; CAS, IOZ], 20 October 2003, H.B. Liang & X.C. Shi collectors [one male and one female; CAS, IOZ]); Tengyue Township (Laifeng Shan, 25.01734°/98.47719°, 1920 m, 1 June 2006, D.H. Kavanaugh, R.L. Brett, H.B. Liang, & D.Z. Dong collectors [two females; CAS, IOZ]); Wuhe Township (1 km S of Picaohe Village, 24.86972°/98.70000°, 1600 m, 28 October 2003, N.D. Penny collector [one female; CAS]), (Xiaodifang Village, 24.85722°/98.75917°, 2150 m, 29 October 2003, H.B. Liang & X.C. Shi collectors [one female; IOZ], D.Z. Dong collector [three males and three females; CAS, IOZ]), (Xiaoheishan Forest Station, 24.82889°/98.76000°, 2025 m, 29 October 2003, H.B. Liang & X.C. Shi collectors [four males and three females; CAS, IOZ]); (Zhengding Forestry Station, Km 28.8 on Route S317, 24.85450°/98.73761°, 1834 m, 23 May 2005, D.Z. Dong & H.M. Yan collectors [two females; CAS, IOZ]).

Members of this species were collected in all parts of the study area except for Core Area 1, in the northwestern part of the study area (Fig. 48). However, the relatively broad geographical range of this species overall (see below) suggests that it probably occurs in that core area as well but has not yet been recorded there.

Overall geographical distribution. Fig. 47. The geographical range of this species spans nearly the entire Asian mainland, from eastern Egypt to eastern China, in a band more or less between about 15° and 40° North latitudes, with the most southerly part of the range in the Middle East and the northernmost part in central Asia. The species has been recorded from the following areas: Afghanistan, China (Fujian, Guangxi, Hong Kong, Sichuan, Yunnan), Egypt (Mt. Sinai), India (Assam, Uttarakhand), Iraq, Iran, Kyrgyzstan, Kuwait, Myanmar, Nepal, Saudi Arabia, Tajikistan, United Arab Emirates, Uzbekistan, Vietnam, and Yemen (Häckel et al 2010). Its occurrence in the study area is about at the eastern one-fourth of its known east/west range and near the center of its north/south geographical range.

Geographical relationships with other *Brosicus* species. Representatives of no other *Brosicus* species have been recorded from within the study area or in any adjacent areas at similar elevations (Fig. 50). The nearest other *Brosicus* species occur in the Himalayan ranges and typically at higher elevations (Schmidt and Arndt 2000).

Genus *Eobrosicus* Kryzhanovskij, 1951

Eobrosicus Kryzhanovskij, 1951:538. Type species: *Eobrosicus richteri* Kryzhanovskij, 1951:538 (= *Brosicus lutshniki* Roubal, 1928:90).

Tosawabrosicus Uéno, 1953:49. Type species: *Tosawabrosicus amabilis* Uéno, 1953:49.

Orobrosicus Morita, 1990:159. Type species: *Eobrosicus masumotoi* Morita, 1990:160 (synonymized by Schmidt et al. 2013:15).

Diagnosis. Members of this genus can be distinguished from those of other broscine genera in the region by the following combination of character states: body size large, BL > 15.0 mm; head with one pair of supraorbital setae; vertex with very deep, sharply defined and impunctate cleft between tempora; gula with two deep transverse grooves on each side; maxillae with two setae on eustipes; mentum with one pair of setae; submentum with three pairs of setae; antennomere 3 with apical whorl of fixed setae only, antennomere 4 with pubescence on apical one-third; pronotum with basolateral setae present; elytra with parascutellar setae present; male pro- and mesotarsi with ventral pads of adhesive setae on tarsomeres 1 and 2.

Diversity and geographical distribution. This genus is represented by only three species (Schmidt et al. 2013): *Eobrosicus lutshniki* (Roubal), restricted to the northeastern China, the Russian Far East, and Japan; *Eobrosicus masumotoi* Morita, 1990, restricted to Taiwan; and *Eobrosicus bhutanensis*, treated below.

15. *Eobrosicus bhutanensis* Morvan, 1982

Figures 5a, 38, 39, 43, 47-50

Eobrosicus bhutanensis Morvan, 1982:77. Holotype, a male, deposited in NHMB. Type locality: Bhutan, near Thimphu.

Eobrosicus uenoi Morita, 1995:8. Holotype, a male, deposited in NSMT. Type locality: Vietnam, Lào Cai, Hoang Lien Son Mountains, N of Mt. Fan Si Pan, 1840 m (synonymized by Schmidt et al. 2013:15).

Diagnosis. Fig. 38a. Because *E. bhutanensis* is the only species of the genus in the region, the generic diagnosis serves also to distinguish members of this species.

Habitat distribution. Within the study area, members of this species were collected mainly under large stones at the edges small streams (Fig. 43), however one specimen was found under a stone along a roadcut though mixed broadleaf evergreen and conifer forest.

Within the Gaoligong Shan region, this species occurs at moderate elevations, with our records documenting its occurrence in the 2527 to 3100 m range (Fig. 49).

Geographical distribution within the Gaoligong Shan. Fig. 38b. We examined a total of

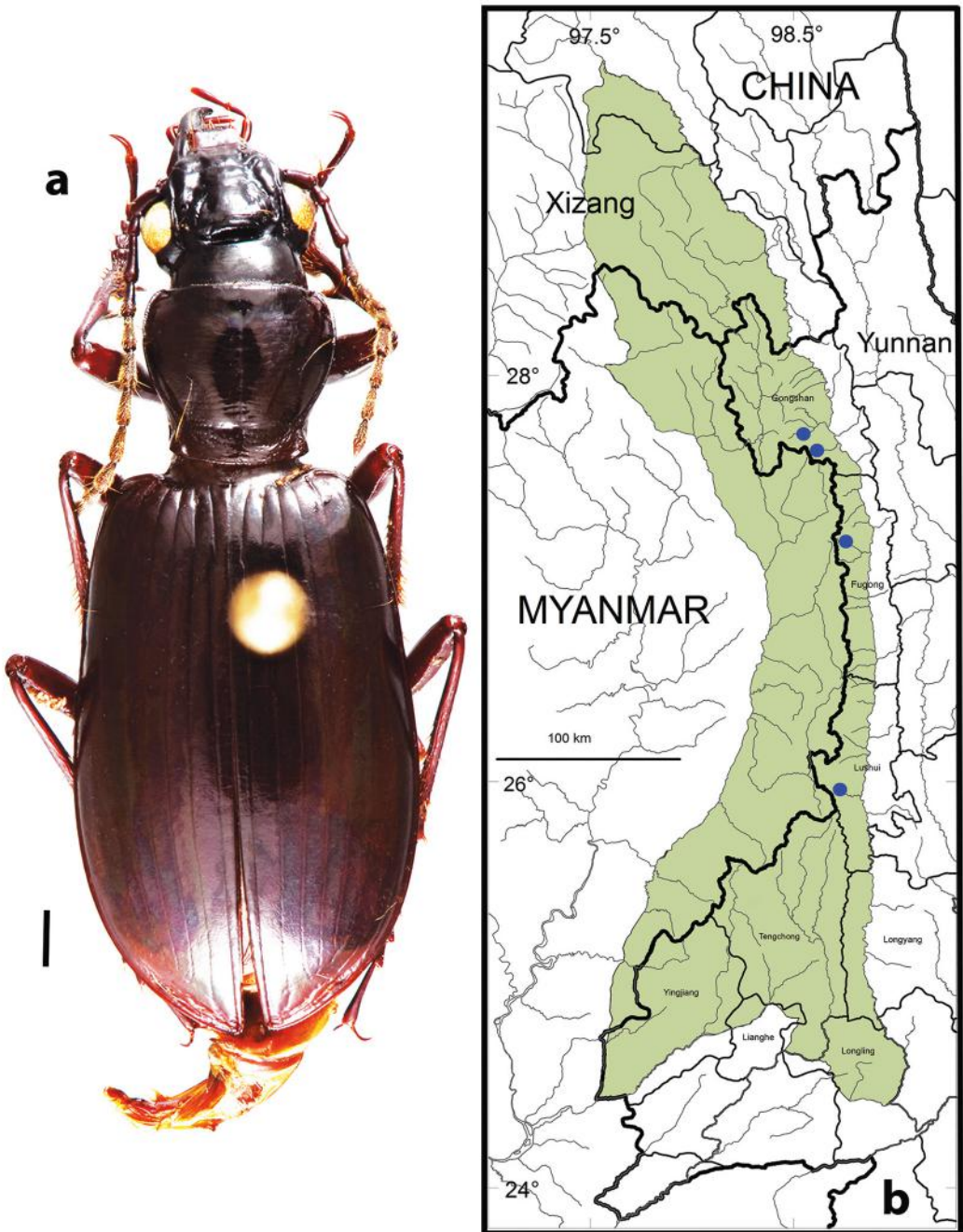


FIGURE 38. *Eobrosicus bhutanensis* Morvan. a. Habitus (CASENT1019340; Lishadi Township, Fugong County, Yunnan, China), dorsal aspect, scale line = 1.0 mm; b. Map showing locality records (blue circles) for this species in the Gaoligong Shan region, scale line = 100 km.

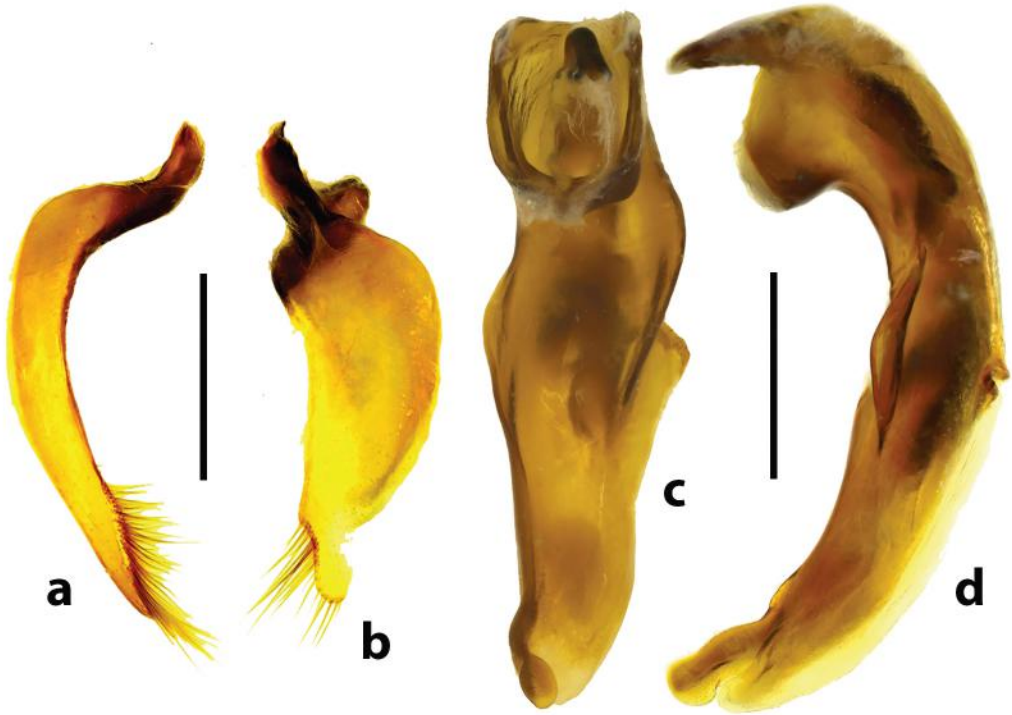


FIGURE 39. Male genitalia, *Eobrosicus bhutanensis* Morvan (CASENT1001452; Danzhu He drainage, Gongshan County, Yunnan, China). a. Right paramere, lateral aspect; b. Left paramere, lateral aspect; c. Median lobe, left lateral aspect; d. median lobe, ventral aspect; scale line = 1.0 mm.

nine specimens (seven males and two females) from the following localities: **Fugong County:** Lishadi Township (2.0 to 4.3 km above Shibali on Shibali Road, 27.17262°/98.76943° to 27.17772°/98.75485°, 2700–2826 m, 3 May 2004, D.H. Kavanaugh, H.B. Liang & C.E. Griswold collectors [one male; CAS]). **Gongshan County:** Cikai Township (Danzhu (27.63056°/98.62056°, 2600 m, 14 April 2002, H.B. Liang & W.D. Ba collectors [one male; IOZ]), (Danzhu He (13.5–13.8 airm SSW of Cikai, 27.63267°/98.60861° to 27.63331°/98.60356°, 2720–2840 m, 30 June – 5 July 2000, D.H. Kavanaugh, C.E. Griswold, H.B. Liang, D. Ubick & D.Z. Dong collectors [five males; CAS, IOZ]), (No. 12 Bridge Camp area (16.3 airm W of Cikai, 27.71503°/98.50244°, 2775 m, 15–19 July 2000, D.H. Kavanaugh, C.E. Griswold, H.B. Liang, D. Ubick & D.Z. Dong collectors [one male; CAS]). **Lushui County:** Luzhang Township (Yaojiaping He at Pianma Road, 25.97722°/98.71091°, 2527 m, 19 May 2005, D.H. Kavanaugh, H.B. Liang & D.Z. Dong collectors [one female; IOZ]).

Members of this species were collected only in the northern two-thirds of the study area, in Core Areas 2, 3 and 5 (Fig. 48), and only on the eastern side of the mountain range. However, the relatively broad geographical range of this species overall (see below) suggests that it probably occurs in the other cores areas as well but has not yet been recorded from them.

Overall geographical distribution. Fig. 47. This species has been recorded from Bhutan, China (Gansu, Shaanxi, Sichuan, Xizang (Tibet), Yunnan), India (Arunachal Pradesh), Myanmar, Nepal, and northern Vietnam. Its occurrence in the study area is near the midpoint of both its known east/west and north/south geographical ranges.

Geographical relationships with other *Eobrosicus* species. Representatives of neither of the other *Eobrosicus* species have been recorded from within the study area or from any other area where *E. bhutanensis* has been found with one exception. A single specimen of *E. lutshniki* (in IOZ) that we examined is labeled [in Chinese characters] as from Lazikou, Gansu Province, China, an area about 2500 km SW of the nearest verified localities for that species. A specimen of *E. bhutanensis* (also in IOZ) bears the same locality label. It is most likely that the specimen of *E. lutshniki* was mislabeled; but if not, then this would represent the only known instance of sympatry of species in the genus.

Within the study area, *E. bhutanensis* has been found in the same area and habitat as two other broscine species, *Brososoma danzhuense* and *B. ribbei* (Fig. 50).



FIGURE 40. Photographs of habitats for broscine species in the Gaoligong Shan region. a. SW slope of Kawakarpu Shan on slope NE of Chukuai Lake, 3950 m, 27.982°/098.480°, Bingzhongluo Township, Gongshan County, Yunnan (habitat for *Brosocodera chukuai* sp. nov.); b. Second cirque S of Shibali Yakou at border post “31”, 3710 m, 27.203°/098.693°, Lumadeng Township, Fugong County, Yunnan (habitat for *Brosocodera chukuai* sp. nov., *Brosocosoma furvum* sp. nov., and *Brosocosoma viridicollare* sp. nov.). Photos by David H. Kavanaugh.



FIGURE 41. Photographs of habitats for broscine species in the Gaoligong Shan region. a. 1.3 km E of Lao Shibali, South Fork of Yamu He, 2250 m, 27.082°/98.787°, Lumadeng Township, Fugong County, Yunnan (habitat for *Brosocodera gaoligongensis* sp. nov.); b. Danzhu He drainage, 2700 m, 27.631°/98.621°, Gongshan County, Yunnan (habitat for *Brosocodera gaoligongensis* sp. nov. and *Brosocosoma ribbei* Putzeys). Photos by David H. Kavanaugh.



FIGURE 42. Photographs of habitats for *Brososoma* species in the Gaoligong Shan region. a. Dulong/Gongshan Yakou area, 3300-3680m, 27.697°/098.454°, Gongshan County, Yunnan (habitat for *Brososoma bicoloratum* sp. nov. and *B. gongshanense* sp. nov.); b. Southeastern slope of Heipu Yakou, 3365m, 27.770°/098.447°, Cikai Township, Gongshan County, Yunnan (habitat for *Brososoma bicoloratum* sp. nov.). Photos by David H. Kavanaugh.



FIGURE 43. Photographs of habitat for broscine species in the Gaoligong Shan region; a. Danzhu He drainage, 2840 m, 27.633°/98.604°, Cikai Township, Gongshan County, Yunnan (habitat for *Brososoma danzhuense* sp. nov. and *Eobrosicus bhtanensis* Morvan). Photo by David H. Kavanaugh.



FIGURE 44. Photographs of habitats for *Broscosoma* species in the Gaoligong Shan region. a. 0.5 km E of Fengxue Yakou, 3150 m, 25.972°/098.683 °, Luzhang Township, Lushui County, Yunnan (habitat for *Broscosoma gaoligongense* sp. nov.); b. Xiao Jiang at Gangfang Sancha Lukou, 1500 m, 26.122°/98.573°, Lushui County, Yunnan (habitat for *Broscosoma holomarginatum* sp. nov.). Photos by David H. Kavanaugh.



FIGURE 45. Photographs of habitats for *Broscosoma* species in the Gaoligong Shan region. a. Snowmelt stream on north-facing slope above North Fork of Yamu He, 8.5 km W of Shibali, 3100-3200 m, 27.18315°/098.71921°, Lumadeng Township, Fugong County, Yunnan (habitat for *Broscosoma parvum* sp. nov.); b. 0.6 km N of Dizhengdang village on Dulongjiang, 1880 m, 28.084°/098.327°, Dulongjiang Township, Gongshan County, Yunnan (habitat for *Broscosoma purpureum* sp. nov.). Photos by David H. Kavanaugh

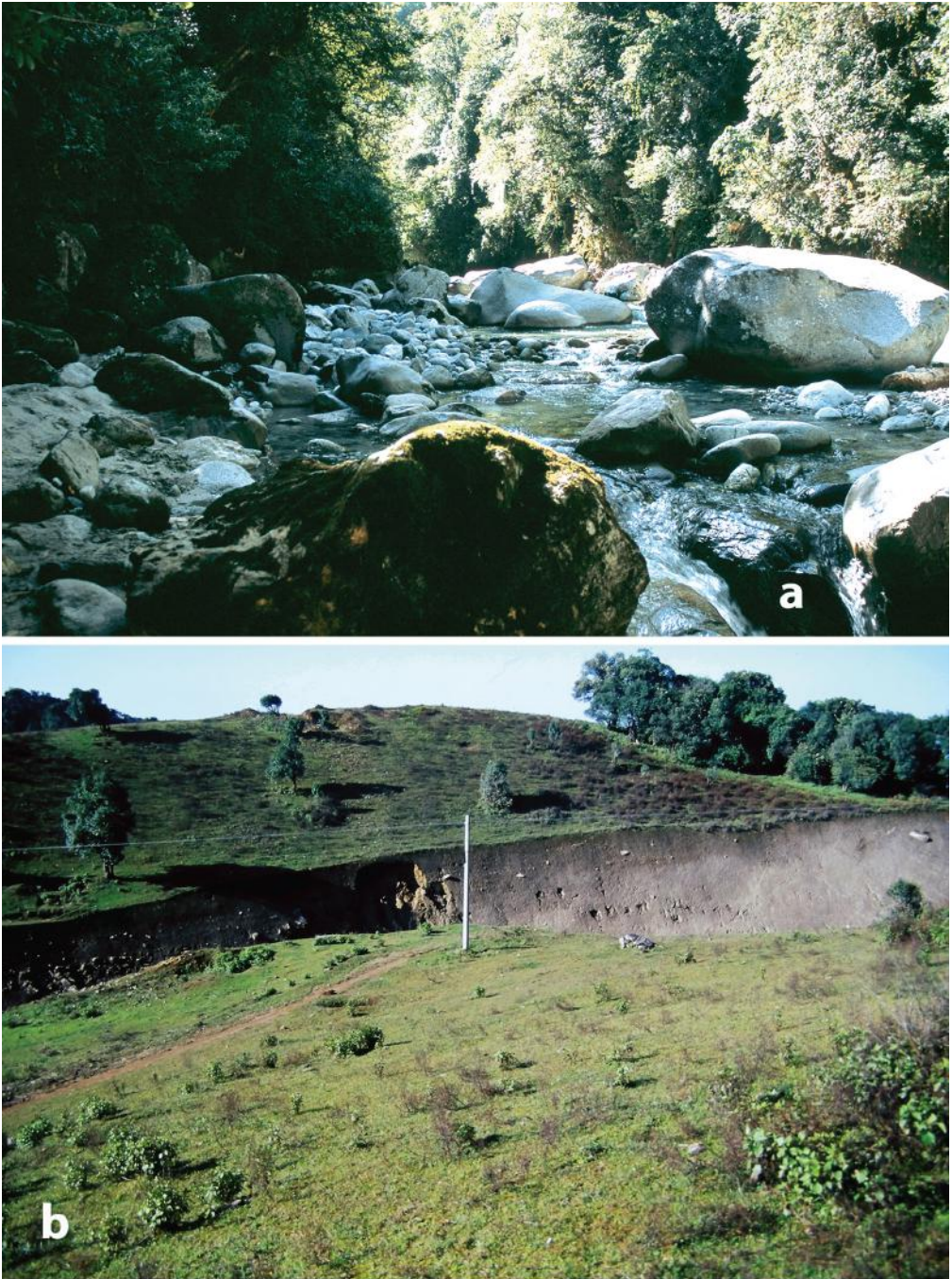


FIGURE 46. Photographs of habitats for broscine species in the Gaoligong Shan region. a. Siran Wang, 0.2 km above confluence with Dulong Jiang, 1720 m, 28.013°/ E098.321°, Dulongjiang Township, Gongshan County, Yunnan (habitat for *Brososoma resbecqi* sp. nov.); b. Nankang Yakou, 2130 m, 24.828°/98.767°, Longyang County, Yunnan (habitat for *Brososoma ribbei* Putzeys and *Brosicus punctatus* (Dejean)). Photos by David H. Kavanaugh.

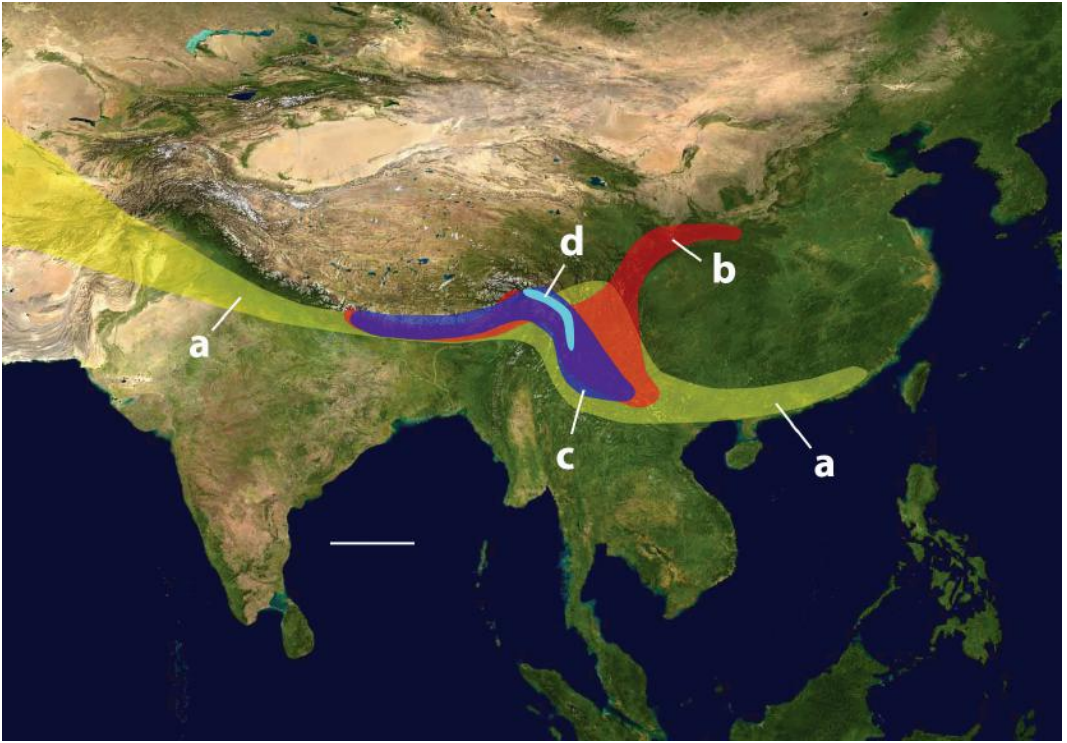


FIGURE 47. Map showing approximate known overall geographical distributions of broscine species occurring in the Gaoligong Shan region as well as outside the study area. a. *Brosicus punctatus* (Dejean); b. *Eobrosicus bhutanensis* Morvan; c. *Brososoma ribbei* Putzeys; d. *Brososoma holomarginatum* sp. nov. Modified from Wikimedia Commons, World Atlas of the World, at URL: http://upload.wikimedia.org/wikipedia/commons/8/8f/Whole_world_-_land_and_oceans_12000.jpg. Scale line = 500 k

species	Core Area						
	1	2	3	4	5	6	7
<i>Broscodera chukwai</i>		X	X				
<i>Broscodera gaoligongensis</i>		X	X	X	X		
<i>Broscosoma bicoloratum</i>	X	X					
<i>Broscosoma danzhuense</i>		X					
<i>Broscosoma furvum</i>			X				
<i>Broscosoma gaoligongense</i>				X	X		
<i>Broscosoma gongshanense</i>		X					
<i>Broscosoma holomarginatum</i>	X			X			
<i>Broscosoma parvum</i>			X				
<i>Broscosoma purpureum</i>	X						
<i>Broscosoma resbecqi</i>	X						
<i>Broscosoma ribbei</i>	X	X	X	X	X	X	X
<i>Broscosoma viridicollare</i>			X				
<i>Broscus punctatus</i>		X	X	X	X	X	X
<i>Eobroscus bhutanensis</i>		X	X		X		

FIGURE 48. Chart showing the representation of broscine species in project-designated Core Areas (see Fig. 3) in the Gaoligong Shan region.

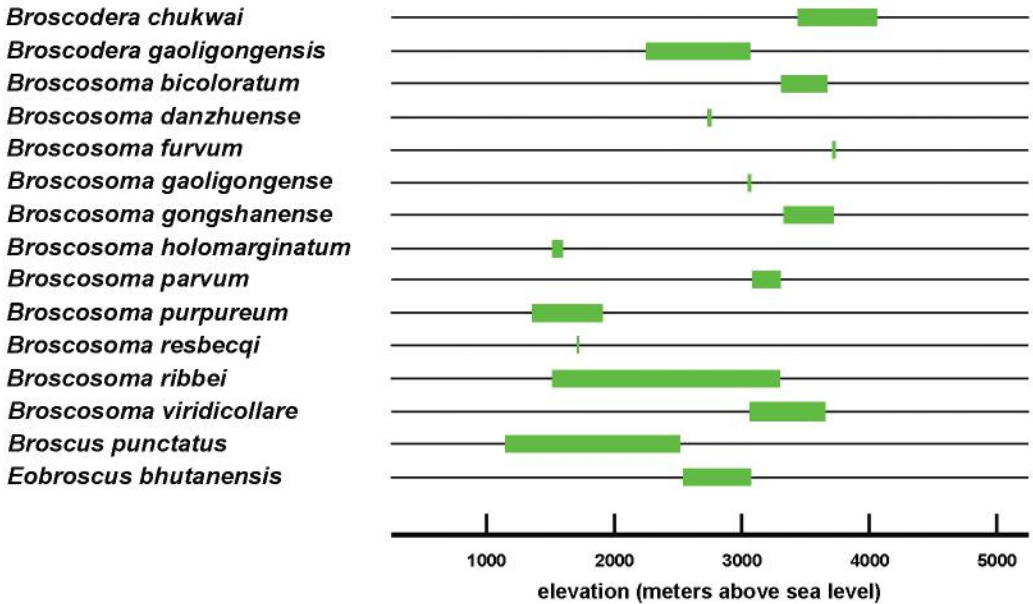


FIGURE 49. Chart illustrating the altitudinal ranges of broscine species represented in the Gaoligong Shan region. Green bars mark the elevational range recorded for each species.

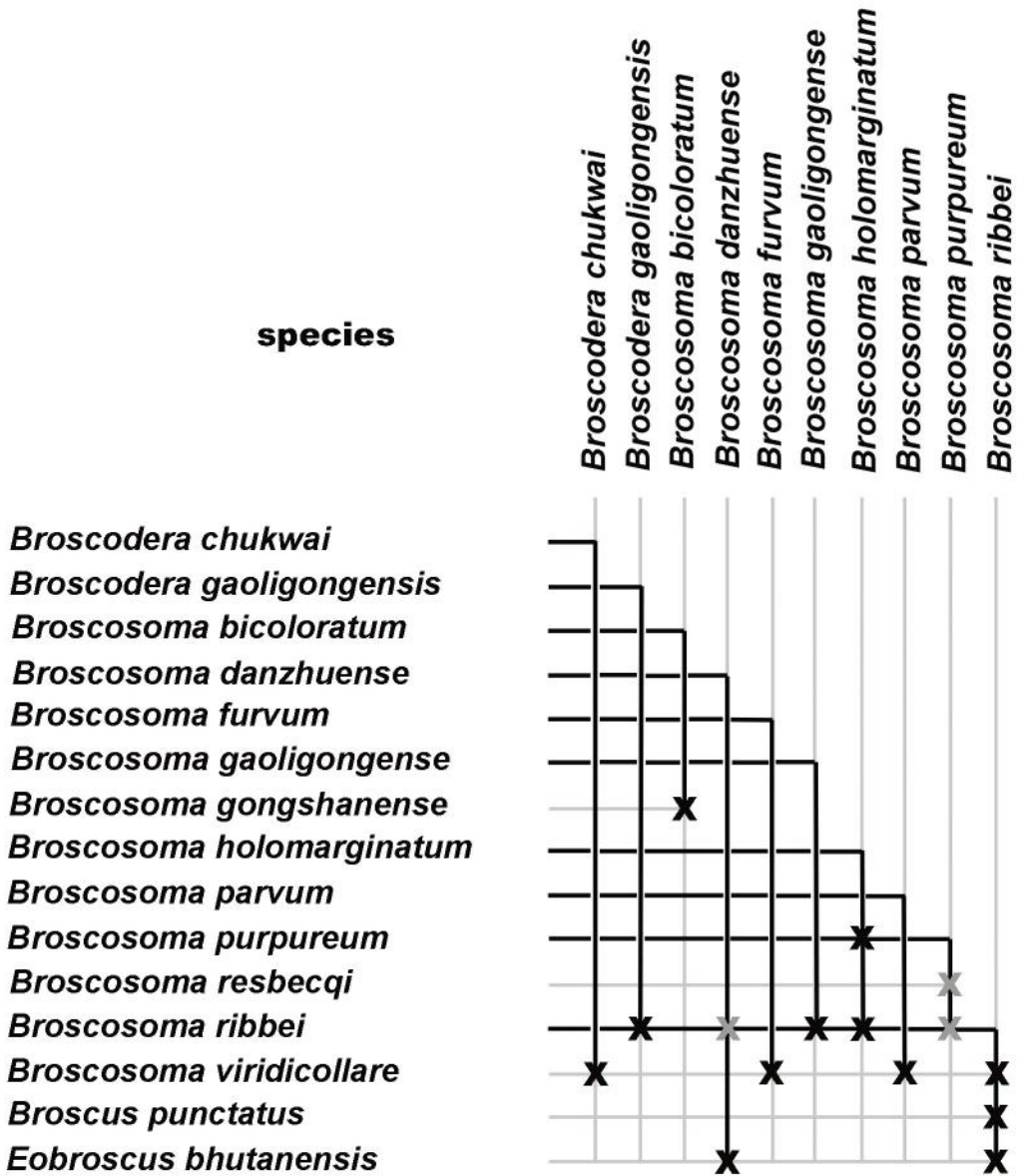


FIGURE 50. Chart illustrating the co-occurrence (syntopy) of broscine species in samples from the same habitats and at the same sites in the Gaoligong Shan region. Incidents of syntopy marked in black represent confirmed co-occurrence, those marked in grey not confirmed by records but likely.

Discussion

The Gaoligong Shan region is a key component of one of the world's biodiversity hotspots (Myers et al. 2000), where faunal elements from the Palearctic and Oriental Regions meet. These elements augment a distinct regional, largely precinctive element, probably of mixed Palearctic/Oriental origin (Deuve 2013), which either became isolated and evolved independently within the region or has been replaced elsewhere by present-day Palearctic and/or Oriental elements. Among the four groups studied in detail to date, the trechines and broscines are the most diverse precinctive elements in the fauna, with 25 of 29 trechine species (86%) and 11 of 15 broscine species (73%) known from nowhere else. We have found no precinctive species among either the omophronines (three species) or the zabrines (13 species).

Relative to the diversity of faunas in other areas of comparable size, the broscine fauna of the Gaoligong Shan region is exceptionally diverse and previously poorly known. Of the 15 species from the area recorded here, 11 are described as new and one additional species, *Broskosoma gaoligongense*, which we also had represented in our samples as new, was only recently described by Deuve and Wrase (2015). This diversity includes not only taxonomic diversity, but also exceptional diversity in morphological features, particularly within the genus *Broskosoma*, but also in *Broscodera* to a lesser degree.

No other comparable region is known to harbor two species of *Broscodera*. Their geographical ranges overlap in part but they appear to occupy different elevational ranges and are also non-overlapping in their respective body size ranges. Members of *Broscodera chukuai* are the smallest members of the genus known to date, with their size range outside the ranges of any of the other congeneric species and subspecies. Whether the differences in body size and elevational range between *B. chukuai* and *B. gaoligongensis* represent character displacement in these morphological and ecological features or have instead resulted from some other historical cause or causes will remain unclear until phylogenetic relationships among *Broscodera* species are better understood.

There appears to us to be at least as much morphological diversity within the *Broskosoma* fauna of the Gaoligong Shan region as is found within the genus throughout the remainder of its entire range. All species with members having lateral margination of the pronotum present, whether distinct on at least part of the pronotal margin, as in *B. resbecqi* and *B. ribbei*, or complete, as in *B. holomarginatum*, are found in this region. *Broskosoma rebecqi* is known only from this region, *B. holomarginatum* also occurs in the adjacent southeastern part of Xizhang (Tibet), and only *B. ribbei* is more widely distributed. No other area has as many species with the elytra humeri more or less distinct. In fact, the number of species with distinct humeri in the Gaoligong Shan region (six) is double the number (three) within the remainder of the genus. Diversity in the presence and distribution of metallic reflection on the dorsum of the body is also exceptional. For example, no described species from any another area has members which have the pronotum without metallic reflection except for the area anterior to the anterior transverse impression, where it is distinctly present in *B. viridicollare* members and faintly present in some members of *B. bicoloratum* as well. Finally, there is exceptional diversity in the genitalic structures of males in the region, particularly in the shape of the median lobe and the sclerites of its internal sac and in the shape of the left paramere. Clearly, the Gaoligong Shan region is and has been a very important area in the evolutionary history of this genus. Better understanding of that history will require phylogenetic analyses of both morphological and DNA data for the genus as a whole.

Broad geographical distribution patterns.

