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The *Xixuthrus* species of Fiji (Coleoptera: Cerambycidae: Prioninae)

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Abstract

There have been four species of the cerambycid genus *Xixuthrus* described from the Fijian archipelago; *X. heros* (Heer), *X. terribilis* Thomson, *X. ganglbaueri* Lameere, and *X. heyrovskyi* Tippmann. Over time, *X. terribilis* had been reduced to synonymy, and it had been suggested that *X. ganglbaueri* was probably from New Guinea rather than Fiji. We here re-establish the validity of *X. terribilis*, place *X. heyrovskyi* in synonymy with it, and designate a neotype for *X. ganglbaueri* to resolve both the species identity and its geographic provenance. Diagnoses of the three confirmed Fijian species are presented, including digital images of type specimens, and notes on temporal and spatial distribution.

Key words: Coleoptera, Cerambycidae, Prioninae, *Xixuthrus*, Fiji, Australasia, conservation

Introduction

Recent interest in developing conservation protocols for rare and endangered wildlife endemic to the Fijian archipelago has, among other things, renewed interest in those members of the cerambycid beetle genus *Xixuthrus* Thomson that occur there. These were, up until recently, believed to comprise only the Giant Fijian Longhorn Beetle, *X. heros* (Heer, 1868), and the Taveuni Beetle, *X. heyrovskyi* Tippmann, 1945 (Dillon & Dillon, 1952). The former is often regarded as the world's second largest beetle species, with specimens sometimes reaching 14 to 15 cm in body length; their size and apparent rarity has made them quite sought-after among beetle collectors, with specimens commanding very high prices, and some websites have even put forth the possibility that the species is extinct. Recent reports (e.g. Ryan et al., 1989) that *X. costatus* Montrouzier, a species from the Solomon Islands, also occurred in Fiji were, upon closer investigation, based on misidenti-

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fications, and there was clearly a need to review the taxonomy and biogeography of this genus in Fiji. A thorough review of original literature, museum holdings, and a public reward program initiated in Fiji has revealed that not only is *heros* not extinct, but that there are at least three species of *Xixuthrus* presently occurring in Fiji, all of them having been originally described as Fijian, one of them essentially unrecognized for the last century.

The third described Fijian species, *X. terribilis* Thomson, 1877, was described from a single male specimen (from "Ins. Fidgi") and placed in synonymy with *heros* by Lameere (1903). It had been widely regarded as such since that time, though Tippmann (1945) believed it to be a valid taxon, and Komiya (2000) figured a putative specimen, noting that it was not conspecific with *heros*. Komiya did not, however, have an opportunity to examine the holotype, which resides in the Muséum National d'Histoire Naturelle (MNHN) in Paris. Recent examination of the type (by S.S.; see Fig. 5) reveals that it is conspecific with *X. heyrovskyi* (see Fig. 6), and was incorrectly recognized by Komiya. Thus, *X. heyrovskyi* must be considered a junior synonym of *X. terribilis*, and Komiya's "terribilis" specimen presents a dilemma. This specimen is identical, in all respects, to specimens of *X. microcerus* White (an indeterminate subspecies, perhaps undescribed) from Irian Jaya. Given that Komiya's specimen was obtained from an anonymous commercial insect dealer, and given that no other specimens resembling it (or any other of the various *microcerus* subspecies) have ever been documented from the Fijian archipelago or nearby areas, we cannot assume that this taxon occurs in Fiji, at least not until other specimens of more credible origin are located.

The fourth described species, *X. ganglbaueri* Lameere, 1912, was also described from a single male specimen (labeled as from "Fidji"), with a very limited diagnosis and no illustrations; essentially the only useful information was regarding the antennal and tarsal proportions. It was asserted in the description that the specimen bore a resemblance to *X. helleri* Lameere, and that since *helleri* was from New Guinea, the specimen must have been mislabeled, and was probably from New Guinea rather than Fiji. Unfortunately, the type specimen of *ganglbaueri* cannot be located, though it was presumed to be in the Boppe collection (which then became part of the Le Moult collection) in Paris. However, some specimens in the insect collection at the Colo-i-Suva Forestry Station (a few of which had been incorrectly identified by Madhu Kamath as *costatus*), plus live specimens brought in as part of the reward program, correspond to what is known about *ganglbaueri*; primarily, that it shares with *X. helleri* prominent glabrous elytral stripes and antennae with relatively short flagellomeres and total length, the antennal proportions thus clearly distinguishing it from *heros* (which it also otherwise resembles; below), and with short forebasitarsi, also a distinguishing feature. The original description failed to mention flagellar spinules, which, we can only presume, would have been mentioned had they been present, and also would have certainly indicated an affinity to *heros* rather than to *helleri*. Accordingly, in order to firmly establish its identity and correct geographic provenance,

and fulfilling all other requirements under the International Code of Zoological Nomenclature (Article 75.3; ICZN, 1999) we designate below a neotype for this species.

