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## Caddisflies from Bali and Lombok with description of two new leptocerids (Trichoptera)

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### Abstract

Light trap collections from South East Bali and West Lombok, Indonesia in December 2019 and March 2020 are reported. Two new leptocerid species from Bali, *Leptocerus goagarbanus* sp. nov. and *Oecetis keboiwai* sp. nov. are described. *Adicella kanake* MALICKY & CHANTARAMONGKOL, 2002 is reported as new to Bali and some other interesting records are discussed.

### Introduction

The caddisfly fauna of Bali and Lombok islands has been the subject of several publications recently: almost 30 new species have been described during this millenium. A checklist and species composition of the islands have been published (MALICKY et al. 2014, 2016). Although the total number of species per island is estimated to retain below a hundred (MALICKY et al. 2014), there are still a number of unknown species hiding as this study shows.

### Material and Methods

The collection site information is given in the following order: site number, island, district, site name, S coordinate, E coordinate, altitude (meters above sea level), collection date. The material from site 8 was collected by Risto Haverinen, all others by Marko Jaakkola and Ari Wekku Sääski. The sites are shown in the map (Figure 1).

1. Bali, Gianyar, Tukad Pakerisan, 8°31'11.0"S, 115°18'28.3"E, 171 m a.s.l., 2.XII.2019 and 8.XII.2019, small river, constructed fast running stone slope.
2. Bali, Gianyar, Sukawati centrum, 8°36'10.0"S, 115°16'54.3"E, 56 m a.s.l., 3.XII.2019, river
3. Bali, Gianyar, Pejeng, 8°30'19.0"S, 115°17'55.7"E, 232 m a.s.l., 4.XII.2019, small straight brook or natural condition ditch
4. Bali, Gianyar, Tukad Panempuhan, 8°29'55.8"S, 115°17'35.7"E, 251 m a.s.l., 5.XII.2019, stony, rocky small brook
5. Bali, Gianyar, Tukad Yeh Unda, 8°33'36.1"S, 115°25'25.9"E, 9 m a.s.l., 6.XII.2019, river, delta
6. Bali, Gianyar, Singapadu Kaler, 8°33'21.4"S, 115°15'01.1"E, 131 m a.s.l., 7.XII.2019, brook
7. Bali, Karangasem, Air terjun Jagasatru, 8°27'32.9"S, 115°30'37.1"E, 405 m a.s.l., 4.III.2020, stony brook, high falls
8. Bali, Tabanan, Banjar Puakan, 8°23'01.5"S, 115°06'29.3"E, 712 m a.s.l., 4.III.2020, stony brook

9. Lombok, West Lombok reGENCY, Senggigi, 8°29'11.2"S, 116°03'31.9"E, 65 m a.s.l., 2.III.2020, stony brook
10. Lombok, West Lombok reGENCY, Air terjun Goa Walet, 8°28'21.3"S, 116°03'37.4"E, 149 m a.s.l., 3.III.2020, stony brook, little falls

Caddisflies were collected using a single battery-operating, custom-built 8 W LED system. using 365 nm, 450 nm, 530 nm and white coloured LEDs at most sites. However, at site 8, two Philips ML 250 W lamps were used in a single setup.

The total number of specimens in the material was about 1100 from Bali and 130 from Lombok.

The species were primarily identified based on males, using MALICKY'S (2010) Atlas of Southeast Asian Trichoptera and original species descriptions. However, some of the females, that seemed to belong to species not represented by males were also paid attention and listed to genus level. In addition to adult caddisflies, one larval specimen was collected and identified on a family level using morphology. The material was mostly stored in alcohol after the dry transport, but some tens of specimens were also pinned. The drawings and their digitization were made by JS using microscope photos and vector graphics.

### Results

The collections from Bali, based on males, comprise 27 species, and those from Lombok 10 species. Counting the females and the larva, at least 40 taxa were recorded in total.

