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COVER IMAGE

Species in the southern Black Mountains that occur in both Mohave and Sonoran deserts (Fig. 4)
(See Butterneck & Daniel, Vegetation and Flora of the Southern Black Mountains of West-Central Arizona)

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES

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Vegetation and Flora of the Southern Black Mountains of West-Central Arizona

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This study documents the botanical resources of the southern Black Mountains along the western edge of Mohave County, Arizona. The flora area covers approximately 883 sq. km (341 sq. mi) in the southern third of the range from Arizona Hwy. 68 to Sacramento Wash along U.S. Interstate 40. Eight plant communities are identified and described and an annotated catalog of the vascular plants of the southern Black Mountains is provided. Seventy-two families, 276 genera, 471 species, and seven additional infraspecific taxa are documented from this region of the Mohave Desert (478 total taxa at rank of species or below). Plant families with the largest presence in the flora area include Asteraceae (89 species), Poaceae (53), Boraginaceae (35), Fabaceae (24), Brassicaceae (19), Cactaceae (16), and Polygonaceae (16). Of the 205 taxa of ephemeral herbs in the flora area, 182 (89%) are winter ephemerals. Thirty-eight taxa (8% of the flora) are not native to the flora of Arizona. Twelve species of biogeographic significance are noted, including *Monardella eplingii*, which is endemic to the Black Mountains.

KEYWORDS: Mohave Desert, Arizona, plant communities, floristics, ethnobotany

The Black Mountains are an extensive desertic mountain range along the western edge of Mohave County, Arizona, paralleling the Colorado River for approximately 156 km (97 mi), from Lake Mead southward to Sacramento Wash. The range was previously called the Ute Mountains, in reference to the Ute people who lived in the vicinity (Barnes 1960). The names Ute Mountains or Black Ute Mountains occur on the labels of several early plant collections from the area. This flora covers the southern third of the range from Union Pass along Arizona Hwy. 68 to Sacramento Wash along U.S. Interstate 40. This portion of the range is approximately 24 km (15 mi) west of Kingman and 13 km (8 mi) east of the Colorado River (Fig. 1). The flora area comprises approximately 883 sq. km (341 sq. mi).

The flora area (Fig. 1) is bounded on the north by Arizona Hwy. 68 through Union Pass, and on the northeast by the main mass of the mountains, generally along the 1036 m (3400 ft) to 853 m (2800 ft) elevation contours from north to south. South of Mohave Co. 10 (Oatman Road), the flora area extends from Meadow Creek southeastward down Sacramento Valley to Sacramento Wash, and follows the wash as it curves to the west near its junction with Franconia Wash. From there the southwest boundary generally follows the 305 m (1000 ft) elevation contour to Mohave Co. 10 (Topock—Oatman road), then continues northward along the eastern edge of Mohave Valley on the west side of McHeffy Butte and Boundary Cone to Mohave Co. 153 (Boundary Cone Road). From there, the boundary continues northward to encompass the hills on the west side of the Black Mountains generally following the 610 m (2000 ft) to 670 m (2200 ft) elevation contours from south to north, and reconnects with Arizona Hwy. 68 in Union Pass.

FIGURE 1. Satellite image of the southern Black Mountains from Google Earth showing boundary (red) of floristic study area, and collecting locales (green) of the authors. The Colorado River, which forms the border between Arizona and California, is at left, and the Sacramento Valley is on the right. Nearby towns outside of the study area are indicated. Within the study area, Oatman (orange diamond) and Black Mesa are shown. Major roads in the vicinity are Interstate Hwy. 40 (=Arizona Hwy. 95) in purple, Arizona Hwy. 68 (traversing the Black Mountains through Union Pass) in yellow, Mohave Co. 10 (=old U.S. Hwy. 66 or "Oatman Road" northward/eastward from Oatman and traversing the eastern Black Mountains through Sitgreaves Pass, and "Oatman–Topock Hwy." southward/westward from Oatman to the Colorado River) in blue, and Mohave Co. 153 in pink. Inset map shows state of Arizona with Mohave County shaded in green, and the location of the satellite image.

Most of the flora area is public land administered by the U.S. Department of Interior's Bureau of Land Management (BLM), and includes two wilderness areas: Mount Nutt Wilderness, a 112-sq. km (27,660-acre) area north of Mohave Co. 10 through Sitgreaves Pass, and Warm Springs Wilderness, a 455-sq. km (112,400-acre) area at the southern end of the Black Mountains (U.S. Department of Interior 2016a, 2016b). Although land ownership is primarily BLM, there are some private and state of Arizona holdings within the flora area, particularly in the town of Oatman and along Mohave Co. 10 (Oatman Road) in Sitgreaves Pass. The Black Mountains are known for their mineral resources. Numerous mines throughout the Oatman mining district produced significant quantities of gold (2.2 million troy oz) and silver (0.8 million troy oz) between 1897 and 1942 (DeWitt et al. 1986).

The present study was undertaken to document the botanical resources of the southern Black Mountains. Based on Moore and Cole (2004), this is the first published flora for a region within the Mohave Desert of Arizona. Certain plant communities such as Great Basin Conifer Woodland and both Desert Oasis Woodland and Streamside Marsh at perennial springs are very restricted in the Black Mountains, and thus are particularly vulnerable to increased warming and drought anticipated from climate change in the region (Garfin et al. 2014). Our results can serve as a basis for examination of future changes in the flora of this range and other areas of Mohave Desert in southern Nevada and southeastern California.

Topography and Geology

The Black Mountains are located in the Basin and Range Physiographic Province (Wilson 1962) and form a north-northwest-trending mountain range with wide valleys on each side—Sacramento Valley to the east and Mohave Valley to the west. The range is known for its extremely rugged terrain. The northern portion of the flora area has a total relief of about 914 m (3000 ft). The highest points in the flora area are an unnamed peak ("Benchmark Nutt") at 1590 m (5216 ft) and Mt. Nutt at 1543 m (5062 ft). These peaks are surrounded by precipitous cliffs, small mesas, steep and rocky slopes, and several steep-walled canyons such as Grapevine Canyon, Cottonwood Canyon, and several unnamed canyons (Gray et al. 1990b). An area that is underlain by Proterozoic granite, schist, and gneiss is exposed near Arizona Hwy. 68 between Thumb Butte and Secret Pass Arch (Nations and Stump 1996). However, most of the remainder of the northern portion of the flora area is overlain by a variety of Tertiary volcanic rocks including rhyolite, andesite, dacite, basalt, and tuff (Gray et al. 1990b). In fact, most of the Black Mountains, including our flora area, are volcanic in nature and in this respect differ from surrounding mountains and basins in Arizona, California, and Nevada—in effect forming a geologic/edaphic "sky island" in the Mohave Desert of western Arizona (Elvin et al. 2013). West of the main mass of the mountains is a complex of volcanic and granitic hills in the vicinity of Pheland Butte, Cathedral Rock, Hardy Mountain, Finger Butte, and Thumb Butte (Nations and Stump 1996; U.S. Department of Agriculture 2016).

Meadow Creek, a major east-west-trending tributary of Sacramento Wash, forms a prominent divide in the southern Black Mountains. Mohave Co. 10 (Oatman Road) east of Sitgreaves Pass generally follows Meadow Creek. The southern portion of the flora area, south of Meadow Creek, is dominated by Black Mesa (Fig. 2), a northwest-trending plateau of Tertiary basalt (Gray et al. 1990a). The summit of Black Mesa ranges in elevation from approximately 975 m (3200 ft) to 1158 m (3800 ft). Topographic relief is abrupt particularly along the east front of the mesa with drops in elevation of 305 m (1000 ft) or more to the surrounding pediment, alluvial fan, and piedmont surfaces that slope gradually across the Sacramento Valley toward Sacramento Wash. The mesa is deeply incised by Warm Springs Creek and several unnamed tributaries (Gray et al. 1990a), and it

FIGURE 2. Southern Black Mountains and plants communities-1. Panoramic view of western escarpment from Needles, California showing (arrows, from right): Black Mesa, Boundary Cone, and Mt. Nutt area (top). Mixed Desert Scrub on Black Mesa (southern portion of the flora area) with *Bromus rubens* (abundant ground cover), *Cylindropuntia* spp., *Ephedra aspera*, *Nolina bigelovii*, and *Yucca schidigera* (center). Mixed Desert Scrub at Secret Pass (northern portion of the flora area) with *Juniperus californica* (bottom). Photos by the authors.

is surrounded by a variety of Tertiary volcanic rocks (Gray et al. 1990a; Nations and Stump 1996). The topography is more complex on the west side of Black Mesa where it consists of lower-elevation buttes, ridges, and rocky hills in the vicinity of McHeffy Butte, Wrigley Peak, and Boundary Cone, a prominent landmark in the area (Fig. 2).

Perennial springs occur occasionally throughout the flora area on slopes (e.g., Shaffer, Fig, and Cave springs), in narrow, boulder-strewn canyons (e.g., Cottonwood, Grapevine Springs, and Twin Springs canyons), and along a few of the major tributaries including Meadow Creek, Warm Springs Creek, and Silver Creek Wash.

Climate

Climatic patterns in Arizona are affected by elevational gradients and by large-scale meteorological systems that affect weather in western North America. As a result of the latter, a biseasonal pattern characterizes precipitation in Arizona (Sellers and Hill 1974). Winter rains generally occur from October to April when the westerlies move moist Pacific air masses eastward. These rains take the form of widespread gentle showers that may last for several days. Summer monsoon rains, concentrated from July to September, are created when moist air masses from the Gulf of California and the Gulf of Mexico move northward into the state. Rapid cooling and condensation occur as moist superheated air rises over mountainous terrain. Summer rains tend to form as localized heavy thunderstorms of short duration.

The character of the biseasonal rainfall pattern varies across the state. In general, as one moves westward, a decreasing proportion of the annual precipitation occurs during the summer. In southeastern Arizona, dependable summer rains contribute up to 70% of the annual total (Hastings and Turner 1965). However, descriptions of mapped ecological sites indicate that summer rains in the flora area account for only 35% of the annual precipitation (U.S. Department of Agriculture 2016). Thus, most of the annual precipitation (ca. 65%) is in the form of winter rains.

There are no site-specific climatic data for the Black Mountains. The nearest climate stations are in Bullhead City to the west, which has hotter and drier conditions, and in Kingman to the east, which has cooler and wetter conditions. However, the average annual precipitation in the portion of the Desert Region of the Basin and Range Province, which includes our flora area, ranges from 12.7 cm (5 inches) to 25.2 cm (10 inches) (Sellers and Hill 1974). Increases in elevation generally correlate with greater average amounts of precipitation. This general pattern is reflected in the ecological site descriptions for the flora area with the lowest elevation sites being in the 7.5–15 cm (3–6 inch) precipitation zone, the mid-elevation sites being in the 15–23 cm (6–9 inch) precipitation zone, and the highest-elevation sites being in the 25–33 cm (10–13 inch) precipitation zone (U.S. Department of Agriculture 2016).

According to Sellers and Hill (1974), average daily temperatures for the region that includes our flora area range from 7° to 10° C (45° to 50° F) during January and from 29° to 32° C (85° to 90° F) during July. Like precipitation, temperatures also follow elevational gradients. Thus, higher areas tend to be cooler and more mesic. Average daily temperatures for January and July are 10.5° and 35° C (51° and 95° F) in the 7.5–15 cm (3–6 inch) precipitation zone, 7° and 30.5° C (45° and 87° F) in the 15–23 cm (6–9 inch) precipitation zone and 6° and 28° C (43° and 82° F) in the 25–33 cm (10–13 inch) precipitation zone (U.S. Department of Agriculture 2016).

Early Inhabitants and Ethnobotany

Excavations at Bighorn Cave, a large and deeply stratified site in the southern Black Mountains, documented an occupational sequence extending back to 1800 BC (Geib and Keller 2002). Bighorn Cave served as a seasonal foraging basecamp with diverse artifact and native plant assemblages. Such base camps tend to be situated near springs or other perennial water sources (Fryman et al. 1977). A series of perennial springs currently exists near the Bighorn Cave site. According to Geib and Keller (2002), native plants (with names in parentheses corresponding to species we documented from the flora area) recovered from Bighorn Cave include: agave (*Agave mckelveyana*), beargrass (*Nolina bigelovii*), cactus (*Opuntia basilaris*, *O. chlorotica*, *O. polyacantha*, *O.* ×*curvospina*), catclaw (*Senegalia greggii*), creosotebush (*Larrea tridentata*), gourd (*Cucurbita palmata*), grass (38 native species), hackberry (*Celtis reticulata*), juniper (*Juniperus californica*), milkweed (*Asclepias albicans*, *A. erosa*, *A. nyctaginifolia*, *A. subulata*), mustard (*Descurainea pinnata*), oak (*Quercus turbinella*), pine (*Pinus monophylla*), reed (*Phragmites australis*), screwbean mesquite (*Prosopis pubescens*), and yucca (*Yucca schidigera*, *Y. baccata*). Several plant taxa reported from Bighorn Cave either as pollen or plant fragments have not been otherwise collected in the flora area or elsewhere in the Black Mountains, based on our collections and on occurrence data in SEINet (2016). These taxa include *Acer negundo, Alnus* sp., *Asclepias latifolia, Canotia holacantha, Cucurbita foetidissima, Juglans major, Nolina microcarpa,* and *Sarcobatus* sp. (Geib and Keller 2002).

During the late and terminal Archaic period (ca. 1200–400 BC and 200 BC–100 AD, respectively) Bighorn Cave was used as a hunting camp, primarily for deer and bighorn sheep, although plants were exploited as well. As farming communities became established along the Colorado River (perhaps during 200 BC–100 AD), the traditional hunting/foraging settlement-subsistence practices gave rise to a "valley centric" settlement-subsistence strategy, which became that of the Mohave people here (Kroeber 1925). Later, during the Formative period (550–1200 AD), plant harvesting and processing became significant. By 1600 AD, Bighorn Cave appears to have been almost abandoned as an important foraging basecamp (Geib and Keller 2002).

During early historic times, the Black Mountains were within the ranges of two peoples, the Upland Yuman group (or Hualapai people) on the east side of the mountains and the River Yuman group (or Mohave people) on the west side (Stone 1987; McGuire 1983). The Hualapai were able to successfully exploit wild resources by using an organizational flexibility that could effectively respond to the patchy distribution of resources and to the seasonal and year-to-year variability and unpredictability of the natural environment (Kniffen 1935; Manners 1974). As a result, camps could change in membership composition, periodically disperse into separate families, or aggregate into larger groups as the availability of resources dictated. Their staples of existence consisted of agave leaves, amaranth, *Mentzelia* seeds, grass seeds, prickly pear fruits, mesquite beans, banana yucca fruits, pinyon nuts, and juniper berries, all of which we documented from the flora area. While most of these wild food plants produce reliable yields from year to year, the various species occur in different areas and became available for harvesting at different times of the year. For instance, grass seeds were obtained in the valleys during the summer months. Juniper berries and pinyon nuts are less dependable. Good yields of juniper berries are produced every two to five years (Jeter 1977). The Hualapai harvested the pinyon nuts every four years (Stone 1987). Hunts to pursue deer and bighorn sheep took place in desert ranges, such as the Black Mountains, during winter months (Castetter and Bell 1951). Additional animals hunted for food included antelope and rabbits (McKennan 1935). Portions of the wild harvest were stored at winter base camps to survive the lean months during winter and early spring (Stone 1987). The excavation of Bighorn Cave documented several storage pits, some of which were lined with juniper bark (Geib and Keller 2002).

The Yuman peoples used many additional plant resources, not only for food but also for fiber, construction, implements, basketry, water proofing, adhesives, dyes, medicine and fuel, among other uses (Stone 1987). We documented the following plant species, which serve as sources for many of these uses, in the flora area: *Allium nevadense, Baccharis salicifolia, Celtis reticulata, Chenopodium berlandieri, Chenopodium fremontii, Chilopsis linearis*, *Fouquieria splendens, Fraxinus anomala, Larrea tridentata, Mentzelia albicaulis, Physalis crassifolia, Pluchea sericea, Populus fremontii, Rhus aromatica, Salix exigua, Salix gooddingii, Salvia columbariae, Typha latifolia,* and *Vitis arizonica*.

The Hualapai in the Black Mountains interacted frequently with the Mohave people, trading wild products for agricultural produce from the floodplain of the Colorado River (Stone 1987). The Mohave practiced a generalized settlement-subsistence pattern, which included farming, fishing, hunting, and gathering wild plants. Their settlements shifted in arrangement, composition, and location from year to year and season to season to cope with the unpredictable variations in the timing and volume of annual floods (Bee 1981). Crops they cultivated included corn, beans, squash, melons, and grasses. However, gathered resources were not mere supplements to cultivated crops but constituted a diverse and important component of the Mohavean diet. According to Castetter and Bell (1951:179–180), mesquite beans continued to be a staple resource into the 20th century and was "more important than maize . . . and virtually supplied the living through the winter and until the next cultivated crop was ready." Because large game was scarce along the river, fish, such as the humpbacked sucker and Colorado salmon or squawfish, and small game were the major sources of protein. During winter, small hunting parties pursued deer and bighorn sheep in the desert mountain ranges, including the Black Mountains. An annual lean period of reduced supplies occurred in the spring, when few wild plant resources were available and fish were relatively scarce. The duration and severity of this lean time depended on the amount and rate of consumption of stored foods from the previous seasons (Stone 1987).

The remote and rugged terrain of the Black Mountains provided the Yuman peoples respite from the effects of early Spanish contact. However, by the 1800s Anglo-American explorers ventured into the area. The California Gold Rush in the 1850s led to increased travel and settlement in western Arizona. In 1863 gold was first discovered in the Black Mountains at the Moss vein northwest of Oatman (Gray et al. 1990b; Ransome 1923). Varying levels of mineral production continued in the Oatman mining district until 1942. Numbers of feral burros, originally released by the miners working in the area, increased significantly, resulting in degradation of the vegetation and perennial springs and competition with the desert bighorn sheep for limited resources. After the introduction of cattle in Mohave County, army officers consistently reported that livestock grazing reduced the quantity of wild game and the supply of edible seed (United States Senate 1936). Davis (1973) documented that Sacramento Valley, now desertscrub dominated by *Larrea tridentata* and *Ambrosia dumosa*, was once an open grassland. In 1865 the Colorado River Indian Reservation was established, thereby providing the Mohave people with only a portion of their former prime farming and gathering lands. In 1883 the Hualapai Indian Reservation was established at the north end of the Hualapai people's historic area of occupation. A profound impact to the Mohave people's way of life resulted from construction of major dams on the Colorado River between 1930 and 1970. These changed the water flows and aquatic temperature, tamed the annual floods, and reduced transport of sediment, all of which contributed to the loss of marshes and mesquite bosques as well as the native fish populations (Cole 1981). Given the magnitude of changes within the past century, it is difficult to see how a traditional subsistence economy could be sustained under current conditions in and around the Black Mountains.

Previous Plant Collectors

Botanical exploration in the Black Mountains apparently began during the 19th century with collections of *Ericameria cuneata* var. *spathulata* and *Ericameria teretifolia* (*Chrysothamnus teretifolius*) from Union Pass by Edward Palmer in 1870 (Kearney et al. 1960). According to McVaugh (1956), in 1870, Palmer traveled from Fort Whipple, in the vicinity of Prescott, across the desert to Fort Mohave on the Colorado River. Presumably he followed the Fort Mohave–Prescott Road, which crosses the Black Mountains at Union Pass (Paulsen 2010). Between 13 and 21 May 1884, Marcus E. Jones made 70 collections in the vicinity of Yucca just outside the southeast boundary of the flora area (Lenz 1986:397); that year he described the desert around Yucca as ". . . a perfect garden in all directions, never was as good for 20 years afterwards."

A search of the Southwest Environmental Information Network (SEINet 2016) indicates that the early 20th century was a rather active period for collecting even in as remote an area as the Black Mountains. The majority of collections from this period were from the Oatman-Sitgreaves Pass area. Frank A. Thackery, an agriculturist with the U.S. Department of Agriculture's Bureau of Plant Industry, collected 8 specimens from Oatman in 1927 and 1928. On 22 March 1931, George John Harrison, with the U.S. Department of Agriculture Field Station in Sacaton, Arizona, made 18 additional collections near Oatman. That same year, Alice Eastwood, curator of botany at the California Academy of Sciences, also collected in the Oatman area. According to her collection notes in the archives at the Academy, she collected 83 specimens in Oatman during 20–21April and 23 specimens on the road to Oatman on 16 May. Thomas H. Kearney and Robert H. Peebles, botanists with the U.S. Department of Agriculture, collected 24 specimens from the "Black Ute Mountains" in the vicinity of Oatman on the following dates: 23 March 1931, 19 April 1935, 18–19 September 1935, and 16 April 1937. On 14 April 1937, Bassett Maguire, then at Cornell University, and Andrew Alexander Nichol, with the Agricultural Experiment Station at the University of Arizona, collected 30 specimens in the Cool Springs area on the east side of the Black Mountains. On 1 October 1940, Nichol made a few additional collections in Union Pass at the northern boundary of the flora area. On 1 and 15 April 1941, Joseph F. Arnold, also with the Agricultural Experiment Station at the University of Arizona, collected in Oatman, Secret Pass, and on the east side of the Black Mountains. On 16 October 1943, botanist Charlotte Goodding Reeder collected *Pluchea odorata* in the Goldroad Region just east of Sitgreaves Pass. Allen R. Phillips, a well-known ornithologist and co-author of *The Birds of Arizona* (Phillips et al. 1964) collected *Quercus turbinella* below Union Pass on 26 November 1947. John Thomas Howell, a curator of botany at the California Academy of Sciences, collected *Larrea tridentata* and *Stephanomeria pauciflora* in the vicinity of Oatman on 29 May 1950.

During the latter half of the 20th century numerous botanists (other than the authors) made additional collections from the Black Mountains, including: J. Anderson, R. J. Barr, J. Biggs, C. Carter, C. Christy, C. Edgar, S. Ferrier, R. Haberle, H. Hammond, G. Helmkamp and F. Helmkamp, R. Hevly, W. Hodgson, M. Hovezak, S. Ickert-Bond, E. Lehto, B. Marshall, C. Michaels, B. Parfitt, J. Parrott, K. Price, A. Phillips, B. Phillips, C. Reeder, J. Reeder, G. Rink, and J. Rominger.

At least 390 collections from the Black Mountains have been made between 2000 and 2016 (SEINet 2016). The vast majority of these specimens was collected north of our flora area and are deposited at ASU, ASC, and/or GMDRC. Within the flora area, the main collectors since 2000 have been G. Goodwin (ASC) and J. André (GMDRC).

VEGETATION

MOHAVE DESERTSCRUB BIOME.—We have relied on Brown et al. (1979) and Turner (1982) for the description of the Mohave Desertscrub Biome. However, in the absence of a single comprehensive system for classifying specific plant communities in Arizona, we generally followed that of Thorne et al. (1981). Their flora covers several mountain ranges in the Mohave Desert of southeastern California; all of these ranges are in close proximity to the Black Mountains, and they include several plant communities that are comparable in scale and composition to those found in our flora area. The plant communities represented in the southern Black Mountains are: Blackbrush Scrub, Creosote Bush Scrub, Desert Oasis Woodland, High-Gradient Desert Wash Scrub, Low-Gradient Desert Wash Scrub, Mixed Desert Scrub, Pinyon-Juniper Woodland, and Streamside Marsh.

The vast majority of our flora area is within the Mohave Desertscrub Biome. Mohave Desertscrub is considered to be intermediate between the Great Basin and Sonoran desertscrub biomes, both geographically and floristically (Brown et al. 1979; Turner 1982). The pattern is well represented in the southern Black Mountains. The following species occur in both the Mohave and Sonoran deserts and are found in the southern Black Mountains: *Ambrosia salsola, Crossosoma bigelovii*, *Dudleya arizonica*, *Encelia farinosa, Eriogonum fasciculatum, Larrea tridentata, Mentzelia involucrata*, *Mohavea confertiflora, Nolina bigelovii, Opuntia bigelovii, Prosopis glandulosa* var. *torreyana, Psorothamnus spinosa, Senegalia greggii, Trixis californica, Yucca baccata,* and *Y. schidigera* (Figs. 3–5). *Coleogyne ramosissima* (Figs. 6, 7) can be a dominant species in either the Mohave or Great Basin deserts. Other species in the southern Black Mountains that occur in both Mohave and Great Basin deserts include: *Echinocereus engelmannii* var. *chrysocentrus*, *Ericameria teretifolia*, *Grayia spinosa*, *Krascheninnikovia lanata*, and *Opuntia polyacantha* var. *erinacea* (Figs. 6, 8). *Monardella eplingii* (Fig. 6), a recently described species, known only from the Black Mountains, is endemic to the Mohave Desert. *Yucca brevifolia*, another Mohave Desert endemic, occurs just outside of the flora area in the vicinity of Yucca.

The Mohave Desertscrub Biome is known for its diversity of winter ephemerals (annuals), presumably due to the preponderance of precipitation between September and December (Beatley 1974). A significant percentage (89%) of the ephemeral species documented in the flora area are winter ephemerals, many of which show a strong geographic affinity with those of the Sonoran Desert. In the flora area, we documented 63 of the 109 species of winter ephemerals listed by Shreve and Wiggins (1964) as characteristic of both the Mohave and Sonoran deserts. They include species of *Amsinckia, Chaenactis, Chorizanthe, Cryptantha, Eriogonum, Eschscholzia, Euphorbia, Gilia, Linanthus, Lupinus, Malacothrix, Mentzelia, Nama,* and *Phacelia,* in addition to *Achyronychia cooperi, Acmispon brachycarpus, Bowlesia incana, Bromus arizonicus, Calycoseris wrightii, Chylismia claviformis, Daucus pusillus, Draba cuneifolia* var. *integrifolia, Descurainea pinnata, Eriophyllum lanosum, Erodium texanum, Eucrypta chrysanthemifolia* var. *bipinnatifida, Eulobus chamaenerioides, Harpagonella palmeri, Lepidium lasiocarpum, Logfia filaginoides, Monoptilon bellioides, Muhlenbergia microsperma, Myosurus cupulatus, Nemacladus glanduliferus, Oligomeris linifolia, Pectocarya heterocarpa, Petunia parviflora, Pholistoma auritum, Plagiobothrys arizonicus, Plantago ovata, Poa bigelovii, Pterostegia drymarioides, Rafinesquia neomexicana, Salvia columbariae, Thysanocarpus curvipes, Vicia exigua,* and *Vulpia octoflora*. Additional winter ephemerals are identified in the species list. Among ephemeral species, a much lower percentage (9%) of summer ephemerals occurs in the flora area, probably as a result of the relatively limited rainfall in August or September. These include *Amaranthus fimbriatus, Boerhavia wrightii, Bouteloua aristidoides, Kallstroemia californica, Kallstroemia parviflora, Muhlen-*

FIGURE 3. Species in the southern Black Mountains that occur in both Mohave and Sonoran deserts-1. *Yucca schidigera* (top left). *Carnegiea gigantea* (top right; photo by E. Butler, provided by and used with permission of J. Pebworth, Arizona Game and Fish Department). *Mohavea confertiflora* (bottom left; photo by L. Makings, SEINet). *Larrea tridentata* (bottom right; photo by S. Carnahan, SEINet). Photos by the authors, except as noted

FIGURE 4. Species in the southern Black Mountains that occur in both Mohave and Sonoran deserts-2. *Fouqueria splendens* (top). *Janusia gracilis* (bottom left). *Mentzelia involucrata* (middle center; photo by P. Alexander, SEINet). *Trixis californica* (bottom center). *Dudleya arizonica* (bottom right). Photos by the authors, except as noted.

bergia fragilis, and *Pectis papposa*. Six species of ephemeral herbs flower throughout the year in response to rainfall: *Aristida adscensionis, Baileya pleniradiata, Chamaesyce setiloba, Conyza canadensis, Eriogonum hookeri*, and *Eriogonum palmerianum*.

Creosote Bush Scrub.—This plant community (Fig. 7) is generally comparable to the Creosotebush Series of Brown et al. (1979) and Turner (1982). It occurs on the lower hills, upper and lower bajadas, and valley basins (generally between 335 m (1100 ft) and 914 m (3000 ft) elevation), from the base of the mountains toward Sacramento Wash on the south and east sides of the flora area and toward the Colorado River on the west side of the flora area. The dominant species *Ambrosia dumosa*, *Encelia farinosa,* and *Larrea tridentata* are characteristic of this plant community. Common associates include: *Cylindropuntia acanthocarpa, Cylindropuntia bigelovii, Ephedra aspera, Fouquieria splendens, Krameria erecta, Opuntia basilaris, Psorothamnus fremontii,* and *Sphaeralcea ambigua* (Figs. 4, 6, 8). Ephemeral species can be abundant in response to rainfall. They include: *Acmispon rigidus, Acmispon maritimus, Acmispon strigosus, Amsinckia intermedia, Amsinckia tessellata, Atrichoseris platyphylla, Bouteloua barbata, Bouteloua aristidoides, Chylismia brevipes, Chylismia claviformis, Chaenactis carphoclinia, Chaenactis fremontii, Chamaesyce arizonica, Chamaesyce melanadenia, Chamaesyce polycarpa, Chorizanthe brevicornu, Chorizanthe rigida, Cryptantha barbigera, Cryptantha maritima, Cryptantha pterocarya, Cryptantha utahensis, Eremothera refracta, Eriastrum diffusum, Eriastrum eremicum, Eriogonum deflexum, Eriogonum inflatum, Eriogonum thomasii, Eriogonum trichopes, Eriophyllum lanosum, Eschscholzia californica, Eschscholzia glyptosperma, Eschscholzia minutiflora, Gilia scopulorum, Gilia stellata, Langloisia setosissima, Linanthus bigelovii, Linanthus demissus, Lupinus concinnus, Malacothrix glabrata, Mentzelia albicaulis, Mentzelia involucrata, Monoptilon bellioides, Nama demissa, Nemacladus orientalis, Pectocarya platycarpa, Pectocarya recurvata, Phacelia crenulata, Phacelia distans, Plantago ovata, Rafinesquia californica, Rafinesquia neomexicana, Stephanomeria pauciflora, Syntrichopappus fremontii,* and *Vulpia octoflora*.

Mixed Desert Scrub.—Mixed Desert Scrub dominates the upper mountain slopes and rock outcrops (generally between 850 m (2800 ft) and 1370 m (4500 ft) elevation) and features a greater diversity of species than Creosote Bush Scrub. This catch-all plant community (Fig. 2) occurs throughout much of the flora area and exhibits various combinations of associated species. Several of the desert growth forms are represented including: stem-succulent cacti (Fig. 8) such as *Cylindropuntia echinocarpa, Echinocereus coccineus, Echinocereus engelmannii, Echinomastus johnsonii, Ferocactus cylindraceus, Mammillaria grahamii, Mammillaria tetrancistra, Opuntia chlorotica, Opuntia ×curvospina,* and *Opuntia polyacantha*; leaf semisucculents like *Agave mckelveyana, Nolina bigelovii, Yucca baccata,* and *Yucca schidigera* (Figs. 3, 5); leaf-succulents (i.e., *Dudleya arizonica*; Fig. 4); shrubby, often microphyllous, species, such as *Brickella atractyloides, Brickellia incana, Encelia resinifera, Encelia virginensis, Ephedra aspera, Ericameria laricifolia, Ericameria linearifolia, Eriogonum fasciculatum, Eriogonum heermannii, Gutierrezia sarothrae, Keckiella antirrhinoides, Salvia dorrii, Salvia mohavensis, Thamnosma montana*, and *Xylorhiza tortifolia* (Figs. 6, 9); subshrubs and perennial herbs, such as *Acmispon rigidus, Artemisia ludoviciana, Baccharis brachyphylla, Boechera perennans, Cryptantha racemosa, Mirabilis laevis, Mirabilis multiflora, Nicotiana obtusifolia, Penstemon eatonii, Physalis crassifolia, Pleurocoronis pluriseta, Porophyllum gracile*, and *Peucephyllum schottii*; perennial grasses including *Acnatherum coronatum, Acnatherum hymenoides*, *Aristida purpurea, Bothriochloa barbinodis, Bouteloua curtipendula, Hilaria rigida, Jarava speciosa, Melica frutescens, Melica imperfecta, Muhlenbergia porteri,* and *Poa fendleriana*; and numerous ephemerals, many of which are listed above. In more mesic sites on north-facing slopes and at the base of cliff faces at higher elevations are found species characteristic of woodland and chaparral plant communities, including: *Ceanoth-*

us vestitus, Forestiera pubescens, Fraxinus anomala, Garrya flavescens, Prunus fasciculata, Quercus turbinella, and *Rhus aromatica*.

Blackbrush Scrub.—Geographically interspersed within the widespread Mixed Desert Scrub are areas of Blackbrush Scrub, which are dominated by *Coleogyne ramosissima* (Figs. 6, 7). This plant community is generally comparable to the Blackbrush Series, which is ecotonal between Great Basin and Mohave desertscrub communities (Turner 1982). Here, perennial grasses such as *Acnatherum hymenoides, Dasyochloa pulchella, Hilaria rigida, Jarava speciosa, Muhlenbergia porteri, Sporobolus cryptandrus*, and *Tridens muticus* are commonly prevalent in unburned stands that are in good condition. According to Bradley (1964), these areas are important for Desert Bighorn Sheep (*Ovis canadensis nelsoni*) because of the occurrence of these grasses. Indeed, extensive areas of high value habitat and lambing grounds for Desert Bighorn Sheep exist in the flora area (U.S. Department of Interior 1996). Other species commonly associated with Blackbrush Scrub include: *Encelia virginensis*, *Ephedra aspera, Eriogonum fasciculatum, Krameria bicolor, Krameria erecta, , Larrea tridentata*, *Opuntia basilaris,* and *Yucca schidigera*. *Juniperus californica*, an indicator species of the southern portion of the Great Basin Conifer Woodland (Brown 1982), is frequently found on dry slopes generally above 914 m (3000 ft.) elevation both with Blackbrush Scrub and Mixed Desert Scrub.

Great Basin Conifer Woodland Biome.—A small area of the Great Basin Conifer Woodland Biome was mapped by Brown et al. (2007) in the southern Black Mountains. We collected two of the characteristic species, *Juniperus californica* and *Pinus monophylla* (Fig. 10), of this biome at higher elevations (1341–1433 m) north of Mt. Nutt. We treat this area as a relict Pinyon-Juniper Woodland plant community due to the rarity of *Pinus monophylla* in the southern Black Mountains. Characteristic species associated with this community in the flora area include: *Artemisia ludoviciana, Coleogyne ramosissima, Echinocereus coccineus, Echinocereus engelmannii, Fraxinus anomala, Garrya flavescens, Krascheninnikovia lanata, Nolina bigelovii, Opuntia basilaris, Purshia stansburyana, Quercus turbinella, Rhamnus ilicifolia, Rhus aromatica,* and *Yucca baccata*. Locally common grasses here are *Achnatherum hymenoides*, *Aristida purpurea, Bouteloua curtipendula, Hilaria rigida, Jarava speciosa, Muhlenbergia porteri, Sporobolus cryptandrus,* and *Tridens muticus*. We collected the following species only in this plant community in the flora area: *Gilia flavocincta* subsp. *australis*, *Hymenopappus filifolius, Linanthus pungens*, *Penstemon palmeri, Ptelea trifoliata,* and *Silene verecunda*. The majority of these associated species also occur with the Interior Chaparral Biome, as described by Pase and Brown (1982). Although not present in our flora area, Interior Chaparral is widespread in the Hualapai Mountains to the east across the Sacramento Valley (Butterwick et al. 1992).

Desert Wash Scrub.—Numerous ephemeral streams occur throughout the flora area. The Desert Wash Scrub plant community varies with stream gradient, which is defined as the change in elevation per unit distance along the stream channel and expressed as a percent (Society of American Foresters 1998). The low-gradient (generally < 3%) tributaries with predominantly sand and gravel substrates form incised arroyos and open, shallow washes at the lower elevations. These tributaries support a Low-Gradient Desert Wash Scrub plant community in and along the channels comprised of small trees such as *Chilopsis linearis, Parkinsonia florida, Prosopis glandulosa* var. *torreyana, Prosopis pubescens,* and *Psorothamnus spinosus.* Representative shrub species include *Ambrosia monogyra, Ambrosia salsola, Bebbia juncea, Lycium exsertum, Psorothamnus fremontii, Scutellaria mexicana, Senegalia greggii,* and *Ziziphus obtusifolia*. Vines such as *Cucurbita digitata, Funastrum cynanchoides*, *Funastrum hirtellum*, *Marah gilensis, Maurandella antirrhiniflora,* and *Neogaerrhinum filipes* are occasionally found twining over the shrubs and trees or trailing along the streambed. These tributaries occur primarily within the Creosote Bush Scrub plant com-

FIGURE 5. Some conspicuous plants in the southern Black Mountains-1. *Nolina bigelovii* (top). *Calochortus kennedyi* (bottom left). *Eschscholzia glyptosperma* (bottom right).

FIGURE 6. Species in the southern Black Mountains and their floristic affinities. *Coleogyne ramosissima* (top left; photo by Keir Morse, SEINet) and *Grayia spinosa* (top right; photo by C. Webber, © California Academy of Sciences, used with permission), occur in both Mohave and Great Basin deserts. *Monardella eplingii,* the only known plant species endemic to the Black Mountains (middle left; plant photo by and copyright reserved to M. Elvin, used with permission; inset photo showing inflorscence with flower by J. Anderson, used with permission). *Psorothamnus fremontii* var. *attenuatus* (bottom left; photo by Daniela Roth, SEINet) and *Salvia mohavensis* (bottom right; photo by A. Schusteff, with permission), occur in both Mohave and Sonoran deserts.

FIGURE 7. Southern Black Mountains, plant communities-2. Creosote Bush Scrub near Warm Springs Wash (with Black Mesa in background) with *Cylindropuntia* spp., *Encelia farinosa*, and *Larrea tridentata* (top). Blackbrush Scrub south of Sitgreaves Pass with *Coleogyne ramosissima* (bottom). Photos by the authors.

FIGURE 8. Some Cactaceae (stem succulents) that occur in the southern Black Mountains. *Cylindropuntia acanthocarpa* (top left). *Cylindropuntia bigelovii* (top center). *Opuntia polyacantha* var. *erinacea* (top right). *Mammillaria grahamii* (center left). *Ferocactus cylindraceus* (center right). *Opuntia basilaris* (bottom left). *Echinocereus coccineus* (bottom right). Photos by the authors.

munity and, thus, feature many of the same species including: *Ambrosia dumosa, Ephedra aspera, Eriogonum fasciculatum, Hilaria rigida, Jarava speciosa*, *Krameria erecta,* and *Larrea tridentata*. With sufficient late winter rains, a high diversity of winter ephemerals are found in the Low-Gradient Desert Wash Scrub, many of which are listed above in the description of the Mohave Desertscrub Biome.

Sacramento Wash is the largest low-gradient drainage near the southern Black Mountains, has multiple channels, and forms the southeastern boundary of the flora area for approximately 32 km (20 mi). The Low-Gradient Desert Wash Scrub here is dominated by *Ambrosia monogyra, Baccharis salisifolia, Parkinsonia microphylla, Psorothamnus spinosus,*and *Senegalia greggii,* with an herbaceous stratum consisting of *Cryptantha decipiens, Cryptantha micrantha, Descurainea pinnata, Pectocarya platycarpa*, *Pectocarya recurvata, Senecio flaccidus,* and *Stillingia linearifolia*. The sand substrate provides suitable habitat for several species not found elsewhere in the flora area including *Baileya pleniradiata, Brickellia incana, Cryptantha circumscissa, Dimorphocarpa wislizenii, Oenothera deltoides* subsp. *deltoides*, *Palafoxia arida,* and *Tiquilia plicata*. An undetermined species of what appears to pertain to *Petalonyx* (*Daniel & Butterwick 6042*) has leaves with a dense pubescence of soft, white, and flexuose hairs, unlike the scabrous herbage of *Petalonyx nitidus*, which occurs elsewhere in the flora area.

Upstream reaches of these tributaries, generally over 914 m (3000 ft) in elevation, are high-gradient (generally >3%) streams often with cobble, boulder, or bedrock substrates and steep side slopes that in places narrow into canyons. The relatively cooler and moister conditions at these sites support a more species-rich variant of Desert Wash Scrub, referred to here as High-Gradient Desert Wash Scrub, and they include several woodland and chaparral species (Fig. 11). We observed this plant community in several tributaries north of Mohave Co. 10 (Oatman Road). In this community species collected on canyon bottoms or adjacent slopes include: *Acamptopappus sphaerocephalus, Amsonia palmeri, Artemisia ludoviciana, Baccharis sergiloides, Bothriochloa barbinodis, Eucnide urens*, *Forestiera pubescens, Fraxinus anomala, Hyptis emoryi, Keckiella antirrhinoides, Melica imperfecta, Nolina bigelovii, Quercus turbinella, Rhamnus ilicifolia,* and *Salvia mohavensis*. In shaded crevices of the canyon walls are found *Brickellia atractyloides, Cheilanthes parryi, Crossosoma bigelovii, Erigeron oxyphyllus*, *Ivesia arizonica, Pellaea truncata, Perityle emoryi, Phacelia perityloides, Phacelia rotundifolia, Phacelia saxicola, Pleurocoronis pluriseta,* and *Pterostegia drymarioides*. Among these, *Erigeron oxyphyllus*, *Ivesia arizonica, Phacelia perityloides, Phacelia rotundifolia,* and *Phacelia saxicola* are apparently rare, and thus far each one has been documented from a single locale in the flora area.

Wetlands.—Year-round sources of water are restricted to perennial springs that occur on slopes, in narrow and boulder-strewn canyons, or in the more open, sand and gravel beds of tributaries at lower elevations. Of the 23 springs we sampled, the linear extent of surface and shallow subsurface flows varies from approximately 0.8 km (0.5 mi), at Cool Spring, to the immediate vicinity of the spring itself. The more extensive springs support a Desert Oasis Woodland plant community with a tree and shrub stratum (Fig. 11) and/or a Streamside Marsh plant community comprised of herbaceous species along the wet streambed and banks (Fig. 11). Several springs with limited flows support very little distinct vegetation, often consisting of single trees, such as *Prosopis glandulosa* var. *torreyana* at Metate Spring and *Celtis reticulata* at Whiskey Spring. In total, the vegetation associated with these perennial springs covers a very small area within this arid landscape and, consequently, many of the species associated with these plant communities are rare in the flora area.

The Desert Oasis Woodland is dominated by the following trees: *Celtis reticulata, Parkinsonia florida, Populus fremontii, Prosopis glandulosa* var. *torreyana*, *Prosopis pubescens*, *Quercus*

turbinella, and *Salix gooddingii*. Common shrub species include *Ambrosia monogyra, Baccharis salicifolia, Baccharis sergiloides, Salix exigua,* and *Pluchea sericea*. The Streamside Marsh may occur as an herbaceous stratum of the Desert Oasis Woodland or alone in more open drainages such as the series of step pools at Columbine Spring (Fig. 11). Species characteristic of the Streamside Marsh are numerous and include: *Adiantum capillis-veneris, Polypogon viridis, Apocynum cannabinum, Aquilegia chrysantha, Carex alma, Castilleja minor* subsp. *spiralis*, *Chenopodium berlandieri, Cyperus laevigatus*, *Eleocharis ovata, Eleocharis parishii, Eleocharis rostellata, Pseudognaphalium luteoalbum, Heliotropium curassavicum*, *Juncus acutus, Juncus bufonius, Juncus ensifolius, Lythrum californicum*, *Mimulus guttatus*, *Mimulus verbenaceus*, *Muhlenbergia rigens*, *Nasturtium officinale, Paspalum dilatatum, Petunia parviflora, Phragmites australis*, *Polypogon interruptus, Polypogon monspeliensis, Rumex hymenosepalus, Solanum americanum, Spergularia marina, Typha latifolia, Veronica anagallis-aquatica, Vitis arizonica,* and *Wislizenia refracta* (Fig. 12).

A few of the herbaceous wetland species are currently known from a single spring. For instance, Columbine Spring, near the headwaters of an ephemeral tributary to Warm Springs Wash, has the only documented occurrence of *Sisyrinchium demissum* and *Zeltnera arizonica* (Fig. 12) in the flora area. Two grass species, *Andropogon glomeratus* and *Imperata brevifolia*, have been documented only from Cottonwood Spring in Cottonwood Canyon in the southern Black Mountains.

FIGURE 9. Some conspicuous plants in the southern Black Mountains-2. *Castilleja chromosa* (top left). *Fallugia paradoxa* (top right). *Eucnide urens* (center left). *Mimulus bigelovii* (center right). *Thamnosma montana* (bottom left; photo by P. Alexander, SEINet). *Oenothera caespitosa* subsp. *marginata* (bottom right). Photos by the authors, except as noted.

FIGURE 10. Southern Black Mountains, plant communities-3. Pinyon-Juniper Woodland on saddle north of Mt. Nutt with *Juniperus californica* (top). *Juniperus californica* with female cones (center right). *Pinus monophylla* (bottom left). Branch with female cones of *P. monophylla* (bottom right). Photos by the authors

FIGURE 11. Southern Black Mountains, plant communities-4. Desert Oasis Woodland in Bighorn Cave Canyon with overstory of *Populus fremontii* and *Baccharis sergiloides* in understory (top left). Streamside Marsh at Columbine Spring (looking downslope with series of step pools) with *Aquilegia chrysantha* and *Mimulus verbenaceus* (top right). Desert Oasis Woodland with Streamside Marsh at "Twin Spring," with *Mimulus guttatus* and *Baccharis sergiloides* in marsh understory (bottom left). High-Gradient Desert Wash Scrub above "Twin Spring" with *Quercus turbinella* (bottom right). Photos by the authors.

FIGURE 12. Plants restricted to springs in the southern Black Mountains. Plants of *Mimulus verbenaceus* and *Aquilegia chrysantha* at Columbine Spring (top). *Aquilegia chrysantha* (center left; photo by Max Licher, SEINet). *Castilleja minor* subsp. *spiralis* (middle center). Plant of *Zeltnera arizonica* (bottom right). Flower of *Zeltnera arizonica* (bottom left). Flowers of *Mimulus verbenaceus* (bottom center). Photos by the authors, except as noted.

Annotated Catalog of the Vascular Plants in the Southern Black Mountains

Our list of plants is based in large part on extensive collection and examination of specimens deposited at ARIZ, ASC, ASU, CAS, DES, GMDRC, MNA, and UCR. We conducted 11 field trips of from one to six days each between 1986 and 1993. Eight of the trips involved sampling the springtime flora between February and May; two of the trips were in June and August; and one trip was in November. An effort was made to sample the diversity of habitats represented. Some sites were revisited in order to obtain a more complete inventory and adequate material for identification. Figure 1 shows the boundary of our flora area and the sites we sampled. Our collections from the southern Black Mountains consist of 1040 numbers, with a complete set of voucher specimens deposited at CAS and duplicates (when available) distributed to ASU, MO, and NY. A query of SEINet (2016) identified several species that might be expected to occur in the southern Black Mountains but which were not encountered by us. We examined these specimens or in some cases images of them in order to verify their localities and identifications.

The vascular flora of the study area consists of 471 species in 276 genera representing 72 families. In at least 44 species infraspecific taxa are recognized, and in seven of these species more than one infraspecific taxon occurs in the southern Black Mountains. Thus, 478 taxa at the rank of species or below are recognized in our study.The flora is summarized based on major taxonomic categories (Table 1), numbers of genera and species in the largest families and numbers of species in the largest genera (Table 2), and life-form (Table 3). The life-form spectrum (Table 3) is characteristic of arid regions—the 205 total ephemeral herbs comprise 43% of the total flora. Thirty-eight taxa (8% of the flora) are not native to the flora of Arizona; most of them have been introduced from Europe. This is nearly the same percentage that was noted by Kearney et al. (7%; 1960) for the non-native flora of the state.The non-native species, *Bromus rubens* and *Erodium cicutarium*, are abundant and conspicuous throughout much of the flora area (Fig. 2).

Occurrences of at least 12 taxa in the southern Black Mountains are noteworthy. *Monardella eplingii* (Fig. 6), a recently described species that is endemic to the Black Mountains (Elvin et al. 2013), is found on various volcanic substrates in cracks of bedrock, among boulders along tributaries, and on rock outcrops, cliffs, and open rocky slopes. In our flora area, the species occurs in association with Mixed Desert Scrub and High-Gradient Desert Wash Scrub plant communities at elevations between 850–1100 m (2789–3608 ft). Six taxa appear to occur at a geographic limit of their respective distributions in the southern Black Mountains: *Asclepias albicans* (northern), *Astragalis newberryi* var. *blyae* (western), *Carnegiea gigantea* (northwestern), *Packera quercetorum* (western), *Phacelia saxicola* (southern), and *Parkinsonia microphylla* (northern). Five additional taxa occur at a geographic limit of the Arizona portion of their respective distributions in our study area: *Coreopsis californica* (northern and western), *Parkinsonia florida* (northern), *Psorothamnus spinosus* (northern), *Typha latifolia* (western), and *Yucca schidigera* (southeastern).

In the following list, nomenclature and taxonomic circumscriptions generally follow *Flora of North America North of Mexico* (Flora of North America Editorial Committee 1993–2016), *The Jepson Manual: Vascular Plants of California* (Baldwin et al. 2012), Vascular Plants of Arizona Project (Vascular Plants of Arizona Editorial Committee 1992–2015), and *Arizona Flora* (Kearney et al. 1960) in that order and as published. In some cases, more recent and/or widely used synonyms are provided. In the following catalog, the name and author of each taxon are followed by an indication of whether the species is native or introduced, life form, plant community(ies) of occurrence, and reference to at least one voucher collection studied. In the collection numbers, "B" refers to a collection by Butterwick (or Butterwick et al.), "DB" refers to a collection by Daniel and

TABLE 1. Summary of the flora of the southern Black Mountains by major taxonomic categories. Infraspecific taxa refers to species with occurrences of more than one variety or subspecies in the flora area.

	Families	Genera	Species	Infraspecific Taxa
Ferns	1	3	5	0
Gymnosperms	3	3	3	0
Flowering Plants	68	270	463	7
Totals	72	276	471	7

TABLE 2. Numbers of genera and species in the largest families and numbers of species in the largest genera.

Largest families	Genera/Species	Largest Genera	Species
Asteraceae	55/89	*Cryptantha*	12
Poaceae	29/53	*Eriogonum*	12
Boraginaceae	12/35	*Phacelia*	7
Fabaceae	13/24	*Bromus*	6
Brassicaceae	14/19	*Chylismia*	5
Cactaceae	7/16	*Cylindropuntia*	5
Polygonaceae	4/16	*Eleocharis*	5
		Ericameria	5
		Gilia	5
		Juncus	5
		Muhlenbergia	5

TABLE 3. Spectrum of life forms in the flora of the southern Black Mountains. WA = winter ephemeral herb; SA = summer ephemeral herb; YRA = year-round ephemeral herb; PH = perennial herb; PV = perennial vine; S = shrub; T = tree; SS = stem succulent; LSS = leaf semisucculent; LS = leaf succulent. Total flora refers to the 478 total taxa at the rank of species or below.

	WA	SA	YRA	PH	PV	S	T	SS	LSS	LS
Number of species	182	17	6	155	7	75	15	16	4	1
Percent of total flora	38	3.6	1.2	32.6	1.5	15.7	3.1	3.4	0.8	0.2

Butterwick, "DBH" refers to a collection by Daniel, Butterwick, and Deborah Hillyard, "DBa" refers to a collection by Daniel and Bruce Bartholomew, and "DBP" refers to a collection by Daniel, Butterwick, Arthur Phillips, and Barbara Phillips. The location of these collections is noted above. For all other collections, the herbarium in which the specimen is deposited is noted. Plant communities in the southern Black Mountains are designated with the abbreviations listed below.

BBS	Blackbrush Scrub
CBS	Creosote Bush Scrub
DOW	Desert Oasis Woodland
HDWS	High-Gradient Desert Wash Scrub
LDWS	Low-Gradient Desert Wash Scrub
MDS	Mixed Desert Scrub
PJW	Pinyon-Juniper Woodland
SSM	Streamside Marsh

FERNS

Pteridaceae

Adiantum capillus-veneris L. Native perennial herb; DOW, SSM. *DB 4518*.

Cheilanthes covillei Maxon Native perennial herb; HDWS, MDS. *DB 6645*, *6682*; *DBH 5704*; *DBP 5954*.

Cheilanthes parryi (D.C. Eaton) Domin Native perennial herb; LDWS, HDWS. *B 8954*; *DB 5919*.

Cheilanthes ×parishii Davenp. Native perennial herb; HDWS. *Windham 347* (ASU).

Pellaea truncata Goodd. Native perennial herb; MDS, HDWS. *B 8957*; *DBH 5695*.

GYMNOSPERMS

Cupressaceae

Juniperus californica Carrière Native shrub (sometimes treelike); BBS, HDWS, MDS, PJW. *B 8992*; *DB 4495*, *6006*; *Hale 5045 (*ARIZ); *Kearney & Peebles 12630* (ARIZ); *Phillips 74-266* (ARIZ). Fig. 10.

Ephedraceae

Ephedra aspera Engelm. ex S. Watson Native shrub; BBS, CBS, HDWS, LDWS, MDS. *B 8887*; *DB4623*, *6483*; *Barr 67-104* (ARIZ), *67-105* (ARIZ); *Carter s.n.* (ASC); *Currie 5* (ASC); *Helmkamp 1555* (ARIZ); *Huisinga s.n.* (ASC); *Ickert-Bond 571* (ASU, ARIZ); *Nelson 9* (ASC); *Nichol s.n.* (ARIZ); *Reeder & Reeder 8981* (ARIZ), *8981a* (ARIZ); *Stevens-Rumann 11* (ASC).

Goodwin 3320 (ASC) was determined as *Ephedra nevadensis* S. Watson. Because the specimen lacks female cones, we were unable to confim this determination.

Pinaceae

Pinus monophylla Torr. & Frém. Native tree; PJW; saddle above Grapevine Spring Canyon, north facing slopes. *DB 6702*, *Hovezak 14* (MNA-not seen). Fig. 10.

We observed and collected this species at a single locale, the saddle above Grapevine Spring Canyon on north-facing slopes at 1357 m elevation. Fewer than 10 individuals were noted at this site. Our collection was from a plant about six meters tall with a trunk diameter (DBH) of 40 cm. Cones were present on the ground. Hovezak's collection appears to have been made about 0.8 km northwest of ours at 1433 meters. Notes on his collection indicate the presence of mature, cone-bearing trees with an average trunk diameter of 46 cm.

FLOWERING PLANTS

Adoxaceae

Sambucus nigra L. subsp. caerulea (Raf.) Bolli (*S. mexicana* C. Presl. ex DC.) Native shrub; MDS. *DB 5933*.

Agavaceae

Agave mckelveyana Gentry Native leaf semisucculent; MDS, HDWS. *DB 4507*; *Gentry 9961* (ARIZ), *21979* (ARIZ, DES), *Hovezak s.n.* (MNA).

The type of this name, *Gentry 21979* (ARIZ, DES), is from Sitgreaves Pass in the southern Black Mountains. Based on a mixed collection of Marcus Jones (*25167* at CAS, POM) from Oatman, Gentry (1982) included *A. utahensis* Engelm. subsp. *utahensis* as occurring in the flora

area.The *A. mckelveyana* portion of the collection was likely collected near Oatman, but subsequent collecting activities have failed to locate *A. utahensis* in the southern Black Mountains. We tentatively exclude it from the currently known flora.

Nolina bigelovii (Torr.) S. Watson Native leaf semisucculent; BBS, HDWS, MDS, PJW. *B 8942*. Fig. 5.

Yucca baccata Torr. Native leaf semisucculent; MDS, PJW. *DB 5673*, *6667*; *DBH 5744*.

Yucca schidigera Ortgies Native leaf semisucculent; BBS, MDS. *B 9349*; *DB 5638*. Fig. 3.

The southeastern extent of the native distribution of this species in Arizona occurs in the southern Black Mountains (ca. 35.037651° lat.; based on *Hodgson et al. 3536* at DES; SEINet 2016).

Amaranthaceae

Amaranthus fimbriatus (Torr.) Benth. ex S. Watson Native summer ephemeral herb; LDWS, HDWS. *DB 4598*.

Tidestromia lanuginosa (Nutt.) Standl. Native summer ephemeral herb; CBS. *André 32087* (GMDRC).

Anacardiaceae

Rhus aromatica Aiton (*R. trilobata* Nutt. var. *anisophylla* (Greene) Jeps.) Native shrub; HDWS, MDS, PJW. *DB 5916*, *5937*; *DBH 5715*.

Apiaceae

Bowlesia incana Ruiz & Pav. Native winter ephemeral herb; CBS, LDWS. *DB 4686*.

Daucus pusillus Michx. Native winter ephemeral herb; CBS, LDWS. *DB 5594*, *6423*, *6473*; *DBH 5750*.

Lomatium nevadense (S. Watson) J.M. Coult. & Rose var. parishii (J.M. Coult. & Rose) Jeps. Native perennial herb; HDWS, PJW. *DB 5973*, *6707*.

Yabea microcarpa (Hook. & Arn.) Koso-Pol. Native winter ephemeral herb; HDWS, MDS. *DBH 5690*.

Apocynaceae

Amsonia palmeri A. Gray Native perennial herb; LDWS, HDWS. *B 6821*, 8932; *DBH 5724*; *DBP 5963*; *Hovezak s.n.* (MNA).

Apocynum cannabinum L. Native perennial herb; DOW, SSM, local at springs. *DB 4519*, *6451*; *B 8922*.

Asclepias albicans S. Watson Native perennial herb; CBS. *DB 6466*.

This collection from the southern portion of our flora area (34.861486° lat.) and one collected in the same region (*Power s.n.* at ASC), represent the northernmost known occurrence of this species (Consortium of California Herbaria 2016; SEINet 2016).

Asclepias erosa Torr. Native perennial herb; CBS, LDWS. *DB 6044*.

Asclepias nyctaginifolia A. Gray Native perennial herb; HDWS. *DBH 5735*.

Asclepias subulata Decne. Native perennial herb; CBS. *DB 4501*; *DBH 5751*.

Funastrum cynanchoides (Decne) Schltr. var. hartwegii (Vail) Krings (*Sarcostemma cynanchoides* Decne. subsp. *hartwegii* (Vail) R.W. Holm.) Native perennial vine; HDWS, LDWS. *B 8990*; *DB 5616*, *5912*; *Hodgson et al. 9203* (DES), *9200* (DES).

Funastrum hirtellum (A. Gray) Schltr. (*Sarcostemma hirtellum* (A. Gray) R.W. Holm) Native perennial vine; LDWS. *B 9330*; *DB 5600*, *6001*.

Matelea parvifolia (Torr.) Woodson Native perennial vine; LDWS, MDS. *DB 4695*; *DBa 5113*.

Asteraceae

Acamptopappus sphaerocephalus A. Gray Native shrub; HDWS, MDS. *B 8935*.

Acourtia wrightii (A. Gray) Reveal & R.M. King Native perennial herb; HDWS. *DB 4562*, *5985*; *DBH 5733*.

Adenophyllum porophylloides (A. Gray) Strother (*Dyssodia porophylloides* A. Gray) Native perennial herb; HDWS, LDWS. *B 8949*, *9354*; *DB 4646*, *6388*.

Ambrosia confertiflora (DC.) Rydb. Native perennial herb; HDWS. *DBP 5942*.

Ambrosia dumosa (A. Gray) W.W. Payne Native shrub; CBS, LDWS, MDS. *B 9337*; *DB 6662*.

Ambrosia eriocentra (A. Gray) W.W. Payne Native shrub; HDWS. *B 8974*; *DB 5981*; *DBH 5725*.

Ambrosia monogyra (Torr. & A. Gray) Strother & B.G. Baldwin (*Hymenoclea monogyra* Torr. & A. Gray) Native shrub; DOW, HDWS, LDWS. *DB 4608*, *6316*.

Ambrosia salsola (Torr. & A. Gray) Strother & B.G. Baldwin (*Hymenoclea salsola* Torr. & A. Gray) Native shrub; LDWS. *B 8877*, *9329*, *9334*.

Amphipappus fremontii Torr. & A. Gray var. spinosus (A. Nelson) Ced. Porter Native shrub; MDS. *Weaver & Webbe s.n.* (DES).

Artemisia dracunculus L. Native perennial herb; HDWS. *DB 4551*.

Artemisia ludoviciana Nutt. Native perennial herb; HDWS, MDS, PJW. *B 8981*.

Atrichoseris platyphylla A. Gray Native winter ephemeral herb; CBS, LDWS. *DB 5607*.

Baccharis brachyphylla A. Gray Native shrub; DOW, HDWS, MDS. *DB 4541*, *6675*; *DBH 5717*.

Baccharis salicifolia (Ruiz & Pav.) Pers. Native shrub; DOW, LDWS. *DB 5993*, *6330*.

Baccharis sergiloides A. Gray Native shrub; DOW, HDWS. *B 8923*; *DB 4517*; *Hovezak s.n.* (DES, MNA).

Bahiopsis parishii (Greene) E.E. Schill. & Panero (*Viguiera deltoidea* A. Gray var. *parishii* (Greene) Vasey & Rose) Native shrub; HDWS, LDWS, MDS. *B 8889*, *8952*; *DB 5595*; *Anderson 4730* (ASU); *Hovezak s.n.* (MNA); *Parfitt & Clark 2182* (ASU); *Rominger 307-65* (ASC), *312-65* (ASC).

Baileya multiradiata Harv. & A. Gray Native perennial (biennial) herb; CBS, HDWS, LDWS. *B 9360*; *DB 5685*.

Baileya pleniradiata Harv. & A. Gray Native year-round ephemeral herb; LDWS. *DB 6035*.

Bebbia juncea (Benth.) Greene var. aspera Greene Native shrub; HDWS, LDWS. *B 8885*; *DB 4513*.

Brickellia atractyloides A. Gray Native shrub; HDWS, MDS. *B 8891*; *DB 5665*.

Brickellia desertorum Coville Native shrub; HDWS, MDS. *B 8919*, *8982*; *DB 4522*, *5991*, *6328*.

Brickellia incana A. Gray Native shrub; LDWS. *DB 6021*.

Brickellia microphylla (Nutt.) A. Gray Native shrub; HDWS. *DB 4521*.

Calycoseris parryi A. Gray Native winter ephemeral herb; HDWS, LDWS, MDS. *DB 6399*; *DBH 5741*.

Calycoseris wrightii A. Gray Native winter ephemeral herb; HDWS, LDWS, MDS. *B 8985*; *DB 4665*; *DBa 5142*.

Centaurea melitensis L. Introduced weedy winter ephemeral herb; LDWS. *DB 5910*.

Chaenactis carphoclinia A. Gray var. carphoclinia Native winter ephemeral herb; CBS, LDWS. *B 9332*; *DB 4697*, *6439*.

Chaenactis fremontii A. Gray Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *B 8934*; *DB 4626*, *4632*, *5589*, *5975*; *DBa 5107*, *5141*.

Chaenactis macrantha D.C. Eaton Native winter ephemeral herb; MDS. *DB 6660*.

Chaenactis stevioides Hook. & Arn. Native winter ephemeral herb; MDS. *DBH 5740*.

Cirsium neomexicanum A. Gray Native perennial (biennial) herb; HDWS, MDS. *B 8964*, *9351*; *DB 6400*.

Conyza canadensis (L.) Cronquist Native weedy, year-round ephemeral herb; HDWS. *DB 4565*.

Coreopsis californica (Nutt.) H. Sharsm. (*Leptosyne californica* Nutt.) Native winter ephemeral herb; MDS; *Kearney & Peebles 11281* (ARIZ).

This collection, presumably from Sitgreaves Pass, represents the northern- and westernmost occurrence of this species in Arizona, and it is apparently the only known occurrence of the species in Mohave County (SEINet 2016).

Dieteria asteroides Torr. var. asteroides (*Machaeranthera asteroides* (Torr.) Greene var. *asteroides*) Native perennial herb; HDWS. *DB 4559*; *Hevly & Hovezak 62* (MNA).

Dieteria canescens (Pursh) Nuttall Native perennial (biennial) herb; HDWS. *B 6817*.

Encelia farinosa A. Gray ex Torr. Native shrub; CBS, MDS. *DB 4620*.

Encelia resinifera C. Clark Native shrub; MDS. *DB 5629*; *Lehto 21055* (ASU).

Encelia virginensis A. Nels. Native shrub; BBS, MDS. *B 9348*.

Ericameria cuneata McClatchie var. spathulata (A. Gray) H.M. Hall Native shrub; MDS. *Palmer s.n.* (US-image).

Ericameria laricifolia (A. Gray) Shinners Native shrub; HDWS, MDS. *B 8997*; *Hovezak s.n.* (MNA).

Ericameria linearifolia (DC.) Urbatsch & Wussow (*Stenotopsis linearifolia* (DC.) Rydb. var. *interior* (Coville) J.F. Macbr.) Native shrub; MDS. *DB 5672*, *5927*.

Ericameria paniculata (A. Gray) Rydberg (*Chrysothamnus paniculatus* (A. Gray) H.M. Hall) Native shrub; HDWS, LDWS. *B 8971*; *DB 5913*, *6020*, *6302*; *Hovezak & Hevly s.n.* (MNA).

Ericameria teretifolia (Durand & Hilgard) Jeps. (*Chrysothamnus teretifolius* (Durand & Hilgard) H.M. Hall) Native shrub; MDS. *Anderson 93-28* (ASU); *Palmer s.n.* (US-image).

Erigeron divergens Torr. & A. Gray Native perennial herb; HDWS, MDS. *DB 4566*, *5926*.

Erigeron lobatus A. Nelson Native winter ephemeral herb; HDWS. *B 8958*.

Erigeron oxyphyllus Greene Native perennial herb; HDWS. *B 8939*.

Eriophyllum lanosum A. Gray Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *B 8968*; *DB 4639*; *DBa 5096*.

Eriophyllum wallacei (A. Gray) A. Gray Native winter ephemeral herb; MDS. *Arnold s.n.* (DES); *Kearney & Peebles 11279* (ARIZ); *Kearney et al. 7617* (ARIZ).

Geraea canescens Torr. & A. Gray Native winter ephemeral herb; CBS. *DB 6469*.

Gutierrezia microcephala (DC.) A. Gray Native shrub (subshrub); HDWS. *Hovezak s.n.* (MNA)

Gutierrezia sarothrae (Pursh) Britton & Rusby Native shrub (subshrub); HDWS, MDS. *B 8945*; *DB 4499*, *6304*; *Hovezak s.n.* (MNA).

Hymenopappus filifolius Hook. var. lugens (Greene) Jeps. Native perennial herb; PJW. *DB 6697*.

Hymenothrix loomisii S.F. Blake Native summer ephemeral herb; MDS. *Rominger 312-65* (ARIZ, ASC).

Layia glandulosa (Hook.) Hook. & Arn. Native winter ephemeral herb; MDS. *DB 5650*, *6690*.

Logfia filaginoides (Hook & Arn.) Morefield (*Filago californica* Nutt.) Native winter ephemeral herb; HDWS, MDS. *B 9007*; *DB 6665*.

Malacothrix coulteri Harv. & A. Gray Native winter ephemeral herb; MDS. *DB5631*, *6658*; *DBa 5108*.

Malacothrix glabrata (A. Gray ex D.C. Eaton) A. Gray (*Malacothrix californica* DC. var. *glabrata* Eaton) Native winter ephemeral herb; CBS, HDWS, LDWS. *B 8986*; *DB 5630*, *6386*; *DBH 5747*; *DBa 5131*.

Malacothrix sonorae W.S. Davis & P.H. Raven Native winter ephemeral herb; MDS. *DB 6689*; *Hodgson H-757* (DES); *Price s.n.* (ASC).

Monoptilon bellioides (A. Gray) H.M. Hall Native winter ephemeral herb; CBS, LDWS. *DB 4661*; *DBa 5153*.

Packera multilobata (Torr. & A. Gray) W.A. Weber & A. Love (*Senecio multilobatus* Torr. & A. Gray) Native perennial herb; HDWS, MDS. *DB 4548*, *5656*, *5920*; *DBH 5713*.

Packera quercetorum (Greene) C. Jeffrey Native perennial herb; DOW, LDWS. *Maguire 17814* (UTC).

This collection from Cool Springs on the east side of the Black Mountains (-114.309949° long.), represents the westernmost known occurrence of this species (SEINet 2016).

Palafoxia arida B.L. Turner & M.I. Morris Native winter ephemeral herb; LDWS. *DB 6034*.

Parthenium incanum Kunth Native shrub; MDS. *DB 6695*.

Pectis papposa Harv. & A. Gray Native summer ephemeral herb; HDWS. *Hovezak s.n.* (MNA).

Perityle emoryi Torr. Native winter ephemeral herb; HDWS, LDWS. *B 8929*; *DB 4691*; *DBa 5156*.

Peucephyllum schottii A. Gray Native shrub; MDS. *DB 5611*.

Pluchea sericea (Nutt.) Coville (*Tessaria sericea* (Nutt.) Shinners) Native shrub; DOW. *DB 5676*, *6462*.

Pleurocoronis pluriseta (A. Gray) R.M. King & H. Rob. Native shrub; CBS, HDWS, MDS. *B 8943*; *DB 4644*.

Porophyllum gracile Benth. Native perennial herb; LDWS, MDS. *B 8880*; *DB 5609*; *DBa 5100*.

Prenanthella exigua (A. Gray) Rydb. Native winter ephemeral herb; CBS, LDWS. *B 9338*; *DB 5601*, *6428*.

Pseudognaphalium canescens (DC.) Anderb. (*Gnaphalium wrightii* A. Gray) Native perennial herb; HDWS, SSM. *DB 4569*; *DBH 5731*, *5737*.

Pseudognaphalium luteoalbum (L.) Hilliard & B.L. Burtt. (*Gnaphalium luteoalbum* L.) Introduced winter ephemeral herb; DOW, SSM. *DB 5995*, *6325*, *6464*.

Pseudognaphalium stramineum (Kunth) Anderb. (*Gnaphalium chilense* Spreng.) Native perennial herb; SSM. *DBH 5771*.

Psilostrophe cooperi (A. Gray) Greene Native perennial herb; HDWS. *B 8996*.

Rafinesquia californica Nutt. Native winter ephemeral herb; CBS, HDWS, MDS. *B 8928*, *9006*; *DB 5636*.

Rafinesquia neomexicana A. Gray Native winter ephemeral herb; CBS, LDWS, MDS. *DB 4633*, *5592*; *DBa 5106*.