We note here that the holotype of *heros* also cannot be located presently (it was originally stated to be in the Godeffroy collection, in Hamburg), but the illustrations of it and descriptions (Heer *in* Graeffe, 1868, and Dohrn, 1868) are excellent and more than adequately detailed to characterize this species with confidence. As the identity of the species is absolutely not in doubt, it is impossible to validly designate a neotype (following ICZN Article 75.2). However, we should note that the putative larva as it was described is probably misassociated; the larva illustrated appears to be that of an *Olethrius* species (another genus of large prionines commonly encountered in rotting logs in Fiji), and is only a fraction of the size reported by Fijians who claim to have seen true *Xixuthrus* larvae. Unfortunately, these larvae are considered special delicacies, on those rare occasions when they are encountered, so there are no known specimens, and those who have found the larvae have not made note of the tree species involved. The only noteworthy feature mentioned in verbal descriptions of putative *Xixuthrus* larvae (aside from their enormous size, evidently approaching 20 cm, with reported tunnel diameters of 5 cm) is that the larval callosities are apparently distinctly darkened, which, if true, should readily distinguish them from *Olethrius* larvae. The only previously-published host records for Fijian *Xixuthrus* were highly suspect, as both involved introduced plants; mango (*Mangifera indica*) and raintree (*Albizzia saman*) (Ryan et al. 1989, Liebregts et al. 2001). Recent field surveys by the Wildlife Conservation Society and the Fiji Department of Foresty, however, have found giant larval tunnels averaging 5 cm in diameter, presumably *Xixuthrus*, in buabua (*Fagraea gracilipes* A. Gray [Loganiaceae]; a threatened species of native hardwood) trees above 80 cm dbh, with the grubs in living trees with some dead wood.