The list of the identified taxa with the collecting site numbers is presented below. The taxa preceded by a double asterisk (\*\*) are described as new to science, and those with single asterisk (\*) are otherwise annotated.

- Rhyacophilidae  
*Rhyacophila anakbatukau* MALICKY, 1995 (8)
- Glossosomatidae  
*Agapetus abbreviatus* ULMER, 1913 (5,10)
- Hydroptilidae  
spp. (2,5,9) (females only)
- Philopotamidae  
\**Chimarra* nr. *aram* MALICKY, 2008 (9,10)  
*Chimarra ard* MALICKY, 2008 (10)  
*Chimarra batukaua* MALICKY, 1995 (10)  
*Chimarra gunungkawi* MALICKY, 1995 (1,8)  
*Chimarra thienemanni* ULMER, 1951 (1,4,5,7,8)  
*Chimarra xumappa* MALICKY, IVANOV & MELNITSKY, 2011 (1)
- Psychomyiidae  
*Paduniella kalamos* MALICKY, 2004 (10)  
*Paduniella koehleri* MALICKY, 1995 (2,5)  
*Paduniella trichobogiella* MALICKY, IVANOV & MELNITSKY, 2011 (10)  
*Psychomyia anaksusuan* MALICKY, 1995 (2,5)  
*Psychomyia feuerborni* ULMER, 1951 (1)  
*Tinodes flavopunctatus* ULMER, 1910 (7)  
*Tinodes mataram* MALICKY, IVANOV & MELNITSKY, 2011 (10)  
*Tinodes pujungana* MALICKY, 1995 (7)

## Hydropsychidae

- Cheumatopsyche concava* ULMER, 1930 (8)  
*Cheumatopsyche dodan* MALICKY & MEY, 2009 (10)  
*Cheumatopsyche globosa* ULMER, 1910 (1,4,6)  
*Cheumatopsyche kraepelini* ULMER, 1915 (1,3,4,6)  
*Cheumatopsyche lucida* ULMER, 1907 (1,3,5)  
*Diplectrona* sp. (7) (female only)  
*Hydropsyche annulata* ULMER, 1905 (1,5)  
*Hydropsyche renschi* MEY, 1999 (8)  
*Hydropsyche saranganica* ULMER, 1951 (7,8)  
*Macrostemum fastosum* (WALKER, 1852) (8)  
*Potamyia* sp. (1) (females only)

## Lepidostomatidae

- Lepidostoma brevior* (ULMER, 1913) (8)

## Goeridae

- Goera pugnio* ULMER, 1951 (8)

## Leptoceridae

- \**Adicella kanake* MALICKY & CHANTARAMONGKOL, 2002 (8)  
 \*\**Leptocerus goagarbanus* SALOKANNEL & JAAKKOLA sp.nov. (1)  
 \*\**Oecetis keboiwai* SALOKANNEL & JAAKKOLA sp. nov. (1)  
 \**Oecetis* cf. *hemerobioides* (MCLACHLAN, 1866) (1)  
*Oecetis tripunctata* FABRICIUS, 1793 (1,3,4,5,6)  
*Setodes karnyi* ULMER, 1930 (3)  
*Setodes klakahanus* ULMER, 1951 (2,3,4,5,10)  
 \**Triaenodes* cf. *pelias* MALICKY, 2005 (4,8) (females only)

## Calamoceratidae

- \*sp. (4) (larva)

## Species descriptions

*Leptocerus goagarbanus* SALOKANNEL & JAAKKOLA, sp. nov.

**Diagnosis.** The elongate, asymmetric, relatively shortly bifurcated segment X as well as the other male genital characters generally resemble those of Sumatran *L. merangirensis* MALICKY, 1993, Thai *L. Chiangmaiensis* MALICKY & CHANTARAMONGKOL, 1991, and *L. kanaan* MALICKY & MEY 2011 from Borneo suggesting *goagarbanus* is a close relative of them. However, each part of the male genitalia differ in the details from the two relatives and others in the genus, indicating *goagarbanus* is a distinct species. For example, the segment X has a unique shape being laterally widest beyond middle and shortly bifurcated dorsally. A female collected in association with the male is also described, but due to lack of female descriptions in the group, no further comparative diagnosis is included.