Senecio flaccidus Less. var. flaccidus (*S. douglasii* DC. var. *douglasii*) Native perennial herb; DOW, HDWS, LDWS, MDS. *B 8879*; *DB 4500*, *6465*.

Senecio flaccidus Less. var. monoensis (Greene) B.L. Turner & T.M. Barkley (*S. douglasii* DC. var. *monoensis* (Greene) Jeps.) Native perennial herb; HDWS. *Hovezak s.n.* (MNA).

Sonchus asper (L.) Hill Introduced winter ephemeral herb; SSM. *DB 5684*.

Sonchus oleraceus L. Introduced winter ephemeral herb; HDWS, SSM. *B 8909*; *DBH 5756*.

Stephanomeria pauciflora (Torr.) A. Nelson Native perennial herb; CBS, HDWS. *B 9336*; *Christy 1482* (ASU); *Hovezak s.n.* (MNA); *Howell 26615* (CAS).

Christy 1482 was previously determined as *Stephanomeria exigua* Nutt. Based on characters of the pappus, length of involucre, and branching pattern, it conforms to *S. pauciflora*. *Stephanomeria exigua* has been collected (*White 527* at CAS) ca. 5 miles north of Union Pass (the northern border of our flora area) and likely also occurs in the southern Black Mountains.

Stylocline micropoides A. Gray Native winter ephemeral herb; CBS, LDWS. *DB 5681*, *6460*; *DBa 5167*.

Symphyotrichum subulatum (Michx.) G.L. Nesom var. parviflorum (Nees) S.D. Sundb. Native winter ephemeral herb; MDS. *DB 5677*.

Syntrichopappus fremontii A. Gray Native winter ephemeral herb; CBS, MDS. *DB5649*, *6004*, *6698*; *DBP 5949*.

Trichoptilium incisum (A. Gray) A. Gray Native winter ephemeral herb; CBS, LDWS. *DB 4690*, *5603*, *6381*, *6437*.

Trixis californica Kellogg Native shrub; CBS, LDWS. *DB 4655*; *DBH 5748*. Fig. 4.

Uropappus lindleyi (DC.) Nutt. (*Microseris lindleyi* (DC.) A. Gray) Native winter ephemeral herb; MDS. *B 9370*; *DB 5667*, *6687*.

Verbesina encelioides (Cav.) Benth. & Hook.f. ex A. Gray Native winter ephemeral herb; CBS, LDWS. *DB 6033*.

Xanthisma spinulosum (Pursh) D.R. Morgan & R.L. Hartman var. gooddingii (A. Nelson) D.R. Morgan & R.L. Hartman (*Machaeranthera pinnatifida* (Hook.) Shinners) Native perennial herb; CBS, MDS. *DB 4641*, *4648*.

Xylorhiza tortifolia (Torr. & A. Gray) Greene Native perennial herb (subshrub); MDS. *DBa 5101*.

Bignoniaceae

Chilopsis linearis (Cav.) Sweet Native tree; LDWS. *DB 4502*.

Boraginaceae

Amsinckia intermedia Fisch. & C.A. Mey. Native winter ephemeral herb; CBS, HDWS, LDWS. *B 9003*; *DB 4588*; *DBa 5133*.

Amsinckia tessellata A. Gray Native winter ephemeral herb; CBS, LDWS, MDS. *DB 4650*, *5608*; *DBa 5089*, *5175*.

Cryptantha angustifolia (Torr.) Greene Native winter ephemeral herb; CBS, HDWS, LDWS. *DB 6028*, *6029*; *DBa 5129*.

Cryptantha barbigera (A. Gray) Greene Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *B 8882*; *DB 4613*, *5588*, *6420*, *6663*, *6668*; *DBa 5088*, *5120*, *5128*, *5136*, *5162*; *Lehto 21048* (ASU).

Cryptantha circumscissa (Hook. & Arn.) I.M. Johnst. Native winter ephemeral herb; LDWS. *DB 6025*.

Cryptantha decipiens (M.E. Jones) A. Heller Native winter ephemeral herb; CBS, HDWS, LDWS. *B 8966*; *DB 6026*.

Cryptantha gracilis Osterh. Native winter ephemeral herb; CBS. *DB 4635*.

Cryptantha maritima (Greene) Greene Native winter ephemeral herb; CBS, LDWS. *DB 4640*, *4645*; *DBa 5161*, *5173*.

Cryptantha micrantha (Torr.) I.M. Johnst. Native winter ephemeral herb; CBS, LDWS. *DB 6027*.

Cryptantha nevadensis A. Nelson & P.B. Kenn. var. nevadensis Native winter ephemeral herb; LDWS, MDS. *DB 5661*; *Dba 5160*.

Cryptantha pterocarya (Torr.) Greene var. cycloptera (Greene) J.F. Macbr. Native winter ephemeral herb; MDS. *DB 6488*.

Cryptantha pterocarya (Torr.) Greene var. pterocarya Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *B 8970*; *DB 4581*, *4602*, *5619*, *6664*; *DBa 5087*, *5117*, *5135*.

Cryptantha racemosa (S. Watson ex A. Gray) Greene Native perennial herb; HDWS, MDS. *B 8916*, *8924*.

Cryptantha utahensis (A. Gray) Greene Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *B 8895*, *8983*; *DB 5587*, *5622*, *5669*, *6481*; *DBa 5163*.

Emmenanthe penduliflora Benth. var. penduliflora Native winter ephemeral herb; HDWS, MDS. *B 8933*; *DBa 5111*.

Eucrypta chrysanthemifolia (Benth.) Greene var. bipinnatifida (Torr.) Constance Native winter ephemeral herb; HDWS. *B 8907*.

Eucrypta micrantha (Torr.) A. Heller has been collected (*Fugate 6* at ASC) ca. 10 miles north of Union Pass and likely also occurs in the southern Black Mountains.

Harpagonella palmeri A. Gray Native winter ephemeral herb; MDS. *André 28622* (GMDRC).

Heliotropium curassavicum L. var. oculatum (A. Heller) Tidestr. Native perennial herb; SSM. *DB 6450*.

Nama demissa A. Gray Native winter ephemeral herb; CBS, LDWS. *B 9342*; *DB 4688*, *6407*; *DBa 5132*.

Nama hispida A. Gray var. spathulata (Torr.) C.L. Hitchc. Native winter ephemeral herb; LDWS. *DB 6041*.

Pectocarya heterocarpa (I.M. Johnst.) I.M. Johnst. Native winter ephemeral herb; CBS, LDWS. *DB 4643b*, *4710*.

Pectocarya platycarpa (Munz & I.M. Johnst.) Munz & I.M. Johnst. Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *DB 4540*, *4603*, *4643*, *4710a*, *6031*; *DBa 5098*, *5134*.

Pectocarya recurvata I.M. Johnst. Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *DB 4538*, *4603a*, *4643a*, *4678*, *6030*; *DBa 5097*, *5174*.

Pectocarya setosa A. Gray Native winter ephemeral herb; MDS. *DB 5972*, *6691*; *DBP 5943*.

Phacelia crenulata Torr. ex S. Watson Native winter ephemeral herb; CBS, HDWS, MDS. *B 8925*, *8925a*; *DB 4671*, *4717*, *6379*; *DBa 5092*, *5122*.

Phacelia cryptantha Greene Native winter ephemeral herb; HDWS, LDWS. *B 6822*; *DB 5647*, *5660*, *6482*; *Edgar s.n.* (ASC); *Hodgson et al. 9143* (DES), *9150* (DES).

Phacelia distans Benth. Native winter ephemeral herb; CBS, HDWS, LDWS. *B 8910*, *8973*; *DB 4590*, *4708*, *5646*, *6478*, *6486*; *DBa 5159*; *Goodwin 3314* (ASC).

Phacelia fremontii Torr. Native winter ephemeral herb; MDS. *DB 6709*.

Phacelia perityloides Coville var. laxiflora (J.T. Howell) Cronquist Native perennial herb; HDWS. *B 8956*; *Hodgson et al. 9185* (DES).

Phacelia rotundifolia Torr. ex S. Watson Native winter ephemeral herb; HDWS. *DB 5617*; *Hodgson 9198 et al.* (DES).

Phacelia saxicola A. Gray Native winter ephemeral herb; HDWS. *B 8917*.

This collection (at 35.119416° lat.) represents the southernmost geographic extent of the species.

Pholistoma auritum (Lindl.) Lilja var. arizonicum (M.E. Jones) Constance Native winter ephemeral herb; HDWS. *B 8913*.

Plagiobothrys arizonicus (A. Gray) Greene ex A. Gray Native winter ephemeral herb; HDWS, MDS. *DB 5659*, *6487*; *DBP 5947*.

Plagiobothrys jonesii A. Gray Native winter ephemeral herb; MDS. *B 9357*

Tiquilia canescens (DC.) A. Richardson var. canescens Native perennial herb; CBS, MDS. *DB 5632*, *6471*; *DBa 5099*.

Tiquilia plicata (Torr.) A. Richardson Native perennial herb; LDWS. *DB 6037*.

Brassicaceae

Athysanus pusillus (Hook.) Greene Native winter ephemeral herb; MDS. *DB 6693*.

Boechera perennans (S. Watson) W.A. Weber (*Arabis perennans* S. Watson) Native perennial herb; HDWS, MDS. *B 9001*; *DB 4612*, *6671*.

Brassica tournefourtii Gouan. Introduced winter ephemeral herb; DOW, SSM. *DB 6447*.

Caulanthus cooperi (S. Watson) Payson Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *B 8896*; *DB 4649*, *5593*; *DBa 5119*.

Caulanthus lasiophyllus (Hook. & Arn.) Payson var. lasiophyllus Native winter ephemeral herb; LDWS, MDS. *DB 4679*, *6655*.

Descurainia pinnata (Walter) Britton subsp. glabra (Wooton & Standl.) Detling Native winter ephemeral herb; HDWS, LDWS, MDS. *DB 4601*, *5613*, *6002*, *6032*, *6656*, *6712*; *DBa 5086*, *5139*.

Dimorphocarpa wislizenii (Englem.) Rollins Native winter ephemeral herb; LDWS. *DB 6023*.

Draba cuneifolia Nutt. ex Torr. & A. Gray var. integrifolia S. Watson Native winter ephemeral herb; HDWS, LDWS. *DB 4580*, *4711*.

Lepidium fremontii S. Watson Native perennial herb; BBS, MDS. *DB 5925*, *6670*; *DBP 5948*.

Lepidium lasiocarpum Nutt. var. lasiocarpum Native winter ephemeral herb; BBS, CBS, HDWS, LDWS, MDS. *DB 4552*, *4584*, *4642*, *4685*, *6492*; *DBa 5116*, *5169*.

Nasturtium officinale W.T. Aiton Introduced perennial herb; DOW, SSM. *B 9367*; *DB 5769*, *5992*.

Physaria tenella (A. Nelson) O'Kane & Al-Shehbaz (*Lesquerella tenella* A. Nelson) Native winter ephemeral herb; MDS. *DB 5743*, *6674*; *Hammond 11118* (ASU); *Marshall & Tall s.n.* (ASC); *Nichol 2983* (ARIZ).

Sisymbrium altissimum L. Introduced winter ephemeral herb; DOW, HDWS, LDWS, MDS. *B 9368*; *DB 5612*, *5621*, *6651*.

Sisymbrium irio L. Introduced winter ephemeral herb; CBS, LDWS. *DB 4662*, *4712*, *6446*.

Sisymbrium orientale L. Introduced winter ephemeral herb; MDS. *DB* 5930; *Carter s.n.* (ASC); *Christy 1493* (ASU); *Hodgson et al. 9163* (DES); *Parfitt 2178* (ASU).

Stanleya pinnata (Pursh) Britton var. pinnata Native shrub; HDWS, MDS. *B 8920*; *DB 5618*, *6479*.

Streptanthella longirostris (S. Watson) Rydb. Native winter ephemeral herb; MDS. *Isobe et al.11* (ASC).

Thysanocarpus curvipes Hook. Native winter ephemeral herb; HDWS, LDWS, MDS. *DB 6646*; *DBa 5114*, *5140*.

Thysanocarpus laciniatus Nutt. var. laciniatus Native winter ephemeral herb; HDWS, MDS. *B 8897*; *DB 4553*, *4582*, *4604*, *5664*.

Cactaceae

Carnegiea gigantea (Engelm.) Britton & Rose Native stem succulent; MDS. Fig. 3.

The iconic columnar cactus of the Sonoran Desert, *Carnegiea gigantea*, attains the northwestern extent of its distribution in the southern Black Mountains. Jeff Pebworth and Erin Butler sighted and photographed (Fig. 3) a single plant on the east side of the Black Mountains south of Sitgreaves Pass (at ca. 35° lat., -114.35° long.).

Cylindropuntia acanthocarpa (Engelm. & J.M. Bigelow) F.M. Knuth var. acanthocarpa Native stem succulent; BBS, CBS, HDWS, LDWS, MDS. *DB 5627*; *Eastwood 18220* (CAS); *Hodgson et al. 9126* (DES), *9183* (DES). Fig. 8.

Some of the collections of this species from the southern Black Mountains have been identified as var. *coloradensis* (L.D. Benson) Pinkava. For those noted above, the number of spines per areole varies between 12 and 22, which conforms to var. *acanthocarpa* (Benson 1982). The number of "abaxial spines deflexed" varies from five to 11, which also suggests the nominate variety (Pinkava 2003). Eastwood's collection was determined by M. Baker as var. *acanthocarpa* in 2015. Thus, we treat these collections as more readily identifiable with var. *acanthocarpa*.

Cylindropuntia bigelovii (Engelm.) F.M. Knuth var. bigelovii Native stem succulent; CBS, HDWS, MDS. *DB 5988*, *6438a*; *Hovezak & Hevly s.n* (MNA). Fig. 8.

Cylindropuntia echinocarpa (Engelm. & J.M. Bigelow) F.M. Knuth Native stem succulent; CBS, MDS. *DB 6438*, *6467*.

Cylindropuntia leptocaulis (DC.) F.M. Knuth Native stem succulent; CBS. *DB 5976*.

Cylindropuntia ramosissima (Engelm.) F.M. Knuth Native stem succulent; CBS. *DBP 5970*.

Echinocereus coccineus Engelm. Native stem succulent; MDS, PJW. *DBH 5687*; *DBP 5938*. Fig. 8.

Echinocereus engelmannii (Parry ex Engelm.) Lem. Native stem succulent; MDS, PJW. *B 9355*; *Eastwood 18215* (CAS); *Hovezak s.n.* (MNA).

Echinomastus johnsonii (Parry ex Engelm.) E.M. Baxter Native stem succulent; MDS. *DB 5908*.

Ferocactus cylindraceus (Engelm.) Orcutt Native stem succulent; CBS, MDS. *DB 6474*. Fig. 8.

A collection (*Hodgson 15527* at DES) cultivated at the Desert Botanical Garden (Phoenix, Arizona) from material collected by P. Quirk in the southern Black Mountains was identified as *Ferocactus wislizeni* (Engelm.) Britton & Rose. The plant has perianth segments (all similar) that conform to *F. wislizeni*, but the color and architecture of the spines are ambiguous with respect to distinguishing that species from *F. cylindraceus*. Because *F. wilsizeni*, in general a more southerly occurring species, is not otherwise known from Mohave County, we feel further studies and/or collections are needed to document the presence of *F. wislizeni* in the Black Mountains.

Mammillaria grahamii Engelm. (*M. microcarpa* Engelm. subsp. *grahamii* (Engelm.) Mottram Native stem succulent; MDS. *DB 6644*, *6656.5*. Fig. 8.

Mammillaria tetrancistra Engelm. Native stem succulent; HDWS, MDS. *DB 5648.5*.

Opuntia basilaris Engelm. & J.M. Bigelow var. basilaris Native stem succulent; BBS, CBS, HDWS, MDS, PJW. *B 9353*; *Hovezak & Hevly s.n.* (MNA). Fig. 8.

Opuntia chlorotica Engelm. & J.M. Bigelow Native stem succulent; HDWS, MDS. *DB 4624.5*, *5662*.

Opuntia ×curvispina Griffiths Native stem succulent; MDS. *DBH 5732*.

Opuntia polyacantha Haw. var. erinacea (Engelm. & J.M. Bigelow) B.D. Parfitt Native stem succulent; CBS, MDS. *DB 5934*, *6017*, *6018*. Fig. 8.

Campanulaceae

Nemacladus glanduliferus Jeps. Native winter ephemeral herb; LDWS. *DBa 5147*.

Nemacladus orientalis (McVaugh) Morin Native winter ephemeral herb; CBS, LDWS. *DB 5586*, *6425*.

Caryophyllaceae

Achyronychia cooperi A. Gray Native winter ephemeral herb; CBS. *Harrison et al. 7552* (ARIZ, not seen; fide SEINet (2016)).

Silene antirrhina L. Native winter ephemeral herb; HDWS, LDWS. *B 8993*; *DBa 5151*.

Silene verecunda S. Watson Native perennial herb; PJW. *DB 6710*.

Spergularia salina J. Presl & C. Presl Native winter ephemeral herb; DOW, SSM. *DB 6459*.

Stellaria nitens Nutt. Native winter ephemeral herb; HDWS, MDS. *DB 5658*, *6684*; *DBH 5714*.

Chenopodiaceae

Atriplex canescens (Pursh) Nutt. var. canescens Native shrub; MDS. *DB 5932*, *6008*.

Atriplex elegans (Moq.) D. Dietr. var. elegans Native winter ephemeral herb; LDWS. *André 30817* (GMDRC).

Atriplex polycarpa (Torr.) S. Watson Native shrub; MDS. *DB 6652*.

Chenopodium berlandieri Moq. var. zschackei (Murr) Graebn. Native summer ephemeral herb; DOW, SSM. *DB 6449*, *6461*.

Chenopodium fremontii S. Watson Native summer ephemeral herb; MDS. *DB 6489*.

Grayia spinosa (Hook.) Moq. Native shrub; BBS, MDS. *DB 5653*. Fig. 6.

Krascheninnikovia lanata (Pursh) A. Meeuse & A. Smit (*Ceratoides lanata* (Pursh) J.T. Howell) Native shrub; BBS, MDS, PJW. *DB 6475*, *6476*.

Salsola tragus L. Introduced winter ephemeral herb; MDS. *DB 6009*.

Cleomaceae

Wislizenia refracta Engelm. Native winter ephemeral herb; DOW, LDWS, SSM. *DB 5749*, *6317*.

Convolvulaceae

Cuscuta californica Hook. & Arn. Native ephemeral parasitic vine; CBS. *DB 4680*, *6427*, *6468*.

Plants were parasitic on *Encelia farinosa* and *Psorothamnus fremontii*.

Crassulaceae

Dudleya arizonica Rose (*D. pulverulenta* (Nutt.) Britton & Rose subsp. *arizonica* (Rose) Moran) Native leaf succulent; HDWS, MDS. *DB 4570*, *6669*. Fig. 4.

Crossosomataceae

Crossosoma bigelovii S. Watson Native shrub; HDWS, MDS. *B 6820*, *8890*; *DB 4616*; *DBP 5960*.

Cucurbitaceae

Cucurbita palmata S. Watson Native perennial vine; HDWS, LDWS. *B 9328*; *DB 5682*, *6398*.

Marah gilensis Greene Native perennial vine; HDWS, LDWS. *B 9002*; *DB 4585*, *5935*, *6391*, *6650*; *DBH 5728*.

Cyperaceae

Carex alma L.H. Bailey Native perennial herb; DOW, SSM. *B 8948*; *DB 4528*, *4628*, *5986*; *DBH 5700*, *5702*, *5703*; *DBP 5952*.

Cyperus laevigatus L. Native perennial herb; DOW, SSM. *DB 6314*, *6320*.

Cyperus odoratus L. Native summer ephemeral herb; SSM. *DB 6312*.

Eleocharis montevidensis Kunth Native perennial herb; DOW, SSM. *B 8963*.

Eleocharis ovata (Roth) Roem. & Schult. Native summer ephemeral herb; DOW, SSM. *DB 6458*.

Eleocharis palustris (L.) Roem. & Schult. Native perennial herb; SSM. *DB 6315*.

Eleocharis parishii Britton Native perennial herb; DOW, SSM. *DB 4511*, *5679*, *5994*.

Eleocharis rostellata (Torr.) Torr. Native perennial herb; SSM. *DBH 5764*, *5770*.

Euphorbiaceae

Chamaesyce albomarginata (Torr. & A. Gray) Small Native perennial herb; LDWS, MDS. *DB 5628*, *6319*.

Chamaesyce arizonica (Engelm.) Arthur Native perennial herb; CBS, HDWS, LDWS, MDS. *B 8946*; *DB 4629*, *5758*, *6318*.

Chamaesyce melanadenia (Torr.) Millsp. Native perennial herb; CBS, MDS. *DB 6014*; *DBH 5739*.

Chamaesyce polycarpa (Benth.) Millsp. Native perennial herb; BBS, CBS, HDWS, MDS. *DB 4651*, *4666*, *4670*; *Hovezak s.n.* (MNA).

Chamaesyce setiloba (Engelm. ex Torr.) Millsp. Native ephemeral herb; HDWS. *DB 4589*.

Ditaxis lanceolata (Benth.) Pax & K. Hoffm. Native perennial herb; CBS, MDS. *DB 4707*.

Ditaxis neomexicana (Muell. Arg.) A. Heller Native perennial herb; HDWS, LDWS, MDS. *DB 4539*, *6411*; *DBa 5118*.

Euphorbia eriantha Benth. Native ephemeral herb; CBS. *DB 6470*.

Euphorbia incisa Engelm. Native perennial herb; HDWS, MDS. *DB 4563*, *6708*; *DBH 5734*.

Stillingia linearifolia S. Watson Native perennial herb; HDWS, LDWS. *DB 4542*, *6024*.

Tragia ramosa Torr. Native perennial herb; HDWS. *DB 5696*.

Fabaceae

Acmispon brachycarpus (Benth.) D.D. Sokoloff (*Lotus humistratus* Greene) Native winter ephemeral herb; MDS. *DBa 5093*.

Acmispon maritimus (Nutt.) D.D. Sokoloff var. brevivexillus (Ottley) Brouillet (*Lotus salsuginosus* Greene var. *brevivexillus* Ottley) Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *B 8936*; *DB 4560*, 4660, *6384*; *DBH 5755*; *DBa 5112*.

Acmispon rigidus (Benth.) Brouillet (*Lotus rigidus* (Benth.) Greene) Native perennial herb; CBS, HDWS, MDS. *B 8969*; *DB 4622*.

Acmispon strigosus (Nutt.) Brouillet (*Lotus strigosus* (Nutt.) Greene var. *tomentellus* (Greene) Isley) Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *B 8886*, *8911*, *8961*; *DB 4595*, *4636*, *4653*, *4657*, *4677*, *4715*, *4716*; *DBa 5094*.

Astragalus lentiginosus Dougl. var. yuccanus M.E. Jones Native perennial herb; LDWS, MDS. *B 9371*; *DB 5977*, *5997*, *6040*.

Astragalus newberryi A. Gray var. blyae (Rydb.) Barneby Native perennial herb; MDS, PJW. *DB 5671*, *6012*, *6706; Pinkava et al. 10268* (ASU).

These collections (from -114.348005° to -114.387081° long.) represent the westernmost geographic extent of the variety.

Astragalus nuttallianus DC. var. imperfectus (Rydb.) Barneby Native winter ephemeral herb; CBS, HDWS, MDS. *B 8978*; *DB 4654*, *4668*; *DBa 5095*.

Astragalus tephrodes Gray var. chloridae (M.E. Jones) Barneby Native perennial herb; HDWS. *DB 4567*.

Dalea mollis Benth. Native winter ephemeral herb; CBS, LDWS. *DB 4658*, *4687*, *4714*, *6038*.

Lupinus brevicaulis S. Watson Native winter ephemeral herb; MDS. *B 9359*.

Lupinus concinnus J. Agardh Native winter ephemeral herb; CBS, HDWS, MDS. *DB 4594*, *6394*, *6683*; *DBH 5727*.

Lupinus sparsiflorus Benth. Native winter ephemeral herb; HDWS, LDWS. *B 8975*; *DBa 5123*.

Marina parryi (Torr. & A. Gray) Barneby Native perennial herb; CBS, LDWS, MDS**.** *B 6813*, *9344*; *DB 6385*, *6429*; *DBa 5105*.

Medicago sativa L. Introduced perennial herb; MDS. *Parfitt 2197* (ASU).

Melilotus indicus (L.) All. Introduced winter ephemeral herb; DOW, LDWS. *B 9361*; *DB 5918*, *6442*.

Parkinsonia florida (Benth. ex A. Gray) S. Watson (*Cercidium floridum* Benth.) Native tree; DOW, HDWS, LDWS. *B 8991*.

Both species of *Parkinsonia* are at or very near the northern extent of their respective native distributions in the southern Black Mountains. *Parkinsonia florida* reaches its northern extent in Arizona in the southern Black Mountains (35.111714° lat., based on the collection noted above), but the species appears to occur slightly farther north in San Bernardino County, California (ca. 35.14333° lat., based on *Harris 2372* at UVSC, not seen; Consortium of California Herbaria 2016; SEINet 2016).

Parkinsonia microphylla Torr. (*Cercidium microphyllum* (Torr.) Rose & I.M. Johnst.) Native tree; CBS, LDWS. *DB 6036*.

This collection from the southeastern portion of our flora area (34.926794° lat.), represents the northernmost known occurrence of this species (Consortium of California Herbaria 2016; SEINet 2016).

Prosopis glandulosa Torr. var. torreyana (L.D. Benson) M.C. Johnst. Native tree; DOW, HDWS, LDWS. *B 8977; DB 6453*; *DBH 5753*.

Prosopis pubescens Benth. Native tree; DOW, LDWS. *DB 4531*, *6311*.

Psorothamnus fremontii (Torr.) Benth. var. attenuatus Barneby Native shrub; CBS, LDWS. *B 9345*, *DB 6435*. Fig. 6.

Psorothamnus spinosus (A. Gray) Barneby Native tree; LDWS. *DB 6016*.

This collection (at 35.082278° lat.), and one collected in the same region (*Rinks.n.* at ASC), represent the northernmost known occurrences of the species in Arizona (SEINet 2016). These collections are also very near the northernmost native geographical extent of the species, which appears to be in San Bernardino County, California at 35.118363° lat. (based on *Gross et al. 1203* at UCR, not seen; Consortium of California Herbaria 2016).

Senegalia greggii (A. Gray) Britton & Rose Native shrub; HDWS, LDWS. *DB 4520*.

Senna covesii (A. Gray) H.S. Irwin & Barneby Native perennial herb; CBS, HDWS, MDS. *DB 4587*; *Eastwood s.n.* (ARIZ).

Vicia ludoviciana Nutt. Native winter ephemeral herb; HDWS. *B 8984*; *DB 4617*; *DBH 5701*.

Fagaceae

Quercus turbinella Greene Native shrub; BBS, DOW, HDWS, MDS, JPW. *DB 4504*, *4506*, *5936*, *6657*, *6700*; *Hevly & Hovezak 45* (MNA); *Hodgson et al. 9141* (DES).

Fouquieriaceae

Fouquieria splendens Engelm. subsp. splendens Native shrub; CBS, MDS. *DB 6661*; *Hovezak s.n.* (MNA). Fig. 4.

Garryaceae

Garrya flavescens S. Watson Native shrub; BBS, HDWS, MDS, PJW. *DBH 5709*; *DBP 5965*, *5966*, *5967*.

Gentianaceae

Zeltnera arizonica (A. Gray) G. Mans. (*Centaurium calycosum* (Buckley) Fernald) Native ephemeral herb; SSM. *DBH 5759*. Fig. 12.

Geraniaceae

Erodium cicutarium (L.) L'Her. ex Aiton Introduced winter ephemeral herb; CBS, HDWS, LDWS. *DB 4596*.

Erodium texanum A. Gray Native winter ephemeral herb; LDWS. *DB 4676*.

Iridaceae

Sisyrinchium demissum Greene Native perennial herb; SSM. *DBH 5760*.

This collection appears to have simple stems and the outer spathe bract slightly longer than the inner one, thus showing some affinity with *S. idahoense* E.P. Bicknell of northeastern Arizona.

Juncaceae

Juncus acutus L. subsp. acutus Native perennial herb; SSM. *DB 4558*

Juncus acutus L. subsp. leopoldii (Parlatore) Snogerup (*J. acutus* var. *sphaerocarpus* Engelm.) Native perennial herb; SSM. *DB 5909*; *DBH 5766*.

Juncus bufonius L. Native summer ephemeral herb; SSM. *DB 4578*, *5678*, *6455*.

Juncus ensifolius Wikstrom var. montanus (Engelm.) C.L. Hitchcock (*J. ensifolius* var. *brunnescens* (Rydb.) Cronquist) Native perennial herb; SSM. *B 6823*; *DB 4510*, *6323*; *Hovezak s.n.* (MNA).

Juncus torreyi Coville Native perennial herb; SSM. *DB 6015*.

Krameriaceae

Krameria bicolor S. Watson (*K. grayi* Rose & Painter) Native shrub; BBS, CBS, MDS. *DB 4494*, *4496*, *6432*.

Krameria erecta Willd. Native shrub; BBS, CBS, LDWS, MDS. *DB 4497*, *5597*, *5987*.

Lamiaceae

Hedeoma nana (Torr.) Briq. Native perennial herb; HDWS, MDS. *B 8898*; *DB 6010*; *DBH 5775*.

Hyptis emoryi Torr. Native shrub; CBS, HDWS, LDWS, MDS. *B 8960*; *DB 4647*.

Marrubium vulgare L. Introduced perennial herb; DOW, HDWS. *B 9369*; *DBH 5745*.

Monardella eplingii Elvin, A.C. Sanders & J.L. Anderson Native shrub (perennial herb to

subshrub); HDWS, MDS. *B 6819*, *8927*; *DB 4550*, *4574*; *Elvin 6292* (UCR), *6295* (UCR), *6300* (UCR); *M. Hovezak s.n.* (MNA). Fig. 6.

This is the only plant species currently recognized as endemic to the Black Mountains. Although the type is from the southern Black Mountains, the species also occurs to the north of Union Pass (Elvin et al. 2013).

Salvia columbariae Benth. Native winter ephemeral herb; HDWS, LDWS, MDS. *B 8987*; *DB 4673*, *6654*; *DBa 5091*.

Salvia dorrii (Kellogg) Abrams var. pilosa (A. Gray) Strachan & Reveal Native shrub; MDS. *DBH 5746*.

Salvia mohavensis Greene Native shrub; CBS, HDWS, MDS. *B 8926*; *DB 4546*, *4664*. Fig. 6.

Scutellaria mexicana (Torr.) A.J. Paton (*Salazaria mexicana* Torr.) Native shrub; HDWS, LDWS, MDS. *B 8876*; *DB 5599*, *5982*, *6485*; *DBH 5686*.

Liliaceae

Allium nevadense S. Watson Native perennial herb; MDS. *Elvin 6298* (UCR, not seen; collector's identification verified by A. Sanders in 2016).

Calochortus kennedyi Porter var. kennedyi Native perennial herb; MDS. *DB 5637*. Fig. 5.

Dichelostemma capitatum (Benth.) Alph. Wood subsp. pauciflorum (Torr.) Keator (*D. pulchellum* (Salisb.) A. Heller) Native perennial herb; MDS. *DBa 5102*; *Edgar s.n.* (ASC).

Loasaceae

Eucnide urens Parry Native perennial herb (subshrub); HDWS. *DBH 5767*. Fig. 9.

Mentzelia albicaulis (Douglas) Douglas ex Torr. & A. Gray Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *B 9341*; *DB 4702*, *4706, 5165*, *5623*, *6713*; *DBH 5693*, *5742*; *DBa 5150*, *5171a*.

Mentzelia involucrata S. Watson Native winter ephemeral herb; CBS, LDWS. *B 9339*; *DB 5591*, *6414*; *DBa 5148*. Fig. 4.

Mentzelia nitens Greene Native winter ephemeral herb; LDWS. *DBa 5171*.

Mentzelia tricuspis A. Gray Native winter ephemeral herb; LDWS. *DBa 5170*.

Petalonyx nitidus S. Watson Native perennial herb (subshrub); LDWS, MDS. *DB 5989*, *6403*, *6672*; *Anderson 95-16* (ASU).

Petalonyx sp. Native perennial herb (subshrub); LDWS. *DB 6042*.

The leaves of this collection have atypical pubescence consisting of dense, soft, white, and flexuose hairs, unlike the scabrous herbage of *Petalonyx nitidus*, which occurs elsewhere in the flora area.

Lythraceae

Lythrum californicum Torr. & A. Gray Native perennial herb; SSM. *DB 4556*, *6321*; *DBH 5752*.

Malpighiaceae

Janusia gracilis A. Gray Native perennial vine; CBS, HDWS, LDWS. *B 8950*; *DB 6043*, *6436*; *Hovezak s.n.* (MNA).

This species has been treated recently as *Cottsia gracilis* (A. Gray) W.R. Anderson & C. Davis (Anderson and Davis 2007).

Malvaceae

Abutilon incanum (Link) Sweet subsp. incanum Native perennial herb; HDWS. *DB 4554*.

Abutilon parvulum A. Gray Native perennial herb; HDWS. *B 8998*; *DB 4512*; *DBH 5723*.

Malva parviflora L. Introduced winter ephemeral herb; LDWS. *André 28583* (GMDRC).

Sphaeralcea ambigua A. Gray Native perennial herb; CBS, HDWS, LDWS, MDS. *B 9343*; *DB 5674*, *5914*, *6390*.

Sphaeralcea emoryi Torr. ex A. Gray Native perennial herb; HDWS. *B 8915*; *Hovezak 5* (MNA).

Sphaeralcea parvifolia A. Nelson Native perennial herb; BBS, MDS. *Reeder & Reeder 8982* (ARIZ).

Moraceae

Ficus carica L. Introduced tree, possibly naturalized; DOW. *Hodgson et al. 9146* (DES).

Myrsinaceae

Anagallis arvensis L. (*Lysimachia arvensis* (L.) U. Manns & Anderb.) Introduced winter ephemeral herb; SSM. *DB 5978*.

Nyctaginaceae

Allionia incarnata L. Native perennial herb; CBS, LDWS, MDS. *DB 4694*, *5663*, *6472*; *Hovezak s.n.* (MNA).

Boerhavia coccinea Mill. Native perennial herb; HDWS. *Hovezak s.n.* (MNA).

Boerhavia wrightii A. Gray Native summer ephemeral herb; HDWS. *DB 4606*.

Mirabilis laevis (Benth.) Curran var. villosa (Kellogg) Spellenb. Native perennial herb; HDWS, MDS. *B 8962*; *DB 4621*; *Eastwood 18221* (CAS); *Hovezak & Hevly 37* (MNA).

Mirabilis multiflora (Torr.) A. Gray var. multiflora Native perennial herb; MDS. *DB 6480*.

Oleaceae

Forestiera pubescens Nutt. var. parvifolia (A. Gray) Nesom Native shrub; HDWS, MDS. *B 8930*; *DB 4523*; *DBH 5707*.

Fraxinus anomala Torr. ex S. Watson Native shrub (small tree); DOW, HDWS, MDS, PJW. *DB 6007.5*, *6703*; *DBH 5710*; *DBP 5961*, *5950*.

Menodora scabra A. Gray var. scabra Native perennial herb (subshrub); MDS. *B 9347*.

Menodora scabra A. Gray var. glabrescens A. Gray ex S. Watson Native perennial herb (subshrub); HDWS. *B 8972*; *Hovezak s.n.* (MNA).

Onagraceae

Chylismia arenaria A. Nelson (*Camissonia arenaria* (A. Nelson) P.H. Raven) Native winter ephemeral herb; HDWS, LDWS, MDS. *B 8906*; *DB 5639*, *6647*.

Chylismia brevipes (A. Gray) Small (*Camissonia brevipes* (A. Gray) P.H. Raven subsp. *brevipes*) Native winter ephemeral herb; CBS, LDWS, MDS. *DB 4625*, *4659*, *4674*, *4713*, *6659*; *DBa 5115*, *5143*.

Chylismia claviformis (Torr. & Frém.) A. Heller subsp. aurantiaca (Munz) W.L. Wagner & Hoch (*Camissonia claviformis* (Torr. & Frém.) P.H. Raven subsp. *aurantiaca* (S. Watson) P.H. Raven) Native winter ephemeral herb; LDWS. *DB 6045*, *6410*; *DBa 5154.5*.

Chylismia claviformis (Torr. & Frém.) A. Heller subsp. peeblesii (Munz) W.L. Wagner & Hoch (*Camissonia claviformis* (Torr. & Frém.) P.H. Raven subsp. *peeblesii* (Munz) P.H. Raven)

Native winter ephemeral herb; CBS, LDWS. *DB 4672*, *4700*; *DBa 5137*, *5154*.

Chylismia multijuga (S. Watson) Small (*Camissonia multijuga* (S. Watson) P.H. Raven) Native winter ephemeral herb; CBS, LDWS. *DB 6405*, *6424*.

Eremothera boothii (Douglas) W.L. Wagner & Hoch (*Camissonia boothii* (Dougl.) P.H. Raven) Native winter ephemeral herb; CBS, LDWS. *DB 6426*.

Eremothera refracta (S. Watson) W.L. Wagner & Hoch (*Camissonia refracta* (S. Watson) P.H. Raven) Native winter ephemeral herb; CBS, HDWS, LDWS. *B 9004*; *DB 4689*, *6406*, *6415*; *DBa 5130*, *5146*.

Eulobus californicus Nutt. ex Torr. & A. Gray (*Camissonia californica* (Nutt. ex Torr. & A. Gray) P.H. Raven) Native winter ephemeral herb; HDWS, LDWS. *B 8884*.

Eulobus chamaenerioides (A. Gray) W.L. Wagner & Hoch (*Camissonia chamaenerioides* (A. Gray) P.H. Raven) Native winter ephemeral herb; HDWS, LDWS. *B 9005*, *8883A*.

Oenothera caespitosa Nutt. subsp. marginata (Nutt. ex Hook. & Arn.) Munz (*O. caespitosa* var. *marginata* (Nutt.) Munz) Native perennial herb; HDWS, LDWS. *B 8980*; *DB 5921*, *6395*. Fig. 9.

Oenothera deltoides Torr. & Frém. subsp. deltoides Native winter ephemeral herb; LDWS. *DB 6019*, *6022*.

Orobanchaceae

Castilleja chromosa A. Nelson Native perennial herb; BBS, HDWS, MDS. *DB 5654*, *5670*, *5922*, *6673*; *DBP 5953*; *Biggs s.n.* (ASC); *Edgar s.n.* (ASC); *LehtoL 21047* (ASU). Fig. 9.

Castilleja minor (A. Gray) A. Gray subsp. spiralis (Jeps.) T.I. Chuang & Heckard (*C. stenantha* A. Gray) Native summer ephemeral herb; SSM. *DB 4561*, *5675*. Fig. 12.

Orobanche ludoviciana Nutt. Native perennial herb; DOW, HDWS. *DB 4583*; *DBP 5951*.

Oxalidaceae

Oxalis albicans Kunth subsp. pilosa (Nutt.) G. Eiten (*Oxalis pilosa* Nutt.) Native perennial herb; HDWS. *B 8901*; *Hovezak 7* (MNA).

Papaveraceae

Eschscholzia californica Cham. subsp. mexicana (Greene) C. Clark Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *DB 4586*, *5640*; *Hovezak & Hevly s.n.* (MNA).

Eschscholzia glyptosperma Greene Native winter ephemeral herb; CBS, LDWS. *DB 4696*, *5606*, 6382. Fig. 5.

Eschscholzia minutiflora S. Watson Native winter ephemeral herb; CBS, HDWS, LDWS. *B 8976*; *DB 4631*, *5598*, *5605*, *6413*; *DBa 5144*, *5158*.

Phrymaceae

Mimulus guttatus DC. Native perennial herb; SSM. *B 8994*, *9364*; *DB 5917*; *Hevly & Hovezak 51* (MNA).

This species has been treated recently as *Erythranthe guttata* (DC.) G.L. Nesom (Barker et al. 2012).

Mimulus bigelovii (A. Gray) A. Gray Native winter ephemeral herb; CBS, LDWS. *DB 4703*, *6417*; *DBa 5152*. Fig. 9.

This species has been treated recently as *Diplacus bigelovii* (A. Gray) G.L. Nesom (Barker et al. 2012).

Mimulus cordatus Greene Native perennial herb; MDS. *Barr 67-97* (ARIZ).

This species has been treated recently as *Erythranthe cordata* (Greene) G.L. Nesom (Barker et al. 2012).

Mimulus verbenaceus Greene (*M. cardinalis Benth.* var. *verbenaceus* (Greene) Kearney & Peebles) Native perennial herb; SSM. *DB 4527*, Fig. 12.

This species has been treated recently as *Erythranthe verbenacea* (Greene) Nesom & Fraga (Barker et al. 2012). Other collections of *Mimulus* with red flowers have been made in the southern Black Mountains (e.g., *Christy 1494, Goodding & Reeder 22*, and *Walker & Prigge s.n.*; all at ASU and seen on SEINet 2016) and show morphological similarities to both *M. cardinalis* and *M. verbenaceus*. These two species have been treated as conspecific and the latter has been recognized as a variety of the former. Molecular studies (Beardsley et al. 2003) reveal the species to be distinct and not phylogenetically sister to one another. Examination of materials at CAS/DS show that most specimens can be distinguished only by the orientation of the anther thecae: parallel to sagittate (i.e., those of the pair spreading from the filament at an angle ≤ 45° and thus arrowhead shaped) in *M. verbenaceus* versus sagittate (but with the pair spreading from the filament at an angle > 45°) to explanate (i.e., those of a pair oriented apex to apex and ± perpendicular to filament) in *M. cardinalis*. Other characters sometimes used to distinguish these species (e.g., corolla tube length from base of sinus between calyx lobes to separation of limb from tube) varies among specimens from the flora area, and do not correlate with anther orientation. The collections from the flora area cited above all have anther thecae as noted for *M. verbenaceus*.

Plantaginaceae

Keckiella antirrhinoides (Benth.) Straw subsp. microphylla (A. Gray) N.H. Holmgren Native shrub; HDWS, LDWS, MDS. *B 8931*; *DB 5644*, *5990*.

Maurandella antirrhiniflora (Willd.) Rothm. (*Maurandya antirrhiniflora* Willd.) Native perennial vine; HDWS, MDS. *B 8967*; *DBH 5736*.

Mohavea confertiflora (Benth.) A. Heller Native winter ephemeral herb; CBS, LDWS. *DB 4663*, *6404*; *DBa 5168*. Fig. 3.

Neogaerrhinum filipes (A. Gray) Rothm. Native winter ephemeral herb (vine-like); CBS, LDWS. *DB 4656*, *4692*; *DBa 5145*.

Penstemon eatonii A. Gray subsp. undosus (M.E. Jones) D.D. Keck Native perennial herb; HDWS, MDS. *B 9000*, *9358*; *DB 5923*, *6494*.

Penstemon palmeri A. Gray Native perennial herb; PJW. *DB 6705*.

Although this fruiting collection lacks flowers, the plant's overall size (to 2 m) is more characteristic of *P. palmeri* than of *P. pseudospectabilis* or *P. bicolor*.

Plantago ovata Forssk. Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *DB 4634*, *4669*; *DBa 5121*.

Plantago major L. Introduced perennial herb; SSM. *DB 5998*.

Veronica anagallis-aquatica L. Introduced perennial herb; SSM. *B 9366*; *DB 6448*.

Poaceae

Achnatherum ×bloomeri (Bol.) Barkworth Native perennial herb; MDS. *Michaels 2091* (ARIZ).

Achnatherum coronatum (Thurb.) Barkworth (*Stipa coronata* Thurb. var. *depauperata* (M.E. Jones) Hitchc.) Native perennial herb; HDWS, MDS. *DB 4543*; *DBH 5688*.

Achnatherum hymenoides (Roem & Schult.) Barkworth (*Oryzopsis hymenoides* (Roem. & Schult.) Ricker) Native perennial herb; BBS, MDS, PJW. *DB* 6477.

Andropogon glomeratus (Walter) Britton, Sterns & Poggenb. Native perennial herb; SSM. *DB 4555*.

Aristida adscensionis L. Native year-round ephemeral herb; HDWS, MDS. *DB 4549*, *6307*.

Aristida purpurea Nutt. var. parishii (Hitchc.) Allred (*A. parishii* Hitchc.) Native perenni-

al herb; HDWS, MDS. *B 8999*; *DB 4600*, *5722*.

Aristida purpurea Nutt. var. nealleyi (Vasey) Allred (*A. purpurea* var. *glauca* (Nees) A.H. Holmgren & N.H. Holmgren) Native perennial herb; CBS, HDWS, LDWS, MDS, PJW. *B 8979*, 9333; *DB 4505*, *4593*, *5602*, *5643*, *6308*.

Avena barbata Pott ex Link Introduced winter ephemeral herb; MDS. *Reeder & Reeder 8986* (ARIZ).

Avena fatua L. Introduced winter ephemeral herb; CBS. *B 9346*; *DB 6011*.

Bothriochloa barbinodis (Lag.) Herter Native perennial herb; HDWS, MDS. *B 8944*; *DB 4575*, *4627*.

Bouteloua aristidoides (Kunth) Griseb. Native summer ephemeral herb; CBS, MDS. *Rominger 319-65* (ASC).

Bouteloua barbata Lag. var. barbata Native winter ephemeral herb; CBS, HDWS. *DB 4619*, *5983*.

Bouteloua curtipendula (Michx.) Torr. var. caespitosa Gould & Kapadia Native perennial herb; HDWS, MDS, PJW. *DB 4571*, *5974*; *DBH 5697*.

Bromus arizonicus (Shear) Stebbins Native winter ephemeral herb; HDWS. *B 8903*; *DBP 5956*.

Bromus berteroanus Colla (*B. trinii* Desv.) Native winter ephemeral herb; HDWS, MDS. *DB 5625*, *5648*; *DBH 5774*; *Reeder & Reeder 8984* (ARIZ, ASU).

Bromus carinatus Hook. & Arn. Native perennial herb; HDWS. *DBH 5694*.

Bromus diandrus Roth (*B. rigidus* Roth) Introduced winter ephemeral herb; DOW, MDS. *B 9356*, *9362*.

Bromus rubens L. Introduced winter ephemeral herb; common throughout. *DB 4610*.

Bromus tectorum L. Introduced winter ephemeral herb; MDS. *Reeder & Reeder 8987* (ARIZ).

Cynodon dactylon (L.) Pers. Introduced perennial herb; SSM. *DB 4529*, *6454*.

Dasyochloa pulchella (Kunth) Willd. ex Rydb. (*Erioneuron pulchellum* (Kunth) Tateoka) Native perennial herb; BBS, HDWS, MDS. *DB 4615*.

Digitaria californica (Benth.) Henrard (*Trichachne californica* (Benth.) Chase) Native perennial herb; HDWS, MDS. *DB 4573*.

Echinochloa colona (L.) Link Introduced summer ephemeral herb; SSM. *DB 6313***.**

Elymus elymoides (Raf.) Swezey subsp. elymoides (*Sitanion hystrix* (Nutt.) J.G. Sm.) Native perennial herb; HDWS, MDS. *DB* 6393, *6484*.

Elymus elymoides subsp. brevifolius (J.G. Sm.) Barkworth (*Sitanion hystrix* var. *brevifolium* (J.G. Sm.) C.L. Hitchc.) Native perennial herb; HDWS, MDS. *DB 6310*; *DBH 5716*.

Elymus multisetus (J.G. Sm.) Burtt Davy (*Sitanion jubatum* J.G. Sm.) Native perennial herb; BBS, MDS. *Gould & Darrow 4294* (ARIZ).

Hilaria rigida (Thurb.) Benth. Native perennial herb; BBS, HDWS, LDWS, MDS, PJW. *DB 4684*; *DBH 5691*.

Hordeum murinum L. subsp. glaucum (Steud.) Tzvelev (*H. glaucum* Steud.) Introduced winter ephemeral herb; SSM. *B 9363*; *DB 5680*, *6493*.

Hordeum pusillum Nutt. Native winter ephemeral herb; SSM. *DBH 5768*.

Imperata brevifolia Vasey Native perennial herb; SSM. *DB 4568*.

Jarava speciosa (Trin. & Rupr.) Peñail. (*Stipa speciosa* Trin. & Rupr.) Native perennial herb; BBS, HDWS, LDWS, MDS, PJW. *B 9350*; *DB 4524*, *4611*, *5655*; *Hevly & Hovezak 58* (DES); *Reeder & Reeder 8985* (ARIZ).

Leptochloa panicea (Retz.) Ohwi subsp. brachiata (Steud.) N. Snow (*L. filiformis* (Lam.) Beauv.) Native winter ephemeral herb; SSM. *DB 5984*.

Melica frutescens Scribn. Native perennial herb; HDWS, MDS. *B 6818*; *DB 6648*; *DBH 5651*.

Melica imperfecta Trin. Native perennial herb; HDWS, MDS. *B 8892*, *8899*, *8900*, *8989*; *Hovezak & Hevly 59* (MNA).

Muhlenbergia appressa C.O. Goodd. Native winter ephemeral herb; HDWS, MDS. *DB 6007*, *6306*; *DBP 5941*.

Muhlenbergia fragilis Swallen Native summer ephemeral herb; HDWS, MDS. *DBP 5945*.

Muhlenbergia microsperma (DC.) Kunth. Native winter ephemeral herb; HDWS, SSM. *DB 4605*; *DBH 5757*.

Muhlenbergia porteri Scribn. Native perennial herb; BBS, HDWS, MDS, PJW. *DB 4618*.

Muhlenbergia rigens (Benth.) Hitchc. Native perennial herb; DOW, SSM. *B 8947*.

Panicum capillare L. Native summer ephemeral herb; BBS, MDS. *Baker 11133* (ASU).

Paspalum dilatatum Poir. Introduced perennial herb; DOW, SSM. *DB 6322*.

Phragmites australis (Cav.) Trin. Introduced perennial herb; DOW, SSM. *DB 4515*, *4557*; *Hovezak s.n.* (MNA).

Poa annua L. Native winter ephemeral herb; SSM. *DB 5999*.

Poa bigelovii Vasey & Scribn. Native winter ephemeral herb; HDWS. *DB 4576*.

Poa fendleriana (Steud.) Vasey subsp. longiligula (Scribn. & T.A. Williams) Soreng Native perennial herb; HDWS, MDS, PJW. *DB 6711*; *DBH 5708*; *DBP 5955*.

Polypogon interruptus Kunth Introduced perennial herb; DOW, SSM. *DB 6324*, *6327*.

Polypogon monspeliensis (L.) Desf. Introduced winter ephemeral herb; DOW, SSM. *B 8959*, *9365*; *DB 6444*.

Polypogon viridis (Gouan) Breistr. (*Agrostis semiverticillata* (Forssk.) C. Chr.) Introduced perennial herb; SSM. *DB 6326*, *6443*, *6452*; *DBH 5763*.

Schismus arabicus Nees Introduced winter ephemeral herb; HDWS, MDS. *DB 4577*, *4607*; *DBH 5773*.

Schismus barbatus (L.) Thell. Introduced winter ephemeral herb; HDWS, MDS. *DB 6418*.

Sporobolus cryptandrus (Torr.) A. Gray Native perennial herb; BBS, LDWS, HDWS, MDS, PJW. *DB 6408*; *DBP 5957*.

Tridens muticus (Torr.) Nash Native perennial herb; BBS, HDWS, MDS, PJW. *DBH 5738*; *DBP 5940*.

Triticum aestivum L. Introduced winter ephemeral herb; MDS. *DB 6491*.

This cultivated species occurs along the roadside and is a probable waif here.

Vulpia microstachys (Nutt.) Benth. var. pauciflora (Scribn. ex Beal) Lonard & Gould Native winter ephemeral herb; HDWS, MDS. *DB 4579*, *5620*; *DBH 5698*, *5721*; *DBP 5944*.

Vulpia octoflora (Walter) Rydb. Native winter ephemeral herb; CBS, HDWS, MDS. *DBH 5772*.

Polemoniaceae

Eriastrum diffusum (A. Gray) H. Mason Native winter ephemeral herb; CBS, HDWS, MDS. *DB 6003*, *6401*; *DBH 5726*.

Eriastrum eremicum (Jeps.) H. Mason Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *B 8875*; *DB 5683*, *6402*, *6416*.

Gilia flavocincta A. Nelson subsp. australis (V.E. Grant) A.G. Grant & V.E. Grant Native winter ephemeral herb; PJW. *DB 6696*.

Gilia minor A.D. Grant & V.E. Grant Native winter ephemeral herb; LDWS. *DBa 5126*, *5127*; *André 28644.*

Plants in the *Gilia inconspicua* (J.E. Sm.) Sweet complex are sometimes distinguishable only with considerable difficulty. None of the color patterns for corollas used by Porter (2014) in the portion of his key that includes these species are evident on the collections noted above. Both *Daniel & Bartholomew 5126* (pinkish corollas) and *5127* (white corollas) were annotated as *G. transmontana* (H. Mason & A.D. Grant) A.D. Grant & V.E. Grant by A. Day in 1989. Based on characters that are present on these plants (i.e., leaf lobes mostly less than 1 mm wide that are pointed toward the leaf apex and ellipsoid capsules that are only slightly exserted beyond the calyx) and using the keys of Wilken and Porter (2005) and Day (2002), these collections are either more consistent with features of *G. minor* (leaf lobes), or are intermediate between *G. minor* and *G. transmontana* (capsules). *André & La Doux 28644*, originally determined as *G. minor*, shares these same characters and has more mature capsules with valves that are not detaching (as reported for *G. minor*). Based on the specimens and data available, we tentatively treat these collections from the southern Black Mountains as *G. minor*. Cronquist (1984) treated *Gilia minor*, *G. sinuata*, and *G. transmontana* as synonyms of a broadly delimited *G. inconspicua*. While such treatment appears reasonable and appealing based on morphological intermediacies present, it has not been followed in the more recent accounts (e.g., Porter 2014; Wilken and Porter 2005) on which our species concepts and nomenclature are based.

Gilia scopulorum M.E. Jones Native winter ephemeral herb; CBS, HDWS, LDWS. *B 8883*, *8953*; *DB 4709*, *5125b; DBa 5138*, *5155*; *Hovezak s.n.* (MNA).

Gilia sinuata Douglas ex Benth. (*G. inconspicua* Sweet var. *sinuata* (Douglas ex Benth.) Brand) Native winter ephemeral herb; CBS. *Helmkamp& Helmkamp 1574* (DES).

Gilia stellata A. Heller Native winter ephemeral herb; CBS, HDWS, LDWS, MDS. *B 8881*; *DB 5615*; *DBa 5104*, *5110*, *5125*, *5172*; *Hevly & Hovezak 65* (MNA).

Langloisia setosissima (Torr. & A. Gray) Greene subsp. setosissima Native winter ephemeral herb; CBS, LDWS, MDS. *DB 5604*, *5635*, *6430*.

Leptosiphon aureus (Nutt.) J.M. Porter & L.A. Johnson (*Linanthus aureus* (Nutt.) Greene) Native winter ephemeral herb; HDWS, MDS. *DBH 5720*.

Linanthus bigelovii (A. Gray) Greene Native winter ephemeral herb; CBS, LDWS. *DB 4704*; *DBa 5149*.

Linanthus demissus (A. Gray) Greene Native winter ephemeral herb; CBS, LDWS. *DB 4705*, *6433*; *DBa 5164*.

Linanthus dichotomus Benth. Native winter ephemeral herb; MDS. *Hodgson et al. 3551* (DES, UCR).

Linanthus pungens (Torr.) J.M. Porter & L.A. Johnson Native perennial herb; PJW. *DB 6704*.

Loeseliastrum schottii (Torr.) Timbrook Native winter ephemeral herb; CBS, LDWS. *Beck s.n.* (ASC); *Helmkamp & Helmkamp 1582A* (UCR).

Both collections determined as *Loeseliastrum schottii* share certain corolla and calyx characteristics with *L. mathewsii* (A. Gray) Timbrook.

Microsteris gracilis (Hook.) Greene Native winter ephemeral herb; MDS. *DB 6692*; *Biggs s.n.* (ASC).

Polygonaceae

Chorizanthe brevicornu Torr. var. brevicornu Native winter ephemeral herb; CBS, LDWS. *DB 4652*, *4681*, *6383*.

Chorizanthe rigida (Torr.) Torr. & A. Gray Native winter ephemeral herb; CBS, LDWS. *DB 4675*, *4693*, 6380.

Eriogonum deflexum Torr. var. deflexum Native winter ephemeral herb; CBS, HDWS, LDWS. *DB 4682*; *Dba 5166*; *Eastwood 18211* (CAS); *Hovezak s.n.* (MNA).

Eriogonum fasciculatum Benth. var. polifolium (Benth.) Torr. & A. Gray Native shrub; BBS, HDWS, LDWS, MDS. *B 8878*; *DB 4599*.

Eriogonum heermannii Durand & Hilg. var. argense (M.E. Jones) Munz Native shrub; HDWS, MDS. *DB 4545*, *6005*.

Eriogonum hookeri S. Watson Native year-round ephemeral herb; LDWS. *DBa 5157*.

Eriogonum inflatum Torr. & Frém. Native perennial herb; CBS, LDWS. *DB 4637*, *6303*.

Eriogonum maculatum A. Heller Native winter ephemeral herb; HDWS. *DB 5624*, *6392*.

Eriogonum nidularium Coville Native winter ephemeral herb; CBS, LDWS. *DB 5610*, 6421.

Eriogonum palmerianum Reveal Native year-round ephemeral herb; HDWS, LDWS. *DB 6412*; *Hovezak & Hevly s.n.* (MNA).

Eriogonum reniforme Torr. & Frém. Native winter ephemeral herb; CBS, LDWS. *B 9340*; *DB 4699*.

Eriogonum thomasii Torr. Native winter ephemeral herb; CBS, LDWS. *B 9335*; *DB 4667*, *4683*, *4698*, *6419*.

Eriogonum trichopes Torr. var. trichopes Native winter ephemeral herb; CBS, LDWS. *B 9331*; *DB 6422*.

Eriogonum wrightii Torr. ex Benth. var. wrightii Native shrub; HDWS. *DB 4544*.

Pterostegia drymarioides Fisch. & Mey. Native winter ephemeral herb; HDWS. *B 8894*; *Hovezak & Hevly 24* (MNA).

Rumex hymenosepalus Torr. Native perennial herb; HDWS, SSM. *DB 4547*; *DBH 5730*; *DBP 5939*, *5962*, *5979*.

Portulacaceae

Claytonia perfoliata Donn ex Willd. subsp. mexicana (Rydb.) John M. Mill. & K.L. Chambers Native winter ephemeral herb; HDWS, MDS. *B 8914*; *DB 5652*.

Primulaceae

Androsace occidentalis Pursh Native winter ephemeral herb; MDS. *DBP 5946*.

Ranunculaceae

Anemone tuberosa Rydb. Native perennial herb; HDWS, MDS. *DB 4614*.

Aquilegia chrysantha A. Gray Native perennial herb; SSM. *B 8921*; *DBH 5761*. Fig. 12.

Delphinium parishii A. Gray subsp. parishii Native perennial herb; HDWS, LDWS, MDS. *B 9352*; *DB 5590*, *6397*.

Delphinium scaposum Greene Native perennial herb; CBS, LDWS, MDS. *DB 6434*; *DBH 5689*.

Myosurus cupulatus S. Watson Native winter ephemeral herb; MDS. *DB 6685*.

Resedaceae

Oligomeris linifolia (Vahl) J.F. Macbr. Native winter ephemeral herb; SSM. *DB 6441*; *DBH 5754*.

Rhamnaceae

Ceanothus vestitus Greene (*C. greggii* A. Gray) Native shrub; MDS. *DB 5712*, *5931*.

Rhamnus ilicifolia Kellogg (*R. crocea* Nutt. var. *ilicifolia* (Kellogg) Greene) Native shrub; HDWS, MDS, PJW. *B 8902*; *DB 4516*.

Ziziphus obtusifolia (Hook. ex Torr. & A. Gray) A. Gray var. canescens (A. Gray) M.C. Johnst. Native shrub; LDWS, MDS. *DB 5633*.

Rosaceae

Coleogyne ramosissima Torr. Native shrub; BBS, MDS, PJW. *DB 5668*, *5924*; *DBa 5103*; *DBP 5968*. Fig. 6.

Fallugia paradoxa (D. Don) Endl .ex Torr. Native shrub; HDWS. *DBH 5706*. Fig. 9.

Ivesia arizonica (Eastw. ex J.T. Howell) Ertter var. arizonica (*Purpusia arizonica* Eastw. ex J.T. Howell) Native perennial herb; HDWS. *B 8908*; *DB 4514*.

This species occurs in isolated populations throughout its range in Arizona, California, Nevada, and Utah, and is considered to be of conservation concern because of its rarity (Ertter and Reveal 2014).

Prunus fasciculata (Torr.) A. Gray var. fasciculata Native shrub; HDWS, MDS. *B 8937*; *DB 5634*; *DBH 5718*; *DBP 5964*.

Purshia stansburyana (Torr.) Henrickson (*P. mexicana* (D. Don) S.L. Welsh var. *stansburiana* (Torr.) S.L. Welsh) Native shrub; MDS, PJW. *DB 5928*, *6701*.

Rubiaceae

Galium aparine L. Native winter ephemeral herb; HDWS. *B 8912*; *DBH 5719*.

Galium microphyllum A. Gray (*Relbunium microphyllum* Hemsl.) Native perennial herb; HDWS. *DB 4564*; *DBH 5699*.

Galium stellatum Kellogg (*G. stellatum* Kellogg var. *eremicum* Hilend & J.T. Howell) Native shrub; LDWS. *DB 5596*.

Rutaceae

Ptelea trifoliata L. Native shrub (small tree); PJW. *DB 6699*.

Thamnosma montana Torr. & Frém. Native shrub; CBS, MDS. *DB 4638*. Fig. 9.

Salicaceae

Populus fremontii S. Watson subsp. fremontii Native tree; DOW. *DB 4508*, *6653*.

Salix bonplandiana Kunth Native tree; DOW. *B 6816*.

Salix exigua Nutt.var. exigua Native tree (shrub); DOW, SSM. *B 8965*; *DB 4509*, *4526*; *DBH 5692*.

Salix gooddingii C.R. Ball Native tree; DOW. *DB 6456*, *6457*; *DBH 5765*.

Saururaceae

Anemopsis californica (Nutt.) Hook. & Arn. Native perennial herb.

The inclusion of this species is based on an observation by the authors on 26 March 1989 of numerous plants growing in an impoundment at Fig Spring, on the eastern side of the range.

Solanaceae

Datura wrightii Regel Native perennial herb (shrub); LDWS. *DB 4503*, *6389*; *Hovezak s.n.* (MNA).

Lycium andersonii A. Gray Native shrub; HDWS, MDS. *DB 5626*, *5657*; *DBa 5090*.

Lycium cooperi A. Gray Native shrub; HDWS. *DB 5971*; *DBP 5969*.

Lycium exsertum A. Gray Native shrub; HDWS, LDWS, MDS. *B 8951*; *DB 4597*, *4609*, *4630*, *5641*, *5911*.

Daniel & Butterwick 5911 from a spring south of Thumb Butte represents the westernmost occurrence for this species both in Arizona and the United States (at -114.434590° long.; Consortium of California Herbaria 2016; SEINet 2016) for this otherwise primarily Sonoran Desert species.

Lycium fremontii A. Gray Native shrub; MDS. *André 28618* (GMDRC).

This specimen differs from *Lycium fremontii* as treated in Chiang and Landrum (2009) in that the fruits appear to have far fewer than 40 seeds.

Nicotiana glauca Graham Introduced tree; LDWS. *DB 5614*, *5996*, *6039*, *6329*.

Nicotiana obtusifolia M. Martens & Galeotti var. obtusifolia (*N. trigonophylla* Dunal) Native perennial herb; HDWS, MDS. *B 8904*.

Petunia parviflora Juss. Native winter ephemeral herb; SSM. *DB 6445*.

Physalis crassifolia Benth. Native perennial herb; HDWS, LDWS, MDS. *B 8995*; *DB 4592*, *6409*; *DBa 5124*.

Physalis hederifolia A. Gray Native perennial herb; MDS. *Christy 1498* (ASU).

Solanum americanum Mill. Native perennial herb; HDWS, LDWS, SSM. *DB 4530*, *6463*.

Solanum douglasii Dunal Native perennial herb; MDS. *Michaels 2094* (ARIZ).

Solanum elaeagnifolium Cav. Native perennial herb; SSM. *DB 6686*.

Tamaricaceae

Tamarix chinensis Lour. Introduced tree; LDWS. *DB 4532*, *6000*, *6387*.

Typhaceae

Typha latifolia L. Native perennial herb; SSM. *DB 5980*, *6396*.

Daniel and Butterwick 5980 from Fig Spring on the east side of the Black Mountains has nearly contiguous spikes and carpellate flowers that lack bracts. Both of these characters support its placement into this species. This collection would appear to represent the westernmost occurrence of *T. latifolia* in Arizona (at -114.307630° long.; SEINet 2016*). Daniel and Butterwick 6396* from the west side of the range is sterile; however, the flat leaf blades suggest that this collection may also pertain to *T. latifolia*. At least one other collection from the northern Black Mountains (i.e., *Cagney et al. 9* at ASC, not seen; SEINet 2016) has been determined as *T. domingensis* Pers.

Ulmaceae

Celtis reticulata Torr. Native tree; DOW, HDWS. *DB 5642*, *6688*; *DBH 5705*; *DBP 5959*.

Urticaceae

Parietaria hespera Hinton Native winter ephemeral herb; HDWS. *B 8893*, *8941*.

Parietaria pensylvanica Muhl. ex Willd. Native winter ephemeral herb; HDWS. *B 8940*; *DB 5645*.

Verbenaceae

Aloysia wrightii (A. Gray) A. Heller Native shrub; HDWS. *B 8938*.

Verbena ciliata Benth. Native perennial herb; HDWS, MDS. *Hodgson 796* (DES); *Hovezak s.n.* (MNA); *Parfitt 2191* (ASU).

Verbena gooddingii Briq. Native perennial herb; HDWS, MDS. *B6815*, *8905*, *8952*; *DB 4591*, *5666*, *6013*; *DBa 5085*; *DBP 5958*.

Viscaceae

Phoradendron californicum Nutt. Native parasitic perennial herb; BBS, HDWS, MDS. *DB 4498*, *4624*, *5915*, *6649*.

Plants were parasitic on *Senegalia greggii*.

Phoradendron coryae Trel. (*P. villosum* (Nutt.) Nutt. ex Engelm. subsp. *coryae* (Trel.) Wiens) Native parasitic perennial herb; MDS. *DB 6694*.

Plants were parasitic on *Quercus turbinella*.

Vitaceae

Vitis arizonica Engelm. Native perennial vine; DOW. *DB 4525*.

Although rare in the southern Black Mountains, this species is locally common in portions of Grapevine Canyon.

Zygophyllaceae

Fagonia laevis Standl. Native shrub; CBS. *Richardson & Ayers 1* (ASC).

Kallstroemia californica (S. Watson) Vail. Native summer ephemeral herb; MDS. *DB 6490*.

Kallstroemia parviflora Norton Native summer ephemeral herb; HDWS. *Hovezak s.n.* (MNA).

Larrea tridentata (DC.) Coville (*L. divaricata* Cav. subsp. *tridentata* (DC.) Felger) Native shrub; BBS, CBS, LDWS, HDWS, MDS. *DB 4701*, *6431*. Fig. 3.

Tribulus terrestris L. Introduced winter ephemeral herb; CBS, MDS. *Deaver 2814* (ASC).

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Chauligenion camelopardalis, a New Genus and Species of Deepwater Snake Eel (Anguilliformes: Ophichthidae) from the East China Sea

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A new genus and species of ophichthid eel, *Chauligenion camelopardalis* McCosker and Okamoto, is described based on a specimen trawled at 150 m off western Okinawa. It differs from other ophichthids in its elongation, its pointed tail and snout, lower jaw extension, anterior nostril condition, elongate jaws, gill arch reduction, vertical gill openings, numerous small closely packed teeth, lack of pectoral fins, and its yellowish-tan coloration overlain with rows of brown spots. It is similar to genera of the tribe Ophichthini; however, we are unable to assign it with confidence.

Keywords: Fish taxonomy, Ophichthidae, *Chauligenion camelopardalis*, genus and sp. nov, East China Sea.

The snake eels of the family Ophichthidae are the most diverse and speciose family of anguilliform fishes, occupying tropical and subtropical habitats including nearshore sand and mud bottoms, rivers and streams, and estuaries and coral reefs, ranging from the sandy intertidal to midwater depths of 800 m and to more than 1000 m in the benthos. Most, however, live shallower than 200 m. The family was revised on the basis of its osteology, morphology and meristics by McCosker (1977), who recognized 49 genera and more than 200 species. Subsequent discoveries and generic revisions have elevated those numbers to 61 genera and nearly 300 valid species. The capture of a remarkably distinctive individual by a bottom trawl at 150 m in the East China Sea has resulted in an additional genus and species. It is so unique that we are unable to assign it a tribal rank, and will be unable to do so until additional material is collected.

Methods and Materials

Measurements are straight-line, made either with a 300 mm ruler with 0.5 mm gradations (for total length, trunk length, and tail length) and recorded to the nearest 0.5 mm, or with dial calipers (all other measurements) and recorded to the nearest 0.1 mm. Body length comprises head and trunk lengths. Head length (HL) is measured from the snout tip to the posterodorsal margin of the gill opening; trunk length is taken from the end of the head to mid-anus; maximum body depth does not include the median fins. Head-pore terminology follows that of McCosker et al. (1989:257) such that the supraorbital pores are expressed as the ethmoid pore + pores in supraorbital canal, e.g., 1 + 3, and the infraorbital pores are expressed as pores along the upper jaw + those in vertical part of canal behind eye (the "postorbital pores"), e.g., 4 + 2, in that frequently the last pore included along the upper jaw is part of the postorbital series. Osteological examination of the gill arches involved clearing and counterstain-

ing with alcian blue and alizarin red dyes (Dingerkus and Uhler 1977). Other osteological examination was made from radiographs. Vertebral counts (which include the hypural) were taken from a radiograph. Radiographic techniques are described in Böhlke (1989). The vertebral formula (VF) is expressed as the predorsal/preanal/total vertebrae (Böhlke 1982). Institutional abbreviations are as listed at *http://asih.org/codons.pdf*. The holotype of the new species is deposited in the fish collection of the National Museum of Nature and Science, Tsukuba, Japan (NSMT-P).