The overall geographical ranges of the four broscine species known to occur both within and outside of the Gaoligong Shan region are graphically approximated, superimposed on one another, in Fig. 47. Among the geographical ranges of these species, three general range patterns are apparent. The first is that shown by two of the four species, *Brososoma ribbei* and *B. holomarginatum*, with geographical ranges that mainly include the Gaoligong Shan region and a narrow swath along the southern slope of the Qinghai-Xizang (Tibetan) Plateau in southeasternmost Xizhang (Tibet) and the Himalayan Range. This pattern has been seen also among omophronines (Kavanaugh et al. 2021), trechines (Deuve et al. 2016), and zabrines (Kavanaugh et al. 2014), with the western extent of the ranges of different species varied, some extended west as far as Pakistan. The range of *B. holomarginatum* extends only slightly northwest from the Gaoligong Shan to southeasternmost Xizhang, whereas that of *B. ribbei* extends westward to central Nepal. The latter species is somewhat unusual in that its range also extends slightly further southeast into southcentral Yunnan instead of northeast into Sichuan or farther east along the southeastern edge of the Qinghai-Xizang (Tibetan) Plateau as is seen in several species of zabrines and trechines. The second pattern is that shown by *Eobrosca bhutanensis* with a known geographical range that includes the Gaoligong Shan region as well as areas toward both the northwest (as in the first pattern) and the northeast along the southern edge of the Qinghai-Xizang (Tibetan) Plateau through Sichuan and southern Gansu. This pattern also has been seen among trechines and zabrines, although the range of *E. bhutanensis* extends farther southeast (to northern Vietnam) than those of other species with this range pattern. Finally, the fourth species, *Brosca punctatus*, shows a pattern not seen among the ranges of any species of the other groups studied to date, namely one extended from the Middle East eastward to the southern slope of the Himalayan Range, the Gaoligongshan region, and then across southern China to Hong Kong and Fujian. In the Gaoligong Shan region, members of this species were found occasionally on the upper sandy banks of the larger rivers (as noted by Schmidt and Arndt (2000) for this species elsewhere), but were far more abundant in other highly disturbed habitats, often in association with human habitation and agricultural or waste areas far from water courses. This geographical range pattern is shared with the platynine, *Orthotrichus cymindoides* (Dejean), 1831, although that species may not share such a close association with some forms of human disturbance (e.g., agriculture) (J. Schmidt, personal communication).

All four of these broscine species with ranges extended outside the Gaoligong Shan region have adults with full-sized, functional hindwings. The ability to fly undoubtedly supports the occupation and maintenance of larger geographical ranges as well as greater potential for dispersal to new areas. Within the broscine fauna of the region, two additional species, *Broscoidea gaoligongensis* and *Brososoma purpureum*, have fully-winged adults but are currently known only from the study area. Their discovery elsewhere at some time in the future would not be surprising, whereas the remaining nine species, all of which have flightless adults, are unlikely to be found anywhere else, except perhaps in the northern extension of the same mountainous region in adjacent parts of southeasternmost Xizhang (Tibet).

With 73% of the species in the broscine fauna of the study area occurring nowhere else, the overall distributions of their genera can provide a broader geographic context for understanding the development of this fauna. The geographical range of *Broscoidea*, subgenus *Sinobrosculus*, extends from eastern Nepal to northeastern Sichuan, with the Gaoligong Shan area occupying the approximate midpoint of that range. The combined range of the five species, including the two described here as new, fits the second overall pattern described above. Genus *Brosca* is widespread in Eurasia, but mainly west and northwest of the Gaoligongshan region. In addition to *B.*

punctatus, only one species, *Brosicus koslovi* Kryzhanovskij, 1995, occurs north of the study area (in Nei Monggol). Conversely, *Eobrosicus* is distributed mainly east of the Gaoligong Shan region, with one species in Taiwan and a second in Japan, North and South Korea, and the Russian Far East. The sequentially disjunct geographical range of *Brosicosoma* includes what appear to be three distinct assemblages, distributed more or less from west to east, across Eurasian. These assemblages not only occupy discrete areas but also share morphological features unique to them, although the monophyly of these assemblages has not yet been tested through phylogenetic analyses. The first assemblage includes two species from the Alps of northern Italy and probably a third species, *B. semenovi*, from the Caucasus region (Belousov and Kataev 1990). The second assemblage includes six described species with a combined geographical range extended from Japan and Taiwan to the Chinese mainland in Fujian and west to Chongqing Municipality. The third assemblage, by far the most diverse, now includes 45 species (including the nine described here as new). The geographical range of this assemblage extends from central Nepal in the west eastward along the Greater Himalayan Range and the eastern margin of the Qinghai-Xizang (Tibetan) Plateau to Shaanxi Province in the east. Just as for *Broscodera*, the combined range of these 45 *Brosicosoma* species fits the second overall pattern described above and, again, with the Gaoligong Shan region at the midpoint of that pattern.

Based initially on distributional data provided by the zabrine fauna and on geologic evidence of the relative ages of the Gaoligong Shan region and the Himalayan Ranges and Qinghai-Xizang (Tibetan) Plateau as summarized by Chaplin (2005), Kavanaugh et al. (2014) suggested that the Gaoligong Shan region may have been an area of differentiation, speciation and origin of montane elements from which, rather than to which, at least some of the species that now range more broadly subsequently spread. Evidence provided by the trechine fauna (Deuve et al. 2016), including the occurrence of four precinctive genera, one apparently precinctive subgenus, and several precinctive species in the region, provided additional support for this hypothesis. The broscine fauna also contributes additional evidence in the form of 11 precinctive species, exceptional morphological diversity, and, again, placement of the Gaoligong Shan region near the geographical center of broscine diversity in southcentral central Asia. These findings confirm that the high diversity of the region is not merely the result of the overlap of widespread Palearctic and Oriental faunal elements but also has involved differentiation and diversification within the region. However, just what role, if any, the the Gaoligong Shan local fauna has played over time in the development of the carabid fauna of central or southcentral Asia, and of the Himalayan mountain system and/or Qinghai-Xizang (Tibetan) Plateau faunas in particular, remains to be determined. Only through phylogenetic analyses for each of these groups, such as that done for the *Ethira* clade of genus *Pterostichus* based on DNA data (Schmidt et al 2012), can we begin to answer this question.

Regional geographical and altitudinal distribution patterns

The chart in Fig. 48 summarizes the recorded regional distributions of the species with respect to our project-designated Core Areas (see Fig. 3); and the recorded altitudinal ranges for each species are shown in Fig. 49. These charts clearly demonstrate the relatively narrow geographical and altitudinal ranges of a majority of the broscine species occurring in the region compared with the ranges of zabrine species in the fauna (see Kavanaugh et al. 2014, figs. 28 and 29). However, they are slightly less restricted on average than the trechines in the fauna (see Deuve et al. 201, figs. 46 and 47). These differences may be expected, based at least in part on differences in flight capability among members of the three groups. Among trechines, 72% of the species have flightless adults compared with 60% of broscine species and no flightless zabrines represented in the fauna.

Only one broscine species, *Broskosoma ribbei*, was recorded from all seven Core Areas and one species, *Brosicus punctatus*, was found in six of the seven Core Areas. In contrast, no trechine species was recorded from more than four Core Areas and only two species out of 29 were found in more than two Core Areas. Six broscine species were recorded from a single Core Area and three more only from two adjacent Core Areas, whereas 18 trechines were recorded from a single Core Area and six more only from two adjacent Core Areas. The gap in our sampling on the western slope of the Gaoligong Shan between Core Areas 1 and 4, an area that is part of Myanmar and thus was not open to our study for sampling, confounds our understand of which species occur in that part of the region. For example, we suspect that *Broskosoma holomarginatum*, recorded from Core Areas 1 and 4, also occurs in the gap area between them in Myanmar. Similarly, *Broskosoma furvum*, *B. parvum*, and *B. viridicollare*, all recorded only from Core Area 3 but at or near the crest of the Gaoligong Shan in that area, probably occur also on the western side of the crest in that same gap area in Myanmar.

Comparing broscine diversity recorded among the Core Areas, we find that each of them is occupied by at least two species, with highest diversity in Core Areas 2 and 3 (with eight species in each) and lowest diversity in Core Areas 6 and 7 (with only two species in each). Among trechines, highest diversity was found also in Core Area 2 and second highest in Core Area 3 (Deuve et al. 2016). Further sampling may confirm the occurrence of *Broskosoma gongshanense* in Core Area 1 because that species inhabits high elevation habitats near the crest of the range in Core Area 2. Its discovery there would raise the diversity in Core Area 1 to six species. Core Areas 1 and 2, 2 and 3, and 4 and 5 each uniquely share one broscine species. *Eobrosicus bhutanensis* is recorded only from Core Areas on the eastern side of the range but is likely to occur also in those on the western side based on its overall geographical distribution.

Three of the seven Core Areas are occupied by at least one species recorded as unique to them. Core Area 3 has three such species and Core Areas 1 and 2 each has two. Comparing species diversity in relation to the north/south axis of the range, we find a distinct pattern. Highest diversity is in the northern region (Core Areas 1 and 2), with 11 of the 15 broscine species found in this region and five of these restricted to it. Eight species occur in the northcentral region (Core Area 3) with three of these restricted to it. Four species occur in the southcentral region (Core Areas 4 and 5) with one of these found only there; and only two species occur in the southern region (Core Areas 6 and 7), both widespread through the study area. Comparing west and east versants of the range, we find eight broscine species recorded from the western side (Core Areas 1, 4, and 6), including two species unique to that side, and 12 species on the eastern side (Core Areas 2, 3, 5, and 7), including four species unique to that side.

The recorded altitudinal ranges of broscine species in the Gaoligong Shan region (Fig. 49) extend from 1185 to 4035 m. Whereas highest trechine diversity is concentrated in a broad zone between about 2250 m and 3750 m, with 27 of the 29 species occurring within this zone (Deuve et al. 2016), and peak diversity among zabrines is at about 2000 m (Kavanaugh et al. 2014), the ranges of broscine species are more dispersed along the altitudinal gradient. Seven species have their known altitudinal ranges restricted to areas above 3000 m and all of these have reduced hindwings and are flightless. Three more species (*Broscoedera gaoligonensis*, *Broskosoma ribbei*, and *Eobrosicus bhutanensis*) have altitudinal ranges that extend above the 3000 m range and all of these have full-sized wings. Of the eight species that have known ranges that extend below the 3000 m level or are restricted to lower elevations, six are fully winged and only two (*Broskosoma danzhuense* and *B. resbecqi*) have their hindwings slightly or markedly reduced and are flightless. The average difference between highest and lowest recorded elevations for each of the 13 broscine species for which more than one elevational record was obtained was 563 m. The most restricted

species, *Broskosoma furvum*, had only a 15 m recorded range (which is undoubtedly an underestimate of its actual range) and the least restricted, *B. ribbei*, had an 1800 m recorded range. These ranges approximate those for trechines in the fauna, which averaged 500 m ranges and had the most restricted species with only a 20 m recorded range and the least restricted with a 1300 m range. These figures contrast sharply with those for zabrines species, which were found to occupy relatively broader altitudinal ranges (with an average range of 1193 m, a 225 m range for the most restricted species and a 2111 m range for the least restricted. Kavanaugh et al. 2014 suggested that this broader range among zabrines is likely due mainly to their preference for open habitats, including those created by humans, which now occur at virtually all elevations in the study area.

Syntopy of species in the regional fauna. Records of the co-occurrence of different broscine species at the same site and in the same habitat (i.e., syntopic) within the study area are summarized in Fig. 50. Syntopy appears to be relatively rare among broscines of the region, especially among congeneric species. As should be expected from its broad geographical and altitudinal ranges within the study area, *Broskosoma ribbei* has been found syntopic at one or more sites with three other *Broskosoma* species and is likely syntopic with two more. It also has been found with *Broscodera gaoligongense*, *Brosclus punctatus*, and *Eobrosclus bhutanensis* at one or more sites. Aside from this species, few other instances of congeneric syntopy were recorded (see Fig. 50). As noted above, the geographical ranges of *Broscodera chukuai* and *B. gaoligongensis* overlap in part, but their altitudinal ranges apparently do not, so they are not considered as syntopic.

The level of syntopy found among broscines is more similar to that seen among trechines than among zabrines but intermediate between them. Seven of 29 trechines were not found syntopic with any other trechine species and only one species was found syntopic with five other species (Deuve et al. 2016). This contrasts sharply with syntopy found among zabrines. All of the 13 *Amara* species in the fauna were found syntopic with at least one other congeneric species, three of them with seven other congeners, and four of them with eight other *Amara* species (Kavanaugh et al. 2014). Again, these differences can be expected when comparing groups with many flightless members and requiring minimally altered habitats with a group most or all members of which are capable of flight and thrive in habitats created by humans.

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***Holographis haenkeana*, a New Combination for
Crossandra haenkeana (Acanthaceae: Acantheae)**

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Aphelandra verticillata, a legitimate replacement name for *Crossandra haenkeana* (non *Aphelandra haenkeana*), was recently transferred to *Holographis*, and the new combination *H. verticillata* was made. However, that new combination was superfluous and illegitimate because of the availability of the earliest epithet (*haenkeana*) in *Holographis*. Therefore, a new combination, *H. haenkeana*, is herewith proposed, and the nomenclatural history of this species is briefly reviewed.

KEYWORDS: Nomenclature, illegitimate names, *Aphelandra verticillata*

Nees (1847) proposed *Crossandra haenkeana* Nees as a new species based on a collection of T. Haenke from Mexico in an otherwise Paleotropical genus. In the protologue, Nees referred to specimen(s) as: “In regno mexicano (Haenke!),” “*Aphelandra verticillata* N. ab E. in h. Haenk.!),” and “(v. in h. Haenk.).” Of these, “*Aphelandra verticillata* N. ab E.,” was listed as a synonym, and thus not validly published (Article 36.1; Turland et al. 2018). Hemsley (1882) transferred *C. haenkeana* to the Neotropical genus *Aphelandra*. Because the name *A. haenkeana* Nees (1847; =*A. scabra* (Vahl) Sm.) already existed for a different species, Hemsley resurrected “*Aphelandra verticillata* Nees” and validated it as a legitimate replacement name for *C. haenkeana*.

Based on molecular phylogenetic, macromorphological, and palynological data, Daniel et al. (2020) transferred *Aphelandra verticillata* to *Holographis* and created the new combination *H. verticillata* (Hemsl.) Daniel et al. Unfortunately, the authors overlooked the availability of the earliest epithet (*haenkeana*) in *Holographis*. Therefore, the new combination *H. verticillata* was superfluous and illegitimate when made. To correct the situation, the authors herewith propose the new combination *H. haenkeana* based on *Crossandra haenkeana*. Daniel et al. (2020) provided an argument for recognizing Haenke’s specimen at PR as the holotype of *C. haenkeana*, and Wasshausen’s (1975) indication of such as an unintended lectotypification.

***Holographis haenkeana* (Nees) T.F. Daniel, McDade & Kiel, comb. nov.**

Crossandra haenkeana Nees in Alph. de Candolle, Prodr. 11:281. 1847. *Aphelandra verticillata* Nees ex Hemsl., Biol. Centr. Amer. Bot. 2:513. 1882. *Holographis verticillata* T.F. Daniel, McDade & Kiel, nom. illeg., Proc. Calif. Acad. Sci. 66:299. 2020. *Aphelandra verticillata* Nees, in Alph. de Candolle, Prodr. 11:281. 1847, nom. nud. TYPE.— MEXICO. Western Mexico, 1791, *T. Haenke* s.n. (holotype, or potentially lectotype: PR!; isotypes: GZU!, PRC!).

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Taxonomic and Photographic Guide to the Acanthaceae of Tamaulipas, Mexico

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Fifty species in 21 genera of Acanthaceae are recognized as occurring in Tamaulipas, the northeasternmost Mexican state. Documented occurrences of five species (*Carlwrightia hapalocarpa*, *Dicliptera sumichrastii*, *Dyschoriste hirsutissima*, *Justicia* sp., and *Thunbergia alata*) are reported for the first time. Eight species are known only from the state. An identification key to the genera and species, photographs of 49 species, and pollen images of the endemics are presented. An account for each species includes data on: distribution, phenology, ecology, taxonomy/nomenclature, and collections.

KEYWORDS: New reports, endemic species, identification key, pollen.

Se reconoce que 50 especies de 21 géneros de Acanthaceae se encuentran en Tamaulipas, el estado más al noreste de México. Por primera vez se reportan registros documentados de cinco especies (*Carlwrightia hapalocarpa*, *Dicliptera sumichrastii*, *Dyschoriste hirsutissima*, *Justicia* sp. y *Thunbergia alata*). Se conocen ocho especies solo del estado. Se presenta una clave de identificación de los géneros y especies, fotografías de 49 especies e imágenes de polen de las endémicas. La información para cada especie incluye datos sobre: distribución, fenología, ecología, taxonomía/nomenclatura y colecciones.

PALABRAS CLAVE: Nuevos registros, especies endémicas, clave de identificación, polen.

Tamaulipas is the northeasternmost and sixth largest state (land area = 80,249 km²) of Mexico. Diverse biotic communities (biomes) lie within its borders, including both arid (e.g., thornscrub, desertscrub, tropical deciduous forest) and mesic to wet (e.g., oak forest, mesophytic montane forest, conifer forest, cloud forest, humid tropical forest, and mangal) ones. Among Mexican states Tamaulipas ranks 15th in the number of vascular plant species (4,278) with 65 of them endemic there (Villaseñor 2016). Sosa and Dávila (1994) indicated northern Mexico (with arid vegetation and grasslands) as one of three priority regions for botanical exploration due to a low (i.e., less than 100) collection density index (Campbell 1989) and a lack of floristic studies there. Since then, several floristic studies have dealt with a considerable portion of central and northeastern Mexico, including the Chihuahuan Desert region (Henrickson and Johnston 2007) and Nuevo León (Villarreal-Quintanilla and Estrada-Castillón 2008). However, a comprehensive floristic study of Tamaulipas remains to be undertaken.

With more than 4,000 species worldwide, Acanthaceae are among the larger families of flow-

ering plants. Most species occur in tropical regions, both wet and dry, with significant radiations of taxa in the New World. Villaseñor (2016) treated Acanthaceae as the 15th largest family of vascular plants in Mexico with 385 species. With 50 species of the family reported below for the state, Tamaulipas ranks 10th in numbers of Acanthaceae among Mexican states. It is thus comparable in numbers of species to those of several nearby states (Daniel, unpublished): Querétaro (53), Hidalgo (52), and San Luis Potosí (49).

The following account of Tamaulipan Acanthaceae documents new occurrence records for the state and provides a key to all of the genera and species. Photographic plates (Figs. 1–5) showing flowers of 49 of the species (no photographs of *Carlowrightia henricksonii* have been located) and scanning electron micrographs of pollen (Fig. 6) for each of the endemic species, highlight some of the floral and palynological diversity among species in the state and illustrate some of the characters used in the key. Summarized information for each species includes distributional data; floral phenology, habitats, and elevations in Tamaulipas; taxonomic and nomenclatural notes; and citations of specimens studied from 48 herbaria.

MATERIALS AND METHODS

The information presented below is based on study of 589 collections of Tamaulipan Acanthaceae from the following herbaria: A, ARIZ, ASC, ASU, B, BM, BR, BRIT, CAS, CHAPA, DAV, DS, DUKE, ENCB, F, G, GH, GZU, ITCV, K, L, LL, LSU, MEXU, MICH, MIN, MO, MSC, NCU, NSW, NY, OS, P, PH, POM, PR, PRC, QMEX, RSA, S, SD, SMU, TEX, U, UAT, UC, US, USF, W, WIS, XAL. A small number of these were studied and confirmed via images only, as indicated in the specimens cited below. Phenological data, habitats, elevational ranges, and specimens cited apply only to plants from Tamaulipas. These data were obtained from herbarium specimen labels, and from occurrences listed in NaturaLista (2021) when identifications of images at that site were verified by us. Taxonomic and nomenclatural synonyms that have sometimes been applied to species from the state are noted. Determinations of extent of occurrence (EOO) and area of occupancy (AOO) criteria (IUCN 2019) for the eight species endemic to Tamaulipas were calculated by georeferencing their collection localities and using the GeoCat (2021) assessment tool. Preliminary conservation assessments are discussed, but not proposed due to a lack of sufficient information on threats, potential threats, and population dynamics.

An estimate of the collection density index (i.e., number of collections from a region \div 100 km² of the region's area; Campbell 1989; Sosa and Dávila 1994) was calculated as follows: 68,175 collections \div (80,249 km² \div 100) = 85. A generous estimate of the number of vascular plant collections from Tamaulipas is based on collection data (as of 30 May 2021) from the following herbaria: MEXU (largest repository of Tamaulipan plants: 18,829), UAT + ITCV (estimate of specimens not duplicated at MEXU from herbaria in Tamaulipas: 15,000), TEX/LL (largest repository of Tamaulipan plants in the U.S.A.: 9,860), US (5,956), Torch Data Portal (2021; with full or partial data from ca. 350 North American herbaria, here excluding TEX/LL: 8,530), and other herbaria worldwide (estimate of specimens not duplicated elsewhere: 10,000). The total number of collections is likely a significant overestimate because of the duplication of specimens among the various herbaria. Thus, the collection density index is probably lower than the estimate calculated here.

RESULTS

The Acanthaceae of Tamaulipas consist of 50 species representing 21 genera. Occurrences of five species (*Carlowrightia hapalocarpa*, *Dicliptera sumichrastii*, *Dyschoriste hirsutissima*, *Justi-*

cia sp., and *Thunbergia alata*) are newly documented from the state. At least seven species (*Carlowrightia albiflora*, *C. henricksonii*, *C. trichocarpa*, *Holographis tamaulipica*, *Louteridium tamaulipense*, *Mirandea andradenia*, and *Yeatesia mabryi*) are currently known only from the state, and are thus treated as endemic there. A species of *Justicia* from Tamaulipas that is currently under study to determine its taxonomic status may represent an additional endemic taxon. All of the endemic species (tentatively also including the undetermined *Justicia*) are either rare (i.e., known from five or fewer collection sites) or would pertain to an IUCN (2019) threatened category if threats or potential threats and their impacts on the plant populations were to be identified. Nine additional species could be considered as pertaining to regional endemics (i.e., distribution limited to Tamaulipas and adjacent and/or nearby states): *Carlowrightia hapalocarpa*, *C. parviflora*, *Dyschoriste crenulata*, *D. greenmanii*, *Elytraria macrophylla*, *Hoverdenia speciosa*, *Justicia linearis*, *Mirandea grisea*, and *Yeatesia platystegia*. Four non-native species have become naturalized in the state: *Hygrophila corymbosa*, *H. polysperma*, *Thunbergia alata*, and *T. fragrans*). The following cultivated species have been recorded from Tamaulipas by photographs (iNaturalist 2021): *Asystasia gangetica* (L.) T. Anderson, *Hypoestes phyllostachya* Baker, *Odontonema callistachyum* (Schltdl. & Cham.) Kuntze, *O. cuspidatum* (Nees) Kuntze, *Pachystachys lutea* Nees, and *Thunbergia grandiflora* Roxb.

Types of at least 14 names consist of plants collected in Tamaulipas. These include the seven species endemic to the state; types of *Dyschoriste crenulata*, *D. greenmanii*, and *Justicia canbyi*; and types of two synonyms of *Justicia pilosella* and one synonym each of *Ruellia ciliatiflora* and *R. simplex*.

Although native Acanthaceae occur in all major biotic communities in Tamaulipas, most occurrences have been recorded as follows (many species occur in more than one community): thornscrub (22), tropical deciduous forest (16), oak forest (11), and tropical subdeciduous forest (10). At least 25 species have been recorded as occurring on limestone substrates (i.e., calcareous soils on limestone).

Seventeen species of Acanthaceae, including three endemics, are currently treated as rare in the state. We propose at least three potential causes for their rarity. 1) Tamaulipas is not as well-collected as many other states in Mexico. Indeed, an estimated collection density index (see calculation in Materials and Methods) for the state of 85 appears to be relatively low. Several remote areas in the Sierra de Tamaulipas and Sierra Madre Oriental, as well as some regions in the coastal lowlands remain to be thoroughly explored. 2). Due to its northern location in Mexico, only about one-third of Tamaulipas lies within the tropics. Acanthaceae are primarily a tropical family. Some species are potentially rare in the state because they attain the northern extent of their geographic distribution there (e.g., *Dicliptera sumichrastii*, *Hoverdenia speciosa*); others attain either their northeasternmost occurrences (e.g., *Aphelandra scabra*) or their northernmost occurrences in eastern Mexico (e.g., *Barleria oenotheroides*) in Tamaulipas. 3) Tamaulipas lacks extensive areas of both desert and lowland humid tropical forest. In Mexico and Central America, Acanthaceae have undergone major diversifications in both of these biotic communities. Although there are extensive arid regions (e.g., various types of thornscrub, tropical dry forest) in the state, the lack of larger regions of both desert and humid tropical forest limits occurrences of species that are more common in those communities occurring in states to the south and west. Indeed, among the 18 Mexican states with humid tropical forest, Tamaulipas has the second lowest percentage (0.6%) of this biotic community (Villaseñor et al. 2018). In spite of their limited extent, the state's acanthaceous flora is enriched by occurrences in several smaller biotic communities: the incursion of Chihuahuan Desert in southwestern Tamaulipas (e.g., *Justicia linearis*, *Mirandea grisea*); the somewhat isolated and northernmost region of tropical cloud forest in the New World (in the Reserva de

la Biósfera El Cielo), where at least nine native species of Acanthaceae have been collected; and mangal along the Gulf Coast (i.e., *Avicennia germinans*).

KEY TO THE GENERA AND SPECIES OF TAMAULIPAN ACANTHACEAE

- 1a. Mangrove trees or shrubs with pneumatophores; fruit a leathery and tardily dehiscent/non-explosive capsule with 1 seed. *Avicennia germinans*
- 1b. Herbs, shrubs, or vines, pneumatophores absent; fruit a woody and explosively dehiscent capsule with 2 or more seeds 2
- 2a. Seeds not borne on hooklike retinacula (retinacula absent or papilliform); plants without cystoliths; anthers 2-theous. 3
- 2b. Seeds borne on conspicuous hooklike retinacula; plants with cystoliths (or if plants without cystoliths, then anthers 1-theous); anthers 2-theous or 1-theous. 4
- 3a. Caulescent twining vines; leaves opposite on elongate stems; inflorescence of 1-flowered pedunculate dichasia in leaf axils, peduncles naked; stigma not touch-sensitive; calyx inconspicuous, shallowly 11–17-lobed; capsule with a prominent sterile distal beak longer than the fertile globose base; pollen spiraperturate *Thunbergia*
- a. Petioles alate; leaf blades sagittate; corolla orange, throat dark purple, internally glandular; thecae pubescent, at least 1 theca per anther with a prominent basal appendage; capsule 14–23 mm long T. alata*
- a'. Petioles naked; leaf blades ovate to narrowly ovate-deltate; corolla entirely white (or with throat faintly yellow), throat internally eglandular; thecae glabrous, lacking basal appendages; capsule 22–27 mm long T. fragrans*
- 3b. Acaulescent or subcaulescent perennial herbs; leaves in a basal cluster; inflorescence borne on peduncles covered with coriaceous and clasping scales; stigma touch-sensitive; calyx deeply 4-lobed, anterior lobe shallowly 2-parted; capsule without a prominent sterile distal beak (beak, if present, considerably shorter than fertile portion of capsule); pollen 3-colpate. *Elytraria*
- a. Leaves 4.5–25 mm wide; bracts lanceolate, 6–11 mm long; calyx 6–8 mm long; corolla pinkish to nearly white. E. bromoides*
- a'. Leaves 27–112 mm wide; bracts broadly ovate, 3.8–5 mm long; calyx 4.5–5.2 mm long; corolla yellow E. macrophylla*
- 4a. Calyx 3-lobed, 32–47 mm long; corolla whitish to greenish cream, lacking colored markings, 55–60 mm long, throat prominently saccate (forming a conspicuous pouch); pollen pantoforate. *Louleridium tamaulipense*
- 4b. Calyx 4- or 5-lobed, 1–30 mm long; corolla not with the above combination of characters; pollen not pantoforate 5
- 5a. Stamens 4, sometimes also with an additional staminode 6
- 5b. Stamens 2, sometimes with additional staminodes. 12
- 6a. Corolla lemon yellow turning dark blue-purple or blackish on drying; calyx deeply 4-lobed, lobes heteromorphic with outer (anterior and posterior) lobes larger than inner (lateral) lobes; anterior lobe apically 2-cleft. *Barleria oenotheroides*

- 6b. Corolla variously colored, but when yellow, not turning dark blue-purple or blackish on drying; calyx 5-lobed, lobes homomorphic (or if heteromorphic, then not with lobes as described above), anterior lobe apically entire 7
- 7a. Cystoliths absent; anthers 1-theous; corolla lobes ascending-cochlear in bud; pollen 3-colpate. 8
- 7b. Cystoliths present; anthers 2-theous; corolla lobes contorted (left-contort) in bud; pollen otherwise. 10
- 8a. Bracts with 2 submarginal clusters of padlike nectaries (up to 16 per cluster) on abaxial surface; corolla reddish, 30–45 mm long, lateral lobes of lower lip much reduced and appearing attached to upper lip, 0.2–2.5 mm long, lower-central lobe reflexed or usually recoiled; anther thecae 3–4 mm long
Aphelandra scabra
- 8b. Bracts without submarginal clusters of padlike nectaries on abaxial surface; corolla pink, white to cream (often with greenish tinge), or yellow, 9–20 mm long, lateral lobes of lower lip neither reduced nor appearing attached to upper lip, 3.5–10 mm long, lower-central lobe not reflexed or recoiled; anther thecae 1.2–2.3 mm long. 9
- 9a. Caulescent shrubs; leaves opposite or whorled; corolla strongly zygomorphic, white to cream (often with greenish tinge) or yellow, limb not rotate; anthers at least partially exerted from mouth of corolla
Holographis
- a. Leaves opposite; abaxial surface of bracts and bracteoles glabrous; corolla white to cream (often with greenish tinge), 9–12 mm long, externally glabrous; seeds papillose with both minute and larger rounded papillae H. tamaulipica*
- a'. Leaves usually whorled (rarely opposite on some shoots); abaxial surface of bracts and bracteoles pubescent; corolla yellow, 12–20 mm long, externally pubescent; seeds ± smooth H. ehrenbergiana*
- 9b. Acaulescent (to subcaulescent) perennial herbs; leaves in a basal cluster; corolla subactinomorphic, pinkish, limb ± rotate; anthers included in corolla tube*Stenandrium dulce*
- 10a. Thecae basally awned or mucronate; pollen 3-colporate, mesocolpia multi-striate with pseudoclopi
Dyschoriste
- a. Glandular trichomes present on some or all of the following: young stems and leaves, bracteoles, calyx, and external surface of corolla. D. hirsutissima*
- a'. Glandular trichomes absent b*
- b. Plants erect, up to 1 m or more tall; leaves ovate to elliptic, not conduplicate (17–) 25–110 mm long, 8–50 mm wide D. quadrangularis*
- b'. Plants mostly prostrate, decumbent, scrambling, or if erect, then up to ca. 3 dm tall; leaves linear to oblanceolate to obovate to obovate-elliptic, often conduplicate, 8–33 mm long, 1–11 (–14) mm wide c*
- c. Leaves oblanceolate to obovate to obovate-elliptic, margin crenulate-sinuate (at least distally) D. crenulata*
- c'. Leaves linear to linear-oblanceolate, margin entire d*
- d. Internodes glabrous or very sparsely pubescent with retrorse trichomes 0.1–0.2 mm long D. greenmanii*

- d'*. Internodes \pm conspicuously pubescent with flexuose to retrorse trichomes to 0.3 mm long.
 *D. schiedeana*
- 10b. Thecae lacking basal awns or mucros; pollen otherwise 11
- 11a. Plants submersed or emergent aquatics, corolla 8–16.5 mm long (septa and retinacula remaining attached to inner capsule wall at maturity), limb zygomorphic (conspicuously 2-labiate); pollen 4-colporate, mesocolpia each with 2–3 pseudocolpi *Hygrophila corymbosa*
- 11b. Plants terrestrial; corolla 20–60 mm long (or 10–20 mm long in *R. blechum*, which has septa and attached retinacula separating from inner capsule wall at maturity), limb subactinomorphic; pollen 3-porate
 *Ruellia*
- a*. Inflorescences of terminal, 4-sided, densely bracteate spikes; calyx 2.5–5 mm long; corolla 10–20 mm long, limb 4–11 mm in diameter; capsule 5.5–7 mm long, septa with attached retinacula separating from inner wall of mature capsule *R. blechum*
- a'*. Inflorescence of 1–many-flowered, sessile to long pedunculate, dichasia in leaf axils; calyx (5.5–) 7–25 mm long; corolla 21–70 mm long, limb 10–49 mm in diameter; capsule 8–29 mm long, septa with attached retinacula remaining attached to inner wall of mature capsule *b*
- b*. Leaves, bracteoles, calyx, corolla, and capsule (at least near apex) beset with conspicuous punctate glands 0.05–0.1 mm in diameter; inflorescence of sessile to subsessile (peduncles to 1 mm long) dichasia in leaf axils, dichasia 1 (–2)-flowered; capsule 8–11 mm long; seeds 4 per capsule.
 *R. hookeriana*
- b'*. Leaves, bracteoles, calyx, corolla, and capsule without conspicuous punctate glands (sparse and/or inconspicuous punctate glands 0.01–0.1 mm in diameter sometimes evident on abaxial surface of leaves of *R. simplex*); inflorescence of pedunculate (peduncles 3–90 mm long) expanded dichasia in leaf axils, dichasia mostly 3–many-flowered (distal dichasia of *R. ciliatiflora* subsessile to pedunculate in axils of reduced leaves or bracts, congested or expanded, and often forming a terminal leafy thyrse); capsule 10–29 mm long; seeds 8–22 per capsule *c*
- c*. Limb of corolla 10–25 mm in diameter; seeds with trichomes restricted to margin, forming a conspicuous marginal band *R. paniculata*
- c'*. Limb of corolla 18–49 mm in diameter; seeds with trichomes covering entire surface and margin *d*
- d*. Internodes of young stems and peduncles of dichasia pubescent with glandular and eglandular trichomes; capsule 10–22 mm long, pubescent with glandular and eglandular trichomes; seeds 8–12 per capsule *R. ciliatiflora*
- d'*. Internodes of young stems and peduncles of dichasia usually glabrous (stems sometimes pubescent with sparse eglandular trichomes and peduncles sometimes with a few scattered eglandular or glandular trichomes); capsule 20–29 mm long, glabrous or with inconspicuous glandular trichomes at apex only; seeds 16–22 per capsule *R. simplex*
- 12a. Androecium of 2 stamens and 2 staminodes. 13
- 12b. Androecium of 2 stamens and 0 staminodes 14
- 13a. Plants submersed or emergent aquatics; corolla 4.5–5.5 mm long, \pm funnellform, tube short, limb zygomorphic (conspicuously 2-labiate); capsule 5–6 mm long, distally pubescent; pollen 3–4-colporate, mesocolpia each with 3–4 pseudocolpi *Hygrophila polysperma*