Species diagnoses and material examined

General account

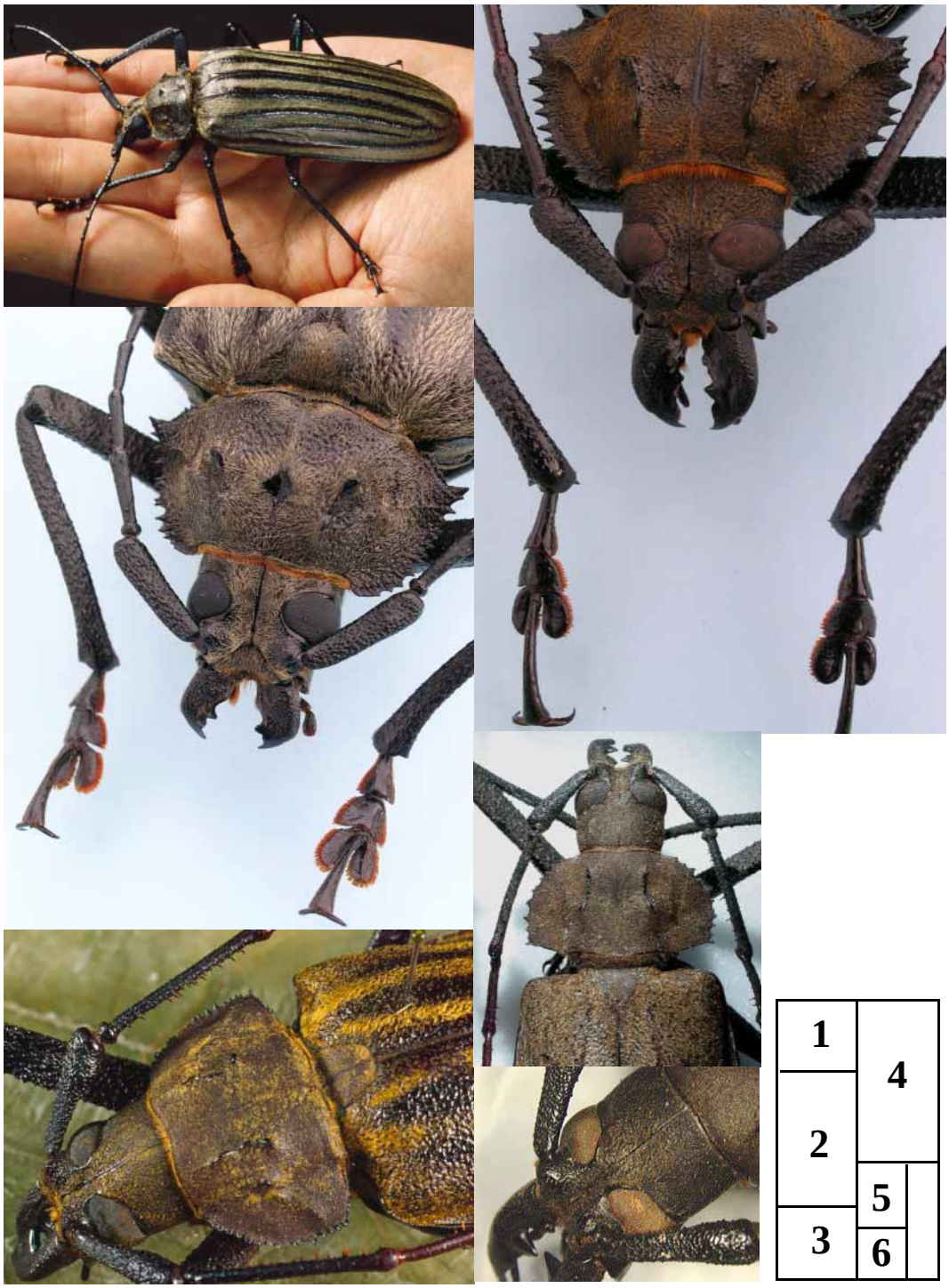
Sexual dimorphism in all of these species is limited but obvious, especially in the longer proportions, in males, of the mandibles, femora, tibiae, basal tarsomeres, and antennae, plus more granulate pronotal and prosternal surfaces. Males also have denser apical hair brushes on the terminal abdominal sterna, and prominent ventral pubescence on the apical tarsomere. Additionally, females of *heros* and *terribilis* lack the prominent flagellar spinules of their respective males, though the scape is still weakly spiculate (compare Figs. 3 & 4). In all species, the features that seem to vary most with size (allometry) are the relative length and spiculation of the male forelegs (the femora and tibiae being disproportionately longer and more prickly in larger males), and we have not relied upon such characters in the species diagnoses unless the variance is non-overlapping between species. It has also been observed (by D.Y. and D.O.) that live *Xixuthrus* produce a very loud, fearsome hissing noise when disturbed or handled, and that the hissing is not produced by

stridulation (prionine cerambycids lack the stridulitra present in other subfamilies), or by rubbing the legs against the elytra (as reported by Ryan, 2000), but rather by abdominal movements apparently forcing trapped air from under the elytra through a narrow aperture at the elytral bases; the hissing apparently more often has a slight "chirp" quality to it in *X. ganglbaueri* than in *heros* or *terribilis*. Note that under "Specimens examined" below, literal text of labels, when given, is in quotes. Repository codens (excluding the private collection of Ziro Komiya in Tokyo, Japan) are: **BMNH** = The Natural History Museum, London, UK; **BPBM** = Bernice P. Bishop Museum, Honolulu, Hawaii, USA; **MAFF** = Department of Forestry, Colo-i-Suva Forestry Station, Suva, Fiji; **MNHM** = Muséum National d'Histoire Naturelle, Paris, France; **USNM** = National Museum of Natural History, Washington, D.C., USA.

***Xixuthrus ganglbaueri* Lameere, 1912**
Figs. 1–2

Specimens examined: Neotype female (here designated), "Fiji, Viti Levu, Tamavua FSN, 28.v.2003, coll. Salanieta Tawake", "NEOTYPE *Xixuthrus ganglbaueri* Lameere, det. D. Yanega 2003" (originally from MAFF; will be permanently deposited in BPBM, as type #16557) [Figs. 1, 2]; 1 female, Fiji, Viti Levu, Nasinu, 05.v.81, coll. Marika Rasekaseka (MAFF); 1 female, same locality, 01.viii.88, coll. A. Vosanibola (MAFF); other specimens known only from photographs.