Family Ophichthidae

Genus *Chauligenion* McCosker and Okamoto, novum
(New Japanese name: Kirin-umihebi-zoku)

Type species: *Chauligenion camelopardalis* McCosker & Okamoto 2016, by original designation.
(Figures 1–6)

Diagnosis.— An elongate ophichthine with tail longer than head and trunk, body cylindrical, becoming laterally compressed in tail region; snout and tail tip pointed; lower jaw slightly extended; anterior nostril a hole above outer lip, without a tube; posterior nostrils along upper lip; jaws elongate, capable of closing completely; orbit large, in posterior half of upper jaw, its rear margin above rictus; gill openings low lateral, vertical; median fins elongate, not elevated; dorsal-fin origin above gill opening; pectoral fins absent; teeth small, conical, numerous and densely packed; preopercular pores 3; coloration yellowish-tan overlain with rows of brown spots.

Description (other characters those of the single species).— An elongate (Fig. 1) ophichthine, with tail longer than head and trunk, cylindrical in head and trunk, becoming laterally compressed in tail region. Snout acute, pointed, its underside not split. Lower jaw slightly in advance of snout tip. Branchial basket moderately expanded. Anterior nostrils above outer lip, without a tube; posterior nostrils along upper lip, not opening into mouth, not visible externally. Jaws elongate, capable of closing completely; orbit large, in posterior half of upper jaw, its rear margin in advance of the rictus. Lips smooth, without crenulae or barbels. Gill openings low lateral (Fig. 2), vertical, not converging forward, opening about twice eye diameter. Median fins elongate, not elevated, entering tail well in advance of pointed tail tip. Dorsal-fin origin above gill opening. Pectoral fins absent. Cephalic and lateral-line pores developed, supraorbital (S0), infraorbital (IO), preoperculomandibular (POP) and median supratemporal pore (ST) and interorbital pores present. Teeth small, conical, numerous and densely packed. Anterior ethmovomerine teeth the largest, slightly retrorse, followed by 6–7 irregular rows of smaller teeth, followed by a row of 25 smaller vomerine teeth. Teeth of maxillary and mandibular in patches, becoming smaller and more numerous posteriorly. Gill arches (Fig. 3) mostly cartilaginous: basibranchials 1–4 cartilaginous; hypobranchials 1–4 cartilaginous; ceratobranchial 1 cartilaginous, 2–4 ossified, 5 minute and cartilaginous; epibranchial 1 cartilaginous, 2–4 ossified; infrapharyngobranchials 2–3 ossified; upper and lower pharyngeal tooth plates with 5 nearly regular rows of small, conical, densely packed and slightly retrorse teeth, the upper pharyngeal tooth plate with 5 longitudinal rows of ca. 15 teeth, plates closely sutured but not fused; the lower pharyngeal tooth plate with 20–25 conical teeth in 5 irregular longitudinal rows. Teeth comparable in size and appearance to those of jaws.Neurocranium depressed (Fig. 4). Supraoccipital condyle developed. Suspensorium nearly vertical; maxillae not tapering posteriorly. Opercle and preopercle weakly developed. Branchiostegal rays slender, condition typically ophichthine (*sensu* McCosker 1977: 28–30), ca. 20–25 (as seen by radiograph to be) attached to outer face of each epihyal. Pectoral girdle reduced to cleithrum and thin supracleithrum.Epipleural ribs attached to precaudal vertebrae 5–11 are elongate**.** Other characters those of the single species.

FIGURE 1.Holotype of *Chauligenion camelopardalis* sp. nov., NSMT-P 125489, female, 407 mm TL, photographed soon after capture and before preservation. Arrows indicate origin of dorsal and anal fins.

DISTRIBUTION.— Known only from the type specimen, collected by trawl in 150 m from the East China Sea.

ETYMOLOGY.— From the Greek *chaulios* (prominent) and *genion* (chin), neuter, in reference to its obtrusive lower jaw tip.

REMARKS.— In that the new genus and species is known only from a single specimen, we were unable to prepare a cleared-and-stained specimen and therefore were unable to make a complete osteological examination. The holotype was preserved in formalin soon after capture and fresh tissue was not removed, making a genomic comparison impossible at this time. We look forward to additional fresh material so that those studies can be performed.

We were able however, based on its morphometry, meristics, and the removal of its gill arches, to make some conclusions as to its similarity to other ophichthids. It is clearly within the subfamily Ophichthinae based on its hard-pointed tail tip (without caudal rays), its frontal and temporal canals,

FIGURE **2.** Head of holotype of *Chauligenion camelopardalis* sp. nov., NSMT-P 125489, female, 407 mm TL, photographed soon after capture and before preservation.

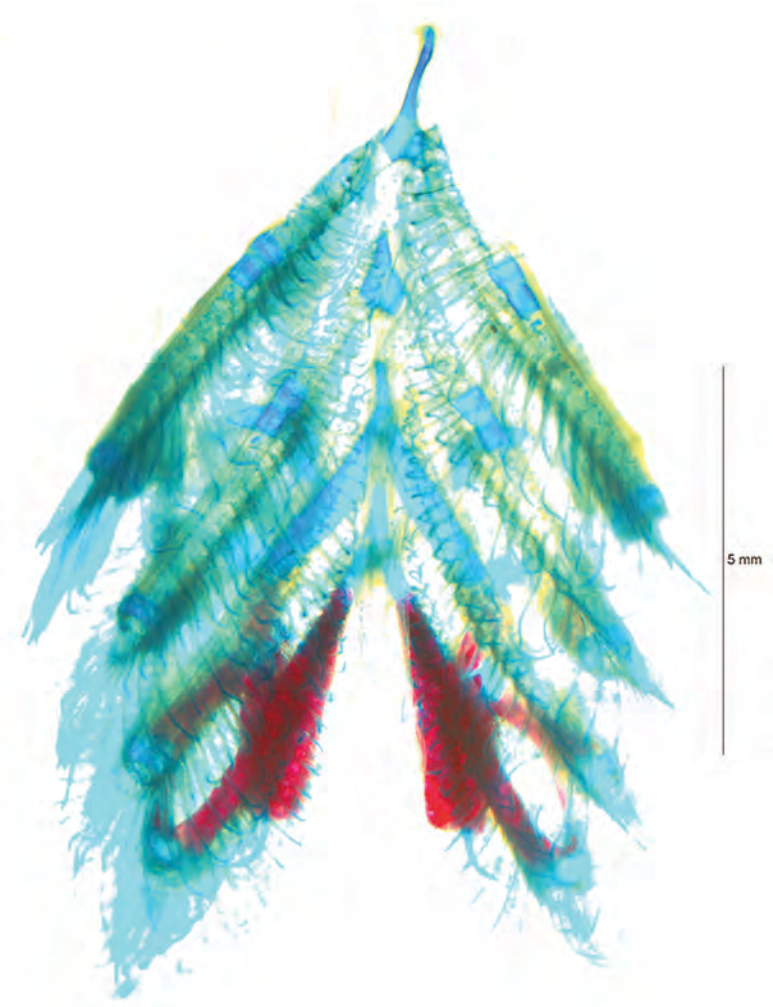

FIGURE **3.** Gill arches (interior view, cut longitudinally along dorsal surface and spread laterally) of holotype of *Chauligenion camelopardalis* sp. nov., NSMT-P 125489, female, 407 mm TL. Bone is stained red and cartilage is blue.

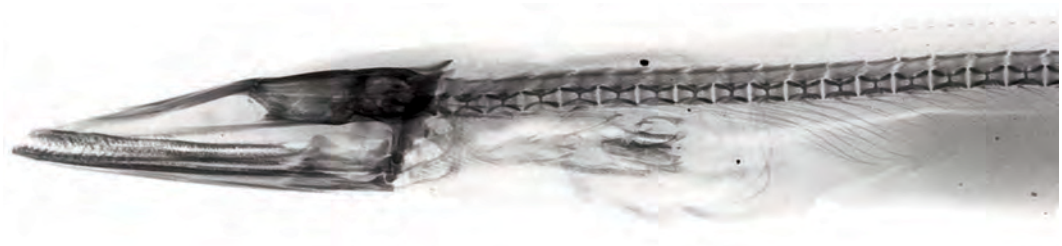

FIGURE **4.** Radiograph of head of holotype of *Chauligenion camelopardalis* sp. nov., NSMT-P 125489, female, 407 mm TL.

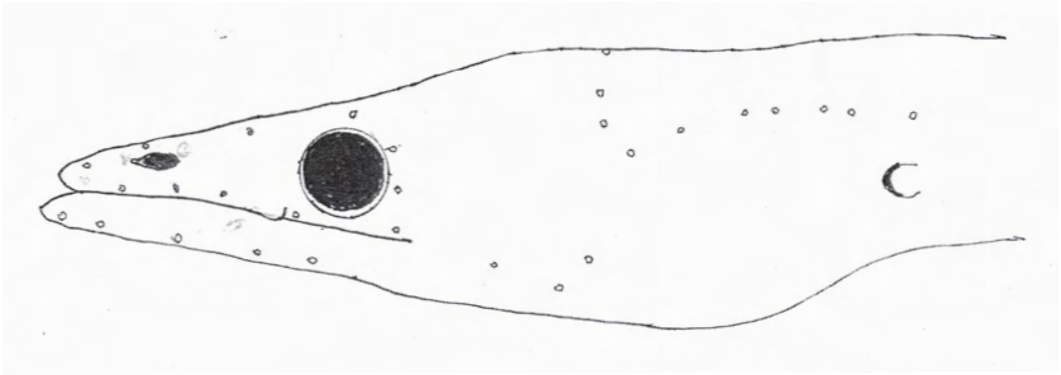

FIGURE **5.** Schematic illustration of head of holotype of *Chauligenion camelopardalis* sp. nov., NSMT-P 125489, female, 407 mm TL.

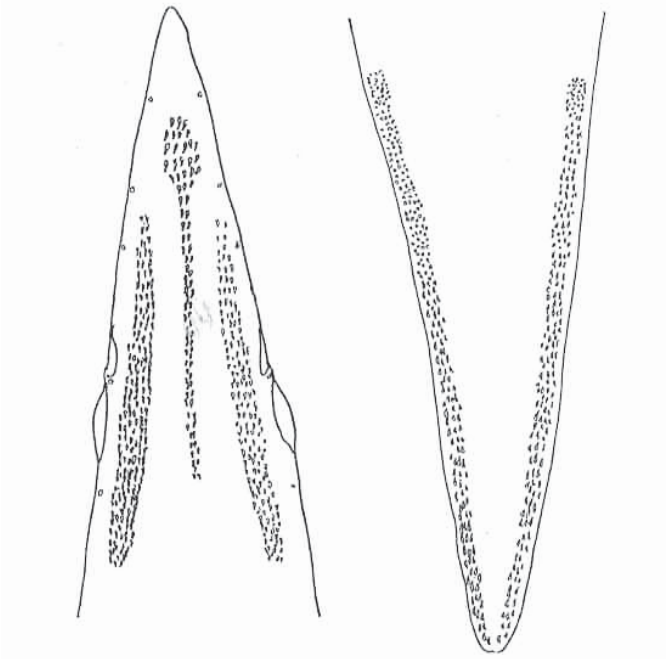

FIGURE **6.** Schematic illustration of dentition (upper jaw left, lower jaw right) of holotype of *Chauligenion camelopardalis* sp. nov., NSMT-P 125489, female, 407 mm TL.

its gill arch condition, and the location of its branchiostegal rays (McCosker 1977). Its other characteristics are so unique that we are unable to confidently place *Chauligenion camelopardalis* within any of the currently recognized tribes. We would exclude it from the tribe Callelchelyini which has a body greater than its tail length, low lateral gill openings, a dorsal fin arising above the nape, and a short and posterior-sloping neurocranium. They too lack pectoral fins, however their pectoral girdle is somewhat simpler. The species of Sphagebranchini are similar in body/tail proportions to the new species, however their gill-opening location is entirely ventral and converging forward, their neurocranium is elongate, and depressed and truncate posteriorly, and their coloration is generally without markings and nearly uniform. The species of Bascanichthyini are similar in their gill-opening location, their body is usually longer than the tail, their dorsal fin usually arises on the head, they lack the third preopercular pore and the fifth ceratobranchial, and their coloration is nearly uniform. The species of the tribe Ophichthini, the most numerous within the family, are the most variable of ophichthids. The new species is similar to many ophichthines in some of its characteristics, but it is unique among them in lacking a pectoral fin and in the location and shape of its posterior nostril. The condition of its extended lower jaw is also unique. Whereas species of other ophichthin genera (*Echiophis*, *Brachysomophis*, and *Aplatophis*) also have lower jaws extending beyond their snouts, those species all possess pectoral fins, slender, fewer, and longer teeth, and are more robust. Species of *Herpetoichthys* and *Quassiremus* are similar in general appearance (boldly spotted), but they too are stouter and have small pectoral fins and have fewer and more slender teeth. The new species is similar to species of *Xyrias* in the size and distribution of its maxillary dentition, and in its snout shape, anterior nostril condition, and spotted appearance, however it differs from all of them in lacking a pectoral fin and in other anatomical characters (*cf.* McCosker et al. 2009).

The gill arch condition of *Chauligenion camelopardalis* deserves special mention. It is clearly that of an ophichthid (Nelson 1966; McCosker 1977), albeit some elements are reduced from bone to cartilage. Ophichthids are unique among anguilliforms (McCosker et al. 1989) in having: a cartilaginous connection between the proximal ends of the dorsal parts of the first and second gill arches; the first basibranchial either ossified or absent, all others are cartilaginous, rudimentary, or absent; hypobranchials 1–2 ossified; the second infrapharyngobranchial is ossified; and, members of the subfamily Ophichthinae possess or have reduced or lost the fifth ceratobranchial, whereas those of the Myrophinae have lost it. *Chauligenion camelopardalis* satisfies all of those conditions.

Chauligenion camelopardalis McCosker & Okamoto, sp. nov.

New English name: Giraffe- spotted snake eel; New Japanese name: Kirin-umihebi
Figures 1–6

Material examined.— Holotype, NSMT-P 125489, 407 mm TL, female, from 27°15′00″N, 125°45′00″E, East China Sea, west of Okinawa, captured by trawl at 150 m, on 25 Nov. 2014.

Diagnosis.— An elongate ophichthine with the following characteristics: tail 53% of TL; snout and tail tip pointed; chin in advance of snout tip; dorsal fin arising above gill opening; median fins low; pectoral fin absent; eye moderate, 10.8 in head, behind middle of upper jaw; cephalic pores small but apparent, 3 preopercular and 3 supratemporal; teeth small, conical, numerous and densely packed on jaws, irregularly biserial on vomer; coloration yellowish-tan overlain with 2 rows of 70–75 eye-sized brown spots; vertebral formula 9/82/186.

Counts and measurements of the holotype (in mm).— Total length 407; head length 33.6; trunk length 158.4; tail length 215; body depth at gill openings *ca.* 9.3; body width at gill openings *ca.* 6.9; body depth at branchial basket *ca.* 7; body width at branchial basket *ca.* 8; body depth at anus *ca.* 10; body width at anus *ca.* 8; origin of dorsal fin 32.6; gill-opening length *ca.* 2.8; isthmus width *ca.*

5; snout length 7.3; tip of snout to tip of lower jaw 0.3; upper-jaw length 13.2; eye diameter 3.1; interorbital distance 1.6. Total left-lateral pores 171, 8–10 above branchial basket, 83 before anus, last pore 13 mm before tail tip. Vertebral formula 9/82/186.

Description (other characters those of the genus).— Body elongate, depth at gill openings 44 in TL, cylindrical in head and trunk, laterally compressed in tail region. Head and trunk 2.2 and head 12.1 in TL. Snout acute, without a median groove on its underside. Jaws elongate, capable of closing completely; center of eye above posterior ⅓ of upper jaw. Lower jaw extended slightly beyond tip of snout. Anterior nostrils open well above upper lip with a small barbel in anterodorsal corner, without a tube or marginal extensions; posterior nostril in upper lip, not entering mouth, covered by a flap and not obvious, its posterior margin abutting anterior margin of orbit. Eye moderate, 10.8 in head and 4.3 in upper jaw, its center above posterior ⅔ of upper jaw, its rear margin in advance of rictus. Interorbital region narrow, slightly elevated. Gill openings low lateral, vertical, not converging forward, opening about twice eye diameter. Pectoral fins absent. Dorsal-fin origin above gill opening. Median fins low, extending to ½ HL before pointed end of caudal fin.

Head pores minute but apparent (Fig. 5); supraorbital pores 1 + 3, infraorbital pores 5 + 3, 5 pores along mandible, 3 pores overlying preopercle, 3 supratemporal pores. A single temporal and interorbital pore. Two infraorbital pores between anterior and posterior nostrils. Approximately 171 lateral-line pores present, 7–10 (7 left, 10 right) above branchial basket, 83 before mid-anus, last pore about 13 mm before tail tip.

Teeth (Fig. 6) small, conical, numerous and densely packed. Anterior ethmovomerine teeth the largest, slightly retrorse, followed by 6–7 irregular rows of smaller teeth, followed by a row of 25 smaller vomerine teeth. Teeth of maxillary and mandibular in patches, becoming smaller and more numerous posteriorly. Maxillary patch is approximately 150 teeth which become smaller and more densely packed posteriorly. Mandibular patch is approximately 250 teeth, becoming smaller and more densely packed posteriorly. (Teeth of the single specimen too difficult to accurately examine without dissection.)

Gill arches (Fig. 3) mostly cartilaginous: basibranchials 1–4 cartilaginous; hypobranchials 1–4 cartilaginous; ceratobranchial 1 cartilaginous, 2–4 ossified, 5 minute and cartilaginous; epibranchial 1 cartilaginous, 2–4 ossified; infrapharyngobranchials 2–3 ossified; upper and lower pharyngeal tooth plates with 5 nearly regular rows of small, conical, densely packed and slightly retrorse teeth, the upper pharyngeal tooth plate with 5 longitudinal rows of *ca.* 15 teeth, plates closely sutured but not fused; the lower pharyngeal tooth plate with 20–25 conical teeth in 5 irregular longitudinal rows. Teeth comparable in size and appearance to those of jaws.

Body coloration in ethyl alcohol (coloration of fresh specimen shown in Figs. 1–2) uniform yellowish-tan, overlain with two rows of distinctive uniformly brown spots equal to or slightly smaller than orbit. Upper row with 70–75 round spots arranged slightly closer than their interspaces, meeting but not crossing at dorsal midline. Lower row has smaller and more numerous spots centered along lateral line that become enlarged in mid-trunk region. Snout spots much smaller, increasing in size behind orbit. Median fins pale. Cheeks, chin, ventral surface and peritoneum overlain with fine brown speckling. Anal opening within a pale spot. Throat and palate pale. Lateral-line pores within pale spots. Tail tip pale like ground color.

Size.— Known only from the holotype, a 407 mm TL female with maturing ova.

Etymology.— From the Latin *camelopardalis* (giraffe), in reference to its coloration, to be treated as a noun in apposition.

Distribution.— Known only from the holotype, captured by trawl at 150 m depth in the East China Sea.

Remarks.— The holotype of the new species is a female and becoming sexually mature. The lat-

eral-line pores above the branchial basket are abnormally distributed for an ophichthid; (Fig. 5); they appear to be in pairs rather than equally spaced. The remainder of the lateral-line pores along the flank appear to be normally spaced.

The new species would not be mistaken for any known ophichthid, on the basis of its elongate body, extended lower jaw, minute dentition, its anterior nostril location, distinctive coloration, and its lack of a pectoral fin.

We look forward to the capture of additional specimens of this remarkable snake eel.

Acknowledgments

We wish to thank: Mysi Hoang (CAS) for staining and clearing the gill arches of the holotype; Erika Garcia (CAS) for photographing the gill arches; Katherine Piatek for assistance with the figures; the staff of the California Academy of Sciences (CAS) and M. Kawazu (Kyushu University) and G. Shinohara (NSMT) for advice and assistance with specimens; and Tomio Iwamoto (CAS), David Smith (USNM), and Yusuke Hibino (Mie University) for reading a draft of this manuscript.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES

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A New Synonymy in the Genus *Pison* Jurine, 1808 (Hymenoptera: Crabronidae)

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***Pison montanum* Cameron, 1908 is newly synonymized with *Pison atrum* (Spinola, 1808). The combined range of *Pison atrum* extends from the Mediterranean Basin into South Africa.**

My recent studies on the genus *Pison* have revealed a previously unnoticed synonymy that is discussed below.

Pison atrum (Spinola)

Alyson ater Spinola, 1808:253, sex not indicated. Lectotype: ♂, Italy: Liguria: Marassi near Genova (Torino), designated by de Beaumont, 1952:42. – As *Pison ater* (correctly: *atrum*): Shuckard, 1838:75 (new combination).

Pison jurinei Spinola, 1808:256, sex not indicated (as *Jurini*, incorrect original capitalization and termination). Lectotype: ♂, Italy: Liguria: no specific locality (Torino), designated by de Beaumont, 1952:42. Synonymized with *Pison atrum* by Shuckard, 1838:75, synonymy confirmed by de Beaumont, 1952:42 (as new synonym).

Tachybulus niger Latreille, 1809:75, ♀. Syntypes: ♀, France: Brive and Italy: Genova (destroyed). Synonymized with *Pison atrum* by Shuckard, 1838:75.

Pison montanum Cameron, 1908:289, ♂ (as *montanus*, incorrect original termination). Holotype by monotypy: ♂, Tanzania: Mount Kilimanjaro: Kibonoto (Naturhistoriska Riksmuseet Stockholm), examined. **New synonym**.

The African species *Pison montanum* was included by Turner (1916), Arnold (1924), and Leclercq (1965) in their keys to Afrotropical *Pison*, but apparently none of them examined the holotype. Of these authors, only Leclercq noticed the species close similarity to *P. atrum*, although he did not synonymize the two names.

Pison montanum, as traditionally interpreted, and also *P. allonymum* Schulz, another Afrotropical species, closely resemble *P. atrum* (the type species of the genus) in having the following combination of characters: presence of three submarginal cells, second recurrent vein joining second intersubmarginal cell or nearly so, punctures of upper frons coarse (Fig. 1), propodeum without longitudinal carina separating side from dorsum and posterior surface, male sternum VIII broadly, deeply emarginate apically. Also, in most specimens the basal declivity of tergum I is covered with erect setae, and the hindcoxal dorsum has the inner carina produced into a conspicuous tooth basally, although the tooth is reduced in size or totally absent in many males.

Pison allonymum Schulz and *P. montanum* (as traditionally interpreted) differ by the position of the hindocelli: in *P. allonymum*, the ocellocular distance is larger than the hindocellar diameter; in *P. montanum* it is smaller than the midocellar diameter in the female and about equal to the midocellar diameter in the male. A hitherto unnoticed difference is the shape of the clypeal lamella of

the female, which is obtusely, roundly angulate in *P. allonymum* and acutely angulate in *P. montanum*. Leclercq (1965) claimed that these species differ by the degree of punctation of gastral terga, but I cannot confirm his statement.

The holotype of *Pison montanum* has lost its head, but its remaining characters clearly indicate that it is either *P. allonymum* or *P. montanum* as traditionally interpreted. The absence of the head precludes recognition based on external characters, also because the position of the hindocelli was not mentioned in the original description. However, the setae of the gonocoxite of the holotype are as long as in the specimens determined as *P. montanum* in various collections and slightly longer than in *P. allonymum*, demonstrating that the species interpretation by Turner (1916), Arnold (1924), and Leclercq (1965) was correct.

In addition, *Pison montanum* is morphologically identical to *P. atrum*. These two names are therefore synonyms.

FIGURE 1. *Pison atrum* (Spinola): upper frons of female.

Pison atrum is known from southern Europe north to southern Germany, Austria, Czech Republic, Slovakia, Romania, southern Russia, Caucasus, and also from Algeria, Canary Islands, Morocco, Cyprus, Turkey and Iran. *Pison montanum*, described from Tanzania, was subsequently recorded from Ethiopia, South Africa, Zambia, and Zimbabwe. The combined geographic range extends from the Mediterranean Basin to South Africa.

ACKNOWLEDGMENT

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A Re-evaluation of the Generic Limits of *Pison* Jurine, and a New Species of the Genus *Aulacophilinus* Lomholdt (Hymenoptera: Crabronidae: Trypoxylini)

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The status of subgenera in the genus *Pison* Jurine is discussed. *Aulacophilinus* Lomholdt and *Entomopison* Menke are restored to genus (revised status). The importance of the mandible in generic discretion is discussed. A new species of *Aulacophilinus* from New Guinea, *A. amblygnathus*, is described. *Pison weiri* Naumann, *P. caliginosum* Turner, *P. mandibulatum* Turner and *P. pyrrhicum* Naumann are transferred to the genus *Aulacophilinus* (all new status). An identification key to the six known species of *Aulacophilinus* is provided.

The Cosmopolitan genus *Pison* has slightly less than 200 species and is one of the largest in the family Crabronidae. As currently interpreted, *Pis*on contains a broad diversity of species morphology. The mandible in *Pison* is one of the more complexly variable features of the genus, and it is more diverse than indicated by Bohart and Menke (1976). The morphological diversity in *Pison s.l.* resulted in several authors describing generic taxa: *Pisonoides* Smith (1857); *Krombeiniellum* Richards (1962); and *Entomopison* Menke (1968). In my review of New World *Pison* (Menke, 1988), these genera were considered synonyms of *Pison* and species groups were established for the species diversity in the fauna of the Western Hemisphere.

The purpose of this paper is to discuss the importance of the mandible as a generic character in *Aulacophilinus*, *Pison*, and *Entomopison*. My studies demonstrate some generic taxa considered as synonyms of *Pison* are really valid genera. Species of *Aulacophilinus* have a mandible which has a unique shape shared by both sexes. Thus I have reinstated *Aulacophilinus* as a genus (revised status). Species of *Entomopison* consistently have a large externoventral notch in both sexes, while species of *Pison s.s.* lack a notch or it is weakly formed. I now recognize the Neotropical *Entomopison* as a genus (revised status). The removal of *Aulacophilinus* and *Entomopison* from *Pison* leaves the latter an assemblage that is morphologically diverse. As such it is probably paraphyletic. Further study may suggest breaking up *Pison s.s.* into 2 or 3 additional genera. *Krombeiniellum* is one taxon that might be elevated to genus based on the densely setose eyes.

Lomholdt (1980) described a new genus, *Aulacophilinus*, from the Solomon Islands in the Western Pacific, that he regarded as a close relative of the New World genus *Aulacophilus* Smith because of its petiolate abdomen. Indeed, the abdomen of *Aulacophilus* and *Aulacophilinus* is very similar, but Lomholt's genus lacks the many parallel pleural carinae that characterize *Aulacophilus*. I have studied Lomholdt's type material and find that *Aulacophilinus* is a close relative of *Pison*. The genus differs from *Pison* in the form of the mandible. In both sexes the apex has a rather broad and distinctive cutting edge (Figs. 3, 8). Furthermore, the outer surface of the mandible is rather uniformly and densely covered with short setae in *Aulacophilinus*. This mandible is unique and not

found in any species of *Pison*. I have discovered additional undescribed species of *Aulacophilinus* in the Western Pacific with the same type of mandible, but the abdomen is not petiolate. Thus *Aulacophilinus* contains species that are more like *Pison* in their general facies. The distinctive mandible defines *Aulacophilinus*. The petiolate abdomen of *Aulacophilinus rennellensis* is strikng (Fig. 1) but this condition is known in some *Pison s.s.*: *pistillum* Menke, 1988 and *woji* Menke, 1988, both from New Guinea. There are other petiolate or clavate species but the examples just listed are the most extreme. The genus *Pisonoides* was described for *obliteratum* Smith (1857), a petiolate species known from India and Indonesia, but abdominal structure is too variable to be used as a generic character. Other petiolate species like *Pisonoides obliteratum* are the Australian *Pison icariodes* Turner, 1908, and *P. difficile* Turner, 1908. Antropov (1999) synonymized *Aulacophilinus* with *Pison*, a genus with which it is more closely allied. But Lomholdt's genus is here resurrected from synonymy.

Naumann (1990) described and keyed four Australian species of *Pison*, two of which were new, that have an apically truncate mandible as in *Aulacophilinus*. He called the assemblage the *caliginosum* group, and included *caliginosum* Turner, *mandibulatum* Turner, *pyrrhicum* Naumann, and *weiri* Naumann. I have discovered more species with this type of mandible in New Guinea, one of which is described below. All of these species belong in the genus *Aulacophilinus* and are new combinations.

Sources of material

American Entomological Institute, Logan, Utah (David Wahl)
Bishop Museum, Honolulu, Hawaii (Gordon Nishida)
The Natural History Museum, London, England (Colin Vardy)(BMNH)
Zoological Museum, Copenhagen, Denmark (Ole Lomboldt)

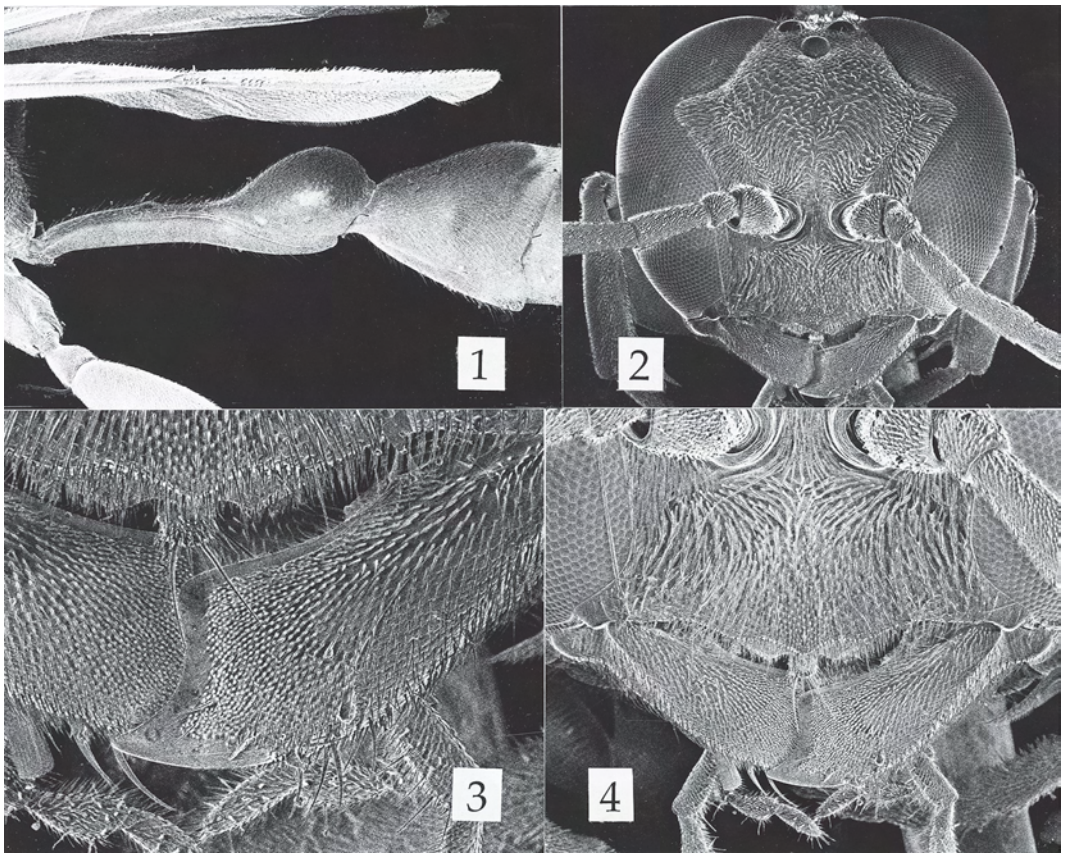
Terminology and procedures

I follow Bohart and Menke (1976) and Harris (1979) for terms. Scanning electron photographs were made by me at the Smithsonian SEM facility back in the 1980s.

Genus *Aulacophilinus* Lomholdt, revised status

Aulacophilinus Lomholdt, 1980. The Natural History of Rennell Island, British Solomon Islands 8:27. Monotypic.
Aulacophilinus, Antropov, 1999. Zoologischeskiy Zhurnal 78:562. Synonymized *Aulacophilinus* with *Pison*.

When Lomholdt described his new genus, he compared it to the Neotropical genus *Aulacophilus* Turner because of similar abdominal elongation, the presence of only two submarginal cells, and the absence of a carina at the top of the propodeal side. These are superficial resemblances, however, and in my opinion *Aulacophilinus* is more closely allied with *Pison*. In fact Antropov (1999) realized the true affinities of Lomholdt's genus and synonymized it with *Pison.* The peculiar elongate abdominal petiole of *rennellensis* (Fig. 1) is approached or paralleled by several species of *Pison* (*woji* Menke, *pistillum* Menke, *icarioides* Turner, *difficile* Turner). The broad mandible common to the various species discussed here is an apomorphy that in my opinion elevates *Aulacophilinus* to genus. The mandible in this genus is acuminate apically, but the inner (or cutting) edge is broadly expanded in an angular fashion near its apical one-third (Figs. 3, 8). In addition, the margin of the cutting edge is narrowly polished. This smooth rim extends along the truncation and around the sharp mandibular apex (Figs. 3, 7). The ventral (posterior) edge of the mandible is fringed with very short, dense setae. Both sexes share this unique type of mandible,



FIGURES 1–4, *Aulacophilinus rennellensis*, male features. 1, lateral profile of abdomen. 2, front view of head. 3 and 4, mandible, clypeus, and labrum

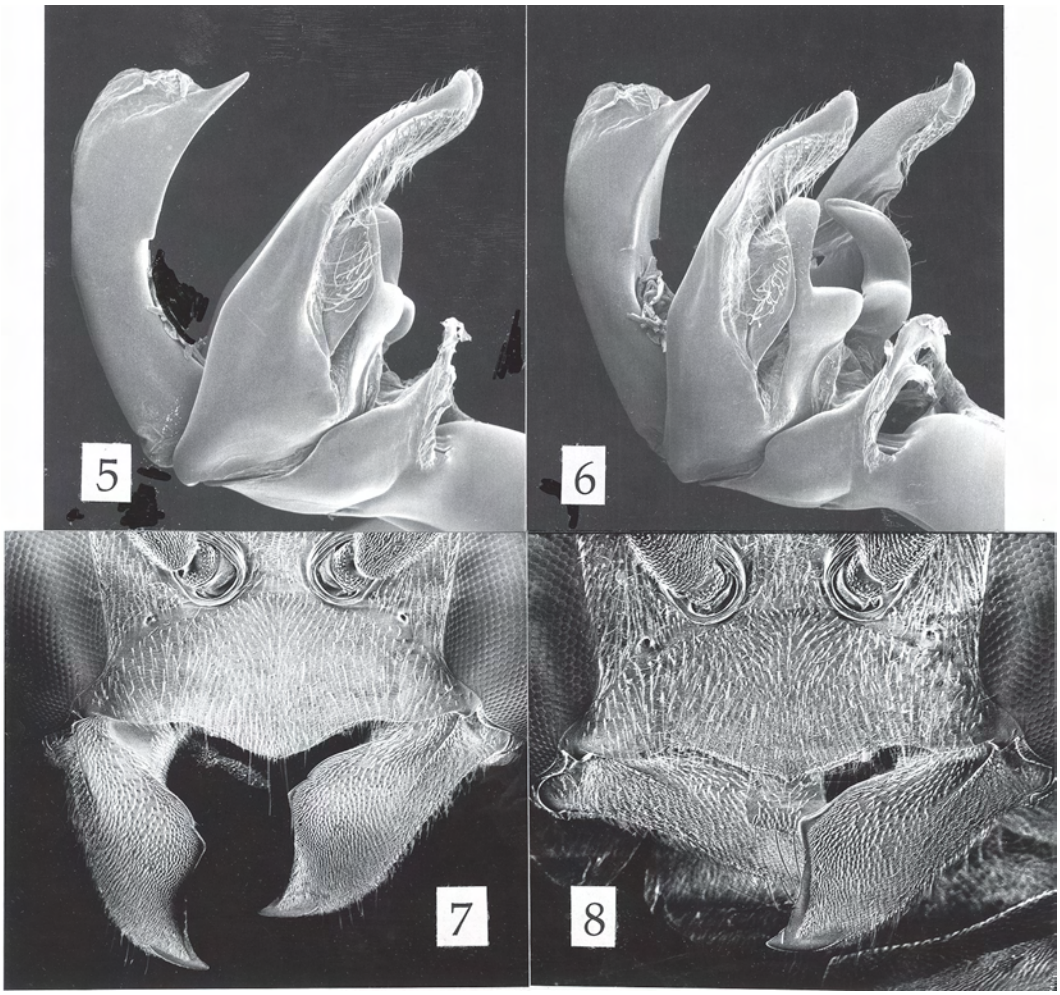
and I agree with Naumann (1990) that this is an apomorphy for *Aulacophilinus*. Another feature common to species of *Aulacophilinus* is a narrow labrum (Figs. 4, 8) and it may prove to be an additional apomorphy.

The species of *Aulacophilinus* are rather diverse morphologically. Two species, *A. caliginosus* and *A. weiri*, have two submarginal cells, the rest three; *A. weiri* has an omaulus on the mesopleuron and a transverse carina on the pronotal collar; two species have a crenulate ridge at the top of the propodeal side (*A. caliginosus*, *A. mandibulatus*); and among the included species the occipital carina varies from a complete circle to interrupted at the midventral line of the head.

***Aulacophilinus amblygnathus* Menke, sp. nov.**

TYPES.— Holotype male: New Guinea: Wau, October l969, P. Shanahan (American Entomological Institute). Paratypes: one female with same data as holotype (American Entomological Institute); one female, Wau, 1200 m, Nov. l, l965, P. Shanahan (Bishop Museum).

DESCRIPTION: *Holotype male*.— Black, shiny except frons and antenna dull, flagellomeres VII-XI pale beneath; clypeus and lower frons with short, appressed silver setae that obscure sculpture; head and thorax with long, erect pale setae except setae in ocellar triangle shorter and black; gaster with short, decumbent, pale setae; wing veins dark brown, membrane slightly infuscate.



FIGURES 5–8, *Aulacophilinus amblygnathus* features. 5 and 6, male genitalia, lateral view, and ¾ view respectively. 7, female clypeus and mandibles. 8, male clypeus, labrum and mandibles.

Upper interocular distance 0.56X lower interocular distance; ocellocular distance 0.22X hindocellus diameter; frons with large, shallow punctures that are l to 2 diameters apart, interspaces minutely roughened, dull; flagellum without tyli or other adornments, lengths of flagellomeres I-III equal, each slightly more than twice as long as wide, VI–X only slightly longer than wide; clypeus with broad, obtusely triangular median lobe that ends in small tooth (Fig. 8), edge of lobe thickened laterad (ventral view); labrum narrowly quadrangular, projecting beyond clypeal edge (Fig. 8); mandible broadening to an obliquely, arcuately truncate apex (Fig. 8); occipital carina essentially complete but becoming very low at midventral line, narrowly separated from hypostomal carina. Pronotum with anteromedial round pit that is about 0.5X hindocellus diameter, several irregular transverse rugae behind pit; collar not carinate but with obtuse elevation at middle; scutum punctate, punctures densest anteriorly (0.5 diameters apart), l to 2 diameters apart on disk, interspaces imbricate (Harris, 1979); scutellum similarly punctate and sculptured; mesopleuron coarsely punctate, punctures 0.5–2 diameters apart, interspaces smooth except minutely roughened

on venter, hypoepimeral area horizontally rugosopuncatate; metapleural flange narrowly lamelliform; propodeum mostly smooth, punctate, most sparsely so on side (1–1.5 diameters apart), punctures of dorsum finer than those on scutum; base of dorsum with short, strong ridges, dorsum with series of short, transverse rugae along midline; propodeal side not delimited dorsad by carina but there is a vague linear series of short transverse rugae between petiole socket and spiracle. Gaster more finely punctate than thorax, interspaces smooth, punctures coarsest on segment I, resembling pinpricks on last few segments, sterna unspecialized, VIII concavely truncate apically. Male genitalia (Figs. 5, 6). Hindtarsomere I swollen beneath subapically in lateral profile, distal third flattened ventrally, this area densely covered with very short white setae, distal two thirds of II covered with similar setal patch ventrally, III–IV with plantulae. Forewing with three submarginal cells, recurrent vein I ending on submarginal cell I but nearly interstitial, recurrent vein II ending on submarginal cell III, separated from II by about an ocellus diameter, forewing media diverging beyond cu-a. Length 6.5 mm.

Paratypes: female (two).— Color as in male except antenna completely black, and appressed silver setae of clypeus sparser, not obscuring sculpture.

Similar to male except upper interocular distance 0.47–0.48X lower interocular distance; ocellocular distance 0.07–0.l0X hindocellus diameter; flagellomeres VII–IX nearly 2X as long as wide; clypeal lobe more angular (Fig. 7); cutting edge of mandible with small indentation basad of truncation (Fig. 7); propodeal side not delimited dorsad in any way; hindtarsomeres I-II unmodified; recurrent vein I ending on submarginal cell I about ocellus diameter from II; Length 8 mm.

DISCUSSION.— *Aulacophilinus amblygnathus* is the only member of *Aulacophilinus* from New Guinea with three submarginal cells in the forewing. Others with three submarginal cells known to me are *mandibulatus* and *pyrrhicus*, both of which are found in Australia.

ETYMOLOGY.— *Amblygnathus*, a noun, is based on the Greek words amblys (= blunt, truncate) and gnathos (= jaw), a reference to the peculiar mandible.

Key to Species of *Aulacophilinus*

1a. Forewing with two submarginal cells 2
1b. Forewing with three submarginal cells 4

2a. Gastral segment I in the form of a slender petiole with tergum swollen only at apex (Fig. 1); propodeal side not delimited above by carina; Solomon Islands (Rennell I.). . . . . *rennellensis* Lomholdt
2b. Gaster sessile, segment I not forming a petiole; propodeal side sometimes delimited above by carina; Australia, Norfolk I 3

3a. Mesopleuron with omaulus; face, scutum and mesopleuron areolate rugulose; pronotum with transverse crenulate carina; northern Australia . . . . . *weiri* (Naumann)
3b. Mesopleuron without omaulus; face, scutum and mesopleuron punctate; pronotum without transverse carina; widespread in Australia, Norfolk I. . . . . *caliginosus* (Turner)

4a. Body entirely black; New Guinea . . . . . ***amblygnathus* sp. nov**.
4b. Body not entirely black, either mandibles or legs and abdomen extensively amber colored; Australia 5

5a. Mandible amber colored, abdomen and legs black; ocellocular distance 0.75 or more times hindocellus diameter; frons densely punctate, interspaces dull; propodeal side delimited dorsad by carina that may be irregular and crenulate; anterior veinlet of third submarginal cell about one third length of posterior veinlet; southwestern Australia . . . . . *mandibulatus* (Turner)

5b. Mandible black, abdomen and legs largely amber colored; ocellocular distance less than half diameter of hindocellus; frons coarsely punctate-areolate, interspaces shiny; propodeal side without carina dorsad; anterior veinlet of third submarginal cell half length of posterior veinlet; northern and eastern Australia. . . . . *pyrrhicus* (Naumann)

Notes on the types of *A. rennellensis*

I studied the holotype female and paratype male in 1989. The mandible of the female has a polished edge from apex along lower side as in other species of the genus, but the cutting edge seems to lack this. It is dull (worn?). The male, on the other hand, has the usual polished cutting edge (Figs. 3, 4). The male antenna has polished, elevated tyli on flagellomeres I–IV (not II–V as stated by Lomholdt who apparently regarded the pedicel as flagellomere I). The male clypeal edge is quite thick. Seen in ventral view it is about an ocellus diameter wide. The male has a tiny labrum just like the female (Fig. 4). It is about as wide as an ocellus diameter. In the female, the pronotum has a round anterodorsal pit that is smaller than ocellus. The pit is within a broad flat but not highly polished area bordering the anterior margin. This flat area is suggestive of the lamella of the *pilosum* group of *Entomopison*, but it is not a lamella, nor is it polished. It is setose. Its hind margin is slightly elevated over a length that is about two thirds width of collar. The occipital carina is a complete circle that is well separated from hypostomal carina, the two separated by about an ocellus diameter. Inner carina of hindcoxa is diagonal and widely separated from apical U-notch for trochanter, outer carina absent. The hindcoxa of *amblygnathus* is intermediate between *rennellensis* and *mandibulatus*. The hindbasitarsis of the female is ordinary. The male abdomen is shown in Fig. 1.

Notes on type of *A. mandibulatus* (Turner), 1916

I studied the lectotype of Turner's species many years ago (BMNH). The following notes are based on this specimen as well as other material.

The amber mandible (and clypeal apex in female) is immediately diagnostic. The propodeal side has a well formed carina at the top in the female, but in the male it is somewhat irregular and more crenulate. The ocellocular distance is broader than in any of the other species in the *mandibulatus* group (i.e., *amblygnathus* and the other New Guinea species), being almost as broad as the ocellar diameter in the female, and broader than the ocellocular distance in the male. The frons is strongly swollen just above the sockets, somewhat wedgelike, forming two humps when viewed from below (*pyrrhicus* is weakly this way). The New Guinea species are merely rounded off in this area. The frons is closely punctate, punctures less than diameter apart, some almost contiguous, and the interspaces are dull. The scutum is similarly punctate, but more uniformly nearly contiguous and the interspaces are somewhat shiny. The mesopleural punctures are also dense, but slightly larger and the interspaces are even shinier. The propodeal dorsum has a median carina that is met by many transverse carinae that are mostly perpendicular and which extend over the middle third of the surface. These carinae fade into dense striatopunctation laterad. The propodeal side is shiny and densely punctate, their size about as on scutum (smaller than mesopleural punctures). The abdominal terga are shiny and densely punctate, the punctures being smaller than anywhere else. The hindcoxa has a long inner carina that is essentially parallel with long axis of segment, and narrowly separated from apical U-shaped emargination. The outer carina is strong on apical half. The hindbasitarsis is not straight like *amblygnathus*. It has a slight curve from base to apex in lateral profile (the hind face when seen in lateral profile has a concave curvature). The male hindbasitarsis is nearly straight. The male antenna lacks tyli or other adornments.

Genus *Entomopison* Menke, revised status

Entomopison Menke, 1968. Los Angeles County Museum Contributions in Science (135):5. Type species *Pison pilosum* Smith, 1873, original designation.

Entomopison is restricted to the New World tropics and contains the following 11 species: *alini* Antropov,1996, *aureofaciale* Strand, 1910, *convexifrons* Taschenberg, 1870, *cooperi* Menke, 1988, *gnythos* Menke, 1988, *longicorne* Menke, 1988, *oaxaca* Menke, 1988, *pilosum* F. Smith, 1873, *sphaerophallus* Menke, 1988, *vincenti* Menke, 1988, and *wasbaueri* Menke, 1988. I (Menke 1988) segregated them into two species groups: the *convexifrons* group and the *pilosum* group. *Pison alini* Antropov (1996), belongs in the *convexifrons* group. Elevation of *Entomopison* to genus makes the contained species all new combinations.

Genus *Pison* Jurine

Pison Jurine in Spinola, 1808:255. Type species *Pison jurini* Spinola 1808, monotypic (properly *jurinei* Spinola, = *Alyson ater* Spinola, 1808).

Pisonoides Smith, 1857. Type species *Pison obliteratum* F. Smith1859, monotypic.

Krombeiniellum Richards, 1962:118. New name for *Paraceramius* Radoszkowski, 1887, nec *Paraceramius* Saussure, 1854. Type species: *Paraceramius koreensis* Radoszkowski, 1887 (junior synonym of *agile* (F. Smith), 1869).

For complete list of generic synonyms see Bohart and Menke (1976). Pulawski's online catalog of Crabronidae lists 198 species of *Pison*. However, a few of these are now in *Aulacophilinus*, 11 are now in *Entomopison*, and many others await descripton. *Pison* likely has more than 200 species worldwide.

Acknowledgments

Michael Ohl critically reviewed the manuscript and offered helpful suggestions. Wojciech Pulawski helped with literature and translated Antropov's 1999 Russian paper for me. An anonymous reviewer also provided additonal helpful recommendations.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES

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Inventory of the Carabid Beetle Fauna of the Gaoligong Mountains, Western Yunnan Province, China: Species of the Tribe Trechini (Coleoptera: Caraboidea), with Descriptions of Four New Genera, One New Subgenus and 19 New Species.

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Our study of 525 specimens of trechine carabids collected during a ten-year biodiversity inventory project in the Gaoligong Shan region of western Yunnan Province, China, recognized a total of 29 different species representing nine different genera. Four of these genera are described as new: *Minutotrechus* Deuve & Kavanaugh (Type species: *Stevensius minutus* Uéno), *Trechepaphiopsis* Deuve & Kavanaugh (Type species: *T. uniporosa* sp. nov.), *Epaphiotrechus* Deuve & Kavanaugh (Type species *E. fortipesoides* sp. nov.), and *Trechepaphiama* Deuve & Kavanaugh (Type species *T. gaoligong* sp. nov.). *Gaoligongtrechus* Deuve & Kavanaugh is described as a new subgenus of *Queinnectrechus* Deuve (Type species: *Q.* (*G.*) *balli* sp. nov.). In addition, 19 of the 29 species are described as new: *Perileptus pusilloides* Deuve & Liang (type locality: China, Yunnan, Tengchong County, Hehua Township, 5.4 km S of Hehua at Dengman village along Daying Jiang, N24.92346°/E98.38612°, 1105 m), *Agonotrechus fugongensis* Deuve and Liang (type locality: China, Yunnan, Fugong County, Shiyueliang Township, 0 to 2 km W of Shibali on Shibali Road, 2300-2530 m), *A. xiaoheishan* Deuve and Kavanaugh (type locality: China, Yunnan, Longling County, Longjiang Township, Xiaoheishan Forest Reserve, 2067 m), *Queinnectrechus* (*s. str.*) *griswoldi* Deuve & Kavanaugh (type locality: China, Yunnan, Gongshan County, Cikai Township, 0.1 km SE of Heipu Yakou, in valley below tunnel, N27.77437°/E098.44793°, 3270 m), *Q.* (*s. str.*) *gongshanicus* Deuve and Liang (type locality: China, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, on slope NE of Chukuai Lake, N27.98206°/E98.48027°, 3950 m), *Q.* (*Gaoligongtrechus*) *balli* Deuve and Kavanaugh (type locality: China, Yunnan, Gongshan County, Qiqi/Dulong divide area, N27.69655°/E98.45389°, 3300-3680 m), *Trechus shiyueliang* Deuve & Kavanaugh (type locality: China, Yunnan, Fugong County, Shiyueliang Townhip, 10-11 km W of Shibali on Shibali Road, 3200-3280 m), *T. mingguangensis* Deuve and Liang (type locality: China, Yunnan, Tengchong County, Mingguang Township, Eighth Boundary Post Pass, N25.80984°/E98.62084°, 2287 m), *T. qiqiensis* Deuve & Kavanaugh (type locality: China, Yunnan, Gongshan County, Qiqi Trail at No. 12 Camp, N27.71503°/E98.50244°, 2775 m), *T. pseudoqiqiensis* Deuve and Liang (type locality: China, Yunnan, Fugong County, Shiyueliang Township, 11.5 km above Shibali on Yaping Road, N27.20676°/E98.71763°, 3290 m), *T. luzhangensis* Deuve & Liang (type locality: China, Yunnan, Lushui County, Luzhang

Township, Pianma Road at Fengxue Yakou [Pass], N25.97228°/E98.68336°, 3150 m), *T. gongshanensis* Deuve & Liang (type locality: China, Yunnan, Gongshan County, Dongshaofang area, N27.69655°/E98.45389°, 3300–3600 m), *T. shibalicus* Deuve & Kavanaugh (type locality: China, Yunnan, Fugong County, Shiyueliang Township, 8,5 km above Shibali on Shibali Road, North Fork of Yamu He, N27.18416°/E98.72026°, 3100 m), *Trechepaphiopsis uniporosa* Deuve & Liang (type locality: China, Yunnan, Lushui County, Pianma Township, 9.3 km ESE of Pianma, N25.99363°/E98.66651°, 2460-2470 m), *T. unisetulosa* Deuve & Kavanaugh (type locality: China, Yunnan, Fugong County, Shiyueliang Township, 0.2 km W of Shibali, N27.16650°/E098.77936°, 2537 m), *T. monochaeta* Deuve & Kavanaugh (type locality: China, Yunnan, Gongshan County, Qiqi Trail at No. 12 Bridge Camp area, 16.3 airkm W of Gongshan, N27.71503°/E98.50244°, 2775 m.), *T. unipilosa* Deuve & Liang (type locality: China, Yunnan, Fugong County, Shiyueliang Township, 8.5 km above Shibali on Shibali Road, North Fork of Yamu He, N27.18416°/E98.72026°, 3100 m), *Epaphiotrechus fortipesoides* Deuve & Kavanaugh (type locality: China, Yunnan, Tengchong County, Houqiao Township, 8.5 airkm NNE of Houqiao at Gaoshidong, N25.39858°/ E98.30533°, 2580 m), and *Trechepaphiama gaoligong* Deuve & Kavanaugh (type locality: China, Yunnan, Gaoligong Shan, Lushui County, 9.3 km ESE of Pianma, N25.99363°/E98.66651°, 2460-2470 m.). Lectotypes are designated for *Perileptus imaicus* Jeannel and *P. pusillus* Jeannel. *Agonotrechiotes* Deuve is proposed as a junior synonym of *Eocnides* Jeannel, and *Agonotrechiotes longiantennatus* Deuve as a junior synonym of *Eocnides fragilis* Ueno. We present keys for identification of adults of all species in the study area, first to genus and then to species for each genus, as well as nomenclatural data, diagnoses, illustrations of dorsal habitus and male genitalia, and 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, and syntopic among species analyzed. A possible role of the Gaoligong Shan region as one source area for the present-day fauna of the Himalaya and southern edge of the Qinghai-Xizang (Tibetan) Plateau is also discussed.

KEYWORDS: Coleoptera, Caraboidea, Trechini, China, Yunnan, Gaoligong Shan, taxonomy, new genera, new species, distribution, biodiversity hotspot

The Gaoligong Shan (Gaoligong Mountains) of extreme western Yunnan Province, China, form the westernmost range of the Hengduan Mountains system of southeastern Xizang Autonomous Region (Tibet), northern and western Yunnan, and western Sichuan (Fig. 1). They extend north to south for more than 600 km, and, in the central part of the range, their crest forms the border between China and Myanmar. They also separate and form 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; and previous biological exploration of the area over the past 150 years has revealed exceptionally high species richness, based almost exclusively 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 con-

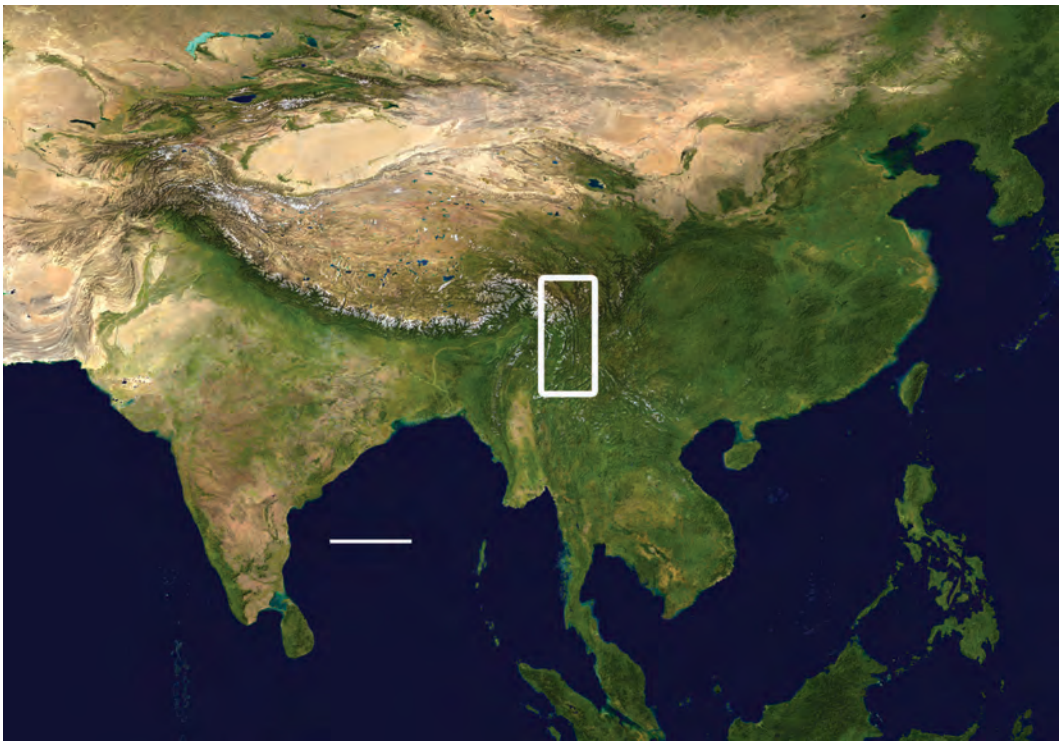


FIGURE 1. Map of Asia with study region outlined; scale line = m 500 km. Modified from Wikimedia Commons, World Atlas of the World, at URL: <*http://upload.wikimedia.org/wikipedia/commons/8/8f/Whole_world_-_land_and_oceans_12000.jpg*> [last accessed 28 September 2016].

duct 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, and 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. More than 100 reports on the project have been published to date, including partial results for bryophytes (e.g., Long 2006, Shevock 2005), plants (e.g., Fritsch et al. 2008, Zhou et al. 2006), birds (Dumbacher et al. 2011), amphibians (e.g., Liu et al. 2000), fishes (e.g., Chen et al. 2005), spiders (e.g., Miller et al. 2009, Wang et al. 2010), and carabid beetles (Kavanaugh and Liang 2004 and 2006; Kavanaugh and Long 1999; Liang and Imura 2003; Liang and Kavanaugh 2006 and 2007; Liu et al. 2010 and 2011).

Prior to the start of the project the carabid beetle fauna of the region was very poorly known. The fauna for the entire Hengduan region included only about 50 species (Yu 1992), and most of these were widespread species from low elevation areas. The region in general and the higher elevations in particular were virtually unexplored with respect to the carabid fauna. As a result of our work on this project to date, we now recognize more than 525 species occurring in the Gaoligong Shan, with additional species undoubtedly represented among materials for groups not yet fully studied. For several of the groups currently under study, (e.g., *Leistus* (Nebriini), *Broscosom*a (Broscini), *Amerizus* (*Tiruka*) (Bembidiini) and *Aristochroa* (Pterostichini), species diversity is much higher in this area than is known anywhere else that these taxa occur.

This report, on the tribe Trechini, represents the second 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 report (Kavanaugh et al. 2014) described the zabrine (Caraboidea: Zabrini) fauna of the region. Subsequent reports will appear as taxonomic work on each group is completed and not in any particular taxonomic or phylogenetic order.

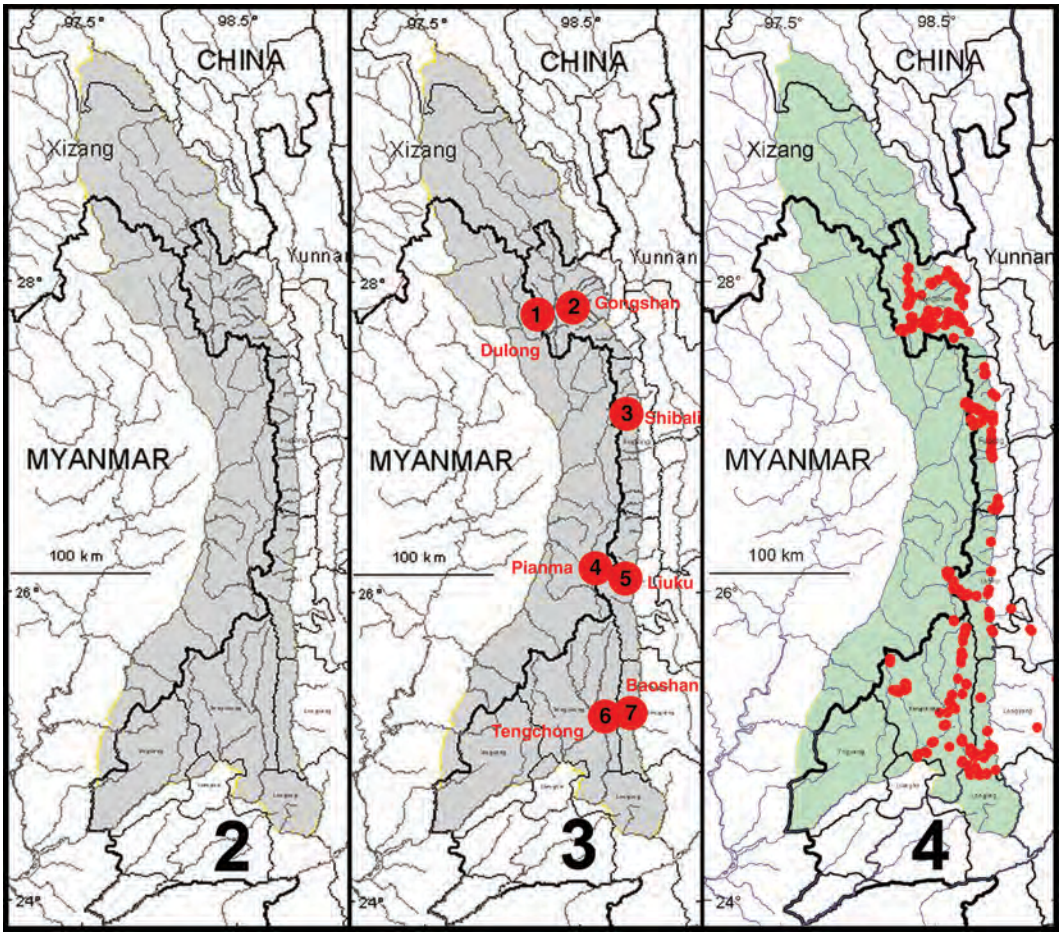
Trechini is a megadiverse taxon, worldwide in distribution, including more than 3,300 described species and subspecies distributed among more than 250 genera and subgenera (Lorenz 2005), and additional new species and genera continue to be described each year, especially from the eastern Palearctic Region. Trechines also occupy a diversity of habitats, from lowland marshes and stream edges to alpine tundra and fellfields; and they are especially diverse in caves, with members of many genera and species morphologically highly specialized for troglobitic life (see a list of the Chinese cavernicolous trechine genera in Tian et al. (2016).

As is the case with most other terrestrial anthropod groups, the trechine fauna of the study area has not been well documented previously. Most of our current knowledge of the Southeast Asian regional fauna is from the works of Belousov and Kabak (2003, 2014a, 2014b, 2016), Deuve (1988, 1992a, 1992b, 1995, 2004, 2005, 2013a); Jeannel (1923, 1928, 1935, 1954), Schmidt (2009) and Uéno (1953, 1962, 1972a, 1972b, 1973, 1977, 1981, 1995, 1996a, 1996b, 1997. 1999a, 1999b), with additional contributions by Andrewes (1936), Casale and Magrini (2009), Deuve et al. (2015), Donabauer (2010), Putzeys (1870), and Uéno and Yin (1993). To date, only five trechine species have been recorded from the Gaoligong Shan region: *Agonotrechus yunnanus* Uéno (1999a), *Stevensius minutus* Uéno (1997), *Trechus asetosus* Uéno (1997), *Trechus unisetiger* Uéno (1997), and *Trechus unisetosus* Deuve (2004). 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 29 trechine species found to occur in the study area. These species represent nine different genera, four of which are described here as new; and 19 of the 29 species are also described as new.

We present here a key for identification of adults to genus and separate keys for identification to species for each genus. Treatments for each species include nomenclatural data, diagnoses, illustrations of dorsal habitus and male genitalia, 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 the seven core areas and to each other, as well as broader geographical range patterns and the altitudinal ranges of the species.

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 Autonomous Region (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 exter-



FIGURES 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.

nal structure and male and female genitalic traits) and detailed systematic studies of taxonomic groups are ongoing.

The present study is based on the examination of 525 specimens of trechine species from the Gaoligong Shan region. Specimens acquired during the project have been divided among and are deposited in the collections of our home institutions. Codens used throughout this report for collections in which specimens, including primary types, are deposited are as follows:

BMNH	British Museum (Natural History), London, United Kingdom
CAS	California Academy of Sciences, San Francisco, U.S.A.
IOZ	National Zoological Museum of China, Institute of Zoology, Beijing, China
MNHN	Muséum National d'Histoire Naturelle, Paris, France
NSMT	National Science Museum (Natural History), Tokyo, Japan
SCAU	South China Agricultural University, Guangzhou, China

MEASUREMENTS.— The following measurements were recorded: body length (BL), measured longitudinally from the apex of the mandibles to the apex of the elytra; pronotal width (PW), meas-

ured transversely at the widest point on the pronotum; and pronotal length (PL), measured longitudinally between the anterior and posterior pronotal margins along the midline. The means of these measures were combined in the ratio, PW/PL, as an indicator of pronotal shape for each species.

Dissections of male genitalia.— Urite IX (the "ring sclerite") and aedeagus were extracted as a unit manually by using a sharp point to slit the intersegmental membrane between segments VIII and IX. The dissected assemblage was then placed in a dilute solution of KOH at room temperature for 24 hours. After rinsing in water, the dissections were dehydrated using 95% EtOH, then urite IX was separated from the aedeagus by severing the connecting membranes. The parts were then mounted in a Euparal preparation between two small coverslips over a hole in a small card and pinned beneath the specimen.

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 South, 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 trechine species represented in the Gaoligong Shan region can be distinguished using the keys provided in this paper. Each key 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.

Key for Identification of Adults of Trechine Genera of the Gaoligong Shan Region

1. Dorsal surface covered with fairly long pubescence; eyes also pubescent . . . . . *Perileptus* Schaum
1' Dorsal surface glabrous except for isolated fixed setae typical for trechines; eyes also glabrous 2

2(1') Mentum and submentum fused or at least partially fused 3
2' Mentum and submentum not fused, separated by a distinct suture 5

3(2) Body length (BL) less than 3 mm, the protibiae not furrowed . . . ***Minutotrechus* gen. nov.**
3' BL more than 4 mm, the protibiae longitudinally furrowed 4

4(3') Fully winged, elytra with discal striae distinctly impressed. . . . . *Agonotrechus* Jeannel
4' Apterous, elytra with discal striae effaced . . . . . *Queinnectrechus* Deuve

5(2') Form slender and flattened, the pronotum relatively small; antennae long and slender, extended nearly to the apical one-fourth of the elytra . . . . . *Eocnides* Jeannel
5' Form more compact and convex, the pronotum average size; antennae shorter, extended only to the basal one-fourth of the elytra or less 6

6(5') Right mandible with the anterior point of the retinaculum free and displaced distally to form a separate tooth; elytra without or with up to two discal setae, elytral surface with or without iridescence 7

6' Right mandible tridentate, but premolar tooth fused with the retinaculum to form a trifid molar with the anterior point not displaced distally; elytra with two or three discal setae; elytral surface not iridescent . . . . . *Trechus* Clairville

7(6) Tempora pubescent; size small, BL less than 3.8 mm; pronotum with basal angles obtuse and rounded; elytra without (in *T. asetosa*) or with only a single discal seta near stria 3 . . . . . ***Trechepaphiopsis* gen. nov.**

7' Tempora glabrous; size larger, BL more than 4.0 mm; pronotum with basal angles sharp and rectangular; elytra with either two discal setae or none 8

8(7') Elytra with two discal setae near stria 3, elytral disc slightly flattened along the length of the median suture . . . . . ***Epaphiotrechus* gen. nov.**

8' Elytra without discal seta, elytral disc evenly convex . . . . . ***Trechepaphiama* gen. nov.**

Genus *Perileptus* Schaum, 1860

Perileptus Schaum, 1860:663.

Type species.— *Carabus areolatus* Creutzer, 1799.

Diagnosis.— Adults of this genus (Figs. 5a, 6a) can be recognized by the following combination of character states: size small to medium (BL = 2.0 to 3.5 mm), fully winged, dorsal surface covered with more or less long pubescence; eyes large, convex, pubescent; frons flat, frontal furrows wide and deep, attenuated posteriorly; terminal palpomeres slender, attenuated apically; mentum free, not fused with submentum; submentum with 10 or 12 setae; antennal scape distinctly pubescent; pronotum narrowed basally, with base broadly projected posteriorly, median longitudinal furrow deeply and sharply defined; elytra elongate and flattened, recurrent stria indistinct; legs short, protibiae without longitudinal furrows.

Geographical distribution.— *Perileptus* is a moderately diverse genus with about 50 described species arrayed in four subgenera (Lorenz 2005). It is represented in the Palearctic, Oriental, Afrotropical, Australian and Neotropical Regions. The study area is within the previously known range of this genus.

Key for Identification of Adults of *Perileptus* Species of the Gaoligong Shan Region

1. Body size larger (BL = 2.6 to 2.8 mm); body color reddish, apex of the elytra darker; pronotum distinctly convex, with sparse setiferous punctures, basal angles markedly projected laterally; elytra smooth, shiny, microsculture effaced, discal striae coarsely punctuate . . . . . *Perileptus imaicus* Jeannel

   Body size smaller (BL = 2.3 mm), body color pale yellowish brown, elytra concolorous; pronotum less convex, with dense setiferous punctures, basal angles less projected laterally; elytra dull, irregular isodiametric microsculpture evident, discal striae distinctly but finely punctuate . . . . . ***Perileptus pusilloides* sp. nov.**

Perileptus imaicus Jeannel, 1923

(Figs. 5, 35a, 45–48)

Perileptus imaicus Jeannel 1923. Lectotype, here designated, a male, in BMNH, labeled: "Lectotype" [red label];/ "W. Almora, Kumoan U.P., India H.G.C."/ P. imaicus Jeannel det."/ "H.E. Andrewes Coll., B.M.

1945-97."/ "Perileptus imaicus Jeannel, lectotype, Deuve & Kavanaugh des. 2016". Type locality: India, Uttar Pradesh, Kumoan, West Almora. Paralectotypes (a total of 8), labeled same as lectotype, in BMNH and MNHN.

Diagnosis.— Adults of this species (Fig. 5a) can be distinguished from those of all other species in the region by the following combination of character states: size small (BL = 2.6 to 2.8 mm), fully-winged; body color reddish with apical part of elytra darker; microsculpture of elytra effaced; dorsal pubescence sparse and long; pronotum slightly transverse (ratio PW/PL = 1.32), distinctly convex, with lateral margins markedly rounded in anterior half, straightened just anterior to basal angles, the latter acute and sharp and laterally projected, median basal area coarsely punctate; elytra shiny, moderately flattened, with striae coarsely punctate.