- 13b. Plants terrestrial; corollas 20–45 mm long, subsalverform, tube elongate, limb subactinomorphic; capsule 10–16 mm long, glabrous; pollen 3-colporate, mesocolpia each with 2 pseudocolpi *Pseuderanthemum*
- a. Calyx 1.5–3 mm long; external surface of corolla glabrous; flowers heterostylous; leaves present during anthesis.* *P. alatum*
- a'. Calyx 3.8–9 mm long; external surface of corolla (at least throat and limb) pubescent; flowers homostylous; leaves mostly or entirely absent during anthesis (of chasmogamous flowers)* *P. praecox*
- 14a. Young stems mostly hexagonal in cross-section; inflorescence units consisting of cymes bearing 1–5 cymules, cymules consisting of 1 or more flowers subtended by an involucre of 2 or more pairs of bracteoles, the outer cymule bracteoles linear to oblanceolate to obovate to spatulate to hourglass shaped, conspicuous and larger than inner pair(s); capsules with septa and attached retinacula separating from inner capsule wall at maturity and protruding prominently from each capsule valve, mature capsule conspicuously ruptured near base of head *Dicliptera*
- a. Corolla not resupinate, red, 24–30 mm long* *D. sexangularis*
- a'. Corolla resupinate, pinkish, 15–18 mm long* *D. sumichrastii*
- 14b. Young stems mostly terete to quadrate in cross-section; inflorescence various, but not as described above, cymules not present; capsules with septa and retinacula remaining attached to inner capsule wall at maturity or retinacula separating slightly near base of head (i.e., *Henrya* and *Tetramerium*) but not protruding prominently from each capsule valve, mature capsule not or barely ruptured near base of head 15
- 15a. Upper lip of corolla rugulate (i.e., centrally enfolded into a stylar furrow); anther thecae collateral to superposed, parallel to perpendicular, usually one or both with a basal appendage (absent in *J. canbyi* and *J. leonardii*) *Justicia*
- a. Calyx 4-lobed, or if 5-lobed then lobes conspicuously unequal in length with posterior lobe up to 1/2 as long as other lobes.* *b*
- a'. Calyx 5-lobed, lobes equal or subequal in length* *c*
- b. Corolla pink, tube cylindric nearly throughout; thecae maroon, 0.8–1.3 mm long, glabrous, lacking basal appendages; pollen apertures flanked on each side by 2 rows of insulae; capsule 9–13.5 mm long; seeds 2.6–3 mm long, surfaces and margin gemmate, lacking trichomes or bristles* *J. canbyi*
- b'. Corolla greenish or yellowish white tinged with pink or maroon, tube conspicuously and abruptly expanded distally (funnelform); thecae greenish yellow, 1.2–2.5 mm long, dorsally pubescent with eglandular trichomes, lower theca with basal appendage to 1.5 mm long; pollen apertures flanked on each side by 1 row of insulae; capsule 14–20 mm long; seeds 3–4 mm long, surfaces and margin covered with subconic trichomelike barbed bristles.* *J. salviiflora*
- c. Leaves mostly crowded at nodes of new growth, sessile, linear to filiform, 0.5–2 mm wide, margin revolute; (inflorescence of sessile dichasia in leaf axils, corollas externally pubescent with eglandular trichomes only, and margins of calyx lobes neither hyaline nor discolored); Chihuahuan deserts scrub* *J. linearis*
- c'. Leaves not mostly crowded at nodes of new growth, subsessile to petiolate, lance-ovate to ovate to elliptic to broadly elliptic, 2.6–71 mm wide, margin not revolute (or if, as in *J. pacifica*, leaves sometimes sessile, linear, and 2.6 mm wide, then margin not revolute, inflorescences mostly in spikes,*

external pubescence of corollas including glandular trichomes, and margins of calyx lobes hyaline to whitish or much lighter green than remainder of calyx); various biotic communities *d*

d. Corolla orange to reddish orange, lacking colored markings, subfusiform to fusiform in bud, lower lip usually recoiled; inflorescence of spikes or panicles of spikes with bracts and bracteoles triangular to subulate, 0.9–2.2 mm long, and abaxially pubescent with eglandular trichomes only; capsule 15–21 mm long, appearing glabrous but inconspicuously pubescent with sessile to subsessile glands less than 0.05 mm long *J. leonardii*

d'. Corolla color various (if orange, as in *J. fulvicoma*, then either with additional colored markings present and/or lower lip not recoiled), obovoid to subcylindric to apically curved in bud, lower lip not recoiled; inflorescence not as described above; capsule 5–15 mm long, glabrous or pubescent with eglandular trichomes only. *e*

e. Petioles usually inconspicuously glandular on abaxial surface; bracts of axillary spikes (when present) heteromorphic (i.e., sterile bracts smaller than fertile bracts); calyx lobes with margins hyaline to whitish or much lighter green than remainder of calyx; corolla tube ± abruptly expanded several mm from base; staminal filaments pubescent with glandular trichomes; thecae greenish; seeds subglobose, surface smooth, pubescent with deciduous trichomes *J. pacifica*

e'. Petioles lacking glands on abaxial surface; bracts (when present) homomorphic; calyx lobes with margins not differentiated from remainder of calyx; corolla tube cylindric or gradually expanded distally; staminal filaments pubescent with eglandular trichomes; thecae not greenish; seeds discoid, surface appearing smooth (minutely granulate), or rugose with tubercles, lacking trichomes *f*

f. Inflorescence of dichasia in leaf axils, leaves bearing dichasia green; corolla pinkish with white markings, externally pubescent with glandular (sometimes sparse and inconspicuous) and eglandular trichomes, tube cylindric (longer than limb); thecae glabrous; capsule glabrous; pollen 2-aperturate. *J. pilosella*

f'. Inflorescence of axillary and/or terminal, densely bracteate, 4-ranked spikes, bracts entirely maroon or with some red or maroon discoloration; corolla white with maroon markings or orange sometimes with red spots, externally pubescent with eglandular trichomes only; tube gradually expanded distally (or if not or only slightly expanded distally, then not longer than limb); thecae dorsally pubescent; capsule pubescent with eglandular trichomes; pollen 3-aperturate *g*

g. Calyx 3.5–3.7 mm long; corolla 11–12 mm long, tube not or only slightly expanded distally; thecae 1.2–1.5 mm long *J. sp.*

g'. Calyx 4–7 mm long; corolla 25–38 mm long, tube gradually expanded distally; thecae 1.7–3.2 mm long *h*

h. Inflorescence drooping or nodding; corolla white (to yellowish) with maroon markings; bracts broadly ovate to ovate; dichasia alternate; seeds appearing smooth (minutely granulate) *J. brandegeana*

h'. Inflorescence erect; corolla orange (sometimes with reddish or yellowish markings); bracts lanceolate to ovate to elliptic; dichasia opposite; seeds rugose with rounded to subconic tubercles *J. fulvicoma*

15b. Upper lip of corolla not rugulate; anther thecae collateral (or slightly offset), parallel to subsagittate, lacking basal appendages 16

- 16a. Corolla (28–) 35–47 mm long, lemon yellow without colored markings, throat slightly saccate; bracts maroon (at least distally); calyx 11–25 mm long; capsule 15.5–25 mm long *Hoverdenia speciosa*
- 16b. Plants not with the above combination of characters 17
- 17a. Corolla 22–45 mm long 18
- 17b. Corolla 6.5–20 mm long 19
- 18a. Inflorescence of mostly loosely and inconspicuously bracteate unilateral spikes or racemes; bracts lanceolate to lance-subulate, 0.5–1.5 (–3.5) mm wide, often caducous; corolla red, tube gradually expanded distally. *Anisacanthus quadrifidus*
- 18b. Inflorescence of densely and conspicuously bracteate 4-sided spikes; bracts lance-ovate to ovate-elliptic to broadly ovate to subdeltate, 5–18 mm wide, persistent; corolla blue, pale purple, or pinkish, tube slender and not (or only very slightly) expanded distally *Yeatesia*
- a. Young stems pubescent with trichomes 0.05–0.2 mm long; leaf blades linear-elliptic to lanceolate to ovate, 2.8–17 mm wide; bracteoles 0.05–2 mm long; calyx 1.5–3.5 mm long; capsule 7–10 mm long, usually 2-seeded *Y. platystegia*
- a'. Young stems pubescent with trichomes 0.3–1 mm long; leaf blades ovate, 19–68 mm wide; bracteoles 9–20 mm long; calyx 5.5–10 mm long; capsule 11–14 mm long, usually 4-seeded *Y. mabryi*
- 19a. Capsule 4.2–7 mm long, retinacula separating slightly from inner wall of mature capsule; seeds 1.2–2.2 mm long; corollas cream to yellow 20
- 19b. Capsule 7–12 (–16) mm long, retinacula remaining attached to inner wall of mature capsule; seeds 3.5–5 (–5.8) mm long; corolla white, blue, or purplish 21
- 20a. Bracteoles fused along one side from base to apex forming a conspicuous floral involucre; inflorescence neither densely bracteate nor 4-ranked; bracts shorter than bracteoles; seeds 2, pubescent on one side with stiff interwoven hygroscopic trichomes; pollen with colpi broad, far exceeding width of centrally positioned ora *Henrya insularis*
- 20b. Bracteoles fused, if at all, only at base up to 1 mm, not forming a floral involucre; inflorescence densely bracteate and 4-ranked; bracts longer than bracteoles; seeds 4, lacking trichomes; pollen with colpi narrow, not or barely exceeding width of centrally positioned ora. *Tetramerium nervosum*
- 21a. Flowers nototribic (i.e., with stamens closer to upper lip and anthers dehiscing toward lower lip of corolla); corollas blue to purplish, concolorous or with white markings on lower lip, lacking yellow, maroon, or darker purple markings; style curved downward near apex; densely branched, woody shrubs . . . *Mirandea*
- a. Bracts linear to oblanceolate, 8–16 (–20) mm long; calyx 5–7 mm long; style glabrous; capsule glabrous; Tamaulipan thornscrub *M. andradenia*
- a'. Bracts lanceolate to subulate, 3.5–8 mm long; calyx 3.5–4 mm long; style pubescent; capsule pubescent; Chihuahuan desertscrub *M. grisea*
- 21b. Flowers stenotribic (i.e., with stamens closer to lower lip and anthers dehiscing toward upper lip of corolla); corolla white (with or without colored markings) or blue to purplish (with yellow + maroon or darker blue/purplish + white markings); style straight near apex; mostly perennial herbs or if shrubby, then ± loosely branched. *Carlowrightia*
- a. Corolla white, lacking colored marking, subactinomorphic; seeds 2, prominently tuberculate on

- concave side and papillose on convex side, additional seeds (if present) thinner, partially folded, and with exaggerated marginal teeth.* *C. albiflora*
- a'. Corolla blue to purplish, or if white, then with colored markings on upper lip, zygomorphic (or sometimes \pm subactinomorphic in *C. parviflora*); seeds usually 4 and homomorphic b
- b. Young stems bisulcate; corolla blue with white and darker blue/purplish markings on upper lip, lower-central lobe usually not prominently keel-like and enclosing stamens and style; anthers golden yellow c
- b'. Young stems terete to quadrate (and sometimes also multi-striate); corolla white with colored markings, or if blue-purple then with a yellow eye streaked with purple veins on upper lip, lower lip prominently keel-like and usually enclosing stamens and style; anthers maroon d
- c. Internodes pubescent with trichomes to 1.5 mm long; leaves cordate, margins not revolute, evenly hirsute-ciliate; capsule 10.5–11.5 mm long, pubescent, seeds 4–4.8 mm long *C. hapalocarpa*
- c'. Internodes pubescent with retrorse trichomes to 0.2 (–0.4) mm long or glabrous; leaves linear to lanceolate to ovate, margins revolute, hirsute-ciliate only near base, if at all; capsule 8–10.5 mm long, glabrous; seeds 3–4 mm long *C. parviflora*
- d. Capsule pubescent *C. trichocarpa*
- d'. Capsule glabrous e
- e. Corolla white with yellow and maroon markings on upper lip, 15–20 mm long; capsule 10–16 mm long. *C. neesiana*
- e'. Corolla blue-purple with yellow and darker purplish markings on upper lip, 9–12 mm long; capsule 7–9.5 mm long *C. henricksonii*

CATALOG OF SPECIES

***Anisacanthus quadrifidus* (Vahl) Nees**

PHENOLOGY.— Flowering: May–October; fruiting: May–September.

DISTRIBUTION.— U.S.A. (Tex.), Mexico (Ags., Coah., Gto., Hgo., Jal., Méx., N.L., Oax., Pue., Qro., S.L.P., Tamps., Ver., Zac.).

HABITAT.— “Matorral alto subinermé,” mesophytic montane forest transitioning to low forest, pine-oak forest, mixed conifer forest, pine forest, sometimes on limestone.

ELEVATION.— 320–2000 meters.

NOTES.— Plants from Tamaulipas pertain to *A. quadrifidus* var. *potosinus* Henrickson and var. *wrightii* (Torr.) Henrickson. Henrickson (1986) discussed and described this species (Fig. 1A), its infraspecific taxa, and intermediates among the varieties recognized. Synonyms of *A. quadrifidus* include *A. wrightii* (Torr.) A. Gray.

REPRESENTATIVE SPECIMENS.— La Vegonia, vic. of San José, *H. Bartlett 10526* (DS, F, LL, US); Sierra de San Carlos, La Tamaulipeca, vic. of San Miguel, *H. Bartlett 10670* (F, US); 16 km NW of Mex. 101 at Palmillas, on rd. to Miquihuana, *D. Breedlove & B. Anderson 63412* (CAS); 33 km N of Tula along Mex. 101, *D. Breedlove & B. Anderson 63595* (CAS); Mpio. Miquihuana: Cañón del Soldado, *J. Galarza 3* (MEXU-image, MO), *M. Yañez 914* (MO); Mpio. Victoria, KM 1 Cañón del Novillo, *L. García-Morales 1572* (ITCV); Mpio. Victoria, Libramiento Naciones Unidas, N de Cd. Victoria, *L. García-Morales 2546* (ITCV); Mpio. Jaumave, KM 18 camino La

Florida—Ávila y Urbina, *L. García-Morales* 3460 (ITCV); ca. 27 air km WNW of Jaumave, 25–35 km SW of Miquihuana on rd. to Hwy. 70, ca. 23°22'N, 099°36'W, *J. Henrickson & W. Hess* 19252 (TEX); ca. 9 air mi NW of Miquihuana, 3 mi N of pueblo Servando Canales, 23°39'N, 099°52'W, *J. Henrickson & V. Heuvel* 22448 (TEX); Mpio. Victoria, Cañón de la Libertad, 10 km W del Ejido La Libertad, *L. Hernández* 1980 (MO); Mpio. Jaumave, Ejido La Reforma al N de Jaumave, *L. Hernández* 2151 (MEXU-image, TEX, UAT); Mpio. Bustamante, 1 km sobre la brecha hacia Bustamante saliendo del KM 79 Tula–Victoria, *M. Martínez* 1307 (MEXU-image, MO, UAT); Mpio. San Nicolás, 1.5 km N de Flechadores, 24°30'58"N, 098°40'32.5"W, *M. Martínez* 4254 (MEXU-image, UAT); Mpio. Guemes, 3 km NE de Los San Pedro, *F. Medrano et al.* 17573 (ASU, MEXU); vic. of Victoria, *E. Palmer* 120 (F, K, MO, UC, US); rd. above Cd. Victoria (west) toward Jaumave, *A. Sharp et al.* 52026 (CAS); 12 km NW of Palmillas on rd. to Miquihuana, 23°35'N, 099°38'W, *L. Stanford et al.* 929 (DS, MO); 0.5 mi S of Huizachal, *L. Stanford et al.* 2178 (DS, UC, US).

Aphelandra scabra (Vahl) Sm.

PHENOLOGY.— Flowering: September–November; fruiting: March.

DISTRIBUTION.— Mexico (Camp., Chis., Gro., Oax., Pue., Q.R., Tab., Tamps., Ver., Yuc.), Central America, South America.

HABITAT.— Tropical deciduous forest, tropical subdeciduous forest, sometimes on limestone.

ELEVATION.— 140–600 meters.

NOTES.— Daniel (1991, 1995) provided descriptions of this species (Fig. 1B), which reaches the northeasternmost extent of its distribution in Tamaulipas. Synonyms include *A. deppeana* Schltdl. & Cham.

REPRESENTATIVE SPECIMENS.— Mpio. Gómez Farías, Rancho El Cielito, 3 km SW del Encino, 23°07'N, 099°08'W, *L. Hernández* 3002 (MEXU-image, XAL); Mpio. Gómez Farías, 4–5 km NW de Gómez Farías, *F. Medrano et al.* 3623 (MEXU); Mpio. Llera, Reserva de la Biósfera El Cielo, nacimiento del Río Sabinas, Ejido La Libertad, *A. Mora-Olivo et al.* 7614 (UAT); near Gómez Farías, ca. 0.5 mi N on rd. to Aguacates, *A. Richardson* 946 (TEX); Mpio. Gómez Farías, 3 km W de Gómez Farías, *A. Valiente B. et al.* 320 (ASU, MEXU).

Avicennia germinans (L.) L.

PHENOLOGY.— Flowering: June–July; fruiting: August–November.

DISTRIBUTION.— U.S.A. (Fla., La., Miss., Tex.), Mexico (B.C., B.C.S., Camp., Col., Chis., Gro., Jal., Mich., Nay., Oax., Q.R., Sin., Son., Tab., Tamps., Ver., Yuc.), Bermuda, West Indies, Central America, South America, Africa.

HABITAT.— Mangal (mangrove swamps), salt marshes, coastal dunes.

ELEVATION.— 0–15 meters.

NOTES.— Daniel (2016) provided a description of this species (Fig. 1C). The synonym *A. nitida* Jacq. has sometimes been applied to Mexican plants.

REPRESENTATIVE SPECIMENS.— Mpio. Altamira, Barra de Chavarría S, entrada por el Barranco, *E. de Dunas* 743 (XAL); 1 km W de La Pesca, cerca de la Laguna Blanca, *L. Hernández* 1567 (MEXU); Mpio. Matamoros, delta del Río Bravo, 25°56'56"N, 097°09'07"W, *D. Infante & J. Vázquez* 656 (XAL); Mpio. Aldama, Rancho Nuevo, 23°08'12"N, 097°46'01"W, *D. Infante et al.* 445 (XAL); Mpio. Soto la Marina, campamento totugero La Pesca, 23°47'27"N, 97°44'12"W, *E. Martínez* 39316 (MEXU); Mpio. Altamira, playa cerca del Puerto Industrial, *A. Mora-Olivo & J. Mora-López* 5450 (MEXU, UAT); Mpio. Altamira/Aldama, Barra de Chavarría, *P. Moreno C. et al.* 743 (MEXU); vic. of Tampico, *E. Palmer* 484 (CAS F, K, NY, US).

***Barleria oenotheroides* Dum. Cours.**

PHENOLOGY.— Flowering: November–December; fruiting: April.

DISTRIBUTION.— Mexico (Camp., Chis., Col., Dur., Gro., Jal., Méx., Mich., Mor., Nay., Oax., Q.R., S.L.P., Sin., Tab., Tamps., Ver., Yuc.), Central America, South America, Africa.

HABITAT.— Tropical subdeciduous forest.

ELEVATION.— 250–400 meters.

NOTES.— A description of *Barleria oenotheroides* was provided by Daniel (1995). Plants reach their northernmost occurrence in eastern Mexico in Tamaulipas. Neotropical plants were previously known as *B. micans* Nees. The yellow corollas (Fig. 1D) turn purplish upon drying.

REPRESENTATIVE SPECIMENS.— Mpio. Ocampo, 3 km W de Chamal Viejo, *M. Martínez 588* (TEX); Mpio. Gómez Farias, 2.5 km SW del Ejido El Nacimiento, cruzando el Río Frio y subiendo la sierra, 22°58.7'N, 099°09.2'W, *A. Mora-Olivo 7768* (BRIT, UAT).

***Carlowrightia albiflora* T.F. Daniel**

PHENOLOGY.— Flowering: April, July–September; fruiting: July–September.

DISTRIBUTION.— Mexico (Tamps.).

HABITAT.— Thornscrub.

ELEVATION.— 300–710 meters.

NOTES.— Daniel (1983a) provided a description of *Carlowrightia albiflora* (Fig. 1E), which is endemic to Tamaulipas. With an EOO of 4,964 km² and an AOO of 24 km², this species could potentially be assessed as Endangered (EN) if threats and their impacts were to be identified (IUCN 2019).

REPRESENTATIVE SPECIMENS.— Sierra de San Carlos, vic. of San Miguel, Cerro de la Tamau-
lipeca, [24.625857°, -98.987272°], *H. Bartlett 10558* (F, MICH, US); along hwy. between
González and Est. Zaragoza, 1.4 mi SE of turnoff to Est. Zaragoza, [23.171058°, -98.770128°], *T.*
Daniel 276 (holotype: MICH!; isotypes: CAS!, ENCB!, F!, GH!, MEXU!, MO!, NY!, TEX!, UC!,
US!), *810* (ARIZ, ASU, CHAPA, DUKE, INIF, LA, MICH, MSC, NCU); 2.8 mi S of San Carlos
along Hwy. 89, [24.554275°, -98.909418°], *T. Daniel 282* (ENCB, GH, MICH, US); along Hwy.
101 S of Victoria, 2.8 mi N of La Maroma, [23.550998°, -99.343397°], *T. Daniel 284* (MICH);
along Hwy. 101, 9.4 mi NNE of Jaumave, [23.544405°, -99.342086°], *T. Daniel & M. Baker 3695*
(ASU); Mpio. Jaumave, 3 km N de San Antonio, [23.612074°, -99.343611°], *L. García-Morales*
5380 (ITCV).

***Carlowrightia hapalocarpa* B.L. Rob. & Greenm.**

PHENOLOGY.— Flowering: August; fruiting: unknown.

DISTRIBUTION.— Mexico (S.L.P., Tamps.).

HABITAT.— Oak-pine forest.

ELEVATION.— 1250–1450 meters.

NOTES.— This is the first documented occurrence of *Carlowrightia hapalocarpa* (Fig. 1I) in Tamaulipas. Daniel (1983a) provided a description of this species, which otherwise occurs in arid and semi-arid regions of central San Luis Potosí.

REPRESENTATIVE SPECIMENS.— Mpio. Jaumave, 18 km N de La Florida, rumbo a Ávila y Urbina, *L. García-Morales 3452* (ITCV); 7 km N de La Florida a Magdalena Águilar, *L. García-Morales s.n.* (ITCV).

Carlowrightia henricksonii T.F. Daniel

PHENOLOGY.— Flowering: April–September; fruiting: April–September.

DISTRIBUTION.— Mexico (Tamps.).

HABITAT.— Sandy prairies, sometimes on limestone.

ELEVATION.— 160–175 meters.

NOTES.— Daniel (1983a) provided a description of this rare species, which is endemic to Tamaulipas. The species is known from only three collections. The whereabouts of Wooton’s collection locality has not been determined, and thus an EOO cannot be determined. Depending on the location of Wooton’s collection, an AOO of either 8 or 12 km² is likely for the species. A potential conservation assessment of either critically endangered (CR) or endangered (EN) would be likely if threats and their impacts to the species were to be identified (IUCN 2019).

REPRESENTATIVE SPECIMENS.— 3 mi W of Morales and 19 mi E of Matamoros–Victoria Hwy. on rd. to Loreto, [24.332986°, -98.105904°], *M. Johnston & J. Crutchfield 5357* (holotype: US!; isotypes: MICH!, TEX!); 20 mi E of San Fernando–Santander Jiménez hwy., 11 mi W of Loreto, [24.326538°, -98.136530°], *M. Johnston & J. Crutchfield 5528B* (TEX, US); Buena Vista Hda., *E. Wooton s.n.* (US).

Carlowrightia neesiana (Schauer ex Nees) T.F. Daniel

PHENOLOGY.— Flowering: March–December; fruiting: March–June, September–November.

DISTRIBUTION.— Mexico (Ags., Dur., Gro., Gto., Hgo., Jal., Mich., Mor., N.L., Oax., Pue., Qro., S.L.P., Tamps.).

HABITAT.— Thornscrub, desertscrub, sometimes on limestone

ELEVATION.— 900–1250 meters.

NOTES.— Daniel (1983a, as *C. glandulosa* B.L. Rob. & Greenm.) and Daniel and Acosta C. (2003) provided descriptions of this species (Fig. 1H).

REPRESENTATIVE SPECIMENS.— Mpio. Jaumave, Balcón del Chihue, carr. Victoria–Jaumave, *L. García-Morales 824* (ITCV); 825 (ITCV); Mpio. Victoria, Ejido Sierra Madre, *L. García-Morales 201* (ITCV); Mpio. Victoria, 3.5 km ENE de El Huizachal, *L. García-Morales 2423* (ITCV); Mpio. Victoria, 3 km ENE de El Huizachal, *L. García-Morales 2482* (ITCV); Mpio. Miquihuana, 1 km S de Altamira, *L. García-Morales 3304b* (ITCV); Mpio. Jaumave, 7 km N de Magdaleno Águilar (Santiagoullo), *F. Medrano et al. 9798* (MEXU); Mpio. Tula, 5 km E de la Y que va a Mamaleón, 23°06.895’N 99°44.385’W, *A. Mora-Olivo et al. 5064* (XAL, UAT); La Mula, S of Victoria, *R. Runyon 769* (TEX, US); mountains near La Jolla Ranch, *R. Runyon 1026* (TEX, US); barranca near Jaumave, *H. von Rozynski 239* (A, F, MICH, UC); near Nogales, *H. von Rozynski 730* (F); Sierra Madre Oriental, 15 mi SW of Cd. Victoria, *G. Webster et al. 11236* (CAS).

Carlowrightia parviflora (Buckl.) Wassh.

PHENOLOGY.— Flowering: January–February, July–December; fruiting: July–December.

DISTRIBUTION.— USA (Tex.), Mexico (Ags., Coah., Dur., Gto., Hgo., N.L., Qro., S.L.P., Tamps.).

HABITAT.— Thornscrub, sometimes on limestone.

ELEVATION.— 180–940 meters.

NOTES.— Daniel (1983a) and Daniel and Acosta C. (2003) provided descriptions of this species (Fig. 1G). Plants with narrow, linear (vs. lanceolate to ovate) leaves, have sometimes been referred to *C. lindauiana* Standl., but are not currently recognized as a distinct taxon; both “leaf forms” occur in Tamaulipas. A white-flowered form of the species (Fig. 1J) is uncommon in portions of its geographic range, including Tamaulipas.

REPRESENTATIVE SPECIMENS.— Cerro Tres Vetas, vic. of San José, *H. Bartlett 10380* (F, MICH); along Hwy. 180, 10 mi S of jct. Hwy. 101 at La Coma, *L. Brown & L. Lowrey 13267* (CAS); along Hwy. 85 between Monterrey and Cd. Mante, 30 mi S of Cd. Victoria, 54 mi N of Cd. Mante, 23°25'N, 099°00'W, *T. Croat & D. Hannon 62924* (MEXU-image); along Hwy. 101, 30.2 mi NNE of Jaumave, *T. Daniel & M. Baker 3701* (ASU, CAS, MEXU, MICH, NY, US); La Minita, E of Las Yucas in the Sierra de Tamaulipas, ca. 40 km NNW of Aldama, *R. Dressler 2099* (GH, MO); near Paso Lajas in the Sierra de Tamaulipas, ca. 40 km NNW of Aldama, *R. Dressler 2329* (GH, MICH, MO); Mpio. Victoria, Bosque Urbano, S de Cd. Victoria, *L. García-Morales 2617* (ITCV); 2 km N de Santuario del Caminero, rumbo a Victoria, *L. García-Morales 4888* (ITCV); 1.5 km N de Santuario del Caminero, rumbo a Victoria, *L. García-Morales 4936* (ITCV); Mpio. Villagrán, 2 km E de Ejido Guadalupe de San Lázaro, *L. García-Morales s.n.* (ITCV); 4 mi NE of Rancho Guadalupe and 2 mi SW of Rancho Buenos Aires, *M. Johnston & J. Graham 4266A* (TEX); 7 mi S of Soto la Marina on rd. to Aldama, *M. Johnston & J. Crutchfield 4967A* (TEX, US); 5 mi NE of Padilla and 1 mi N on rd. to San Carlos, *M. Johnston & J. Crutchfield 4991* (TEX); 13 mi E of the San Fernando–Santander Jiménez Hwy. on rd. to Loreto, *M. Johnston & J. Crutchfield 5590* (TEX, US); N of San Fernando, *J. Rose & P. Russell 24312* (US).

Carlowrightia trichocarpa T.F. Daniel

PHENOLOGY.— Flowering: April, June–December; fruiting: July–October.

DISTRIBUTION.— Mexico (Tamps.).

HABITAT.— Tropical deciduous forest, thornscrub, disturbed sites, sometimes on limestone.

ELEVATION.— 150–1100 meters.

NOTES.— Daniel (1983a) provided a description of *Carlowrightia trichocarpa* (Fig. 1F), which is endemic to Tamaulipas. With an EOO of 18,240 km² and an AOO of 64 km², this species could potentially be assessed as either vulnerable (VU) or endangered (EN) if threats and their impacts were to be identified (IUCN 2019).

REPRESENTATIVE SPECIMENS.— Sierra de San Carlos, Cerro Parreña, vic. of San José, [ca. 24.602092°, -98.822104°], *H. Bartlett 10304* (F, MICH); Sierra de San Carlos, Cerro Tres Vetas, vic. of San José, *H. Bartlett 10377* (F, MICH); Sierra de Tamaulipas, lower slopes of Cerro El Platero above Rancho El Platero, 0.5 mi S of Ejido El Higuierón, [23.333333°, -98.166667°], *T. Daniel 260* (holotype: MICH!; isotypes: CAS!, ENCB!, F!, GH!, K!, MEXU!, MO!, NY!, TEX!, UC!, US!); along rd. between González and Ejido Progreso, 4.6 mi N of RR station in González, [22.892284°, -98.411051°], *T. Daniel 273* (ARIZ, DUKE, GH, INIF, LA, MICH, MSC, NCU); along hwy. between González and Est. Zaragoza, 1.4 mi S of turnoff to Est. Zaragoza, [23.171058°, -98.770128°], *T. Daniel 275* (MICH); along Hwy. 89 between San Carlos and Hwy. 101, 0.7 mi N of Hwy. 101, [24.050000°, -98.716667°], *T. Daniel 278* (MICH); 2.8 mi S of San Carlos along Hwy. 89, [24.554275°, -98.909418°], *T. Daniel 279* (MICH); 0.6 mi E of Hwy. 101, 16.5 mi NE of La Presita, [ca. 23.336868°, -99.540352°], *T. Daniel 285* (ASU, CAS, ENCB, MEXU, MICH, PH, US, WIS); along Hwy. 85 S of Victoria, 7.2 mi N of jct. Hwy. 85 and hwy. to González, [23.406637°, -98.988268°], *T. Daniel 321* (ENCB, F, MICH, TEX); 1.4 mi E Hwy. 101 in Jiménez, [24.230414°, -98.455399°], *T. Daniel 791* (ENCB, MICH); along rd. between Abasolo and Soto la Marina, 6.2 mi NW Hwy. 180, [23.837016°, -98.177386°], *T. Daniel 806* (CAS, ENCB, F, GH, MICH, NY, TEX, UC, US); along Mex. 101, S of Cd. Victoria, 1.3 mi S of bridge over Río San Marcos, [23.695263°, -99.193302°], *T. Daniel & M. Baker 3692* (CAS); La Minita, E of Rancho Las Yucas, ca. 40 mi NNW of Aldama, [ca. 23.473974°, -98.221107°], *R. Dressler 2096* (GH); Mpio. Victoria, Bosque Urbano, S de Cd. Victoria, [23.725745°, -99.119182°], *L. García-Morales 2002* (ITCV); Mpio. Victoria, Calle 8 Aldama, Centro de Cd. Victoria, *L. García-Morales 2896*

(ITCV), *L. García-Morales* 5594 (ITCV); Mpio. Villagrán, Ejido Guadalupe de San Lázaro, [24.600850°, -99.227291°], *L. García-Morales s.n.* (ITCV); Mpio. Villagrán, Rancho 3 de Marzo, *L. García-Morales s.n.* (ITCV); 1 mi E of Ejido San Lázaro, [24.583333°, -99.216667°], *M. Johnston & J. Graham* 4278 (TEX, US); 13 mi S of Victoria toward Mante, [23.557528°, -99.019410°], *M. Johnston & J. Graham* 4399 (MICH, TEX, US); 2 mi S of San Carlos on rd. to Padilla, [24.562848°, -98.913733°], *M. Johnston & J. Crutchfield* 5001A (TEX); near Tropic of Cancer, *L. Kenoyer & H. Crum* 3459 (A); vic. of Victoria, *E. Palmer* 434 (F, GH, NY, US).

***Dicliptera sexangularis* (L.) Juss.**

PHENOLOGY.— Flowering: January–April; fruiting: February–April.

DISTRIBUTION.— U.S.A. (Fla., Tex.), Mexico (Camp., Chis., Hgo., Oax., Pue., Qro., Q.R., S.L.P., Tamps., Ver., Yuc.), West Indies, Central America, South America.

HABITAT.— Thornscrub, mesquite scrub with *Sabal mexicana*, tropical subdeciduous forest, riparian vegetation, disturbed sites.

ELEVATION.— 5–240 meters.

NOTES.— Daniel (1995) and Daniel and Acosta C. (2003) provided descriptions of this species (Fig. 1K).

REPRESENTATIVE SPECIMENS.— Along Rte. 85, ca. 4–5 mi S of Cd. Mante, *R. King* 3794 (F, MICH, UC, US); San José, *H. LeSueur* 445 (ARIZ, US); Mpio. Nuevo Morelos, 25 km N de Nuevo Morelos, Rancho San Juanito, *F. Medrano* 12167 (MEXU); Mpio. González: Rancho Los Berlajes, presa, *A. Mora-Olivo* 7373 (UAT); Mpio. González, 3 km NW de Estación Manuel, 22°45'27"N, 098°21'10"W, *A. Mora-Olivo* 7392 (UAT); Mpio. Jiménez, N.C.P. José Silva Sánchez, carr. Jiménez–Matamoros, 29°15'40"N, 098°28'13"W, *A. Mora-Olivo et al.* 6840 (UAT); Mpio. Soto la Marina, Mex. Hwy. 180, 3.5 km S of “Lavaderos,” at Tropic of Cancer monument, *M. Nee* 20061 (XAL); vic. of Tampico, *E. Palmer* 93 (CAS, GH, US); Manuel, *H. Puig* 3716 (MEXU); Tampico, *H. Viereck* 1082 (US); Mpio. Tampico, Marisma El Moralillo, 5 km sobre carr. a Tamos, 22°14'N, 097°54'W, *A. Vovides & G. Pattison* 762 (XAL).

***Dicliptera sumichrastii* Lindau**

PHENOLOGY.— Flowering: February–March, August–September, December; fruiting: March, September.

DISTRIBUTION.— Mexico (Oax., Pue., S.L.P., Tamps., Ver.), Central America.

HABITAT.— Oak woodland, grassland.

ELEVATION.— 270–900 meters.

NOTES.— This represents the first report of this species (Fig. 1L) from Tamaulipas, where it attains the northern extent of its distribution. Plants occurring in the state are part of a species complex consisting of *D. brachiata* (Pursh) Spreng. from the southern U.S.A. and Nuevo León (Daniel, in press), plants occurring in eastern and southern Mexico and treated as either *D. acuminata* (Ruiz & Pav.) Juss. var. *spicata* Nees or *D. sumichrastii* (the types of both are from Veracruz), plants treated in Central America as *D. antidysenterica* A. Molina R. (Daniel 2005, 2010), *D. acuminata* from western South America, and probably other New World taxa as well. Specimens cited below show characteristics somewhat intermediate between extremes of *D. brachiata* and *D. sumichrastii*, but conform more closely to the latter species. The taxonomy of these entities remains to be satisfactorily resolved.

REPRESENTATIVE SPECIMENS.— Vic. of El Milagro, Cerro Zamora, *H. Bartlett* 11152 (DS, US); Mpio. Victoria, Cañón de La Peregrina, ca. 13 km W de Ejido La Libertad, *L. García-Morales*

4180 (ITCV); Mpio. Villa de Casas, Sierra de Tamaulipas, from Rancho "Las Yucas" to Santa María de los Nogales and Hac. Acuna, from Cerro de San Juan to Santa María de los Nogales, *F. Martinez M. & G. Borja L. F-1982* (TEX); Mpio. Soto la Marina, Cañón del Diablo, *H. Puig 4150* (P).

***Dyschoriste crenulata* Kobuski**

PHENOLOGY.— Flowering: February–July, October; fruiting: July, October.

DISTRIBUTION.— U.S.A. (Tex.), Mexico (Coah., Tamps.).

HABITAT.— Thornscrub, disturbed sites, sometimes on limestone.

ELEVATION.— 120–350 meters.

NOTES.— Henrickson (1999) provided a description, discussed the taxonomy, and mapped the distribution of this species (Fig. 2A). The type of *D. crenulata* (*Nelson 6604*) is from Tamaulipas.

REPRESENTATIVE SPECIMENS.— Sierra de San Carlos, La Tamaulipeca, vic. of San Miguel, *H. Bartlett 10646* (F); along Hwy. 81 between González and Hwy. 85, 38.1 mi SE of jct. Hwy. 85, *T. Daniel & B. Bartholomew 5084* (CAS); between Victoria and Antiguo, *G. Happ 37* (MO); Mpio. Abasolo, Carr. 80, KM 232 Tampico–Matamoros, tramo Soto la Marina a La Coma, Ejido Los Morales, "La Labor," 7 km NE de Los Morales, 24°23'08"N, 098°21'02"W, *M. González G. 213* (MEXU); 48 mi from Reynosa on San Fernando rd., 27 mi from Matamoros–San Fernando hwy. turnoff, *M. Johnston & J. Graham 4382* (TEX, US); San Fernando to Jiménez [Santander Jiménez], *E. Nelson 6604* (holotype: GH-image!; isotype: US-image!); 20 mi W of Reynosa, *J. Painter & F. Barkley 14393* (MO, TEX); 3 mi N of Santander Jiménez on Rte. 101, *R. Wilbur 35266* (MEXU-image).

***Dyschoriste greenmanii* Kobuski**

PHENOLOGY.— Flowering: April–July, December; fruiting: June–December.

DISTRIBUTION.— Mexico (Coah., N.L., Tamps.).