Diagnosis: This species can easily be confused with *heros* (with which it is sympatric; both species are presently confirmed only from Viti Levu, primarily the SE quadrant of the island), though careful examination reveals that it differs in numerous characters, ultimately uniquely sharing little more than the broad glabrous elytral stripes. The major differences (compare Figs. 2 and 4) include the lack of prickly spicules on the antennal scape, which is instead covered with distinct, shallow punctures; the scape is only gradually and slightly enlarged apically, in distinct contrast to the apically swollen scape in *heros* and *terribilis*; much shorter antennae relative to body length; there is a glabrous, impunctate, diamond-shaped area in the center of the pronotum; and, in particular, the forebasitarsi are scarcely longer than broad (the mid and hind basitarsi are similarly proportioned, but the difference between *ganglbaueri* and the other species is more evident in the foretarsi). Additionally, the posterior portion of the head is not as elongated, nor are the mandibles; the mandibular teeth are much smaller; the frontal groove is rather deeply impressed from the clypeus up to the vertex; the distal tarsomere is relatively shorter; the pronotal surface is more generally shining, with the medial ridges generally weaker but more strongly produced and somewhat tuberculate posteriorly. The general coloration of the pubescence is more grayish, or somewhat silvery, in comparison to the usual coloration of *heros*, which is more brownish to golden, but this difference is somewhat less evident in more worn specimens.



FIGURES 1–6. **1–2.** *Xixuthrus ganglbaueri* Lameere, female neotype: **1,** habitus; **2,** head, prothorax, and forelegs. **3–4.** *X. heros* (Heer): **3,** male; head and prothorax; **4,** female; head, prothorax, and forelegs. **5–6.** *X. terribilis* Thomson: **5**, male holotype of *terribilis*; head and prothorax; **6,** male holotype of *heyrovskyi* Tippmann [= *terribilis*]; head.

Remarks: The female chosen as the neotype is considered appropriate for two reasons: (1) this is the specimen from which a mesotarsus was removed for sequencing while it was still alive, and it is the genetic voucher for the species, and (2) given Lameere's original claim that the species resembled *helleri*, and the description of the antennae and foretarsi, the evidence supports that the neotype is in fact the same species that Lameere originally described. The alternative hypothesis, that *ganglbaueri* was a mislabeled New Guinean species, and there just happens, by coincidence, to be an undiscovered Fijian species which shares several features with it, is far less acceptable. New Guinean specimens which Tippmann identified as *ganglbaueri* have proven, upon examination (by S.S.), to be *helleri*. We have seen only a photograph of one male which could definitively be associated with the female, and it also possesses short forebasitarsi, short antennae, strong pronotal ridges, and grayish pubescence (though not clear, it does seem that the photo shows a punctate scape, and central glabrous pronotal spot, but to be cautious we do not use these features in the key below); it is possible that other males may be more difficult to distinguish from male *heros*, but at least this one specimen is readily separable. We further note that the shorter head, mandibles, and antennae of *ganglbaueri* are not an artifact of the specimens being smaller than those of *heros* (i.e., the differences are not due to allometry), even though the average size appears slightly smaller; the neotype female is nearly 9 cm, while the *heros* female figured is 11 cm, and the differences are independent of the size of *heros* individuals used for comparison (several of which were in fact smaller).

Gene sequencing (performed by David Hawks) leaves no doubt whatsoever that this specimen is not conspecific with *X. heros* from the same general locality; the number of base pair differences and large number of insertions (54 base pair changes and 49 insertions in ribosomal 28S regions D2 and D5) constitute as substantial a genetic difference as is sometimes seen between different genera in other families of beetles (Hawks & Heraty, in prep.). The numerous genome insertions suggest that *ganglbaueri* is the more derived taxon, and we expect to find that when *terribilis* is sequenced, it will prove to be the sister taxon to *heros*, rather than *ganglbaueri*.