Comments.— *Perileptus denticollis* Jeannel (1923), known from the Dali region of Yunnan Province, is probably conspecific with *P. imaicus* because there appear to be no morphological features to distinguish members of these two nominal species. Members of *Perileptus davidsoni* Deuve (1989), described from the Kathmandu area in Nepal, also are externally similar in form and structure to those of *P. imaicus*, but the apex of the median lobe of the aedeagus of males of *P. davidsoni* is more broadly rounded (more narrowly rounded in *P. imaicus* males (Fig. 5b)).

Habitat distribution.— Members of this species have been found in daytime on sandy flats, in gravel and under stones along the open, unshaded banks of small to large streams running through agricultural areas and other disturbed areas at elevations ranging from 680 to 2030 m (Fig. 35a). Most specimens were driven from their hiding places by splashing the banks with water from the stream. At the collecting site in Longyang County (see below), members of this species were found syntopic with members of *Perileptus pusilloides* sp. nov.

Geographical distribution within the Gaoligong Shan.— Fig. 5c. We examined a total of 84 specimens (25 males and 59 females) from the following localities: ***Gongshan County:*** Bingzhongluo Township (Xiao Shangla He at Shuangla Village, N27.97514°/E98.65502°, 1550 m, 9 October 2002, Stop # DHK-2002-043, D.H. Kavanaugh, H.B. Liang, & W.D. Ba collectors [2 males and 30 females; CAS, IOZ, MNHN]). ***Longyang County:*** Bawan Township (Kunhong He at Bingmen, N25.09065°/E98.83721°, 680 m, 22 May 2005, Stop# 2005-019, D.H. Kavanaugh & H.B. Liang collectors [12 males and 14 females; in CAS, IOZ)], 1 June 2005, Stop# 2005-039, D.H. Kavanaugh & H.B. Liang collectors [11 males and 11 females; CAS, IOZ]). ***Tengchong County:*** Jietou Township (0.75 km N of Dahetou Ligganjiao on Longtang He, N25.74622°/E98.69612°, 2030 m, 18 May 2006, Stop # DHK-2006-029, D.H. Kavanaugh, R.L. Brett, & H.B. Liang collectors [3 females; in CAS, IOZ]; stream 0.7 km N of Jietou, N25.43128°/E98.64773°, 1564 m, 22 May 2006, Stop # DHK-2006-036A, D.H. Kavanaugh & R.L. Brett collectors [1 female; CAS]). These localities are at low to middle elevations in Core Areas 2, 6 and 7.

Overall geographical distribution.— Fig. 45. This species currently is known from the Himalayan region of India from Himachal Pradesh to Darjeeling and Sikkim. It has also been reported from Yunnan under the name *P. denticollis* Jeannel (1923) (see Uéno 1996b)

Perileptus pusilloides Deuve and Liang sp. nov.

(Figs. 6, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1039259"/ "CHINA, Yunnan, Tengchong County, Hehua Township, 5.4 km S of Hehua at Dengman village along Daying Jiang, N24.92346°/E98.38612°,"/ "1105 m, 2 June 2006, Stop # DHK-2006-053, D.H. Kavanaugh, R.L. Brett & D.Z. Dong collectors"/ "HOLOTYPE *Perileptus pusilloides* Deuve & Liang, sp. nov. designated 2016" [red label]. Paratypes (a total of 4): 2 males and 1 female (in CAS, IOZ, MNHN)

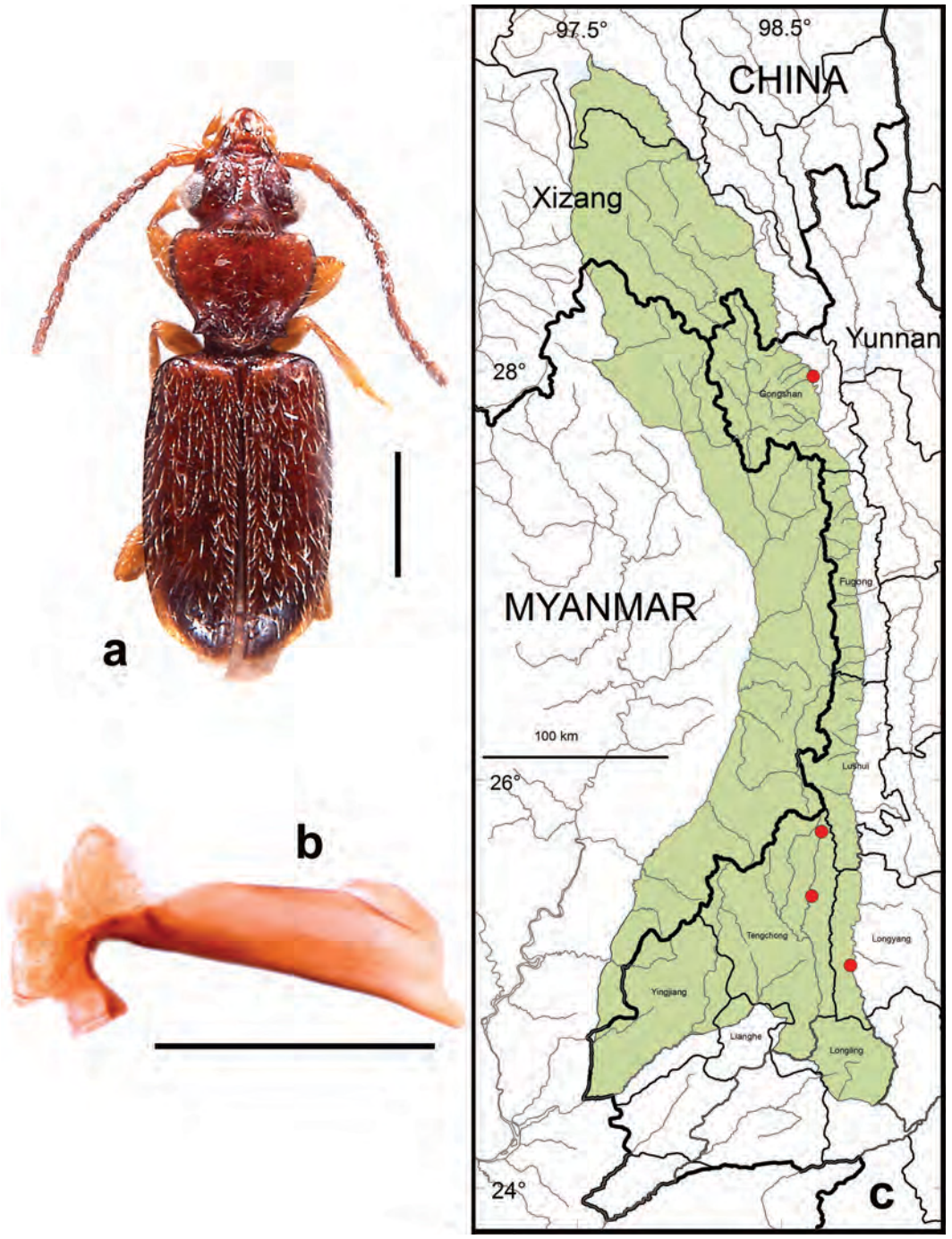


FIGURE 5. *Perileptus imaicus* Jeannel; a. Dorsal habitus (CASENT1036287). b. Median lobe of aedeagus of male (CASENT10363020), left lateral aspect. c. Map of locality records (red circles) for *P. imaicus* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

labeled same as holotype except first label "CASENT 1039257" and "CASENT 1039260" and "CASENT 1039258", respectively; 1 female (in IOZ) labeled: "CASENT 1036294"/ "CHINA, Yunnan, Longyang County, Bawan Township, Kunhong He at Bingmen, N25.09065°/ E98.83721°,"/ "680 m, 1 June 2005, Stop# 2005-039, D.H. Kavanaugh & H.B. Liang collectors". All paratypes also bear the following label: "PARATYPE *Perileptus pusilloides* Deuve & Liang, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Tengchong County, Hehua Township, 5.4 km S of Hehua at Dengman village along Daying Jiang, N24.92346°/E98.38612°, 1105 m.

Etymology.— The species epithet, *pusilloides*, is a combination of the species epithet, *pusillus,* and the Greek suffix, *–ειδής* (transliterated into Latin as *–oides*), meaning resembling, in reference to the similarity of members of this species to those of *T. pusillus* Jeannel (1923).

Diagnosis.— Adults of this species (Fig. 6a) can be distinguished from those of all other species in the region by the following combination of character states: size very small (BL = 2.3 mm), fully-winged; body color light yellowish brown, elytra concolorous throughout; microsculpture of elytra irregularly isodiametric and moderately impressed; dorsal pubescence dense and rather short; pronotum slightly transverse (ratio PW/PL = 1.32) only slightly convex, with lateral margins moderately rounded in anterior half, straightened just anterior to basal angles, the latter acute and sharp but small, median basal area rugulose; elytra alutaceous, distinctly flattened, striae finely punctate.

Description.— Size very small, BL = 2.3 mm. Color of dorsum pale yellowish brown, head and pronotum slightly pale reddish in some specimens, appendages pale yellow, antennomeres 3 to 11 slightly darker yellowish brown; dorsal surface covered with dense but short pubescence.

Head. Relatively large, with eyes large and convex. Tempora very short. Frons flattened, nearly smooth, shiny but finely punctate; frontal furrows arcuate and deeply impressed to posterior margin of tempora; two pairs of supraorbital setae present and distinctly longer than setae of pubescence. Labrum broad with apical margin distinctly emarginate or concave. Mandibles small, slender. Mentum deeply concave, with median tooth broad and truncate. Submentum with a transverse row of ten setae anteriorly. Gula broad. Antennae of moderate length, antennomeres 2 and 3 of equal length.

Pronotum. Slightly transverse (ratio PW/PL = 1.32) and flattened, widest at anterior one-fourth, with lateral margins markedly rounded anteriorly, less so posteriorly, briefly and deeply sinuate just anterior to basal angles, the latter acute and sharp but small; basal margin projected posteriorly as a short, truncate lobe medial to lateral sinuations. Disc moderately punctate, flattened medially and slightly convex laterally; median basal area rugulose, only faintly defined anteriorly; median longitudinal impression distinct throughout, narrow anteriorly, widened toward base. Lateral margination slender throughout, slightly reflexed dorsally. One lateral seta (at anterior one-fifth) and one basolateral seta (on basal angle) present on each side.

Elytra. Alutaceous, moderately elongate, with humeri very distinct, rectangular but broadly rounded; elytral disc flattened, only moderately convex laterally; lateral margination slender and slightly reflexed dorsally; basal margin terminated medially at the origin of stria 5; striae 1 to 4 or 5 dinstinctly impressed and moderately punctate, striae 5 or 6 to 8 effaced. Recurrent stria absent. Umbilicate setal series with setae of humeral group equidistance from each other, those of the median group inserted posterior to middle.

Legs. Short. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Venter. Ventral surface of head and thoracic pleurae, prosternum, metasternum, metepisterna and abdominal ventrites punctate. Pubescence denser on abdominal ventrites than on thoracic venter.

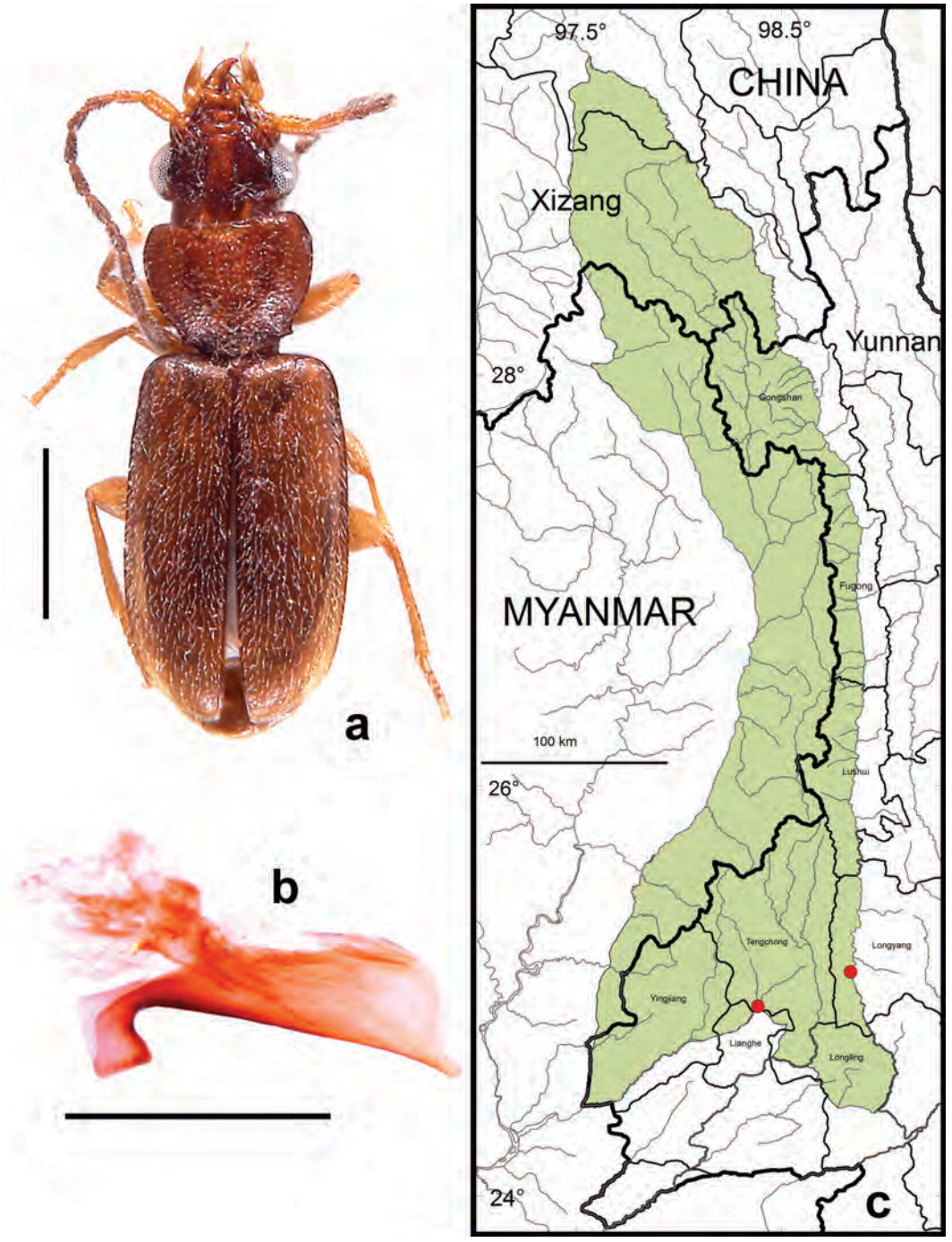


FIGURE 6. *Perileptus pusilloides* sp. nov.; a. Dorsal habitus (CASENT1039260). b. Median lobe of aedeagus of male (CASENT1039259), left lateral aspect. c. Map of locality records (red circles) for *P. pusilloides* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

Male aedeagus. Median lobe (Fig. 6b) with apex narrowly lobate, apically rounded.

Comments.— Based on features of form and structure, this species appears to be closely related to *P. pusillus*, described from northern Vietnam. Its members can be distinguished from those of the latter in having their elytra wider, less shiny, more alutaceous, and with more finely punctate striae, and the pronotum relatively larger, with a less smooth surface, and with the greatest pronotal width more anterior. The type series of *P. pusillus* originally consisted of ten syntypes, seven of which are in the Jeannel Collection in MNHN, each with a "Type" label. Among these, six specimens match Jeannel's description of *P. pusillus* very closely. The seventh specimen, a male, instead may be a member of our new species, *P. pusilloides*. Consequently, in order to properly establish the identity to *P. pusillus*, we here designate a lectotype as follows: a male, in MNHN, labeled: "Hoa Binh, Tonkin"/ "*Perileptus pusillus* Jeannel, lectotype, design. 2016, ex coll. R. Jeannel, in coll. MNHN, Paris". The remaining six MNHN syntypes are all paralectotypes of *P. pusillus*, including the lone possible male of *P. pusilloides*, which we are not including in the type series of the latter species.

Habitat distribution.— Members of this species have been found in daytime on sandy flats, in gravel and under stones along the open, unshaded banks of small to large streams running through agricultural areas with subtropical crops at elevations ranging from 680 to 1105 m. Most specimens were driven from their hiding places by splashing the banks with water from the stream. At the collecting site in Longyang County (see below), members of this species were found syntopic with members of *Perileptus imaicus*.

Geographical distribution within the Gaoligong Shan.— Fig. 6c. We examined a total of 5 specimens (3 males and 2 females) from low elevations on both western and eastern slopes of the southern part of the Gaoligong Shan in Tengchong and Longyang Counties, (see Type material above for exact collection data), which are in Core Areas 6 and 7, respectively.

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

Genus *Agonotrechus* Jeannel, 1923

Agonotrechus Jeannel, 1923:428.
Paragonotrechus Uéno, 1981:2.
Bhutanotrechus Uéno, 1977:188.

Type species.— *Trechus birmanicus* Bates, 1892.

Diagnosis.— Adults of this genus (Figs. 7a–9a) can be recognized by the following combination of character states: size medium to large for a trechine (BL = 4.5 to 7.0 mm) members of most species with full hindwings and large, convex eyes, but those of a few species apterous and with eyes reduced in size and/or convexity, some even microphthalmous or nearly anophthalmous; frons flattened, depressed; dorsolateral margin of mandibular scope with a row of small setae aligned as a sparse comb in some members (Belousov & Kabak 2003); right mandible (Fig. 16a) bidentate, the premolar tooth fused with the retinaculum, from which the anterior tooth is distinctly projected and in a forward position and the posterior tooth is absent or flush; left mandible with only a short, subconical, more or less trifid ridge; clypeus with six setae in most members; labium with anterior margin not or only slightly concave; mentum fused with submentum, incompletely in some members; submentum with six setae in most members, but some with eight setae; pronotum little narrowed basally, with lateral explanation distinctly broadened basally in many members; elytra with discal striae varied, from complete to effaced, punctate in many members, parascutellar striole very long in many members; anterior discal seta present in all members and inserted at the

basal one-fifth or one-sixth of elytra, middle discal seta present or absent, preapical seta present at or near stria 2 in most members, absent from a very few members; legs slender, protibiae furrowed, the basal two protarsomeres dilated and toothed; abdominal ventrites glabrous except for usual paramedial setae; aedeagus with a spoon-shaped copulatory piece.

Taxonomic notes.— Members of the first known *Agonotrechus* species had only the anterior discal seta of the elytron inserted at the basal one-fifth or one-sixth. Consequently, this feature was used by Jeannel (1923) to define his new genus. Members of *Paragonotrechus* Uéno (1981) are very similar and differ only in having a more slender body form and the parascutellar striole very long. Those of *Bhutanotrechus* Uéno (1977), described from Bhutan, were distinguished by having the elytral discal striae effaced and a second elytral discal seta (the middle seta) present. The presence of the middle seta is a plesiotypic feature in Trechini, but species with members having two discal setae sometimes have been grouped together or assigned to genus *Bhutanotrechus* (Deuve 1992b, 1995). Genus *Agonotrechus* is really a homogenous group, despite the differences among its members in impression of the elytral discal striae, length of the parascutellar stiole, number of elytral discal setae and size of the eyes, differences in the last feature being associated with differential flight capability. There appears to be no reason to maintain *Paragonotrechus* and *Bhutanotrechus* as distinct genera.

The bidentate dentition of the right mandible of *Agonotrechus*, with the premolar tooth completely fused with retinaculum, distinguishes this group from members of the *Stevensius* Complex, with which Jeannel (1923, 1928) had grouped it.

Geographical distribution.— This genus, which at present includes 16 species, is known from the southeastern part of the Palearctic Region and northern edge of the Oriental Region, from Nepal eastward to southern Gansu Province in the north and Myanmar, Vietnam, and Hubei and Shaanxi Provinces; and one species has been described from Japan. The study area is within the previously known range of this genus.

Key for Identification of Adults of *Agonotrechus* Species of the Gaoligong Shan Region

1. Eyes less projected, less convex and only about twice as long as the tempora; pronotum only slightly transverse, lateral explanation narrow anteriorly; lateral elytral discal striae deep and markedly punctate, elytral intervals convex . . . . . ***A. xiaoheishan* sp. nov.**
   Eyes large and projected, more convex and more than twice as long as the tempora 2
2. Size smaller, BL less than 5.5 mm. Pronotum smaller, lateral explanation narrow anteriorly; lateral elytral discal striae deep and elytral intervals only slightly convex. *A. yunnanus* Uéno
   Size larger, BL = 5.8 to 6.5 mm. Pronotum larger, lateral explanation wider anteriorly; lateral elytral discal striae more faintly impressed and elytral intervals nearly flat. 3
3. Elytral silhouette subovoid, rather short; pronotum narrower, with lateral explanation narrow, slightly widened basally; elytral recurrent stria abruptly terminated, not connected to apex of discal stria 5. . . . . ***A. fugongensis* sp. nov**.
   Elytral silhouette more subquadrate; pronotum markedly transverse, with lateral explanation wide anteriorly, also widened and slightly explanate basally; elytral recurrent stria continuous anteriorly with discal striae 5 . . . . . *A. wuyipeng* Deuve

Agonotrechus fugongensis Deuve and Liang, sp. nov.

(Figs. 7, 35b, 36a, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1019979"/ "CHINA, Yun-

nan, Fugong County, Lishadi Township, 0 to 2 km E of Shibali on Shibali Road, N27.16536°/ E098.78003° to N27.16100°/"/ "E098.79370°, 2300-2530 m, 18 August 2005, Stop# DHK-2005-096, D. Z. Dong collector"/ "HOLOTYPE *Agonotrechus fugongensis* Deuve & Liang, sp. nov. designated 2016" [red label]. Paratypes (only 1): a female (in CAS) labeled: "CASENT 1006974"/ "CHINA, Yunnan, Gaoligong Shan, Nujiang Prefecture, Nujiang State Nature Reserve, Qigi He, 9.9 airkm W of Gongshan,"/ "N27.71542°/ E98.56529°, 2000m, 9-14 July 2000, Stop#00-22A, D.H. Kavanaugh, C.E. Griswold, Liang H.-B., D. Ubick, & Dong D.-Z. collectors"/ "IMAGE" [pale green label]/ "PARATYPE *Agonotrechus fugongensis* Deuve & Liang, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Fugong County, Shiyueliang Township, 0 to 2 km W of Shibali on Shibali Road, 2300-2530 m.

Derivation of species name.— The species epithet, *fugongensis*, is derived from the name of the county (Xian) in which the holotype was collected, Fugong, and the Latin suffix, *-ensis*, denoting place.

Diagnosis.— Adults of this species (Fig. 7a) can be distinguished from those of all other species in the region by the following combination of character states: size large (BL = 5.8 to 6.0 mm), fully-winged, dorsum dark piceous to reddish brown, shiny, pronotum and elytra slightly iridescent; eyes convex, moderately projected; clypeus with four setae; mentum and submentum fused, submentum with six setae; pronotum small but transverse, ratio PW/PL = 1.30, median basal area smooth, framed by two deep, oblique furrows, lateral explanation rather narrow, broadened only posteriorly, lateral margins with a short sinuation anterior to the sharp, rectangular or slightly acute basal angles; elytra with all discal striae evident and finely punctate, striae 1 to 4 moderately impressed, striae 5 to 8 more faintly impressed, parascutellar striole rather long, recurrent stria deeply impressed but abruptly terminated anteriorly, not connected with stria 5, intervals slightly convex, two discal seta (anterior and middle setae) present in stria 3, the anterior seta inserted within basal one-sixth of elytra, the middle seta inserted near elytral middle, preapical seta also present; median lobe of aedeagus of male (Fig. 7b) long and slender, endophallus with copulatory piece spoon-shaped.

Description.— Size large, BL = 5.8 to 6.0 mm. Color of dorsum piceous to reddish brown, shiny, pronotum and elytra slightly iridescent, appendages paler, palpi yellowish tan.

Head. Moderate in size, slightly elongate, eyes large, convex, moderately projected, their diameter more than two times length of tempora. Tempora short, only slightly convex and glabrous, joined to neck region at ca. 135° angle. Frons more or less flattened, with two pairs of supraorbital setae, frontal furrows distinct, impressed posterior to or beyond posterior supraorbital setae. Clypeus with four setae. Labrum with six setae, apical margin slightly concave. Mandibles slender; right mandible bidentate, the anterior tooth far forward and long, the basal tooth reduced, obtuse and blunt; left mandible with a very slender trifid process, formed from fusion of the retinaculum with premolar tooth. Palpi with apical palpomeres fusiform. Mentum and submentum fused. Mentum bifossulate, divided into three sectors, a median and two lateral parts, separated by two deep, longitudinal furrows; medial tooth simple, subtriangular with blunt apex, half as long as lateral lobes. Submentum with six setae subapically, gula broad. Genae with a single ventral seta on each side. Antennae of moderate length, with only four antennomeres extended beyond the pronotal base; antennonmeres 3 and 4 virtually the same length and each longer than antennomere 2.

Pronotum. Rather small, moderately narrow posteriorly, ratio PW/PL = 1.30, widest slightly anterior to middle, lateral margins with short sinuation just anterior to sharp, rectangular or slightly acute basal angles; pronotal disc convex, median longitudinal impression very fine and shallow,

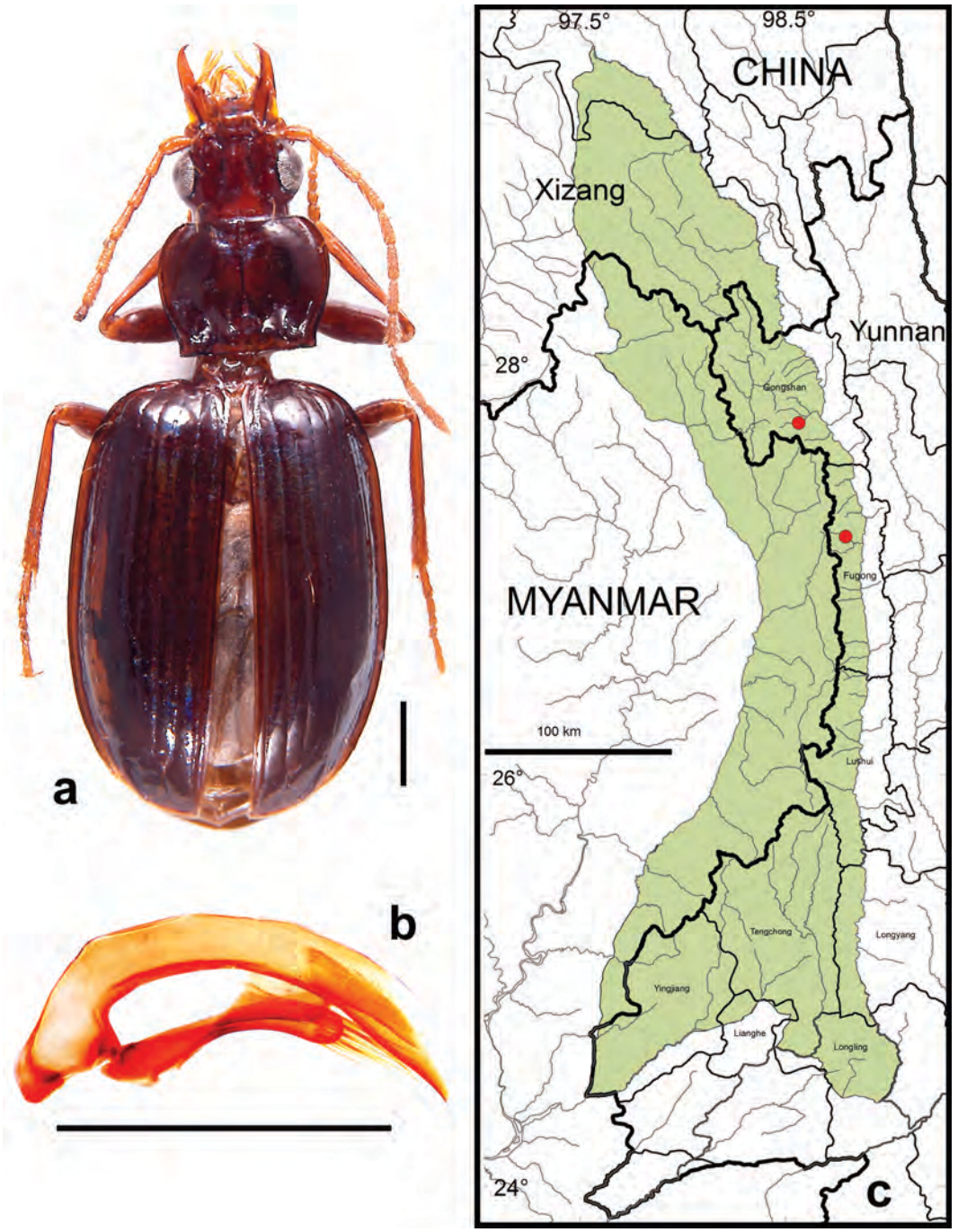


FIGURE 7. *Agonotrechus fugongensis* sp. nov.; a. Dorsal habitus (CASENT1019979). b. Median lobe of aedeagus of male (CASENT1019979), left lateral aspect. c. Map of locality records (red circles) for *A. fugongensis* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

extended posteriorly to near basal margin, but not as close anteriorly to apical margin; basal foveae small vaguely delimited; median basal area smooth, delimited laterally by short but deep and oblique furrows; basal margin nearly straight, slightly sinuate. Lateral explanation moderately narrow and slightly reflexed, widened posteriorly but not flattened. Midlateral pair of setae inserted anterior to middle and basolateral pair inserted at hind angles.

Elytra. Moderately wide, elytral silhouette subovoid, humeri distinct but rounded, disc convex. All discal striae evident and finely punctate, striae 1 to 4 moderately impressed, striae 5 to 8 more faintly impressed, partially effaced, parascutellar striole rather long, recurrent stria deeply impressed but abruptly terminated anteriorly, not connected with discal stria 5, intervals slightly convex. Parascutellar setiferous pore present at base at common origin of discal striae 1 and 2. Two discal seta (anterior and middle setae) present in stria 3, the anterior seta inserted within basal one-sixth of elytra, the middle seta inserted near elytral middle. Preapical seta also present, inserted on interval 2 near stria 2, closer to sutural elytral margin than to apex. Umbilicate setal series with setae of humeral group equidistant for each other and those of median group both inserted posterior to middle of elytra.

Legs. Slender, moderately long. Protibiae furrowed, without anteroapical pubescence. Male protarsi with tarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Ventrites each with a pair of paramedial setae, ventrite VII of males with a single pair of paramedial apical setae, of females with two pairs.

Male aedeagus. Median lobe (Fig. 7b) long and slender, endophallus with a spoon-shaped sclerite.

Comments.— Males of this species are most similar to those of *A. wuyipeng* in features of the aedeagus; but they are smaller, their pronota distinctly narrower, more slender, and with much narrower lateral margination, and the recurrent stria does not connect anteriorly with stria 5 as it does in *A. wuyipeng* members.

Habitat distribution.— The holotype specimen of this species was found under a stone on moist substrate along a roadcut through an agricultural area formed in a large clearcut in what had been mixed broadleaf evergreen and conifer forest at an elevation somewhere between 2300 and 2530 m (Fig. 36a). The paratype specimen was collected under stones on the shaded bank of the Qiqi River just above the Forestry station at Qiqi at an elevation of 2000 m (Fig. 35b). Members of no other *Agonotrechus* or other trechine species have been found syntopic with those of *A. fugongensis*.

Geographical distribution within the Gaoligong Shan.— Fig. 7c. We examined a total of 2 specimens (1 male and 1 female) from Fugong and Gongshan Counties, respectively (see Type material above for exact collection data).

Specimens of this species were collected only in the northern half of the study area (Core Areas 2 and 3) and only on the eastern side of the mountain range. This distribution pattern may be an artifact of inadequate sampling on the western slope of the mountain range in the north, much of which is in Myanmar. The geographical range of this species overlaps that of *A. wuyipeng*, but members of the latter species appear to occupy slightly higher elevations in the same general areas.

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

Agonotrechus wuyipeng Deuve, 1992

(Figs. 8, 36b, 45–48)

Agonotrechus wuyipeng Deuve, 1992b:172. Holotype, a male, in IOZ. Type locality: China, Sichuan, Wolong, Wuyipeng, 2500 m.

DIAGNOSIS.— Adults of this species (Fig. 8a) can be distinguished from those of all other species in the region by the following combination of character states: size large (BL = 6.5 to 6.7 mm), fully-winged, dorsum piceous to reddish brown and distinctly iridescent; head slender, eyes markedly projected; clypeus with four or six setae; mentum and submentum incompletely fused, submentum with six or eight setae; mandibles with four to six small setae along the dorsolateral margin of the scrobe; pronotum transverse (ratio PW/PL = 1.30), with lateral explanation broader, especially basally, basal angles rectangular and sharp with a small apical tooth projected laterally; elytra broad, with all discal striae evident and finely punctate, striae 1 to 5 moderately impressed, striae 6 to 8 more faintly impressed, parascutellar striole rather long, recurrent stria continuous anteriorly with stria 5, intervals only faintly convex, two discal setae (anterior and middle setae) present, the anterior seta inserted within basal one-sixth of elytra in stria 3, the middle seta near elytral middle in stria 3; median lobe of aedeagus of male (Fig. 8b) long and slender, with apex short, recurved dorsally and bluntly pointed, endophallus with a spoon-shaped sclerite.

COMMENTS.— The polymorphism we observed in the number of setae on both the clypeus (four or six) and submentum (six or eight) among specimens from the Gaoligong Shan populations was surprising. Belousov & Kabak (2003) described *Agonotrechus dubius*, based on a single female from Gansu Province, and noted similarities with *A. wuyipeng*. We have examined a male specimen from Shaanxi Province (Ningshan County, Huoditang Township, 1549 m, collected by Matt Brantley on 9 July 2005) which shares features described for the holotype of *A. dubius*, including six setae on the submentum, which Belousov & Kabak (2003) contrasted with the eight setae reported for *A. wuyipeng* members (Deuve 1992b). Together with other similarities, the polymorphism in this feature found among Gaoligong Shan specimens suggests that these two species may be better treated as conspecific, with *A. dubius* as a distinct subspecies, members of which have smaller size, relatively wider pronota, and more coarsely punctate elytral discal striae but are otherwise similar to members of the nominate form.

HABITAT DISTRIBUTION.— Specimens of this species were collected in daytime from under stones in shaded roadside and trailside areas with scattered grasses at elevations ranging from 2687 to 2770 m (Fig. 36b). Members of no other *Agonotrechus* or other trechine species have been found syntopic with those of *A. wuyipeng*.

GEOGRAPHICAL DISTRIBUTION WITHIN THE GAOLIGONG SHAN.— Fig. 8c. We examined a total of 10 specimens (7 males and 3 females) from the following localities: ***Fugong County:*** Shiyueliang Township (1 km above Shibali on Yaping Road, 2687 m, 1 May 2004, H.B. Liang collector [1 female; MNHN]. ***Gongshan County:*** Qiqi Trail at No 12 Bridge, N27.71500°/ E98.50222°, 2770 m, 2 May 2002, H.B. Liang & W.D. Ba collectors [7 males and 2 females; CAS, IOZ, MNHN].

Specimens of this species were collected only in the northern half of the study area (Core Areas 2 and 3) and only on the eastern side of the mountain range. This distribution pattern may be an artifact of inadequate sampling on the western slope of the mountain range in the north, much of which is in Myanmar. The geographical range of this species overlaps that of *A. fugongensis*, but members of the latter species appear to occupy slightly lower elevations in the same general areas.

OVERALL GEOGRAPHICAL DISTRIBUTION.— Fig. 45. This species currently is known only from the type locality in northcentral Sichuan and the northern half of the Gaoligong Shan in western Yunnan, but it probably occurs in the intervening region as well.

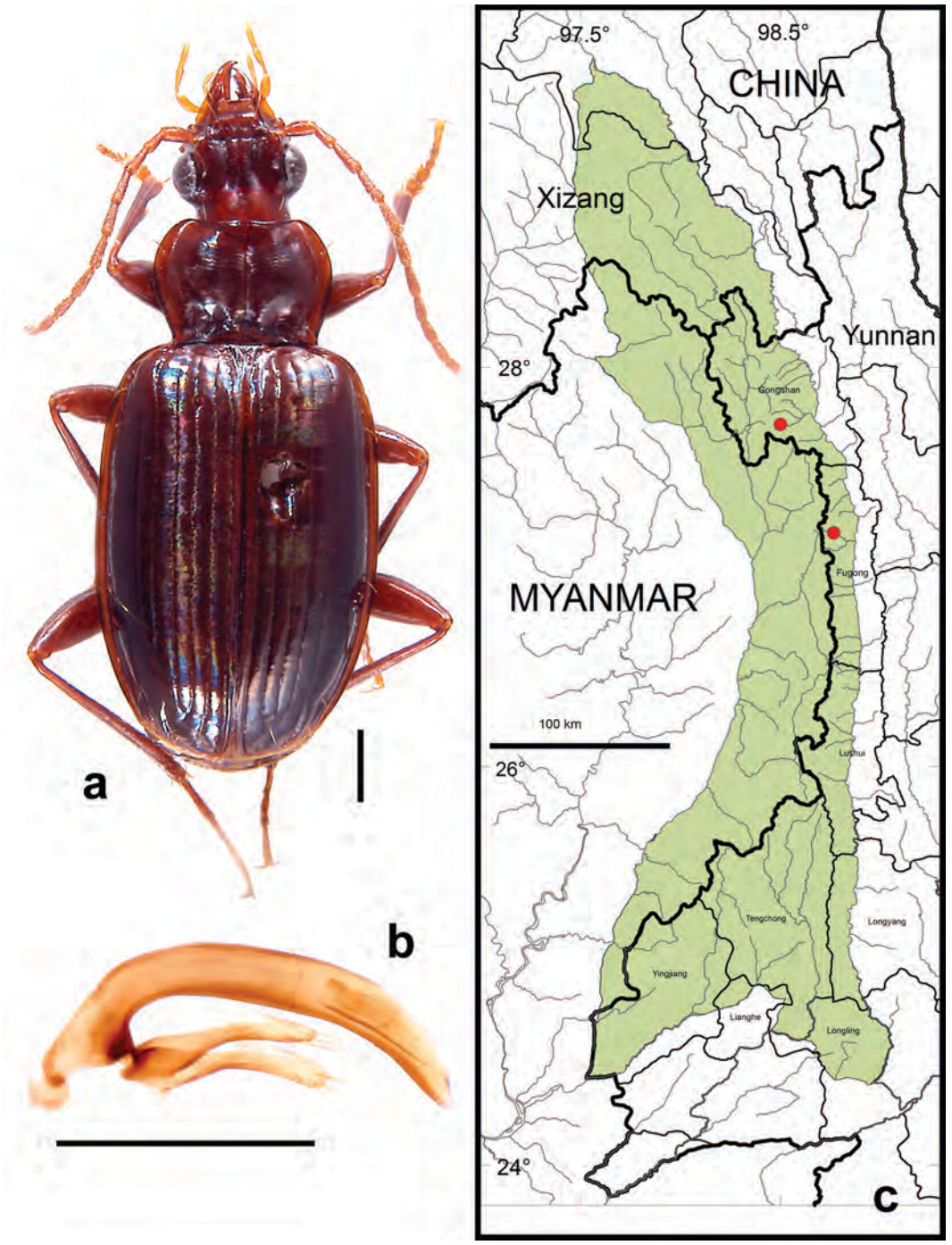


FIGURE 8. *Agonotrechus wuyipeng* Deuve; a. Dorsal habitus (CASENT1010854). b. Median lobe of aedeagus of male (CASENT1010854), left lateral aspect. c. Map of locality records (red circles) for *A. wuyipeng* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

Agonotrechus xiaoheishan **Deuve and Kavanaugh, sp. nov.**
(Figs. 9, 16a, 44, 46–48)

TYPE MATERIAL.— Holotype, a male, in IOZ, labeled: "CASENT 1036866"/ "CHINA, Yunnan, Longling County, Longjiang Township, Xiaoheishan Forest Reserve, N24.83671°/ E098.76185°,"/ "2067 m, 28 May 2005, Stop# HBL-05-19, H.B. Liang, H.M. Yan & K.J. Gao collectors"/ "HOLOTYPE *Agonotrechus xiaoheishan* Deuve & Kavanaugh, sp. nov. designated 2016" [red label]. Paratypes (a total of 13): 2 males and 7 females (in CAS, IOZ, MNHN) labeled same as holotype except first label "CASENT 1036874", "CASENT 1036875", "CASENT 1036867", "CASENT 1036868", "CASENT 1036869", "CASENT 1036870", "CASENT 1036871", "CASENT 1036872" and "CASENT 1036873", respectively; 1 male and 1 female (in CAS) labeled "CASENT 1036863" and "CASENT 1036864", respectively/ "CHINA, Yunnan, Longling County, Longjiang Township, Xiaoheishan Forest Reserve, Guchengshan, 2020 m, N24.82888°/ E098.76001°,"/ "28 May 2005, Stop# 2005-033B, D.H. Kavanaugh, H.B. Liang, D.Z. Dong & J.L. Yang collectors"; 2 females (in CAS) labeled "CASENT 1031915" and "CASENT 1031916", respectively/ "CHINA, Yunnan, Longling County, Longjiang Township, Xiaoheishan Forest Reserve, Guchengshan, 2020 m, N24.82888°/ E098.76001°,"/ "28 May 2005, Stop# 2005-033C, D.H. Kavanaugh, C.E. Griswold, H.B. Liang, D.Z. Dong, H.M. Yan & K.J. Guo collectors". All paratypes also bear the following label: "PARATYPE *Agonotrechus xiaoheishan* Deuve & Kavanaugh, sp. nov. designated 2016" [yellow label].

TYPE LOCALITY.— China, Yunnan, Longling County, Longjiang Township, Xiaoheishan Forest Reserve, N24.83671°/E098.76185°, 2067 m.

DERIVATION OF SPECIES NAME.— The species epithet, *xiaoheishan*, is a noun in apposition, derived from the name of the area in which the holotype was collected.

DIAGNOSIS.— Adults of this species (Fig. 9a) can be distinguished from those of all other species in the region by the following combination of character states: size medium (BL = 5.3 to 5.7 mm), fully-winged, dorsum piceous to reddish brown and distinctly iridescent; head slender, eyes only moderately projected; clypeus with four setae; mentum and submentum fused, submentum with six setae; mandibles with two or three small setae along the dorsolateral margin of the scrobe; pronotum small and narrow (ratio PW/PL = 1.21), basal angles subrectangular, basal flattened area restricted; midlateral seta inserted at anterior one-fourth, basolateral seta at hind angle; elytra with all discal striae evident, deeply impressed and punctate, however striae 1 to 4 effaced or nearly so near base, parascutellar striole rather long, recurrent stria continuous anteriorly with stria 5, intervals convex, only a single discal seta (anterior seta) present, inserted at basal one-eighth of elytra in stria 3; median lobe of aedeagus of male (Fig. 9b) short, with apex bent ventrally and bluntly pointed, endophallus with a spoon-shaped sclerite.

DESCRIPTION.— Size medium, BL = 5.3 to 5.7 mm. Color of dorsum piceous, shiny, iridescent, femora concolorous, tibiae, tarsi, antennae and mandibles paler reddish tan, palpi yellowish tan.

Head. Relatively slender, eyes only moderately projected, but nonetheless convex and with diameter twice length of tempora. Tempora not or only slightly convex, joined to neck region at ca. 120° angle. Frons slightly flattened, with two pairs of supraorbital setae, frontal furrows linear, distinct between the eyes, but effaced posterior to insertion of second supraorbital seta. Clypeus with four setae. Labrum slightly widened apically, apical margin slightly concave. Mandibles sharp, the right mandible (Fig. 16a) bidentate with the anterior tooth spaced well forward of the posterior tooth and the left mandible with only a small subtriangular process, also with two or three small setae along the dorsolateral margin of the scrobe. Mentum and submentum fused. Mentum with medial tooth rather broad, with the apex either obtuse or truncate, less than one-half as long as lat-

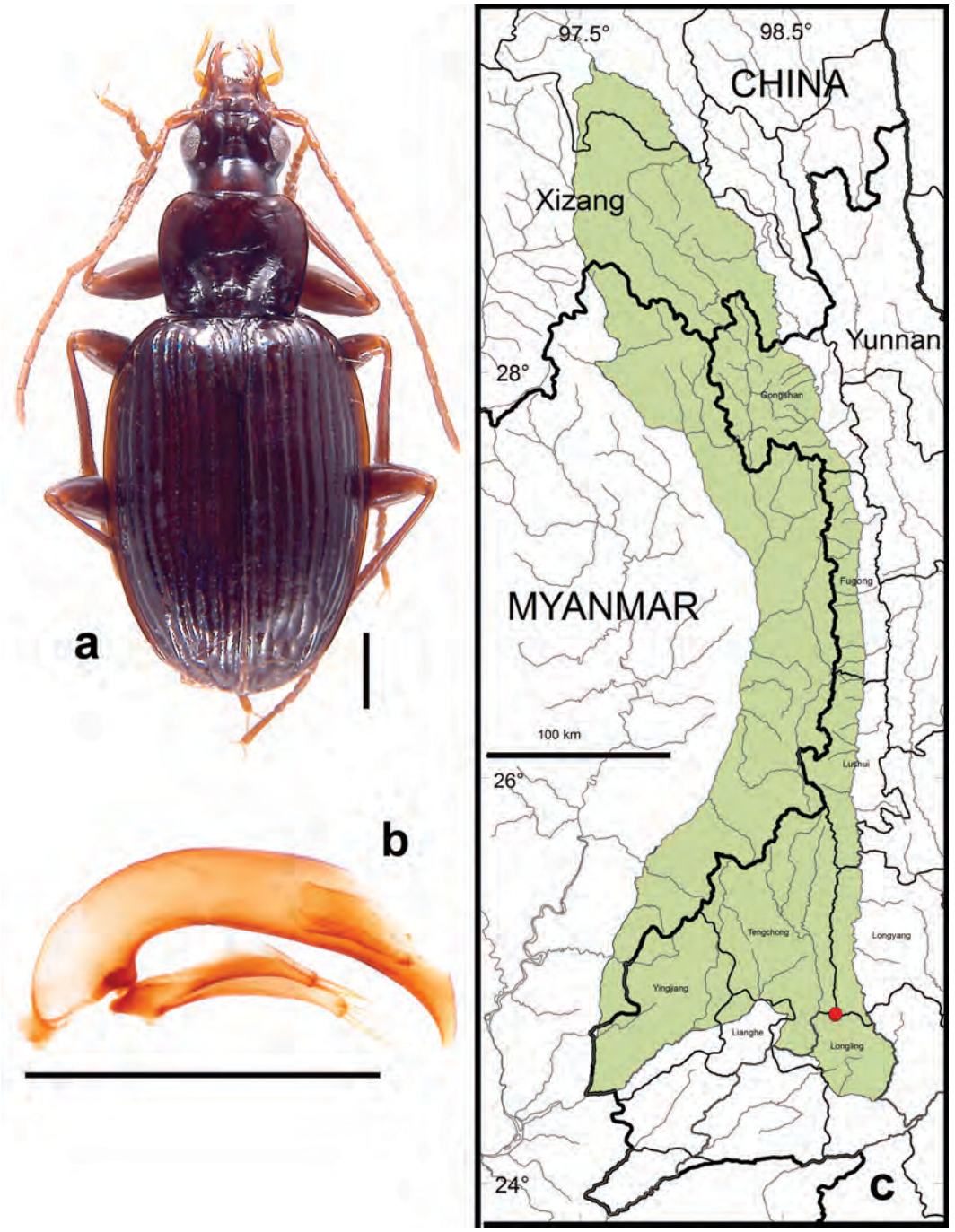


FIGURE 9. *Agonotrechus xiaoheishan* sp. nov.; a. Dorsal habitus (CASENT1036866). b. Median lobe of aedeagus of male (CASENT1036866), left lateral aspect. c. Map of locality records (red circles) for *A. xiaoheishan* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

eral lobes. Submentum with six setae subapically, gula broad. Genae with a single seta ventrally on each side. Antennae long and slender, extended to (in females) or slightly beyond (in males) the middle of the elytra, with five or six antennomeres beyond the pronotal base; antennonmeres 3 and 4 virtually the same length and antennomere 2 slightly shorter.

Pronotum. Relatively small, not or only slightly narrowed basally, only slightly transverse, ratio PW/PL = 1.21, widest at anterior one-third; lateral margins rectilinear in basal half, not sinuate except for a very slight and short inflexion just anterior to the basal angle, which is subrectangular and sharp; pronotal disc smooth, glabrous, moderately convex; median longitudinal impression very fine; basal foveae deep, basal flattened area rather small, delimited laterally by short but deep and oblique furrows. Lateral explanation slender and moderately reflexed in anterior two-thirds, then progressively broader in basal one-third without. Midlateral pair of setae inserted at anterior one-fifth and basolateral pair inserted at hind angles.

Elytra. Convex, large and broad, especially in relation to pronotum, elytral silhouette ovoid, about equally narrowed apically and basally, humeri evident but rounded. All discal striae evident, regular, deeply impressed and punctate, however striae 1 to 4 effaced or nearly so near base, parascutellar striole rather long, recurrent stria continuous anteriorly with discal stria 5, intervals convex, only a single discal seta (anterior seta) present, inserted at basal one-eighth near stria 3. Parascutellar setiferous pore present at base at common origin of discal striae 1 and 2. Anterior discal seta present, inserted at basal one-eighth of elytra in stria 3, which is effaced anterior to that point. Middle discal seta absent. Preapical seta present on interval 3 near stria 2 opposite the anterior edge of the subapical sinuation. Umbilicate setal series with setae of humeral group equidistant for each other and those of median group both inserted posterior to middle of elytra.

Legs. Slender but only moderately long. Protibiae furrowed. Male protarsi with tarsomeres 1 and 2 dilated and apicomedially toothed.

Male aedeagus. Median lobe (Fig. 9b) short, with apex bent ventrally and bluntly pointed, endophallus with a spoon-shaped sclerite.

Comments.— Members of this new species are morphologically similar to those of *Agonotrechus birmanicus* Bates (1892), described from Kachin State in Myanmar, and *Agonotrechus tenuicollis* Uéno (1986), described from eastern Nepal. However, they can be distinguished from members of both of these other species by the following features: pronotum with anterior margin straight, not concave, anterior angles only faintly projected and more broadly rounded, and lateral borders more slender anteriorly and at middle; and apex of the median lobe of the male aedeagus narrower and more curved.

Habitat distribution.— Members of this species have been found in and under rotting logs in dark, closed-canopy broadleaf evergreen forest (Fig. 44) at elevations ranging from 2020 to 2067 m. Although members of no other *Agonotrechus* species have been found syntopic with those of *A. xiaoheishan*, specimens of *Trechus indicus* were collected in the same samples.

Geographical distribution within the Gaoligong Shan.— Fig. 9c. We examined a total of 14 specimens (4 males and 10 females), all from Xiaoheishan Forest Reserve in the southern part of the Gaoligong Shan (see Type material above for exact collection data).

This species was recorded only from near the top of the western slope in the southern part of the study area (Core Area 6). Its known geographical range does not overlap with that of any other *Agonotrechus* species, although *A. yunnanus* has been recorded from the adjacent Core Area 7 on the eastern slope of the Gaoligong Shan, 13.3 km to the north.

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

Agonotrechus yunnanus Uéno, 1999

(Figs. 10, 46–48)

Agonotrechus yunnanus Uéno, 1999a:215. Holotype, a male, in NSMT. Type locality: China, Yunnan, Gaoligong Shan, Longyang County, 24.95°/ 98.75°, 2200-2500 m.

Notes on type material.— We have not had an opportunity to study the unique holotype of this species, so features noted below are taken from Uéno's orginal description.

Diagnosis.— Adults of this species (see Uéno 1999a, Fig. 1) can be distinguished from those of all other species in the region by the following combination of character states: size slightly small for the genus (BL = 5.4 mm); eyes large and projected; tempora short; pronotum rather small and only slightly transverse (ratio PW/PL = 1.28), lateral explanation slender anteriorly, slightly widened basally, basal angles subrectangular and sharp; elytra with intervals only slightly convex, discal striae deeply impressed and punctate, two discal setae (anterior and middle) present near stria 3; median lobe of aedeagus of male (see Uéno 1999a, Figs. 2–3) with apex short and broadly rounded.

Habitat distribution.— Although no precise habitat information accompanied the unique holotype specimen, Uéno (1999a:219) suggested it was probably collected near the pass across the crest of the Gaoligong Shan on the route from "Bawan to Shang'ying, which lies near the lower edge of the *Rhododendron* zone." According to Uéno (1999a), specimens of *Trechus indicus* Putzeys (which he recorded as *Trechus macrops* Jeannel) and *Epaphiotrechus fortipes* (Uéno) comb. nov. were also collected in the same area.

Geographical distribution within the Gaoligong Shan.— Fig. 10. ***Longyang County:*** N24.95°/E98.75°, 2200-2500 m, 8-16 May, O. Semala collector [1 male; NSMT]. No specimens of this species were collected during this study.

The type locality for this species is on the eastern slope of the southern part of the

FIGURE 10. *Agonotrechus yunnanus* Uéno; Map of locality record (red circle) in the Gaoligong Shan region. Scale line = 100 km.

Gaoligong Shan in the northern part of Core Area 7. This area is not within the geographical range of any other *Agonotrechus* species, although *A. xiaoheishan* has been recorded from the adjacent Core Area 6 on the western slope of the Gaoligong Shan, 13.3 km to the south.

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

Genus *Minutotrechus* Deuve and Kavanaugh, gen. nov.

Type species.— *Stevensius minutus* Uéno, 1997.

Derivation of genus group name.— The genus group name (masculine) is a combination of the Latin adjective, *minutus*, meaning very small, and the generic name, *Trechus*, in reference to the small size of members of this genus.

Diagnosis.— Adults of this genus (Fig. 11a) can be recognized by the following combination of character states: size small (BL = 2.7 to 2.9 mm), apterous, body color brown to black; head large with small but protruding eyes, their diameter shorter than length of tempora; mandibles short, obtusely bidentate, mentum and submentum at least partial fused, labial suture partially perceptible, mentum with medial tooth truncate; pronotum small, cordate, narrow (ratio PW/PL = 1.25), very convex, globulose, glabrous, basal angles small and subrectangular, slightly obtuse, with basal margin broadly lobate, basal area convex, both midlateral and basolateral setae present; elytra ovoid and markedly convex, with discal striae 2 to 8 striae effaced, stria 1 deeply impressed and punctate, both anterior and middle discal setae present, preapical seta absent, lateral groove abruptly terminated anteriorly at humerus; legs short, protibiae without longitudinal furrows.

Comments.— This new genus is known from only six female specimens that were originally assigned by Uéno (1997) to genus *Stevensius* Jeannel (1923) of the eastern Himalayan region. However, they can be distinguished from members of that genus by their smaller head size, protibiae without longitudinal furrows, pronotum more cordate and with basal angles smaller and basal margin broadly lobate and elytra with the lateral groove abruptly terminated anteriorly at humerus. *Minutotrechus* appears to be more closely related to *Hubeitrechus* Deuve (2005), but its members can be distinguished from those of the latter in having the mentum and submentum at least partial fused, the mandibular teeth short and obtuse, the pronotum with the median basal area more convex and basal margin broadly lobate and without margination, and lateral groove abruptly terminated at the humerus. Because no male specimens of *Minutotrechus* have been collected to date, we do not know if male protarsomeres 1 and 2 are elongate as in males of *Hubeitrechus* or broad as in *Stevensius* males. Members of this new genus can also be compared with those of *Uenoites* Belousov and Kabak (2016), from which they differ in having the right mandible obtusely bifid (tridentate in *Uenoites* members), the protibiae without longitudinal furrows (longitudinal furrows present in *Uenoites* members), the mentum and submentum at least partial fused (not fused in *Uenoites* members), elytra with only two discal setae (three or more discal setae present in *Uenoites* members), the preapical seta absent (present in *Uenoites* members) and the lateral groove abruptly terminated at humerus (gradually narrowed anterior to humerus in *Uenoites* members).

Geographical distribution.— This genus currently is known only from the type species, which is known only from the southern part of the Gaoligong Shan region of western Yunnan Province, China.

Minutotrechus minutus (Uéno, 1997)

(Figs. 11, 46–48)

Stevensius minutus Uéno, 1997:182. Holotype, a female, in NMST. Type locality: China, Yunnan, Gaoligong Shan, Tengchong County, Dabei, 2430 m.

Minutotrechus minutus (Uéno) **New Combination**.

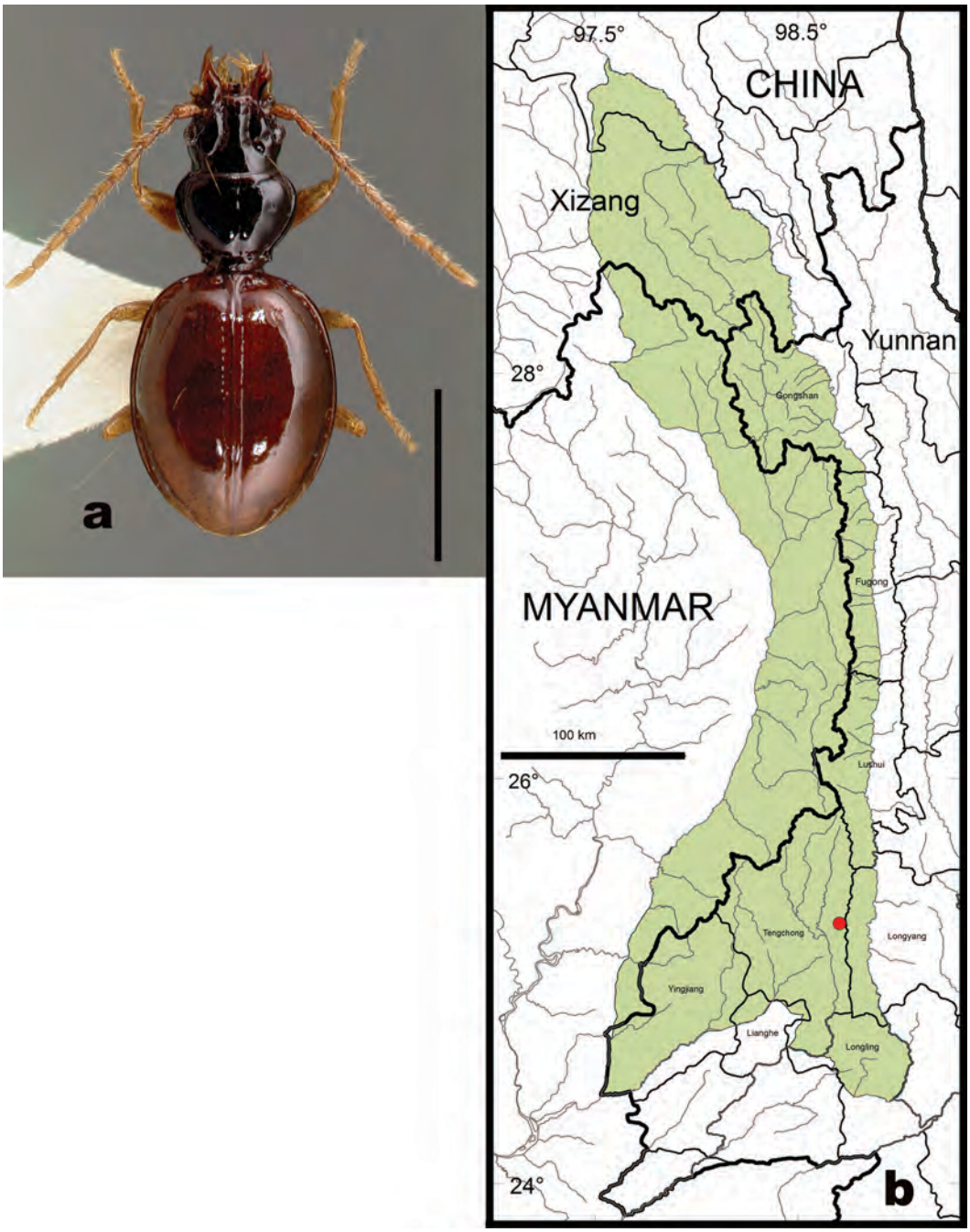


FIGURE 11. *Minutotrechus minutus* (Uéno); a. Dorsal habitus (paratype). scale line = 1.0 mm; b. Map of locality records (red circle) for *M. minutus* in the Gaoligong Shan region. Scale lines a = 0.5mm, b = 100 km.

Notes on type material.— We have not had an opportunity to study the holotype of this species, but we have examined a paratype female deposited in IOZ. Features noted below are based on our examination of that paratype and Uéno's orginal description.

Diagnosis.— Adults of this species (Fig. 11a), the only known species in this new genus, can be distinguished from those of all other species in the region by the combination of character states noted in the generic diagnosis.

Habitat distribution.— According to Uéno (1997) specimens of the type series were collected at an elevation of 2430 m in a dense *Rhododendron* forest by sifting moist leaf litter accumulations on the ground. He also noted that many specimens of "*Trechus asetosus* Uéno" (1997) were also collected in the same litter samples.

Geographical distribution within the Gaoligong Shan.— Fig. 11b. This species is known only from the six female specimens of the type series collected at the type locality, in Tengchong County, high on the western slope of the southern part of the Gaoligong Shan in Core Area 6.

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

Genus *Queinnectrechus* Deuve, 1992

Queinnectrechus Deuve, 1992b:354.

Type species.— *Queinnectrechus excentricus* Deuve, 1992a

Diagnosis.— Adults of this genus (Figs. 12–14) can be recognized by the following combination of character states: size moderate (BL = 3.5 to 4.8 mm), apterous, body dark, reddish brown to piceous, surface micaceous; head with small eyes, mentum and submentum fused; right mandible tridentate, the premolar tooth distinct but joined with the retinaculum (see Deuve 1992b, Fig. 23); pronotum cordiform and markedly convex, lateral margination effaced posteriorly, with two setae (midlateral and basolateral) present on each side; elytra markedly convex, inflated, slightly tear-shaped, humeri effaced, elytral discal striae absent or vestigial, with two (in most members) or three (in a few members) discal setae present, aligned on interval 3 near stria 3, preapical seta absent from most members, in some of these members inserted forward in a subdiscal position, in very few placed in typical trechine position nearer elytral apex and next to stria 2; protibiae furrowed; abdominal ventrites IV to VI glabrous except for a single pair of paramedial setae; endophallus of male aedeagus with two sclerites.

Comments.— Two new genera closely related to *Queinnectrechus* have recently been described. Members of *Dactylotrechus* Belousov and Kabak (2003) are distinguished by the supernumerary setae present on the external margins of the pronotum and on more lateral areas of the elytral disc. Members of *Puertrechus* Belousov and Kabak (2014a) are distinguished by the presence of a single discal setae subbasally on interval 5. Members of both taxa have a preapical seta inserted near stria 2, a plesiomorphic feature among trechines. Taxonomic limits and phylogenetic relationships among the "genera" *Stevensius*, *Kozlovites* Jeannel (1935), *Queinnectrechus*, *Dactylotrechus*, *Puertrechus*, *Sinotrechiama* Uéno (2000), *Uenoite*s Belousov and Kabak (2016) and *Minutotrechus* (describe above) are still poorly resolved. This is why we describe below a new taxon, *Gaoligongtrechus*, provisionally with the rank of subgenus. This assignment can be changed as needed in the future.

Geographical distribution.— This genus, which currently include 13 described species (Belousov and Kabak 2003, Casalle and Magrini 2009, Deuve 1992a, and Uéno 1998a and 1998b) is currently known from the Min Shan region of northern Sichuan Province southwest to western

Yunnan Province. The Gaoligong Shan forms the southwestern limit of the known distributional range of the genus.

Key for Identification of Subgenera of *Queinnectrechus* in the Gaoligong Shan Region

1. Pronotum with basal angles prolonged posteriorly as slender digitiform processes (Figs. 12a, 13a) . . . . . Subgenus *Queinnectrechus* Deuve
1' Pronotum with basal angles simple (Fig. 14a). . . Subgenus ***Gaoligongtrechus* subgen. nov.**

Subgenus *Queinnectrechus* Deuve, 1992

Queinnectrechus Deuve, 1992a:354.

Diagnosis.— Adults of this subgenus (Figs. 12a, 13a) can be recognized by the following combination of character states: size moderate (BL = 3.5 to 4.8 mm), apterous, body dark, reddish brown to piceous, surface micaceous; pronotum with basal angles prolonged posteriorly as slender digitiform processes, with two setae (midlateral and basolateral) present on each side; elytra markedly convex, inflated, slightly tear-shaped, humeri effaced, elytral discal striae effaced, with two (in most members) or three (in a few members) discal setae present, aligned on interval 3 near stria 3, preapical seta absent from most members.

Geographical distribution.— Same as for genus (see above).

Key for Identification of Adults of Subgenus *Queinnectrechus* species of the Gaoligong Shan Region

1. Size larger (BL = 4.3 to 4.8 mm), elytra (Fig. 12a) more elongate; median lobe of male aedeagus broadest at mid-shaft, with apex long and recurved. . . . . ***Q. griswoldi* sp. nov**.
Size smaller (BL = 3.5 to 3.8 mm), elytra (Fig. 13a) shorter, ovoid; median lobe of male aedeagus slender, with apex short and not at all curved. . . . . ***Q. gongshanicus* sp. nov.**

Queinnectrechus (*s. str.*) *griswoldi* Deuve and Kavanaugh, sp. nov.

(Figs. 12, 37b, 38a, 38b, 39b, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1026334"/ "CHINA, Yunnan, Gongshan County, Cikai Township, 0.1 km SE of Heipu Yakou in valley below tunnel, N27.76978°/ E98.44681°,"/ "3720 m, 13 August 2006, Stop #DHK-2006-073 D.H. Kavanaugh & J.A. Miller collectors"/ "HOLOTYPE *Queinnectrechus* (*s. str.*) *griswoldi* Deuve & Kavanaugh, sp. nov. designated 2016" [red label]. Paratypes (a total of 20): 5 males and 3 females (in CAS, IOZ, MNHN) labeled same as holotype except first label "CASENT 1026333", "CASENT 1026335" to "CASENT 1026338" and "CASENT 1026330" to "CASENT 1026332", respectively; 1 female (in IOZ) labeled "CASENT 1010344"/ "CHINA, Yunnan, Gongshan County, Cikai Township, 52.6 km W of Gongshan on Dulong Valley Road, 3360-3380 m,"/ "N27.77032°/ E098.44661°, 1-2 October 2002, Stop #DHK-2002-034, D.H. Kavanaugh & P.E. Marek collectors"; 1 male and 3 females (in CAS, IOZ) labeled "CASENT 1024862" and "CASENT 1024863" to "CASENT 1024865", respectively/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, on slope NE of Chukuai Lake, 3950,"/"N27**.**98206°/ E098.48027°, 20 August 2006, Stop #DHK-2006-086 Y. Liu, P. Hu, D.Z. Dong, & J. Wang collectors"; 3 males and 1 female (in CAS, IOZ, MNHN) labeled "CASENT 1026813" to "CASENT 1026815" and "CASENT 1026815", 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 J.A. Miller, D.Z. Dong, & Y. Liu collectors"; 1 female (in CAS) labeled

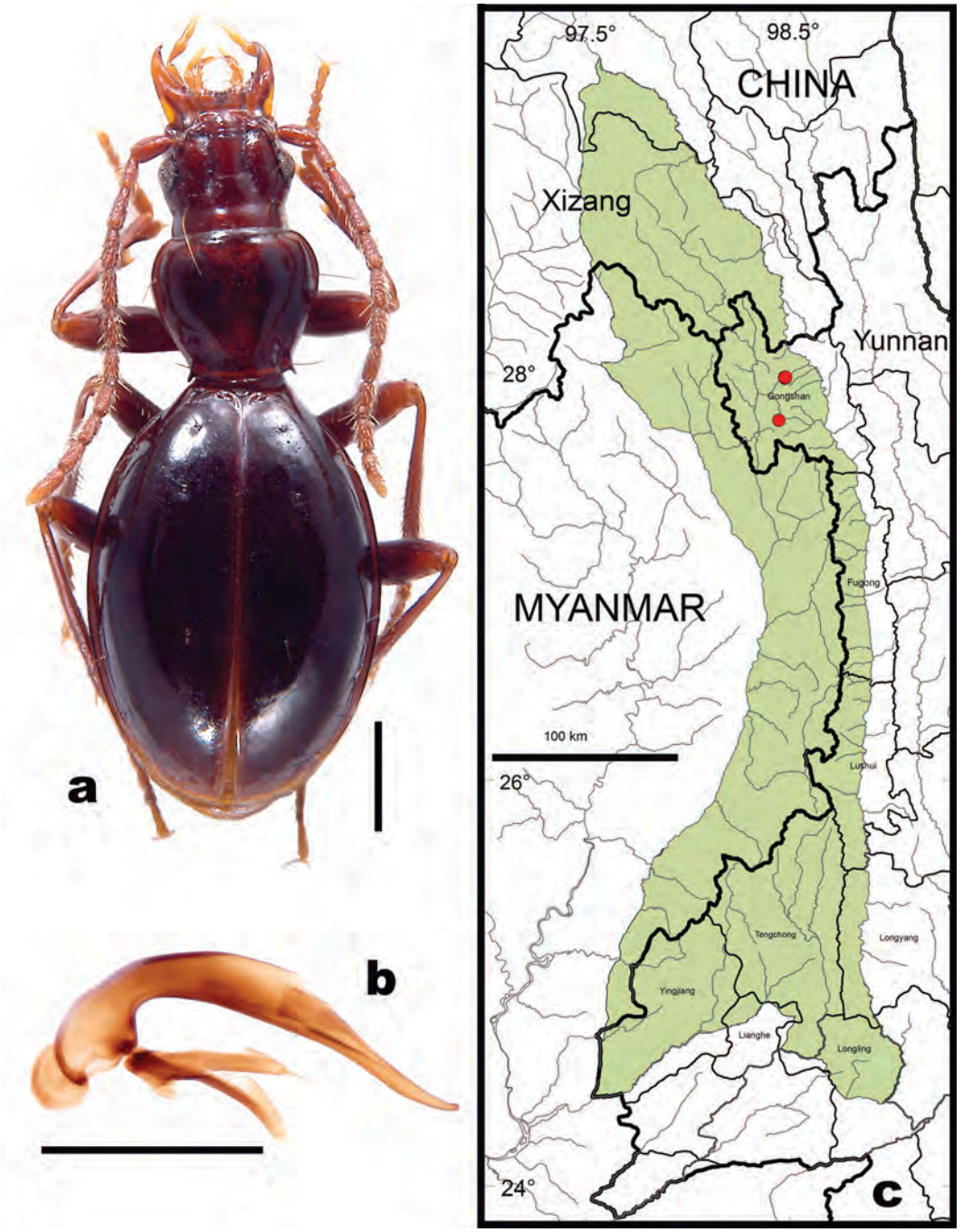


FIGURE 12. *Queinnectrechus* (*s. str.*) *griswoldi* sp. nov.; a. Dorsal habitus (CASENT1026334). b. Median lobe of aedeagus of male (CASENT1026334), left lateral aspect. c. Map of locality records (red circles) for *Q. griswoldi* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

"CASENT 1025813"/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan 0.3 km SW of Chukuai Lake at campsite,"/, "N27.97686°/ E098.47799°, 3750 m, 18 August 2006 Stop #DHK-2006-078 D.H. Kavanaugh collector"; 2 females (in IOZ) labeled "CASENT 1025836" and "CASENT 1025837", respectively / "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.3 km SW of Chukuai Lake at campsite,"/ "N27.97686°/ E098.44779°, 3750 m, 19 August 2006, Stop #DHK-2006-082 Y. Liu collector". All paratypes also bear the following label: "PARATYPE *Queinnectrechus* (*s. str.*) *griswoldi* Deuve & Kavanaugh, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Gongshan County, Cikai Township, 0.1 km SE of Heipu Yakou, in valley below tunnel, N27.77437°/ E098.44793°, 3270 m.