HABITAT.— Oak woodland, oak-pine forest, often on limestone.

ELEVATION.— 150–1360 meters.

NOTES.— Henrickson (1999) provided a description, discussed the taxonomy, and mapped the distribution of this species (Fig. 2C). The type of *D. greenmanii* (*Palmer 492*) is from Tamaulipas.

REPRESENTATIVE SPECIMENS.— El Madroño, 14 mi SW of Cd. Victoria along Mex. 101 to Jau-mave, *J. Dwyer et al. 46* (MO); 6 mi N of Santander Jiménez, *M. Johnston 4899* (MEXU-image, TEX); 5 mi E of Casas on Victoria–Soto la Marina hwy., *M. Johnston & J. Crutchfield 5785c* (TEX); along Mex. 101 at KM 160, SW of Cd. Victoria, *D. Lemke 017* (TEX); Mpio. San Carlos, Sierra de San Carlos, ca. 5 mi S of San Carlos, 24°31.5'N, 098°57.6'W, *G. Nesom et al. 6094* (MEXU-image), *6132* (TEX); vic. of Victoria, *E. Palmer 492* (holotype: US-image!; isotypes: F!, GH-image!, NY-image!, US); 11 mi SW of Victoria, rd. to Huisachal, *L. Stanford et al. 1969* (DS, US); 3–5 km S of Huisachal, *L. Stanford et al. 2118* (DS, US), *2141* (US).

***Dyschoriste hirsutissima* (Nees) Kuntze**

PHENOLOGY.— Flowering: November; fruiting: unknown.

DISTRIBUTION.— Mexico (Ags., Chih., Chis., Col., Dur., Gto, Gro., Hgo., Jal., Méx., Mich., Mor., Nay., Oax., Pue., Sin., Son., Tamps., Ver., Zac.), Central America.

HABITAT.—Thornscrub.

ELEVATION.— Ca. 15–500 meters.

NOTES.— *Dyschoriste hirsutissima* (Fig. 2B) is newly documented as occurring in Tamauli-

pas, and the specimens cited below represent its northeasternmost known occurrences. Daniel (1995) and Daniel and Acosta C. (2003) provided descriptions of the species.

REPRESENTATIVE SPECIMENS.— Altamisa [Altamira] Rd., Tampico, *L. Kenoyer 864* (F); Jardín Botánico del Noreste [proposed site], Sierra Madre Occidental, ladera E de Sierra Gorda, W de Cd. Victoria, *A. McDonald 1052* (TEX).

Dyschoriste quadrangularis (Oerst.) Kuntze

PHENOLOGY.— Flowering: January, April, July–October; fruiting: September–October.

DISTRIBUTION.— Mexico (Chis., Gto., N.L., Qro., S.L.P., Tamps., Ver.), Central America .

HABITAT.— Oak forest, oak-juniper forest.

ELEVATION.— 50–1555 meters.

NOTES.— Daniel (1995) and Daniel and Acosta C. (2003) provided descriptions of this species (Fig. 2D).

REPRESENTATIVE SPECIMENS.— “Malpays de Sa. Barbara” [Ocampo], *Hb. Berlandierianum Texano-Mexicanum 2174 = 754* (GH); 19 km E of Tula on rd. to Ocampo, *D. Breedlove & B. Anderson 63645* (CAS); 13 km E of Tula on rd. to Ocampo, *D. Breedlove & B. Anderson 63705* (CAS); Mpio. Hidalgo, Puerto Purificación, *G. Hinton et al. 24842* (MEXU, TEX); 11 mi W of Victoria toward Jaumave, *M. Johnston & J. Graham 4129* (TEX); 10 mi W of Victoria, *Kenoyer & Crum 3405* (A); Tampico, *H. Viereck 1078* (US); sierra near San Lucas, Jaumave, *von Rozynski 534* (F).

Dyschoriste schiedeana (Nees) Kuntze

PHENOLOGY.— Flowering: July–August; fruiting: July–August.

DISTRIBUTION.— Mexico (Ags., Coah., Dur., Gto., Hgo., N.L., Oax., Pue., Que., S.L.P., Tamps., Ver., Zac.).

HABITAT.— Thornscrub, oak forest, sometimes on limestone.

ELEVATION.— 700–2460 meters.

NOTES.— Plants of this species (Fig. 2E) from Tamaulipas were described and treated by Henrickson (1999) as pertaining to var. *schiedeana* (Coah., Hgo., N.L., Que., S.L.P., Tamps., Ver., Zac.). Those cited below generally conform to his “Type 3” form (Coah., N.L., Tamps.) of the variety with narrow, linear to linear-oblongate, and mostly conduplicate leaves. The morphological distinctions between this taxon and *D. greenmanii* are subtle at best. In general, plants treated as *D. schiedeana* are more conspicuously pubescent throughout than are those of *D. greenmanii*. *Bartlett 10328* (F) from Cerro Tinaja near San José in the Sierra de San Carlos (850 meters) was annotated by Henrickson in 1999 as *D. poliodes* Leonard & Gentry var. *poliodes*. Henrickson (1999) did not cite this collection, and occurrences of the taxon were restricted to northern and central Nuevo León. With its flat and oblong to oblongate leaves, the identity of *Bartlett 10328* remains undetermined, but it “keys” closest to *D. schiedeana* in our key to Tamaulipan *Dyschoriste*.

REPRESENTATIVE SPECIMENS.— 6 km W de Miquihuana, *P. Hiriart et al. 883* (MEXU); near Miquihuana, 23°42'N, 099°45'W, *L. Stanford et al. 759* (DS); 11 mi W of Cd. Victoria on Hwy. 101 to San Luis Potosí, *G. Tucker 1960* (CAS); Jaumave Valley, 5 mi NE of Jaumave, 23°29'N, 099°21'W, *G. Webster & W. Armbruster 20550* (MEXU, MO).

Elytraria bromoides Oerst.

PHENOLOGY.— Flowering: January, April–October; fruiting: July–August.

DISTRIBUTION.— U.S.A. (Tex.), Mexico (Camp., Chih., Chis., Coah., Hgo., Nay., N.L., Oax., Qro., Q.R., S.L.P., Tamps., Ver., Yuc.), Central America.

HABITAT.— Tropical deciduous forest, tropical montane forest, pastures, sometimes on limestone.

ELEVATION.— 320–1372 meters.

NOTES.— Daniel (1995) and Daniel and Acosta C. (2003) provided descriptions of *E. bromoides* (Fig. 2G). The most common Neotropical species of *Elytraria*, *E. imbricata* (Vahl) Pers., might be expected to occur in Tamaulipas, but has not yet been collected there. It differs from both Tamaulipan species of the genus by its apically three-parted floral bracts and blue-purple corollas.

REPRESENTATIVE SPECIMENS.— 35 mi N of Valles, *F. Barkley 17M058* (F); Sierra de San Carlos, La Tamaulipeca, vic. of San Miguel, *H. Bartlett 10693* (DS, F, GH, MICH, US); Sierra de San Carlos, vic. of Marmolejo, La Morita, *H. Bartlett 10820* (DS, F, GH, MEXU, US); along rd. between Tula and Ocampo, 13–16 mi E of Tula, *T. Daniel 303* (CAS); along Hwy. 85, 11.2 mi NNW of El Tomaseño, *T. Daniel & M. Baker 3683* (ASU, CAS, DUKE, MEXU, MICH, NY); along Hwy. 101 S of Cd. Victoria, 1.3 mi. S of bridge over Río San Marcos, *T. Daniel & M. Baker 3690* (CAS); Mpio. Aldama, Sierra de Tamaulipas, region of Rancho Las Yucas, ca. 40 km NW of Aldama, *R. Dressler 2139* (GH); Victoria, *G. Fisher 3391* (F, GH); Mpio. Victoria, 1 km S del entronque al Cañón del Novillo, carr. Victoria–Altas Cumbres, *L. García-Morales 5473* (ITCV); Mpio. Aldama, Ejido El Nacimiento, “Pozas de la Azufrosa,” 22°59'30"N, 098°09'55"W, *M. González G. 95* (MEXU-image); Mpio. Gómez Farías, Rancho El Cielito, 3 km SW de El Encino, 23°07'N, 99°08'W, *L. Hernández 2997* (BRIT, MEXU, UAT); 13 mi S of Cd. Victoria, *C. Hitchcock & S. Stanford 6890* (DS, POM, UC, US); 0.5 mi E of Nuevo Morelos, *M. Johnston & J. Graham 4487B* (MICH); Villagrán, *C. Lundell & A. Lundell 7303* (MICH); Mpio. Victoria, partes bajas de la sierra frente a Cd. Victoria, Zona del Campamento de los Soldados, 23°45'19"N, 099°10'42"W, *A. Mora-Olivo 7464* (UAT); Mpio. Santander Jiménez, fishing camp on NE side of Lago Vicente Guerrero, 30 km SW of Santander Jiménez [29°02'42"N, 098°42'06"W], *M. Nee & G. Diggs 24441* (XAL); vic. of Victoria, *E. Palmer 402* (F, GH, K, US); Presa de la Purificación, 7 mi N of Padilla, *Shutt & Drawe 35* (SMU); on rd. to El Huisachal, 11 mi SW of Victoria, *L. Stanford et al. 1971* (DS, G, NCU, RSA, U, UC, US); KM 6 Lib. a S.L.P. al Pie de la Sierra, Cd. Victoria, *O. Valladares R. 158* (ENCB); Sierra Madre Oriental, ca. 12 mi SW of Cd. Victoria, *G. Webster et al. 11256* (DAV); Buena Vista Hda., *E. Wooton s.n.* (US).

Elytraria macrophylla Leonard

PHENOLOGY.— Flowering: July; fruiting: July.

DISTRIBUTION.— Mexico (Hgo., Qro., S.L.P., Tamps.).

HABITAT.— Tropical deciduous forest.

ELEVATION.— 200–420 meters.

NOTES.— Daniel and Acosta C. (2003) provided a description of this uncommon species, which is rare in Tamaulipas. The lemon yellow flowers (Fig. 2F) turn whitish with age.

REPRESENTATIVE SPECIMENS.— Mpio. Aldama, Sierra de Tamaulipas, Las Yucas (ca. 23° 14'N, 98°10'W), *R. Dressler 2018* (GH, MO, US); Mpio. Villa de Casas, Cañón del Diablo, *H. Puig 454* (ENCB).

Henrya insularis Nees ex Benth.

PHENOLOGY.— Flowering: October–April; fruiting: October–April.

DISTRIBUTION.— U.S.A. (Ariz.), Mexico (Ags., B.C.S., Chih., Chis., Col., Dur., Gro., Gto.,

Jal., Méx., Mich., Mor., Nay., Oax., Pue., Qro., S.L.P., Sin., Son., Tamps., Ver., Yuc., Zac.), Central America.

HABITAT.— Thornscrub, tropical deciduous forest, tropical subdeciduous forest, mesophytic montane forest, disturbed sites.

ELEVATION.— 150–650 meters.

NOTES.— Daniel (1990) provided a description of this species and discussed morphological variation throughout its geographic range. *Henrya insularis* varies in the position of the mucros on the partially fused bracteoles, and in the color and markings of corollas. Most plants from Tamaulipas are noted to have yellowish corollas (Fig. 2H).

REPRESENTATIVE SPECIMENS.— Ca. 50 mi N of Valles, *F. Barkley 17M277* (TEX); Sierra de Tamaulipas, Ejido Las Yucas, ca. 40 km NNW of Aldama, ca. 21°14'N, 098°10'W, *R. Dressler 2426* (GH, MEXU, MICH, MO); Julillo to Río Sabinas, N of Mante, *J. Duke M3606* (MO); pass above El Abra, ca. 11 mi S of Cd. Mante, *P. Fryxell & R. Magill 2267* (CAS, ENCB, MICH, MO); Mpio. Aldama, Ejido El Nacimiento, “Pozas de la Azufrosa,” 22°29'30"N, 098°09'55"W, *M. González G. 57* (MEXU-image), *63* (MEXU-image); Mpio. Gómez Farías, 500 m N del entronque a Ojo de Agua, *L. García-Morales s.n.* (ITCV); Mpio. Villagrán, Rancho 3 de Marzo, *L. García-Morales s.n.* (ITCV); Mpio. Xicotécatl, 1 km E de El Azteca, *L. García-Morales s.n.* (ITCV); Mpio. Mante, Cueva del Abra, 20 km S de Cd. Mante, *L. Hernández 1614* (MEXU-image); Rancho Buenos Aries, outskirts of Ocampo, *M. Johnston & J. Crutchfield 5189* (TEX, MICH, US); Bernal, *Karwinski 547* (LE); Mpio. Gómez Farías, La Servilleta, 4 km W de La Charca, 2 km S de Riachuelo, *M. Martínez et al. 547* (MEXU, MO); Mpio. Ocampo, 3 km W de Chamal Viejo, *M. Martínez et al. 592* (MEXU); 30 km NE de Soto la Marina, *F. Medrano 1005* (CAS); 30 km S de Soto la Marina, camino a La Pesca, *F. Medrano 1005-A* (MEXU, MO); Mpio. Ocampo, 18 km SW de Ocampo, Sierra del Chamal, *F. Medrano 3322* (MEXU-image); Mpio. Ocampo, 1 km N de Flores Magón, *F. Medrano & A. Valiente B. 12122* (ARIZ, ENCB, MEXU); Mpio. Ocampo, Reserva de la Biósfera El Cielo, Ejido El Refugio, *J. Mora-López et al. 262* (MEXU); Mpio. Ocampo, Ejido El Tigre, *J. Moreno 20* (MEXU-image); 13 mi N of González, *K. Schmidt & D. Davis s.n.* (F); Soto la Marina, *H. Viereck 1061* (US); Tampico, *H. Viereck 1087* (US); near Gómez Farías, *S. Walker 72030* (ARIZ).

Holographis ehrenbergiana Nees

PHENOLOGY.— Flowering: May–September; fruiting: August.

DISTRIBUTION.— Mexico (Gto., Hgo., Nay., N.L., Pue., Qro., S.L.P., Tamps.).

HABITAT.— Thornscrub, tropical subdeciduous forest, sometimes on limestone.

ELEVATION.— 420–1900 meters.

NOTES.— Daniel (1983b) and Daniel and Acosta C. (2003) provided descriptions of this species (Fig. 2I).

REPRESENTATIVE SPECIMENS.— Sierra de San Carlos, vic. of San Miguel, *H. Bartlett 10623* (F, MICH); Mpio. Aldama, Cerro El Platero above Rancho El Platero, 0.5 mi S of Ejido El Higuierón in Sierra de Tamaulipas, *T. Daniel 268* (MICH); along Hwy. 85 SSE of Cd. Victoria, 5.5 mi NNW of turn to San Francisco, *T. Daniel & M. Baker 3703* (CAS, K); along Hwy. 85 SSE of Cd. Victoria, 7.3 mi NNW of Tropic of Cancer, *T. Daniel & M. Baker 3712* (ASU, BR, CAS); Mpio. Miquihuana, 1 km E del entronque a San José del Llano, *L. García-Morales s.n.* (ITCV); 1 km S of Carabanchel, *Gilbert 74* (TEX); 4 km W del Ejido El Salitrillo, *P. Hiriart et al. 839* (MEXU); 28 km N de Tula, [23°16'14"N, 099°41'00"W], *P. Hiriart et al. 984* (MEXU, UAT); 1 km S of Carabanchel, *Gilbert 74* (TEX); 3 mi E of San Fernando–Santander Jiménez hwy. on rd. to Loreto, *M. Johnston & J. Crutchfield 5593* (MEXU, TEX, US); Mpio. San Fernando, 22 km E

de El Rivereño, cerca de El Temascal, *F. Medrano et al.* 2313 (MEXU); Mpio. Jaumave, 3 km NE de La Florida, *F. Medrano et al.* 9839 (MEXU); Mpio. Tula, 3 km SE de Las Cruces, *F. Medrano et al.* 10513 (MEXU); by Mex. 85, 10.6 mi N of San José and 16 mi N of ejido, *R. Kral* 27326 (MO); Buena Vista Hda., *E. Wootton s.n.* (US).

Holographis tamaulipica T.F. Daniel

PHENOLOGY.— Flowering: February–May; fruiting: May.

DISTRIBUTION.— Mexico (Tamps.).

HABITAT.— Tropical deciduous forest, oak woodland, riparian vegetation (*Myriocarpa*, *Taxodium*, *Bauhinia*, *Quercus*, *Populus*), sometimes on limestone.

ELEVATION.— 250–1470 meters.

NOTES.— Daniel (1983b) provided a description of *Holographis tamaulipica* (Fig. 2J), which is endemic to Tamaulipas. With an EOO of 6,295 km² and an AOO of 40 km² this species could potentially be assessed as either vulnerable (VU) or endangered (EN) if threats and their impacts were to be identified (IUCN 2019).

REPRESENTATIVE SPECIMENS.— Mpio. Victoria, 500 m N de Santuario del Caminero, carr. Victoria–Altas Cumbres, [23.622026°, -99.211910°], *L. García-Morales* 763 (ITCV); Mpio. Victoria, 500 m S del entronque a la Estación de Microondas Las Mulas, [23.614098°, -99.245689°], *L. García-Morales* 789 (ITCV); KM 1 Cañón del Novillo, [23.695979°, -99.197155°], *L. García-Morales* 927 (ITCV), 937 (ITCV); track from Gómez Farías to Rancho del Cielo, [ca. 23.070987°, -99.171188°], *S. Ginzburg et al.* 617 (MEXU, US); Mpio. González, 4 km S de Torrecillas [La Torrecilla], “Pico Torrecillas,” [ca.23.130106°, -98.363191°], *F. Medrano et al.* 7263 (MEXU); 12 mi from river at Victoria on rd. to Jaumave, [23.600984°, -99.226994°], *H. Moore & A. Valiente M.* 6159A (US); Mpio. Hidalgo, Río Salto del Tigre, [ca. 24.002910°, -99.344230°], *A. Mora-Olivo* 6807 (MEXU, UAT); vic. of Victoria, *E. Palmer* 135 (holotype: GH!; isotypes: F!, K!, MO!, NY!, US!); Cañón del Diablo, [ca. 23.506174°, -98.417210°], *H. Puig s.n.* (P); near Victoria, [ca. 23.738581°, -99.184440°], *R. Runyon* 754 (TEX, US); San Lucas, *Viereck* 146 (US); Mpio. Gómez Farías, NW of Gómez Farías in Sierra de Guatemala, Rancho de Cielo, [23.099896°, -99.199950°], *L. Woodruff et al.* 166 (TEX-image, MEXU).

Hoverdenia speciosa Nees

PHENOLOGY.— Flowering: February–April; fruiting: February–March.

DISTRIBUTION.— Mexico (Hgo., Qro., S.L.P., Tamps.).

HABITAT.— Thornscrub.

ELEVATION.— 20–400 meters.

NOTES.— A description of *Hoverdenia speciosa* (Fig. 2K) was provided by Daniel and Acosta C. (2003), and its phylogenetic relationships based on molecular sequence data were discussed by Kiel and McDade (2014). This uncommon species is rare in Tamaulipas, where it reaches the northern limit of its distribution.

REPRESENTATIVE SPECIMENS.— Cerca de la presa derivadora Los Alazanes (La Patria es Primero), *P. Hiriart et al.* 656 (ENCB, UAT); Mpio. Jiménez, 2 km SW de la presa Las Alanzas, *F. Medrano et al.* 2823 (MEXU); Soto la Marina, *H. Viereck* 1066 (US).

Hygrophila corymbosa (Blume) Lindau

PHENOLOGY.— Flowering: March–May, October–December; fruiting: May.

DISTRIBUTION.— Native to southeastern Asia; naturalized in Mexico (Tamps.).

HABITAT.— Riparian vegetation (irrigation canals).

ELEVATION.— 80 meters.

NOTES.— This cultivated aquatic (aquarium trade) sometimes escapes and becomes naturalized in the New World (Fig. 3A, B). The two species of *Hygrophila* in Tamaulipas appear in different sections of the key above; they can be readily distinguished from one another by the following couplet:

1a. Young stems and leaves of emergent shoots, calyces, corollas, and capsules pubescent with glandular trichomes; flowers in expanded dichasia or in thyrses (bearing expanded dichasia in axils of subfoliose bracts) in leaf axils; corollas purplish with white ridges, 8–16.5 mm long; stamens 4. . . . *H. corymbosa*

1b. Young stems, leaves, calyces, corollas, and capsules glabrous or pubescent with eglandular trichomes; flowers in terminal spikes; corollas pale lavender, 4.5–5.5 mm long; stamens 2. *H. polysperma*

REPRESENTATIVE SPECIMENS.— Mpio. El Mante, irrigation water channels, 22°44'54.25"N, 099°00'26.89"W, *A. Mora-Olivo 15620* (UAT); Mpio. El Mante, 22°43'56.66"N, 098°58'09.20"W, *L. Alvarez 121* (UAT).

***Hygrophila polysperma* (Roxb.) T. Anderson**

PHENOLOGY.— Flowering: March, December; fruiting: March, December.

DISTRIBUTION.— Native to tropical Asia; naturalized in Mexico (Tamps.).

HABITAT.— Aquatic and riparian vegetation (canals).

ELEVATION.— 10–100 meters.

NOTES.— This cultivated aquatic (aquarium trade) sometimes escapes and becomes naturalized in the New World (Fig. 3C).

REPRESENTATIVE SPECIMENS.— Mpio. Tampico, Laguna del Chairel Norte, *A. Mora-Olivo 13* (MEXU); Mpio. Tampico, Laguna del Chariel Sur, *A. Mora-Olivo 95* (MEXU), *368* (MEXU); Mpio. Xicoténcatl, Río Guayalejo, cerca de Xicoténcatl, *A. Mora-Olivo 485* (MEXU); Mpio. Tampico, Laguna del Chariel, Canal Americano, *A. Mora-Olivo 565* (MEXU); Mpio. Xicoténcatl, Canal Xicoténcatl, cerca de la presa, 23°01.4'N, 98°51'W, *A. Mora-Olivo 1582* (MEXU); Mpio. Mante, canales de riego a la salida de Mante rumbo a González, *A. Mora-Olivo & D. Rodríguez C. 6952* (MEXU); Mpio. Mante, Río Guayalejo, Playitas de El Limón, 22°49.5'N, 099°00.6'W, *A. Mora-Olivo & D. Rodríguez C. 6955* (MEXU); Mpio. Mante, 5 km S de El Limón en la carr. Mante–Victoria, *A. Mora-Olivo & M. Galván 7652* (MEXU); Mpio. Gómez Farías, Bocatoma II, inicio del Canal Principal Alto DR 029 Río Frio, 22°59.01'0.5"N, 099°08'47.1"W, *A. Mora-Olivo 7772* (MEXU).

***Justicia brandegeana* Washh. & L.B. Sm.**

PHENOLOGY.— Flowering: All year; fruiting: February–April.

DISTRIBUTION.— Mexico (Mor., N.L., Qro., S.L.P., Tamps.).

HABITAT.— Tropical deciduous forest, tropical subdeciduous forest, mesophytic montane forest; sometimes on limestone.

ELEVATION.— 250–1970 meters.

NOTES.— This species (Fig. 4A) is native to Mexico and widely cultivated worldwide. Daniel and Acosta C. (2003) provided a description of it. A common synonym of this species is *Beloperone guttata* Brandegee.

REPRESENTATIVE SPECIMENS.— Sierra Madre Oriental between Ocampo and Tula, NW of Cd. Mante, *L. Brown & L. Lowrey 13322* (CAS); between Tula and Ocampo, 11–13 mi E of Tula, ca. 22°59'N, 099°40'W, *T. Daniel 291* (CAS); 2 mi W of Gómez Farías toward Rancho del Cielo, *T.*

Daniel & M. Baker 3714 (ASU, CAS); near Rancho Gómez Farías, *J. Duke M3556* (MEXU-image); La Alamillosa, ca. 2 km W de Alta Cima, *L. García-Morales s.n.* (ITCV); near Victoria, *G. Happ 29* (MO); Mpio. Tula, Ejido Allende (Aniceto Medrano), 20 km de Ocampo, *L. Hernández 1403* (MO); Cañón de Galeana, *H. LeSueur 450* (US); Mpio. Gómez Farías, 3 km E del Cielo por Gómez Farías, *M. Martínez 1790* (MO); a 5 km al SE de Rancho del Cielo, camino a Gómez Farías, *E. Martínez S. et al. 3874* (MEXU, MO, XAL); Mpio. Nuevo Morelos, 3 km E de Nuevo Morelos, *F. Medrano & A. Valiente B. 12179* (ARIZ, MEXU); Mpio. Gómez Farías, Rancho del Cielo a 11 km de Gómez Farías, *F. Medrano et al. 7436* (MEXU-image); Mpio. Gómez Farías, Valle del Ovní, Rancho Viejo, 23°04'N, 089°13'W, *A. Mora-Olivo 660* (UAT); Mpio. Gómez Farías, Reserva de la Biósfera El Cielo, camino de Gómez Farías al Rancho del Cielo, *A. Mora-Olivo 2264* (UAT); vic. of Gómez Farías, *E. Palmer 332* (F, GH, K, MO, NY, UC, US); Rancho del Cielo, between gate and ranch, *A. Richardson 213* (TEX); near Gómez Farías, *A. Richardson 937* (TEX); Gómez Farías area, between El Arce and Agua del Indio, Indian Springs trail, *A. Richardson 1079* (TEX); 6 km S of Huisachal, *L. Stanford et al. 2090* (DS, UC); Gómez Farías, 23°02'N, 99°08'W, *S. Thompson et al. 1295* (CAS, F, MEXU-image, US); 3 km NW of Gómez Farías, camino a Rancho del Cielo, *R. Torres C. & H. Hernández 3109* (CAS, MEXU); Mpio. Llera de Canales, 6 km NE de El Encino, *A. Valiente B. et al. 378* (MEXU); Mpio. Gómez Farías, entre Gómez Farías y Rancho del Cielo, *F. Vázquez B. 829* (XAL); sierra near San Isidro, Jaumave, *H. von Rozynski 388* (F).

Justicia canbyi Greenm.

PHENOLOGY.— Flowering: January–August, November–December; fruiting: November–August.

DISTRIBUTION.— Mexico (Gto., Hgo., N.L., Qro., S.L.P., Tamps., Ver.).

HABITAT.— Thornscrub, tropical deciduous forest, tropical subdeciduous forest, tropical evergreen forest, usually on limestone.

ELEVATION.— 50–1750 meters.

NOTES.— Daniel and Acosta C. (2003) provided a description of *Justicia canbyi* (Fig. 4G). A syntype of it (*Nelson 6650*) is from Tamaulipas, and a common synonym is *Siphonoglossa canbyi* (Greenm.) Hilsenb.

REPRESENTATIVE SPECIMENS.— Mpio. Victoria, carr. Cd. Victoria–Cd. Tula, 7 km S de Cd. Victoria, Cañón La Escondida, *M. Cárdenas L. 11* (CAS); along Hwy. 85 between Monterrey and Cd. Mante, 30 mi S of Cd. Victoria, 54 mi N of Cd. Mante, 23°25'N, 099°00'W, *T. Croat & D. Hanon 62898* (CAS, MEXU-image); 2.8 mi S of San Carlos along Hwy. 89, ca. 24°33'N, 098°55'W, *T. Daniel 281* (CAS); 15 km N de El Carmen, camino a Puerto Purificación, *A. García M. & C. Ramos 2909* (CAS, MEXU); Mpio. Aldama, 1.2 km N de Ejido Piedras Negras, *L. García-Morales 6064* (ITCV); Mpio. Victoria, entronque al Cañón del Novillo, carr. Victoria–Altas Cumbres, *L. García-Morales 5019* (ITCV); Mpio. Victoria, 200 m N del entronque al Cañón del Novillo, carr. Victoria–Altas Cumbres, *L. García-Morales 5068* (ITCV); Ejido San Francisco, Presa La Escondida, *C. González R. 351* (XAL); 11 mi SW of Cd. Victoria on rd. to El Huisachal, *Hitchcock et al. 1984* (DS); 4 mi N of Tomaseño on Victoria–Villagrán hwy., *M. Johnston & J. Graham 4679* (US); 11 mi SW of Cd. Victoria on rd. to El Huisachal, *Lauber et al. 1984* (DS, US); Mpio. San Carlos, Sierra de San Carlos, camino al Cerro del Diente, 5 km W de San Carlos, *M. Martínez & J. Martínez 2021* (XAL); Mpio. Soto la Marina, 30 km NE de Soto la Marina, *F. Medrano 1011* (MEXU); Mpio. El Mante, 8 km SW de Cd. Mante, “El Nacimiento” del Río Mante, *F. Medrano & A. Valiente B. 12230* (MEXU); Mpio. Abasolo, Ejido Gildardo Magaña, 23°50'20"N, 098°26'44"W, *J. Mora-López 128* (MEXU, UAT); Soto la Marina, *E. Nelson 6650* (syntypes: GH-

image!, US-image!); 9 km E of Palmillas, 23°32'N, 099°27'W, *L. Stanford et al.* 953 (ARIZ, DS); sierra near San Vicente–Jaumave, *von Rozynski* 324 (F).

Justicia fulvicoma Schltdl. & Cham.

PHENOLOGY.— Flowering: June–March; fruiting: July, October–December.

DISTRIBUTION.— Mexico (Gro., Gto., Hgo., Méx., Mor., N.L., Oax., Qro., S.L.P., Tamps., Ver.).

HABITAT.— Thornscrub, tropical deciduous forest, disturbed sites, often on limestone.

ELEVATION.— 5–1750 meters.

NOTES.— Daniel and Acosta C. (2003) provided a description of *J. fulvicoma* (Fig. 4E). Synonyms of the species include *Beloperone pringlei* S. Watson, *B. comosa* Nees, and *Justicia straminea* D.N. Gibson.

REPRESENTATIVE SPECIMENS.— Sierra de San Carlos, La Tamaulipeca, vic. of San Miguel, *H. Bartlett* 10690 (F); Sierra de San Carlos, La Sardiña, *H. Bartlett* 10958 (F); Tampico, *L. Berlandier* 123 (G-DC, GZU); near San Esteban E of Aldama, *L. Brown & L. Lowrey* 13304 (CAS); Mpio. Jaumave, 1.26 km SE de Los Nogales, cañón tributario del Río Guayalejo, 23°25'40.5N, 099°15'54.7W, *P. Carrillo-Reyes & E. Piedra* 5723 (CAS); along Hwy. 85 between Cd. Mante and Cd. Valles, 12.3 mi S of Cd. Mante, 22°34'N, 099°02'W, *T. Croat & D. Hannon* 62963 (MEXU-image); along Hwy. 101, ca. 14 mi NNE of Jaumave, *T. Daniel & M. Baker* 3696 (ASU, BR, CAS, K); Quintero, *C. Diaz s.n.* (ENCB); Mpio. Aldama, Sierra de Tamaulipas, Las Yucas, ca. 40 km NNW of Aldama, ca. 23°14'N, 98°10'W, *R. Dressler* 1900 (MO); La Pesca, mouth of Río Soto de Marina, *H. Gentry* 6748 (ARIZ, DS, UC); Mpio. Jaumave, 0.5 km N de Padrón y Juárez, 23°20'N, 099°25'W, *L. Hernandez* 3203 (MEXU-image); KM 552, hwy. Mexico to Laredo, *I. Langman* 3004 (PH); San José, *H. LeSueur* 446 (ARIZ, F); Cañón de Galeana, *H. LeSueur* 450 (ARIZ, F); Mpio. Aldama, 20 km E de Aldama, *M. Martínez* 883 (MEXU); Mpio. Soto la Marina, El Tejón, 4.9 km NNW de la casa principal del Rancho Los Ebanos, 23°30'18"N, 097°47'50.4"W, *Martínez & A. Contreras* 41692 (MEXU); Mpio. Soto la Marina, 14 km N de vista Hermosa, camino a Guayabas, 23°56'06"N, 097°65'45"W, *Martínez & Ibarra* 40460 (MEXU); Mpio. Soto la Marina, 7.3 km WSW de Guayabas, camino a El Caracol, 23°59'46"N, 097°53'57"W, *E. Martínez & A. Ibarra* 40982 (MEXU); Las Yucas, along rd. WSW from village of Las Yucas for 2.2 mi, 23°13'00"N, 098°09'30"W, *Mayfield et al.* 866 (MEXU-image); Sierra de Tamaulipas, alrededores de Ejido El Cabrito, ca. 45 km E de Cruce de Santa Cruz, *McDonald* 945 (MEXU); Mpio. Jaumave, 3 km W de La Unión, NW de Jaumave, *F. Medrano* 9661 (MEXU); Mpio. Palmillas, 14 km al SE de Palmillas al W de Rancho El Balcón, *F. Medrano* 9983 (MEXU); along Hwy. 85, 2.2 km SW of El Abra, ca. 15 km SW of Cd. Mante, *M. Nee* 22261 (F); along Hwy. 101 SW of Cd. Victoria, 7.15 mi W of Cumbres Ranch entrance, *C. Peterson* 1362 (CAS); along Rte. 101, 21.6 mi NE of Jaumave, *D. Pinkava et al.* 9709 (ASU, ENCB); 10 km al S de Llera, *H. Puig* 5202 (ENCB); 9 km E of Palmillas on small creek, 23°32'N, 99°27'W, *L. Stanford et al.* 956 (ARIZ, DS, GH, MO, NY, UC); ca. 2 km E de Gómez Farías, Sierra Chiquita, *A. Valiente B. & D. Baro P.* 541 (MEXU); near S. Vicente–Jaumave, *H. von Rozynski* 110 (UC); 140 (F, UC); between Jaumave and Victoria, *H. von Rozynski* 153 (UC); 5 mi NE of Palmillas, 23°22'N, 99°30'W, *G. Webster & S. Armbruster* 20528 (DAV; MEXU-image); KM 656, C.N. 1, near Victoria, *O. White* 59 (F); 13 mi S of Cd. Mante on Hwy. 85, *J. Wilson s.n.* (UAT); 3 mi N of Llero, *R. Wunderlin et al.* 1170 (MO); Mpio. González, 2.7 km S del Ejido El Cabrito, *M. Yáñez* 974 (MO).

Justicia leonardii Wassh.

PHENOLOGY.— Flowering: All year; fruiting: February–May, September–October.

DISTRIBUTION.— Mexico (Coah., Gro., Gto., Hgo., N.L., Qro., S.L.P., Tamps., Ver.).

HABITAT.— Thornscurb, tropical deciduous forest, tropical subdeciduous forest, tropical evergreen forest, oak forest, often on limestone.

ELEVATION.— 230–1500 meters.

NOTES.— Daniel and Acosta C. (2003) provided a description of this species (Fig. 4B). It is often misidentified as *J. spicigera* Schltld. (“muicle”), a very similar looking plant, which may be cultivated in Tamaulipas. Muicle differs by having considerably less pubescent leaves which, when placed in hot water, produce a colored tonic that is used as a health aid and which yields a blue-purple dye.