***Xixuthrus heros* (Heer, 1868)**
Figs. 3-4

Specimens examined: 1 male, "Viti Lefu" (BMNH); 1 male, Fiji, 1962 N.W. Simmonds (BMNH); 1 male, 1 female, Fiji, Suva, 15.ix.1932, W. Simmonds (BMNH); 1 male, no data (BMNH); 1 male, Fiji, 1953 H. Simmonds (BMNH); 1 male, Fiji, 1905, Fry Coll. (BMNH); 1 male, Fiji, Viti Levu, Lami, 5.vii.1986, coll. Tevita Tuimereke (MAFF); 1 male, Fiji, Viti Levu, Naivikinikini village, 178°24'E, 18°06'S, 30.xii.2003, 50m, coll. Isikeli Delaivuna (MAFF) [Fig. 3]; 1 female, Fiji, Viti Levu, Colo-i-Suva Forest Station 22.v.1996 (MAFF) [Fig. 4]; 1 male, "Fidgi" (Z. Komiya); 1 female "Fidsdsi, Tassein Viti Levu" (Z. Komiya); 1 male, Viti Levu, Navai Mill, nr. Nandarivatu, 13.ix.1938, 2,400ft. (BPBM).

Diagnosis: This species is easily distinguished from the other Fijian species as the elytra have broad glabrous stripes and the flagellomeres (except the distal pair) bear numerous prominent spinules in the male (Fig. 3). Females (Fig. 4) are further distinguished from *ganglbaueri* by numerous structural features, as mentioned above, including the longer forebasitarsi, apically swollen and spiculate scape, less produced medial pronotal ridges, and longer antennae. A few specimens have the frontal groove nearly as deep as in *ganglbaueri*, so this feature seems of limited diagnostic value, though we have seen none with elytral pubescence of exactly the same color. Structurally, both sexes of *heros* are nearly identical to *terribilis*, though the latter typically have a slightly more elongated vertex (Figs. 5 & 6) and lack elytral stripes. These latter two species share not only the male antennal spinules and long necks and mandibles, but also have the same pronotal and prosternal sculpture, and forebasitarsal proportions, in both sexes.

Remarks: We consider it likely that *heros* and *terribilis* are very close sister taxa, and they may or may not be allopatric; anecdotal reports indicate that *heros* may occur on Vanua Levu (not on Taveuni, contrary to Ryan, 2000), where *terribilis* has also been found, and the holotype of *heyrovskyi* is labeled as having come from Viti Levu, though no other specimens have ever been recorded from the island. As mentioned earlier, the holotype of *heros* is missing, but the identity of the species is not in doubt, so a neotype cannot be designated (following ICZN Article 75.2). A male from Fiji, Viti Levu, Lami, collected in 2004 (not listed above), was selected as a genetic voucher for this species. Komiya (2000) has an excellent habitus photo of a male *heros*.

***Xixuthrus terribilis* Thomson, 1877**
Figs. 5-6

Xixuthrus heyrovskyi Tippman, 1945 NEW SYNONYMY

Specimens examined: Holotype male *X. terribilis*, "Ins. Fidgi" (MNHN; labeled "TYPE") [Fig. 5]; holotype male *X. heyrovskyi*, "Insel Viti Levu Fidschi," coll. Dr. Knoth (USNM; labeled "TYPE") [Fig. 6]; 2 males, Fiji, Taveuni, Silvester Evans (BMNH); 1 male, same data but 1.1925 (BMNH); 1 female, Taveuni, 14.vi.1925, Dr. H.S.Evans (BMNH); 1 female, Taveuni, "Qacovilo" (? spelling obscured by pin hole), 26.v.1925, Dr. H.S. Evans (BMNH); 1 male, 2 females, no data (BMNH); 1 male, Vanua Levu, Caukadrove Province, Natewa Peninsula, Buca, Buca Bay, 24.vii.2003, 179°32' S, 16°39' E, 50m, collector Tomasi Mateavula (MAFF); 1 male, 1 female, Somo Somo, Taveuni, 6.ii.1990, George Bennett Coll. (Z. Komiya)

Diagnosis: For diagnostic features, see entry above under *heros*.