Derivation of species name.— The species epithet, *griswoldi*, is the Latinized form (in the genitive case) of the surname of Charles E. Griswold, now Curator Emeritus and former Schlinger Chair of Arachnology at the California Academy of Sciences, who participated in several of the expeditions to the study area and helped collect many carabid specimens for this project. We are pleased to name this elegant species in his honor.

Diagnosis.— Adults of this species (Fig. 12a) can be distinguished from those of all other species in the region by the following combination of character states: size medium (BL = 4.3 to 4.8 mm), body dark reddish brown, very shiny; eyes small and convex, tempora slightly convex; pronotum markedly narrowed posteriorly, markedly convex, globulose, narrowly cordate, disc smooth, basal angles with distict digitorm projections, each side with a single midlateral and basolateral seta; elytra markedly convex, tear-shaped, discal striae effaced, with three discal setae in a row along the presumed location of stria 3, preapical seta absent; median lobe of male aedeagus (Fig. 12b) large, elongate, broadest at mid-shaft, with apex long and recurved dorsally, endophallus with internal sclerites acuminate apically.

Description.— Size medium, BL = 4.3 to 4.8 mm. Color of body, antennae and legs dark reddish brown, palpi paler, yellowish tan, body surface very shiny, micaceous, smooth and glabrous.

Head. Moderate in size, eyes small and convex, their convexity greater than and their diameter about as long as tempora, the latter only slightly convex and glabrous. Frons with frontal furrows deep, rounded, and not interrupted posteriorly; two suporaorbital setae present, the anterior inserted opposite midpoint of eye, the posterior inserted in postocular groove. Clypeus with four setae. Labrum with six setae, anterior margin distinctly concave. Right mandible tridentate. Left mandible with a small, minutely tridentate process. Mentum and submentum fused. Mentum with medial tooth wide, bifid or truncate, one half the length of the lateral lobes. Submentum with six setae anteriorly. Gula wide. Genae with a single seta ventrally on each side. Antennae of moderate length, extended posteriorly almost to or slightly beyond basal one-fourth of elytra, with 3.5 antennomeres in females and 4.5 antennomeres in males extended beyond basal pronotal margin, antennomeres slightly broadened, antennomere 3 slightly longer than antennomeres 2 or 4.

Pronotum. Shape narrowly cordiform, only slightly transverse (ratio PW/PL = 1.1), widest at the anterior one-fourth, markedly narrowed posteriorly, lateral margins distinctly sinuate anterior to basal angles, the latter extended posteriorly as slender, pointed, digitiform processes. Disc markedly convex, globulose, smooth and glabrous, with median longitudinal impression very faintly impressed or effaced, basal fovea small and smooth; median basal area smooth; basal margin slightly convex and rounded. Lateral border of pronotum slender, distinctly defined only in anterior one-third to one-half, effaced in posterior one-half to two –thirds. Single midlateral setae on each side inserted at anterior one-third; single basolateral seta on each side, inserted on basal angle at base of digitform process.

Elytra. Elytral silhouette slightly tear-shaped, with humeri effaced, disc markedly convex, smooth and glabrous. All discal striae effaced except for faintly impressed parascutellar striole and a short, faintly impressed recurrent stria. Basal setiferous pore present. Three discal setae present, aligned along presumed track of stria 3. Preapicale seta absent, one or two apicoangular setules present. Umbilicate setal series with setae of humeral group equidistance from each other, with the first slightly more medially inserted than the others, setae of median group inserted distinctly posterior to middle.

Legs. Moderately long but slender. Protibiae with longitudinal furrow, sparely pubescent apically on anterior surface. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, females with two pairs.

Male aedeagus. Median lobe (Fig. 12b) large, elongate, broadest at mid-shaft, with apex long and recurved dorsally; endophallus with internal sclerites acuminate apically.

Comments.— Based on similarities in the form of the aedeagus of males, this species is closely related to *Queinnectrechus jiuhecola* Deuve & Kavanaugh (Deuve et al. 2015), described from Lijiang County, northwestern Yunnan. However, members of this new species are distinguished from those of the latter by their much smaller size (BL = 5.3 to 5.8 mm in *Q. jiuhecola* members), more elongate body form, more convex elytra, discal striae fully effaced (at least three medial striae evident in *Q. jiuhecola* members) and, most significantly, preapical seta absent (present near stria 2 subapically in *Q. jiuhecola* members).

In a recent paper, Belousov and Kabak (2016) established a new genus, *Uenoites*, in which they placed *Q. jiuhecola*, as well as three other species previously included in *Kozlovites* or *Deuveotrechus* Uéno (1995), based on the presence of a preapical seta, more convex tempora, and the median lobe of the male aedeagus not markedly hooked apically. However, all these features are plesiomorphic among trechines, which is problematic for demonstrating phylogenetic affinity of the included taxa. Clearly, phylogenetic relationships among these groups of species remain unresolved. As noted above, the genitalia of *Q. griswoldi* males are very similar to those of *Q. jiuhecola* males, wherease those of the new species described below, *Queinnectrechus gongshanicus* sp. nov., are of a very different form, although both of the new species described here are members of genus *Queinnectrechus*.

Habitat distribution.— Members of this species have been found in a variety of microhabitats in the alpine zone near the crest of the Gaoligong Shan and the eastern slope, at elevations ranging from 3270 to 3950 m. Specimens were collected under stones in moist meadows and on tundra slopes and ridges with sparse to thick herbaceous vegetation (Figs. 37b, 38a, 38b, 39b), at the edges of small streams and seeps from talus slopes, and at the edges of *Rhododendron* thickets up to 1.5 m tall. Members of this species have been found syntopic with specimens of *Queinnectrechus* (*Gaoligongtrechus*) *balli* sp. nov., *Queinnectrechus* (*s. str.*) *gongshanicus* sp. nov., *Trechus gongshanensis* sp. nov., *Trechus qiqiensis* sp. nov. and *Trechepaphiopsis monochaeta* sp. nov.

Geographical distribution within the Gaoligong Shan.— Fig. 12c. We examined a total of 21 specimens (10 males and 11 females), all from the northern part of the Gaoligong Shan, in Bingzhongluo and Cikai Townships, Gongshan County (see Type material above for exact collection data). These localities are all on the crest or eastern slope of the Gaoligong Shan in Core Area 2.

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

***Queinnectrechus* (*s. str.*) *gongshanicus* Deuve and Liang, sp. nov.**
(Figs. 13, 39a, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1024868"/ "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"/ "HOLOTYPE *Queinnectrechus* (*s. str.*) *gongshanicus* Deuve & Liang, sp. nov. designated 2016" [red label]. Paratypes (a total of 10): 2 females (in CAS, IOZ) labeled same as holotype except first label "CASENT 1024866" and "CASENT 1024867", respectively; 1 male and 1 female (in IOZ, MNHN) labeled: "CASENT 1025160" and "CASENT 1025161", respectively/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.75 km NW of Chukuai Lake,"/ "N27**.**98631°/ E098.47069°, 21 August 2006, Stop #DHK-2006-095 Y. Liu, P. Hu, & J. Wang collectors"; 1 male and 3 females (in CAS, IOZ) labeled "CASENT 1025935" and "CASENT 1025936" to "CASENT 1025938", respectively/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.3 km SW of Chukuai Lake at campsite, "N27.97686°/ E098.44779°"/ "3750 m, 19-22 August 2006, Stop #DHK-2006-095C D.H. Kavanaugh, J.A. Miller, D.Z. Dong, Y. Liu, P. Hu, & J. Wang collectors"; 2 males (in CAS, MNHN) labeled "CASENT 1026203" and "CASENT 1026204", respectively/ "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". All paratypes also bear the following label: "PARATYPE *Queinnectrechus* (*s. str.*) *gongshanicus* Deuve & Liang, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, on slope NE of Chukuai Lake, N27**.**98206/E098.48027°, 3950 m.

Derivation of species name.— The species epithet, *gongshanicus*, is derived from the name of the county (Xian) in which the holotype was collected, Gongshan, and the Latin adjectival suffix, *-icus*, meaning belonging to or pertaining to.

Diagnosis.— Adults of this species (Fig. 13a) can be distinguished from those of all other species in the region by the following combination of character states: same features as members of *Q. griswoldi* except, size smaller (BL = 3.5 to 3.8 mm), body form short, with elytra, in particular, shorter and more oval, less elongate; digitiform projections of pronotal basal angles slightly more divergent laterally; elytral recurrent stria slightly deeper impressed, median lobe of male aedeagus (Fig. 13b) markedly different, with shaft thin and straighter, abruptly bent basally, apex short and rectangular, endophallus with a single apically acuminate internal sclerite.

Description.— Size smaller, BL = 3.5-3.8 mm. Body color dark, reddish-piceous, antennae and legs reddish tan, palpi and tarsi paler, yellowish tan.

Head. Moderate in size; eyes small and convex, their convexity greater than and their diameter about as long as tempora, the latter moderately convex and glabrous. Frons not flattened; frontal furrows deep, rounded, slightly attenuated posterior to the eyes. Clypeus with four setae. Labrum with six setae, anterior margin distinctly concave. Mentum and submentum fused. Mentum with medial tooth short, wide, bifid, less than one-half the length of the lateral lobes. Submentum with six setae anteriorly. Gula wide. Genae with a single seta ventrally on each side. Antennae slightly shorter, with only two antennomeres extended posteriorly beyond basal pronotal margin, antennomeres slightly broadened, antennomere 3 slightly longer than antennomeres 2 or 4.

Pronotum. Cordate (ratio PW/PL = 1.15), markedly narrowed posteriorly, greatest width near anterior one-third, lateral margins rounded anteriorly, then straightened posteriorly just anterior to basal angles, the latter prolonged as slender, slightly divergent digitiform processes. Disc marked-

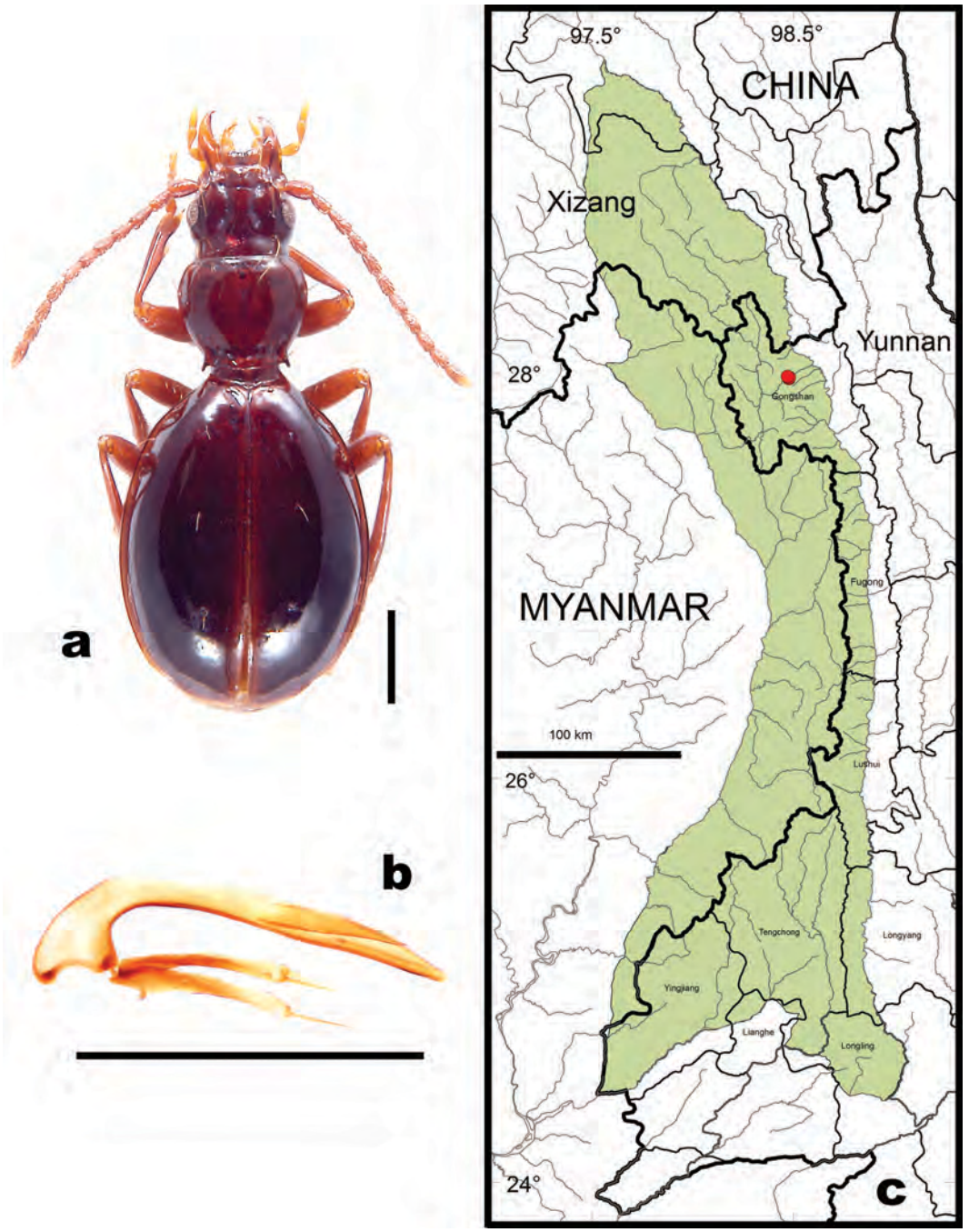


FIGURE 13. *Queinnectrechus* (*s. str.*) *gongshanicus* sp. nov.; a. Dorsal habitus (CASENT1024868). b. Median lobe of aedeagus of male (CASENT1024868), left lateral aspect. c. Map of locality records (red circles) for *Q. gongshanicus* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

ly convex, smooth and glabrous, median longitudinal impression only superficially impressed; basal foveae distinct but small and round; median basal area smooth and markedly transverse, delimited anteriorly by a faint transverse impression; basal margin convex and rounded. Lateral border of pronotum rudimentary, extremely slender, distinctly defined only in anterior one-third to one-half, effaced in posterior one-half to two –thirds. Single midlateral setae on each side inserted at anterior one-third; single basolateral seta on each side, inserted on basal angle at base of digitform process.

Elytra. Short, ovoid, very slightly tear-shaped, narrower anteriorly than posteriorly, humeri effaced. Disc markedly convex and smooth. All discal striae effaced, except for a faintly impressed parascutellar striole and a short and shallow recurrent stria. Basal setiferous pore present. Three discal setae present, aligned along presumed track of stria 3. Preapicale seta absent, two or three apicoangular setules present. Umbilicate setal series with setae of humeral group equidistance from each other, with the first slightly more medially inserted than the others, setae of median group inserted distinctly posterior to middle.

Legs. Slightly short but slender. Protibiae with longitudinal furrow, glabrous or sparely pubescent apically on anterior surface. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, of females with two pairs.

Male aedeagus. Median lobe (Fig. 13b) with shaft with shaft thin and straight, abruptly bent basally, apex short and rectangular, endophallus with a single long, apically acuminate internal sclerite.

Habitat distribution.— Members of this species have been found in a variety of microhabitats in the alpine zone on the southwest slope of Kawakarpu Shan, at elevations ranging 3745 to 3950 m. Specimens were collected from under stones in moist meadows, on tundra slopes and ridges with sparse to thick herbaceous vegetation, at the edges of small streams and seeps from talus slopes They were also collected in pitfall traps placed at the edges of *Rhododendron* thickets up to two meters tall. Members of this species have been found syntopic with specimens of *Queinnectrechus* (*Gaoligongtrechus*) *balli* sp. nov., *Queinnectrechus* (*s. str.*) *griswoldi* and *Trechus gongshanensis* sp. nov.

Geographical distribution within the Gaoligong Shan.— Fig. 13c. We examined a total of 11 specimens (4 males and 7 females), all from the southwest slope of Kawakarpu Shan in the northern part of the Gaoligong Shan, in Bingzhongluo Township, Gongshan County (see Type material above for exact collection data). These localities are all in Core Area 2.

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

Subgenus *Gaoligongtrechus* Deuve and Kavanaugh, subgen. nov.

Type species.— *Queinnectrechus* (*Gaoligongtrechus*) *balli* sp. nov.

Derivation of genus group name.— The genus group name (masculine) is a combination of *Gaoligong*, the name of the mountain range where this taxon was discovered, and the genus name *Trechus*.

Diagnosis.— Adults of this subgenus (Fig. 14a) can be recognized by the following combination of character states: size moderate (BL = 4.3 to 4.8 mm), apterous, body dark and very shiny, micaceous; head slightly elongate, eye small, their diameter less than length of tempora; right mandibles tridentate; mentum and submentum fused; pronotum narrowed posteriorly, narrowly cordate, pronotal disc markedly convex and glabrous, basal angles acute but without digitiform extensions, basal margin roundly convex and fitted to concave elytral base, laterally with two or

three anteromedial setae and a single basal seta on each side; elytral silhouette tear-shaped, widest distinctly posterior to middle, humeri effaced, disc very convex and smooth, without distinct discal striae, except recurrent stria short but distinctly impressed, with four to six discal setae aligned near presumed location of stria 3, preapical seta present; abdominal ventrite IV to VI each with a pair of paramedial setae; male aedeagus with median lobe rather slender, bent basally about 90° to shaft, endophallus with a pair of slender sclerites tapered to points on both ends.

Geographical distribution.— At present this subgenus includes the single species described below, which is known only from the northern part of the Gaoligong Shan in western Yunnan Province, China.

Queinnectrechus (*Gaoligongtrechus*) *balli* Deuve and Kavanaugh, sp. nov.

(Figs. 14, 37b, 39b, 40a, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1001935"/ "CHINA, Yunnan Province, Gaoligong Shan, Nujiang Prefecture, Nujiang State Nature Reserve, Dulong/Gongshan Yakou [= Qiqi/Dulong divide] area, 21 airkm W of Gongshan,"/ "N27.69655°/ E98.45389°, 3300-3680m, 16-17 July 2000, Stop#00-24C, D.H. Kavanaugh, C.E. Griswold, Liang H.-B., D. Ubick, & Dong D.-Z. collectors"/ "HOLOTYPE *Queinnectrechus* (*Gaoligongtrechus*) *balli* Deuve & Kavanaugh, sp. nov. designated 2016" [red label]. Paratypes (a total of 32): 2 males and 12 females (in CAS, IOZ, MNHN) labeled same as holotype except first label "CASENT 1001933" to "CASENT 1001934" and "CASENT 1001936" to "CASENT 1001947", respectively; 1 female (in CAS) labeled "CASENT 1010343"/ "CHINA, Yunnan, Gongshan County, Cikai Township, 52.6 km W of Gongshan on Dulong Valley Road, 3360-3380 m,"/ "N27.77032°/ E098.44661°, 1-2 October 2002, Stop #DHK-2002-034, D.H. Kavanaugh & P.E. Marek collectors"; 1 female (in CAS) labeled "CASENT 1024375"/ "CHINA, Yunnan, Gongshan County, Cikai Township, southeast slope of Heipu Yakou, 3365 m, N27.77032°/ E098.44674°,"/ "11 August 2006, Stop #DHK-2006-069A, D.H. Kavanaugh, J.A. Miller, D.Z. Dong, & Y. Liu collectors"; 3 males and 2 females (in IOZ, MNHN) labeled "CASENT 1025840" to "CASENT 1025842" and "CASENT 1025838" to "CASENT 1025839", respectively/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.3 km SW of Chukuai Lake at campsite,"/ "N27.97686°/ E098.44779°, 3750 m, 19 August 2006, Stop #DHK-2006-082 Y. Liu collector"; 1 female (in CAS) labeled "CASENT 1026202"/ "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"; 5 males and 2 females (in CAS, IOZ) labeled ""CASENT 1026323" to "CASENT 1026327" and "CASENT 1026328" to "CASENT 1026329", respectively/ "CHINA, Yunnan, Gongshan County, Cikai Township, 0.1 km SE of Heipu Yakou in valley below tunnel, N27.76978°/ E98.44681°,"/ "3720 m, 13 August 2006, Stop #DHK-2006-073 D.H. Kavanaugh & J.A. Miller collectors"; 1 male (in CAS) labeled "CASENT 1026707"/ "CHINA, Yunnan, Gongshan County, Dulongjiang Township, NW slope of Heipu Yakou, 3350 m, N27.77437°/ E098.44793°,"/ "13 August 2006, Stop #DHK-2006-075 D.H. Kavanaugh & J.A. Miller collectors"; 2 females (in IOZ) labeled "CASENT 1026817" and "CASENT 1026818", 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 J.A. Miller, D.Z. Dong, & Y. Liu collectors". All paratypes also bear the following label: "PARATYPE *Queinnectrechus* (*Gaoligongtrechus*) *balli* Deuve & Kavanaugh, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Gaoligong Shan, Gongshan County, Qiqi/Dulong divide area, N27.69655°/E98.45389°, 3300-3680 m.

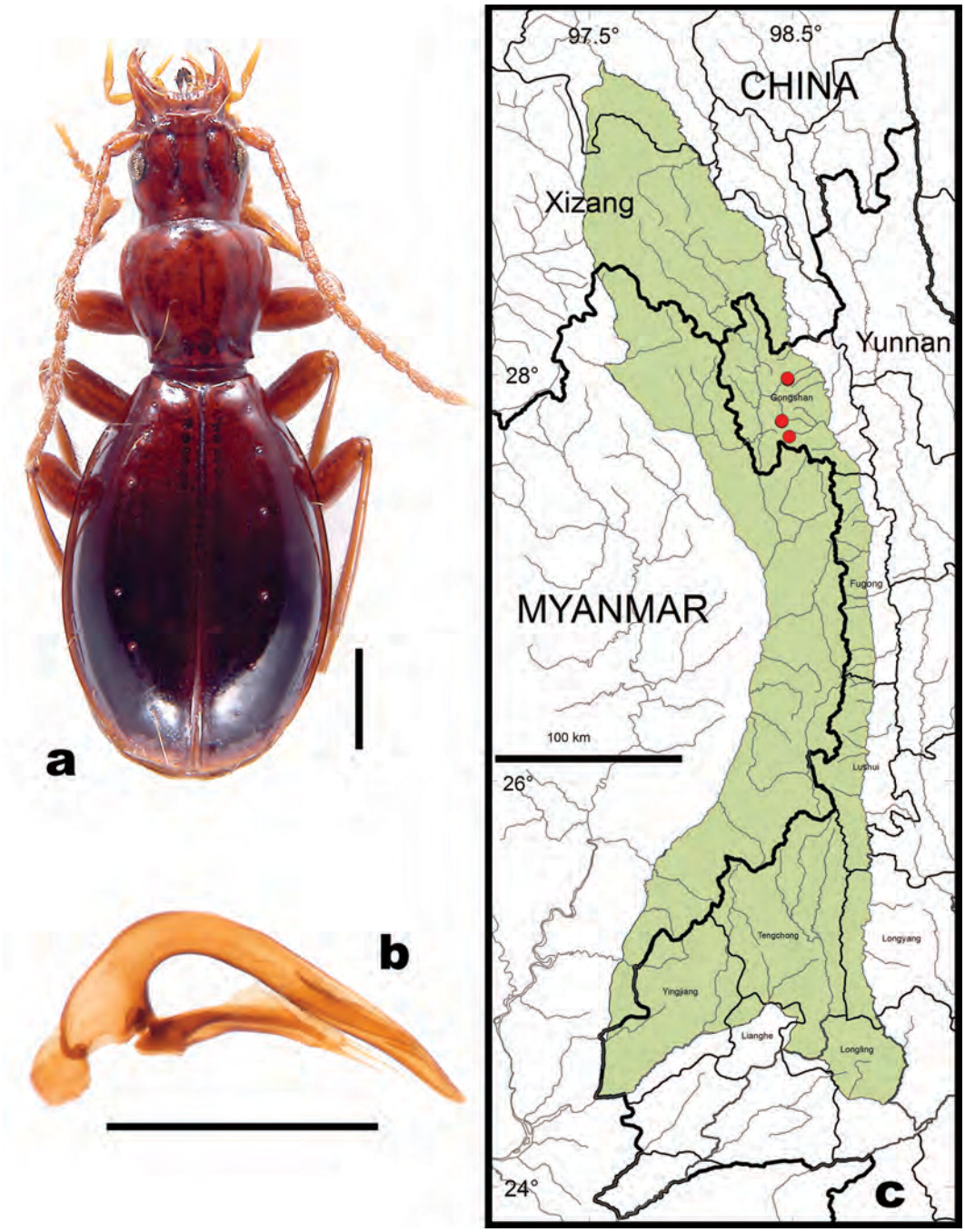


FIGURE 14. *Queinnectrechus* (*Gaoligongtrechus*) *balli* sp. nov.; a. Dorsal habitus (CASENT1001935). b. Median lobe of aedeagus of male (CASENT1001935), left lateral aspect. c. Map of locality records (red circles) for *Q. balli* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

Derivation of species name.— The species epithet, *balli*, is the Latinized form (in the genitive case) of the surname of George Eugene Ball, Professor Emeritus at the University of Alberta, Edmonton, Alberta, Canada — our mentor, dear friend, and one of the world's most accomplished and inspirational systematists. We are pleased to name this extraordinary species in his honor.

Diagnosis.— Adults of this species (Fig. 14a) can be distinguished from those of all other trechine species in the region by the combination of character states noted in the diagnosis for this genus.

Description.— Size moderate, BL = 4.3 to 4.8 mm. Color of dorsum dark, forebody dark reddish brown, elytra piceous to black, antennae and legs reddish brown, palpi slightly paler, reddish tan; surface smooth and markedly shiny.

Head. Slightly elongate, with eyes small but convex, their diameter less than length of tempora. Tempora not or only slightly convex, glabrous, and joined to neck region at a markedly obtuse (ca. 150°) angle. Frons with deep frontal furrow that delimit three (two lateral and medial) very convex areas, however furrows abruptly interrupted or less impressed posteriorly; two pairs of supraorbital seta present, the anterior pair inserted near middle of eyes, the posterior pair inserted dorsally on the tempora near the postocular furrow. Clypeus with four setae. Labrum with six setae, anterior margin distinctly concave. Right mandible tridentate, with the middle tooth reduced, obtuse, left mandible with premolar tooth fused with retinaculum to form a small caniniform process with a sharp tip. Mentum and submentum fused. Mentum with medial tooth broad, truncate, about half as long as lateral lobes, the latter apically pointed. Submentum with six setae anteriorly. Genae with a single ventral seta on each side. Antennae pubescent from apical half of scape distally, extended posteriorly to basal one-third of elytra, with four antennomeres posterior to the pronotal base, antennomere 3 slightly longer than antennomere 4.

Pronotum. Narrowly cordate, not transverse, about as long as wide (PW/PL = 1.0), markedly narrowed posteriorly, the lateral margins distinctly sinuate anterior to basal angles, the latter acute, projected, but without digitiform extensions. Disc markedly convex, globose, glabrous; median longitudinal impression faintly impressed; basal foveae formed as small, deep, circular pits, median basal area smooth, faintly delimited, basal margin dilated medially as a broad, round projection. Lateral margination narrow, evident only in anterior one-third, effaced in posterior two-thirds. Two or three anteromedial setae and a single basal seta present on each side, the latter inserted slightly but distinctly anterior to basal angle.

Elytra. Elytral silhouette tear-shaped, narrower anteriorly than posteriorly, widest distinctly posterior to middle, humeri effaced, basal part of lateral explanation not visible from above. Disc markedly convex and smooth, with basal part abruptly and truncate, concave, fitted to convex base of pronotum, without distinct discal striae, except recurrent stria short but evidently impressed. Parascutellar setiferous pore present. Four to six discal setae present and aligned near presumed location of stria 3. Preapical seta present, inserted slightly more medially than the row of discal setae. Umbilicate setal series with setae of humeral group aggregated with distance between first and second setae less than between second and third and third and fourth, setae of median group distinctly posterior to middle.

Legs. Moderately long but slender; protibiae with longitudinal furrow, sparely pubescent apically on anterior surface. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side and ventrite VII of females with two setae on each side.

Male aedeagus. Median lobe (Fig. 14b) slender, bent basally about 90° to shaft, basal bulb with a large sagittal aileron, apex short and slightly narrowed, blunt; endophallus with a pair of slender sclerites tapered to points on both ends.

Comments.— Members of this new genus exhibit practically the same chaetotaxic pattern as those of genus *Kozlovites* Jeannel (1935), with a row of four to six discal setae apparently aligned on interval 3 in or near stria 3 and a preapical seta apparently inserted on interval 3 near stria 2 but in a position forward of the level of the anterior tip of the recurrent stria. However, *Gaoligongtrechus* members are distinguished from those of *Kozlovites* (and of *Uenoites* Belousov and Kabak 2016) by the extreme convexity of both the pronotum and elytra, which are of similar form to that seen in members of *Queinnectrechus* (*s. str.*), and by the posterior projection of the pronotal basal area and margin and its fit with the modified elytral base. Additional distinguishing features include the lateral marginations, each of which bears one or two anteromedial setae and is effaced in the posterior two-thirds, the effaced elytral discal striae, the medial tooth of the mentum truncate rather than bifid, the abdominal ventrites each with only a single pair of paramedial setae, except for the female ventrite VII which has two pairs of subapical paramedial setae, as is typical among Trechini. In addition, Belousov and Kabak (2016) considered the apex of the male median lobe formed as a large apical hook as a synapomorphy for *Kozlovites* species. The apex of the median lobe of *Q.* (*G.*) *balli* males (Fig. 14b) has no trace of a hook; and the slender shaft and abruptly bent (at a 90° angle) basal region are unlike that seen in males of any described *Kozlovites* or *Uenoites* species.

Members of subgenus *Gaoligongtrechus* differ from those of subgenus *Queinnectrechus* Deuve and *Dactylotrechus* Belousov and Kabak, (2003), in having the basal pronotal angles simple, without the digitiform extensions seen in members of these two genera. Like *Dactylotrechus* members, those of our new subgenus have anterolateral setae in the pronotal margins and a preapical seta apparently inserted near stia 2; however, this seta is inserted farther forward, in a subdiscal position, in *Q.* (*G.*) *balli* members.

Habitat distribution.— Members of this species have been found under stones on moist, organic substrate in alpine meadows, slopes and ridges with low, dense to sparse herbaceous vegetation, at elevations ranging from 3300 to 3750 m (Fig. 37b, 39b, 40a). One specimen was collected at night, found walking on the barren slope of a roadcut at 3350 m elevation. Members of this species have been found together (syntopic) repeatedly with specimens of *Queinnectrechus gongshanicus*, *Queinnectrechus griswoldi*, *Trechus gongshanensis* sp. nov., and *Trechus qiqiensis* sp. nov.

Geographical distribution within the Gaoligong Shan.— Fig. 14c. We examined a total of 33 specimens (12 males and 21 females), all from the northern part of the Gaoligong Shan, in Bingzhongluo, Cikai and Dulongjiang Townships in Gongshan County (see Type material above for exact collection data). These localities are in Core Areas 1 and 2.

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

Genus *Eocnides* Jeannel, 1954

Eocnides Jeannel, 1954:10.
Agonotrechiotes Deuve 2010:17. **New Synonymy**

Type species.— *Eocnides assamensis* Jeannel, 1954

Diagnosis.— Adults of this genus (Fig. 15a) can be recognized by the following combination of character states: size large (BL = 4.8 to 5.2 mm); body form long and slender, fully-winged; eyes moderately large; frontal furrows deep; mentum and submentum fused or not; antennae long and slender; pronotum small, elytra long and flattened, discal striae partially effaced basally and laterally, with two discal setae present inserted in stria 3, umbilicate setae aggregated into humeral and

median groups; legs slender; protibiae longitudinally furrowed; abdominal ventrites with long, very sparse pubescence medially in addition to two or more apical paramedial setae; median lobe of male aedeagus slender, the apex slightly recurved ventrally, endophallus with internal sclerite very long and tapered.

Comments.— This genus was described by Jeannel (1954) based on a single female specimen, which he considered as close to genus *Cnides* Motschulsky (1862), based on overall form and features of elytral sculpture. However, the discovery of a second species and two males allowed Uéno (1989) to find that the median lobe of the male aedeagus was formed as a closed tube, not at all open on its ventral face. He concluded that it should be considered as a taxon in subtribe Trechina and placed near the "*Trechoblemus*" and "*Trechus*" Complexes. We here recognize for the first time *Agonotrechiotes* Deuve (2010) as a junior synonym of *Eocnides* Jeannel (1954).

Geographical distribution.— This genus currently is known from only two species with a combined disjunct distribution including Assam (northeastern India) and Sichuan Province, China. The discovery of members of this genus in the study area in western Yunnan Province partially fills a gap in the distribution of the genus.

Eocnides fragilis Uéno, 1989

(Figs. 15, 45–48)

Eocnides fragilis Uéno, 1989:14. Holotype, a male, in NMST. Type locality: China, Sichuan, Nanping County, Jiuzhaigou, Xiajijie Hai, ca. 2600 m.

Agonotrechiotes longiantennatus Deuve 2010:17. **New Synonymy**

Diagnosis.— Adults of this species (Fig. 15a) can be distinguished from those of all other species in the region by the following combination of character states: size large (BL = 4.8 to 5.2 mm), fully-winged; body color pale, brownish-tan; head with eyes only moderate in size; frontal furrows attenuated; anterior pair of supraorbital setae not foveate; pronotum slightly transverse (ratio PW/PL= 1.48), median longitudinal impression distinctly impressed, especially basally, least so at middle; basal foveae prolonged anteriorly parallel to lateral margin in basal one-half; elytra with discal stria 2 partially effaced near base, striae 5 and 6 faintly but distinctly impressed; median lobe of male aedeagus (Fig. 15b) slender, apex slightly recurved ventrally.

Habitat distribution.— Members of this species were found by splashing gravel bars at the edges of a small, lowland stream adjacent to disturbed, agricultural areas, at elevations ranging from 1610 to 1630 m. This microhabitat is similar to that described by Uéno (1999b) for specimens collected at Munigou He, 2670 m, in Songpan County, northern Sichuan. No other trechines were collected at these sites.

Geographical distribution within the Gaoligong Shan.— Fig. 15c. We examined a total of 2 specimens (1 male and 1 female) from the following localities: ***Gongshan County:*** Bingzhongluo Township (Niwaluo He, just below Nu Jiang Road, 1630 m, N28.05140°/E98.59319°, 8 October 2002, D.H. Kavanaugh, P.E. Marek and D.Z. Dong collectors [1 male; CAS]; Bingzhongluo Township (Yimaluo He, just below Nu Jiang Road, 1610 m, N28.02499°/E98.62564°, 8 October 2002, D.H. Kavanaugh, P.E. Marek and H.B. Liang collectors [1 female; IOZ]. Both of these localities are in Core Area 2.

Overall geographical distribution.— Fig. 45. This species has been recorded previously from five localities in northern Sichuan Province, in Jiuzhaigou and Songpan Counties (Uéno 1989, 1999b) and in Luding County (Deuve 2010). We report here the following new record for Sichuan: ***Wenchuan County***: Qionglai Shan, Sanjiang Township (Sanjiang Nature Reserve, river at gate to reserve, 1300 m, N30.94697°/E103.31217°, 9 September 2007, D.H. Kavanaugh collec-

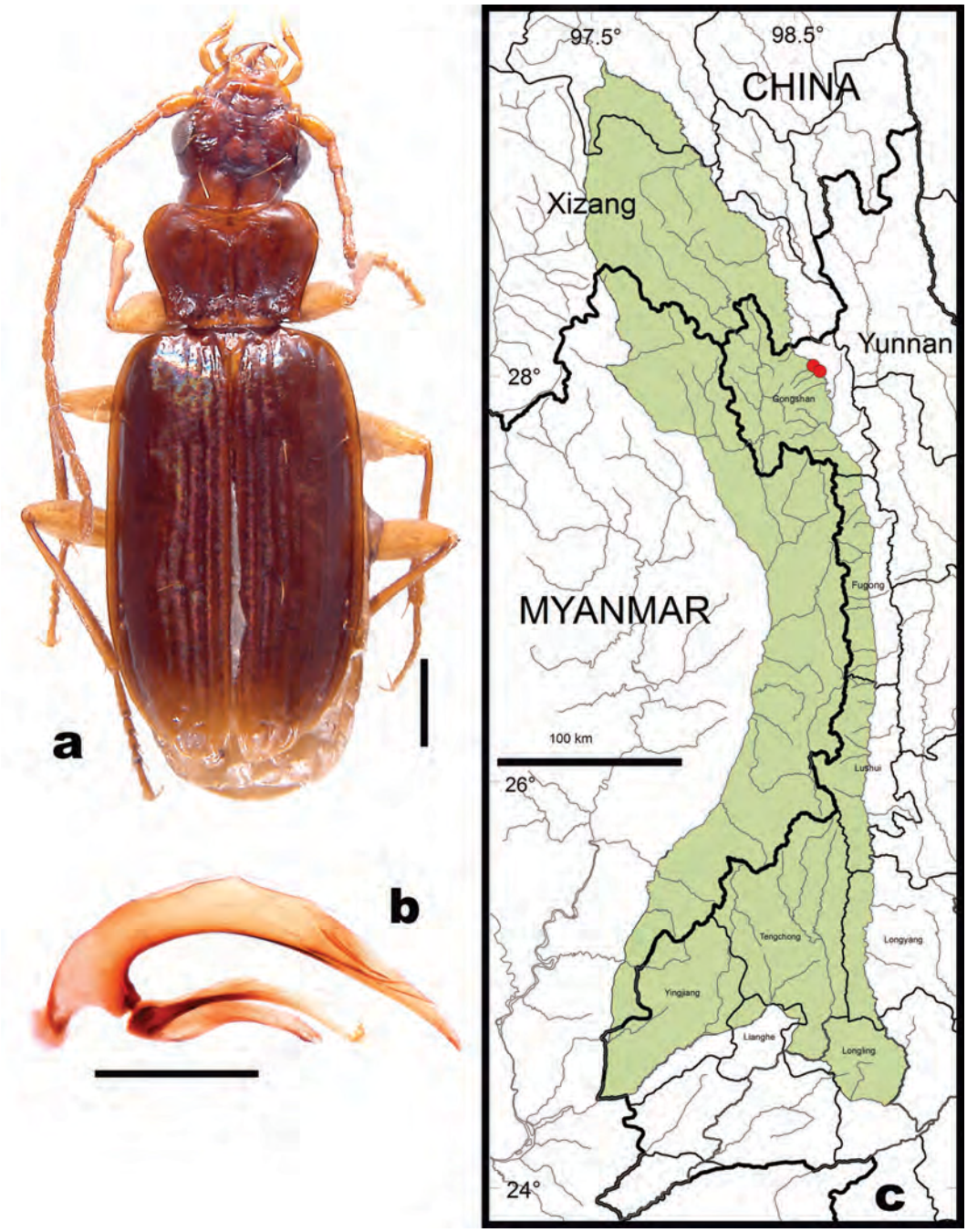


FIGURE 15. *Eocnides fragilis* Uéno; a. Dorsal habitus (CASENT1029485). b. Median lobe of aedeagus of male (CASENT1029485), left lateral aspect. c. Map of locality records (red circles) for *E. fragilis* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

tor [1 female; CAS]. This record extends the range of *E. fragilis* in Sichuan. The discovery of *E. fragilis* in the northern Gaoligong Shan region, in western Yunnan Province, extends its known range an additional 260 km SW.

Genus *Trechus* Clairville, 1806

Trechus Clairville, 1806:22.

Type species.— *Carabus rubens*, Clairville, 1806 [nec Fabricius, 1801] (= *Carabus quadristriatus* Schrank, 1781), designated by Blanchard (in Audouin et al. 1841, plate 25). See also comments on type species by Bousquet (2012: 505).

Diagnosis.— Adults of this genus (Fig. 17-25) can be recognized by the following combination of character states: size very small to small for family (BL = 2.5 to 7.0 mm), fully-winged or apterous, eyes large and projected or reduced, with some members eyeless; body color varied, from pale yellowish-tan to black; body form varied, compact and convex in most members, more slender and depressed in some members; labrum with anterior margin concave; right mandible bidentate or tridentate, but with the premolar fused with the retinaculum; submentum free, not fused with mentum, with six setae anteriorly in most members; pronotum with disc glabrous, two pairs of setae lateral present, one each side near middle and near basal angle; elytra with discal striae distinctly impressed and complete or more or less effaced, recurrent stria distinct, discal setae only on interval 3, near or in stria 3 in most members, two setae present in most members, but with more, one or none present in a few members; preapical seta present near discal stria 2 or absent, in a few members present and inserted more anteriorly in a discal position on interval 3 near stria 2 or 3; umbilicate setae of the humeral group equally spaced; protibiae longitudinally furrowed or not.

Comments.— As can be inferred from the above diagnosis, the large genus *Trechus* is markedly heterogeneous and probably polyphyletic. This hypothesis of polyphyletism has been corroborated by early results of analyzes of nucleic acid sequences data (Faille et al. 2010, 2013a).

Among morphological features commonly used in comparative systematic studies of genus *Trechus*, two deserve special attention because they have allowed us to distinguish three new genera, described below, among species occuring in the Gaoligong Shan Mountains. These features include (1) the presence and position or the absence of a preapical elytral seta, and (2) the dentition of the mandibles.

1) *Presence and position of preapical seta*: The primary elytral discal setae of carabid beetles are located on the odd intervals: 3, 5, 7 and 9 (Jeannel 1941). Jeannel named the setae of interval 9 the "*série ombiliquée*", the umbilicate series.

In members of subtribe Trechina, the umbilicate series includes a group of four consecutive humeral setae, a middle group of two consecutive setae, and two more isolated posterior setae; discal setae are absent from interval 7; they occur on interval 5 in some members (eg., in *Trechiama* Jeannel (1927) and *Epaphiopsis* Uéno (1953)). In most members, there are three setae on interval 3, inserted subbasally, near the middle and preapically, respectively. Although this can be considered the basic number for members of the subtribe, but this number is varied, more or less.

In members of genus *Trechus*, there are typically three discal setae in interval 3, the first two inserted in or against stria 3, the third in prepical position inserted against stria 2. In some species (eg., *Trechus perissus* Andrewes (1936), described from Sikkim (see Uéno 1972a), or *Trechus setitemporalis* Deuve (2005), described from southern Xizang Autonomous Region), an additional discal seta is present, inserted next to stria 3, between the middle and preapical setae. In a few species, it is the preapical seta itself, typically inserted preapically against stria 2 that is advanced anteriorly to a discal position on the 3rd interval and inserted either in the center of the interval or

even against stria 3. In the latter case, it is difficult to know if it is actually the preapical seta shifted forward or a supernumerary discal seta with the preapical seta absent. Forward displacement of the preapical seta has been observed in other Trechina as well, such as in members of *Epaphiopsis* subgenus *Pseudepaphius* Uéno (1962), occuring in subtropical China.

Among the representatives of the genus *Trechus* occuring in the Gaoligong Shan, we have identified a particular group of species that we call the "*Trechus qiqiensis* Group", members of which share this forward displacement of the preapical seta. We suggest that this is a synapomorphy for this group. Moreover, with the exception of *T. shiyueliang* sp. nov., members of this group share another synapomorphy: the recurrent stria is continuous anteriorly with stria 7, which is unusual in genus *Trechus*, although previously observed in *Trechus yasudai* Ueno (1973) from eastern Nepal. Based on these two unusual features, this group of species appears to represent a natural, monophyletic group.

Members of the *Trechus qiqiensis* group may be related to some Himalayan species, such as *Trechus himalayanus* Ueno (1972b), in which the preapical seta is displaced forward (Deuve 1988) but the recurrent stria is not in line anteriorly with stria 7. Forward displacement of the preapical seta has long been known to occur also in members of genus *Epaphius* Samouelle (1819).

2) *Dentition of the mandibles*: Jeannel (1926, 1941) separated the Trechini into two groups: (1) the "Tridentati", with a premolar tooth on the mandibles, which grouped what he called the "more primitive" lineages; and (2) the "Bidentati', "without a premolar tooth", which corresponded to the Trechina, including genus *Trechus*. This fundamental dichotomy was accepted by most authors, who, as seemed appropriate, described the mandibles as either "tridentate" or "bidentate". However, this was actually a source of confusion because assigned to the Bidentati were some members with a cleft retinaculum that appeared trifid. The mandibles of those Bidentati with a trifid retinaculum were thus often called "tridentate" in species descriptions. However, Jeannel defined the distinction between the Bidentati of Tridentati precisely, with the criterion being the presence or absence of the premolar tooth.

The mandibles are naturally asymmetrical in order to allow meshing of the teeth when closed. It is the right mandible which serves as the benchmark because it best shows the components: molar, premolar and retinacular blade [For a good understanding of this classic nomenclature, see Acorn and Ball (1991)].

Study of cave Trechina of China recently has revealed that, within the genus *Guizhaphaenops* Vigna Taglianti (1997), members of some species had the right mandible tridentate while in those of other species it was bidentate. The explanation given was that the premolar tooth was merged with the retinaculum to form a trifid ("tridentate") process, and that in the species with the "bidentate" mandible, the median point of this process had been lost subsequently, resulting in a bidentate process, formed in reality of the merged premolar tooth and the retinaculum retaining only its anterior tooth (Deuve and Queinnec 2014). It appears that what was described by Jeannel as disappearance of the premolar tooth was actually the result of a merger of the latter with the retinaculum.

The combination of the unifid premolar with the bifid retinaculum to form a trifid process is evident in genus *Queinnectrechus*, for which the right mandible has been described and illustrated by Deuve (1992a, 1992b), then by Belousov and Kabak (2003), and in which the two teeth, premolar and retinacular, are not yet fully merged.

Among *Trechus* members, the right mandible has been considered as of the "bidentate" type, but with both bidentate and tridentate retinacula represented (Jeannel 1941). In fact, in both cases the premolar tooth is present but fused with the retinaculum. This is the case among all the true

Trechus we have examined from the Gaoligong Shan, which all show a trifid state (Fig. 16b-d). However, in members of a very specific and homogeneous group of species in the study area, the right mandible has dentition of another type: the premolar tooth is incompletely fused with rétinacle (a relatively symplesiomorphic condition) and the anterior tooth of the retinaculum is located forward (a synapomorphy), a greater distance from the posterior tooth (Fig. 16f). Members of this group of species also present two additional remarkable features. First, there is only one or no discal setae on elytral interval 3; and second, the tempora are sparsely pubescent, whereas they are glabrous in all other "*Trechus*" of the Gaoligong Shan region. Members of some species in Tibet, such as *Trechus setitemporalis* Deuve (2005), or those of the "*Trechus dacatraianus* Group" (Schmidt 2009), also have pubescent tempora. However, it is the combination of the three states mentioned above, especially the mandibular structure, which leads us to exclude these species from *Trechus* and consider them as representing a distinct genus within the *Epaphiopsis* Complex of genera. Descriptions of this genus and the included species are provided below. A related species, but one in which members have the tempora glabrous and the premolar and retinaculum of the right mandible (Fig. 16h) more fully fused, is also excluded from *Trechus* and described as a separate genus. Finally, we also exclude two additional species from the southern part of the Gaoligong Shan from *Trechus*. In members of these species, the right mandible (Fig. 16g) is very similar to a bidentate type, but the premolar tooth is not fused with the retinaculum. We consider these also as representing a new and distinct genus described below.

Geographical distribution.— Genus *Trechus* is a megadiverse taxon with more than 900 described species and subspecies arrayed in eight subgenera (Lorenz 2005); and about 95% of these species-group taxa are currently classified in the nominate subgenus. The genus is predominately Holarctic in distribution and widespread in that Region (Jeannel 1927, Casale & Laneyrie 1982), with a few species also recorded from the Afrotropical and Oriental Regions. Several species from subtropical or tropical parts of Southeast Asia have been described in genus *Trechus.* Examples of such species include *Trechus thai* Deuve (1995) from Thailand, *Trechus myanmarensis* Deuve (2005) and *Trechus natmataungensis* Donabauer (2010) from Myanmar and *Trechus vietnamicus* Uéno (1995) from Vietnam. However, the genus is not known from tropical or subtropical parts of China, where it appears to be replaced by species representing the *Epaphiopsis* Complex of genera.

Key for Identification of Adults of *Trechus* Species of the Gaoligong Shan Region

1. Size larger (BL = 4.2 to 5.0 mm), fully-winged; elytra elongate, recurrent stria terminated abruptly on interval 6; preapical seta absent or vestigial and inserted near elytral apex, also without a third discal seta in apical one-fouth of elytra . . . . . *T. indicus* Putzeys
   Size varied, but generally smaller (BL = 3.3 to 4.7 mm), elytra short, recurrent stria continuous anteriorly with stria 5 or 7, preapical seta present and inserted near stria 2 in a subdiscal position or as third discal seta near stria 3 in apical one-fourth of elytra (*Trechus qiqiensis* Group) 2

***Trechus qiqiensis* Group**:

2. Elytra with recurrent stria in line anteriorly with stria 5, preapical seta inserted near stria 2; size moderately large for group (BL = 4.0 to 4.2 mm) (*Fugong County*). . ***T. shiyueliang* sp. nov.**
   Elytra with recurrent stria in line anteriorly with stria 7, preapical seta inserted in interval 3, either near stria 2 or stria 3; size varied. 3

3. Size larger, BL at least 4.0 mm 4
   Size smaller, BL less than 4.0 mm. 6

4. Size larger (BL = 4.5-4.7 mm); pronotum less transverse (ratio PW/PL = 1.40), with anterior transverse impression indistinct; elytra broad, disc slightly flattened (*Tengchong County*) . . . . . ***T. mingguangensis* sp. nov.**
   Size smaller (BL = 4.0 to 4.2 mm); pronotum more transverse (ratio PW/PL = 1.44 to 1.46), with anterior transverse impression distinct; elytra ovoid, disc convex, not at all flattened . 5

5. Elytra with discal striae very distinctly punctate and slight attenuated toward elytral apex; pronotum with basal foveae deep, distinct (*Gongshan County*) . . . . . ***T. qiqiensis* sp. nov.**
   Elytra with discal striae only faintly punctate and not attenuated toward elytral apex; pronotum with basal foveae shallow, less well defined (*Fugong County*) . . . . . ***T. pseudoqiqiensis* sp. nov.**

6. Size larger (BL = 3.7-3.8 mm), elytra with lateral discal striae more shallowly impressed but still clearly evident (*Lushui County*) . . . . . ***T. luzhangensis* sp. nov.**
   Size smaller (BL = 3.3-3.5 mm); elytra with discal striae 6 and 7 effaced, faintly or not at all evident 7

7. Tempora only slightly convex (*Gongshan County*) (Fig. 23a) . . . . ***T. gongshanensis* sp. nov.**
   Tempora markedly convex (*Fugong County*) (Fig. 24a) . . . . . ***T. shibalicus* sp. nov**.

Trechus (*Trechus*) *indicus* Putzeys, 1870

(Figs. 16b, 17, 41a, 44, 45–48)

Trechus indicus Putzeys, 1870:175. Holotype, lost (see Jeannel 1923, footnote p. 416). Type locality: eastern India.

Trechus (*s. str.*) *indicus* Putzeys: Jeannel, 1927:157, 158 (in part)

Trechus (*s. str.*) *macrops* Jeannel, 1927:157, 160 (in part). Type locality: China, Yunnan. Synonymized by Jeannel (1935: 275).

Trechus macrops Jeannel: Andrewes, 1935 63, 67.

Trechus indicus Putzeys: Jeannel, 1935:275.

Trechus indicus Putzeys: Deuve, 1988:80.

Trechus (*s. str.*) *indicus* Putzeys: Uéno 1977:181.

Trechus (*s. str.*) *macrops* Jeannel: Uéno & Yin, 1993:354. These authors considered *T. macrops* as a distinct species.

Diagnosis.— Adults of this species (Fig. 17a) can be distinguished from those of all other species in the region by the following combination of character states: size large for genus (BL = 4.2 to 5.0 mm); fully-winged; eyes markedly large, tempora very short, joined to neck region at nearly a right angle; frontal furrows angulate at midlength; right mandible as in Fig. 16b; mentum and submentum not fused; mentum with medial tooth simple, triangular; antennae with antennomeres 3 and 4 subequal in length, antennomere 2 slightly shorter; pronotum transverse (ratio PW/PL = 1.43), with lateral margins not sinuate posteriorly, straight just anterior to basal angles, the latter small and rectangular, lateral explanation very wide basally, basal margin slightly convex medally; elytra oblong, lateral discal striae effaced, only the medial four or five striae distinctly impressed, recurrent stria markedly impressed; preapical seta absent or vestigial, two discal setae present, inserted in stria 3 at anterior one-fifth and at middle, respectively; median lobe of male aedeagus (Fig. 17b) not arcuate, with apex slender, ventrally hooked, endophallus with two elongate, projecting sclerites, one apically tapered, the other apically lobate.

Comments.— Uéno (1977:182) correctly pointed out that this widely distributed species, with members fully-winged, is morphologically varied across its range. In particular, the preapical seta

tends to be absent from members of eastern populations. The many specimens we examined from localities in the study area confirm his observation. Among them, the prepical seta is absent from most specimens. If present, the seta is very small or vestigial, and only present unilaterally in most such cases. This led Uéno (1999a:215), while reporting the presence of this species in the Gaoligong Shan for the first time, to consider the eastern populations, including those in the study area, as a separate species, *T. macrops* Jeannel.

Habitat distribution.— Members of this species have been found in a variety of microhabitats at elevations ranging from 1230 to 2486 m. They have been collected in daytime from under stones on the shaded and open banks of small to large streams, along roadcuts, and in closed canopy forest. At night, they have been found active on open sandy beaches and floodplain flats of larger streams (Fig. 41a) and on the ground along roadcuts. In almost all of the localities where specimens of *T. indicus* were founded, they were the only trechine collected. However, they were found syntopic with specimens of *Agonotrechus xiaoheishan* at Xiaoheishan Forest Reserve in the southern part of the study area. Uéno (1999a) reported that specimens of this species (which he recorded as *Trechus macrops* Jeannel) were found in the same area as specimens of *Agonotrechus yunnanus* and *Epaphiotrechus fortipes* (Uéno) comb. nov.

Geographical distribution within the Gaoligong Shan.— Fig. 17c. We examined a total of 86 specimens (45 males and 41 females) from the following localities: ***Fugong County*:** Lumadeng Township (Lumadeng, 1230 m, N27.02606°/E98.86269°, 23 April 2004, D.H. Kavanaugh collector [1 female; CAS]). ***Gongshan County*:** Dulongjiang Township (Bapo, 1412 m, N27.73902°/E98.34975°, 3 November 2004, H.B. Liang collector [1 male; IOZ]; Bapo area, Dulong Jiang at Mulangdang, 1355 m, N27.75256°/E98.34745°, 4 November 2004, H.B. Liang collector [1 male; IOZ]; 0.6 km N of Dizhengdang village on Dulong Jiang, 1880 m, N28.084427°/E98.32652°, 29-30 October 2004, D.H. Kavanaugh, D.Z. Dong & G. Tang collectors [9 male and 8 females; CAS, IOZ]; Dulong Jiang at Elideng village, 1640 m, N28.000287°/E98.32145°, 3 November 2004, D.H. Kavanaugh, D.Z. Dong & G. Tang collectors [13 male and 8 females; CAS, IOZ]; Dulong Jiang at Xianjiudang village, 1580 m, N27.94092°/E98.33340°, 4 November 2004, D.H. Kavanaugh, M.A. Dixon, D.Z. Dong & G. Tang collectors [1 male and 7 females; CAS, IOZ]; 0.2 km S of confluence of Dulong Jiang and Muke Wang, 1450 m, N27.84125°/E98.33979°, 7 November 2004, D.H. Kavanaugh, V.F. Lee & D.Z. Dong collectors [1 female; CAS]; 0.5 km N of Kongdang, 1500 m, N27.88111°/E98.34063°, 25 October 2004, D.H. Kavanaugh, H.B. Liang, D.Z. Dong & G. Tang collectors [1 female; CAS]; Moqie Wang at Gongshan-Dulong Road Km 91, 1550 m, N27.89934°/E98.34999°, 6 November 2004, D.H. Kavanaugh & H.B. Liang collectors [2 males and 4 female; CAS, IOZ]). ***Longling County*:** Longjiang Township (small stream 1.2 km SSE of Km 23.5 on Route 23.5, 2020 m, N24.2888°/E98.76001°, 25 May 2005, D.H. Kavanaugh, H.B. Liang & D.Z. Dong collectors [1 male; CAS]; Xiaoheishan Forest Reserve, 2067 m, N24.83671°/E98.76185°, 28 May 2005, H.B. Liang, K.J. Guo & H.M. Yan collectors [3 males; CAS, IOZ]); Zhen'an Township (Bangbie village, 1540 m, N24.81306°/E98.83306°, 30 October 2003, H.B. Liang & X.C. Shi collectors [1 male; IOZ]). ***Longyang County:*** Bawan Township (Baoshan-Tenchong Road Km 24 at Nankang Yakou, 2130 m, N24.82583°/E98.77222°, 26 October 2003, H.B. Liang & X.C. Shi collectors [1 female; IOZ]; Bawan-Tengchong Road at Km 40-41, 2404 m, N24.93750°/E98.75083°, 12 October 2003, H.B. Liang & X.C. Shi collectors [1 male; IOZ]; Bawan-Tengchong Road at Km 41, 2486 m, N24.93750°/E98.75083°, 11 October 2003, H.B. Liang collector [1; female; IOZ]; Bawan-Tengchong Road at Km 42-46, 2290 m, N24.95361°/E98.74222°, 14 October 2003, H.B. Liang & X.C. Shi collectors [1 female; IOZ]; Luoshuidong area at Sancha He, 2300 m, N24.94833°/E98.75667°, 26-31 October 1998, D.H. Kavanaugh & C.E. Griswold collectors [1 female; CAS]). ***Tengchong County:*** Jietou Township

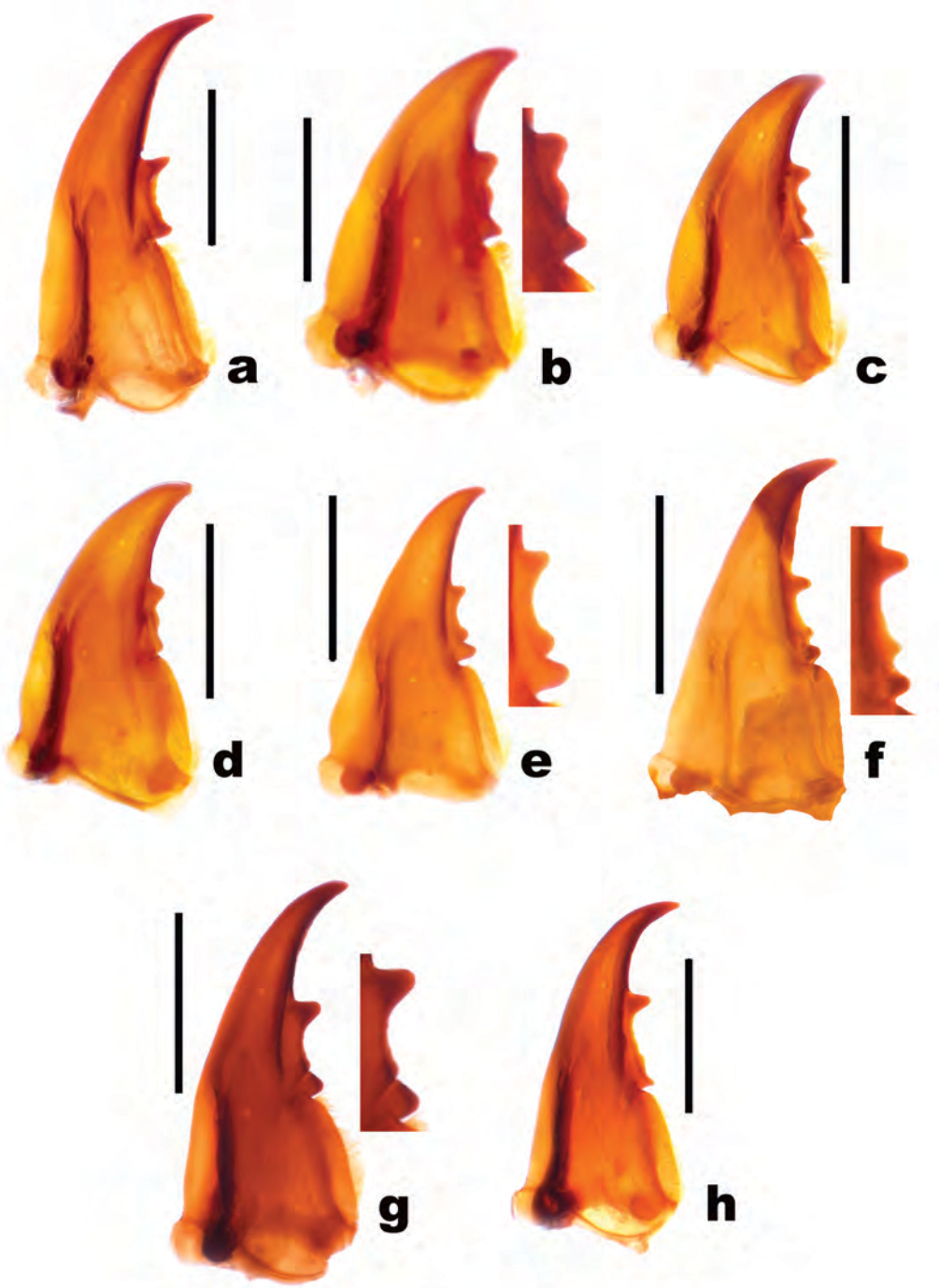


FIGURE 16. Trechine right mandibles, ventral aspect. a. *Agonotrechus xiaoheishan* sp. nov. b. *Trechus indicus* Putzeys with dentition enlarged. c. *Trechus gongshanensis* sp. nov. d. *Trechus shibalicus* sp. nov. e. *Pseudepaphius gonggaicus* Deuve with dentition enlarged (China, Sichuan Province, Moxi Township, NE slope of Gongga Shan). f. *Trechepaphiopsis uniporosa* sp. nov. with dentition enlarged. g. *Epaphiotrechus fortipesoides* sp. nov. with dentition enlarged. h. *Trechepaphiama gaoligong* sp. nov. Scale lines = 0.5 mm.

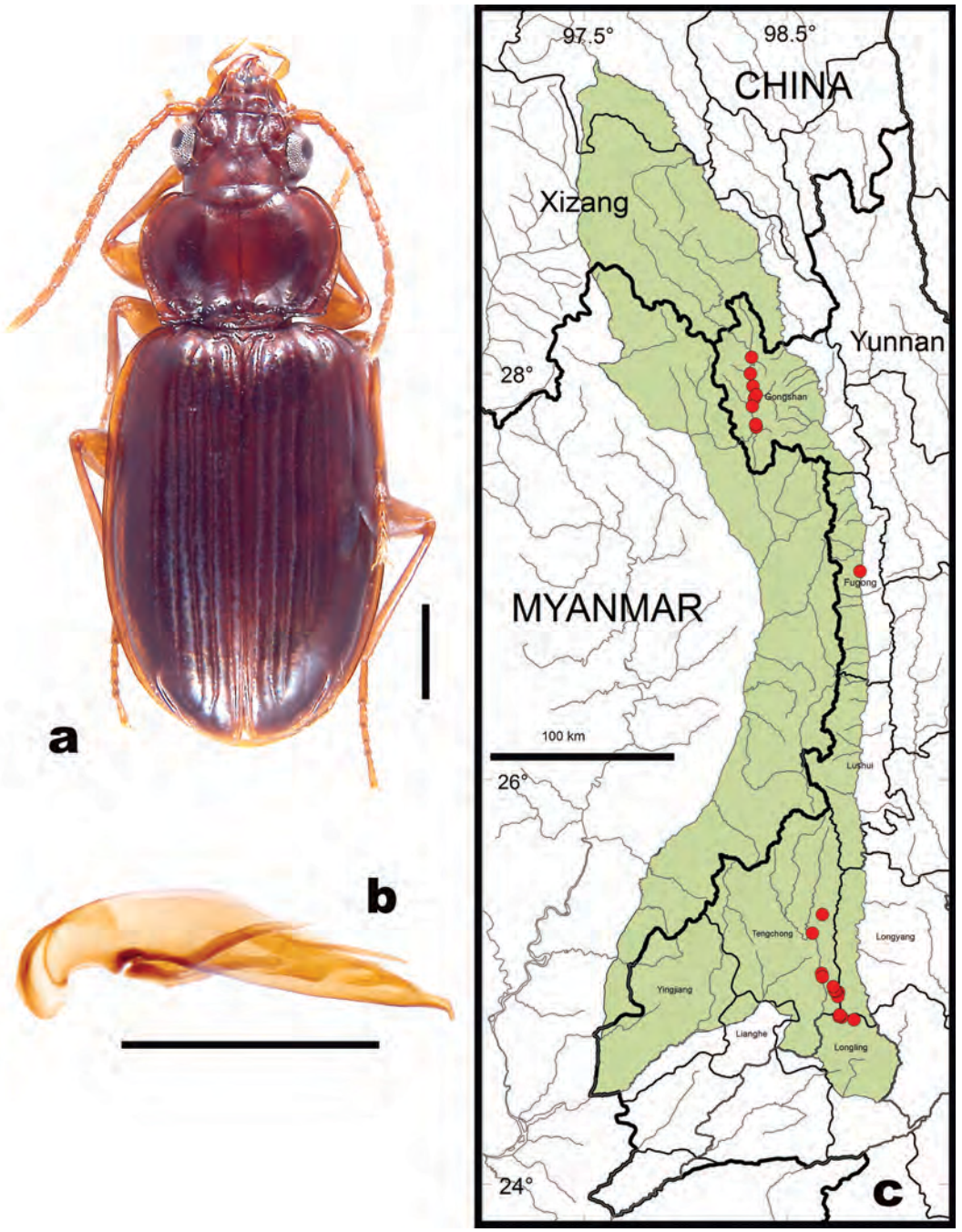


FIGURE 17. *Trechus indicus* Putzeys; a. Dorsal habitus (CASENT1016115). b. Median lobe of aedeagus of male (CASENT1015874), left lateral aspect. c. Map of locality records (red circles) for *T. indicus* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

(Zhoujia-po village, 1740 m, N25.33222°/E98.67611°, 24 October 2003, D.Z. Dong collector [1 male; CAS]); Qushi Township (Longchuan Jiang at Xiaojiangqiao, 1445 nm, N25.23944°/E98.63722°, 21 October 2003, H.B. Liang & X.C. Shi collectors [1 male; IOZ]); Shangying Township (Bawan-Tengchong Road Km 46-51, 2220 m, N24.95722°/E98.73667°, 17 October 2003, H.B. Liang & X.C. Shi collectors [1 male; IOZ]); Bawan-Tengchong Road Km 48-51 at Dahaoping Forest Station, 2014 m, N24.97556°/E98.73000°, 18 October 2003, H.B. Liang collector [6 males and 6 females; CAS, IOZ, MNHN]; Bawan-Tengchong Road Km 65, beside Longchuanjiang, 1335 m, N24.04167°/E98.67306°, 19 October 2003, H.B. Liang & X.C. Shi collectors [1 male and 1 female; CAS IOZ]; Bawan-Tengchong Road Km 65 at Longwenqiao, 1285 m, N25.02396°/E98.67675°, 20 October 2003, H.B. Liang & X.C. Shi collectors [1 male; IOZ]); Wuhe Township (Xiaoheishan Forest Station, 2025 m, N24.82889°/E98.76000°, 29 October 2003, H.B. Liang collector [1 male and 1 female; CAS, IOZ]).

Members of this species have been collected in both northern and southern parts of the study area and on both eastern and western slopes of the Gaoligongshan. We have recorded this species from Core Areas 1, 3, 6, and 7. The absence of records from Core Areas 2, 4 and 5 is likely the result of inadequate sampling.

Overall geographical distribution.— Fig. 45. This species is widely distributed along the southern edge of the Himalayan Mountains and Qinghai-Xizang (Tibetan) Plateau from eastern Afghanistan to Sichuan Province, China. Attainment and maintenance of this broad geographical range is no doubt facilitated by the flight capability of members of this species.

Trechus (*Trechus*) *shiyueliang* Deuve and Kavanaugh, sp. nov.