REPRESENTATIVE SPECIMENS.— 6 km SW of Cd. Victoria 23°42'N, 099°10'W, *R. Clausen & J. Edwards 7386* (MEXU); along Hwy. 85, 6.1 mi W of Antiguo Morelos, 10 km E of Tamaulipas–S.L.P. border, 22°32'N, 099°11'W, *T. Croat & D. Hannon 62973* (CAS, MEXU-image, MO); Mpio. Bustamente, Hwy. 70 N of La Presita and 23.1 mi N of Tula, *L. Dorr & T. Atkins 2343* (MEXU); on Hwy. 80 (Antigua–Morelos), 7 mi W of jct. Hwy. 85, *Dunn & Harmon 17623* (MO); near Llera, between Victoria and Limón, *T. Frye & W. Frye 2952* (DS, F); pass above El Abra, ca. 11 mi S of Cd. Mante, *P. Fryxell & R. Magill 2262* (CAS); Mpio. Victoria, 1.5 km W del entronque a Estación de Microondas Las Mulas, carr. Victoria–Jaumave, *L. García-Morales 25* (ITCV); Mpio. Victoria, 3 km W de El Huizachal, carr. nueva a Jaumave, *L. García-Morales 2437* (ITCV); KM 23 Cañón de La Peregrina, *L. García-Morales 3928* (ITCV); Cuatro Caminos, Hidalgo, *Hinton et al. 24624* (ARIZ); Sierra de San Carlos, 20 km W del Rancho El Lucero, *P. Hiriart et al. 633* (MEXU); Mpio. Aldama, Ejido El Carrizo, 22°59'10"N, 098°10'05"W, *F. Iribe 449* (MEXU); camino al Cañón del Novillo a La Altura de la Peñita, *J. Jiménez 6* (MEXU); 16 mi E of Casas on rd. to Soto la Marina, *M. Johnston & J. Crutchfield 5034* (US); along rte. 70, ca. 6 mi S of Cd. Victoria, *R. King 4506* (F); Mpio. Victoria, Ejido La Libertad, 6 km NW of Cd. Victoria, *T. Lammers & M. Vincent 7981* (ASC, F); “El Carrizo,” KM 635, hwy. between Monterrey and Valles, *I. Langman 3003* (US); San José, *H. LeSueur 443* (F); W of Gómez Farias off of Hwy. 85 to Victoria, rd. to Rancho del Cielo, *N. McCarten & R. Bittman 2626* (ARIZ); 30 km NE de Soto la Marina, camino a La Pesca, *F. Medrano 896* (CAS, MEXU, MO), *1007* (MO); Mpio. Soto la Marina, Sierra de Tamaulipas, 20 km S de Soto la Marina, *F. Medrano 2128* (MEXU); Mpio. Casas, 21 km E de Casas, *F. Medrano & M. Hernández 1864* (ARIZ, MEXU); Mpio. Villa Mainero, Las Peñitas, 4 km W de la Oveja, camino a Camarones, *F. Medrano & P. Hiriart 12984* (ARIZ, MEXU); Mpio. Ocampo, 3 km S de Las Flores, *F. Medrano & A. Valiente B. 12157* (ARIZ, MEXU); Mpio. San Nicolás, entre San José del Alto (Las Adjuntas) y El Palmar, *F. Medrano et al. 2789* (MEXU); Mpio. Tula, 3 km SE de Los Cauces, *F. Medrano et al. 10489* (MEXU); Mpio. Hidalgo, 31 km W de El Carmen, cerca de El Alamo, *F. Medrano et al. 13896* (MEXU); 12 mi from river at Victoria on rd. to Jaumave, *H. Moore & A. Valiente M. 6158* (MEXU); Mpio. Soto la Marina, carr. Soto la Marina – Aldama, Rancho Las Aguilas, *J. Mora-López 142* (MEXU-image); Mpio. Gómez Farias, Ejido Alta Cima, *J. Moreno 46* (MEXU-image, MO); vic. of Victoria, *E. Palmer 58* (F, GH, K, MO); Mpio. Victoria, 15 km SW de Cd. Victoria, carr. Cd. Victoria–San Luis Potosí, *C. Ramos et al. s.n.* (MEXU-image); mountains W of the Río Sabinas, on rd. to Hulilo, *K. Robertson & D. LeDoux 171* (MEXU-image); Mpio. Villa de Casas, Los Angeles, *H. Puig 4125* (P); carr. 70, 65 km de Cd. Victoria a Soto la Marina, Rancho el Piruli, *J. Valdez R. & M. Carranza C-415* (MEXU-image); near Río San Vicente, Jaumave, *H. von Rozyński 335* (B, F, P); Mpio. Gómez Farias, NW of Gómez Farias in the Sierra de Guatemala, area of Rancho del Cielo, 23°, 06'N, 099°12'W, *L. Woodruff et al. 139* (CAS, MEXU); Buena Vista Hda., *E. Wootton s.n.* (US).

Justicia linearis B.L. Rob. & Greenm.

PHENOLOGY.— Flowering: August; fruiting: unknown.

DISTRIBUTION.— Mexico (Dur., S.L.P., Tamps.) .

HABITAT.— Desertscrub.

ELEVATION.— 1600 meters.

NOTES.— This Chihuahuan Desert species (Fig. 4D) is rare in Tamaulipas.

REPRESENTATIVE SPECIMEN.— Mpio. Tula, 25 km S de Tula, *P. Hiriart et al. 166* (MEXU).

Justicia pacifica (Oerst.) Hemsl.

PHENOLOGY.— Flowering: August–December; fruiting: October–November.

DISTRIBUTION.— USA (Tex.), Mexico (Ags., Chih., Chis., Col., D.F., Dur., Gro., Gto., Hgo., Jal., Méx., Mich., Mor., Nay., N.L., Oax., Pue., Qro., S.L.P., Sin., Son., Tamps., Zac.), Central America.

HABITAT.— Thornscrub, tropical deciduous forest, wetlands, disturbed sites .

ELEVATION.— 50–600 meters.

NOTES.— Daniel (2011) provided a description of *J. pacifica* (Fig. 4I). Other names that have been applied to this species include: *J. caudata* A. Gray, *J. runyonii* Small, and *J. furcata* Jacq. *Mora-Olivo 5676* has elongate-linear leaves (e.g., 115 × 8 mm), and was noted to be a hydrophyte.

REPRESENTATIVE SPECIMENS.— Mpio. Victoria, Cañón de Calamaco, W de Ciudad Victoria, *L. García-Morales 854b* (ITCV); 1 km S de Santa Librada, *L. García-Morales 4647* (ITCV); Mpio. Villagrán, Rancho 3 de Marzo, *L. García-Morales, s.n.* (ITCV); 37 mi from Tampico on Monte hwy., *M. Johnston 4092* (US); KM 647 on top of Mesa de Llera, *M. Johnston & J. Graham 4403* (US); 4 mi N of Tomaseño on Victoria–Villagrán hwy., *M. Johnston & J. Graham 4678* (US); 2 mi W of Mante–Victoria hwy. on rd. to Gómez Farías, *M. Johnston & J. Crutchfield 5731* (US); KM 678, hwy. Mexico to Laredo, *I. Langman 3000* (US); Cuesta de Llera, KM 660 of hwy., *C. Lundell & A. Lundell 12488* (US); Mpio. Victoria, Ejido Santa Ana, 23°52.0'N, 099°13.6'W, *J. Martínez s.n.* (UAT); Mpio. Villagrán, Ejido Campoamor, 24°29.3'N, 099°18.3'W, *A. Mora-Olivo 1289* (UAT); Mpio. Abasolo, Río Soto la Marina, a la izquierda de la cabecera municipal de Abasolo, 24°02.4'N, 098°22.9'W, *A. Mora-Olivo 5676* (MEXU, UAT); Mpio. Llera, Ejido La Antostura, rumbo al Río Guayalejo, 23°02'06"N, 099°00'42"W, *A. Mora-Olivo 7763* (UAT); Río Sabinas, “Rancho de Las Calavasas,” opposite KM 619 on Pan American Hwy., N of El Limón, *A. Sharp & E. Hernández X. 50/50385* (MEXU).

Justicia pilosella (Nees) Hilsenb.

PHENOLOGY.— Flowering: All year; fruiting: March–December .

DISTRIBUTION.— U.S.A. (N.M., Tex.), Mexico (Chih., Coah., Dur., Gto., Hgo., N.L., Pue., Qro., S.L.P., Tamps., Ver., Zac.) .

HABITAT.— Thornscrub, tropical deciduous forest, oak forest, disturbed sites.

ELEVATION.— 75–1570 meters.

NOTES.— Daniel and Acosta C. (2003) and Daniel (2011) provided descriptions of this species (Fig. 4F), synonyms of which include: *Adhatoda dipteracantha* Nees (the lectotype, *Berlandier 192* at G-DC is from Tamaulipas), *Siphonoglossa pilosella* (Nees) Torr., *S. greggii* Greenm. & C.H. Thomps. (the holotype, *Gregg 915* at MO is from Tamaulipas), and *J. turneri* Hilsenb.

REPRESENTATIVE SPECIMENS.— Ad Tampico de Tamaulipas, *J. Berlandier 192* (G-DC!); 5 km NNE of Jaumave sobre la carr. a Cd. Victoria, 23°27'09"N, 099°21'42"W, *P. Carrillo-Reyes 5682* (CAS); Mpio. Aldama, Sierra de Tamaulipas, Cerro El Platero above Rancho El Platero, 0.5 mi S

of Ejido El Higuerón, *T. Daniel* 267 (CAS); along Hwy. 89 between San Carlos and Hwy. 101, 0.7 mi N of Hwy. 101, ca. 24°03'N, 098°43'W, *T. Daniel* 277 (CAS); 1.4 mi E of Hwy. 101 in Jiménez, ca. 24°11'N, 098°29'W, *T. Daniel* 790 (CAS); along rd. between Jiménez and Abasolo, 6 mi NW of Abasolo, ca. 24°09'N, 098°27'W, *T. Daniel* 796 (CAS); along Hwy. 85, 11.2 mi NNW of Tomaseño, *T. Daniel & M. Baker* 3684 (CAS); Mpio. Aldama, Sierra de Tamaulipas, Las Yucas, ca. 40 km NNW of Aldama, ca. 23°14'N, 098°10'W, *R. Dressler* 2013 (MEXU, MO); Mpio. Victoria, KM 3 Cañón de Santa Ana, N de Cd. Victoria, *L. García-Morales* 440 (ITCV); Mpio. Victoria, 3 km N de Santuario del Caminero, carr. Victoria–Altas Cumbres, *L. García-Morales* 681 (ITCV); Mpio. Victoria, Bosque Urbano, S de Cd. Victoria, *L. García-Morales* 1945 (ITCV); Mpio. Victoria, Libramiento Naciones Unidas, N de Ciudad Victoria, ca. Benito Juárez, *L. García-Morales* 2548 (ITCV); Mpio. Miquihuana, 1.5 km S de Estanque Los Walle, *L. García-Morales* 3276 (ITCV); Mpio. Tula, Arroyo Loco, W de Tula, *L. García-Morales* s.n. (ITCV); Mpio. Villagrán, 5 km NE de Ej. Guadalupe de San Lázaro, *L. García-Morales* s.n. (ITCV); Mpio. Villagrán, Rancho 3 de Marzo, *L. García-Morales* s.n. (ITCV); Matamoros, *J. Gregg* 915 (MO); bridge on Hwy. 85, 11 km S of Cd. Victoria, *B. Hansen & M. Nee* 7333 (USF); Mpio. Gómez Farías, Cañón de la Servilleta, 4 km W de la Charca, 22°51'N, 099°10'W, *L. Hernández* 1708 (MEXU); 11 mi NE of Jaumave on upper terraces of Río Guayalejo, *M. Johnston & J. Crutchfield* 5616 (US); 23 mi from San Fernando–Matamoros hwy. jct. on rd. to Reynosa (3 mi N of Rancho El Garateno), *M. Johnston & J. Graham* 4715 (US); Mpio. Victoria, Ejido La Libertad, 6 km NW of Cd. Victoria, *T. Lammers & M. Vincent* 7971 (ASC); Mpio. San Carlos, 6 km E del Ejido El Gavilán, 24°41'N, 099°02'W, *M. Martínez & J. Martínez* 2391 (MEXU-image); 16 mi W of Hwy. 85 on Rd. A70 to Ocampo, *N. McCarten & R. Bittman* 2587 (ARIZ-image); Mpio. Villa Mainero, Las Peñitas, 4 km W de La Oveja, camino a Camarones, *F. Medrano & P. Hiriart* 12959 (ARIZ, MEXU); Mpio. Hidalgo, 31 km W de El Carmen, cerca de El Alamo, *F. Medrano et al.* 13856 (ARIZ, MEXU); Río San Marcos, 5 mi W of Cd. Victoria, *F. Meyer & D. Rogers* 2504 (MO, US); vic. of Victoria, *E. Palmer* 535 (US); N of San Fernando, *J. Rose & P. Russell* 24305 (US), 24329 (US); Capason Ranch, S of Canales, *R. Runyon* 413 (US); near Victoria, *R. Runyon* 896 (US); 3–5 km S of Huisachal, *L. Stanford et al.* 2139 (DS, US); 4 mi S of Jaumave, *L. Stanford et al.* 2274 (DS, US); Jaumave, *H. Viereck* 656 (US); Jaumave, sierra near San Vicente, *H. von Rozynski* 108 (F).

Justicia salviiflora Kunth

PHENOLOGY.— Flowering: November; fruiting: unknown.

DISTRIBUTION.— Mexico (Chih., Chis., Col., Dur., Gro., Jal., Méx, Mich., Mor., Nay., Oax., Sin., Son., Tamps., Zac.).

HABITAT.— Mesophytic montane forest.

ELEVATION.— Ca. 1050 meters.

NOTES.— Daniel (1995) provided a description of this species (Fig. 4C), which attains its northeasternmost occurrence and is rare in Tamaulipas.

REPRESENTATIVE SPECIMENS.— Mpio. Ocampo, Ejido El Refugio en la Reserva de la Biósfera El Cielo, [23°00'00"N, 099°20'58"W], *J. Mora-López. et al.* 268 (UAT, XAL).

Justicia sp.

PHENOLOGY.— Flowering: September–October; fruiting: September.

DISTRIBUTION.— Mexico (Tamps.); see notes below.

HABITAT.— Thornscrub.

ELEVATION.— 1700 meters.

NOTES.— This is the first documented occurrence of this species (Fig. 4H) in Tamaulipas. Its identity remains unknown at present. Plants from Tamaulipas greatly resemble a group of species from several regions of Mexico (e.g., *J. lundellii* Leonard [Yucatán Peninsula], *J. maya* T.F. Daniel [Chiapas], and *J. zamudioi* T.F. Daniel [Querétaro] and additional plants currently unassigned to species from other regions of the country—e.g., Hidalgo, Jalisco, Oaxaca, San Luis Potosí). All of these plants have densely bracteate and four-sided inflorescences, prominent bracts with maroon discoloration near the margin, a five-lobed calyx with \pm homomorphic lobes, relatively small, whitish to yellowish corollas with pink to maroon markings on the lower lip, \pm parallel anther thecae, and triaperturate pollen. They differ from one another in characters such as the distribution and type of pubescence, bract shape, calyx length, pollen apertures flanked by insulae vs. pseudocolpi, capsule length, and seed ornamentation. Like some of the unidentified plants from other regions of Mexico, Tamaulipan plants are as yet imperfectly known. The two known sites in Tamaulipas are about 20 km apart. Additional collections and studies should provide sufficient data to determine whether they can be attributed to one of the described species or if they represent a distinct species. Plants noted below are tentatively treated here as a species endemic to Tamaulipas. Whatever its ultimate status, this species is rare in the state.

REPRESENTATIVE SPECIMENS.— Mpio. Jaumave, ca. 20 km SE de Jaumave camino a 20 de Abril, 23.254742, -99.381573, *L. García-Morales s.n.* (ITCV); Mpio. Palmillas, 14 km SE de Palmillas, al W del Rancho El Balcón, *F. Medrano et al. 9981* (MEXU).

Louteridium tamaulipense A. Richardson

PHENOLOGY.— Flowering: January–June, September, December; fruiting: March–April, September.

DISTRIBUTION.— Mexico (Tamps.).

HABITAT.— Tropical deciduous forest, tropical evergreen forest, cloud forest, on limestone.

ELEVATION.— 340–560 (–1400) meters.

NOTES.— Daniel and Tripp (2018) provided a description of *Louteridium tamaulipense* (Fig 3D), which is endemic to Tamaulipas. Its occurrences in the state represent, by ca. 500 kilometers, the northernmost extent of the genus. With an EOO of 23 km² and an AOO of 24 km² this species could potentially be assessed as either critically endangered (CR) or endangered (EN) if threats were to be identified (IUCN 2019).

REPRESENTATIVE SPECIMENS.— Mpio. Gómez Farías, 1 km SW de la Estación Canindo (sitio Cedros II), [23.050000°, -99.150000°], *L. Hernández 3022* (BRIT, QMEX, UAT); cultivated from plants collected above Encino, on rd. to lumber camp Julillo [ca. 23.127069°, -99.162620°], *P. Hutchison 60-889-1* (UC); 8 km por la brecha W de Gómez Farías [ca. 23.045419°, -99.169347°], *E. Martínez S. et al. 3854* (ENCB, MEXU); ca. 5 km NW of Gómez Farías toward Aguacates [ca. 23.063313°, -99.168914°], *A. Richardson 1388* (holotype: TEX!, mounted on 4 sheets; isotypes: ENCB-image!, F!, GH, K!, MEXU!, MICH!, NY!, OS-image, UC!, US!, WIS-images); ca. 5 km NW of Gómez Farías, [ca. 23.083517°, -99.184750°], *A. Richardson 1398* (K); Mpio Gómez Farías, 2 km W de Gómez Farías, postrimerias de la Sierra Madre Oriental, [23.048044°, -99.174054°], *A. Valiente B. et al. 285* (ARIZ, MEXU, RSA); Mpio. Gómez Farías, 1.5 km E de Gómez Farías, ladera de orientación W sobre la “Sierra Chiquita,” [23.047383°, -99.140541°], *A. Valiente B. et al. 443* (MEXU); Mpio. Gómez Farías, 1.5 km E de Gómez Farías, laderas de orientación WSW sobre la Sierra Chiquita [ca. 23.046731°, -99.140653°], *A. Valiente B. et al. 490* (MEXU).

Mirandea andradenia T.F. Daniel

PHENOLOGY.— Flowering: August–October; fruiting: August–September.

DISTRIBUTION.— Mexico (Tamps.).

HABITAT.— Thornscrub, on limestone.

ELEVATION.— 700–1500 meters.

NOTES.— Daniel (1986a) provided a description of this rare species (Fig. 3E), which is endemic to Tamaulipas. Phylogenetic relationships among species of *Mirandea* (Kiel and McDade 2014), suggest that the genus is not monophyletic as currently delimited. With an EOO of 179 km² and an AOO of 16 km² this species could potentially be assessed as endangered (EN) if threats and their impacts were to be identified (IUCN 2019).

REPRESENTATIVE SPECIMENS.— Along Hwy. 101, 3.3 mi NNE of Jaumave, ca. 0.5 mi NNE of Tropic of Cancer, [23.456556°, -99.361313°], *T. Daniel & M. Baker 3693* (holotype: NY!; isotypes: ASU!, CAS!, ENCB!, MEXU!, MICH!, MO!, OSH!, UC!, US!); Mpio. Jaumave, Río Chihue cerca del puente N de San Antonio, [23.588639°, -99.334905°], *L. García-Morales s.n.* (ITCV); along Fed. Rte. 101, 4.7 mi N of Jaumave, [23.474865°, -99.354411°], *N. Harriman 11586* (US); Mpio. Jaumave, Magdalena Aguilar, 7 km N de Magdalena Águilar (Santiaguillo), [23.511700°, -99.585971°], *F. Medrano 9855* (MEXU).

Mirandea grisea Rzedowski

PHENOLOGY.— Flowering: July–November; fruiting: July–September.

DISTRIBUTION.— Mexico (Coah., S.L.P., Tamps.).

HABITAT.— Desertscrub.

ELEVATION.— 1040–1600 meters.

NOTES.— Daniel (1982) provided a description of this Chihuahuan Desert species (Fig. 3F), which is rare in Tamaulipas.

REPRESENTATIVE SPECIMENS.— 25 km S de Tula, *P. Hiriart & F. Medrano 165* (CAS, MEXU); Mpio. Tula, 20 km S de Tula, *F. Medrano et al. 8213* (MEXU).

Pseuderanthemum alatum (Nees) Radlk. ex Lindau

PHENOLOGY.— Flowering: June–October; fruiting: July–October.

DISTRIBUTION.— Mexico (Camp., Chis., Gro., Hgo., Jal., Mich., Oax., Qro., Q.R., S.L.P., Tamps., Ver., Yuc.), Central America.

HABITAT.— Tropical deciduous forest, tropical subdeciduous forest, mesophytic montane forest, often on limestone.

ELEVATION.— 300–1450 meters.

NOTES.— Daniel (1995) and Daniel and Acosta C. (2003) provided descriptions of this species (Fig. 3G), which is sometimes cultivated for ornament, especially a form with brownish leaves.

REPRESENTATIVE SPECIMENS.— Along rd. from Gómez Farías to Rancho del Cielo, 2 mi W of Gómez Farías, *T. Daniel & M. Baker 3713* (ASU, BR, CAS); Sierra de Tamaulipas, Las Yucas, ca. 40 km NNW of Aldama, *R. Dressler 2031* (GH); Mpio. Gómez Farías, 4 km N of Gómez Farías toward Rancho del Cielo, *P. Fryxell 3770* (F, MEXU, MICH, NY, TEX, US); ca. 6 km E of Ocampo on rd. from Mex. 85, *W. Graham 1158* (MICH); Mpio. Gómez Farías, alrededor de la estación biológica Los Cedros, 23°03'N, 099°09'W, *L. Hernández 3284* (MEXU-image); Galeana Canyon, *L. Kenoyer & H. Crum 3475* (MICH), 3507 (A, MICH); Ocampo, *L. Kenoyer & H. Crum 3564* (A, MICH); Cañón de Galeana, *H. LeSueur 452* (ARIZ, F); Mante–Llera hwy. at KM 627.5 from Mexico City, *F. Martinez M. & G. Borja L. F-1652* (TEX); Mpio. Gómez Farías, 6 km SE de Gómez Farías, 23°02'45"N, 099°09'15"W, *F. Medrano et al. 4249* (MEXU-image); 55 mi S of Cd. Victo-

ria, *F. Meyer & D. Rogers 2867* (BR, MO, US); Mpio. Gómez Farías, Reserva de la Biósfera “El Cielo,” Ejido Lázaro Cárdenas II, *J. Mora-López et al. 415* (UAT); Mpio. Gómez Farías, Reserva de la Biósfera El Cielo, camino de Gómez Farías al Rancho del Cielo, *A. Mora-Olivo 2224* (UAT); Mpio. Gómez Farías, Los Naranjos, *H. Puig 7201* (ENCB); Gómez Farías, *D. Seigler et al. 14147* (MEXU-image); 10 km NW of El Progreso which is 18 km NW of Ocampo, 23°N, 099°30'W, *L. Stanford et al. 1010* (DS, GH, MO, NY); Mpio. Gómez Farías, Sierra de Guatemala, *J. Sullivan 767* (TEX); Mpio. Gómez Farías, ca. 2 km E de Gómez Farías, *A. Valiente B. & J. Viveros 211* (MEXU), *266* (ARIZ, MEXU); Mpio. Gómez Farías, 2 km W de Gómez Farías, *A. Valiente B. et al. 295* (MEXU); Mpio. Gómez Farías, 3 km W de Gómez Farías, *A. Valiente B. et al. 303* (MEXU-image); 3 mi N of Llero, *R. Wunderlin et al. 1169* (MO).

***Pseuderanthemum praecox* (Benth.) Leonard**

PHENOLOGY.— Flowering: April; fruiting: unknown.

DISTRIBUTION.— Mexico (Ags., Chis., D.F., Dur., Gto., Gro., Hdo., Jal., Méx., Mich., Mor., Nay., N.L., Oax., Pue., Qro., S.L.P., Sin., Son., Tamps., Zac.)

HABITAT.— Unknown.

ELEVATION.— 1500 meters.

NOTES.— Daniel (1995) and Daniel and Acosta C. (2003) provided descriptions of this species (Fig 3H). Although apparently known by a single collection from Tamaulipas, plants were noted to be “Widespread but scattering on tops of mts.” In other parts of its geographic range (e.g., Sonora, Daniel 2004), plants produce chasmogamous flowers after most or all leaves have fallen, followed by leafy stems with cleistogamous flowers. A group of species and names that includes *P. praecox*, *P. hispidulum* (Nees) Radlk., *P. axillare* Leonard, and *P. biceps* Lindau has not been completely sorted out (cf. Daniel and Acosta C. 2003); some of these appear to be represent growth forms of a widespread *P. praecox*.

REPRESENTATIVE SPECIMENS.— Santa Rita Ranch, *R. Runyon 1053* (TEX, US).

***Ruellia blechum* L.**

PHENOLOGY.— Flowering: All year; fruiting: January–September.

DISTRIBUTION.— Mexico (B.C.S., Camp., Chis., Col., Gro., Hgo., Jal., Méx., Mich., Mor., Nay., N.L., Oax., Pue., Qro., Q.R., S.L.P., Sin., Son., Tab., Tamps., Ver., Yuc.), West Indies, Central America, South America.

HABITAT.— Aquatic vegetation, semiaquatic vegetation (mangal, roadside ditches).

ELEVATION.— 2–350 meters.

NOTES.— Native to the Neotropics, plants have become naturalized in the U.S.A. and in the Paleotropics. Common synonyms of this species (Fig. 5A) include *Blechum brownei* Juss. and *B. pyramidatum* (Lam.) Urb. Descriptions of it under the latter name were provided by Daniel (1995) and Daniel and Acosta C. (2003).

REPRESENTATIVE SPECIMENS.— 50 mi N of Valles, *F. Barkley 17M130* (F); 53 mi S of Cd. Victoria, *F. Barkley & G. Smith 17M173* (F); Tampico, Wegränder bei der Lagune, *Brenning 1050* (B); Tampico, *G. Fisher 46190* (ARIZ, S); Mpio. Gómez Farías, La Alamillosa, ca. 2 km W de Alta Cima, *L. García-Morales s.n.* (ITCV); Mpio. Xicoténcatl, 500 m E de El Azteca, *L. García-Morales s.n.* (ITCV); S edge of El Guayabo on Hwy. 85, 23°11'N, 99°06'W, *E. Judziewicz 2987* (WIS); Tampico, Pujal Rd., *L. Kenoyer 860* (F); grounds of Campo Agrícola Experimental del Sur de Tamaulipas, off Mex. 180 at La Huastecas, *A. Lievens & B. Gregory 2459* (LSU); Mpio. Altamira, 13 km de Las Salinas rumbo a la cabecera municipal de Altamira, 22°23.083'N, 097°53.921'W, *A.*

Mora-Olivo 7291 (MEXU-image, UAT); Mpio. Altamira, Nuevo Madero, Laguna Las Marismas, 22°22'46"N, 097°51'15"W, *A. Mora-Olivo* 7316 (UAT); Mpio. Llera, Reserva le la Biósfera El Cielo, arroyo en camino de El Encino a La Libertad, *A. Mora-Olivo* 7414 (MEXU-image, UAT); Mpio. Antiguo Morelos, Arroyo La Misión, cerca del pueblo, 22°33'13.0"N, 099°05'28.5"W, *A. Mora-Olivo* 8514 (UAT); Mpio. Tampico, Laguna de Tancol, 22°18.158'N, 097°53.965'W, *A. Mora-Olivo & J. Mora-López* 7842 (MEXU-image, UAT); vic. of Tampico, *E. Palmer* 159 (F, CAS, US); vic. of Gómez Farías, *E. Palmer* 320 (F, US); Tampico, *C. Pringle* 6807 (F, MEXU, PR, PRC, S, UC, US); banks of Río Sabinas, ca. 5 km NW of El Encino, *J. Pruski* 1740 (LSU); Sierra Madre Oriental, ca. 6–8 km NW of El Encino, ca. 30 km N on Hwy. 85 of Cd. Mante, *J. Pruski & N. Barker* 1680 (NY).

***Ruellia ciliatiflora* Hook.**

PHENOLOGY.— Flowering: February–November; fruiting: March–November.

DISTRIBUTION.— USA (Ariz., Tex.), Mexico (B.C.S., Camp., Chih., Chis., Coah., Col., Dur., Hgo., Mor., N.L., Oax., Pue., Qro., Q.R., S.L.P., Sin., Son., Tab., Tamps., Ver., Yuc.), West Indies, Central America, South America.

HABITAT.— Thornscrub, tropical subdeciduous forest, moist forest, disturbed sites, often on limestone.

ELEVATION.— 8–1750 meters.

NOTES.— Daniel (1995) and Daniel and Acosta C. (2003) provided descriptions of this morphologically variable species under the widely used name, *R. nudiflora* (Engelm. & A. Gray) Urb. Flowers are usually blue-purple (Fig. 5B), but occasionally white-flowered individuals occur. Numerous names have been applied to variants of this species from Tamaulipas and elsewhere, including: *R. davisiorum* Tharp & F.A. Barkley, *R. nudiflora*, *R. occidentalis* (A. Gray) Tharp & F.A. Barkley, *R. occidentalis* var. *lundelliorum* Tharp & F.A. Barkley (the type, *Lundell & Lundell* 7281, is from Tamaulipas), *R. runyonii* Tharp & F.A. Barkley, and *R. yucatanana* (Leonard) Tharp & Barkley. Daniel (1995, 2013a) provided a partial listing of and discussions about names treated as synonymous with *R. ciliatiflora*.

REPRESENTATIVE SPECIMENS.— Sierra de San Carlos, vic. of San Miguel, La Tamaulipeca, *H. Bartlett* 10637 (DS, US); 26.2 mi S of Nuevo Laredo on Mex. Hwy. 85, *C. Broome* 321 (USF-image); Mpio. Jaumave, 1 km SE de Los Nogales, 23°25'57"N, 099°15'50.9", *P. Carillo-Reyes & E. Piedra* 5701 (CAS); Mpio. Aldama, Sierra de Tamaulipas, lower slopes of Cerro El Platero above Rancho El Platero, 0.5 mi S of Ejido El Higuierón, ca. 23°20'N, 098°10'W, *T. Daniel* 261 (MICH, CAS); 1.4 mi E of Hwy. 101 in Jiménez, ca. 24°11'N, 98°29'W, *T. Daniel* 792 (CAS); along Hwy. 101 S of Cd. Victoria, 1.3 mi S of bridge over Río San Marcos, *T. Daniel & M. Baker* 3689 (CAS); along Hwy. 101, 3.3 mi NNE of Jaumave, ca. 0.5 mi NNE of Tropic of Cancer, *T. Daniel & M. Baker* 3694 (CAS); along Hwy. 85 SSE of Cd. Victoria, 5.5 mi NNW of turn to San Francisco, *T. Daniel & M. Baker* 3702 (ASU, CAS); Río de Soto la Marina, *J. Franks & T. Filer* 637 (ASU); near El Limón, ca. 73 mi S of Cd. Victoria on Pan American Hwy., *T. Frye & E. Frye* 2663 (DS, US); Mpio. Victoria, 5 km S de la entrada al Cañón del Novillo, carr. Victoria–Altas Cumbres, *L. García-Morales* 1351 (ITCV); Mpio. Victoria, 2 km N de Santuario del Caminero, carr. Victoria–Altas Cumbres, *L. García-Morales* 1485 (ITCV); Mpio. Victoria, Cañón del Novillo, *L. García-Morales* 2140 (ITCV); Mpio. Victoria, Bosque Urbano, S de Ciudad Victoria, *L. García-Morales* 2184 (ITCV); Mpio. Gómez Farías, La Bocatoma, *L. García-Morales s.n.* (ITCV); Mpio. Villagrán, Rancho 3 de Marzo, *L. García-Morales s.n.* (ITCV); ca. 27 (air) km WNW of Jaumave, 25–35 km SW of Miquihuana on rd. to Hwy. 70, ca. 23°22'N, 099°36'W, *Henrickson & Hess* 19258 (MEXU-image); ca. 13 mi S of Cd. Victoria, *C. Hitchcock & S. Stanford* 6884 (DS); Mpio.

Hidalgo, El Mirador, *Hinton et al.* 24641 (MEXU-image); Galeana Canyon, *C. Lundell & A. Lundell* 7281 (holotype: US-image; isotypes: SMU, US); Sierra Madre Oriental, Jardín Botánico del Noreste, ladera E de Sierra Gorda, W de Cd. Victoria, *A. McDonald* 1029 (UAT); Mpio. Soto la Marina, Rancho de R. Dragustinovis, 23°53'38"N, 097°48'36"W, *E. Martínez & A. Ibarra* 40323 (MEXU-image); Mpio. San Carlos, 6 km E del Ejido El Gavilán, en la brecha hacia San Miguel, 24°41'N, 099°02'W, *Martínez & Martínez* 2395 (MEXU-image); N of Los Rayones on Mex. 101, ca. 0.5 km N of the Soto la Marina cutoff (Mex 80), 24°28'10"N, 098°20'27"W, *Mayfield et al.* 773 (MEXU-image); San Fernando to Jiménez, *E. Nelson* 6005 (US); vic. of Tampico, *E. Palmer* 172 (K, US); along Rte. 101, 12 mi SW of Jaumave, *D. Pinkava et al.* 9683 (ASU); 10 km E of Cd. Victoria, R.F. 70, *H. Puig* 3386 (P); Mpio. Villagrán, Rancho Vista Hermosa en Garza Valdés, *A. Rodríguez* 783 (MEXU-image); San Fernando, *J. Rose & P. Russell* 24319 (US); Mpio. Cd. Victoria, Col. Enrique Cárdenas González, 23°44'04"N, 099°09'55"W, *J. Sifuentes* 26 (UAT); 9 km E of Palmillas, 23°32'N, 99°27'W, *L. Stanford et al.* 945 (DS); 4 mi S of Jaumave, *L. Stanford et al.* 2304 (DS, CAS); Sierra Madre Oriental, 9 mi S of Cd. Victoria on rd. to Palmillas, *G. Starr cv s.n.* (CAS); camp on Gilbert Hernández Rancho on rd. to Gómez Fariás, *S. Trott et al.* 306 (MEXU-image); Mpio. Gómez Fariás, 2 km E de Gómez Fariás, *A. Valiente B. & J. Viveros* S. 217 (MEXU, US); 6 mi SW of Cd. Victoria, 23°42'N, 099°11'W, *G. Webster & S. Armbruster* 21398 (MEXU-image); Sierra Madre Oriental, 9.9 rd. mi SW of Cd. Victoria, 5.1 rd. mi NE of Alta Cumbre, *R. Worthington* 8429 (CAS); 17.2 rd. mi NE of Tula, 2 rd. mi NE of La Presita, 25.2 rd. mi SW of Jaumave, *R. Worthington* 8475 (CAS).

***Ruellia hookeriana* (Nees) Hemsl.**

PHENOLOGY.— Flowering: March–April; fruiting: March–April.

DISTRIBUTION.— Mexico (Ags., Chis., Gro., Gto., Jal., Méx., Mich., Mor., Nay., Oax., Pue., Qro., S.L.P., Sin., Tamps., Ver., Zac.), Central America.

HABITAT.— Unknown.

ELEVATION.— 15–325 meters.

NOTES.— Daniel (1995) and Daniel and Acosta C. (2003) provided descriptions of this species (Fig. 5C), which reaches its northeasternmost distribution and is rare in Tamaulipas.

REPRESENTATIVE SPECIMENS.— Mpio. Victoria, Ejido Vicente Guerrero, Cañón de La Peregrina, cruce del río, *L. García-Morales s.n.* (ITCV); Mpio. Xicotécatl, 3.5 km N de Ejido Ojo de Agua, *L. García-Morales s.n.* (ITCV); vic. of Tampico, *E. Palmer* 215 (CAS, K, US).

***Ruellia paniculata* L.**

PHENOLOGY.— Flowering: December–April; fruiting: January–April.

DISTRIBUTION.— Mexico (Camp., Chis., Gro., Nay., Oax., Q.R., S.L.P., Sin., Tamps., Ver., Yuc.), West Indies, Central America, South America.

HABITAT.— Tropical deciduous forest, oak forest, disturbed sites, aquatic vegetation, sometimes on limestone.

ELEVATION.— 15–290 meters.

NOTES.— Daniel (1995) provided a description of this species (Fig. 5D), which attains its northeasternmost occurrence in Tamaulipas.

REPRESENTATIVE SPECIMENS.— Mpio. Gómez Fariás, KM 7 carr. Gómez Fariás–Cd. Mante, *S. Avendaño R. & H. Narave* F. 1715 (XAL); 50 mi N of Valles, *F. Barkley* 17M129 (ARIZ-image); Altamira, *J. Berlandier* 2191 (= 771) (K, P); along Hwy. 85 between Cd. Mante and Cd. Valles, 10 mi S of Cd. Mante, 22°35'N, 099°01'W, *T. Croat & D. Hannon* 62929 (CAS, MEXU); along Rte. 85, ca. 4–5 mi S of Cd. Mante, *R. King* 3800 (US); 2 mi NE of Altamira, *R. King* 4044 (US); Mpio. Nuevo Morelos, 3 km E de Nuevo Morelos, *F. Medrano & A. Valiente B.* 12201 (ARIZ-image);

Mpio. Llera, La Clementina, Río Guayalejo, 23°15'35"N, 098°50'50"W, *A. Mora-Olivo* 1595 (UAT); Mpio. San Fernando: Río Conchos, 19 km SE de San Fernando rumbo a Carboneras, 24°45.977'N, 097°59.961'W, *A. Mora-Olivo et al.* 6262 (UAT); vic. of Tampico, *E. Palmer* 108 (CAS, K, US); near Villa Juárez, *A. Perkins & J. Hall* 3415 (CAS); Nogales–Jaumave, *H. von Rozynski* 275 (P); Tampico, *H. Viereck* 1084 (US).