Remarks: The holotypes of both *X. terribilis* and *X. heyrovskyi* were examined, and are unquestionably conspecific. The holotype of *terribilis* is a relatively small specimen, measuring 99 mm, and differs from typical male specimens (including the holotype of *hey-*

rovskyi) only in those features which show distinct allometry. Several specimens from Taveuni (in George Bennett's private collection in Suva, Fiji) were also briefly examined (by D.Y.) in addition to those listed above. Note that the pubescence along the elytral costae may occasionally show some wear, creating very narrow, obscurely glabrous stripes. Aside from the holotype of *X. heyrovskyi*, there are no confirmed records of this species from any islands other than Taveuni and Vanua Levu, despite anecdotal claims of its presence on Viti Levu, and unless new specimens are found there, we consider it most likely that the *heyrovskyi* type is mislabeled. It is probable that Lameere did not have a specimen of genuine *heros* when he placed *terribilis* into synonymy with it; especially suspicious is that he placed considerable emphasis on the broad elytral stripes of *ganglbaueri* and *helleri* when discussing their resemblance, when *heros* shares these stripes, implying that perhaps his putative *heros* specimen did not have stripes (i.e., that it was actually a specimen of *terribilis*). Nonetheless, we are not aware of any specimens of *terribilis* (other than the holotype itself) old enough to have been examined by Lameere. Komiya (2000) has an excellent habitus photo of a male *terribilis* (figured as *heyrovskyi*).

A Key to Fijian *Xixuthrus* Sspecies

1 Elytra without complete, glabrous, longitudinal stripes (Fig. 5)...*X. terribilis* Thomson
- Elytra with complete, glabrous, longitudinal stripes (Fig. 1)..... 2
2 Forebasitarsi only slightly longer than broad (at apex; Fig. 2) *X. ganglbaueri* Lameere
- Forebasitarsi at least two times longer than broad (Fig. 4) ..... *X. heros* (Heer)

Discussion

We are compelled to conclude that there are presently only three species of *Xixuthrus* occurring in Fiji (*ganglbaueri*, *heros*, and *terribilis*), all of them endemic. All three are rather rarely collected, though *ganglbaueri* is clearly the rarest, despite its sympatry with *heros* in a fairly populated region in Fiji. Reasons for the apparent rarity of the various Fijian *Xixuthrus* are still uncertain, but their scarcity may be due to life history characteristics associated with their large size. The giant larvae may require very large host trees (the only documented larval tunnels are in a tree of 80 cm dbh) and such trees are uncommon in Fiji's cyclone forests and are becoming increasingly rare as widespread logging targets big trees. Few larvae may coexist in host trees as well, limiting the population size. Moreover, a review of known localities for the beetles initially suggests they may prefer lowland forests (<500m elevation) which are rapidly disappearing due to logging and clearance for agriculture. Ryan et al. (1989) pondered whether *Xixuthrus* populations may normally occur at low densities but may periodically increase in numbers after a cyclone produces great quantities of dead wood that then becomes available for reproduction, but

data are lacking. Entomological surveys are few in Fiji, perhaps due to the rugged, inaccessible terrain and high rainfall, so the rarity of *Xixuthrus* may also be due, in part, to limited collections in appropriate areas.

Lack of knowledge regarding host plant associations also hampers attempts to predict distributions of these beetles. The small number of specimens that include the date of capture are from nearly every month of the year, though collections and observations over the last three years suggest adults are perhaps more abundant from May to September. Collection data and observations also suggest these beetles require intact native forest, as older specimens are from or adjacent to forested areas, and most recent collections have come from adults flying to lights situated adjacent to natural forest (D.O., pers. obs.).

While all of the species are under some pressure from insect collectors, given their great size and popular appeal, it is also apparent that *X. ganglbaueri* is (by virtue of its evident rarity, and possibly more limited distribution) potentially more likely to be threatened, including by habitat loss, than the other species. Indigenous consumption of larvae appears to be largely (if not entirely) opportunistic, and unlikely to represent significant threat. It is only an assumption, though not without logic, that present attempts to enact protective measures for these species (for example, CITES listing) will have a significant positive effect on their survival; at the very least, however, we need to gather sufficient knowledge of these beetles' biology to determine exactly what measures will be most beneficial. For example, we suspect these beetles require relatively large trees to reproduce effectively, and this information can be conveyed to the Forestry and Environment departments to integrate into forest use policies. With knowledge of host associations, it may become possible to "farm" these beetles and create an indigenous industry, as has been done for birdwing butterflies elsewhere in the Pacific. Such attempts will hopefully be facilitated by the present review, which was necessary to clarify the identities of the species in question.

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