(Figs. 18, 40b, 42b, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1021004"/ "CHINA, Yunnan, Fugong County, Lishadi Township, 10-11 km W of Shibali on Shibali Road, 3200-3280 m, NN27.19980°/E98.71375° to N27.20654°/E98.71772°,"/ 8 August 2005, Stop#DHK-2005-068 D.H. Kavanaugh, H.B. Liang, P. Paquin, & D.Z. Dong collectors"/ "IMAGE" [green label]/ "HOLOTYPE *Trechus shiyueliang* Deuve & Kavanaugh, sp. nov. designated 2016" [red label]. Paratypes (a total of 8): 1 female (in IOZ) labeled same as holotype, except first label: "CASENT 1021005"; 1 male and 1 female (in IOZ) labeled: "CASENT 1018374" and "CASENT 1018373", respectively/ "CHINA, Yunnan, Fugong County, Lishadi Township, 10 km W of Shibali on Shibali Road, 3221 m,"/ , N27.20055°/E98.71399°, 16 August 2005, Stop #PP-3805 P. Paquin collector"; 1 female (in CAS) labeled: "CASENT 1023759"/ "CHINA, Yunnan, Fugong County, Lishadi Township, 8.5 km above Shibali on Shibali Road, North Fork of Yamu He, N27.18416°/E98.72026°,"/ "3100 m, 7 May 2004 Stop #DHK-2004-038A D.H. Kavanaugh, C.E. Griswold, Liang H.-B., & Zhu B.-X. collectors"; 1 male (in IOZ) labeled: "CASENT 1020019"/ "CHINA, Yunnan, Fugong County, Lumadeng Township, ridge S of Shibali Yakou, N27.20802°/E98.69644°,"/ "3740 m, 12 August 2005, Stop #DHK-2005-092 D. H. Kavanaugh collectors"; 2 males and 1 female (in CAS) labeled: "CASENT 1021323" to "CASENT 1021324" and "CASENT 1021325", respectively/ "CHINA, Yunnan, Fugong County, Lumadeng Township, Lao Shibali Yakou, 3270 m, N27.06429°/E98.75123°, 13 August 2005,"/ "Stop# DHK-2005-079, D.H. Kavanaugh, H.B. Liang, D.Z. Dong, & G. Tang collectors". All paratypes also bear the following label: "PARATYPE *Trechus shiyueliang* Deuve & Kavanaugh, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Fugong County, Shiyueliang Township, 10-11 km W of Shibali on Shibali Road, 3200-3280 m.

Derivation of species name.— The species epithet, *shiyueliang*, a noun in apposition, is

derived from the name of the township in which the type locality is located, Shiyueliang. This is the current name for the former Lishadi township.

Diagnosis.— Adults of this species (Fig. 18a) can be distinguished from those of all other species in the region by the following combination of character states: size relatively large (BL = 4.0 to 4.2 mm), apterous; body color reddish-brown; head slightly elongate; tempora glabrous; pronotum moderately transverse (ratio PW/PL = 1.42); elytra with striae not or faintly punctate, recurrent stria continuous anteriorly with stria 5, two discal setae present and inserted next to stria 3, preapical seta present and inserted next to stria 2 in forward position near apical one-fourth of elytra; median lobe of male aedeagus with apex thin and faintly reflexed dorsally in lateral view (Fig. 18b), endophallus with only a single, small thin elongate sclerite.

Description.— Size relatively large, BL = 4.0 to 4.2 mm. Body color reddish-brown, shiny, appendages slightly paler. Body surface smooth, head capsule finely alutaceous.

Head. Moderate in size, slightly elongate and thick; eyes small and moderately convex, their diameter about 1.5 times as long as tempora, the latter short, moderately convex and glabrous. Frons slightly flattened; frontal furrows deep, rounded, slightly attenuated posterior to the eyes. Two pairs of supraorbital setae present, the anterior pair inserted in foveae. Clypeus with four setae. Labrum with six setae, anterior margin distinctly concave. Mandibles short; right mandible tridentate with middle tooth closer to basal tooth (premolar) than to distal tooth. Mentum and submentum not fully fused but nearly so, suture between them only faintly impressed. Mentum with medial tooth apically truncate, less than one-half the length of the lateral lobes. Submentum with six setae anteriorly, swollen anteriorly. Gula wide. Genae with a single seta ventrally on each side. Antennae short, with less than two antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 3 and 4 slightly longer than antennomere 2.

Pronotum. Moderately transverse (ratio PW/PL = 1.42), narrowed posteriorly, greatest width near anterior one-third; lateral margins markedly rounded, straightened only just anterior to small, rectangular and sharp basal angles. Disc convex, smooth and glabrous, median longitudinal impression deeply impressed, interrupted anteriorly a short distance from anterior margin; basal foveae distinct; median basal area with several faint, irregular, punctiform depressions, delimited laterally by oblique furrows. Lateral borders of pronotum moderately slender, regular, slightly reflexed, lateral grooves deeply impressed. Single midlateral setae on each side inserted at anterior one-third; single basolateral seta on each side, inserted slightly anterior to apex of basal angle.

Elytra. Ovoid, humeri distinct but rounded. Disc convex and smooth. Striae not or only faintly punctate, striae 1 to 5 deeply impressed, striae 6 to 8 very faintly impressed but evident. Parascutellar striole present. Recurrent stria continuous anteriorly with stria 5. Basal setiferous pore present at common origin of striae 1 and 2. Two discal setae present and inserted next to stria 3, one at anterior one-fourth and one near middle of elytra. Preapical seta present and inserted on interval 3 next to stria 2 in forward position near apical one-fourth of elytra.

Umbilicate setal series with setae of humeral group equidistance from each other and setae of median group inserted slightly posterior to middle.

Legs. Short, protibiae with longitudinal furrow. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, of females with two pairs.

Male aedeagus. Median lobe (Fig. 18b) moderately broad basally with sagittal aileron present and moderate in size; shaft gradually narrowed toward apex; apical lamella short, rectilinear, extremely thin and slightly recurved dorsally in lateral view; endophallus with a single thin and elongate sclerite.

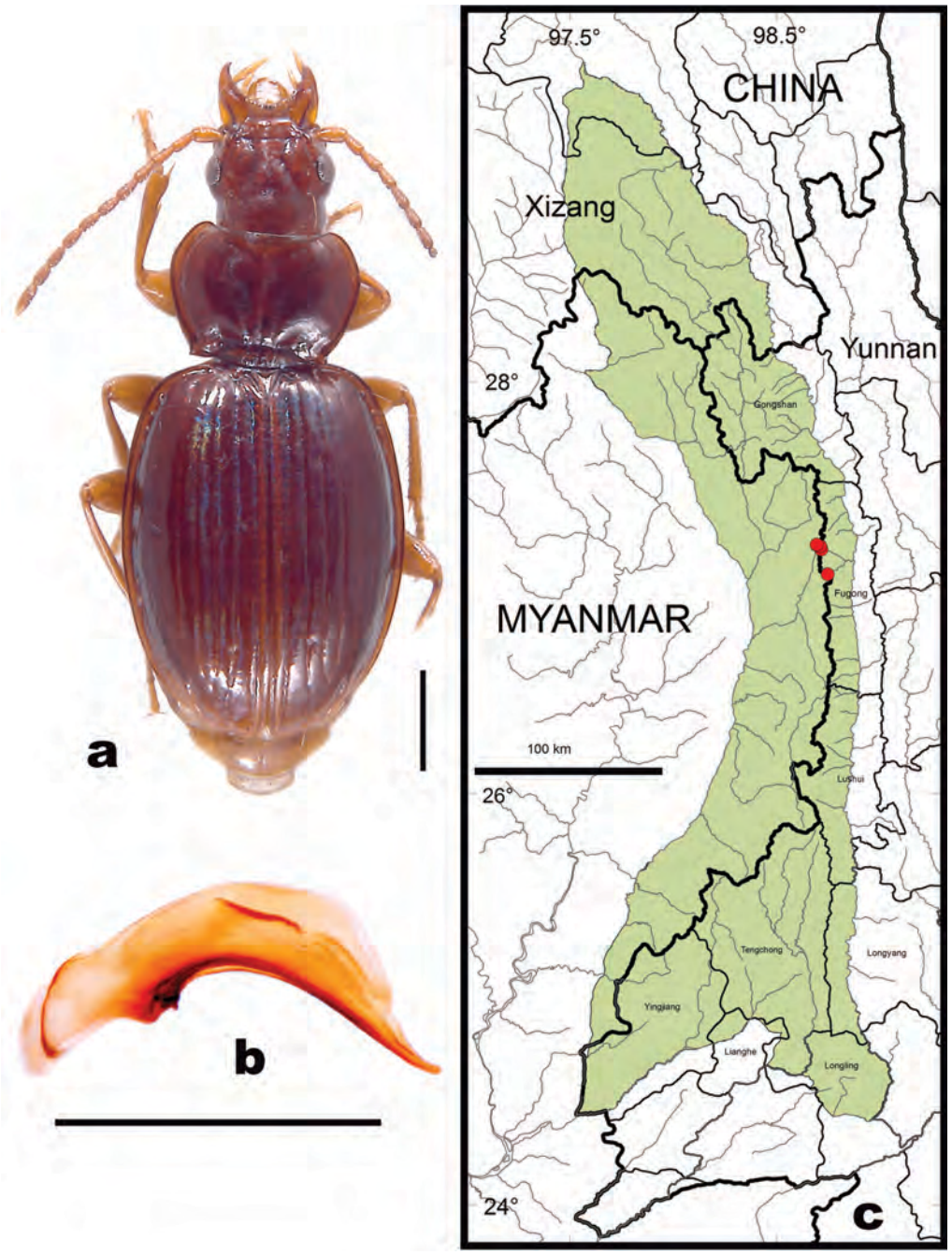


FIGURE 18. *Trechus shiyueliang* sp. nov.; a. Dorsal habitus (CASENT1021004). b. Median lobe of aedeagus of male (CASENT1021004), left lateral aspect. c. Map of locality record s(red circles) for *T. shiyueliang* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

Habitat distribution.— Members of this species have been found in a variety of microhabitats at elevations ranging from 3100 to 3740 m. They have been collected in daytime from under stones in thickets of bamboo and *Prunus*, in rocky open areas cleared by snow avalanches (Fig. 40b), in meadows adjacent to bamboo and *Rhododendron* thickets (Fig. 42b) and along roadcuts through such thickets. They have also been collected at night, found walking on the substrate along roadcuts through areas of bamboo with an overstory of scattered *Abies* trees. At higher elevations, they were the only trechine encountered in this area; but they were found syntopic with specimens of *Trechus shibalicus* sp. nov., *Trechepaphiopsis unipilosa* sp. nov. and *Trechepaphiopsis unisetulosa* sp. nov. at the upper limit of the altitudinal range of this last mentioned species (3100 m).

Geographical distribution within the Gaoligong Shan.— Fig. 18c. We examined a total of 9 specimens (5 males and 4 females), all from Fugong County on the eastern slope and crest of the northcentral part of the Gaoligong Shan (see Type material above for exact collection data). These localities are all in Core Area 3.

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

Trechus (*Trechus*) *mingguangensis* Deuve and Liang, sp. nov.

(Figs. 19, 41b, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1038692"/ "CHINA, Yunnan, Tengchong County, Mingguang Township, Eighth Boundary Post Pass, N25.80984°/ E98.62084°, 2287 m, 23 May 2006,"/ "Stop # DHK-2006-037A, D.H. Kavanaugh, R.L. Brett, X.P. Wang & D.Z.Dong collectors"/ "HOLOTYPE *Trechus mingguangensis* Deuve & Liang, sp. nov. designated 2016" [red label]. Paratypes (only 1): a female (in CAS) labeled: "CASENT 1038840"/ "CHINA, Yunnan, Tengchong County, Mingguang Township, small stream on SW-facing slope below 7.9 airkm N of Zizhi village, 2200 m,"/ "N25.80314°/E98.62117°, 2200 m, 23 May 2006,"/ "Stop # DHK-2006-038A, D.H. Kavanaugh & D.Z. Dong collectors"/ "PARATYPE *Trechus mingguangensis* Deuve & Liang, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Tengchong County, Mingguang Township, Eighth Boundary Post Pass, N25.80314°/E98.62117°, 2287 m.

Derivation of species name.— The species epithet, *mingguangensis*, is derived from the name of the township in which the type locality is located, Mingguang, and the Latin suffix, *-ensis*, denoting place.

Diagnosis.— Adults of this species (Fig. 19a) can be distinguished from those of all other species in the region by the following combination of character states: size large (BL = 4.5 to 4.8 mm), apterous; body color reddish-brown; tempora glabrous, short and convex; pronotum transverse (ratio PW/PL = 1.40), basal angles acute and sharp; elytra very slightly elongate, striae finely punctate, striae 1 to 4 deeply impressed, stria 5 more faintly impressed, striae 6 to 8 effaced or nearly so, recurrent stria terminated anteriorly at a slight convexity in line with the presumed location of stria 7 apically; two normal discal setae present, inserted next to stria 3, preapical seta present, inserted in a discal position next to stria 3 at apical one-fourth of elytra; median lobe of male aedeagus with a large sagittal aileron, apical lamella long and rectilinear, nearly straight, apex thin, endophallus with copulatory piece poorly defined (Fig. 19b).

Description.— Size large, BL = 4.5 to 4.8 mm. Body color dark reddish-brown, shiny, appendages paler, yellowish- or reddish-tan, palpi pale yellow. Body surface smooth, only head capsule faintly alutaceous.

Head. Moderate in size; eyes slightly reduced, moderately convex, but their diameter less than twice as long as tempora, the latter short, moderately convex and glabrous. Frons moderately flat-

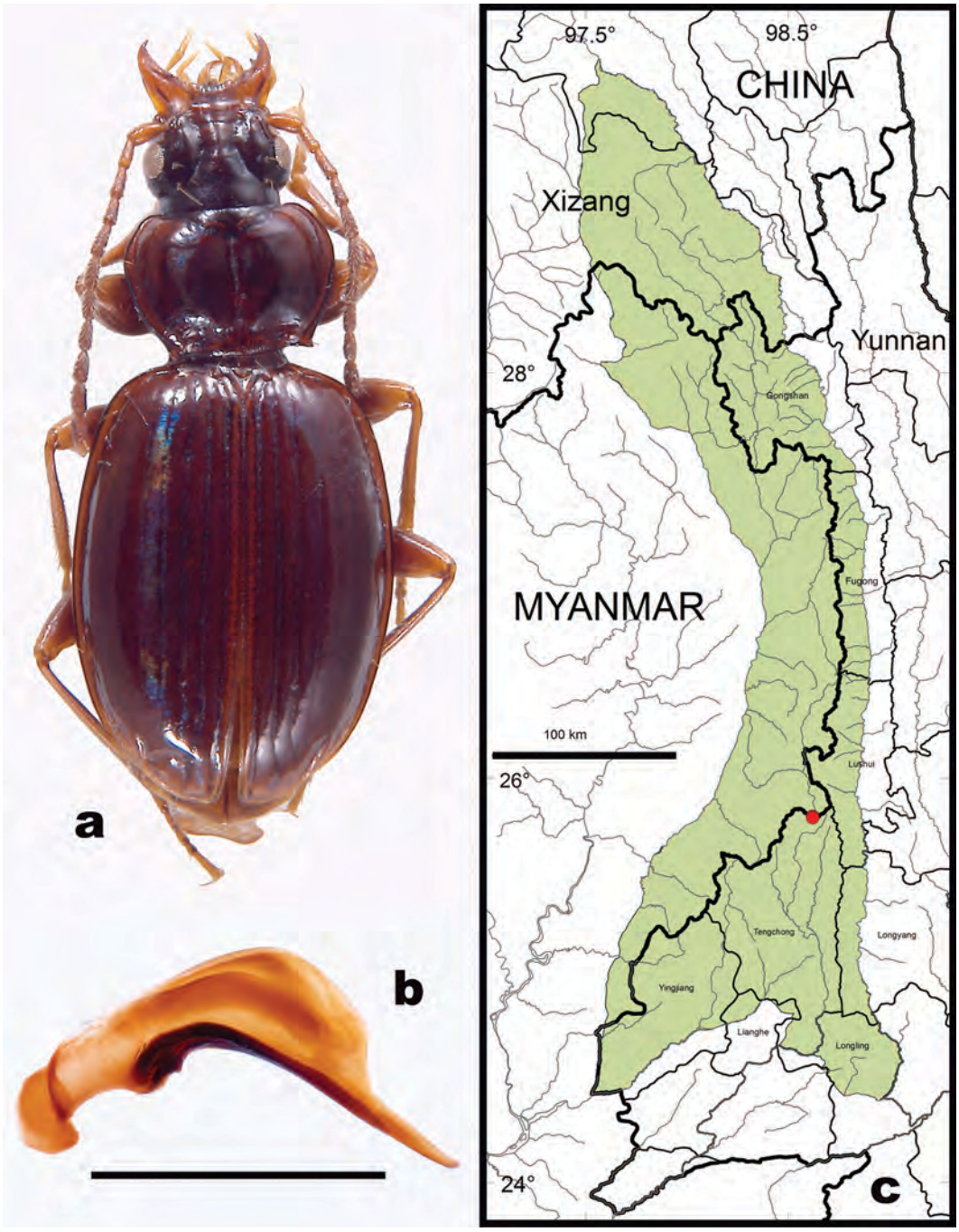


FIGURE 19. *Trechus mingguangensis* sp. nov.; a. Dorsal habitus (CASENT1038692). b. Median lobe of aedeagus of male (CASENT1038692), left lateral aspect. c. Map of locality records (red circles) for *T. mingguangensis* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

tened; frontal furrows deep, curved, prolonged and not attenuated posterior to the eyes. Two pairs of supraorbital setae present, the anterior pair inserted in foveae. Clypeus with four setae. Labrum with six setae, anterior margin distinctly concave. Mentum and submentum not fused but suture between them only faintly impressed. Mentum with medial tooth broad and apically truncate, about one-half the length of the lateral lobes. Submentum with six setae anteriorly. Gula wide. Genae with a single seta ventrally on each side. Antennae short, not quite extended to the basal one-fourth of elytra, male with about 2.5 to 3 antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 2 and 3 about equal in length, antennomere 4 slightly shorter.

Pronotum. Moderately transverse (ratio PW/PL = 1.40), narrowed posteriorly, greatest width anterior to middle; lateral margins widely rounded, straightened only just anterior to basal angles, the latter small, but projected, acute and sharp. Disc convex, smooth and glabrous, median longitudinal impression sharply impressed, not quite extended to anterior margin; basal foveae distinct, subcircular; median basal area with several faint, longitudinal rugulae, delimited laterally by oblique furrows. Basal margin slightly bisinuate, slightly reflexed and oblique laterally, slightly projected medially. Lateral borders of pronotum moderately slender, regular, slightly reflexed, lateral grooves deeply impressed. Single midlateral setae on each side inserted slightly anterior to middle; single basolateral seta on each side, inserted at basal angle.

Elytra. Ovoid, only very slightly elongate, more narrowed basally than apically, humeri distinct but rounded. Disc convex and smooth. Striae very finely punctate, striae 1 to 4 deeply impressed, stria 5 more faintly impressed, striae 6 to 8 effaced or nearly so. Parascutellar striole present. Recurrent stria terminated anteriorly by a slight convexity at the presumed location of stria 7 apically. Basal setiferous pore present at common origin of striae 1 and 2. Two discal setae present and inserted next to stria 3, one at anterior one-fourth and one near middle of elytra. Preapical seta present and inserted in a discal position on interval 3, next to stria 3 in forward position at apical one-fourth of elytra. Umbilicate setal series with setae of humeral group equidistance from each other and setae of median group inserted slightly posterior to middle.

Legs. Relatively short, protibiae with longitudinal furrow. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, of females with four pairs.

Male aedeagus. Median lobe (Fig. 19b) only slightly enlarged basally but with a large sagittal aileron present; shaft markedly narrowed at middle and broader subapically; apical lamella long, rectilinear, extremely thin in lateral view; endophallus voluminous but without well-defined sclerites.

Habitat distribution.— One specimen of this species was found under stones and debris along a roadcut (Fig. 41b) through slightly disturbed primary forest of *Tsuga*, with small, scattered small bamboo thickets; and the other specimen was found under stones along a small stream crossing the road in the same general area. No other trechines were collected in either of these sites, which range in elevation from 2200 to 2287 m.

Geographical distribution within the Gaoligong Shan.— Fig. 19c. We examined a total of 2 specimens, both from Mingguang Township in Tengchong County on the western slope of the southern part of the Gaoligong Shan (see Type material above for exact collection data). Both of these localities are in Core Area 6.

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

***Trechus* (*Trechus*) *qiqiensis* Deuve and Kavanaugh, sp. nov.**
(Figs. 20, 37b, 42a, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1007384"/ "CHINA, Yunnan Province, Gaoligong Shan, Nujiang Prefecture, Nujiang State Nature Reserve, No. 12 Bridge Camp area, 16.3 airkm W of Gongshan,"/ "N27.71503°/E98.50244°, 2775 m, 15-19 July 2000, Stop#00-23A, D.H. Kavanaugh, C.E. Griswold, Liang H.-B., D. Ubick, & Dong D.-Z. collectors"/ "IMAGE" [green label]/ "HOLOTYPE *Trechus qiqiensis* Deuve & Kavanaugh, sp. nov. designated 2016" [red label]. Paratypes (at total of 11): 2 males and 4 females (in CAS, IOZ, MNHN) labeled: same as holotype, except first label "CASENT 1007380" to "CASENT 1007381" and "CASENT 1007382" to "CASENT 1007383" and "CASENT 1007385" to "CASENT 1007386", respectively; 1 male and 2 females (in CAS, IOZ) labeled: "CASENT 1010345" and "CASENT 1010346" to "CASENT 1010347"/ "CHINA, Yunnan, Gongshan County, Cikai Township, 52.6 km W of Gongshan on Dulong Valley Road, 3360-3380 m,"/ "N27.77032°/E98.44661°, 1-2 October 2002, Stop #DHK-2002-034, D.H. Kavanaugh & P.A. Marek collectors";1 male (in CAS) labeled: "CASENT 1015626"/ "CHINA, Yunnan, Gongshan County, Cikai Township, 48 km W of Gongshan on Dulong Valley Road, 3330 m,"/ "N27.78075°/E98.47000°, 13 November 2004, Stop # DHK-2004-086, D.H. Kavanaugh collector"; 1 male (in IOZ) labeled: "CASENT 1025832"/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.3 km SW of Chukuai Lake at campsite,"/ "N27.97686°/E98.47799°, 3750 m, 19 August 2006, Stop #DHK-2006-082, Y. Liu collector". All paratypes also bear the following label: "PARATYPE *Trechus qiqiensis* Deuve & Kavanaugh, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Gongshan County, Qiqi Trail at No. 12 Camp, N27.71503°/E98.50244°, 2775 m.

Derivation of species name.— The species epithet, *qiqiensis*, is derived from the name of the ancient trail, Qiqi Trail, passing through the type locality, and the Latin suffix, *-ensis*, denoting place.

Diagnosis.— Adults of this species (Fig. 20a) can be distinguished from those of all other species in the region by the following combination of character states: size relatively large (BL = 4.0 to 4.2 mm), apterous; body color reddish-brown; eyes slightly convex; tempora glabrous, short and convex; pronotum transverse (ratio PW/PL = 1.44), basal angles rectangular and sharp; elytra with striae 1 to 4 deeply impressed on disc but attenuated apically, remaining striae successively less distinct, the outermost effaced or nearly so; recurrent stria terminated anteriorly by a slight convexity in line with stria 7; two discal setae present, inserted on interval 3 next to stria 3; preapical seta present and inserted in a discal position on interval 3, next to either stria 2 or 3 in forward position near apical one-fourth of elytra; median lobe of male aedeagus large and robust, subapically bent ventrally, apical lamella sinuate and reflexed dorsally (Fig. 20b), endophallus with a more heavily sclerotized voluminous lobe or scaly fold.

Description.— Size relatively large, BL = 4.0 to 4.2 mm. Body color reddish-brown, shiny, appendages concolorous but paler, palpi pale yellow. Body surface smooth, only head capsule faintly alutaceous.

Head. Moderate in size; eyes only slightly projected, slightly more convex, their diameter less than twice as long as tempora, the latter short, convex and glabrous. Frons slightly flattened; frontal furrows deep, curved, continuous but attenuated posterior to the eyes. Two pairs of supraorbital setae present, the anterior pair inserted in foveae. Clypeus with four setae. Labrum with six setae, anterior margin distinctly concave. Mandibles short; right mandible distinctly tridentate with middle tooth closer to basal tooth (premolar) than to distal tooth, left mandible with a small slightly bifid process. Mentum and submentum not fused but suture between them only faintly impressed.

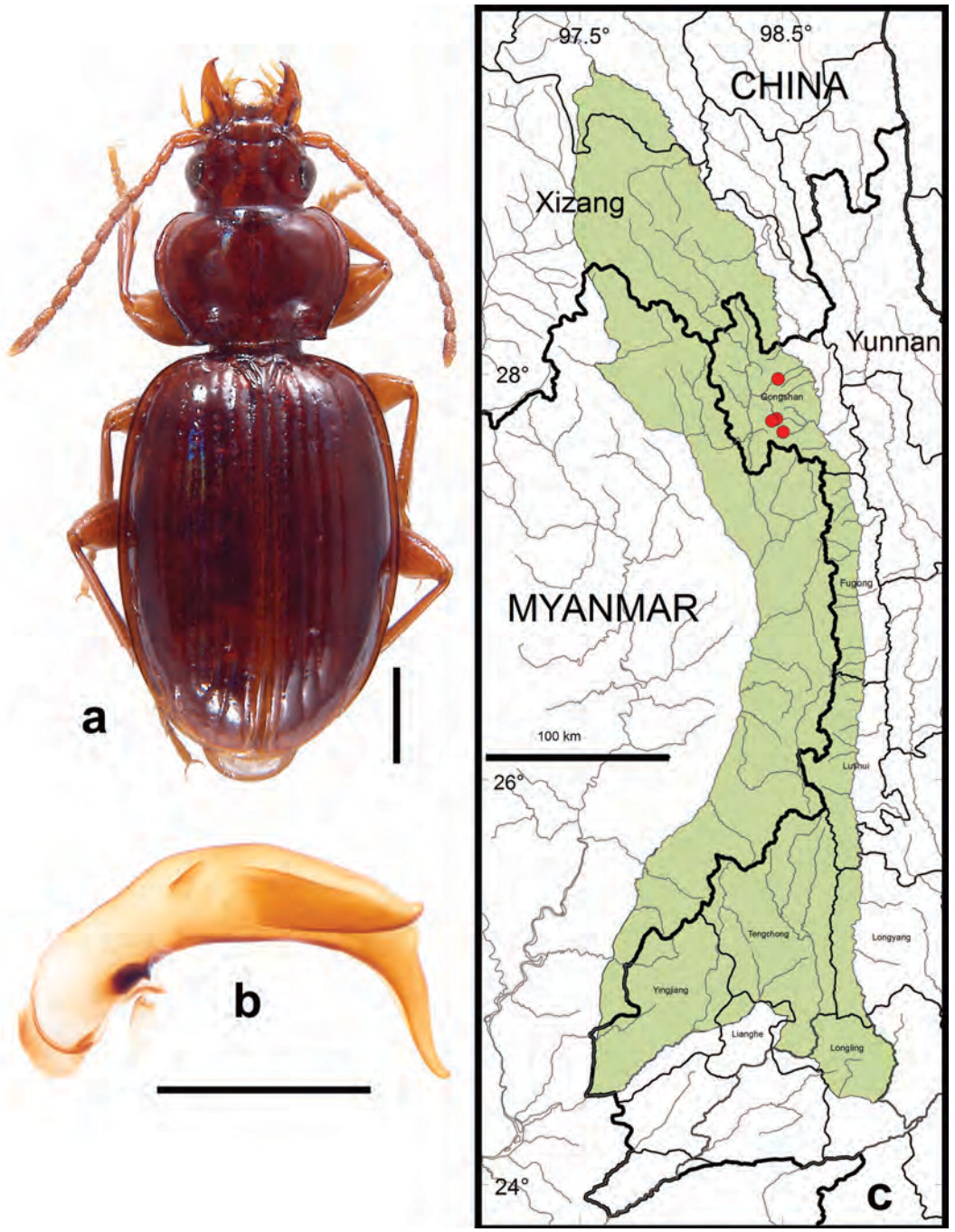


FIGURE 20. *Trechus qiqiensis* sp. nov.; a. Dorsal habitus (CASENT1007384). b. Median lobe of aedeagus of male (CASENT1007384), left lateral aspect. c. Map of locality records (red circles) for *T. qiqiensis* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

Mentum with medial tooth broad and apically truncate, about one-half the length of the lateral lobes. Submentum with six setae anteriorly. Gula wide. Genae with a single seta ventrally on each side. Antennae short, extended posteriorly to basal one-sixth of elytra, with about 2 or 3 antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 2 and 3 about equal in length, antennomere 4 slightly shorter.

Pronotum. Transverse (ratio PW/PL = 1.44), narrowed posteriorly, greatest width near anterior one-fourth; lateral margins markedly rounded, with a short sinuation just anterior to basal angles, the latter small, rectangular and sharp. Disc convex, smooth and glabrous, median longitudinal impression finely impressed, but continuous between anterior and posterior margins; basal foveae distinct, circular; median basal area faintly rugulose, delimited laterally by short, oblique furrows. Basal margin nearly rectilinear, slightly projected medially. Lateral borders of pronotum moderately slender, regular, narrowly and regularly reflexed, lateral grooves narrow but distinctly impressed. Single midlateral setae on each side inserted slightly anterior to middle; single basolateral seta on each side, inserted at basal angle.

Elytra. Ovoid, humeri distinct but rounded. Disc convex and smooth. Striae finely punctate, intervals faintly convex; striae 1 to 4 deeply impressed but attenuated apically, stria 5 more faintly impressed, striae 6 to 8 effaced or nearly so. Parascutellar striole present. Recurrent stria terminated anteriorly by a slight convexity at the presumed location of stria 7 apically. Basal setiferous pore present at common origin of striae 1 and 2. Two discal setae present and inserted next to stria 3, one at anterior one-fourth and one near middle of elytra. Preapical seta present and inserted in a discal position on interval 3, next to either stria 2 or 3 in forward position at apical one-fourth of elytra in most specimens; in a few specimens two preapical setae present, one inserted farther forward next to stria 3, as a third discal seta, the second inserted less far forward and next to stria 2. Umbilicate setal series with setae of humeral group equidistance from each other and setae of median group inserted slightly posterior to middle.

Legs. Medium proportions, slightly short, protibiae with longitudinal furrow. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, of females with two pairs.

Male aedeagus. Median lobe (Fig. 20b) large and robust, with a moderate-sized sagittal aileron; shaft subapically bent ventrally; apical lamella sinuate and reflexed dorsally, bluntly pointed apically; endophallus with a more heavily sclerotized voluminous lobe or scaly fold.

Habitat distribution.— Members of this species have been found at elevations ranging from 2775 to 3750 m in a variety of habitats. At the lowest elevation (2775 m), specimens were collected by sifting meager leaf litter and mosses on the forest floor and on rotting logs (Fig. 42a). This area had abundant conifers (*Abies*, *Thuja*, and *Picea* species) that formed a partly open canopy. Litter and mosses were moist and substrate underneath was composed of crumbling granitic sand. Specimens of *Trechepaphiopsis monochaeta* sp. nov. were also collected in the same litter samples at this site. At higher elevations (above 3300 m), specimens were found under stones in meadows, talus slopes, in low *Rhododendron* thickets, and on heath-covered tundra slopes (Fig. 37b). In such areas, *T. qiqiensis* specimens were found syntopic with those of *Queinnectrechus* (*Gaoligongtrechus*) *balli* and *Queinnectrechus* (*s. str.*) *griswoldi,* and at highest elevation (3750 m) also with members of *Trechus gongshanensis* sp. nov.

Geographical distribution within the Gaoligong Shan.— Fig. 20c. We examined a total of 12 specimens (5 males and 7 females), all from Bingzhiongluo and Cikai Townships in Gongshan County on the crest and eastern slope of the northern part of the Gaoligong Shan (see Type material above for exact collection data). These localities are all in Core Area 2.

Overall geographical distribution.— This species currently is known only from Gongshan County on the crest and eastern slope of the northern part of the Gaoligong Shan, in western Yunnan Province, China.

Trechus (*Trechus*) *pseudoqiqiensis* Deuve and Liang, sp. nov.

(Figs. 21, 42b, 46–48)

Type material.— Holotype, a female, in IOZ, labeled: "CASENT 1014205"/ "CHINA, Yunnan, Fugong County, Lishadi Township, 11.5 km above Shibali on Yaping Road, N27.20676°/E98.71763°,"/ "3290 m, 8 May 2004 Stop #DHK-2004-040 D.H. Kavanaugh, C.E. Griswold, Liang H.-B., Li X.-Y., & Zhu B.-X. collectors"/ "HOLOTYPE *Trechus pseudoqiqiensis* Deuve & Liang, sp. nov. designated 2016" [red label].

Type locality.— China, Yunnan, Fugong County, Shiyueliang Township, 11.5 km above Shibali on Yaping Road, N27.20676°/E98.71763°, 3290 m.

Derivation of species name.— The species epithet, *pseudoqiqiensis*, is a combination of the Greek prefix, *ψευδής* (translated into Latin as *pseudo-*) meaning false, and the species epithet, *qiqiensis*, in reference to the similarity of the unique holotype female of this species to members of *T. qiqiensis*.

Diagnosis.— Adults of this species (Fig. 21a) can be distinguished from those of all other species in the region by the following combination of character states: similar to *T. qiqiensis* in size (BL = 4.0 mm) and most features, except body color paler, more reddish; elytral striae more faintly punctate, almost impunctate toward elytral apex, more deeply impressed on center of disc and not attenuated near apex, recurrent stria less abruptly interrupted by a convexity and nearly continuous anteriorly with stria 7; preapical seta present and inserted on interval 3 next to stria 2 near apical one-fourth of elytra.

Description.— Size relatively large (BL = 4.0 mm). Body color bright brownish red, shiny, appendages yellowish-tan, palpi pale yellow.

Head. Moderate in size; eyes slightly convex, their diameter about 1.5 times as long as tempora, the latter short, convex and glabrous. Frons not flattened; frontal furrows deep, rounded, not or only slightly attenuated posterior to the eyes. Two pairs of supraorbital setae present, the anterior pair inserted in foveae. Clypeus with four setae. Labrum with six setae, anterior margin distinctly concave. Mentum and submentum not fused. Mentum distinctly concave at middle, with medial tooth broad and apex slightly bifid, about one-half the length of the lateral lobes. Submentum with six setae anteriorly. Gula wide. Genae with a single seta ventrally on each side. Antennae short, with about 2 antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 2 and 4 about equal in length, antennomere 3 slightly longer.

Pronotum. Transverse (ratio PW/PL = 1.45), slightly narrowed posteriorly, greatest width near anterior one-third; lateral margins broadly rounded, not sinuate subbasally, straightened only immediately anterior to basal angles, the latter small and rectangular. Disc convex, smooth and glabrous, median longitudinal impression finely impressed, interrupted slightly posterior to anterior margin but extended to basal margin; basal foveae distinct, but shallower and slightly convex at center; median basal area mainly smooth, but with several small foveae anteriorly near the posterior transverse impression. Basal margin rounded and slightly projected medially. Lateral borders of pronotum slender, narrowly reflexed, lateral grooves distinctly impressed. Single midlateral setae on each side inserted near anterior one-third; single basolateral seta on each side, inserted at basal angle.

Elytra. Ovoid and only slightly elongate, humeri not very broad but rounded. Disc convex and smooth. Striae very finely punctate, nearly smooth in apical half, intervals moderately convex;

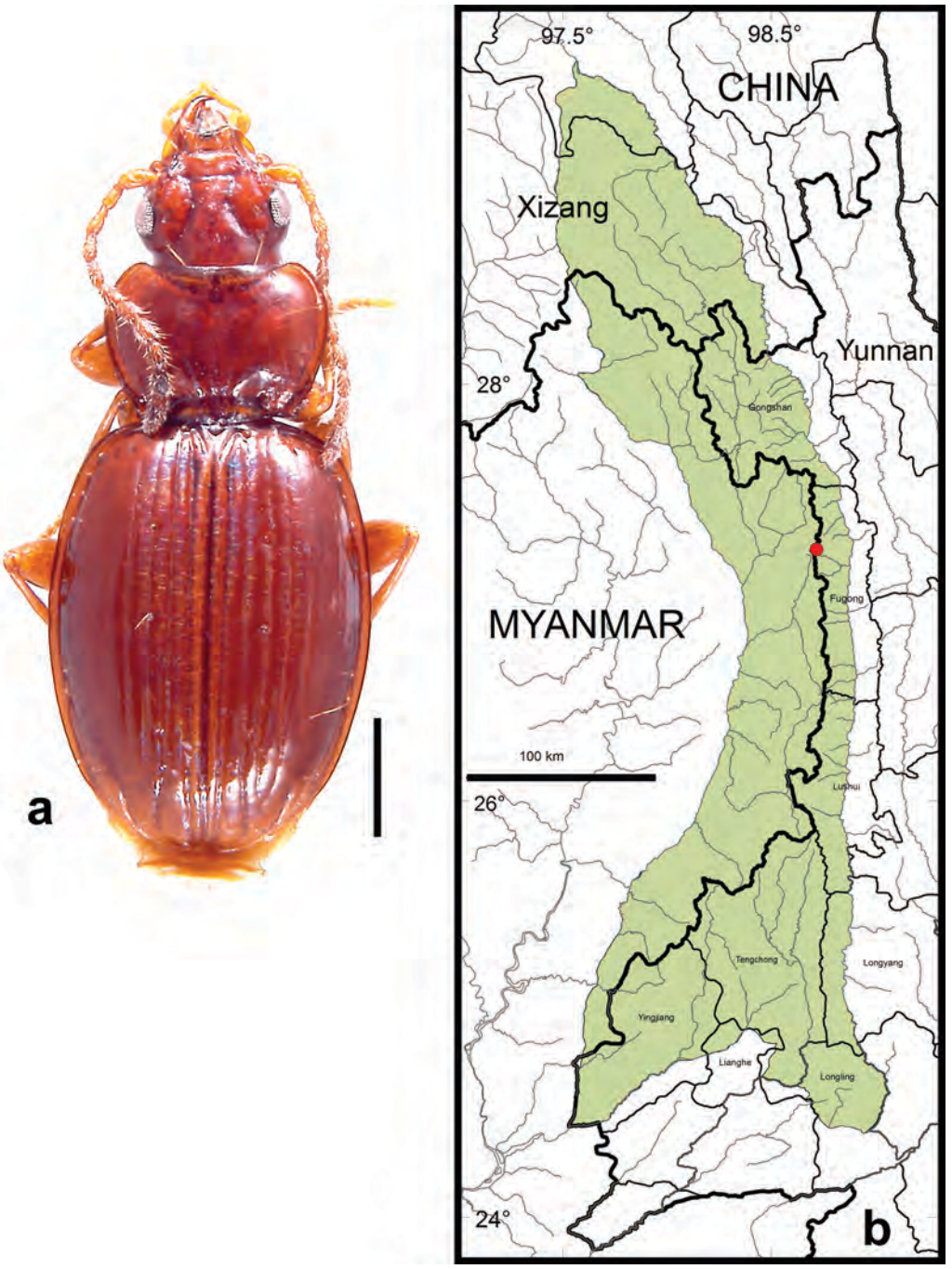


FIGURE 21. *Trechus pseudoqiqiensis* sp. nov.; a. Dorsal habitus (CASENT1014204). b. Map of locality record (red circle) for *T. pseudoqiqiensis* in the Gaoligong Shan region. Scale lines a = 0.5mm, b = 100 km.

striae 1 to 4 deeply impressed and not attenuated apically, stria 5 to 8 successively more faintly impressed by still evident. Parascutellar striole present, short. Recurrent stria less abruptly interrupted by a convexity and nearly continuous anteriorly with stria 7. Basal setiferous pore present at common origin of striae 1 and 2. Two discal setae present and inserted next to stria 3, one at anterior one-fourth and one near middle of elytra. Preapical seta present and inserted in a discal position on interval 3 next to stria 2 in forward position at apical one-fourth of elytra. Umbilicate setal series with setae of humeral group equidistance from each other and setae of median group inserted slightly posterior to middle.

Legs. Slightly short, protibiae with only a faint longitudinal furrow.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of female apically with two pairs of paramedial setae.

Habitat distribution.— The unique holotype female of this species was found under a stone in an open area cleared of forest but surrounded by bamboo thickets and scattered *Abies*, *Rhododendron* and *Prunus* species at an elevation of 3290 m (Fig. 42b). One specimen of *Trechus shibalicus* sp. nov. also was found at the same site.

Geographical distribution within the Gaoligong Shan.— Fig. 21b. This species is known from a single locality in Fugong County, on the eastern slope of the northcentral part of the Gaoligong Shan (see Type material above for exact collection data). This locality is in Core Area 3.

Overall geographical distribution.— This species currently is known only from the type locality on the eastern slope of the northcentral part of the Gaoligong Shan, in western Yunnan Province, China.

Trechus (*Trechus*) *luzhangensis* Deuve and Liang, sp. nov.

(Figs. 22, 43a, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1017595"/ "CHINA, Yunnan, Lushui County, Luzhang Township, Piana Road at Fengxue Yakou, N25.97228°/E98.68336°, 3150 m, 11 May 2005,"/ "Stop# 2005-007, D.H. Kavanaugh, H.B. Liang, C.E. Griswold, D.Z. Dong & K.J. Guo collectors"/ "HOLOTYPE *Trechus luzhangensis* Deuve & Liang, sp. nov. designated 2016" [red label]. Paratypes (only 1): a female (in CAS) labeled same as holotype, except first label "CASENT 1017596" and last label "PARATYPE *Trechus luzhangensis* Deuve & Liang, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Lushui County, Luzhang Township, Pianma Road at Fengxue Yakou [Pass], N25.97228°/E98.68336°, 3150 m.

Etymology.— The species epithet, *luzhangensis*, is derived from the name of the township, Luzhang, in which the type locality is found, and the Latin suffix, *-ensis*, denoting place.

Diagnosis.— Adults of this species (Fig. 22a) can be distinguished from those of all other species in the region by the following combination of character states: size medium (BL = 3.7 to 3.8 mm), apterous; body color dark piceous, shiny, elytra with interval 1, lateral margins and apicomedial area reddish; tempora glabrous, convex, half as long as diameter of eyes; pronotum transverse (ratio PW/PL = 1.46), basal angles rectangular and sharp; elytra ovoid, convex, striae finely impressed, striae 1 to 3 deeply impressed on disc, not attenuated apically, remaining striae successively less distinct, the outermost very faint but still evident; recurrent stria terminated anteriorly at distinct convexity of interval 7; two discal setae present, inserted on interval 3 next to stria 3; preapical seta present and inserted in a discal position on interval 3, near stria 2 in forward position near apical one-fourth of elytra; median lobe of male aedeagus (Fig. 22b) with moderate-sized

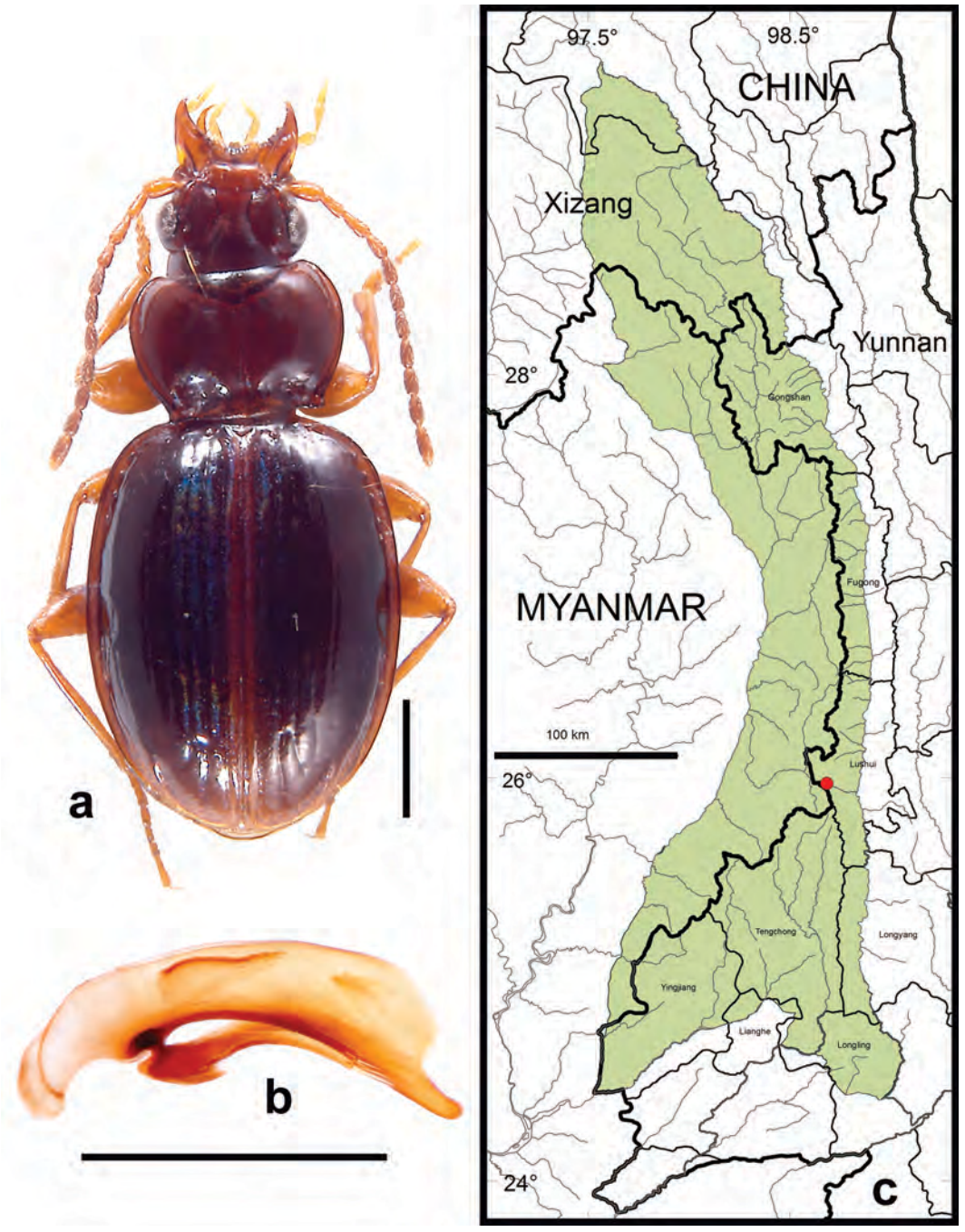


FIGURE 22. *Trechus luzhangensis* sp. nov.; a. Dorsal habitus (CASENT1017595). b. Median lobe of aedeagus of male (CASENT1017595), left lateral aspect. c. Map of locality records (red circles) for *T. luzhangensis* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

sagittal aileron, apical lamella short and thick, with apex blunt, endophallus with a sclerotized line and a scaly area.

Description.— Size medium, BL = 3.7 to 3.8 mm. Body color dark piceous, shiny, elytra with interval 1, lateral margins and apicomedial area more or less reddish, appendages paler, yellowish-orange, palpi pale yellow. Body surface smooth, head capsule faintly alutaceous.

Head. Moderate in size; eyes only slightly projected but convex, their diameter twice as long as tempora, the latter short, moderately convex and glabrous. Frons not flattened; frontal furrows deep, rounded, prolonged and not attenuated posterior to the eyes. Two pairs of supraorbital setae present, the anterior pair inserted in foveae. Clypeus with four setae. Labrum with six setae, anterior margin distinctly concave. Mandibles short; right mandible distinctly tridentate with middle tooth closer to basal tooth (premolar) than to distal tooth. Mentum and submentum not fused but nearly so, suture between them only faintly impressed. Mentum with medial tooth apically truncate, less than half the length of the lateral lobes. Submentum with six setae anteriorly, swollen anteriorly. Gula wide. Genae with a single seta ventrally on each side. Antennae rather short, with about 2 antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 2 and 3 about equal in length, antennomere 4 slightly shorter.

Pronotum. Transverse (ratio PW/PL = 1.46), moderately narrowed posteriorly, greatest width anterior to middle; lateral margins widely rounded, straightened only just anterior to basal angles, the latter very small, but projected, acute and sharp. Disc convex, smooth and glabrous, median longitudinal impression slender but sharply impressed, extended anteriorly to near anterior margin; basal foveae distinct, subcircular; median basal area faintly, longitudinally rugulose, delimited laterally by obliquely curved furrows. Lateral borders of pronotum moderately slender, narrowly reflexed, lateral grooves deeply impressed. Single midlateral setae on each side inserted near anterior one-third; single basolateral seta on each side, inserted at basal angle.

Elytra. Ovoid, only slightly more narrowed basally than apically, humeri distinct but rounded. Disc convex and smooth. Striae finely impressed, not or only faintly punctate; striae 1 to 3 deeply impressed on disc, not attenuated apically, remaining striae successively less distinct, the outermost very faint but still evident. Parascutellar striole present. Recurrent stria terminated anteriorly at distinct convexity of interval 7. Basal setiferous pore present at common origin of striae 1 and 2. Two discal setae present and inserted next to stria 3, one at anterior one-fourth and one near middle of elytra. Preapical seta present and inserted in a prediscal position on interval 3, closer to stria 2 than 3 in forward position at apical one-fourth of elytra. Umbilicate setae of humeral group equidistance from each other and setae of median group inserted slightly posterior to middle.

Legs. Relatively short, protibiae with longitudinal furrow. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, of females with two pairs.

Male aedeagus. Median lobe (Fig. 22b) only moderately enlarged basally but with a medium-sized sagittal aileron present; shaft narrow subbasally, progressively thicker toward subapical portion; apical lamella short and thick, with apex blunt, endophallus with a sclerotized line and a scaly area, similar to that seen in males of *T. shiyueliang* sp. nov. (Fig. 18b).

Habitat distribution.— Members of this species have been found under stones on slopes above (Fig. 43a) and below the road and both side of the pass at an elevation of 3150 m. The habitat in this area includes broken scrub vegetation of two to four meter high bamboo and *Rhododendron* thickets on a thin layer of organic substrate, as well as open areas with stones on granitic sand substrate, and small seeps. Both specimens were found at the edges of thickets on organic substrate. No other trechines were found at this site.

Geographical distribution within the Gaoligong Shan. Fig. 22c. We examined a total of 2 specimens (1 male and 1 female), both from the crest of the southcentral part of the Gaoligong Shan in Lushui County (see Type material above for exact collection data). This locality straddles Core Areas 4 and 5.

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

Trechus (*Trechus*) *gongshanensis* Deuve and Liang, sp. nov.

(Figs. 16c, 23, 38a, 39a, 39b, 40a, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1001929"/ "CHINA, Yunnan Province, Gaoligong Shan, Nujiang Prefecture, Nujiang State Nature Reserve, Dulong/Gongshan Yakou area, 21 airkm W of Gongshan,"/ "N27.69655°/ E98.45389°, 3300-3680 m, 16-17 July 2000, Stop#00-24C, D.H. Kavanaugh, C.E. Griswold, Liang H.-B., D. Ubick, & Dong D.-Z. collectors"/ "HOLOTYPE *Trechus gongshanensis* Deuve & Liang, sp. nov. designated 2016" [red label]. Paratypes (a total of 51): 1 male and 4 females (in CAS, IOZ) labeled: same as holotype, except first label "CASENT 1001928" and "CASENT 1001930" to "CASENT 1001932" and "CASENT 1008148", respectively; 8 males and 4 females (in CAS, IOZ) labeled: "CASENT 1010348" to "CASENT 1010355" and "CASENT 1010356" to "CASENT 1010359", respectively/ "CHINA, Yunnan, Gongshan County, Cikai Township, 52.6 km W of Gongshan on Dulong Valley Road, 3360-3380 m,"/ "N27.77032°/ E98.44661°, 3360-3380 m, 1-2 October 2002, D.H. Kavanaugh & P.E. Marek collectors"; 1 female (in IOZ) labeled: "CASENT 1024869"/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, on slope NE of Chukuai Lake, 3950 m,"/ "N27.98206°/ E98.48027°, 20 August 2006 Stop #DHK-2006-086 Y. Liu, P. Hu, D.Z. Dong & J. Wang collectors"; 1 male (in CAS) labeled: "CASENT 1025105"/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.4 km NW of Chukuai Lake,"/ "N27.98231°/ E98.47069°, 3808 m, 21 August 2006 Stop #DHK-2006-094 D.Z. Dong collector"/ 2 males and 2 females (in CAS, IOZ) labeled: "CASENT 1025164" to "CASENT 1025165" and "CASENT 1025162" to "CASENT 1025163", respectively/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.75 km NW of Chukuai Lake,"/ "N27.98631°/ E98.47069°, 3820 m, 21 August 2006 Stop #DHK-2006-095 Y. Liu, P. Hu, & J. Wang collectors"; 1 male and 2 females (in CAS, IOZ) labeled: "CASENT 1025833" and "CASENT 1025834" to "CASENT 1025835", respectively/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.3 km SW of Chukuai Lake at campsite,"/ "N27.98631°/ E98.47069°, 3820 m, 21 August 2006 Stop #DHK-2006-082 Y. Liu collector"; 1 female (in IOZ) labeled: "CASENT 1025920"/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan at Chukuai Lake, 3720 m,"/ "N27.98121°/ E98.47580°, 19 August 2006 Stop #DHK-2006-095B D.H. Kavanaugh, J.A. Miller, D.Z. Dong, Y. Liu, P. Hu, & J. Wang collectors"; 1 female (in CAS) labeled: "CASENT 1025939"/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.3 km SW of Chukuai Lake at campsite, N27.97686°/ E98.47799°,"/ "3750 m, 19 August 2006 Stop #DHK-2006-095C D.H. Kavanaugh, J.A. Miller, D.Z. Dong, Y. Liu, P. Hu, & J. Wang collectors"; 4 males and 2 females (in CAS, IOZ) labeled: "CASENT 1026196" to "CASENT 1026199" and "CASENT 1026200" to "CASENT 1026201", respectively/ / "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.3 km NNE of Chukuai Lake, N27.98393°/ E98.47491°,"/ "3745 m, 19 August 2006 Stop #DHK-2006-081

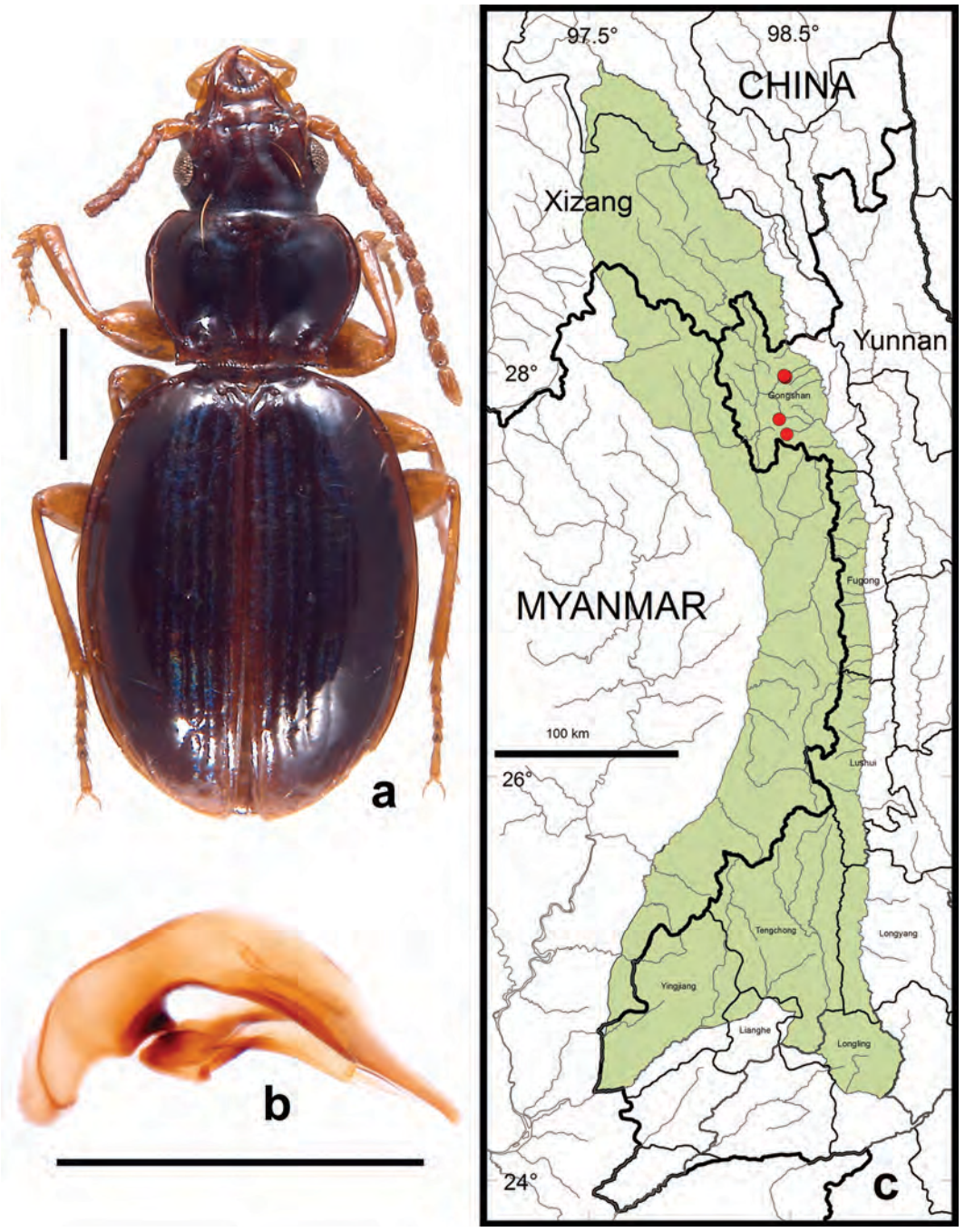


FIGURE 23. *Trechus gongshanensis* sp. nov.; a. Dorsal habitus (CASENT1001929). b. Median lobe of aedeagus of male (CASENT1001929, left lateral aspect. c. Map of locality record s(red circles) for *T. gongshanensis* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

D.H. Kavanaugh, J.A. Miller, & D.Z. Dong collectors"; 3 males (in CAS, IOZ) labeled: "CASENT 1026320" to "CASENT 1026322", respectively/ "CHINA, Yunnan, Gongshan County, Cikai Township, 0.1 km SE of Heipu Yakou in valley below tunnel, N27.76978°/ E98.44681°,"/ "3720 m, 13 August 2006, Stop #DHK-2006-073 D.H. Kavanaugh & J.A. Miller collectors"; 1 male (in CAS) labeled: "CASENT 1026366"/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan at Chukuai Lake, 3720 m,"/ "N27.98121°/ E98.47580°, 19 August 2006 Stop #DHK-2006-080 D.H. Kavanaugh & J.A. Miller collectors"; 8 males and 5 females (in CAS, IOZ, MNHN) labeled: "CASENT 10263824" to "CASENT 10263831" and "CASENT 10263819" to "CASENT 10263823", respectively/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan at Chukuai Lake, 3720 m,"/ "N27.98121°/ E98.47580°, 18 August 2006 Stop #DHK-2006-079 D.H. Kavanaugh, J.A. Miller, D.Z. Dong, & Y. Liu collectors". All paratypes also bear the following label: "PARATYPE *Trechus gongshanensis* Deuve & Liang, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Gongshan County, Dongshaofang area, N27.69655°/E95.45389°, 3300-3600 m.

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

Diagnosis.— Adults of this species (Fig. 23a) can be distinguished from those of all other species in the region by the following combination of character states: size small (BL = 3.3 to 3.5 mm), apterous; body color dark piceous, elytra slightly reddish near sutural and lateral margins; tempora glabrous and only slightly convex; pronotum transverse (ratio PW/PL = 1.45), basal angles acute and sharp; elytra convex, discal striae 1 to 3 or 4 finely impressed, striae 6 to 8 effaced, recurrent stria joined anteriorly with apex of stria 7, two discal setae present on interval 3 next to stria 3, preapical seta present and inserted in a discal, forward position near apical one-fourth of elytra on interval 3, near stria 2 in most individuals, nearer to stria 3 in a few; aedeagus of male with base robust, apical lamella elongate with apex blunt, endophallus with a slightly sclerotized scaly area.

Description.— Size small, BL = 3.3 to 3.5 mm. Body color dark piceous and shiny, elytra slightly reddish near sutural and lateral margins, appendages paler reddish yellow, palpi paler yellow. Body surface smooth, head capsule faintly alutaceous.

Head. Moderate in size, eyes moderately convex, their diameter only slightly longer than length of tempora, the latter glabrous and only slightly convex. Frontal furrows deep, rounded, slightly attenuated posteriorly but prolonged posterior to the eyes. Clypeus with four setae. Labrum with six setae, apical margin distinctly concave. Right mandible as in Fig. 16c. Mentum and submentum not fused but nearly so, suture between them very fine and only faintly impressed. Mentum with medial area concave, median tooth short, apically bifid, less than half as long as lateral lobes. Submentum with six setae anteriorly, swollen anteriorly. Gula wide. Genae with a single seta ventrally on each side. Antennae short, extended posteriorly to basal one-fifth of elytra, with about 2 antennomeres extended posteriorly beyond basal pronotal margin; antennomere 3 slightly longer than antennomere 2 or 4.

Pronotum. Transverse (ratio PW/PL = 1.45), widest at anterior one-third, narrowed posteriorly, lateral margins rounded, then abruptly sinuate just anterior to basal angles, the latter acute, sharp and slightly projected laterally. Disc convex, smooth, median longitudinal impression finely impressed but prolonged to the basal margin, slightly widened and deepened in the median basal area, the latter also with several faint longitudinal rugulae and delimited anteriorly by an arcuate posterior transverse impression that is partially effaced medially. Basal foveae distinct but smooth.

Basal margin nearly rectilinear. Lateral margination slender throughout and narrowly reflexed, lateral grooves distinctly impressed. Single midlateral setae on each side inserted near anterior one-third; single basolateral seta on each side, inserted slightly anterior to apex of basal angle.

Elytra. Ovoid, humeri distinct but rounded. Disc convex, with striae 1 to 3 or 4 finely impressed, the more lateral striae successively more faintly impressed, striae 7 and 8 effaced, striae slightly and irregularly punctate. Parascutellar striole rudimentary. Recurrent stria distinct, moderately deep, terminated at the posterior end of stria 7. Basal setiferous pore present at common origin of striae 1 and 2. Two discal setae present and inserted next to stria 3, one at anterior one-fourth and one near middle of elytra. Preapical seta present and inserted in a prediscal position on interval 3, closer to stria 2 than 3 in most specimens (closer to stria 3 in a few) in forward position at apical one-fourth of elytra.

Legs. Relatively short, protibiae with longitudinal furrow. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, of females with two pairs.

Male aedeagus. (Fig. 23b). Median lobe with basal bulb robust and with a thick sagittal aileron; apical lamella elongate, slightly tapered, with apex blunt. Endophallus nearly unarmed, with only a faintly sclerotized scaly area.

Habitat distribution.— Members of this species have been found in a variety of microhabitats in the alpine zone at elevations ranging from 3360 to 3950 m. Specimens were collected from under stones in moist meadows, on tundra slopes and ridges with sparse to thick herbaceous vegetation (Fig. 38a, 39b, 40a) and at the edges of small streams and seeps from talus slopes (Fig. 39a). They were also collected in pitfall traps placed at the edges of *Rhododendron* thickets up to two meters tall. Members of this species have been found syntopic with specimens of *Queinnectrechus* (*Gaoligongtrechus*) *balli*, *Queinnectrechus* (*s. str.*) *griswoldi*, *Queinnectrechus* (*s. str.*) *gongshanicus*, and *Trechus qiqiensis* at one or more sites.

Geographical distribution within the Gaoligong Shan.— Fig. 23c. We examined a total of 52 specimens (22 males and 30 females), all from Bingzhiongluo and Cikai Townships in Gongshan County on the crest and eastern slope of the northern part of the Gaoligong Shan (see Type material above for exact collection data). These localities are all in Core Area 2.

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

Trechus (*Trechus*) *shibalicus* Deuve and Kavanaugh, sp. nov.

(Figs. 24, 16d, 40b, 42b, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1017532"/ "CHINA, Yunnan, Fugong County, Lishadi Township, 8.5 km above Shibali on Shibali Road, north bank of North Fork of Yamu He, N27.18416°/ E98.72026°,"/ "3100 m, 8 August 2005 Stop #DHK-2005-067A D.H. Kavanaugh, H.B. Liang, D.Z. Dong, & J.F. Zhang collectors"/ "HOLOTYPE *Trechus shibalicus* Deuve & Kavanaugh, sp. nov. designated 2016" [red label]. Paratypes (a total of 43): 1 male and 3 females (in IOZ, CAS) labeled: same as holotype, except first label "CASENT 1017531" and "CASENT 1017533" to "CASENT 1017535", respectively; 1 male (in CAS) labeled: "CASENT 1014204"/ "CHINA, Yunnan, Fugong County, Lishadi Township, 11.5 km above Shibali on Yaping Road, N27.20676°/ E98.71763°,"/ "3290 m, 8 May 2004 Stop #DHK-2004-040 D.H. Kavanaugh, C.E. Griswold, Liang H.-B., Li X.-Y., & Zhu B.-X. collectors"; 1 male (in IOZ) labeled: "CASENT 1018365"/ "CHINA, Yunnan, Fugong County, Lishadi Township, headwaters of North Fork Yamu He just E of Shibali Yakou, 3450 m,"/ "N27.21034°/ E98.70141°, 7 August

2005, Stop# LHB-05-52, H.B. Liang & J.F. Zhang collectors"; 1 male (in IOZ) labeled: "CASENT 1018605"/ "CHINA, Yunnan, Fugong County, Lishadi Township, headwaters of North Fork Yamu He just E of Shibali Yakou, 3450 m,"/ "N27.21034°/ E98.70141°, 12 August 2005, Stop# LHB-05-54, H.B. Liang & J.F. Zhang collectors"; 1 male (in CAS) labeled: "CASENT 1018844"/ "CHINA, Yunnan, Fugong County, Lishadi Township, Shibali area, 2535 m, N27.16536°/ E98.78003°, 4-17 August 2005,"/ "Stop# DHK-2005-059 D.H. Kavanaugh, H.B. Liang, P. Paquin, & D.Z. Dong collectors"; 1 female (in CAS) labeled: "CASENT 1020015"/ "CHINA, Yunnan, Fugong County, Lumadeng Township, second cirque S of Shibali Yakou, 3675 m,"/ "N27.20244°/ E98.69526°, 17 August 2005, Stop# DHK-2005-093, D.H. Kavanaugh collector"; 2 males and 2 females (in CAS, IOZ) labeled: "CASENT 1020903" to "CASENT 1020904" and "CASENT 1020905" to "CASENT 1020906", respectively/ "CHINA, Yunnan, Fugong County, Lishadi Township, Shibali Yakou, 3612 m, N27.21231°/ E98.69575°, 7 August 2005,"/ "Stop# DHK-2005-066, D.H. Kavanaugh, H.B. Liang, P. Paquin, & D.Z. Dong collectors"; 1 female (in CAS) labeled: "CASENT 1021290"/ "CHINA, Yunnan, Fugong County, Lishadi Township, 0.5 km NE of Shibali Yakou, N27.21447°/ E98.70064°,"/ "3460 m, 12 August 2005, Stop# DHK-2005-077, D.H. Kavanaugh, P. Paquin, & D.Z. Dong collectors"; 6 males and 5 females (in CAS, IOZ) labeled: "CASENT 1022286" to "CASENT 1022291" and "CASENT 1022292" to "CASENT 1022296", respectively/ "CHINA, Yunnan, Fugong County, Lumadeng Township, 8.5 km above Shibali on Shibali Road, North Fork of Yamu He,"/ "N27.18416°/ E98.72026°,"/ "3100 m, 5 May 2004, Stop #LHB-04-023 Lian H.-B., Li X.-Y., & Zhu B.-Q. collectors"; 1 female (in CAS) labeled: "CASENT 1023606"/ "CHINA, Yunnan, Fugong County, Lishadi Township, 11.5 km above Shibali on Shibali Road, N27.20676°/ E98.771763°,"/ "3290 m, 6 May 2004 Stop #DHK-2004-036 D.H. Kavanaugh, C.E. Griswold, Liang H.-B., & Zhu B.-X. collectors"; 9 males and 4 females (in CAS, IOZ, MNHN) labeled: "CASENT 1023743" to "CASENT 1023745" and "CASENT 1023747" to "CASENT 1023752" and "CASENT 1023753" to "CASENT 1023756", respectively/ "CHINA, Yunnan, Fugong County, Lishadi Township, 8.5 km above Shibali on Shibali Road, North Fork of Yamu He, N27.18416°/ E98.72026°,"/ "3100 m, 7 May 2004 Stop #DHK-2004-038A D.H. Kavanaugh, C.E. Griswold, Liang H.-B., & Zhu B.-X. collectors"; 1 male and 3 females (in CAS, IOZ) labeled: "CASENT 1023775" and "CASENT 1023776" to "CASENT 1023778", respectively/ "CHINA, Yunnan, Fugong County, Lumadeng Township, 8.5 km above Shibali on Shibali Road, North Fork of Yamu He,"/ " N27.18326°/ E98.72002°, 3100 m, 7 May 2004 Stop #DHK-2004-038B D.H. Kavanaugh collector". All paratypes also bear the following label: "PARATYPE *Trechus shibalicus* Deuve & Kavanaugh, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Fugong County, Shiyueliang Township, 8,5 km above Shibali on Shibali Road, North Fork of Yamu He, N27.18416°/E98.72026°, 3100 m.

Derivation of species name.— The species epithet, *shibalicus*, is derived from the name of settlement, Shibali, at and near which specimens of the type series were collected, and the Latin adjectival suffix, *-icus*, meaning belonging to or pertaining to.

Diagnosis.— Adults of this species (Fig. 24a) can be distinguished from those of all other species in the region by the following combination of character states: size small (BL = 3.3 to 3.5 mm), apterous; body color reddish brown; tempora glabrous, short and distinctly convex; pronotum transverse (ratio PW/PL = 1.44), basal angles rectangular or slightly acute and sharp; elytra with striae finely punctate, lateral striae more or less effaced, recurrent stria abruptly interrupted at slight convexity at posterior end of stria 7, two typical discal setae present, preapical seta present and inserted in a discal, forward position near apical one-fourth of elytra on interval 3 next to stria 2; male aedeagus with sagittal aileron present but reduced, apical lamella slender with blunt apex, endophallus with a distinct scaly area.