Ruellia simplex Wright

PHENOLOGY.— Flowering: July–April; fruiting: April, July–December.

DISTRIBUTION.— Mexico (Ags., Camp., Chis., Gro., Hgo., Oax., Pue., Qro., Q.R., S.L.P., Sin., Son., Tab., Tamps., Ver., Yuc.), West Indies, Central America, South America.

HABITAT.— Aquatic and riparian vegetation.

ELEVATION.— 12–330 meters.

NOTES.— Daniel (1995) and Daniel and Acosta C. (2003) provided descriptions of this species under the name *R. coerulea* Morong. The species reaches the northernmost extent of its presumably native distribution in Tamaulipas. The names *R. brittoniana* Leonard and *R. coerulea* are often applied to plants of the species with very narrow leaves (e.g., *Mora-Olivo* 5688, *Mora-Olivo & Galván* 7647), and *R. malacosperma* Greenm. is often applied to plants with somewhat wider leaves (e.g., *Mora-Olivo* 5689, *Pringle* 6806). Plants of *R. simplex* are often cultivated and sometimes become naturalized (e.g., U.S.A.). Flowers of cultivated plants vary from blue-purple (Fig. 5E) to pink to white (Fig. 5F). The native distribution in the Neotropics is not known with certainty, and possible native occurrences in some of the Mexican states listed above may instead reflect naturalized occurrences. The type of *R. malacosperma* (*Pringle* 6806) is from Tamaulipas.

REPRESENTATIVE SPECIMENS.— Mpio. Gómez Farías, Río Sabinas, falda de la Sierra de Gómez Farías, *M. Chazaro B.* 1332 (XAL); El Coyote Creek, 5 km S of Nuevo Laredo, *M. Domínguez M.* 45 (TEX); Mpio. Victoria, S del Bosque Urbano, Cd. Victoria, *L. García-Morales* 1951 (ITCV); Río San Marcos, ca. Col. Horacio Terán, Cd. Victoria, *L. García-Morales* 2034 (ITCV); KM 2 Cañón de La Peregrina, *L. García-Morales* 5184 (ITCV); Mpio. Tampico, Laguna de Tancol, 22°18'00"N, 097°53'57"W, *A. Mora-Olivo* 1775 (MEXU-image, UAT); Mpio. Gómez-Farías, Reserva de la Biósfera El Cielo, Río Frio, en el Puente, 22°57'20"N, 099°07'30"W, *A. Mora-Olivo* 5075 (UAT); Mpio. Llera, Reserva de la Biósfera “El Cielo,” Ejido La Libertad, Río Sabinas, 23°08'06"N, 099°09'00"W, *A. Mora-Olivo* 5457 (UAT); Mpio. Victoria, Cd. Victoria, Arroyo María, Fraccionamiento Villa Real, *A. Mora-Olivo* 5688 (MEXU, UAT), 5689 (MEXU, UAT); Mpio. Gómez Farías, Río Guayalejo, poblado La Esperanza, en el puente, 22°56'56.7"N, 098°59'53.1"W, *A. Mora-Olivo* 8488 (UAT); Mpio. Mante, Río Guayalejo, El Limón, *A. Mora-Olivo & M. Galván* 7647 (MEXU-image, UAT); Mpio. Valle Hermoso, Distrito de Riego 025 Bajo Río Bravo, *A. Mora-Olivo & J. Mora-López* 5209 (UAT); Tampico, *C. Pringle* 6806 (lectotype: GH-image!; isolectotypes: BM!, BR!, F!, GH!, K!, L!, LL, MEXU, MIN!, NSW!, NY, P!, PR!, PRC!, S!, UC!, US, W!); along Río Sabinas, E. Storms’ “Rancho de Las Calavasas,” opposite KM 619 on Pan American Hwy., N of El Limón, *A. Sharp & E. Hernández X.* 50/50385 (GH); edge of Río Sabinas, W of El Encino, *A. Sharp & D. Richards MV-741* (USF-image).

Stenandrium dulce (Cav.) Nees

PHENOLOGY.— Flowering: July–September; fruiting: July–September.

DISTRIBUTION.— USA (Fla., Tex.), Mexico (Ags., Chih., Coah., D.F., Dur., Gro., Gto., Hgo., Jal., Méx, Mich., Nay., N.L., Oax., Pue., Qro., S.L.P., Sin., Tamps., Ver., Zac.), Central America, South America.

HABITAT.— Thornscurub, on limestone.

ELEVATION.— 10–175 meters.

NOTES.— Daniel (1984) and Daniel and Acosta C. (2003) provided descriptions of this species (Fig. 5G).

REPRESENTATIVE SPECIMENS.— 20 mi E of the San Fernando–Santander Jiménez hwy. on rd. to Loreto, 11 mi W of Loreto, *M. Johnston & J. Crutchfield 5535A* (TEX, US); Papalote de la Mirandena, 3 mi SSW of headquarters, Loreto Ranch, 24°20'N, 98°W, *M. Johnston & J. Crutchfield 5568B* (US); S of Lomas del Real, 7 mi N of main hwy., *M. Johnston & S. Graham 4539* (TEX); Morales, *H. LeSueur 546* (F, LL); Flor de Mayo, 50 mi SW of Matamoros, *R. Runyon 417* (TEX, US); 2 mi S of Marcella, between Peña Nevada and Hermosa, *L. Stanford et al. 2522* (DS, US); sierra near San Vicente, Jaumave, *H. von Rozynski 456* (F, P).

***Tetramerium nervosum* Nees**

PHENOLOGY.— Flowering: February–December; fruiting: March–December.

DISTRIBUTION.— U.S.A. (Ariz., N.M., Tex.), Mexico (Ags., B.C.S., Camp., Chih., Chis., Coah., Col., Dur., Gro, Gto., Hgo., Jal., Méx., Mich., Mor., Nay., N.L., Oax., Pue., Qro., Q.R., S.L.P., Sin., Son., Tamps., Ver., Yuc., Zac.), Central America, South America.

HABITAT.— Tropical deciduous forest, oak woodland and forest, disturbed sites, often on limestone

ELEVATION.— 400–1360 meters.

NOTES.— Daniel (1986b, 1995) and Daniel and Acosta C. (2003) provided descriptions of *Tetramerium nervosum*. Daniel (1986b) discussed morphological variation of the species throughout its geographic range. Flowers vary in color from white to cream to yellow. Yellow corollas (Fig. 5H) appear to be most prevalent in Tamaulipas. Many collections have been identified with the synonym *T. hispidum* Nees.

REPRESENTATIVE SPECIMENS.— 52 mi N of Valles, *F. Barkley 17M054* (F, TEX); Sierra de San Carlos, Cañón La Tamaulipeca, *H. Bartlett 10709* (DS, F, MICH, SD, US); San José, Sierra San Carlos, *O. Briones V. 1671* (MEXU-image); along Hwy. 101 S of Cd. Victoria, 1.3 mi S of bridge over Río San Marcos, *T. Daniel & M. Baker 3687* (CAS); Sierra de Tamaulipas, ca. 40 km NNW of Aldama, near Paso Lajas, *R. Dressler 2323* (GH, MICH, MO); W of Antiguo Morelos toward El Salto, *D. Dunn & D. Dunn 19216* (ENCB, NY); 7 mi W of jct. Hwy. 80 & 85 on Hwy. 80 in Antiguo Morelos, *D. Dunn & Harmon 17617* (ASU); along Hwy. 85, 34 mi S of Cd. Victoria, *D. Dunn et al. 23108* (ENCB, MO, MSC, NY); Mpio. Victoria, Altas Cumbres, carr. Victoria–Jaumave, *L. García-Morales 259* (ITCV); Mpio. Victoria, El Madroño, carr. Victoria–Jaumave, *L. García-Morales 459* (ITCV); Mpio. Victoria, 3 km E de El Huizachal, *L. García-Morales 2444* (ITCV); Mpio. Victoria, KM 2 Cañón de La Peregrina, *L. García-Morales 4828b* (ITCV); 1.5 km N de Santuario del Caminero, carr. Victoria–Altas Cumbres, *L. García-Morales 4948* (ITCV); Mpio. Villagrán, Rancho 3 de Marzo, *L. García-Morales s.n.* (ITCV); Mpio. Aldama, Ejido el Nacimiento, “Pozos de la Azufrosa,” 22°59'30"N, 098°09'55"W, *M. González G. 256* (MEXU-image); Mpio. Victoria, KM 20 al S de Cd. Victoria, “Altas Cumbres,” *L. Hernández 1515* (MEXU-image); Mpio. Hidalgo, El Mirador, *Hinton et al. 25031* (MEXU-image); 11 mi SW of Victoria on rd. to Huisachal, *Lauber, Taylor & Stanford 1976* (US); Mpio. San Carlos, 2 km E de Marmolejo en el camino a Rosario, 24°37'N, 099°01'W, *M. Martínez & J. Martínez 2188* (XAL); Mpio. Villa Mainero, Las Peñitas, 4 km W de La Oveja, en el camino a Camarones, *F. Medrano & P. Hiriart 12957* (MEXU); Mpio. Hidalgo, 31 km W de El Carmen, *F. Medrano et al. 13878* (MEXU); Río San Marcos, 5 mi W of Cd. Victoria, *F. Meyer & D. Rogers 2597* (US); Mpio. Cd. Victoria, SE outskirts of Cd. Victoria, *M. Nee 22214* (XAL); vic. of Victoria, *E. Palmer 86* (F, GH, K, MO, NY, UC, US); 11 mi SW of Victoria toward Huizachal, *L. Stanford et al. 1976* (DS, RSA,

UC, US); Sierra Madre Oriental, 20.5 (rd.) mi SW of Cd. Victoria, *R. Worthington 8460* (ASU); Jaumave, *H. Viereck 290* (US); Cañón de la Peregrina, Ejido La Libertad, Río San Felipe, *M. Yáñez N-146* (MEXU).

***Thunbergia alata* Sims**

PHENOLOGY.— Flowering: April; fruiting: unknown.

DISTRIBUTION.— Native to Africa; widely cultivated and sometimes becoming naturalized elsewhere (e.g., Tamaulipas).

HABITAT.— Tropical subdeciduous forest, disturbed sites.

ELEVATION.— 770 meters.

NOTES.— This is the first documented occurrence of *Thunbergia alata* in Tamaulipas. Daniel (1995) and Daniel and Acosta C. (2003) provided descriptions of this introduced species, which is often cultivated for ornament. Most plants have orange corollas with a dark brownish black throat (Fig. 5J), but cultivated forms sometimes have white, yellow, or pink to reddish corollas.

REPRESENTATIVE SPECIMENS.— Mpio. Aldama, 500 m W de Ejido El Plomo rumbo a Mar de Nubes, *L. García-Morales 6101b* (ITCV); Mpio. González, Sierra de Tamaulipas, La Torrecilla, 028°08'49.13"N, 098°22'32.48"W, *A. Mora-Olivo SN* (UAT).

***Thunbergia fragrans* Roxb.**

PHENOLOGY.— Flowering: February–April, September–November; fruiting: February–April, September–November.

DISTRIBUTION.— Native to India; widely cultivated, and sometimes becoming naturalized elsewhere (e.g., Tamaulipas).

HABITAT.— Tropical subdeciduous forest, disturbed sites.

ELEVATION.— 200–1000 meters.

NOTES.— Daniel (1995) and Daniel and Acosta C. (2003) provided descriptions of this species (Fig. 5I).

REPRESENTATIVE SPECIMENS.— Mpio. Victoria, 2 km E de Mina de Serpentina, Cañón del Novillo, *L. García-Morales 510* (ITCV), *564* (ITCV); Mpio. Victoria, KM 4 Cañón de La Peregrina, *L. García-Morales 4858* (ITCV); Mpio. Gómez Farías, rumbo a la sierra, *A. Mora-Olivo 7777* (BRIT, UAT).

***Yeatesia mabryi* Hilsenb.**

PHENOLOGY.— Flowering: April–December; fruiting: April–December.

DISTRIBUTION.— Mexico (Tamps.).

HABITAT.— Oak forest, sometimes on limestone.

ELEVATION.— 320–1400 meters.

NOTES.— Hilsenbeck (1989) provided a description of this species (Fig. 5K), which is endemic to Tamaulipas. Phylogenetic relationships among species of *Yeatesia* (Kiel and McDade 2014) suggest that the genus is not monophyletic as currently delimited. With an EOO of 4,133 km² and an AOO of 76 km² this species could potentially be assessed as endangered (EN) if threats and their impacts were to be identified (IUCN 2019).

REPRESENTATIVE SPECIMENS.— Sierra Madre Oriental, 9 mi W of Cd. Victoria on rd. to Valley of Jaumave, [23.622488°, -99.206609°], *E. Anderson 1141* (RSA); 12 mi SW of Cd. Victoria toward Tula, [23.603944°, -99.217881°], *C. Bell & J. Duke 16531* (MEXU, NCU); Sierra de Tamaulipas, along Hwy. 70 between Soto la Marina and Casas E of Victoria, [ca. 23.575172°, -

98.431607°], *L. Brown* 13279 (CAS); along Hwy. 101, 27.3 mi NNE of Jaumave in mt. pass, [23.627081°, -99.203234°], *T. Daniel & M. Baker* 3698 (CAS, K); Mpio. Victoria, KMs 1 y 3 Cañón de Santa Ana, N de Cd. Victoria, [23.865997°, -99.241243° and 23.854950°, -99.252881°], *L. García-Morales* 358 (ITCV), 367 (ITCV), 369 (ITCV); Mina de Serpentina, Cañón del Novillo, [23.715196°, -99.273581°], *L. García-Morales* 536 (ITCV); KM 1 Cañón del Novillo, [23.695979°, -99.197155°], *L. García-Morales* 2160 (ITCV); KM 14 Cañón del Novillo, [23.734012°, -99.272929°], *L. García-Morales* 2338 (ITCV); KMs 2 y 5 Cañón de La Peregrina, [23.778406°, -99.204743° and 23.774996°, -99.230102°], *L. García-Morales* 5192 (ITCV), 5395 (ITCV); 3 km N del Santuario del Caminero, carr. Victoria–Altas Cumbres, [23.632406°, -99.196726°], *L. García-Morales* 5502 (ITCV); ca. 25 km W of Adelaida, base of Sierra Madre Oriental, [24.074261°, -99.427521°], *S. Ginzburg et al.* 106 (MEXU-image); Hidalgo, Los Mimbres, *Hinton et al.* 24291 (NY); Mpio. Hidalgo, Río Los Mimbres, [24.113982°, -99.390485°], *Hinton et al.* 24519 (MEXU-image); 9 mi W of Victoria, [23.622488°, -99.206609°], *L. Kenoyer & Crum* 3345 (A); La Escondida, 34 km SW de Cd. Victoria, [ca. 23.554482°, -99.345271°], *F. Medrano & P. Hiriart* 12864 (MEXU); vic. of Cd. Victoria, *E. Palmer* 175 (holotype: F!; isotypes: GH!, K!, MO, UC!, US!); Cañón de Garrapata, [ca. 23.613121°, -98.407450°], *R. Runyon* 952 (TEX-image, US); 5 mi W of Cd. Victoria, [23.651486°, -99.197871°], *F. Shreve & E. Tinkham* 9802 (GH); 5 km S of Hoja [Joya] Verde, [23.566295°, -99.224529°], *L. Stanford et al.* 2212 (CAS, DS, NCU, RSA, U, UC, US); ca. 11 mi SW of Cd. Victoria along Hwy. 101 toward San Luis Potosí, [23.606063°, -99.208895°], *C. Taylor* 1866 (DUKE, F); Jaumave, Sierra near San Lucas, *H. von Rozyński* 386 (B, F, US); Jaumave, [ca. 23.421300°, -99.367868°], *H. von Rozyński* 447 (F, US).

Yeatesia platystegia (Torr.) Hilsenb.

PHENOLOGY.— Flowering: March, July–September; fruiting: March, July–August.

DISTRIBUTION.— U.S.A. (Tex.), Mexico (Coah., N.L., Tamps.).

HABITAT.— Thornscrub, oak forest, on limestone.

ELEVATION.— 320–700 meters.

NOTES.— Hilsenbeck (1989) provided a description of this species (Fig. 5L).

REPRESENTATIVE SPECIMENS.— Sierra de San Carlos, vic. of San Miguel, Cerro de la Tamaulipeca, *H. Bartlett* 10557 (ENCB, NY, U, US); Sierra de Tamaulipas, along Hwy. 70 between Soto la Marina and Cd. Casas E of Victoria, *L. Brown* 13279 (CAS); 5 km N del Ejido El Palmar en la cañada La Sardinia, 24°43'N, 098°54'W, *J. Martínez & J. Mora* 360 (MEXU); vic. of Victoria, *E. Palmer* 175 (F, GH); Buena Vista Hda., *E. Wootton* 18 (US).

FUTURE WORK

Previously, Daniel (2013b) indicated occurrences of 40 species of Acanthaceae from Tamaulipas. The increase to 50 species now known from the state has resulted from additional collections made and/or studied since 2013. Thus, it is likely that continued collecting, especially in those regions of both the coastal lowlands and remote portions of the mountains that remain insufficiently explored, will further supplement the number of Acanthaceae there. Species that might be expected to occur natively in the state, based on their occurrences in nearby states and the presence of suitable habitats in Tamaulipas include: *Bravaisia berlandieriana* (Nees) T.F. Daniel, *Carlowrightia purpurea* T.F. Daniel, *C. texana* Henrickson & T.F. Daniel, *C. torreyana* Washh., *Dicliptera brachiata* (Pursh) Spreng., *Dyschoriste linearis* (Torr. & A. Gray) Kuntze, *D. poliodes* Leonard & Gentry, *Elytraria imbricata* (Vahl) Pers., *Justicia hintoniorum* Nesom, *Odontonema callystachyum* (Schltdl. & Cham.) Kuntze, *O. cuspidatum* (Nees) Kuntze, and *Ruellia parryi* A.

Gray. The names of some of these and other species have been misapplied to collections from Tamaulipas, but we have yet to verify their occurrences in the state. Other Acanthaceae that are often cultivated are likely to be found naturalized in the state, including *J. spicigera* Schldl. (native to Mexico) and *Hypoestes phyllostachya* Baker (native to Madagascar).

In order to provide more complete conservation assessments, field observations on the endemic and rare species are necessary to gauge threats or potential threats and their documented or potential impacts on populations. The taxonomic issues noted above concerning *Dicliptera sumichrastii*, several taxa of *Dyschoriste*, *Justicia* sp., *Pseuderanthemum praecox*, and the genera *Mirandea* and *Yeatesia* remain to be resolved. Next-generation molecular studies will likely greatly assist in sorting out the taxonomic circumscriptions of these taxa. It is our hope that this guide will permit the identification of acanthaceous plants from Tamaulipas and inspire local botanists to help resolve remaining taxonomic problems toward a comprehensive account of the vascular flora of the state.

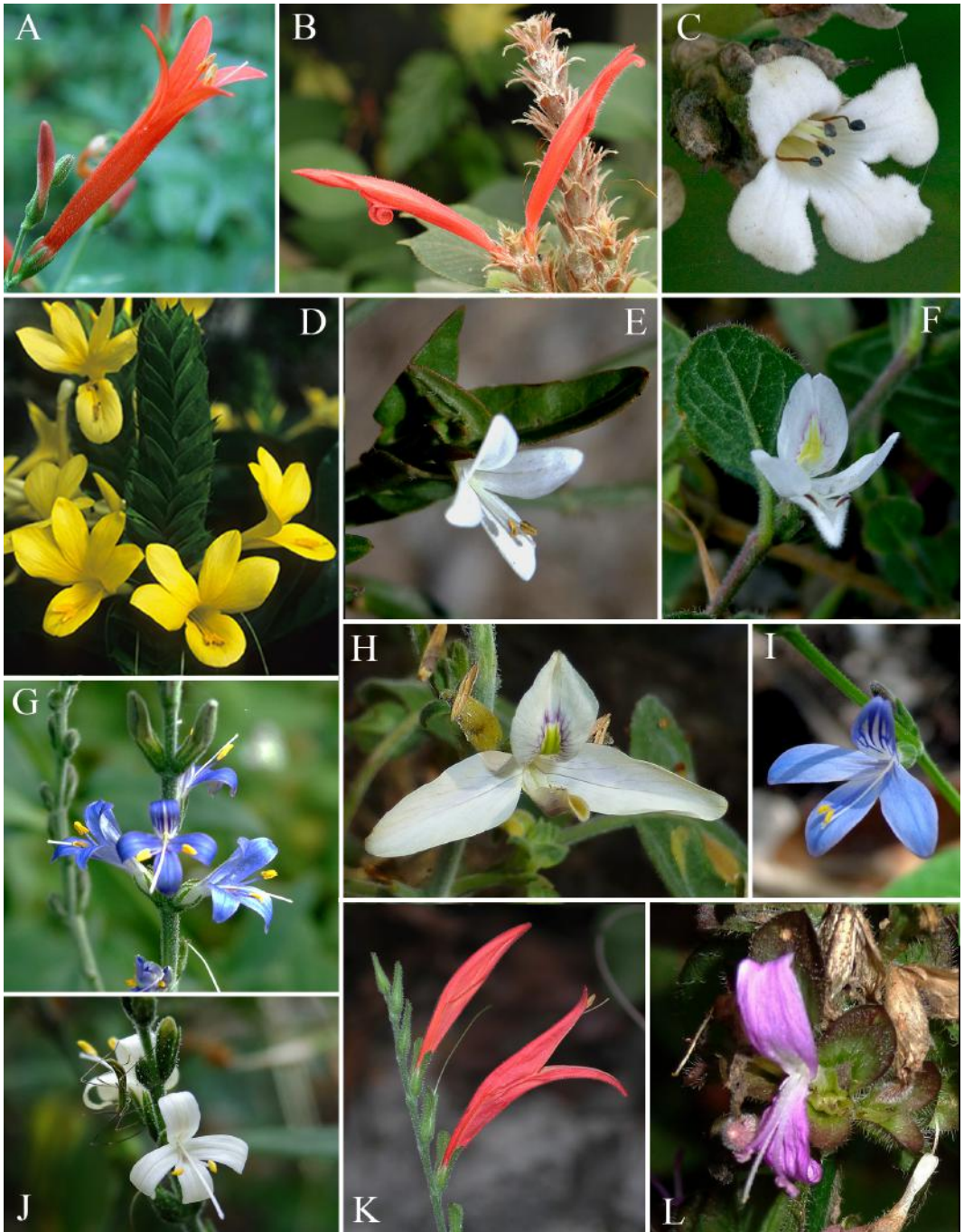


FIGURE 1. Tamaulipan Acanthaceae I. A. *Anisacanthus quadrifidus*. B. *Aphelandra scabra*. C. *Avicennia germinans*. D. *Barleria oenotheroides*. E. *Carlowrightia albiflora*. F. *Carlowrightia trichocarpa*. G. *Carlowrightia parviflora* (blue-flowered form). H. *Carlowrightia neesiana*. I. *Carlowrightia hapalocarpa*. J. *Carlowrightia parviflora* (white-flowered form). K. *Dicliptera sexangularis*. L. *Dicliptera sumichrastii*. Photos by T. Daniel (A, B, D, H, K), W. Eckerman (C), and L. García-Morales (E–G, I, J, L).

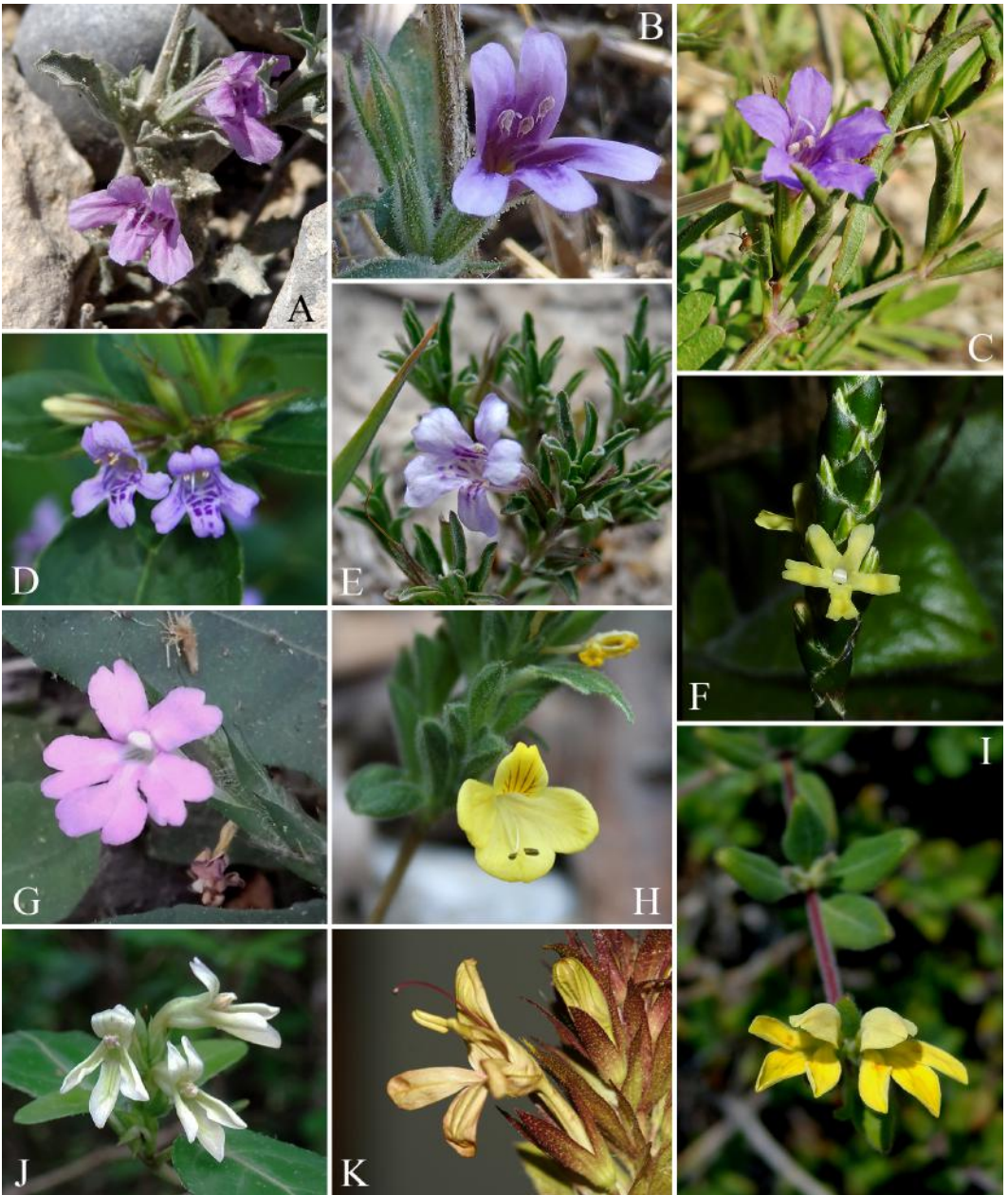


FIGURE 2. Tamaulipan Acanthaceae II. A. *Dyschoriste crenulata*. B. *Dyschoriste hirsutissima*. C. *Dyschoriste greenmanii*. D. *Dyschoriste quadrangularis*. E. *Dyschoriste schiedeana*. F. *Elytraria macrophylla*. G. *Elytraria bromoides*. H. *Henrya insularis*. I. *Holographis ehrenbergiana*. J. *Holographis tamaulipica*. K. *Hoverdenia speciosa*. Photos by T. Daniel (B, F, H), L. García-Morales (A, C, E, I, J), S. Niebla-Alvarez, cropped, CC BY-NC-SA 4.0, (D), E. Fernández, cropped, CC BY-NC 4.0 (G), G. Starr (to whom copyright is reserved), used with permission (K).

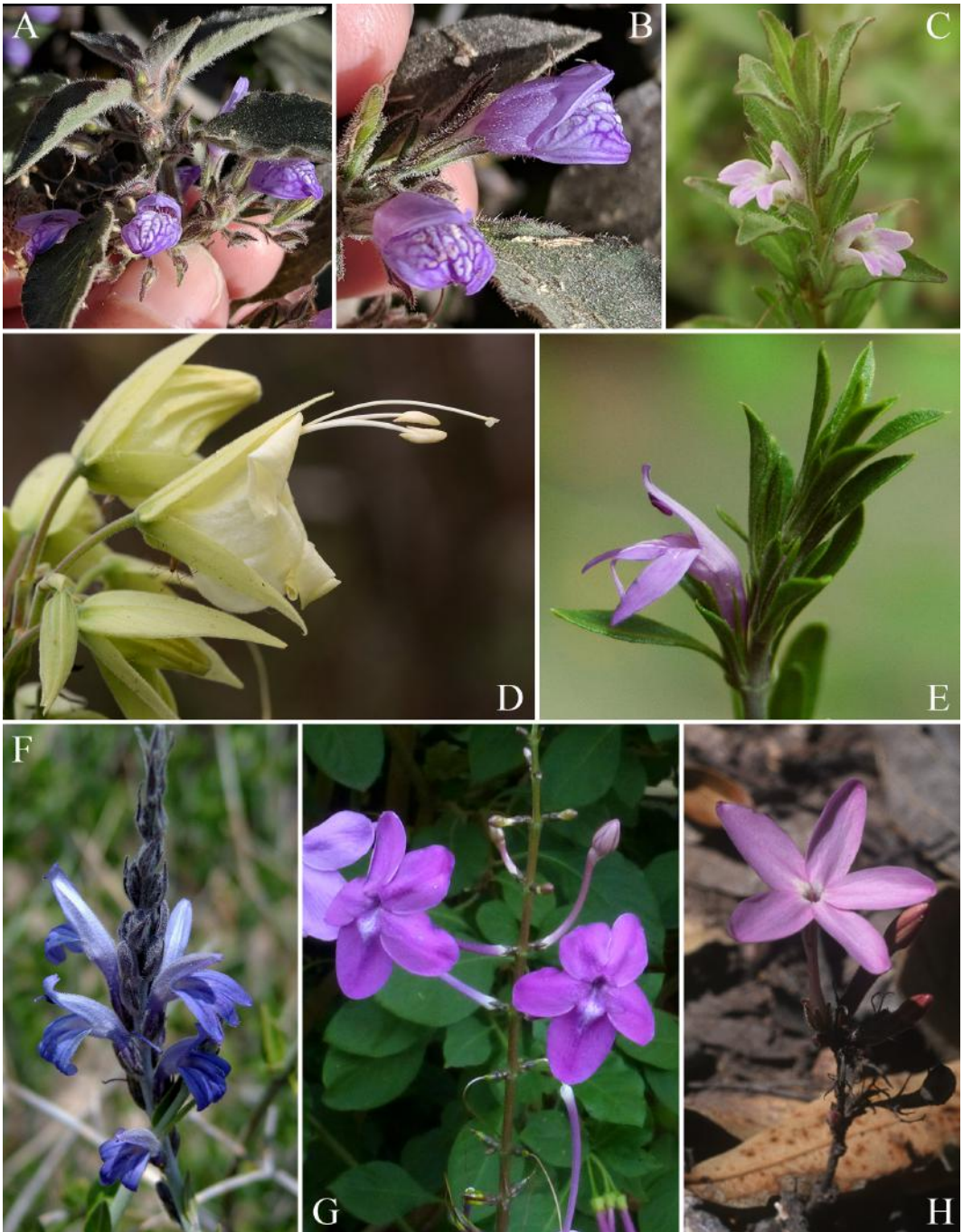


FIGURE 3. Tamaulipan Acanthaceae III. A, B, *Hygrophila corymbosa*. C, *Hygrophila polysperma*. D, *Louteridium tamaulipense*. E, *Mirandea andradenia*. F, *Mirandea grisea*. G, *Pseuderanthemum alatum*. H, *Pseuderanthemum praecox*. Photos by T. Daniel (G, H), L. García-Morales (F), C. Kiel (E), A. Northup, public domain, CC0 1.0 Universal (A, B), A. Mora-Olivo (D), S. Winterton, Aquarium and Pond Plants of the World, Ed. 3, USDA APHIS PPQ, Bugwood.org, cropped, CC- By-NC-3.0 (C).



FIGURE 4. Tamaulipan Acanthaceae IV. A. *Justicia brandegeana*. B. *Justicia leonardii*. C. *Justicia salviiflora*. D. *Justicia linearis*. E. *Justicia fulvicoma*. F. *Justicia pilosella*. G. *Justicia canbyi*. H. *Justicia* sp. I. *Justicia pacifica*. Photos by T. Daniel (A–C, E) and L. García-Morales (D, F–I).



FIGURE 5. Tamaulipan Acanthaceae V. A. *Ruellia blechum*. B. *Ruellia ciliatiflora*. C. *Ruellia hookeriana*. D. *Ruellia paniculata*. E. *Ruellia simplex* (blue-flowered form). F. *Ruellia simplex* (white-flowered form). G. *Stenandrium dulce*. H. *Tetramerium nervosum*. I. *Thunbergia fragrans*. J. *Thunbergia alata*. K. *Yeatesia mabryi*. L. *Yeatesia platystegia*. Photos by T. Daniel (A, C–G, I, J), E. Fernández, cropped, CC BY-NC 4.0 (H), L. García-Morales (B, K), B. Leander, used with permission from the Lady Bird Johnson Wildflower Center (L).

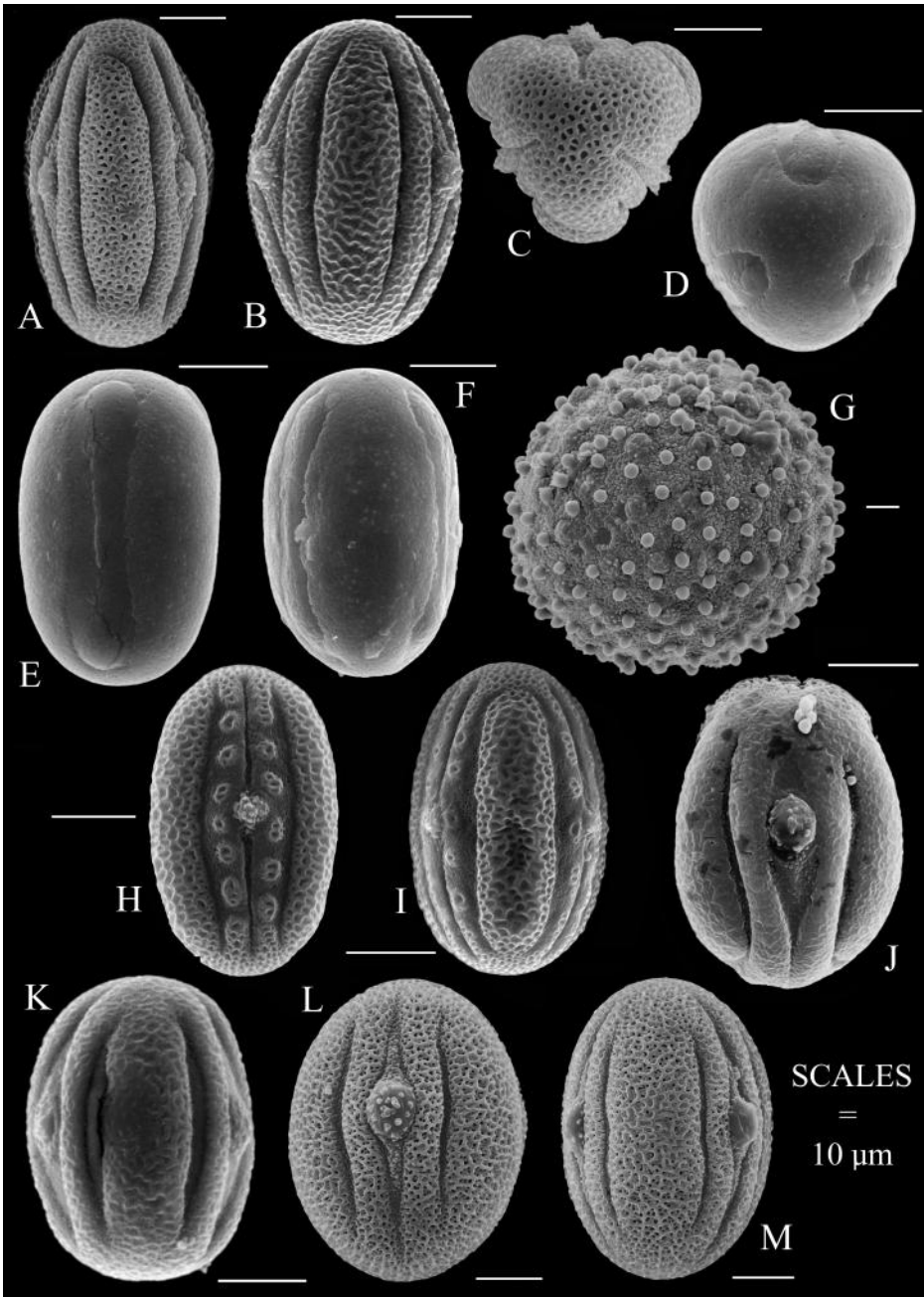


FIGURE 6. Pollen of Acanthaceae endemic to Tamaulipas. A–C. *Carlowrightia*, 3-colporate, 6-pseudocolpate, A. *C. albiflora* (Daniel 276), interapertural view, B. *C. henricksonii* (Johnston & Crutchfield 5357), interapertural view, C. *C. trichocarpa* (Daniel 260), polar view. D–F. *Holographis tamaulipica* (Woodruff et al. 166), 3-colpate, D. polar view E. apertural view, F. interapertural view. G. *Louteridium tamaulipense* (Hutchinson s.n.), pantoforate. H, I. *Justicia* sp. (Medrano et al. 9981), 2-aperturate (colporate) with apertures flanked by 1 row of insulae on each side, H. apertural view, I. interapertural view. J, K. *Mirandea andradenia* (Daniel & Baker 3693), 3-colporate, 6-pseudocolpate, J. apertural view, K. interapertural view. L, M. *Yeatesia mabryi* (Daniel & Baker 3698), 3-colporate, 6-pseudocolpate, L. apertural view, M. interapertural view.

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Deep-Sea Octocoral Biodiversity Surveys in Central California

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A review article is presented to summarize aspects of the history of near-coastal marine science in central California, as well as recent discoveries resulting from the collaboration between the National Marine Sanctuaries of NOAA and the Invertebrate Zoology and Geology Department of the California Academy of Sciences. Beginning in 2012, the Invertebrate Zoology collections at the Academy became the repository for benthic invertebrates (predominantly corals and sponges) from the Greater Farallones, Cordell Bank, and northern part of Monterey Bay National Marine Sanctuaries, collected by remotely operated vehicles (ROV). Significant outcomes that have previously been made as a result of this collaboration include the naming of a new genus to replace an incorrect generic name, and three new species (one deep-sea pennatulacean and two mesophotic plexaurid corals). Some of the more noteworthy taxa that were previously unknown from central California are illustrated with scanning electron micrographs of sclerites. Also included are descriptions of recently recognized benthic ecological interactions from mesophotic and deep-sea depths.

KEYWORDS: California, Marine Protected Areas, National Marine Sanctuaries, deep-sea, benthic biodiversity, museum collections, coral diversity

The offshore coastal waters of the San Francisco Bay region are predominantly federally protected in three national marine sanctuaries – Greater Farallones National Marine Sanctuary, Cordell Bank NMS, and the northern portion of Monterey Bay NMS (Fig. 1). The only terrestrial area within these sanctuaries are the Farallon Islands, which represent a small archipelago of exposed rocky outcrops in the Gulf of the Farallones approximately thirty miles west of San Francisco. The islands are managed by the U.S. Fish and Wildlife Service named as the Farallon Islands National Wildlife Refuge, as well as the California Department of Fish and Wildlife in several Marine Protected Areas in the area. The waters surrounding the islands benefit from protection as part of the Greater Farallones NMS of the National Oceanic and Atmospheric Administration. The national marine sanctuaries of the San Francisco Bay region include open ocean waters and portions of the continental slope and shelf with concomitant submerged ridges, banks, and canyons, to depths of at least 3400 m.

Beginning in 2012, the Department of Invertebrate Zoology and Geology of the California Academy of Sciences (CASIZ) has filled an instrumental role in the production of biodiversity survey data required for boundary expansion proposals by NOAA. In addition, relatively recent improvements in the development of ROV technology have allowed for deep-sea exploration and low impact specimen collection (Fig. 2). Biodiversity surveys were necessary to provide baseline data that was essential for regional expansion proposals in the nutrient-rich waters of Gulf of the Farallones and Cordell Bank National Marine Sanctuaries. The substantial boundary expansions of

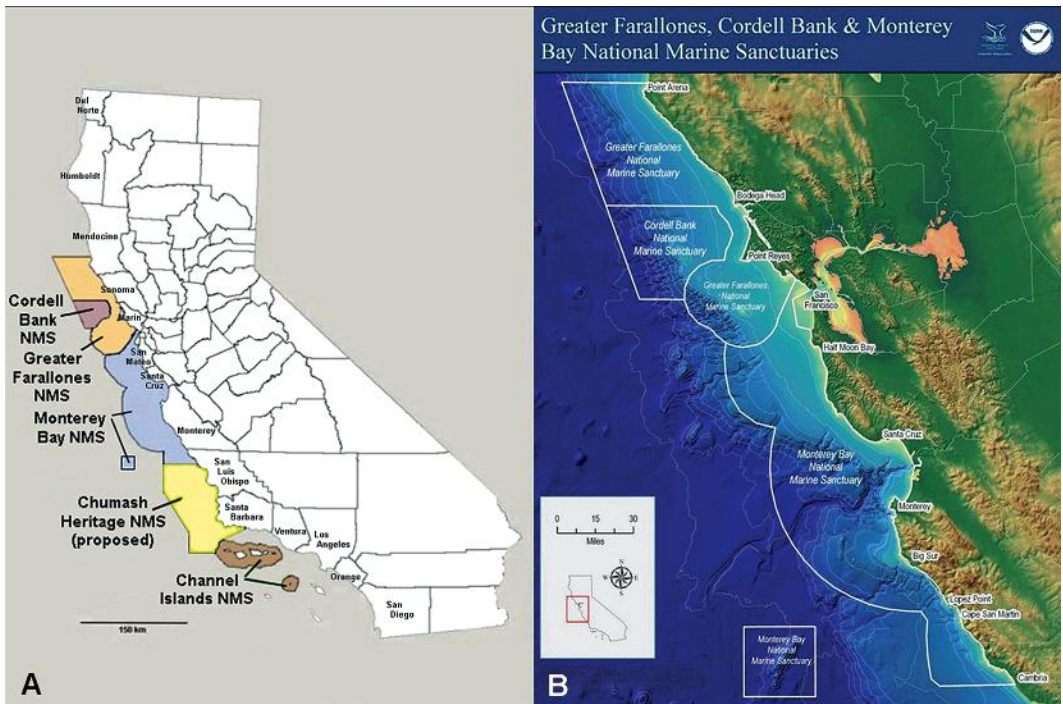


FIGURE 1. National Marine Sanctuaries in California. A. Map showing the coastal counties of California with distribution of the four current and one proposed national marine sanctuaries. B. Detailed map of central California showing the current boundaries of three national marine sanctuaries (courtesy: NOAA Office of National Marine Sanctuaries).

both Gulf of the Farallones and Cordell Bank NMS's were officially established during the first half of 2015 (Boundary Expansion, 2017). The name, Gulf of the Farallones NMS was changed to Greater Farallones NMS at the time of boundary expansion establishment.

In addition to several NOAA research vessels, Ocean Exploratory Trust (OET) operates the E/V *Nautilus* and the state-of-the-art ROV, *Hercules* (Figs. 2B), which frequently conducts exploratory cruises along the U.S. Pacific Coast and within the national marine sanctuaries.

As a result of this recently established collaborative relationship, the invertebrate zoology collection of the Academy was established as the repository for benthic invertebrates (mostly corals and sponges) that have been collected by sanctuary and Academy researchers in Greater Farallones NMS, Cordell Bank NMS, and the northern section of Monterey Bay NMS. Since then, annual exploratory and collecting expeditions have taken place along various parts of the California coast under the auspices of the NOAA and the Ocean Exploration Trust. This endeavor has involved the utilization of several oceanographic research ships including the FSV *Bell M. Shimada*, the R/V *Fulmar*, and the E/V *Nautilus*.

MATERIALS AND METHODS

Collaborative collecting expeditions between GFNMS and the CASIZ began in 2012, and subsequently expanded to include CBNMS and the northern portion of MBNMS, as well as collaboration with OET. Periodic fieldwork was conducted aboard one of three NOAA and OET oceanographic research ships: the R/V *Fulmar* (Fig. 2F) in 2012 and 2014, the E/V *Nautilus* (Figs. 2D, 2E) in 2016, 2017, 2019, 2020, and the FSV *Bell M. Shimada* (Fig. 2A) in 2018.



FIGURE 2. Offshore Operations . A. Scientific staff on board FSV *Bell M. Shimada* with the MARE ROV, “Beagle”, August 2018. B. The ROV “Hercules” on board E/V *Nautilus*. C. The manipulator arm of the ROV “Hercules” on the E/V *Nautilus*, collecting branches of the bamboo coral, *Keratosis* sp. D. The E/V *Nautilus* at harbor, San Francisco. E. Bow of the E/V *Nautilus* approaching the Golden Gate. F. The CBNMS ROV on board R/V *Fulmar*. Photograph 2C courtesy OET and NOAA.

Fieldwork included deep-sea exploration and benthic surveys from 2012-2020. Benthic invertebrates were collected by Remotely Operated Vehicles (Figs. 2A, 2B, 2F), using a manipulator arm on the ROV to collect biological samples (Fig. 2C).

CASIZ is the repository for benthic collections in the central California national marine sanctuaries since 2012. Collected material continues to be curated and housed in the marine invertebrate collections of the Academy’s Department of Invertebrate Zoology and Geology. Most material is wet-preserved in 95% ethanol, while a few larger specimens are preserved dry. All material

is in the process of being curated and catalogued into the IZ collection database (https://researcharchive.calacademy.org/research/izg/iz_coll_db/index.asp). Microscopic examination of coral skeletal structures and scanning electron micrographs were made using a Hitachi SU3500 SEM.

Abbreviations used in the text are as follows: **CASIZ** – California Academy of Sciences Invertebrate Zoology; **CBNMS** – Cordell Bank National Marine Sanctuary; **EV** – Exploratory Vessel; **FORE** – Farallones Oceanic Research Expedition; **FSV** – Fisheries Survey Vessel; **GFNMS** – Greater Farallones National Marine Sanctuary (formerly Gulf of the Farallones National Marine Sanctuary); **MARE** – Marine Applied Research and Engineering; **MBARI** – Monterey Bay Aquarium Research Institute; **MBNMS** – Monterey Bay National Marine Sanctuary; **MLML** – Moss Landing Marine Laboratories; **NMS** – National Marine Sanctuary; **NMSP** – National Marine Sanctuaries Program; **NOAA** – National Oceanic and Atmospheric Administration; **OET** – Ocean Exploration Trust; **ROV** – Remotely Operated Vehicle; **RV** – Research Vessel; **SEM** – Scanning Electron Microscope; **USDOC** – United States Department of Commerce; **USDOJ** – United States Department of Interior; **USGS** – United States Geological Survey.

HISTORICAL CONSIDERATIONS

Interest in the coastal marine environment provided a foundation for marine research since the latter part of the nineteenth century. Marine biological research associated with various university-level institutions in central California has had a long history with the establishment of several marine research and education facilities. Included here are Hopkins Marine Station in 1892 (Stanford University), Pacific Marine Station founded in 1933 and fully opened by 1947 (University of the Pacific), Bolinas Marine Station in 1958 (College of Marin), and Bodega Marine Laboratories in 1960 (University of California, Berkeley, now affiliated solely with the University of California, Davis <<https://marinescience.ucdavis.edu/bml/about>>).

In the early 1970s when public awareness of environmental problems and its potential protection had increased following the first Earth Day in April of 1970, the federal National Marine Sanctuaries Program was created as a division of the National Oceanic and Atmospheric Administration in the U.S. Department of Commerce.

In 1972, the United States Congress passed the Marine Protection, Research, and Sanctuaries Act, which established the National Marine Sanctuary Program. As of 2021, there are a total of thirteen National Marine Sanctuaries (NMSs) that have been established along the coasts of the continental United States. Currently, there are four NMSs in California, a region extending from southern Mendocino County in the north to the northern Channel Islands in the south. An additional unit has been proposed, which would result in an uninterrupted north to south region of offshore marine protection (Fig. 1).

A national marine sanctuary is a federally designated region in the United States to manage and protect one freshwater and thirteen marine regions that exhibit particular qualities, including scientific, educational, recreational, cultural, historical, or anthropological attributes. The National Marine Sanctuaries Program was instituted three years after the Santa Barbara Oil Spill of 1969 and during concomitant public concern about the vulnerability and lack of protection of near-shore and coastal environments. There are currently six designated NMSP units along the coast of the Atlantic and Gulf of Mexico, two in the Great Lakes, five on the Pacific Coast (Olympic Coast National Marine Sanctuary in Washington plus four in California), and two in the central Pacific (NOAA National Marine Sanctuaries, 2020; Williams & Lipski, 2019).

The four existing sanctuaries in California are from north to south, Greater Farallones, Cordell

Bank, Monterey Bay, and Channel Islands (Fig. 1A). In addition, a recently proposed sanctuary was nominated for designation – Chumash Heritage National Marine Sanctuary – which would join the southern boundary of Monterey Bay National Marine Sanctuary with Channel Islands National Marine Sanctuary (Chumash Heritage National Marine Sanctuary, 2020).

EXPLORATION AND RESEARCH

Since the middle of the nineteenth century, scientific exploration of the California coast commenced with exploration of the coast and offshore water by the U.S. Coast and Geodetic Survey and later in the century by trawling expeditions to sample fish and invertebrate fauna, such as the many notable exploratory cruises of the “Albatross” expeditions of the Pacific coast from 1888–1916 (Moring, 1999). Regarding recent times are the mid-water and deep-sea benthic explorations using remotely operated vehicles by the Monterey Aquarium Research Institute, which began in 1987 (MBARI, 1997).

Scientific exploration of the California coastal region

Of the many scientific exploratory cruises and expeditions that have occurred since the mid-nineteenth century, two in particular deserve special mention for their relationships with the California Academy of Sciences.

In the latter half of the 19th century, the contributions of geographer and astronomer George Davidson of the U.S. Coast and Geodetic Survey are particularly noteworthy. In recognition of his many contributions to west coast science, Davidson Seamount in Monterey Bay National Marine Sanctuary was named for him (MBNMS, 2019). He founded the Davidson Observatory in San Francisco in 1869, and served as president of the California Academy of Sciences from 1871 to 1887 (Leviton & Aldrich, 1997). He directed much of the Pacific Coast Survey work of the United States Coast and Geodetic Survey from 1868–1995 (Online Archive of California, 2010). These detailed surveys of the coast produced coastline maps, maritime charts, and positioning data of the California coast and coastal waters (Wagner, 1932; Gosliner & Behrens, 1996).

The Farallones Oceanic Research Expedition (FORE) was conducted by the Moss Landing Marine Laboratories in 1991 under the direction of Dr. James W. Nybakken, formerly Professor of Biological Sciences at Moss Landing Marine Laboratories, and senior author of a highly rated marine biology textbook (Nybakken & Bertness, 2004). The FORE efforts yielded a wealth of benthic invertebrate material, which was collected by beam trawl on board the R/V *Point Sur* within the U.S. Navy Chemical Munitions Dumping Area. The invertebrate zoology collections of the California Academy of Sciences was the repository for many of the collected invertebrates. Much of this material was subsequently curated and incorporated into the collections of the Department of Invertebrate Zoology and Geology (Williams and Lipski, 2019).

SCIENTIFIC RESULTS

Contemporary Research (CAS and California deep-sea research)

Ecological Interactions (Fig. 3)

Coral communities provide habitat for overall marine biodiversity. The use of video and still imaging by ROVs of deep-sea benthic faunal communities have revealed particular ecological interactions between diverse organisms, that have not otherwise been observed together *in situ*. A particularly remarkable example is that of three associates on the red gorgonian coral *Chromoplexaura marki* (Fig. 3). In this single image can be seen a large predatory nudibranch *Tritonia*

tetraquetra, three predatory ovulid gastropods *Simnia barbarensis*, and several commensal barnacles that appear as spherical, gall-like structures, *Conopea* sp.

Deep-Sea Coral Diversity in Central California – Notable exemplars (Figs. 4-6)

Several notable examples of deep-sea octocorals from off the region of the San Francisco Bay Area include an unidentified species of the plexaurid gorgonian genus *Swiftia* (Fig. 4A) and the mushroom soft coral *Heteropolypus ritteri* (Fig. 4B), both from the CBNMS at circa 100 m depth. Three genera of Isidid gorgonians, also known as bamboo corals, include unidentified species of *Acanella* (Fig. 5A). In figure 5B is shown the cleared axis of *Keratoisis* sp., in which branching occurs at the calcareous internodes, while Fig. 5C displays the cleared axis of *Isidella* sp., in which branching occurs at the proteinous nodes. An *in situ* image of a live colony of the unbranched bamboo coral *Lepidisis* sp. is shown in Fig. 5D. Several anemones can be seen adhering to the rachis between some of the octocoral polyps. Several mesophotic and deep-sea pennatulaceans (sea pens) have been observed from the region, including *Acanthoptilum gracile* (Fig. 6A) and *Ptilosarcus gurneyi* (Fig. 6B), both from MBNMS.

Recent Discoveries (Figs. 7-10)

Relatively recent noteworthy discoveries (Fig. 7A-D) include gorgonian material collected in 2012 from Greater Farallones National Marine Sanctuary (formerly Gulf of the Farallones National Marine Sanctuary) that was used in naming a new genus, *Chromoplexaura*, for a taxon previously placed in a superficially similar Indo-West Pacific genus (Williams, 2013). In 2014, a population of unbranched, whip-like gorgonian was discovered in GFNMS, and was subsequently described as a new species in the gorgonian genus *Swiftia* (Williams and Breedy, 2016). In 2018, a small unidentified, sparsely branched gorgonian allocated to the genus *Chromoplexaura* was discovered and collected in Cordell Bank NMS, and was later described as a new species (Williams & Breedy, 2019). Lastly, multiple samples of a deep-sea pennatulacean in the genus *Protoptilum* were collected during the benthic biodiversity survey of the 1991 Farallones Oceanic Research Expedition (FORE) in the region of Cordell Bank and the Farallon Islands, and was subsequently described as a new species (Williams and Lipski, 2019). In 2019, new material of this species was collected on the continental slope of the western expansion area of Cordell Bank National Marine Sanctuary at 3307 m in depth.

Recently established new records have resulted from material collected in the three central Californian national marine sanctuaries including two gorgonians previously unknown from California: the bubblegum coral *Paragorgia yutlinux* Sanchez, 2005 (Fig. 8), originally described from the Washington/British Columbia border region (Sanchez, 2005), and the unbranched chryso-gorgioid gorgonian *Radicipes stonei* Cordeiro, Cairns & Perez, 2017 (Fig. 9), originally described from the Aleutian Islands, Alaska (Cordeiro, et al., 2017). In addition, the observation and collection of one gorgonian establishes a geographical range extension northward along the California coast (*Eugorgia rubens* Verill, 1868, CASIZ 228213). The species was previously recorded from Peru to Monterey Bay, California (Breedy, et al., 2009), and is here extended north from Monterey to San Mateo County, California, latitude: 37° 23' 20.301" (Fig. 10).

Other noteworthy publications that have recorded deep-sea coral fauna of California include Cairns 2007, Kükenthal 1913, Nutting 1909, and Williams & Alderslade 2011.

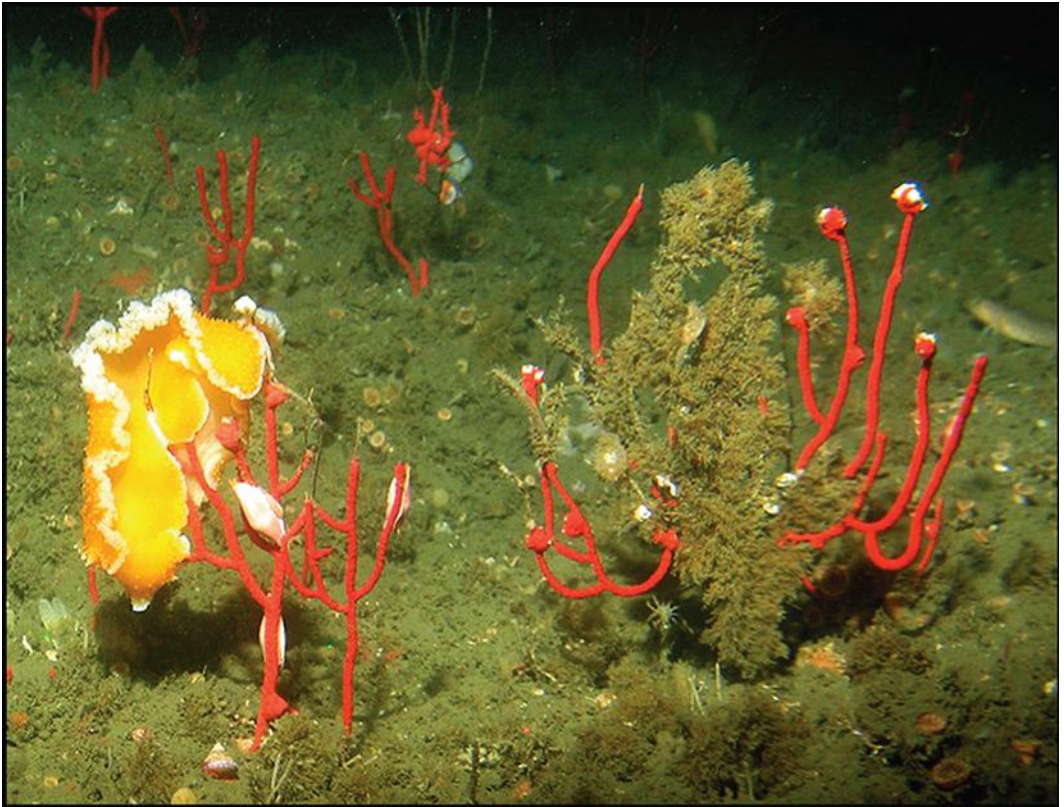


FIGURE 3. Ecological Interactions. Living colonies and associates *in situ* off San Mateo County, Monterey Bay NMS, 48 m, 2 August 2018; several gorgonian colonies *Chromoplexaura marki*, with the nudibranch *Tritonia tetraquetra*, ovulid snails *Simnia barbarentis*, and epizoic barnacles *Conopea* sp. Photograph courtesy NOAA and MARE.

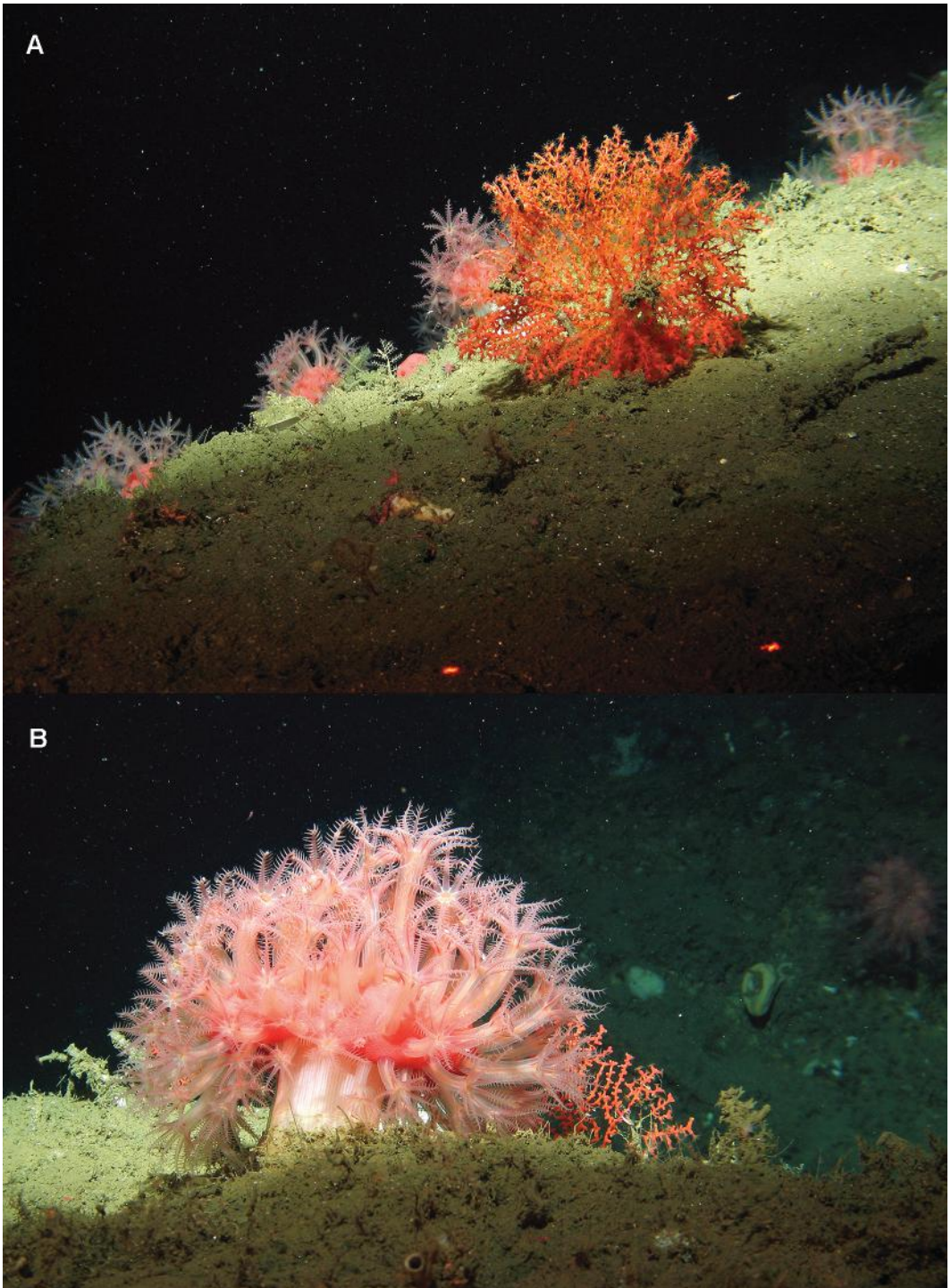


FIGURE 4. *In situ* images made by the MARE ROV “Beagle” of two deep-sea octocorals in CBNMS, August 6, 2018, on board FSV *Bell M. Shimada*. A. *Swiftia* sp. B. *Heteropolypus ritteri*. Photographs courtesy NOAA and MARE.



FIGURE 5. Isidids. A. *Acanella* sp., laboratory photograph of wet-preserved specimen. B. *Keratoisis* sp., two portions of axes showing branching arising from calcareous internodes. C. *Isidella* sp., portion of an axis showing branches arising from proteinous nodes. D. *Lepidisis* sp., portion of living colony *in situ*. Several anemones are attached to the rachis as well (arrows). Photograph 5D courtesy of OET and NOAA.

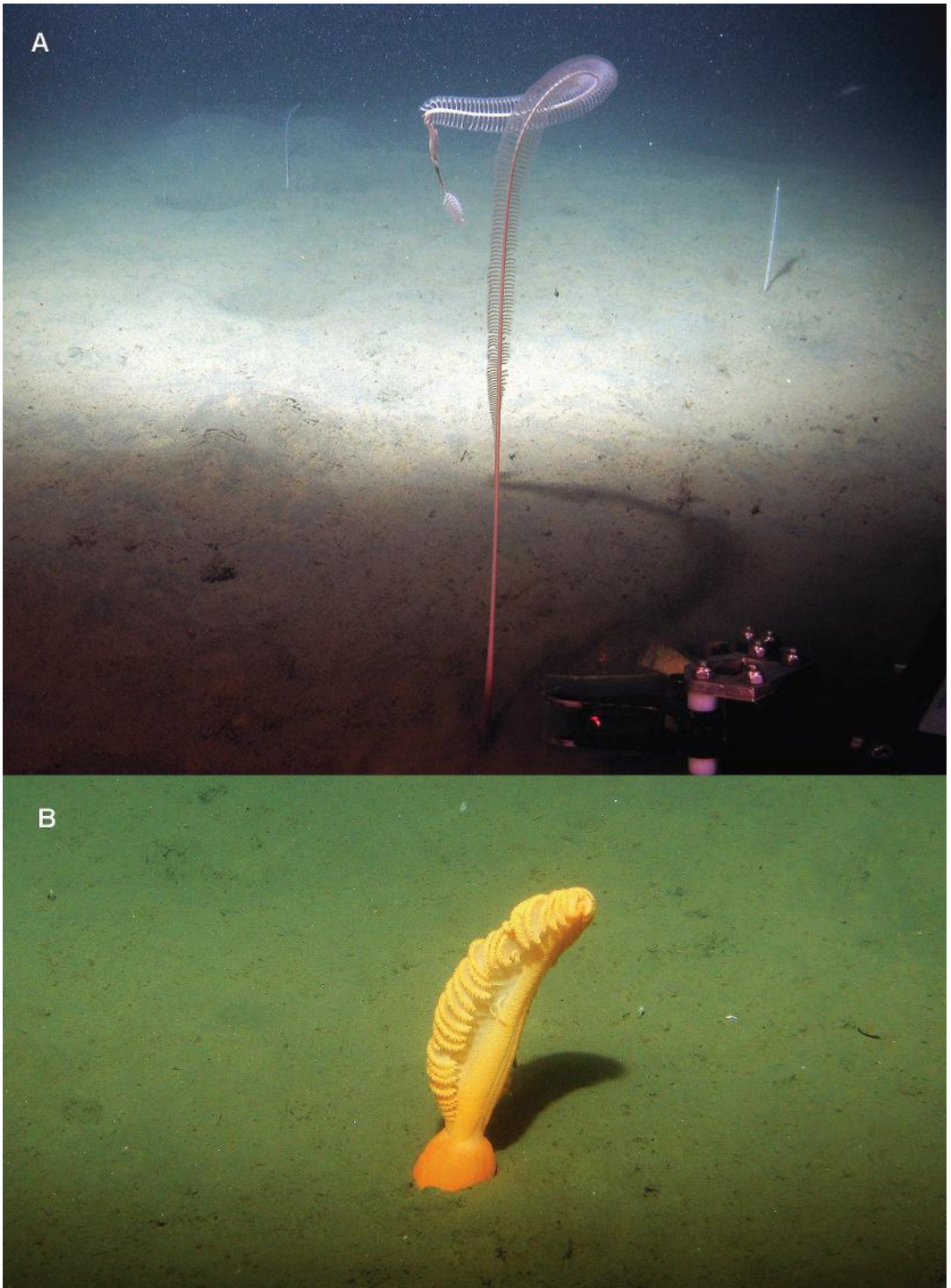


FIGURE 6. *In situ* images made by the MARE ROV “Beagle” of two deep-sea pennatulaceans in CBNMS, August 2-3, 2018, on board FSV *Bell M. Shimada*. A. *Acanthoptilum gracile*. B. *Ptilosarcus gurneyi*. Photographs courtesy of NOAA and MARE.



FIGURE 7. Recent discoveries. A. *Protoptilum nybakkeni* (CASIZ 106702), Holotype, west of the Farallon Islands, 2900 m. B. *Chromoplexaura cordellbankensis* (CASIZ 207519), Paratype, MBNMS, 107 m. C. *Chromoplexaura marki* (CASIZ 228197), CBNMS, 97 m. D. *Swiftia farallonesica* (CASIZ 196930), Holotype, GFNMS, 182 m. Scale bar for A = 25 mm; scale bar for B-E = 50 mm.

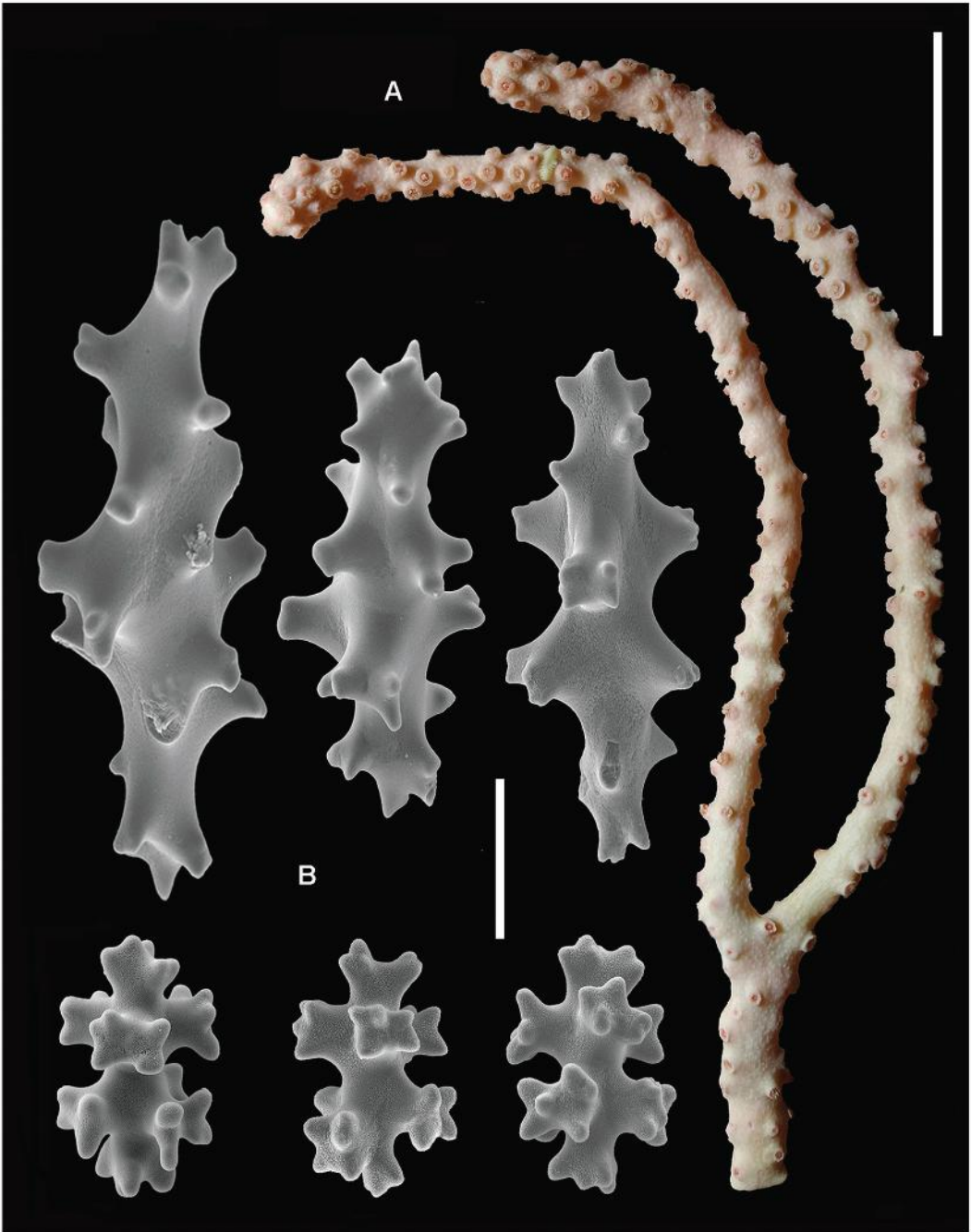


FIGURE 8. *Paragorgia yutlinx* (CASIZ 220970). A. Partial colony, scale bar = 50 mm. B. Coenenchymal sclerites, scale bar = 0.04 mm.