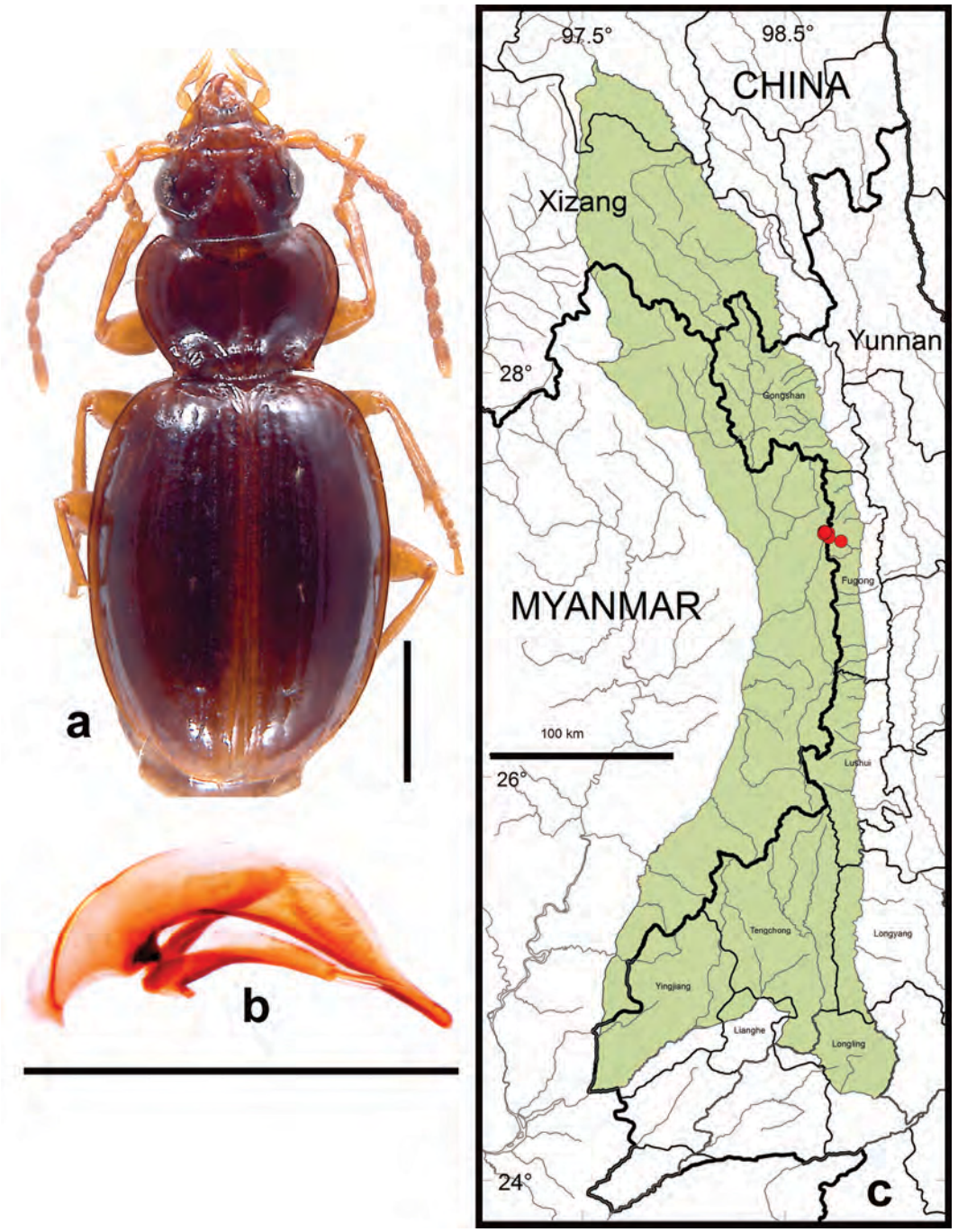


FIGURE 24. *Trechus shibalicus* sp. nov.; a. Dorsal habitus (CASENT1017532). b. Median lobe of aedeagus of male (CASENT1017532), left lateral aspect. c. Map of locality records (red circles) for *T. shibalicus* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

Description.— Size small, BL = 3.3 to 3.5 mm. Body color dark brown and shiny, elytra slightly reddish near sutural and lateral margins, appendages paler reddish yellow, palpi paler yellow. Body surface smooth.

Head. Short and thick, eyes slightly convex, their diameter slightly greater than length of tempora, the latter glabrous and distinctly convex. Frons not flattened; frontal furrows deep, broadly rounded, not attenuated posteriorly. Two pairs of supraorbital setae present, the anterior pair inserted in foveae. Clypeus with four setae. Labrum with six setae, anterior margin distinctly concave. Right mandible as in Fig. 16d. Mentum and submentum not fused. Mentum with median tooth bifid apically, half as long as lateral lobes. Submentum with six setae anteriorly. Gula wide. Genae with a single seta ventrally on each side. Antennae rather short, with about 1.5 to 2 antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 2 and 3 about equal in length, antennomere 4 slightly shorter.

Pronotum transverse (ratio PW/PL = 1.44), greatest width slightly anterior to middle, slightly narrowed posteriorly, lateral margins rounded, abruptly sinuate just anterior to basal angles, the latter rectangular or slightly acute and sharp. Disc convex; median longitudinal impression distinctly impressed, slightly widened and deepened in the median basal area, the latter also with several longitudinal rugulae and delimited laterally by short, oblique furrows. Basal foveae distinct, small and rounded. Lateral margination narrow and slightly widened basally, lateral border slightly reflexed, lateral grooves distinctly impressed. Single midlateral setae on each side inserted near anterior one-third; single basolateral seta on each side, inserted at basal angle.

Elytra. Ovoid, humeri distinct but rounded. Disc convex; striae finely punctate, striae 1 to 4 distinctly impressed, the more lateral striae more or less effaced, stria 6 barely perceptible, stria 7 and 8 indistinct. Scutellar striole short but deeply impressed. Recurrent stria distinct, abruptly interrupted at slight convexity at posterior end of stria 7. Basal setiferous pore present at common origin of striae 1 and 2. Two discal setae present and inserted next to stria 3, one at anterior one-fourth and one near middle of elytra. Preapical seta present and inserted in a prediscal position on interval 3 next to stria 2 in forward position more than twice as far from apex as from sutural margin\.

Legs. Short, protibiae with longitudinal furrow. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, of females with two pairs.

Male aedeagus. Median lobe (Fig. 24b) with base moderate in size, sagittal aileron present but reduced, shaft moderately thick subbasally, apical lamella narrowed, moderately elongate, with blunt apex; endophallus only faintly sclerotized but with a distinct scaly area.

Habitat distribution.— Members of this species have been found in a variety of microhabitats over a broad elevational range, from 2535 to 3675 m. They have been collected in daytime from under stones in thickets of bamboo (various elevations) (Fig. 42b), in subalpine forests of scattered *Abies* and *Rhodondendron* mixed with bamboo thickets (at 3290 m), in rocky open areas cleared by snow avalanches but shaded by 3 meter high herbaceous cover (3100 m) (Fig. 40b), in meadows adjacent to bamboo and *Rhodondendron* thickets (3400 m) and along roadcuts through such thickets, and on talus and vegtetated slopes in a glacial cirque (3675 m). At the lowest recorded elevation (2535 m), one specimen was collected under a stone along a roadcut on moist, shaded ground. At both highest and lowest elevations, they were the only trechine encountered; but they were found syntopic with specimens of *Trechus shiyueliang*, *Trechus pseudoqiqiensis, Trechepaphiopsis unisetulosa* sp. nov., and *Trechepaphiopsis unipilosa* sp. nov. at one or more mid-elevation (3100 to 3290 m) sites.

Geographical distribution within the Gaoligong Shan.— Fig. 24c. We examined a

total of 44 specimens (23 males and 21 females), all from Fugong County on the eastern slope and crest of the northcentral part of the Gaoligong Shan (see Type material above for exact collection data). These localities are all in Core Area 3.

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

Genus *Trechepaphiopsis* Deuve and Kavanaugh, gen. nov.

Type species.— *Trechepaphiopsis uniporosa*, sp. nov.

Derivation of genus group name.— The genus group name (feminine) is a combination of two other trechine generic names, *Trechus* and *Epaphius*, plus the Greek suffix, οψις (translated into Latin as *-opsis*) meaning having the aspect of, here referring to a similarity with *Epaphius* members.

Diagnosis.— Adults of this genus (Figs. 25–31) can be recognized by the following combination of character states: size small to moderate (BL = 2.8 to 3.7 mm), apterous; body color light to dark brown, reddish-brown, or piceous-brown, most members with dorsum slightly iridescent, dorsal surface glabrous except for isolated fixed setae typical for trechines, eyes also glabrous; head short, with eyes small; tempora convex, swollen in some members, sparsely pubescent; right mandible (Fig. 16e) with premolar tooth not fused with retinaculum and anterior point of the retinaculum free and displaced distally to form a separate tooth; mentum and submentum not fused; mentum with median tooth apical truncate or bifid; submentum with six setae; pronotum transverse, disc glabrous, basal foveae only slightly distinct, median basal area short and very transverse, delimited laterally by short, obliquely curved furrows, basal margin slightly projected posteriorly in most members, basal angles small, obtuse, rounded; elytra distinctly convex, with striae finely impressed, more or less punctate, lateral striae attenuated or effaced, recurrent stria terminated anteriorly with a bend or hook on interval 5 or 6, with a single discal seta on interval 3 next to stria three or without discal setae; preapical seta present, inserted next to stria 2; median lobe of male aedeagus of varied form, but endophallus membraneous, with spiny or scaly areas in some members, more or less sclerotized but without distinct sclerites.

Comments.— In subtropical China, the "Epaphiopsis Complex" of genera is represented mainly by *Pseudepaphius* Uéno (1962), members of which are distinguished from true *Epaphiopsis* members by their smooth pronotum and the presence of a single discal seta on interval 5 next to stria 5 (Deuve 1995). Members of our new genus, *Trechepaphiopsis*, are easily distinguished by their elytra chaetotaxy. Genus *Junnanotrechus* Uéno and Yin (1993) also belongs in this generic complex and is probably closely related to *Pseudepaphius*, based on both morphological (Deuve 2013a) and molecular (A. Faille, unpublished) data. The illustration of the mandibles of *Junnanotrechus elegantulus* Belousov and Kabak (2014b, Fig. 1) confirms this phylogenetic affinity. The right mandible presents the same morphological features shared with *Pseudepaphius* (Fig. 16e) and *Trechepaphiopsis* members (Fig. 16f), namely the unfused premolar and the anterior tip of the retinaculum distinctly displaced anteriorly to form a separate tooth.

Geographical distribution.— This genus currently is known only from the Gaoligong Shan region of western Yunnan Province, China, where it is represented by the seven species treated here. Three were previously described, all in genus *Trechus*, and four are described here as new. Each species apparently occupies only a narrow geographical range within the Gaoligong Shan, but their combined known ranges cover all but the northernmost part of the study area.

As is reflected in the key to species presented below, only male members of most of these species can be reliably distinguished, and that only by extraction and examination of their genitalic structure. To date, only two of these species have been recorded as sympatric and syntopic,

namely *T. unisetosa* (Deuve) and *T. uniporosa* sp. nov. (in Core Area 4). Two species, *T. unisetulosa* sp. nov. and *T. unipilosa* sp. nov. occur in the same general area but apparently have different, non-overlapping altitudinal ranges. So, at least for the present, locality data may aid in tentative identifications of females and undissected males, except for the first two species mentioned above.

Key for Identification of Adults of *Trechepaphiopsis* Species of the Gaoligong Shan Region

1. Elytra without discal setae . . . . . *T. asetosa* (Uéno)
   Elytra with a single discal seta, at or near mid-elytral length, next to stria 3 2
2. Size larger, BL = 3.5 to 3.7 mm; specimen from southeastern part of Gaoligong Shan region (*Baoshan County*) . . . . . *T. unisetigera* (Uéno)
   Size smaller, BL = 2.8 to 3.5 mm; specimen from more northerly part of the Gaoligon Shan region 3
3. Median lobe of male aedeagus (Fig. 27b) with a sinuous form, apical lamella very thin in lateral view, trilobed in apical view (Fig. 27c), endophallus formed as a long sleeve densely covered with long, fine spines; specimen from the southcentral part of the Gaoligong Shan region (*Lushui County*) . . . . . *T. unisetosa* (Deuve)
   Median lobe of male aedeagus (Figs. 28b–31b) with a more simple form, apical lamella thicker in lateral view, monolobate in apical view (Fig. 28c), endophallus with scaly areas but without long spines 4
4. Median lobe of male aedeagus (Fig. 28b) with apical lamella progressively narrowed in lateral view, apex narrow, bluntly rounded and slightly recurved dorsally (*Lushui County*). . . . . ***T. uniporosa* sp. nov.**
   Median lobe of male aedeagus (Figs. 29b–31b) with apex thicker and more broadly rounded in lateral view. 5
5. Size larger, BL = 3.3 to 3.5 mm; median lobe of male aedeagus (Fig. 29b) with shaft thicker subbasally, then moderately narrowed toward apex, apex broadly rounded, slightly lobate (*Fugong County*). . . . . ***T. unisetulosa* sp. nov.**
   Size smaller, BL = 2.7 to 3.1 mm; median lobe of male aedeagus (Figs. 30b–31b) with shaft of more consistent thickness throughout its length, apex short and rounded, not dilated. . . . 6
6. Median lobe of male aedeagus (Fig. 30b) with scaly spoon-shaped area of endophallus only slightly narrowed toward apex (*Gongshan County*) . . . . . ***T. monochaeta* sp. nov.**
   Median lobe of male aedeagus (Fig. 31b) with scaly spoon-shaped area of endophallus markedly narrowed toward apex (*Fugong County*) . . . . . ***T. unipilosa* sp. nov.**

Trechepaphiopsis asetosa (Uéno), 1997

(Figs. 25, 46–48)

Trechus (s. str.) asetosus Uéno, 1997: 185. Holotype, a male, in NMST. Type locality: China, Yunnan, Gaoligong Shan, Tengchong County, Dabei, 2430 m.

Trechepaphiopsis asetosa (Uéno), NEW COMBINATION

NOTES ON TYPE MATERIAL.— We have not had an opportunity to study the holotype or any other specimens of this species. Features noted below are based on Uéno's (1997) original description and illustrations.

DIAGNOSIS.— Adults of this species (see Uéno 1997, Fig. 2) can be distinguished from those of all other species in the region by the following combination of character states: size small to medium (BL= 3.0 to 3.5 mm), apterous; body color dark brown to piceous, dorsum slightly irides-

cent; eyes very small, flattened, not projected laterally beyond tempora ; tempora convex, slightly inflated; pronotum large and transverse (ratio PW/PL = 1.32 to 1.49), widest near anterior two-fifths, lateral margins slightly more curved in apical half than in basal half, basal angles obtuse and rounded; elytra ovoid, relative long and narrow, convex, striae 1 and 2 distinct, nearly complete and finely punctate, striae 3 and 4 faintly evident, stria 5 to 7 effaced, striae 8 evident but interrupted in apical half; recurrent stria terminated anteriorly in presumed location of interval 6; discal setae absent; preapical seta present, inserted next stria 2, inserted closer to sutural than to apical margin; median lobe of male aedeagus (see Uéno 1997, Figs. 3 and 4) with apex short and narrow, faintly recurved dorsally, endophallus without sclerites, but covered with scales.

Habitat distribution.— According to Uéno (1997), members of this species were collected by sifting moist leaf litter accumulations on the ground in the "*Rhododendron* zone" at elevations ranging from 2340 to 2440 m. At one of three sites where specimens of *T. asetosa* were found (at 2340 m), specimens of *Minutotrechus minutus* were also collected in the same litter samples.

Geographical distribution within the Gaoligong Shan.— Fig. 25. We examined a single paratype specimen from the type locality, the only site from which the species has been recorded, in eastern Tengchong County in the southern part of the Gaoligong Shan region. This site is in Core Area 6.

Overall geographical distribution.— This species currently is known only from the type locality, in eastern Tengchong County in the southern part of the Gaoligong Shan, in western Yunnan Province, China.

Trechepaphiopsis unisetigera (Uéno), 1997

(Figs. 26, 46–48)

Trechus (*s. str.*) *unisetiger* Uéno, 1997: 190. Holotype, a female, in NMST. Type locality: China, Yunnan, Gaoligong Shan, Longyang County, Hongxinshu, 2700 m.

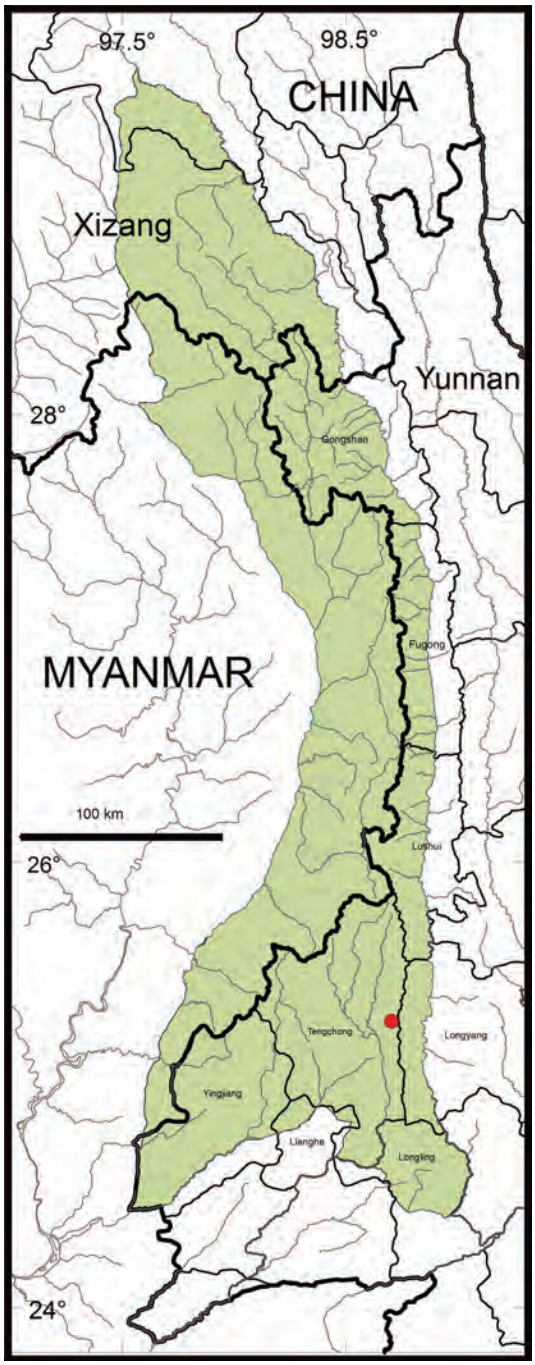


FIGURE 25. *Trechepaphiopsis asetosa* (Uéno); a. Dorsal habitus (paratype). b. Map of locality record (red circle) for *T. asetosa* in the Gaoligong Shan region. Scale line = 100 km.

Trechepaphiopsis unisetigera (Uéno), **New Combination**

Notes on type material.— We have not had an opportunity to study the holotype or any other specimens of this species. Features noted below are based on Uéno's (1997) original description. He did not provide any illustrations for this species.

Diagnosis.— Adults of this species can be distinguished from those of all other species in the region by the following combination of character states: size medium (BL = 3.3 to 3.7 mm), apterous; body color dark reddish brown, dorsum slightly iridescent; eyes very small; tempora convex; pronotum transverse (ratio PW/PL = 1.34 to 1.40), widest slightly anterior to middle, lateral margins evenly curved throughout,with basal angles obtuse and rounded; elytra broad, relatively short, convex, stria 1 to 3 distinct, punctate, striae 4 to 7 faintly impressed but evident in basal two-thirds, striae 8 evident in apical half; recurrent stria terminated anteriorly in presumed location of interval 6; one discal setae present near apical one-third and inserted next to stria 3; preapical seta present, inserted next stria 2, inserted slightly closer to sutural than to apical margin.

Habitat distribution.— According to Uéno (1997) the two specimens of the type series of this species were "sorted out from soil samples taken in a forest of *Lithocarpus variolosus*" at an elevation of 2700 m. No other trechines have been found syntopic with members of this species.

Geographical distribution within the Gaoligong Shan.— Fig. 26. This species is known only from the type locality in Longyang County in the southern part of the Gaoligong Shan region. This locality is in Core Area 7.

Overall geographical distribution.— This species currently is known only from Longyang County in the southern part of the Gaoligong Shan region, western Yunnan Province, China.

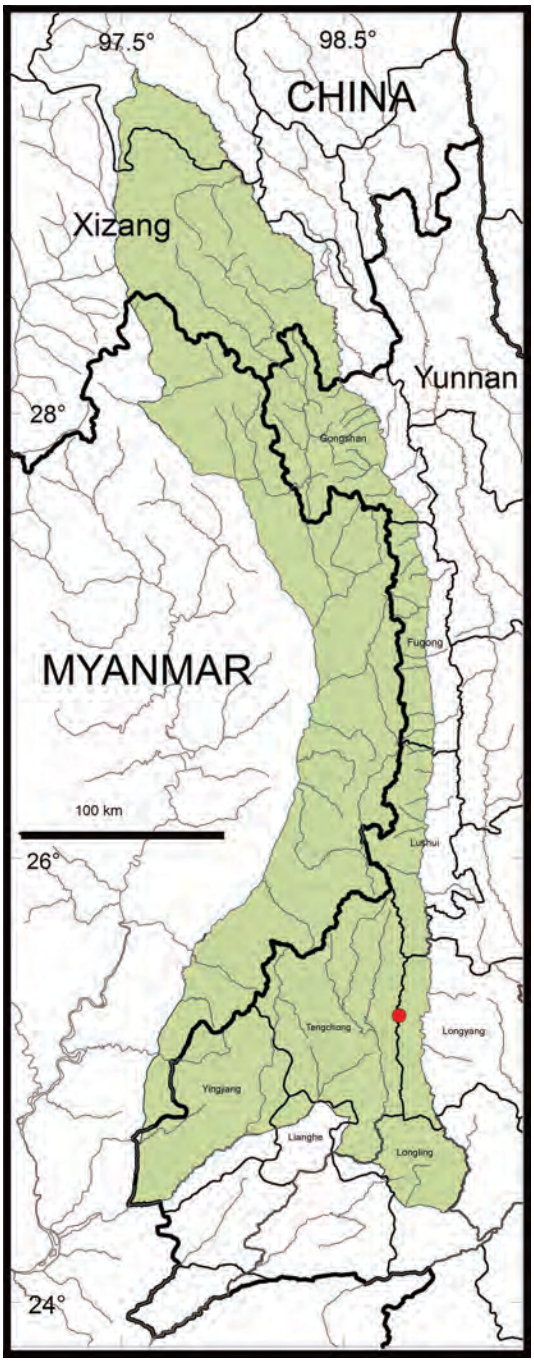


Figure 26. *Trechepaphiopsis unisetigera* (Uéno); Map of locality record (red circle) for *T. unisetigera* in the Gaoligong Shan region. Scale line = 100 km.

***Trechepaphiopsis unisetosa* (Deuve), 2004 (sp. 2)**
(Figs. 27, 37a, 43b, 46–48)

Trechus unisetosus Deuve, 2004: 220. Holotype, a female, in SCAU. Type locality: China, Yunnan, Gaoligong Shan, Lushui County, Fengxue Yakou [Pass], 2600-2700 m.
Trechepaphiopsis unisetosa (Deuve), **NEW COMBINATION**

DIAGNOSIS.— Adults of this species (Fig. 27a) can be distinguished from those of all other species in the region by the following combination of character states: size medium (BL = 3.1 to 3.5 mm), apterous; body color light brown, dorsum slightly iridescent; eyes small but convex; tempora very convex, sparsely pubescent; pronotum transverse (ratio PW/PL = 1.35), with basal angles obtuse and rounded; elytra convex, with median 2 or 3 striae deeply impressed, lateral striae faintly impressed to effaced; recurrent stria terminated anteriorly in presumed location of interval 6; only one discal setiferous pore present, inserted at anterior one-third next to stria 3; preapical seta present, inserted next to stria 2; median lobe of male aedeagus (Fig. 27b) highly distinctive, with ventral margin of shaft sinuous and apex short and thin in lateral view, with broad apical projects in ventral view; endophallus without sclerites, but with a long tubular sleeve covered with long, slender spines.

COMMENTS.— Among males of all the species of *Trechepaphiopsis*, those of *T. unisetosa* have an endophlallus most like that typical for members of the *Epaphiopsis* complex of genera, especially of certain species of *Epaphius* described from China (Jeannel 1962, Deuve 1992b). These also have a long tubular sleeve covered with long spines, symmetrically arranged in ventral view (Fig. 27c)

HABITAT DISTRIBUTION.— Members of this species have been found in mixed broadleaf evergreen/ deciduous forest at elevations ranging from 2460 to 2470 m and collected using both pitfall traps and sifting of leaf litter from the forest floor (Fig. 37a). Specimens of *Trechepaphiosis uniporosa* sp. nov and *Trechepaphiama goaligong* sp. nov were collected in the same sifted leaf litter samples and are therefore syntopic with *T. unisetosa* at this site. Additional specimens of *T. unisetosa* were collected in pitfall traps set in *Rhododendron* and bamboo thickets on the east flank of the summit ridge just south of the Fengxue Yakou at 3150 m (Fig. 43b), a site slightly above the type locality for the species.

GEOGRAPHICAL DISTRIBUTION WITHIN THE GAOLIGONG SHAN.— Fig. 27d. We examined a total of 25 specimens (10 males and 16 females) from the following localities: ***Lushui County:*** Luzhang Township (100 m S of Fengxue Yakou on east side of pass, 3150 m, N25.97195°/E97.68381°, 11-21 May 2005, D.H. Kavanaugh, C.E. Griswold & K.J. Guo collectors [1 male and 1 female; CAS, IOZ]); Pianma Township (9.3 km ENE of Pianma along road to Lushui at Changyan He, 2460-2470 m, N25.99363°/E97.66651°, 15-18 October 1998, D.H. Kavanaugh, C.E. Griswold, C. Ferraris & C.L. Long collectors [7 males, 12 females; CAS, IOZ, MNHN], 12-21 May 2005, D.H. Kavanaugh, C.E. Griswold & K.J. Guo collectors [2 male and 2 females; CAS, IOZ]).

Members of this species have been collected only in the southcentral part of the study area, on both western and eastern slopes of the Gaoligongshan, which are in Core Areas 4 and 5, respectively.

OVERALL GEOGRAPHICAL DISTRIBUTION.— This species currently is known only from Lushui County in the southcentral part of the Gaoligong Shan region, western Yunnan Province, China.

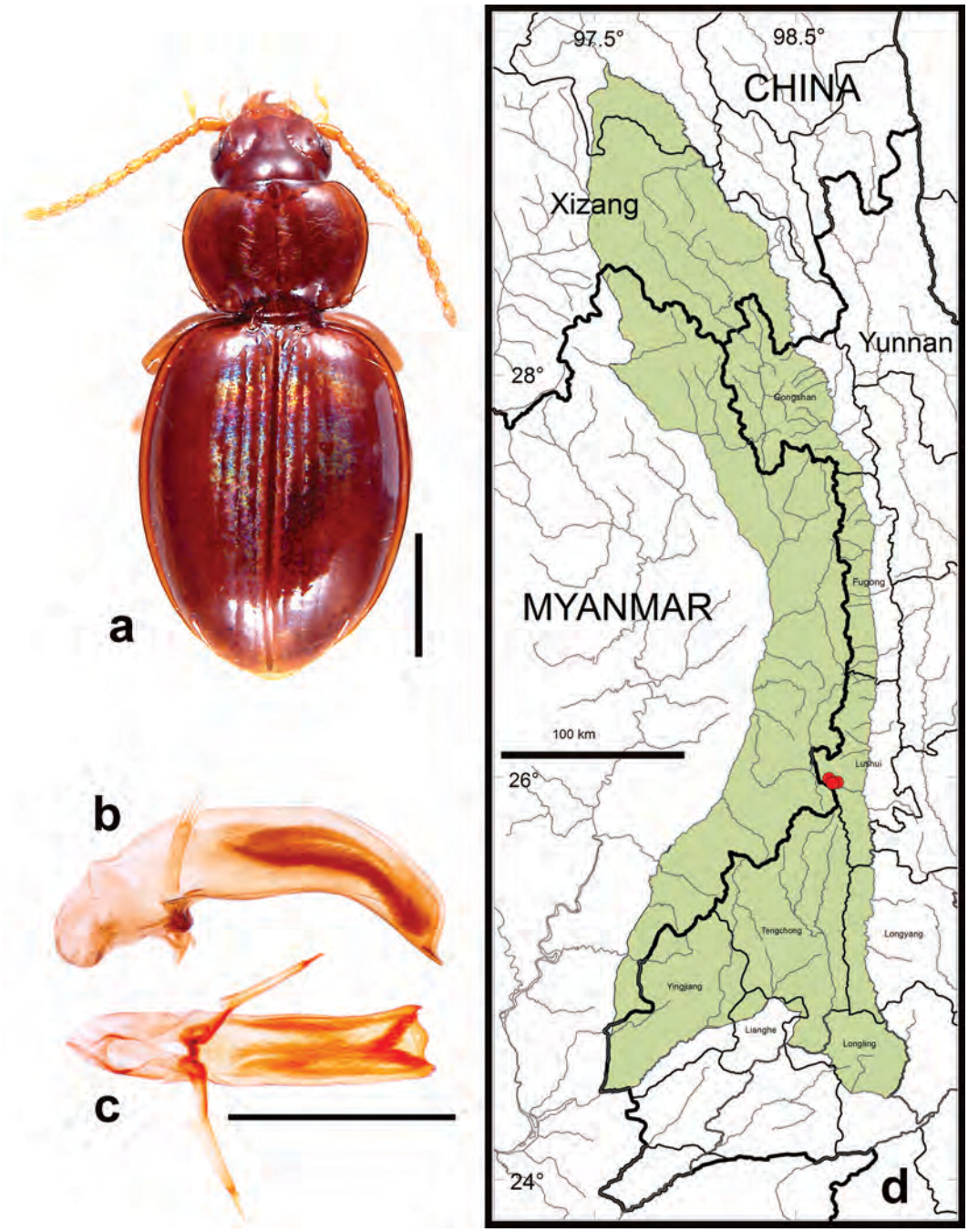


FIGURE 27. *Trechepaphiopsis unisetosa* (Deuve); a. Dorsal habitus (CASENT1024491). b-c. Median lobe of aedeagus of male (CASENT1001903); b. left lateral aspect; c. ventral aspect. d. Map of locality records (red circles) for *T. unisetosa* in the Gaoligong Shan region. Scale lines a-c = 0.5 mm, d = 100 km.

***Trechepaphiopsis uniporosa* Deuve and Liang, sp. nov.**
(Figs. 16f, 28, 37a, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1001923"/ "CHINA, Yunnan Province, Gaoligongshan Mountains, Nujiang Prefecture, 9 [actually 9.3] km ESE of Pianma, 25°59.6'N/ 98°37.6'E."/ "2450 [actually 2460-2470] m, 15-18 October 1998, Stop #98-118D D.H. Kavanaugh, C.E. Griswold, C. Ferraris & C.-L. Long collectors"/ "IMAGE" [green label]/ "HOLOTYPE *Trechepaphiopsis uniporosa* Deuve & Liang, sp. nov. designated 2016" [red label]. Paratypes (a total of 5): 3 males and 2 females (in CAS, IOZ, MNHN) labeled: same as holotype, except first label "CASENT 1001920" to "CASENT 1001922" and "CASENT 1001924" to "CASENT 1001925", respectively. All paratypes also bear the following label: "PARATYPE *Trechepaphiopsis uniporosa* Deuve & Liang, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Gaoligong Shan, Lushui County, Pianma Township, 9.3 km ESE of Pianma, 25.99363°/ 98.66651°, 2460-2470 m.

Derivation of species name.— The species epithet, *uniporosa*, is an adjective derived from the Latin words, *unus*, meaning one, and *porus*, meaning pore or hole. The name refers to the single discal setiferous pore found on the elytra of members of this species.

Diagnosis.— Adults of this species (Fig. 28a) can be distinguished from those of all other species in the region by the following combination of character states: size medium (BL = 3.3 to 3.5 mm), apterous; body color light brown, slightly iridescent; eyes small; tempora distinctly convex, sparsely pubescent; pronotum transverse (ratio PW/PL = 1.34), with basal angles obtuse and rounded; elytra convex, with stria 1 deeply impressed and finely punctate, other striae more faintly impressed and lateral striae effaced; recurrent stria terminated anteriorly in presumed location of interval 6; only one discal setiferous pore present, inserted at anterior one-third next to stria 3; preapical seta present, inserted next to stria 3; median lobe of male aedeagus (Fig. 28b) with apex slender but bluntly rounded and slightly recurved dorsally, endophallus with a faintly sclerotized scaly area.

Description.— Size medium BL = 3.3 to 3.5 mm. Body color light brown, appendages concolorous, except palpi paler, dorsum shiny, slightly iridescent.

Head. Moderate in size, short; eyes small, not projected, their diameter about equal to length of tempora but their convexity less than that of tempora, the latter markedly convex, inflated and sparsely pubescent. Frontal furrows thin and linear, deeply impressed, arcuate, continuous posteriorly to hind margins of tempora. Two pairs of supraorbital setae present, the anterior pair inserted in foveae. Clypeus with four setae. Labrum with six setae, anterior margin distinctly concave or emarginate. Mandibles short and slender, right mandible as in Fig. 16f. Mentum and submentum not fused. Mentum with medial tooth apically truncate, about one-half the length of the lateral lobes. Submentum with six setae anteriorly. Antennae rather short, not quite extended posteriorly to basal one-fourth of the elytra, only 2.5 antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 2 and 3 about equal in length, antennomere 4 slightly shorter.

Pronotum. Distinctly transverse (ratio PW/PL = 1.34), with greatest width near anterior one-third, only slightly narrowed posteriorly; lateral margins rounded, slightly more so anteriorly, slightly straighten just anterior to basal angles, the latter obtuse and rounded. Disc smooth and convex, median longitudinal impression finely impressed, but continuous between anterior and posterior margins; basal foveae shallow, faintly impressed; median basal area reduced, faintly delimited, slightly punctate in some specimens. Basal margin nearly rectilinear. Lateral pronotal borders moderately slender, regular, narrowly and regularly reflexed, lateral grooves narrow but distinctly impressed. Single midlateral setae on each side inserted near anterior one-third; single basolateral seta on each side, inserted at basal angle.

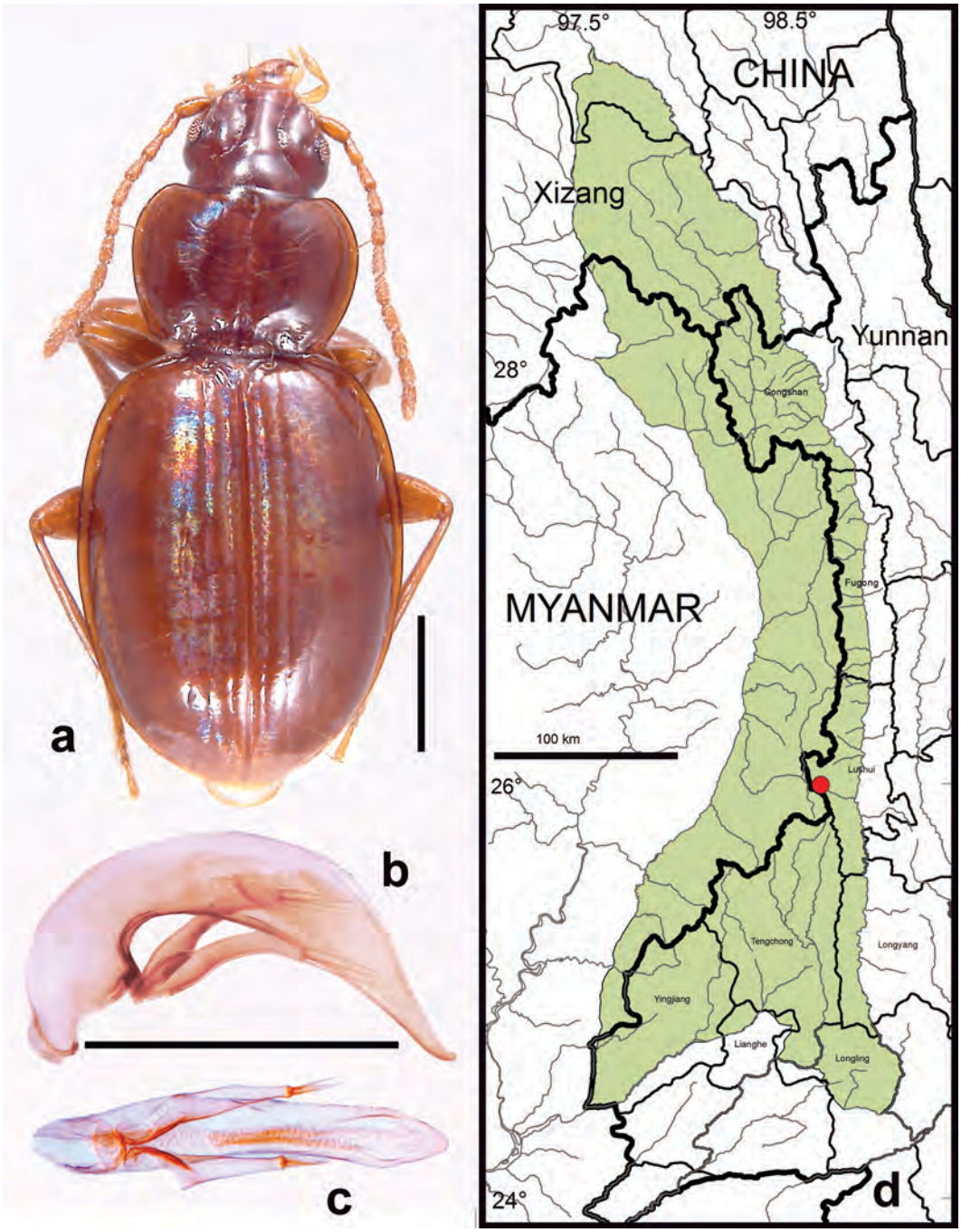


FIGURE 28. *Trechepaphiopsis uniporosa* sp. nov.; a. Dorsal habitus (CASENT1001923). b-c. Median lobe of aedeagus of male (CASENT1001923); b. left lateral aspect; c. ventral aspect. d..Map of locality records (red circles) for *T. uniporosa* in the Gaoligong Shan region. Scale lines a-c = 0.5 mm, d = 100 km.

Elytra. Ovoid, only slightly more narrowed anteriorly than posteriorly, humeri distinct but rounded. Disc convex, striae faintly impressed and finely punctate, the medial three or four striae distinctly impressed, the more lateral striae more or less effaced, but perceptible if only by the presence of fine punctures seen as rows of brown dots visible through the integument. Parascutellar striole present. Recurrent stria abruptly terminated anteriorly in presumed location of interval 6. Parascutellar setiferous pore present at base at common origin of discal striae 1 and 2. Only one discal setiferous pore present, inserted slightly anterior to middle next to stria 3. Preapical seta present on interval 3 near stria 3, closer to elytra apical margin that to sutural margin.

Legs. Short, protibiae with longitudinal furrow. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, of females with two pairs.

Male aedeagus. Median lobe (Fig. 28b) with sagittal aileron very small, shaft moderately broad basally, expanded near mid-length, then gradually narrowed apically to a thin, bluntly rounded apex, the latter slightly recurved dorsally; endophallus with a small scaly sclerotized area (Fig. 28c).

Habitat distribution.— Members of this species have been found in mixed broadleaf evergreen/ deciduous forest at elevations ranging from 2460 to 2470 m and collected by sifting leaf litter on the forest floor (Fig. 37a). Specimens of *Trechepaphiosis unisetosa* and *Trechepaphiama gaoligong* sp. nov were collected in the same sifted leaf litter samples and are therefore syntopic with *T. uniporosa* at this site.

Geographical distribution within the Gaoligong Shan.— Fig. 28d. We examined a total of 6 specimens (4 males and 2 females) from the type locality on the western slope of the southcentral part of the Gaoligong Shan in Lushui County (see Type material above for exact collection data). This locality is in Core Area 4.

Overall geographical distribution.— This species currently is known only from western Lushui County in the southcentral part of the Gaoligong Shan region, western Yunnan Province, China.

Trechepaphiopsis unisetulosa Deuve and Kavanaugh, sp. nov.

(Figs. 29, 40b, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1018407"/ "CHINA, Yunnan Province, Fugong County, Lishadi Township, 0.2 km W of Shibali, 2357 m, N27.16650°/E098.77936°"/ "18 August 2005, in leaf litter, Stop# PP-4405, P. Paquin"/ "IMAGE" [green label]/ "HOLOTYPE *Trechepaphiopsis unisetulosa* Deuve & Kavanaugh, sp. nov. designated 2016" [red label]. Paratypes (a total of 26): 1 female (in IOZ) labeled: same as holotype, except first label "CASENT 1018408"; 1 female (in CAS) labeled: "CASENT 1014246"/ "CHINA, Yunnan Province, Fugong County, Lishadi Township, 0.4 km SE of Shibali along North Fork of Yamu He, N27.16337°/E098.78208°, 2475 m, 8-11 May 2004"/ "from mini-Winkler extraction of leaf litter siftate, Stop #CGY37, C. E. Griswold, D. H. Kavanaugh, & Yan H.-M. collectors"; 1 male (in CAS) labeled: "CASENT 1019222"/ "CHINA, Yunnan Province, Fugong County, Lishadi Township, Shibali Road at Shibali, N27.16786°/E098.77741°,"/ " 2560 m, 3 May 2004 Stop #DHK-2004-024, D.H. Kavanaugh & C. E. Griswold. collectors"; 1 female (in IOZ) labeled: "CASENT 1020952"/ "CHINA, Yunnan Province, Fugong County, Lishadi Township, 8.5 km above Shibali on Shibali Road, north bank of North Fork of Yamu He, N27.118416°/E098.72026°"/ "3100 m, 9 August 2005, Stop DHK-2005-067A D.H. Kavanaugh, H.B. Liang, D.Z. Dong, & P. Paquin collectors"; 1 male and 1 female (in CAS) labeled: "CASENT

1021953" and "CASENT 1021952", res/ "CHINA, Yunnan Province, Fugong County, Lishadi Township, 0.3 km above Shibali on Shibali Road, N27.116791°/E098.77655°"/ "2563 m, in pitfall trap, 3-11 May 2004, Stop #CGY21, C. E. Griswold, D. H. Kavanaugh, Liang H.-B., & Yan H.-M. collectors"; 10 males and 10 females (in CAS, IOZ, MNHN) labeled: "CASENT 1023285" to "CASENT 1023294" and "CASENT 1023295" to "CASENT 1023304", respectively/ "CHINA, Yunnan Province, Fugong County, Lishadi Township, 0.3 km above Shibali on Shibali Road, N27.1166361°/E098.77667°"/ "2563 m, in pitfall trap, 4 May 2004, Stop #DHK-2004-026, D. H. Kavanaugh & C. E. Griswold collectors". All paratypes also bear the following label: "PARATYPE *Trechepaphiopsis unisetulosa* Deuve & Kavanaugh, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Fugong County, Shiyueliang Township, 0.2 km W of Shibali, N27.16650°/E098.77936°, 2537 m,

Derivation of species name.— The species epithet, *unisetulosa*, is an adjective derived from the Latin words, *unus*, meaning one, and *setulosus*, meaning bearing bristles or setae. The name refers to the single discal seta found on the elytra of members of this species.

Diagnosis.— Adults of this species (Fig. 29a) can be distinguished from those of all other species in the region by the following combination of character states: size small to medium (BL = 3.3 to 3.5 mm), apterous; body color dark reddish brown, dorsum shiny, very slightly iridescent; eyes small, only slightly projected laterally; tempora convex and sparsely pubescent; pronotum transverse (ratio PW/PL = 1.40), with basal angles obtuse and rounded; elytra convex, with medial three or four stria distinct, finely punctate, more lateral striae more or less effaced; recurrent stria terminated anteriorly in presumed location of interval 6; only one discal setiferous pore present, inserted near anterior one-third next to stria 3; preapical seta present, inserted next to stria 2; median lobe of male aedeagus (Fig. 29b) with apex lobated and broadly rounded; endophallus with a large, scaly sclerorized area.

Description.— Size small to medium, BL = 3.3 to 3.5 mm. Body color dark reddish brown, interval 1 of elytra slightly paler, reddish, appendages yellowish brown, palpi paler yellow; dorsum smooth, pronotum and elytra shiny, very slightly iridescent, head slightly alutaceous from more deeply impressed isodiametric microsculpture.

Head. Rather broad; eyes small, only slightly projected laterally, their diameter about equal to length of tempora, the latter convex and sparsely pubescent. Frons convex, with frontal furrows evenly rounded and deeply impressed, continuous to posterior margins of tempora. Two pairs of supraorbital setae present, the anterior pair inserted in foveae. Clypeus with four setae. Labrum with six setae, anterior margin distinctly emarginate. Mentum and submentum not fused. Mentum with medial tooth broad and apically bifid, less than half the length of the lateral lobes. Submentum with six setae anteriorly. Gula broad. Genae with a single ventral seta one each side. Antennae short, with only about 1.5 antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 2 and 4 about equal in length, antennomere 3 slightly longer.

Pronotum. Transverse (ratio PW/PL = 1.40), with greatest width near anterior one-third, moderately narrowed posteriorly; lateral margins rounded, slightly more so anteriorly, slightly straighten, but not at all sinuate, just anterior to basal angles, the latter bluntly obtuse. Disc convex, median longitudinal impression finely impressed, continuous from posterior side of apical median swelling to posterior margin; basal foveae shallow, faintly impressed; median basal area well defined but short and transverse. Lateral borders slender and finely relexed dorsally, lateral grooves deeply impressed. Single midlateral setae on each side inserted near anterior one-third; single basolateral seta on each side, inserted at basal angle.

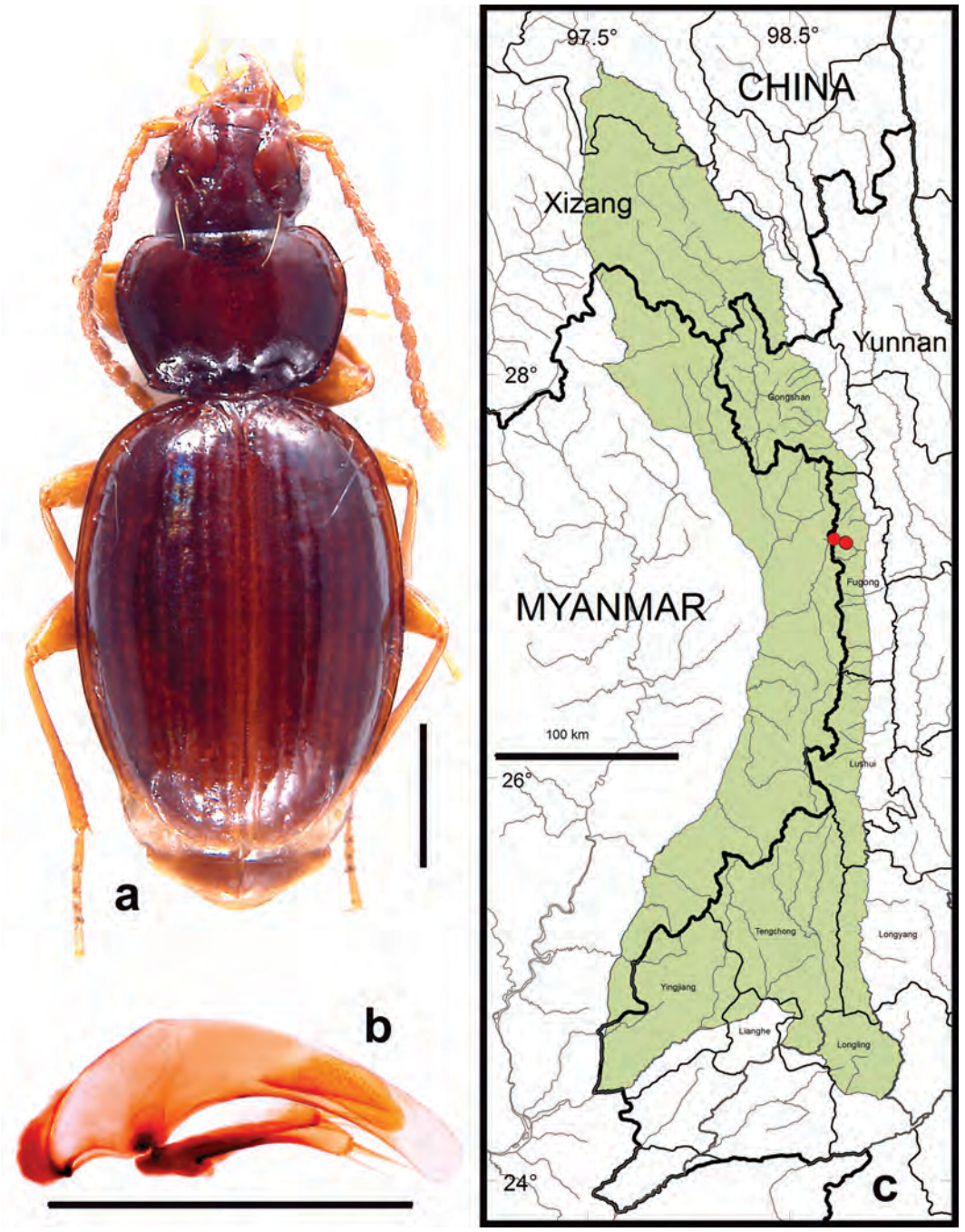


FIGURE 29. *Trechepaphiopsis unisetulosa* sp. nov.; a. Dorsal habitus (CASENT1018407). b. Median lobe of aedeagus of male (CASENT1001903), left lateral aspect. c. Map of locality records (red circles) for *T. unisetulosa* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

Elytra. Ovoid, not or only slightly elongate, about equally narrowed anteriorly and posteriorly, humeri distinct but rounded. Disc convex, striae faintly impressed and finely punctate, the medial three or four striae distinctly impressed, the more lateral striae more or less effaced, bearly perceptible. Parascutellar striole present, longer than average for genus. Recurrent stria abruptly terminated anteriorly in presumed location of posterior end of stria 5. Parascutellar setiferous pore present at base at common origin of discal striae 1 and 2. Only one discal setiferous pore present, inserted at anterior two-fifth of elytral length next to stria 3. Preapical seta present on interval 3 next to stria 2 and about equidistant from apical and sutural elytral margins. Umbilicate setal series with setae of humeral group equidistance from each other and setae of median group inserted slightly posterior to middle.

Legs. Short, protibiae with longitudinal furrow. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, of females with two pairs.

Male aedeagus. Median lobe (Fig. 29b) with sagittal aileron moderate in size, shaft broad basally, then gradually narrowed apically to a broadly rounded apex; endophallus with a large, scaly sclerorized area with two parts or folds.

Habitat distribution.— Members of this species have been collected in pitfall traps set in slightly disturbed broadleaf forest with large trees, dense understory of ferns and other herbs, and a deep leaf litter layer, and also by sifting leaf litter in this same habitat. One specimen was beaten from roadside vegetation with suspended leaf and twig debris in that vegetation in the same area. One specimen was collected at a higher elevation (3100 m) from under stones in a rocky open areas cleared by snow avalanches but shaded by three meter high herbaceous cover (Fig. 40b). Specimens of *Trechus shiyueliang*, *T. shibalicus* and *Trechepaphiopsis unipilosa* sp. nov.were found syntopic with the specimen of *T. unisetulosa* at this last site.

Geographical distribution within the Gaoligong Shan.— Fig. 29c. We examined a total of 27 specimens (13 males and 14 females) from sites on the eastern slope of the northcentral part of the Gaoligong Shan in Fugong County (see Type material above for exact collection data). All of these sites are in Core Area 3.

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

Trechepaphiopsis monochaeta Deuve and Kavanaugh, sp. nov.

(Figs. 30, 38b, 42a, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: labeled: "CASENT 1007387"/ "CHINA, Yunnan Province, Gaoligong Shan, Nujiang Prefecture, Nujiang State Nature Reserve, No. 12 Bridge Camp area, 16.3 airkm W of Gongshan,"/ "N27.71503°/E98.50244°, 2775 m, 15-19 July 2000, Stop#00-23A, D.H. Kavanaugh, C.E. Griswold, Liang H.-B., D. Ubick, & Dong D.-Z. collectors"/ "IMAGE" [green label]/ "HOLOTYPE *Trechepaphiopsis monochaeta* Deuve & Kavanaugh, sp. nov. designated 2016" [red label]. Paratypes (at total of 56): 14 males and 17 females (in CAS, IOZ, MNHN) labeled: same as holotype, except first label "CASENT 1007388" to "CASENT 1007400" and "CASENT 1021923" and "CASENT 1007401" to "CASENT 1007416" and "CASENT 1021924", respectively; 10 males and 14 females (in CAS, IOZ) labeled: "CASENT 1006508" to "CASENT 1006517" and "CASENT 1006518" to "CASENT 1006530" and "CASENT 1021922", respectively/ "CHINA, Yunnan Province, Gaoligong Shan, Nujiang Prefecture, Gongshan County, Dazhu He drainage, 13.5 airkm SW of Gongshan, 2830m"/ "N27.62947°/E98.62010°, 30 June- 5 July 2000, Stop#00-17I, D.H. Kavanaugh, C.E. Griswold,

Liang H.-B., D. Ubick, & Dong D.-Z. collectors"; 1 female (in CAS) labeled: "CASENT 1025812"/ "CHINA, Yunnan, Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan 0.3 km SW of Chukuai Lake at campsite,"/, "N27.97686°/ E098.47799°, 3750 m, 18 August 2006 Stop #DHK-2006-078 D.H. Kavanaugh collector". All paratypes also bear the following label: "PARATYPE *Trechepaphiopsis monochaeta* Deuve & Kavanaugh, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Gaoligong Shan, Gongshan County, Qiqi Trail at No. 12 Bridge Camp area, 16.3 airkm W of Gongshan, N27.71503°/E98.50244°, 2775 m,

Derivation of species name.— The species epithet, *monochaeta*, is an adjective derived from the Greek words, *μόνος* (transliterated into Latin as *mono*), meaning one or single, and *χαίτα* (transliterated into Latin as *chaeta*), meaning hair or bristle. The name refers to the single discal seta found on the elytra of members of this species.

Diagnosis.— Adults of this species (Fig. 30a) can be distinguished from those of all other species in the region by the following combination of character states: size small (BL = 2.8 to 3.0 mm), apterous; body color reddish brown, dorsum shiny, very slightly iridescent; eyes small but convex; tempora convex and sparsely pubescent; pronotum transverse (PW/PL = 1.38), with basal angles obtuse and rounded; elytra convex, medial four or five striae distinctly impressed, more lateral striae more or less effaced; recurrent stria terminated anteriorly in presumed location of interval 6; only one discal setiferous pore present, inserted anterior to and next to stria 3; preapical seta present, inserted next to stria 2; median lobe of male aedeagus (Fig. 30b) with apex moderately broad and apically rounded, slightly deflected ventrally; endophallus with an elongate and scaly sclerotized area not narrowed apically.

Description.— Size small, BL = 2.8 to 3.0 mm. Body color reddish brown, appendages slightly paler, yellowish brown, palpi paler yellow; dorsum shiny, slightly iridescent.

Head. Medium in size; eyes small but moderately convex, their diameter about equal to length of tempora, the latter distinctly convex and sparsely pubescent. Frons convex, with frontal furrows slightly angulate and deeply impressed, continuous to posterior margins of tempora, not or slightly attenuated posterior to margins of eyes. Two pairs of supraorbital setae present, the anterior pair inserted in foveae. Clypeus with four setae. Labrum with six setae, anterior margin distinctly emarginate or concave. Mentum and submentum not fused. Mentum with medial tooth broad and apically truncate or faintly bifid, about half the length of the lateral lobes. Submentum with six setae anteriorly. Gula broad. Genae with a single ventral seta one each side. Antennae short, with only about 1.5 antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 2 and 3 about equal in length, antennomere 4 slightly shorter.

Pronotum. Transverse (ratio PW/PL = 1.38), with greatest width slightly anterior to middle; lateral margins rounded, slightly more so anteriorly, not or only slightly straighten posteriorly just anterior to basal angles, the latter obtuse and bluntly or rounded. Disc convex and smooth, median longitudinal impression finely impressed, continuous from middle of apical median swelling to posterior margin; basal foveae very small and shallow, faintly impressed; median basal area well defined but short and transverse, smooth but with several small longitudinal foveae. Lateral borders slender and finely relexed dorsally, lateral grooves deeply impressed. Single midlateral setae on each side inserted near anterior one-third; single basolateral seta on each side, inserted at basal angle.

Elytra. Ovoid, only slightly narrowed anteriorly and posteriorly, humeri distinct but rounded. Disc convex, striae finely impressed and not or only faintly punctate, the medial three or four striae clearly impressed, the more lateral striae more or less effaced, but still evident. Parascutellar striole present and distinct. Recurrent stria deeply impressed, its anterior recurved end terminated in

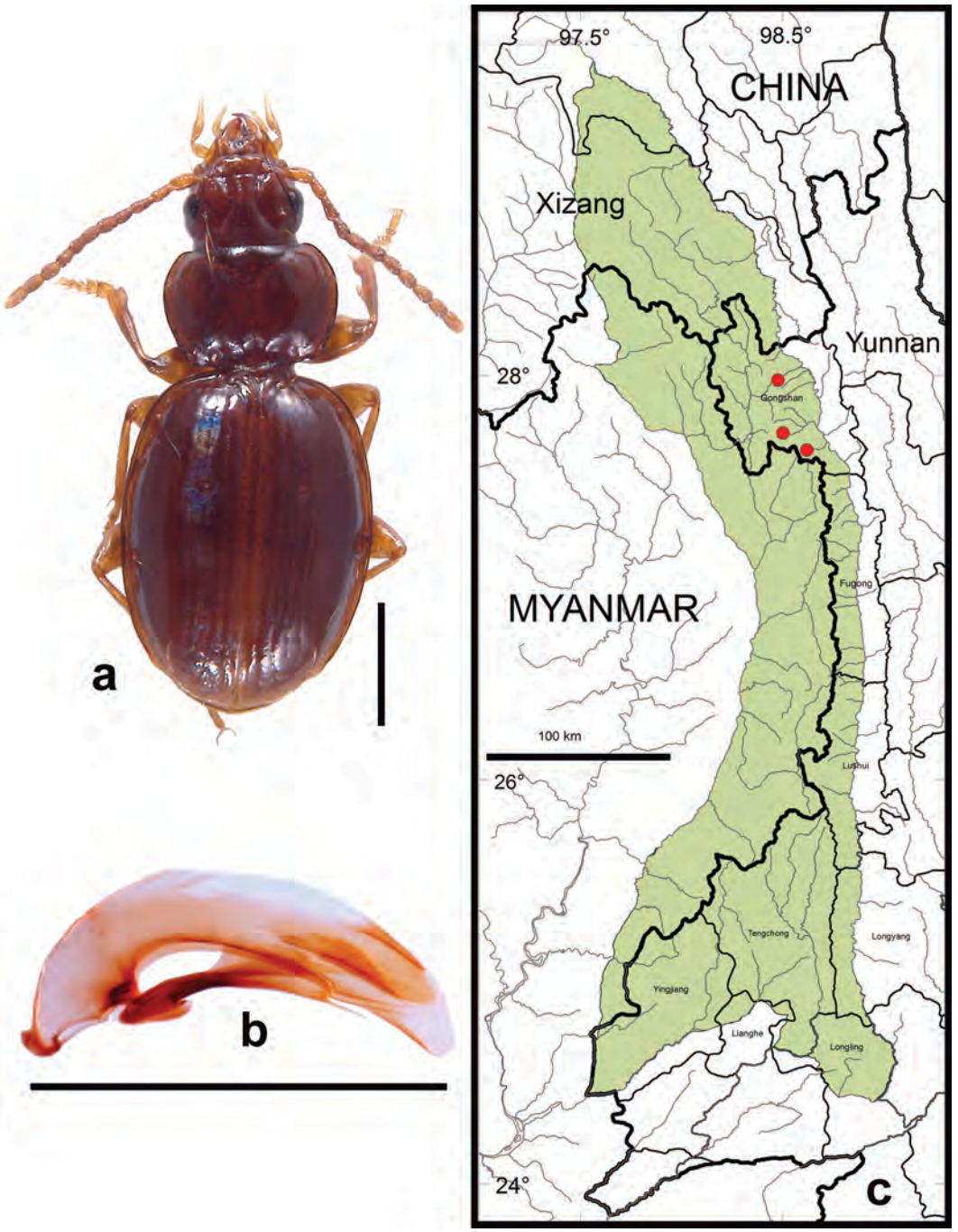


FIGURE 30. *Trechepaphiopsis monochaeta* sp. nov.; a. Dorsal habitus (CASENT1007411). b. Median lobe of aedeagus of male (CASENT1007411), left lateral aspect. c. Map of locality records (red circles) for *T. monochaeta* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

the posterior end of stria 5. Only one discal setiferous pore present, inserted slightly anterior to middle next to stria 3. Preapical seta present, inserted on interval 3 next to stria 2 and about equidistant from apical and sutural elytral margin.

Legs. Short, protibiae with longitudinal furrow. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, of females with two pairs.

Male aedeagus. Median lobe (Fig. 30b) with sagittal aileron very small, shaft moderately broad basally, then gradually narrowed, with apex moderately broad and apically rounded, slightly deflected ventrally; endophallus with an elongate and scaly sclerotized area not narrowed apically.

Comments.— This species appears to be very closely related (perhaps sister species) to *T. unipilosa* sp. nov., but its male members can be distinguished from those of the latter by having the base of the median lobe of the male aedeagus broader (narrower in *T. unipilosa* members, see Fig. 31b) and the scaly sclerotized area of the endophallus of more equal width throughout and not narrowed distally (as it is in *T. unipilosa* males).

Habitat distribution.— Members of this species have been collected by sifting leaf litter and mosses from the floor of closed canopy forest with an understory of ferns and large-leafed (ca. 60 cm long leaves) *Rhododendron* sp. at elevations ranging from 2775 to 2830 m (Fig. 42a). At the lowest elevation, specimens of *Trechus qiqiensis* were collected in the same litter samples. One specimen was also found under stones or wood chips in a disturbed open meadow area surrounded by one meter high *Rhododendron* thickets at an elevation of 3750 m (Fig. 38b); and specimens of *Queinnectrechus griswoldi* were found in this same area

Geographical distribution within the Gaoligong Shan.— Fig. 30c. We examined a total of 57 specimens (23 males and 34 females) from sites on the crest or eastern slope of the northern part of the Gaoligong Shan in Gongshan County (see Type material above for exact collection data). All of these sites are in Core Area 2.

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

Trechepaphiopsis unipilosa Deuve and Liang, sp. nov.

(Figs. 31, 40b, 46–48)

Type material.— Holotype, a male, in IOZ, labeled: "CASENT 1023757"/ "CHINA, Yunnan, Fugong County, Lishadi Township, 8.5 km above Shibali on Shibali Road, North Fork of Yamu He, N27.18416°/E98.72026°,"/ "3100 m, 7 May 2004 Stop #DHK-2004-038A D.H. Kavanaugh, C.E. Griswold, Liang H.-B., & Zhu B.-X. collectors"/ "HOLOTYPE *Trechepaphiopsis unipilosa* Deuve & Liang, sp. nov. designated 2016" [red label]. Paratypes (at total of 17): 2 females (in CAS, IOZ) labeled: same as holotype, except first label "CASENT 1023746" and "CASENT 1023758", respectively; 1 male and 2 females (in CAS, IOZ) labeled: "CASENT 1017488" and "CASENT 10174896" to "CASENT 1017490", respectively/ "CHINA, Yunnan, Fugong County, Lumadeng Township, 8.5 km above Shibali on Shibali Road, south bank of North Fork of Yamu He, N27.18326°/ E98.72002°"/ 3100 m, 8 August 2005 Stop #DHK-2005-067B D.H. Kavanaugh, H.B. Liang, D.Z. Dong, & J.F. Zhang collectors"; 7 males and 1 female (in CAS, IOZ, MNHN) labeled: "CASENT 1018375" to "CASENT 1018381" and "CASENT 1018382", respectively/ "CHINA, Yunnan, Fugong County, Lishadi Township, 10 km W of Shibali on Shibali Road, 3250 m,"/ "N27.20055°/E98.71399°, 16 August 2005 Stop #PP-3805 P. Paquin collector"; 1 male (in CAS) labeled: "CASENT 1018392"/ "CHINA, Yunnan, Fugong County, Lishadi Town-

ship, 10.5 km W of Shibali on Shibali Road, 3221 m,"/ "N27.20192°/E98.71329°, 17 August 2005 Stop #PP-4105 P. Paquin collector"; 3 males (in CAS, IOZ) labeled: "CASENT 1023607", "CASENT 1023608" and "CASENT 1023820", respectively/ "CHINA, Yunnan, Fugong County, Lishadi Township, 11.5 km above Shibali on Shibali Road, N27.20676°/E98.71763°,"/ "3290 m, 6 May 2004 Stop #DHK-2004-036 D.H. Kavanaugh, C.E. Griswold, Liang H.-B., & Zhu B.-X. collectors". All paratypes also bear the following label: "PARATYPE *Trechepaphiopsis unipilosa* Deuve & Liang, sp. nov. designated 2016" [yellow label].

Type locality.— China, Yunnan, Fugong County, Shiyueliang Township, 8.5 km above Shibali on Shibali Road, North Fork of Yamu He, N27.18416°/E98.72026°, 3100 m.

Derivation of species name.— The species epithet, *unipilosa*, is an adjective derived from the Latin word, *unus*, meaning one, and the Greek word, *πίλος* (transliterated into Latin as *pilus*), meaning hair. The name refers to the single discal seta found on the elytra of members of this species.

Diagnosis.— Adults of this species (Fig. 31a) can be distinguished from those of all other species in the region by the following combination of character states: size small (BL = 2.7 to 3.1 mm), apterous; body color reddish brown, dorsum shiny, pronotum and elytra slightly iridescent; eyes small but convex; tempora convex and sparsely pubescent; pronotum transverse (ratio PW/PL = 1.42), with basal angles obtuse and rounded; elytra convex, medial striae (1 to 5 or 6) distinct, finely punctate, more lateral striae more or less effaced; recurrent stria terminated anteriorly on interval 6; only one discal setiferous pore present, inserted at anterior one-third next to stria 3; preapical seta present, inserted next to stria 2; median lobe of male aedeagus (Fig. 31b) with apex slender and rounded, endophallus with a faintly sclerotized scaly area distinctly narrowed distally.

Description.— Size small, BL = 2.7 to 3.1 mm. Body color reddish brown, antennmae concolorous, legs slightly paler, yellowish brown, palpi paler yellow; dorsum shiny, pronotum and elytra slightly iridescent, head slightly alutaceous from more deeply impressed, irregularly isodiametric microsculpture.

Head. Broad; eyes small but convex, their diameter about equal to length of tempora, the latter short, distinctly convex and sparsely pubescent Frons convex, frontal furrows sharply impressed and rounded, not attenuated posterior to eyes. Two pairs of supraorbital setae present, the anterior pair inserted in foveae. Clypeus with four setae. Labrum with six setae, anterior margin distinctly emarginate. Mentum and submentum not fused. Mentum with medial tooth apically bifid, about half the length of the lateral lobes. Submentum with six setae anteriorly. Gula broad. Genae with a single ventral seta one each side. Antennae short, with only about two antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 2 and 4 about equal in length, antennomere 3 slightly longer.

Pronotum. Transverse (ratio PW/PL = 1.42), with greatest width at anterior one-third; lateral margins rounded, slightly more so anteriorly, not or only slightly straighten posteriorly just anterior to basal angles, the latter obtuse and blunted. Disc convex and smooth, median longitudinal impression finely impressed, continuous from middle of apical median swelling to posterior margin; basal foveae small and shallow, faintly impressed; median basal area well defined but short and transverse, smooth or with a few small longitudinal foveae. Lateral borders slender and finely relexed dorsally, lateral grooves deeply impressed. Single midlateral setae on each side inserted near anterior one-third; single basolateral seta on each side, inserted at basal angle.