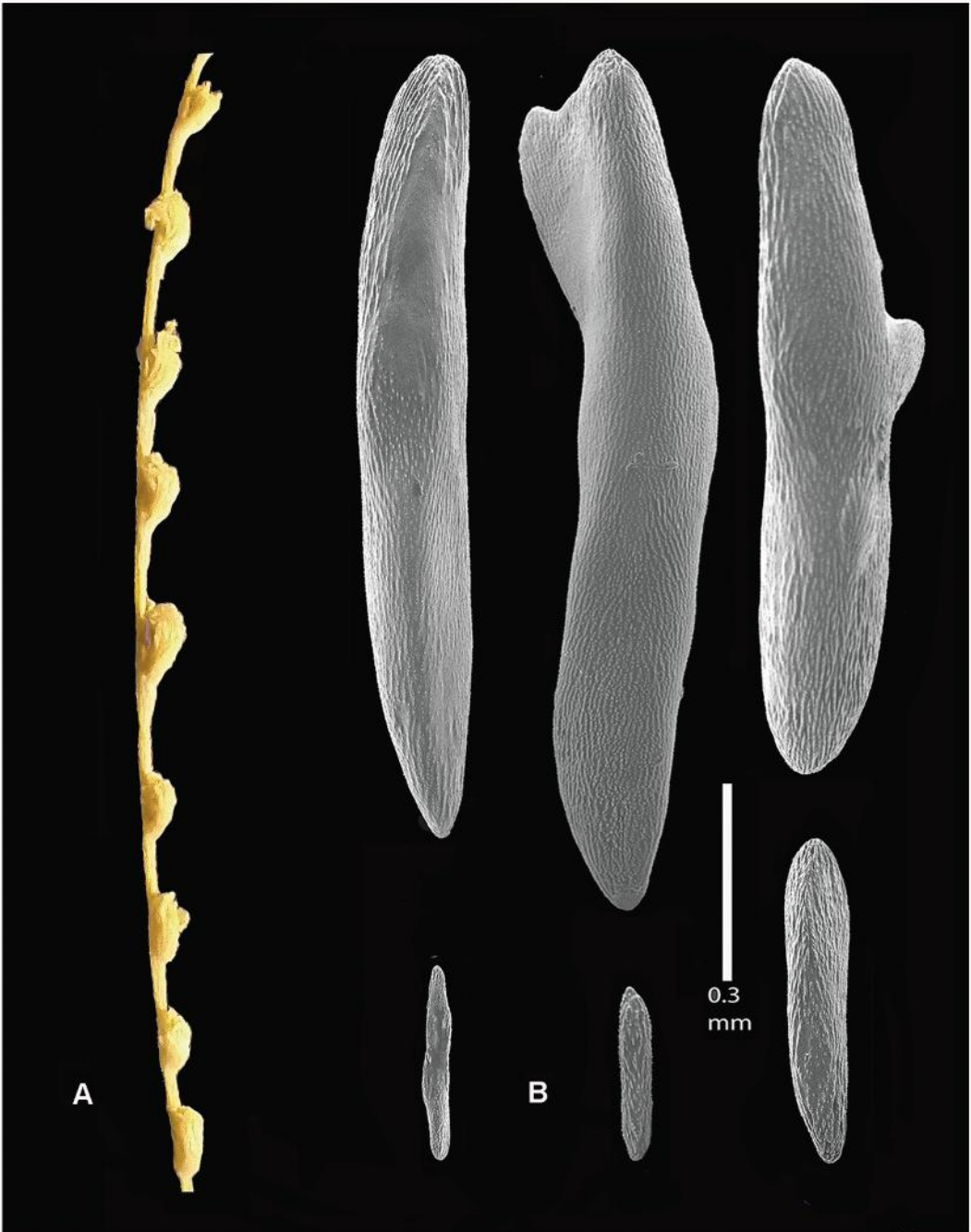


FIGURE 9. *Radicipes stonei* (CASIZ 207516). A. Partial colony, total length = 48 mm. B. CASIZ 207517, Coenenchymal sclerites, scale bar = 0.30 mm.

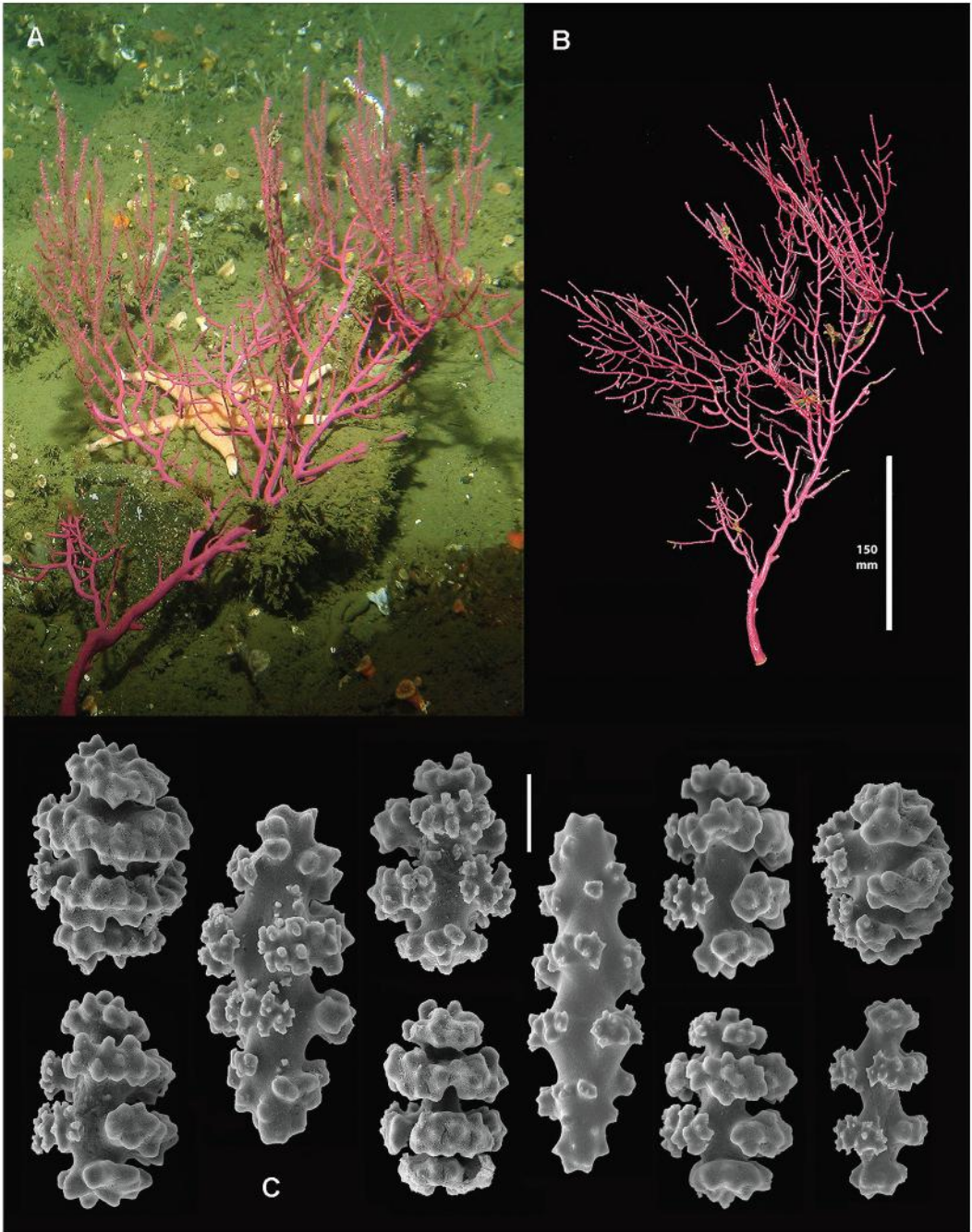


FIGURE 10. *Eugorgia rubens*. A. Living colony *in situ* off San Mateo County, Monterey Bay NMS, 75 m depth, 3 August 2018. CA. B. Dried specimen (CASIZ 228213) of the colony shown in A; scale bar = 150 mm. C. Scanning electron micrographs of coenenchymal sclerites; scale bar = 0.02 mm. Photograph 10A courtesy of NOAA and MARE.

DISCUSSION

Coral Diversity

The number of extant coral species worldwide is estimated to be approximately 5500 species, and two-thirds of these are octocorals (Williams & Cairns, 2018). The California coral species diversity perhaps exceeds several hundred species, but since the number of valid vs. nominal species is not determined, a more credible estimation is currently not possible to assess.

Octocoral Species List (2012-2020)**Order Alcyonacea**

- Family Clavulariidae
Clavularia sp.
- Family Alcyoniidae
Heteropolypus ritteri
- Family Nephtheidae
Gersemia juliepackardae
- Family Paragorgiidae
Paragorgia pacifica
Paragorgia yutlinux
- Family Acanthogorgiidae
Acanthogorgia sp.
- Family Plexauridae
Chromoplexaura cordellbankensis
Chromoplexaura marki
Swiftia farallonesica
Swiftia simplex
Swiftia torreyi
Swiftia sp.
- Family Gorgoniidae
Eugorgia rubens
- Family Primnoidae
Callogorgia kinoshitae
Narella bowersi
Parastenella ramosa
- Family Chrysogorgiidae
Radicipes stonei
- Family Isididae
Acanella sp.
"Isidella" *tentaculatum*
Keratoisis sp.
Lepidisis sp.

Order Pennatulacea

- Family Funiculinidae
Funiculina parkeri
Funiculina quadrangularis
- Family Protoptilidae
Distichoptilum gracile
Protoptilum nybakkeni
- Family Stachyptilidae
Stachyptilum superbum
- Family Umbellulidae
Umbellula sp.
- Family Balticinidae
Balticina californica
- Family Virgulariidae
Acanthoptilum gracile
Stylatula elongata
Virgularia sp.
- Family Pennatulidae
Ptilosarcus gurneyi

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the Museum of Comparative Zoology at Harvard University, and the California Academy of Sciences. I thank the crews and scientific staffs of E/V *Nautilus*, FSV *Bell M. Shimada*, and R/V *Fulmar*. In particular, I extend my gratitude to the following individuals (in alphabetical order): Rick Botman, Maria Brown, Steve Cairns, Michael Carver, Guy Cochrane, Dwight Coleman, Peter Etnoyer, Carina Fish, Kaitlin Graiff, Justin Holl, Steve Holz, Dan Howard, Katie Jewett, Chad King, Andy Laueremann, Kirsten Lindquist, Danielle Lipski, Johanna Loacker, Heidi Lovig, Christina Piotrowski, Nicole Raineault, Jan Roletto, Dirk Rosen, Ren Salgado, Jennifer Stock, Sage Tezak, and Jamie Wagner.

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Synonymy of the Caridean Shrimp Genus *Paralatreutes* Kemp, 1925 with *Latreutes* Stimpson, 1860 (Decapoda: Hippolytidae)

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We examined a single specimen of *Paralatreutes bicornis* on loan from the California Academy of Sciences, which was collected during the 2014 Verde Island Passage Expedition. We found no visible differences between the present specimen and that of the original type description. The form of the body closely resembled that of species of *Latreutes*. We conducted a genetic analysis and found no significant difference between that of *L. porcinus* and our specimen. We therefore consider *Paralatreutes* Kemp, 1925 to be a junior subjective synonym of *Latreutes* Stimpson 1860. We provide a diagnosis of the species and extensions of its range.

KEYWORDS: *Latreutes*, *Paralatreutes*, Hippolytidae, shrimp, Philippine Islands

RESUMEN

Un espécimen único de *Paralatreutes bicornis* Kemp, 1925, recolectado durante la expedición 2014 “Verde Island Passaged Expedition”, fue examinado. No se encontraron diferencias visibles entre este espécimen y aquel utilizado en la descripción original del tipo. La forma del cuerpo es muy parecida a la forma del cuerpo observada en especies de *Latreutes*. Se realizó un análisis genético y no se observaron diferencias significativas entre *L. porcinus* Kemp, 1916 y nuestro espécimen. Consecuentemente, consideramos que *Paralatreutes* Kemp, 1925 es un sinónimo júnior, subjetivo de *Latreutes* Stimpson, 1860. Se proporciona una diagnosis de *Latreutes bicornis* nueva combinación y una ampliación de su interval de distribución.

PALABRAS CLAVE.— *Latreutes*, *Paralatreutes*, Hippolytidae, camarones, Islas Philipinas

Eighteen species of the caridean genus *Latreutes* are currently recognized (Worms, 2021a), while *Paralatreutes* is a monotypic genus (Worms, 2021b). Caridean shrimps of the family Hippolytidae tend to be small, 30 mm in total length or less, and difficult to see. They may be colored like algae or sea grasses, or have blotches, spots or broad bands that conceal them. They may be collected by accident. Such may be the case for the tiny shrimp *Paralatreutes bicornis*, known previously from three female specimens described from the Andaman Islands in 1925. We obtained a specimen from the Philippine Islands. This specimen provides the opportunity to compare it with the original description and adds to knowledge of its living color and geographic range. We conducted a genetic comparison of our specimen with a species of *Latreutes*, and found no significant difference between the genotypes of *Paralatreutes* and *Latreutes*. We herein reassign *P. bicornis* to *Latreutes* and provide a new diagnosis.

FAMILY HIPPOLYTIDAE SPENCE BATE, 1888

Genus *Latreutes* Stimpson, 1860*Latreutes bicornis* (Kemp, 1925)

Paralatreutes bicornis Kemp, 1925: 334-338, figs. 23-24; Holthuis 1993: 245, fig. 242; Chace 1997: 55; Yang 2005: 462.

Material examined.— Female, not ovigerous, carapace length 5.33 mm. Philippine Islands: Luzon, Mabini (Calumpan Peninsula), Balayan Bay, Matotongil Point, 13.76°N, 120.91°E, 18 m, 27 April 2014, Peri Paleracio, coll., on Porifera; California Academy of Sciences catalog number CASIZ202665.

Diagnosis.— Body form robust. Rostrum with dorsal margin bearing 8–11 teeth, diminishing in size from posterior to anterior; apex truncate, one sharp apical spine and two spinules, lower margin without teeth; widest at level of peduncle of first antenna. Carapace dorsally carinate with two large teeth posterior to rostrum, submarginal articulated antenna tooth, series of 9–10 spinules along anterior margin. Eyes large, pigmented; ocular peduncle with antero-internal process projecting slightly beyond cornea. First antenna with sharp anterolateral tooth on first segment, flagella equal in length, stylocerite acute, reaching end of first segment; second and third segments unarmed. Antennal scale triangular, three times as long as wide, nearly same length as rostrum, spine exceeding blade. Peduncle of second antennae reaching top end of second segment of antennular peduncle. Mandible without palp. First and second maxilliped with exopods, Third maxilliped without exopod. Epipods on first four pereopods, without arthrobranchs. First to fourth pereopods with epipods. First pereopods shorter than third maxillipeds, merus with blunt tooth at distal tooth, chelate, fingers shorter than palm. Second pereopod slender, chelate, carpus with three articles. Third pereopod with merus having distolateral sharp tooth, upper margin with blunt tooth, propodus with coarse spinules, dactyl biunguiculate with 4 spines posterior to terminal unguis. Fourth and fifth pereopods similar but shorter. Abdominal somites without dorsal teeth or carinae. Pleura blunt or rounded but posteroventral border of fifth somite with at least one minute tooth. Telson with two pairs dorsal spines, apex with two lateral spines on each side, inner spines longer than outer.

Color in life.— Carapace and abdomen dull, plum-colored or vermilion, with large reddish mid-dorsal patch on carapace; antennal scale and anterior third of rostrum plum-colored or mottled with grey and green, legs red or vermilion or with distal end of merus and carpus pale grey green and propodus purplish orange, propodus of pereopods 3–4 transparent with large deep blue apical spot, fifth dactyl bright red; pleopods dull reddish purple, eggs orange. (Kemp 1925). Figure 1 shows two views of the specimen in life, and shows the “dorsal patch” on the carapace and marks of tan and red on the pereopods. Photographs of a similar shrimp from Kwajalein show a shrimp that is dark blue with white bands of brown, with hair-like processes on the body (www.underwaterkwaj.com/uw-misc/shrimp/Shrimp-Halimeda-blue.htm).

Type location.— Ross Channel, Port Blair, Andaman Islands, 11°036.1'N, 92°054.5'E, 57 m. The type material, three female specimens, was deposited in the Indian Museum (now the Zoological Survey of India, Calcutta). Some of the specimens of this or other species described by Kemp were sent to the Natural History Museum in London, the Australian Museum, and other locations. The specimens may still exist (Shane Ahyong, Australian Museum, pers. comm.) but as of this writing, they have not been found.

Genetic analysis.— Whole genomic DNA was extracted from 2–4 pleopods using an EZNA Tissue DNA kit (Omega Bio-tek Inc.) following the manufacturer's protocol. The 16S ribosomal RNA (16S) was amplified via polymerase chain reaction (PCR) using primer sets and conditions

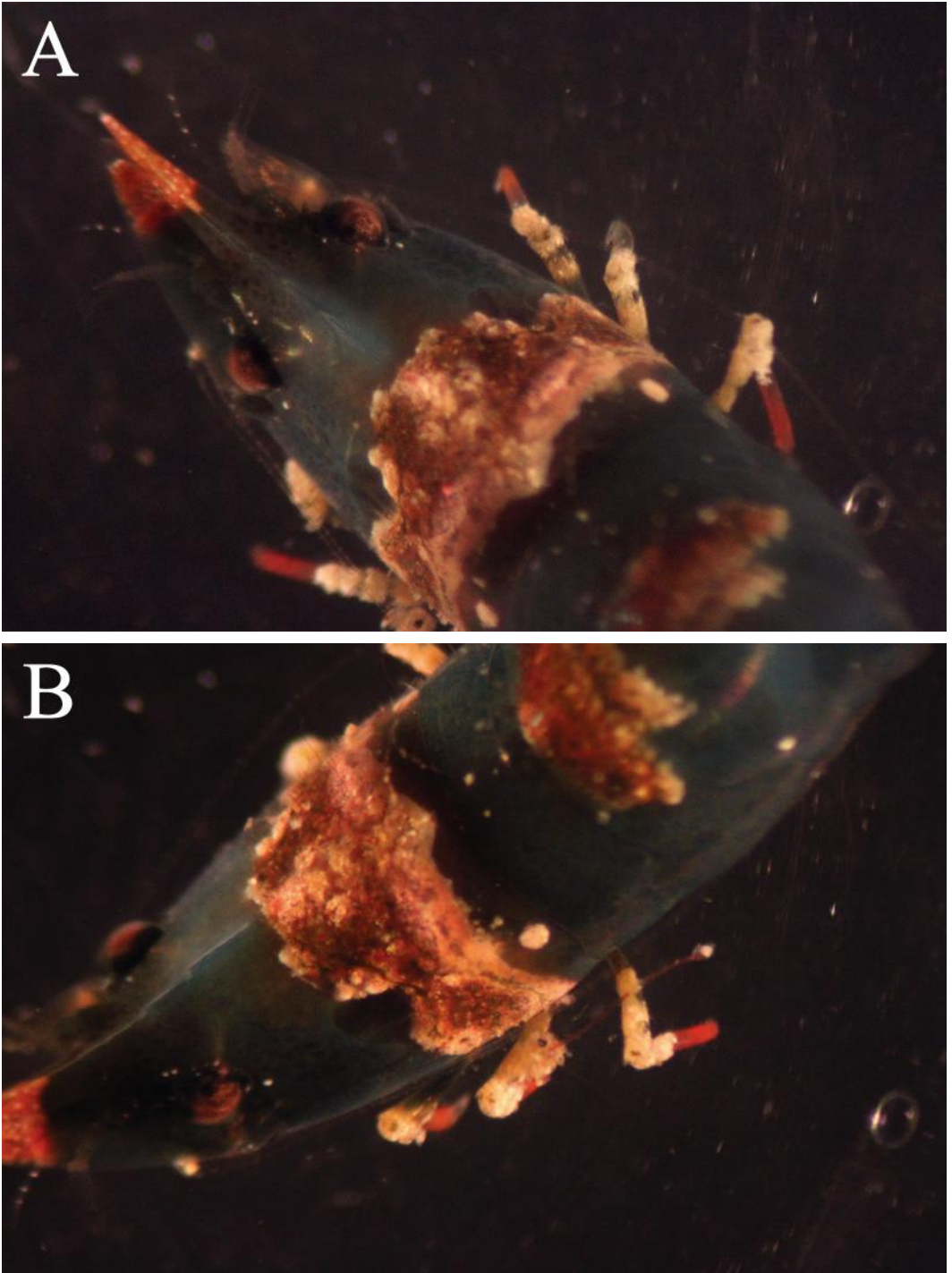


FIGURE 1. A, *Latreutes bicornis* (Kemp, 1925) (CASIZ 202665), dorsal view showing rostrum and anterior carapace. B, Same specimen, dorsal view showing abdomen and posterior pereopods.

as described in Cuesta et al. (2012). Forward and reverse strand Sanger sequencing was performed at Psoimagen, Inc. (<https://psomagen.com/>). Chromatograms were manually checked in MEGA7 (Kumar et al. 2016), cleaned and filtered, and then a BLAST search was performed to verify the identity of the sequence and evaluated similarity to existing sequences in the NCBI database (<https://blast.ncbi.nlm.nih.gov/Blast.cgi>). The sequence aligned with 99.18% identity to a 481 bp 16S sequence of *Latreutes porcinus* (Kemp, 1916) (MK722383; Terossi et al. 2019), indicating that the collected shrimp known as *Paralatreutes bicornis* should be assigned to *Latreutes* instead of a separate genus. The sequence has been deposited in GenBank (MZ367600). We also sequenced CO1 but the result was of poor quality, possibly due to a pseudogene, and not usable for further analysis. The high genetic similarity between *L. bicornis* and *L. porcinus* could indicate that the two are con-specific, but at present this similarity reflects an analysis of only one gene.

The original separation of the monotypic genus *Paralatreutes* was based on the lack of an exopod on the third maxilliped. This feature has been seen to be variable in other related carideans (G. Jensen, University of Washington, pers. comm). The large dorsal teeth on the carapace are not present in other species of *Latreutes* but occur in other related genera.

Discussion.—The large carapace teeth and the lack of an exopod on the third maxilliped readily distinguish *L. bicornis* from other species of *Latreutes*. (See Chace, 1972 for a key to the species). All four specimens (the three in the type series and the present specimen) are or were females with a ventrally expanded rostrum, as in other species of *Latreutes*. Male *Latreutes* have a narrow rostrum with fewer teeth. *Latreutes bicornis* also may be sexually dimorphic.

The original description of *L. bicornis* and the specimen we examined both show two very large flat teeth on the dorsal surface of the carapace instead of a series of short more or less equal teeth, as are found in other species such as *L. porcinus*. Anker and De Grave (2016) provided photos of *L. porcinus* in which its color resembled that of sea grasses or sand. Color patterns of species of *Latreutes* tend to be variable but the color pattern of the present specimen of *L. bicornis* more closely resembles that in the description by Kemp than that seen in photographs of *L. porcinus*. Pending analysis of additional specimens we prefer to consider *L. porcinus* and *L. bicornis* to be separate species.

The family designation of the species of *Latreutes* remains in question. Stimpson (1860) placed *Latreutes* within the Hippolytidae, as did Holthuis (1993) and Chace (1997). Yang (2005), on examining the larvae of *Latreutes anoplonyx* Kemp, 1914 and comparing them with other *Latreutes* species, noted there were significant differences between the first zoea of these species and those of other species of the Hippolytidae. Christoffersen (1987) suggested that members of the genera *Gelastocaris*, *Gelastreutes*, *Latreutes*, *Paralatreutes*, *Tozeuma* and *Trachycaris* might consist a subfamily, the Latreutinae. Yang disagreed, noting differences in the morphology of the first zoea between *Tozeuma carolinense* (Kingsley, 1878) and species of *Latreutes*. De Grave et al. (2014) using genetical analyses, concluded that the family Hippolytidae *sensu* Stimpson was polyphyletic. According to this analysis, *Latreutes* remains in a clade that contains the type genus, *Hippolyte*. This species may be more widespread in the Indian and Pacific Oceans than previously recorded. We received a photograph likely to be this species taken off Kwajalein Atoll (9.19° N, 167.42° E, Johnson and Johnson, pers. comm.)

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Daphne Gail Fautin
(May 25, 1946 – March 12, 2021)

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Daphne Gail Fautin passed away on March 12th 2021. She was one of the premier coelenterate systematic biologists and contributed immensely to our understanding of systematics. She was also deeply committed to building contemporary online databases of marine biodiversity through her involvement and leadership in the Census of Marine Life and the Ocean Biogeographic Information System. Daphne was a field biologist, a superb histologist and dedicated advocate for advancing the training of systematic biologists and mentoring students. She will be greatly missed by all whose lives she touched and whose careers she influenced. Daphne is survived by her husband and professional colleague, Robert Buddemeier.

EARLY DAYS

Daphne was born on May 25, 1946. She stated that her parents had the good sense to move to Laramie, Wyoming when she was three months old. Daphne spent most of her formative years in Wyoming and then went to Beloit College where she completed her Bachelor of Science degree in 1966. She graduated Magna Cum Laude and was a member of Phi Beta Kappa, a Porter Scholar, and member of Mortar Board and Alpha Lambda Delta. From Beloit, Daphne entered the Peace Corps and taught science at Sri Mersing Secondary School, Mersing, Johor, Malaysia from January 1967 - December 1968. After her stint in the Peace Corps, Daphne then came to U. C. Berkeley and the Bodega Marine Lab to start her PhD on the natural history and reproductive biology of the brooding sea anemone *Epiactis prolifera* under the mentorship of Cadet Hand (Fig. 1). This is where two of us as undergraduates (TMG and GCW) first met Daphne. After completing her PhD in 1972, Daphne started a postdoctoral Fellowship at the University of Hawaii in the Department of Pharmacology at the School of Medicine. This opportunity launched Daphne's life-long interest in biomedical use of marine natural products. From Hawaii, Daphne returned to Malaysia from 1973-1975 as a Research Associate at the University of Malaya, in Kuala Lumpur.

CALIFORNIA ACADEMY OF SCIENCES

Daphne returned to California in 1975 and immediately became a Research Biologist at the California Academy of Sciences. In July, 1980 she was appointed as Assistant Curator, in the Department of Invertebrate Zoology at the Academy (Fig. 2). In this capacity, Daphne became active in the search for a new Executive Director after the retirement of George Lindsay, following his nearly two-decade long leadership. With the arrival of Frank Talbot as Executive Director,



FIGURE 1. Daphne with Cadet Hand (2002), former Director of the Bodega Marine Laboratory, University of California. Photograph courtesy of Marymegan Daly.

Daphne became a leader in the establishment and development of the Christiansen Research Institute in Madang, Papua New Guinea and organized a program of visiting fellowships to explore the biodiversity of Madang Province. During this period, Daphne also built a histology laboratory at the Academy and published widely, including the first documentation of production of chitin by sea anemones in constructing a covering over commensal hermit crabs in deep-sea tropical environments. Her interest in brooding reproduction and commensalism continued to grow and expanded to her study of the symbiotic relationship between sea anemones and clownfishes. Daphne's accomplishments were widely recognized and she advanced through the ranks as Associate Curator in 1984 and Curator in 1989. Over her entire career, Daphne was deeply committed to serving broader communities of scientists and colleagues. At the Academy, Daphne served as Editor of Scientific Publications from 1984-1988 and became the first female Director of Research from 1988-1990. Daphne loved teaching and from 1983-1984 took a sabbatical leave from the Academy to teach at her undergraduate institution, Beloit College. Daphne also developed a sabbatical policy for Academy scientists, so that others could take formal temporary leave to pursue other academic interests away from the Academy. Daphne was devoted to professionalizing museum-based research and bringing standards in line with formal academic institutions. She was a great champion of diversifying opportunities, building communities of scholars and advancing science.

UNIVERSITY OF KANSAS

Daphne moved to Kansas in 1990, serving first in courtesy roles before being appointed



FIGURE 2. Daphne Fautin in the invertebrate collections as Curator of Invertebrate Zoology at the California Academy of Sciences, circa 1986. Photograph courtesy California Academy of Sciences.

Professor of Ecology and Evolutionary Biology and Curator in the KU Natural History Museum (later KU Biodiversity Institute) in 1995. Under Daphne's leadership, the KU Biodiversity Institute Invertebrate collection grew to more than 2000 lots, with strengths in sea anemones and annelids. She taught courses in Invertebrate Zoology and scientific writing and served as primary supervisor for ten graduate students and dozens of undergraduate students. Daphne was famed for wearing an item of jewelry related to a student's thesis topic to graduate candidacy exams, and many students tracked her extensive jewelry collection in the years preceding their exam to anticipate the item that might spark their question. The taxonomic focus of Daphne's research while at Kansas was on species in the Pacific Ocean, building from her active field program in the region and her participation in research expeditions under the "Pulse" program at the Scripps Institute of Oceanography. She and her students described seven species from the deep Pacific and five species from the tropical Indo-West Pacific. Her work in the Indo-West Pacific included a series of collaborations with citizen-scientists and enthusiasts in Singapore, which coalesced into what Daphne and collaborators called the "anemone army" following a series of talks and workshops. This interest in building local communities was a thread throughout her career. Daphne was tireless in her engagement with enthusiasts and with other scientists who had questions about sea anemones.

At the University of Kansas, Daphne undertook her most significant research effort, the development of *Hexacorallians of the World*. This digital database of taxonomy, distribution, and literature on sea anemones and their allies was funded by a series of awards from the National Science

Foundation (NSF DEB 95-21819, DEB 99-78106, OCE 00-03970, EF 05-31779). It compiled all published records for all species of sea anemone and served images and label information for type specimens from museums across the globe within a framework of a relational databases that had tools to visualize synonymies and distributions. This decade-long project ultimately involved scores of collaborators who were expert on other lineages of Cnidaria, provided training and support for dozens of undergraduate and graduate students, and was pivotal to the Census of Marine Life and to its successors, the Global Biodiversity Information Facility (GBIF) and Ocean Biodiversity Information System (OBIS), international consortia providing species occurrence data. Beyond the contribution of data, Daphne was a key figure in the development of these global efforts to organize and share biodiversity data, chairing the US National Committee for the Census of Marine Life, and serving as a founding member of the first international committee of OBIS, and vice-chair of the GBIF science committee. *Hexacorallians of the World* also underpinned key taxonomic references, including the Integrated Taxonomic Information System and the World Registry of Marine Species, and was excerpted and summarized in multiple publications, notably Daly et al (2007), Fautin et al (2007), and Fautin (2016). Her contributions to understanding marine biodiversity were recognized in several publications with her Census of Marine Life, OBIS, and GBIF colleagues, including the landmark study led by Appeltans (2012) that estimated the scope of knowledge about marine biodiversity.

In addition to her contributions to sea anemone taxonomy and marine biodiversity science, Daphne was instrumental in the articulation of the “adaptive bleaching hypothesis,” which posits that bleaching of symbiotic anthozoans might have adaptive value, allowing a sessile host to respond in times of local environmental stress by replacing ill-suited genotypes of photosymbionts with phototsymbionts of a genotype better able to thrive under the new conditions (Fautin and Budemeier, 1993). This idea spurred intense debate about the underlying concepts and inspired numerous empirical studies. The larger idea described within this hypothesis, that the coral holobiont has multiple pathways for adaptive response because it is a symbiotic system, is deeply embedded in varied approaches to coral conservation.

Daphne was indefatigable in her service to the professional community, bringing energy and focus to roles large and small. Notably, she was a Councilor of the International Commission on Zoological Nomenclature (ICZN) from 2006- 2013, serving as Vice President 2009- 2013. Daphne was instrumental in securing financial support for the Commission, developing a partnership between the ICZN and the National University of Singapore to provide support when the trust that had historically funded the commission became insolvent. In addition to the roles described above within the Census of Marine Life, GBIF, ICZN, and OBIS, Daphne was a member of the US National Committee for the International Union of Biological Science (2001-2007) and the scientific advisory council of the European Distributed Institute of Taxonomy (2006-2007); the treasurer of the International Coral Reef Society (1992-2000); and a Program Officer of Systematic Zoology (1990-1991) and Chair-elect/Chair of Invertebrate Zoology (1995-1999) for the Society for Integrative and Comparative Biology. She was an active member and a leader within the University of Kansas chapter of Sigma Xi, serving as Treasurer (1998-200) and Vice-President (2000-2001), and inducting many graduate and undergraduate students as members. She provided editorial leadership to the Annual Reviews of Ecology and Systematics (1992-2001), Biological Bulletin (1992-1998), Wallaceana (1992-1998), and Zootaxa (2005-2012). Daphne led the organizing committee for the 7th International Conference on Coelenterate Biology (2003). She was an extremely conscientious editor, motivated by the desire to make manuscripts accessible to non-native speakers and novices.

Service and work converged for Daphne in a stint at the US National Science Foundation.



FIGURE 3. Daphne exploring tide pools at Pillar Point, San Mateo County, California. Photograph courtesy of Adorian Ardelean.

From 2011-2013, Daphne took a leave of absence from KU to work as a Program Director for the Division of Biological Infrastructure, managing a portfolio that included research grants focusing on natural history collections and biodiversity databases, among other activities. This time at NSF coincided with the start of a phased retirement from KU. Her full retirement began in 2015, when she and her husband (and collaborator) Bob Buddemeier moved to the retirement community at Rogue Valley Manor. Even in retirement, however, Daphne managed to put her professional skills to use, volunteering in the library and as the RVM historian.

Other interests and accomplishments (Fig. 3) include involvement in the Lawrence Jewish community, a love of travel and enthusiasm for birding and natural history more broadly. Daphne was an accomplished pilot, flying a plane called *Hespervolita*—a name of a sea anemone and the Latin translation of Western Flyer, after the Ricketts and Steinbeck vessel — from Kansas to the Atlantic as part of an all-female navigational race. She was an excellent cook and an avid runner. One consistent aspect of Daphne's career was her willingness to take on courtesy or voluntary positions. From these, she always demonstrated her passion, competence and dedication and soon rendered herself indispensable and inevitably resulted in more permanent positions. However, Daphne clearly did all of these things from her innate sense of service to larger communities, not to advance her own stature, but to truly advance science.

SPECIES OR SUBSPECIES DESCRIBED: 32

Taxon	Authority
<i>Anthopleura handi</i>	Dunn, 1978
<i>Aulactinia incubans</i>	Dunn, Chia & Levine, 1980
<i>Amplexidiscus fenestrafer</i>	Dunn & Hamner, 1980
<i>Paraphelliactis pabista</i>	Dunn, 1982
<i>Bolocera paucicornis</i>	Dunn, 1983
<i>BathypHELLIA australis</i>	Dunn, 1983
<i>Eltaninactis infundibulum</i>	Dunn, 1983
<i>Epiactis lisbethae</i>	Fautin & Chia, 1986
<i>Epiactis fernaldi</i>	Fautin & Chia, 1986
<i>Stylobates loisetteae</i>	Fautin, 1987
<i>Acontiophorum niveum</i>	Fautin, Eppard & Mead, 1988
<i>Manania handi</i>	Larson & Fautin, 1989
<i>Manania gwilliamsi</i>	Larson & Fautin, 1989
<i>Marianactis bythios</i>	Fautin & Hessler, 1989
<i>Metridium giganteum</i>	Fautin, Bucklin & Hand, 1990 ¹
<i>Entacmaea medusivora</i>	Fautin & Fitt, 1991
<i>Maractis rimicarivora</i>	Fautin & Barber, 1999
<i>Anthosactis nomados</i>	White, Wakefield Pagels & Fautin, 1999
<i>Corallimorphus denhartogi</i>	Fautin, White & Pearson, 2002
<i>Corallimorphus pilatus</i>	Fautin, White & Pearson, 2002
<i>Anthopleura mariscali</i>	Daly & Fautin, 2004
<i>Adamsia obvolva</i>	Daly, Ardelean, Cha, Campbell, and Fautin 2004
<i>Megalactis comata</i>	Ardelean & Fautin, 2004
<i>Anthopleura buddemeieri</i>	Fautin, 2005
<i>Epizoanthus giveni</i>	Philipp & Fautin, 2009
<i>Epizoanthus karenae</i>	Philipp & Fautin, 2009
<i>Epizoanthus rodmani</i>	Philipp & Fautin, 2009
<i>Neoaiphtasia morbilla</i>	Fautin & Goodwill, 2009
<i>Ptychodactis aleutiensis</i>	Eash-Loucks, Jewett, Fautin, Hoberg & Chenelot, 2010
<i>Corallimorphus niwa</i>	Fautin 2011
<i>Stylobates birtlesi</i>	Crowther, Fautin & Wallace, 2011
<i>Synpeachia temasek</i>	Yap, Fautin, Ramos & Tan, 2014

¹ Now recognized as *Metridium farcimen* (Brandt, 1835)

DAPHNE G. FAUTIN PUBLICATIONS

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