Elytra. Ovoid only slightly elongate, not or only very slightly more narrowed anteriorly than posteriorly, humeri distinct but rounded. Disc convex, striae finely punctate, only medial striae 1 to 3 distinctly impressed, more lateral striae more or less effaced, but still evident in most specimens. Parascutellar striole present, distinct but short. Recurrent stria deeply impressed, its anterior

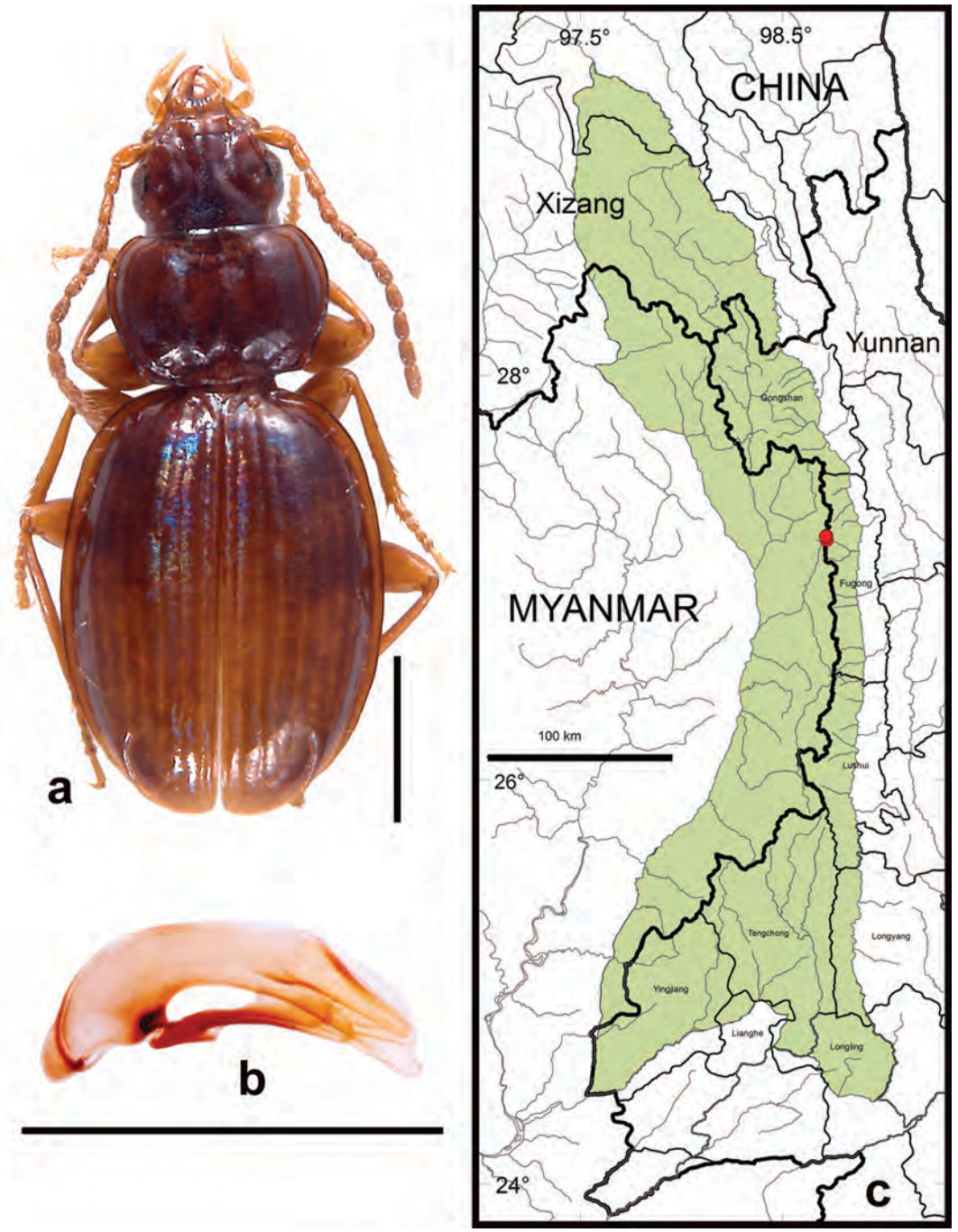


FIGURE 31. *Trechepaphiopsis unipilosa* sp. nov.; a. Dorsal habitus (CASENT1023757). b. Median lobe of aedeagus of male (CASENT1023757), left lateral aspect. c. Map of locality records (red circles) for *T. unipilosa* in the Gaoligong Shan region. Scale lines a, b = 0.5 mm, c = 100 km.

end abruptly terminated in the posterior end of stria 5. Parascutellar setiferous pore present at base at common origin of discal striae 1 and 2. Only one discal setiferous pore present, inserted at anterior two-fifth of elytral length next to stria 3. Only one discal setiferous pore present, inserted slightly anterior to middle next to stria 3. Preapical seta present, inserted on interval 3 next to stria 2 and about equidistant from apical and sutural elytral margin. Umbilicate setal series with setae of humeral group equidistance from each other and setae of median group inserted slightly posterior to middle.

Legs. Short, protibiae with longitudinal furrow. Male protarsomeres 1 and 2 dilated and apicomedially toothed.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of males apically with one pair of paramedial setae, of females with two pairs.

Male aedeagus. Median lobe (Fig. 31b) with sagittal aileron very small, shaft moderately broad basally, then gradually narrowed apically to a narrowly rounded apex; endophallus with a faintly sclerotized scaly area distinctly elongate and narrowed distally.

Comments.— This species appears to be very closely related (perhaps sister species) to *T. monochaetus*, but its male members can be distinguished from those of the latter by having the base of the median lobe of the male aedeagus narrower (broader in *T. monochaeta* members, see Fig. 30b) and the scaly sclerotized area of the endophallus distinctly narrowed distally (of more equal width throughout in *T. monochaeta* males).

Habitat distribution.— Members of this species have been collected by sifting leaf litter from forests of scattered, large *Abies* sp. trees with a dense understory of bamboo or *Rhododendron* spp. at elevations ranging from 3221 to 3290 m. Specimens of *Trechus shiyueliang and T. shibalicus* were collected in one or more of the same litter samples. Specimens of *T. unipilosa* were also collected at 3100 m elevation under stones at the open edges of a small stream draining a north-facing glacial cirque with a large snowfield in its basin (Fig. 40b). A specimen of *Trechepaphiopsis unisetulosa* sp. nov. was also collected in this area, at the upper limit of the altitudinal range of this last mentioned species.

Geographical distribution within the Gaoligong Shan.— Fig. 31c. We examined a total of 18 specimens (13 males and 5 females) from sites on the eastern slope of the northcentral part of the Gaoligong Shan in Fugong County (see Type material above for exact collection data). All of these sites are in Core Area 3.

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

Genus *Epaphiotrechus* Deuve and Kavanaugh, gen. nov.

Type species.— *Epaphiotrechus fortipesoides* sp. nov.

Derivation of genus group name.— The genus group name (masculine) is a combination of two other trechine generic names, *Epaphius* and *Trechus*.

Diagnosis.— Adults of this genus (Fig. 33a) can be recognized by the following combination of character states: size large (BL = 4.5 to 4.7 mm), apterous; body color dark piceous with elytral interval 1 and lateral areas of pronotum and elytra more or less reddish; dorsum shiny, distinctly iridescent, dorsal surface glabrous except for isolated fixed setae typical for trechines, eyes also glabrous; right mandible (Fig. 16g) with premolar not fused with retinaculum but closely associated with the latter [possibly representative of an intermediate state in the evolution of the "bidentate" mandibular type (see discussion above for genus *Trechus*)], anterior tip of retinaculum enlarged as a distinct tooth and displaced anteriorly (but not quite as far as in members of *Trechepaphiopsis* species); pronotum with basal angles small and rectangular; elytra elongate, oblong,

slightly flattened along the median suture area, striae finely impressed, crenulate or finely punctate, lateral striae partly effaced but striae 6 and 7 still evident; two discal setae present on interval 3 next to stria 3, inserted near the anterior one-sixth and near mid-elytral length, respectively; preapical seta present, inserted next to stria 2.

COMMENTS.— When Uéno (1999) described *Trechus* (*s. str.*) *fortipes*, he noted that it was a "strange species similar to certain *Epaphiopsis*", with the distinct premolar on the right mandible. However, characters of the male aedeagus, particularly the presence of a distinct endophallic sclerite, led him to consider this species as a basal member of genus *Trechus* in which the plesiomorphic right mandibular dentition was retained.

GEOGRAPHICAL DISTRIBUTION. This genus currently is known from only two species, both found only in the southern part of the Gaoligong Shan region of western Yunnan Province, China.

Key for Identification of Adults of *Epaphiotrechus* Species of the Gaoligong Shan Region

1. Median tooth of mentum small and simple, apex not bifid; elytra with stria 5 distinctly deepened at the base, recurrent stria short, terminated anteriorly at a slight convexity at apex of stria 5; preapical seta inserted equidistant from both apical and sutural margins. . . . . *E. fortipes* (Uéno)
   Median tooth of mentum long and wide, apex bifid; elytra with stria 5 not or only faintly deepened at the base, recurrent stria long, terminated anteriorly at a slight convexity at apex of stria 6; preapical seta inserted closer to sutural than to apical margin . . . ***E. fortipesoides* sp. nov.**

Epaphiotrechus fortipes (Uéno), 1999

(Fig. 32, 46-48)

Trechus (*s. str.*) *fortipes* Uéno, 1999a: 219.
Epaphiotrechus fortipes (Uéno), **NEW COMBINATION**

TYPE MATERIAL.— Holotype, a male, in NSMT. Type locality: China, Yunnan, Gaoligong Shan, Baoshan County, N24°57′/ E98°45′, 2200-2500 m

NOTES ON TYPE MATERIAL.— We have not had an opportunity to study the holotype or any other specimens of this species. Features noted below are based on Uéno's (1999a) original description and illustrations.

DIAGNOSIS.— Adults of this species (see Uéno 199a, Fig. 4) can be distinguished from those of all other species in the region by the following combination of character states:

Size large (BL = 4.5 mm), apterous; female holotype with unusually broad protarsomeres; body color dark piceous, slightly paler reddish on elytral interval 1; right mandible tridentate; mentum with median tooth short and simple; pronotum slightly narrowed (ratio PW/PL = 1.26), with basal angles small and rectangular; elytra elongate, slightly flattened medially, striae finely impressed, medial three or four striae distinctly crenulate (due to strial punctures), more lateral striae slightly effaced, but striae 6 and 7 evident, stria 5 deepened at its base; parascutellar striole present, slightly elongate; recurrent stria short, terminated near apex of stria 5; two discal setiferous pores present, inserted at anterior one-sixth and slightly posterior to middle, respectively, on interval 3 near stria 3; preapical seta present, inserted on interval 3 next to stria 2 and about equidistant from apical and sutural elytral margins; median lobe of male aedeagus (see Uéno 1999a, Figs. 5 and 6) with apex, expanded, securiform in lateral view; endophallus with distinct, elongate-triangular sclerite.

HABITAT DISTRIBUTION.— No members of this species were found during field collecting for this project, and no habitat information accompanied the type material. Uéno (1999a) suggested that the type locality was located "near the lower edge of the *Rhododendron* zone. He visited the

area and collected very briefly in "*Rhododendron* and bamboo thickets" there without success. We concur with him that such thickets represent the most likely habitat for members of this species. Uéno (1999a) reported that specimens of this species (which he described as *Trechus fortipes*) were found in the same area as specimens of *Agonotrechus yunnanus* and *Trechus indicus* (which he recorded as *Trechus macrops* Jeannel).

Geographical distribution within the Gaoligong Shan.— Fig. 32. This species is known only from a single male specimen from the type locality in Baoshan County in the southern part of the Gaoligong Shan region. This locality is in Core Area 7.

Overall geographical distribution.— This species currently is known only from Baoshan County in the southern part of the Gaoligong Shan region, western Yunnan Province, China.

Epaphiotrechus fortipesoides Deuve and Kavanaugh, sp. nov.

(Figs. 16g, 33, 46–48)

Type material.— Holotype, a female, in IOZ, labeled: "CASENT 1039089"/ "CHINA, Yunnan, Tengchong County, Houqiao Township, 8.5 airkm NNE of Houqiao at Gaoshidong, 2580 m, N25.39858°/E98.30533°,"/ "27 May 2006, Stop # DHK-2006-043, D.H. Kavanaugh, R.L. Brett, & D.Z. Dong collectors"/ "IMAGE" [green label]/ "HOLOTYPE *Epaphiotrechus fortipesoides* Deuve and Kavanaugh, sp. nov. designated 2016" [red label].

Type locality.— China, Yunnan, Tengchong County, Houqiao Township, 8.5 airkm NNE of Houqiao at Gaoshidong, N25.39858°/E98.30533°, 2580 m.

Derivation of species name.— The species epithet, *fortipesoides*, is a combination of the species epithet, *fortipes*, and the Greek suffix, *–ειδής* (transliterated into Latin as *–oides*), meaning resembling, in reference to the similarity of the unique holotype female of this species to members of *T. fortipes*.

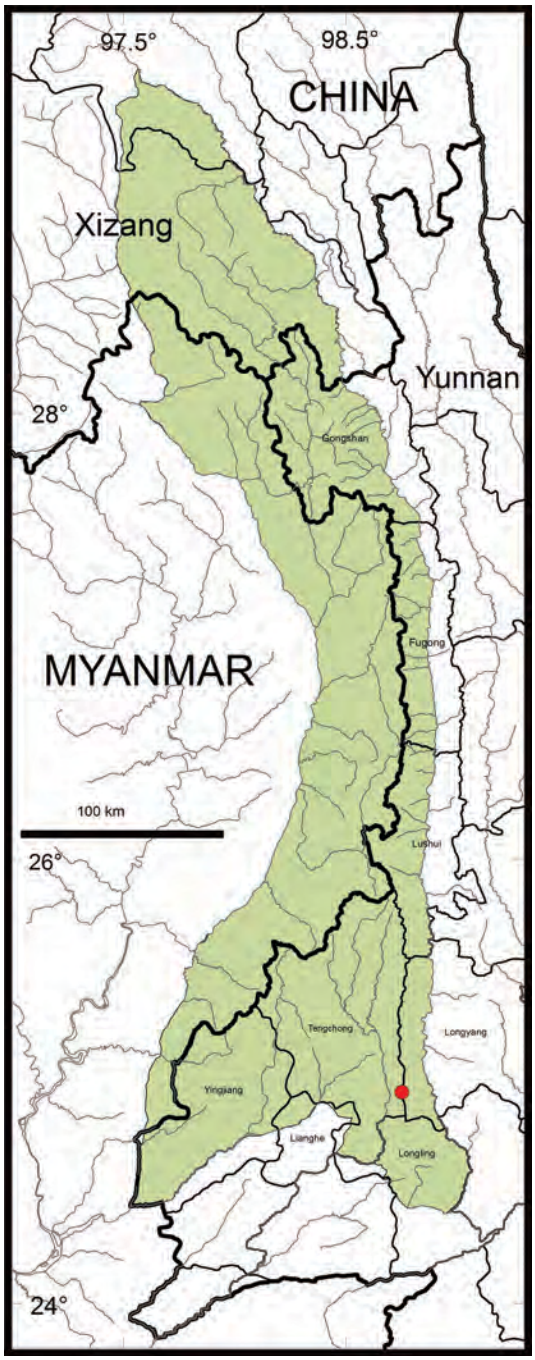


Figure 32. *Epaphiotrechus fortipes* (Uéno); Map of locality record (red circle) in the Gaoligong Shan region. Scale line = 100 km.

Diagnosis.— Adults of this species (Fig. 33a) can be distinguished from those of all other species in the region by the following combination of character states: size large (BL = 4.7 mm), apterous; body color piceous, sutural and lateral elytral margins slightly paler, reddish; tempora glabrous; median tooth of mentum apically truncate, almost bifurcate; antennae long; pronotum slightly narrowed (ratio PW/PL = 1.28), basal angles small, sharp, rectangular; elytra oblong, slightly flattened along median suture, striae finely impressed, finely punctate, striae 1 to 2 or 3 more deeply impressed, more lateral striae more or less effaced but still evident, stria 5 not more deeply impressed at its base; recurrent stria long, deeply impressed, abruptly terminated on interval 7; two discal setiferous pores present, inserted at anterior one-sixth and slightly posterior to middle, respectively, on interval 3 near stria 3; preapical seta present, inserted 1.5 times as far from apical elytral margin as from sutural margin.

Description.— Size large, BL = 4.7 mm. Body color dark piceous, head, basal and lateral pronotal margins, and lateral and sutural margins of elytra more or less reddish, appendages paler reddish brown, palpi yellowish brown, dorsum smooth, shiny with pronotum and elytra moderately iridescent, head faintly alutaceous due to moderately impressed isodiametric microsculpture.

Head. Broad, slightly elongate. Eyes slightly convex, their diameter slightly less than twice length of tempora, the latter short but distinctly convex. Frons convex, with frontal furrows sharply impressed, not attenuated posterior to eyes. Two pairs of supraorbital setae present, the anterior pair inserted in slight foveae. Clypeus with four setae. Labrum with six setae, anterior margin distinctly concave. Right mandible (Fig. 16g) with premolar not fused with retinaculum but closely associated with the latter, anterior tip of retinaculum enlarged as a distinct tooth and displaced anteriorly. Mentum and submentum not fused. Mentum with medial tooth apically truncate, about one-half the length of the lateral lobes. Submentum with six setae anteriorly. Genae with a single ventral seta one each side. Antennae moderate in length, with about 2.5 antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 3 and 4 about equal in length, antennomere 2 slightly shorter.

Pronotum. Slightly narrowed (ratio PW/PL = 1.28), with greatest width anterior to middle, only slightly narrowed posteriorly; lateral margins rounded, straightened for a short distance posteriorly, then slightly sinuate just anterior to basal angles, the latter small, sharp and rectangular; basal margin with median region slightly and convexly projected posteriorly. Disc convex, with median longitudinal impression distinct, markedly deepened in median basal area, not extended anteriorly to apical margin; basal foveae moderate in size and depth; median basal area delimited laterally by a pair of short, oblique furrows, smooth except for a pair of paramedial longitudinal foveae. Single midlateral setae on each side inserted anterior to middle; single basolateral seta on each side, inserted at basal angle.

Elytra. Elongate ovoid, slightly narrowed anteriorly, humeri rounded and only slightly evident. Disc moderately convex, slightly flattened in sutural area; striae finely impressed, finely punctate, striae 1 to 2 or 3 more deeply impressed, more lateral striae more or less effaced but still evident, stria 5 not more deeply impressed at its base. Parascutellar striole present, deeply impressed and long. Recurrent stria long, deeply impressed, abruptly terminated on interval 7 slightly anterior to the insertion point of preapical seta. Two discal setiferous pores present, inserted at anterior one-sixth and near middle, respectively, on interval 3 near stria 3. Preapical seta present, inserted 1.5 times as far from apical elytral margin as from sutural margin on interval 3 next to stria 2.

Legs. Short; protibiae with longitudinal furrow.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of female apically with two pairs of paramedial setae.

Comments.— This species appears to be closely related to *E. fortipes*, but its members can be

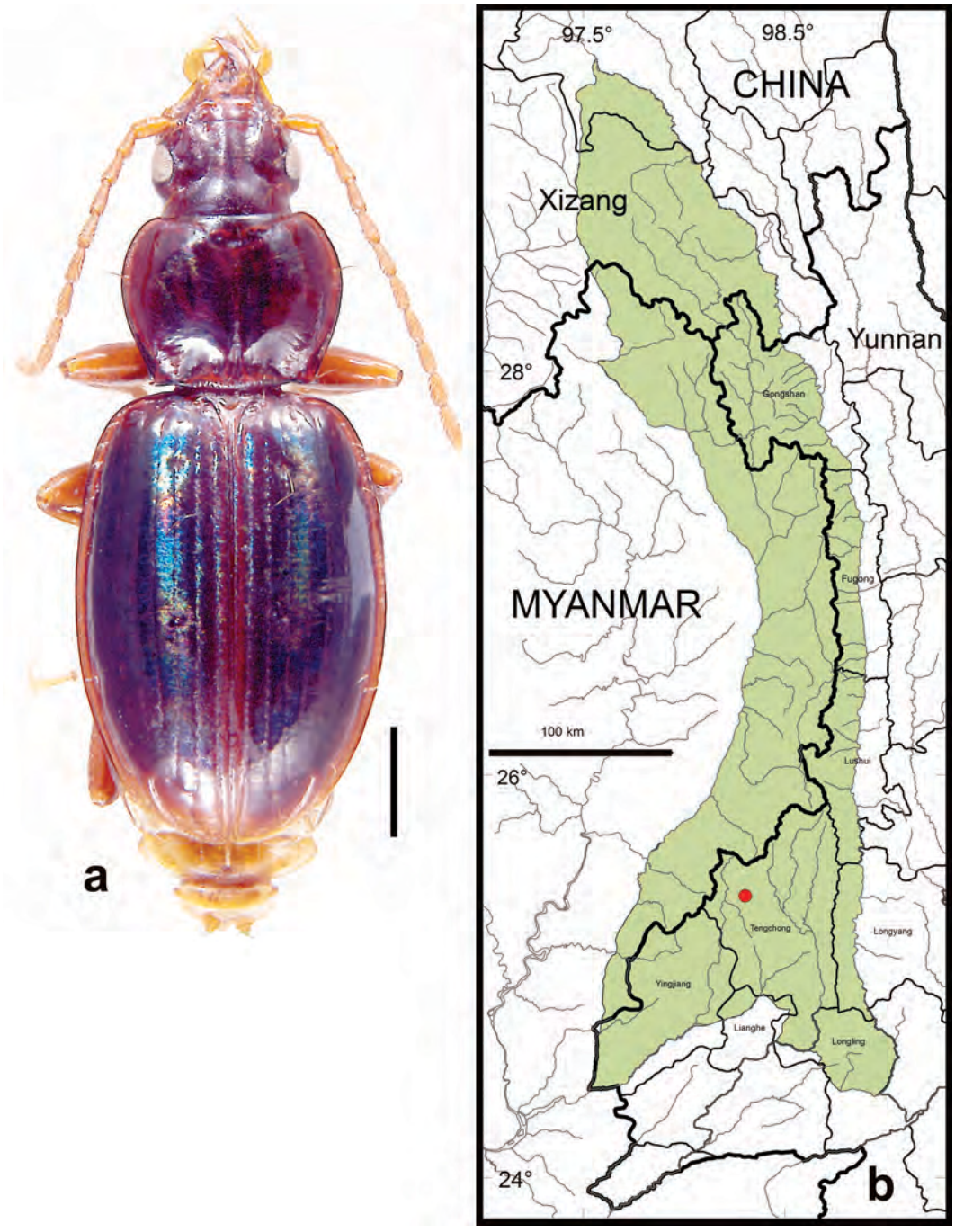


FIGURE 33. *Epaphiotrechus fortipesoides* sp. nov.; a. Dorsal habitus (CASENT1039089). b. Map of locality record (red circle) for *E. fortipesoides* in the Gaoligong Shan region. Scale lines a = 0.5 mm, b = 100 km.

distinguished from those of the latter by the truncate, almost bifurcate, median tooth of the mentum (simple in *E. fortipes* members), elytral stria 5 not more deeply impressed basally (distinctly more deeply impressed in *E. fortipes* members), recurrent stria longer (shorter in *E. fortipes* members) and terminated on interval 7 (terminated on interval 5 in *E. fortipes* members), and the preapical seta inserted 1.5 times as far from apical elytral margin as from sutural margin (inserted about equidistant from apical and sutural margins in *E. fortipes* members).

Habitat distribution.— The unique holotype female of this species was found on the ground under a stone or log in a managed conifer forest along a roadcut at an elevation of 2580 m. No other trechines were found in this area.

Geographical distribution within the Gaoligong Shan.— Fig. 33b. This species is known only from a single female specimen from the type locality in western Tengchong County in the southern part of the Gaoligong Shan region. This locality is in Core Area 6.

Overall geographical distribution.— This species currently is known only from Tengchong County in the southern part of the Gaoligong Shan region, western Yunnan Province, China.

Genus *Trechepaphiama* Deuve and Kavanaugh, gen. nov.

Type species.— *Trechepaphiama gaoligong* sp. nov.

Derivation of genus group name.— The genus group name (masculine) is a combination of two other trechine genus group names, *Trechus* and *Epaphiama*.

Diagnosis.— Adults of this genus (Fig. 34a) can be recognized by the following combination of character states: size large (BL = 4.2 mm), apterous; body color reddish brown, dorsum shiny, slightly iridescent, dorsal surface glabrous except for isolated fixed setae typical for trechines, eyes also glabrous, small, only slightly convex; tempora glabrous; right mandible (Fig. 16h) with premolar tooth fused with retinaculum, anterior tip of retinaculum enlarged to form a distinct tooth and displaced distally, posterior tip of retinaculum reduced, nearly flattened; mentum and submentum not fused; mentum with median tooth simple with apex rounded; submentum [probably] with six setae [only five setae visible in unique female holotype of type species]; pronotum slightly convex, disc glabrous, basal foveae only slightly distinct, median basal area delimited laterally by oblique furrows, basal margin slightly curved medially, slightly sinuate and oblique laterally; elytra broadly rounded, more narrowed apically than basally, humeri broad, disc convex with striae finely impressed, slightly punctate, lateral striae attenuated, recurrent stria deeply impressed, its anterior end straight, almost continuous anteriorly with the apex of stria 5; no discal setae present, preapical seta present, inserted next to stria 2.

Comments.— This genus, known from only a single female specimen, belongs to the "Epaphiopsis Complex" of genera as evidenced by the dentition of the mandibles. Its members can be distinguished from those of other genera of this lineage by the absence of elytral discal setae, which is exceptional among trechines, and by their markedly convex, dorsally inflated elytra, imparting an appearance similar to that of *Epaphiama* Jeannel (1962) members — short and convex. In contrast, *Trechepaphiopsis* members are similar in habitus to small *Epaphiopsis* members while those of *Epaphiotrechus* are more similar in habitus to large *Trechu*s members. A better understanding of phylogenetic affinities of this new genus must await discovery of a male and study of its genital structure and/or comparative molecular study.

Geographical distribution.— This genus currently is known only from the type species, which is known only from the southcentral part of the Gaoligong Shan region of western Yunnan Province, China.

***Trechepaphiama gaoligong* Deuve and Kavanaugh, sp. nov.**
(Figs. 16h, 34, 37a, 46–48)

Type material.— Holotype, a female, in IOZ, labeled: "CASENT 1001926"/ "CHINA, Yunnan Province, Gaoligongshan Mountains, Nujiang Prefecture, 9 [actually 9.3] km ESE of Pianma, 25°59.6'N/ 98°37.6'E."/ "2450 [actually 2460-2470] m, 15-18 October 1998, Stop #98-118D D.H. Kavanaugh, C.E. Griswold, C. Ferraris & C.-L. Long collectors"/ "IMAGE" [green label]/ "HOLOTYPE *Trechepaphiama gaoligong* Deuve & Kavanaugh, sp. nov. designated 2016" [red label].

Type locality.— China, Yunnan, Gaoligong Shan, Lushui County, 9.3 km ESE of Pianma, N25.99363°/ E98.66651°, 2460-2470 m.

Derivation of species name.— The species epithet, *gaoligong*, is a noun in apposition, derived from the name of the mountain range, the Gaoligong Shan, in which the holotype was collected.

Diagnosis.— Adults of this species (Fig. 34a) can be distinguished from those of all other species in the region by the following combination of character states: size large (BL = 4.2 mm), apterous; body color reddish brown, dorsum shiny; eyes reduced, their diameter about equal to length of tempora, the latter distinctly convex and glabrous; pronotum moderately transverse (ratio PW/PL = 1.26), basal angles subrectangular; elytra broad, markedly convex, slightly inflated, humeri broadly rounded, striae 1 to 5 deeply impressed and slightly punctate, more lateral striae more or less effaced, intervals 1 to 4 slightly convex, more lateral intervals flat; recurrent stria anteriorly nearly continuous with posterior end of stria 5; discal setiferous pores absent; preapical seta present, inserted on interval 3 next to stria 2.

Description.— Size large, BL 4.2 mm. Body color reddish brown, appendages concolorous, except palpi yellowish brown, dorsum smooth, shiny, pronotum and elytra very faintly iridescent, head faintly alutaceous due to moderately impressed isodiametric microsculpture

Head. Moderate in size, slightly broad; eyes small, only slightly projected laterally, their diameter about equal to length of tempora, the latter short, convex and glabrous. Frons only slightly convex, with frontal furrows deeply impressed but less so posterior to hind margins of eyes. Two pairs of supraorbital setae present, the anterior pair inserted in distinct foveae. Clypeus with four setae. Labrum with six setae, anterior margin moderately concave. Right mandible (Fig. 16h) with premolar tooth fused with retinaculum, anterior tip of retinaculum enlarged to form a distinct tooth and displaced distally, posterior tip of retinaculum reduced, nearly flattened. Left mandible with only a relatively small, feebly trifid tooth. Mentum and submentum not fused. Mentum with medial tooth broad, apically rounded, about one-half the length of the lateral lobes. Submentum with four setae anteriorly. Gula broad. Genae with a single ventral seta one each side. Antennae rather short, only about two antennomeres extended posteriorly beyond basal pronotal margin; antennomeres 2 and 4 about equal in length, antennomere 3 slightly longer.

Pronotum. Slightly narrow (ratio PW/PL = 1.26), with greatest width anterior to middle, only slightly narrowed posteriorly; lateral margins rounded, straightened for a short distance posteriorly, then very slightly sinuate just anterior to basal angles, the latter blunt and subrectangular, very slightly and bluntly projected laterally; basal margin with median region slightly and convexly projected posteriorly. Disc distinctly convex, with median longitudinal impression very finely impressed, superficial, effaced in the median anterior area but extended to basal margin; basal foveae distinct but shallow; median basal area small, delimited laterally by a pair of oblique furrows, smooth except for several short longitudinal depressions; basal margin slightly bisinuate, slightly convex medially; lateral borders slender, gradually widened posteriorly, faintly reflexed

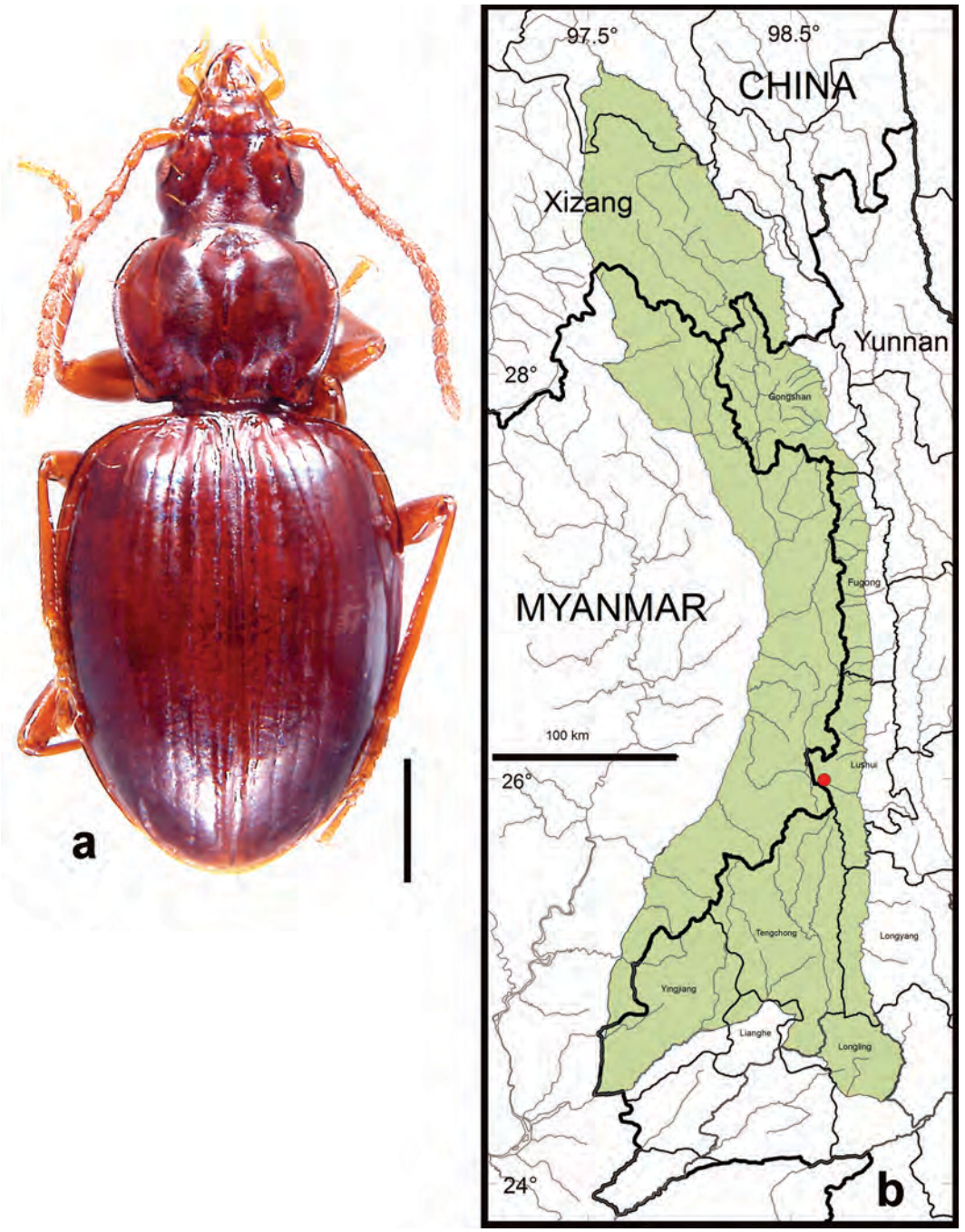


FIGURE 34. *Trechepaphiama gaoligong* sp. nov.; a. Dorsal habitus (CASENT1001926). b. Map of locality record (red circle) for *T. gaoligong* in the Gaoligong Shan region. Scale lines a = 0.5 mm, b = 100 km.

dorsally, lateral grooves widened near base. Single midlateral setae on each side inserted anterior to middle; single basolateral seta on each side, inserted at basal angle.

Elytra. Broad, ovoid, slightly more narrowed posteriorly than anteriorly, markedly convex, slightly inflated; humeri broadly rounded; striae 1 to 5 deeply impressed and slightly punctate, more lateral striae more or less effaced, barely evident; intervals 1 to 4 slightly convex, more lateral intervals flat; basal margination terminated medially at origin of stria 5. Parascutellar striole present, short but distinct. Recurrent stria anteriorly nearly continuous with posterior end of stria 5. Discal setiferous pores absent. Preapical seta present, inserted on interval 3 next to stria 2. Umbilicate setal series with setae of humeral group equidistance from each other and setae of median group inserted slightly posterior to middle.

Legs. Short; protibiae with longitudinal furrow.

Abdomen. Abdominal ventrites glabrous, except for a single paramedial seta on each side, and ventrite VII of female apically with two pairs of paramedial setae.

Habitat distribution.— The unique holotype female of this species was collected by sifting leaf litter taken on sandy substrate on a secondary floodplain covered by a broadleaf forest canopy at an elevation of 2460 m (Fig. 37a). Specimens of *Trechepaphiopsis uniporosa* and *T. unisetosa* were collected in the same sifted litter samples at this site.

Geographical distribution within the Gaoligong Shan.— Fig. 34b. This species is known only from a single female specimen from the type locality in western Lushui County on the western slope of the southcentral part of the Gaoligong Shan region. This locality is in Core Area 4.

Overall geographical distribution.— This species currently is known only from Lushui County in the southcentral part of the Gaoligong Shan region, western Yunnan Province, China.

Discussion

The Gaoligong Shan region is at the very heart of one of the world's biodiversity hotspots (Myers et al. 2000), where faunal elements from the Palearctic and Oriental Regions meet. Adding to this diversity is a distinct regional Chinese element, probably of mixed Palearctic/Oriental origin (Deuve 2013b), which either became isolated and evolved independently within the region or has been replaced elsewhere by present-day Palearctic and/or Oriental elements. Perhaps the most well-known representative of this element is the giant panda, *Ailuropoda melanoleuca* David (1869); but there are also several endemic carabid generic and subgeneric representatives as well (e.g., the nebriine genus *Archastes* Jedličika (1935) and the trechine genus *Eocnides*).

The trechine carabid fauna of the region is hyperdiverse, and the fauna of the Gaoligong Shan region itself is exceptionally species-rich. Of the 29 trechine species recorded from the latter, including the 19 species reported here as new, 25 are known from nowhere else. This pattern contrasts dramatically with that found among the zabrines of the region (Kavanaugh et al. 2014), all 13 of which have been recorded from outside the Gaoligong Shan region and none of which were new to science. In the following sections, we discuss broader geographical distribution patterns of the four trechine species known from outside the region and of the supraspecific taxa of which Gaoligong Shan trechines are members. We also examine geographical and altitudinal distribution patterns and patterns of syntopy (co-occurrence in the same habitat) among species in the regional fauna.

Broad geographical distribution patterns.— The overall geographical ranges of the four trechine species known to occur both inside and outside of the Gaoligong Shan region are graphically approximated, superimposed on one another, in Fig. 45. Among the geographical

ranges of these species, three general range patterns are apparent. The first pattern (1) is shown by one species, *Perileptus imaicus*, with a geographical range that includes only a narrow swath along the southern base of the Himalayan Range from Himachal Pradesh, India in the west to the Gaoligong Shan region, where it reaches its eastern distributional limit. Among the zabrines, *Amara elegantula* Tschitschérine shares this same pattern but in higher elevation habitats (Kavanaugh et al. 2014). The second (2) pattern is shown by two species, *Agonotrechus wuyipeng* and *Eocnides fragilis*, both of which have a geographical range that extends from central or northern Sichuan, respectively, southwest to the northern half of the Gaoligong Shan region, where they reach their western distributional limit. Finally, the fourth species, *Trechus indicus*, shows the third pattern (3), which is a combination of the first two. The range of *T. indicus* extends from eastern Afghanistan eastward along the southern edge of Himalayan range and the Qinghai-Xizang (Tibetan) Plateau to northcentral Sichuan, with its southern limit in the mountains of the Gaoligong Shan region. Several zabrine species, including *Amara sikkimensis* Andrewes, *A. chalciope* (Bates), *A. dissimilis* Tschitschérine, *A. latithorax* Baliani, and *A. birmana* Baliani share this same pattern (Kavanaugh et al. 2014, Fig. 27), although with varied eastern and western extents. Deuve (1997, 2013b) recognized what he called subzones within both the southern Palearctic and northern Oriental Regions based mainly on his biogeographic analysis of the *Carabus* fauna of China and adjacent areas. Our general ranges patterns (1) to (3) correspond well to the southern parts of his Sichuano-Tibetan subzone ("Sous-zone Sichuano-Tibétaine", subzone III in Deuve 2013b, Fig. 13); and pattern (2) is similar to his Yunnan Plateau subregion ("Plateau du Yunnan", subzone IIIa in the same figure).

It is likely no coincidence that all four of the trechine species with known ranges extended beyond the Gaoligong Shan region have adults that are fully-winged. The ability to fly undoubtedly supports the maintenance of larger occupied ranges as well as greater potential for dispersal to new areas. Within the trechine fauna of the study area, four additional species have fully-winged adults: *Perileptus pusilloides*, *Agonotrechus fugongensis*, *A. xiaoheishan*, and *A. yunnanus*. Although all of these species are currently known only from the study area, the discovery of one or more of them in additional, adjacent areas is possible or even likely in the future. However, it would be unexpected to discover populations of any of the remaining 21 species, all of which have flightless adults, outside the Gaoligong Shan region.

With such a large proportion of the trechine fauna of the region known from nowhere else (25 of 29 known species [86%] and four of eight genera [50%, plus one additional subgenus]), a look at the overall distributions of the genera or subgenera to which these trechines belong may provide a broader geographic context for understanding the composition of fauna. *Perileptus* is widely distributed in tropical to temperate portions of all continents in the Eastern Hemisphere and in the Caribbean portion of the Neotropical Region, probably introduced into the latter from Africa with commercial trade. *Agonotrechus* is restricted to the southern portion of the Sichuano-Tibetan subzone and the Subtropical China subzone ("Sous-zone de Chine subtropicale", subzone V in Deuve 2014b, Fig. 13) including Japan. *Eocnides* is restricted to the southcentral portion of the Sichuano-Tibetan subzone and *Queinnectrechus* to the Yunnan Plateau subregion of that subzone. *Trechus*, with its present taxonomic inclusiveness, is Holarctic in distribution, and species in the study area likely have their closest relatives to the north. Three of the remaining genera, *Trechepaphiopsis*, *Epaphiotrechus*, and *Trechepaphiama*, are members of the *Epaphiopsis* complex of genera, which mainly occupy the Subtropical China subzone. The phyletic affinity of *Minutotrechus* remains unclear based on morphological features. As noted above, it is likely related to either *Uenoites*, and therefore has a Sichuano-Tibetan affinity, or to *Hubeitrechus,* and hence has a Subtropical China affinity.

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. This hypothesis was based on meager evidence provided by the zabrine fauna of the Gaoligong Shan, but also on geologic evidence. The Hengduan Mountains date their origins to the late Mesozoic, whereas the uplift of the Himalayan Ranges and Qinghai-Xizang Plateau began later, in the early Cenozoic (Chaplin 2005). Hence the biota of the Gaoligong Shan region probably predates that of these other areas as well. The trechine fauna of the region supports this hypothesis even more strongly. The occurrence of four precinctive genera and one apparently precinctive subgenus of small, flightless beetles, two of which are represented by two and seven species, respectively, suggests differentiation and diversification within the region. The occurrence of another nine likely precinctive species in other genera suggests speciation *in situ*. Finally, even the four species with ranges extended beyond the Gaoligong Shan region all have those ranges either centered on the region of anchored there. As with the zabrines, a better understanding of phylogenetic relationships among the Gaoligong Shan, Eurasian and Oriental *trechine* species and genera is required in order to test this hypothesis, and such an analysis has not yet been undertaken.

Regional geographical and altitudinal distribution patterns.— Within the Gaoligong Shan study area, most of the trechine species represented are narrowly distributed, both geographically and altitudinally. This is not surprising given the high percentage (72%) of species with flightless adults and their preferences for moist, undisturbed habitats. Such areas are restricted within the region mainly to remaining forested areas at low to middle elevations and alpine meadows, moist tundra, stable talus slopes, stream edges and bamboo and *Rhododendron* thickets at higher elevations. Many such areas in the region are separated from each other by deep valleys and, increasingly, by disturbance associated with agriculture and human habitation. While human disturbance is relatively recent, topographic diversity of the region has been developing since the Miocene (Chaplin 2005).

The chart in Fig. 46 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. 47. These charts clearly demonstrate the relatively narrow geographical and altitudinal ranges of most of the trechine species occurring in the region. This is especially apparent from comparisons with the ranges of zabrine species in the same area (see Kavanaugh et al. 2014, Figs. 28 and 29). Among the 13 zabrine species in the fauna, one is recorded from all 7 Core Areas, one from 6 Core Areas (all except 5) and three from four or five Core areas; and most of these species are likely to occur in all seven Core Areas. In contrast, only one species, *Trechus indicus*, is recorded from as many as four Core Areas (1, 3, 6 and 7) and also has a relatively broad known altitudinal range (1230 to 2486 m). Given that it is recorded from the northernmost and southernmost core areas, as well as from both eastern and western slopes of the Gaoligong Shan, it is likely to be found in additional, if not all, core areas with further sampling. Only one additional species, *Perileptus imaicus*, is recorded from as many as three Core Areas (2, 6 and 7) and also has a broad known altitudinal range (from 680 to 2030 m). Like *T. indicus*, it is recorded from both northernmost and southernmost core areas and from both slopes of the mountain range, so it is likely to be more widespread in the region than is presently known, at low to middle elevations. Five additional species are recorded from as many as two core areas: *Perileptus pusilloides* (Core Areas 6 and 7, known altitudinal range from 680 to 1105 m); *Agonotrechus fugongensis* (Core Areas 2 and 3, known altitudinal range from 2300 to 2530 m); *A. wuyipeng* (core areas 2 and 3, known altitudinal range from 2687 to 2770 m); *Queinnectrechus balli* (Core Areas 1 and 2, known altitudinal range from 3300 to 3750 m); and *Trechepaphiopsis unisetosa* (Core Areas 4 and 5, known altitu-

dinal range from 2460 to 3150 m). For each of these species, Core Areas known to be occupied are immediately adjacent. A sixth species, *Trechus luzhangensis* is recorded only from the pass dividing Core Areas 4 and 5 (at 3150 m) and so has been attributed to both Core Areas. Among these six species, only *P. pusilloid*es, *A. fugonensis* and *A. wuyipeng* have fully-winged adults and are likely to have ranges greater than are presently known. The other three species, *Q. balli*, *T. unisetosa*, and *T. luzhangensis*, have flightless adults and are not likely to have ranges outside their presently known Core Areas. The remaining 21 species are presently known only from a single Core Area and have altitudinal ranges of varied breadth. Among these, only *Agonotrechus xiaoheishan*, *A. yunnanus*, and *Eocnides fragilis* have fully-winged adults and therefore are likely to be significantly more widespread within the region than presently known.

A comparison of recorded diversity for *trechine* species among the seven Core Areas (Fig. 46) shows that all of them are occupied by at least two species, with highest diversity in Core Area 2 (with 10 of the 29 species), second highest in Core Areas 3 and 6 (each with 8 species) and lowest recorded diversity in Core Areas 1 and 5, which are the Core Areas least extensively sampled and perhaps most heavily impacted by human disturbance, respectively. In contrast, the zabrines were found to be most diverse in Core Area 6, second most diverse in Core Area 2, and least diverse in Core Area 4 (Kavanaugh et al. 2014). At present, Core Areas 1 and 2 (West/East versants in the northernmost part of the region) are known to uniquely share only one species, *Queinnectrechus balli*, adults of which are flightless. Further sampling is likely to confirm the occurrence in Core Area 1 of additional species presently known only from Core Area 2, particularly those inhabiting high elevation habitats there. Core Areas 2 and 3 (areas adjacent North/South on the eastern slope of the Gaoligong Shan) share two species uniquely, *Agonotrechus fugongensis* and *A. wuyipeng*, both of which have fully-winged adults. Unfortunately, the China/Myanmar border forms the western limit of Core Area 3 and also of our study area (see Material and Methods section above), so the fauna of the western versant of the Gaoligong Shan in the northcentral part of the range remains unknown. Core Areas 4 and 5 (West/East versants in the southcentral part of the region) uniquely share two species, *Trechus luzhangensis* and *Trechepaphiopsis unisetosa*, both with flightless adults.

Five of the seven Core Areas are inhabited by at least one species recorded from no other Core Area. Six species are uniquely recorded from Core Area 2, the northernmost eastern versant of the region. All of these except *Eocnides fragilis* have flightless adults. Five species are uniquely recorded from Core Areas 3 and 6, respectively; and all of these except *Agonotrechus xiaoheishan* (in Core Area 6) have flightless adults. Three species are uniquely recorded from Core Area 7, the southernmost eastern versant of the region, and two from Core Area 4. Among these, all except *Agonotrechus yunnanus* have flightless adults.

If we ignore the two most widespread species, *Trechus indicus* and *Perileptus imaicus*, it is clear that five different Core Areas or combinations thereof have distinctive trechine assemblages. (1) The northermost part of the Gaoligong Shan region (Core Areas 1 and 2 together) is the most diverse and distinctive region, with seven species (six of which have only flightless adults) unique to it. Only *Agonotrechus fugongensis* and *A. wuyipeng*, both with fully-winged adults, are shared with any other area (adjacent Core Area 3). (2) Core Area 3, the north central part of the region, also has a distinctive trechine fauna, with five species (all with flightless members) unique to it (plus the two species shared with Core Area 2 as just noted). (3) The southcentral portion of the region (Core Areas 4 and 5 together) also has a distinct trechine assemblage of four species, all with flightless members, unique to it. *Trechus indicus*, *Perileptus imaicus* and *P. pusilloides*, all with fully-winged adults, are recorded from Core Areas 6 and 7, but otherwise the trechine assemblages of these areas are distinctive. (4) Four species are unique to Core Area 6, all except *Agonotrechus*

xiaoheishan with flightless adults; and (5) three species are uniquely recorded from Core Area 7, with only *A. yunnanus* having fully-winged adults.

With respect to the distributions of genera within the Gaoligongshan region, a broader picture emerges. Both *Perileptus* and *Agonotrechus* range from Core Area 2 in the northeast to Core Areas 6 and 7 in the south, with gaps in records from the middle part of region. *Minutotrechus* is recorded only from Core Area 6 in the southwestern part of the region and *Eocnides* only from Core Area 2 in the northernmost part. *Queinnectrechus* also appears restricted to Core Areas 1 and 2 in the northernmost part. Although *Trechus indicus* is widespread both within and beyond the region, the remaining species of *Trechus*, which we have informally labeled the "*qiqiensis* group" appear restricted to the northern and central parts of the region (Core Areas 2, 3, 4, and 5). *Trechepaphiopsis* is widely distributed in the region, from northernmost to southernmost Core Areas but most diverse in the northcentral and southcentral areas (Core Areas 3 and 4). *Epaphiotrechus* is recorded only from Core Areas 3 and 7, non-adjacent northcentral and southern parts of the region on the east slope of the Gaoligong Shan, and *Trechepaphiama* is known only from Core Area 4 on the western slope in the southcentral part of the mountain range. In general, genera that have affinities with faunas of the Palearctic Region (e.g., *Trechus* species) and with the Sichuano-Tibetan subzone in particular (e.g., *Queinnectrechus* and *Eocnides*) mainly occupy northern and central parts of the region, whereas genera with affinities with the Oriental Region and with the Subtropical China subzone of the region in particular, mainly occupy the central and southern parts of the region. However, the adaptations of individual species in each of these affinity classes to diverse local topographic differences, which foster geographical and altitudinal isolation in the region, and differences in the respective flight capabilities of their members, which support broader or narrower distributional ranges, serve to partially obscure this overall pattern.

With respect to the altitudinal distribution of the trechine fauna of the study area (Fig. 47), several points can be made. Highest diversity is concentrated in a broad zone between about 2250 m and 3750 m, with 27 of the 29 species occurring within this zone. Only two species, *Perileptus imaicus* and *P. pusilloides* occur below 1000 m in the study area; and only two more, *Eocnides fragilis* and *Trechus indicus*, occur below 2000 m. As noted for each elsewhere above, all of these species have fully-winged adults. Eight species (*Queinnectrechus griswoldi*, *Q. gongshanicus*, *Q. balli*, *Trechus shiyueliang*, *T. qiqiensis*, *T. gongshanensis*, *T. shibalicus*, and *Trechepaphiopsis monochaeta*) occur above 3500 m, but only *Q. gongshanicus* appears to be restricted to that elevation or above. All of these species have flightless adults. Compared with the distributions of zabrines in the region, the trechines occupy relatively restricted altitudinal ranges. The average difference between highest and lowest elevations recorded for each of the 24 trechine species for which more than one elevational record is known is 500 m (range = 20 to 1350 m), whereas the average difference for zabrine species in the region is 1193 m (range = 225 to 2111 m), more than double that for trechine species (Kavanaugh et al. 2014). Also, six of 13 zabrine species occupy greater altitudinal ranges than any trechine species in the same area.

In the preceding discussion, we have repeatedly noted relationships between the extent of geographical and/or altitudinal ranges and flight capability. Why? As Schmidt et al. (2016) noted, "… considering the low dispersal ability of the tiny wingless beetles within their mountainous environment, very small distributional areas can be expected for each of the species and therefore the contemporary existence of a large number of closely related allopatric *Trechus* species." This certainly describes very well the trechine fauna of the Gaoligong Shan region, and also explains how it differs so markedly from the zabrine fauna of the same region.

Syntopy of species in the regional fauna.— Records of the co-occurrence of different trechine species at the same site and in the same habitat (i.e., syntopic) within the study area are sum-

marized in Fig. 48. Syntopy appears to be relatively rare among trechines of the region, especially compared with the zabrines of the region. Four of 13 zabrine species have been recorded syntopic with eight other zabrine species, three other species syntopic with seven other species, and all 13 species syntopic with at least one other species (Kavanaugh et al. 2014). In contrast, seven of the 29 trechine species have not been found syntopic with any other species. Only one trechine species, *Queinnectrechus griswoldi*, has been found syntopic with five other species (*Q. balli*, *Q. gongshanicus*, *Trechus qiqiensis*, *T. gongshanensis*, and *Trechepaphiopsis monochaeta*), but at no single site with more than four of those species. *Queinnectrechus balli* and *T. gongshanensis* have been found syntopic with the same cadre of species except *T. monochaeta*, and *T. qiqiensis* has been found syntopic with all of the above except *Q. gongshanicus*. All the above records of syntopy are from the northernmost part of the study area, in Core Area 2. *Trechus shibalicus* has been found syntopic with four other species (*Trechus shiyueliang*, *T. pseudoqiqiensis*, *Trechepaphiopsis unisetulosa* and *T. unipilosa*) in Core Area 3. *Trechus shiyueliang* has been found syntopic with the same cadre of species except *T. pseudoqiqiensis* in the same area. *Trechus indicus* has also been found syntopic with three other species (with *Agonotrechus xiaoheishan* in Core Area 6 and with *A. yunnanus* and *Epaphiotrechus fortip*es in Core Area 7).

Given the low level of syntopy among the trechines of the area overall, it is perhaps surprising to find it among congeneric species in several genera. The two *Perileptus* species in the fauna are syntopic in Core Areas 6 and 7. All three of the *Queinnectrechus* species are syntopic in Core Area 2. Among *Trechus* species in the region, *T. qiqiensis* and *T. gongshanensis* have been found syntopic in Core Area 2 and *T. pseudoqiqiensis*, *T. shibalicus* and *T. shiyueliang* in Core Area 3. Among the species of *Trechepaphiopsis*, only *T. unisetulosa* and *T. unipilosa* have been found syntopic, also in Core Area 3. For several of these syntopic pairs of congeneric species we have noted evident differences in body size between the pair members. The ranges in size (BL) of *Perileptus imaicus* and *P. pusilloides* adults are 2.6 to 2.8 mm and 2.3 mm, respectively. Those of the two species of *Queinnectrechus (s. str.*), *Q. griswol*di and Q. *gongshanicus*, are 4.3 to 4.8 mm and 3.5 to 3.8 mm, respectively. Those of *Trechus qiqiensis* and *T. gongshanensis* are 4.0 to 4.2 mm and 3.3 to 3.5 mm, respectively; and those of *Trechus pseudoqiqiensis* and *T. shibalicus* are 4.0 mm and 3.3 to 3.5 mm, respectively (*T. shiyueliang* [BL = 4.0 to 4.2] appears to be more distantly related based on key morphological features). Finally, those of *Trechepaphiopsis unisetulosa* and *T. unipilosa* are 3.3 to 35 mm and 2.7 to 3.1 mm, respectively. Sokolov and Kavanaugh (2014) found similar size differences among closely related, small, flightless, litter-dwelling and syntopic anillines of the genus *Geocharidius* in Nuclear Centeral America. Just what role such size differences may play in facilitating syntopy is unclear, but perhaps they allow members of the different species to share slightly different microspaces and/or food (prey) in their shared habitat without or with reduced competition.

Finally, we cannot resist commenting on the *Agonotrechus* fauna of the region. Four species occur there, all with fully-winged adults, and none of them has yet been recorded syntopic with any another, although *A. fugongensis* and *A. wuyipeng* have been collected in adjacent habitats in the southern part of Core Area 2. Unlike members of both *Perileptus* species, which are syntopic in the southern part of the region, those of all the *Agonotrechus* species apparently only occupy habitats above 2000 m in elevation (range = 2000 to 2770 m). Just how, when, or even if these beetles use their wings remains unknown.

FIGURE 35. Photographs of habitats for trechine species in the Gaoligong Shan region. a. Gongshan County, Bingzhongluo Township, Xiao Shangla He at Shuangla Village, elevation 1550 m; habitat in which specimens of *Perileptus imaicus* Jeannel were collected. b. Gongshan County, Qigi He, 9.9 airkm W of Cikai, elevation 2000 m; habitat in which specimens of *Agonotrechus fugongensis* sp. nov. were collected. Photos by David H. Kavanaugh.

FIGURE 36. Photographs of habitats for trechine species in the Gaoligong Shan region. a. Fugong County, Shiyueliang Township, 1 km E of Shibali on Shibali Road, elevation 2400 m; habitat in which specimens of *Agonotrechus fugongensis* sp. nov. were collected. b. Gongshan County, Cikai Township, Qiqi Trail at No. 12 Bridge Camp, elevation 2770 m; habitat in which specimens of *Agonotrechus wuyipeng* Deuve were collected. Photos by David H. Kavanaugh.

FIGURE 37. Photographs of habitats for trechine species in the Gaoligong Shan region. a. Lushui County, Pianma Township ,9.3 km ENE of Pianma along road to Lushui at Changyan He, elevation 2460 m; habitat in which specimens of *Trechepaphiopsis unisetosa* (Deuve), *T. uniporosa* sp. nov., and *Trechepaphiama gaoligong* sp. nov. were collected. b. Gongshan County, Cikai Township, slope S of of Heipu Yakou, elevation 3370 m; habitat in which specimens of *Queinnectrechus griswoldi* sp. nov., *Q. balli* sp. nov., and *Trechus qiqiensis* sp. nov. were collected. Photos by David H. Kavanaugh.

FIGURE 38. Photographs of habitats for trechine species in the Gaoligong Shan region. a. Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan 0.3 km SW of Chukuai Lake, elevation 3750 m; habitat in which specimens of *Queinnectrechus griswoldi* sp. nov. and *Trechus gongshanicus* sp. nov. were collected. b. same area, but habitat in which specimens of *Queinnectrechus griswoldi* sp. nov. and *Trechepaphiopsis monochaeta* sp. nov. were collected. Photos by David H. Kavanaugh.

FIGURE 39. Photographs of habitats for trechine species in the Gaoligong Shan region. a. Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan, 0.3 km NNE of Chukuai Lake, elevation 3745 m; habitat in which specimens of *Queinnectrechus gongshanicus* sp. nov., *Q. balli* sp. nov. and *Trechus gongshanensis* sp. nov. were collected. b. Gongshan County, Bingzhongluo Township, SW slope of Kawakarpu Shan on slope NE of Chukuai Lake, elevation 3950 m; habitat in which specimens of *Queinnectrechus griswoldi* sp. nov. and *Trechus gongshanensis* sp. nov. were collected. Photos by David H. Kavanaugh.

FIGURE 40. Photographs of habitats for trechine species in the Gaoligong Shan region. a. Gongshan County, 21 air km W of Cikai on east slope of Qiqi/Dulong divide, elevation 3600 m; habitat in which specimens of *Queinnectrechus balli* sp. nov. and *Trechus gongshanensis* sp. nov. were collected. b. Fugong County, Shiyueliang Township, 8.5 km above Shibali on Shibali Road, elevation 3100 m; habitat in which specimens of *Trechus shiyueliang* sp. nov., *T. shibalicus* sp. nov., *Trechepaphiopsis unisetulosa* sp. nov. and *T. unipilosa* sp. nov. were collected. Photos by David H. Kavanaugh.

FIGURE 41. Photographs of habitats for trechine species in the Gaoligong Shan region. a. Gongshan County, Dulongjiang Township, Dulong Jiang at Elideng village, elevation 1640 m; habitat in which specimens of *Trechus indicus* Putzeys were collected. b. Tengchong County, Mingguang Township, slope SW of Eighth Boundary Post Pass, elevation 2887 m; habitat in which specimens of *Trechus mingguangensis* sp. nov. were collected. Photos by David H. Kavanaugh.

FIGURE 42. Photographs of habitats for trechine species in the Gaoligong Shan region. a. Gongshan County, Cikai Township, Qiqi Trail at No. 12 Bridge Camp area, elevation 2775 m; habitat in which specimens of *Trechus qiqiensis* sp. nov. and *Trechepaphiopsis monochaeta* sp. nov. were collected. b. Fugong County, Shiyueliang Township, 11.5 km above Shibali on Shibali Road, elevation 3290 m; habitat in which the holotype of *Trechus pseudoqiqiensis* sp. nov. was collected. Photos by David H. Kavanaugh.

FIGURE 43. Photographs of habitats for trechine species in the Gaoligong Shan region. a. Lushui County, Luzhang Township, Piana Road 0.1 km E of Fengxue Yakou, elevation 3150 m; habitat in which specimens of *Trechus luzhangensis* sp. nov. were collected. b. Lushui County, Luzhang Township, 100 m S of Fengxue Yakou on east side of pass, elevation 3150 m; habitat in which specimens of *Trechepaphiopsis unisetosa* (Deuve) were collected. Photos by David H. Kavanaugh.

FIGURE 44. Photograph of habitat for trechine species in the Gaoligong Shan region. Longling County, Longjiang Township, Xiaoheishan Forest Reserve, elevation 2020 m; habitat in which specimens of *Agonotrechus xiaoheishan* sp. nov. and *Trechus indicus* Putzeys were collected. Photo by David H. Kavanaugh.

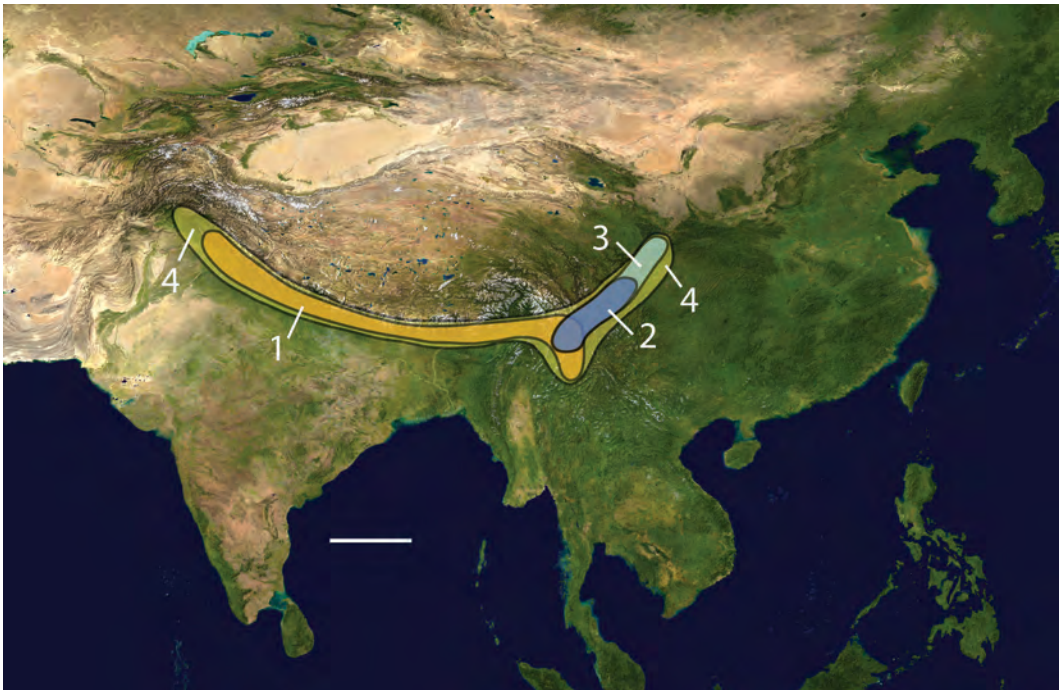


FIGURE 45. Map showing approximate overall known geographical distributions of species occurring in the Gaoligong Shan region as well as outside the region. 1 = *Peripleptus imaicus* Jeannel. 2 = *Agonotrechus wuyipeng* Deuve. 3 = *Eocnides fragilis* Uéno. 4 = *Trechus indicus* Putzeys. Scale line = 500 km.

	Core Area						
species	1	2	3	4	5	6	7
Perileptus imaicus		X				X	X
Perileptus pusilloides						X	X
Agonotrechus fugongensis		X	X				
Agonotrechus wuyipeng		X	X				
Agonotrechus xiaoheishan						X	
Agonotrechus yunnanus							X
Minutotrechus minutus						X	
Queinnectrechus balli	X	X					
Queinnectrechus griswoldi		X					
Queinnectrechus gongshanicus		X					
Eocnides fragilis		X					
Trechus indicus	X		X			X	X
Trechus shiyueliang			X				
Trechus mingguangensis						X	
Trechus qiqiensis		X					
Trechus pseudoqiqiensis			X				
Trechus luzhangensis				X	X		
Trechus gongshanensis		X					
Trechus shibalicus			X				
Trechepaphiopsis asetosa						X	
Trechepaphiopsis unisetigera							X
Trechepaphiopsis unisetosa				X	X		
Trechepaphiopsis uniporosa				X			
Trechepaphiopsis unisetulosa			X				
Trechepaphiopsis monochaeta		X					
Trechepaphiopsis unipilosa			X				
Epaphiotrechus fortipes							X
Epaphiotrechus fortipesoides						X	
Trechepaphiama gaoligong				X			

FIGURE 46. Chart showing the representation of trechine species in project-designated Core Areas (see Fig. 3) in the Gaoligong Shan region.

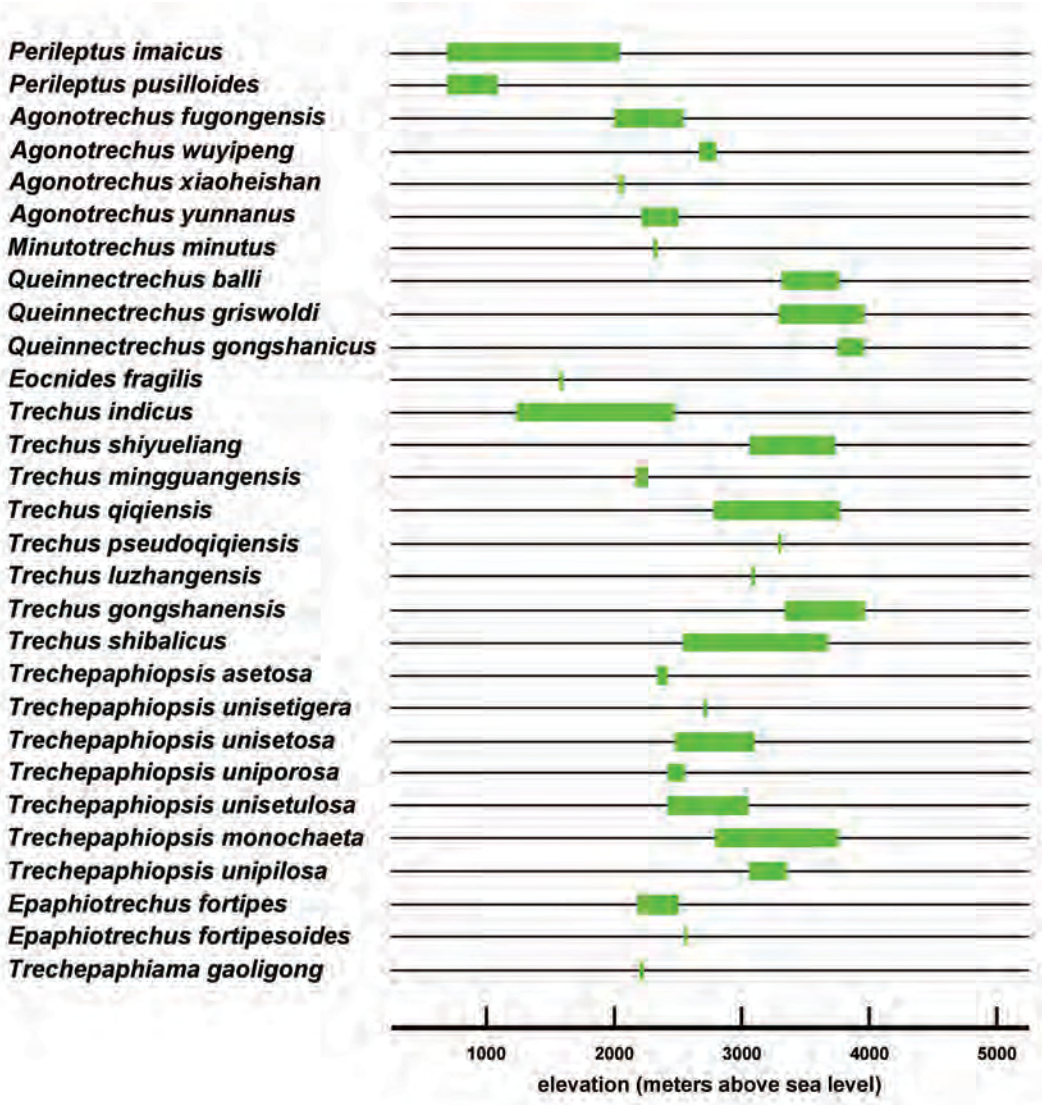


FIGURE 47. Chart illustrating the altitudinal ranges of trechine species represented in the Gaoligong Shan region.

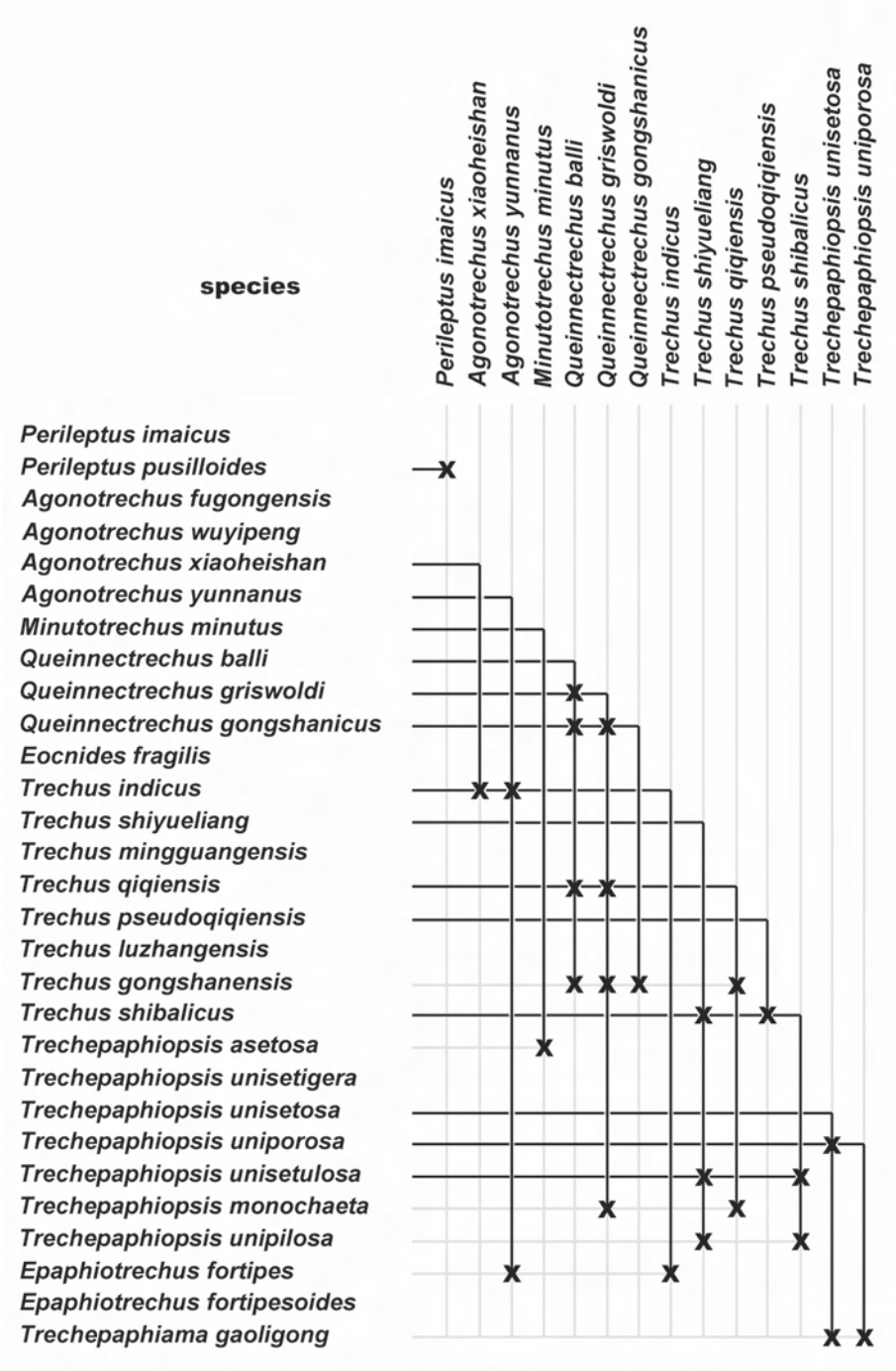


FIGURE. 48. Chart illustrating the co-occurence (syntopy) of trechine species in samples from the same habitats and at the same sites in the Gaoligong Shan region.

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Table of Contents