**Description.** Holotype male pinned, last abdominal segments cleared in 10% NaOH. Head and thorax black with black and dark grey hairs; abdomen and appendages lighter yellowish grey hairs. Basal segment of antenna dark brown, about three times as thick as segment 3, shorter than head. Antennal segments from the 3<sup>rd</sup> segment in the proximal half yellowish grey, segment joints with narrow whitish and dark ring. The distal half of antennae almost unicolorously dark grey. Antenna at least 2 times longer than forewing – they are more or less damaged in the holotype. Spur formula 0-2-2. Forewing length 6.3 mm. Forewing covered with blackish setae and partially with shorter but slightly wider setae that shine silvery when reflecting light. In the proximal half, the silvery setae are dense between radial sector and cubital veins, in distal third they form a narrow diagonal stripe from the front edge to the crossing of median vein and transverse crossveins. The silvery setae occur sparsely at the

distal part, except absent on the front edge. Hind wings slightly lighter than forewings. The female paratype stored in ethanol, generally similar to the holotype, but the forewing hairs mostly lost. Paratype forewing length 5,4 mm.

**Male genitalia** (Figs. 2a-c). Segment IX onion-shaped. Segment X elongate, laterally widest beyond middle (Fig. 2a), dorsally asymmetric, relatively shortly bifurcated (Fig. 2b). Both forks laterally bent down before the slightly upwards pointing tip. Inferior appendages narrow, basally wide in ventral view; wide with blunt tip reaching as long as segment X in lateral view. Inner faces of the inferior appendages with backwards turned spines (Fig. 2c). Distal part of phallus slightly narrowing towards the curved tip (Fig. 2a). A narrow process above the phallus strongly curved down in lateral view.

**Female genitalia** (Fig. 2d-f). Tergum IX dorsally bell-shaped (Fig. 2e). Tergum X tip forked dorsally. Lower posterolateral edge of segment X sharp, upper half with long setae (Fig. 2d). Sternum IX sides and middle part protruding posteroventrally, middle further than the sides (Fig. 2f). Sternum X with pointed lobes. Inner structure ventrally arrowhead-shaped (Fig. 2f).

**Material.** Holotype, ♂ and Paratype ♀: Indonesia, Bali, Gianyar, Tukad Pakerisan, WGS84 8°31'11.0"S, 115°18'28.3"E, 171 m a.s.l. LED light trap, 8.XII.2019, small river, stony constructed slope, Marko Jaakkola & Ari Wekku Sääski leg. Both the holotype (specimen id: JSLK-BALI-T004) and paratype (specimen id: JSLK-BALI-T013) will be deposited in the Natural History Museum of Helsinki, Finland. The museum references are: <http://id.luomus.fi/GZ.50794> (holotype) and <http://id.luomus.fi/GZ.50797> (paratype).

**Etymology.** The species is named after Goa Garba, a cave and ancient temple, which is located upstream along the same river as the collecting site.

*Oecetis keboiwai* SALOKANNEL & JAAKKOLA sp. nov.

**Diagnosis.** The species may be considered as part of the *Oecetis raghava* SCHMID, 1995 species complex (OLAH 2013), the group with normal terga I-VI, partially honeycomb-shielded tergum VII and fully shielded tergum VIII. However, *O. keboiwai*'s shields on tergum VII are not only small patches but covering most of the dorsal surface of the tergum. Also, *O. keboiwai* differs from the other species of the *raghava* complex in the genital characters; each appendage is slightly different than in the related species, e.g. the ratio of the basal and distal width of the inferior appendages and the minor internal structure of the phallus (SCHMID 1995, OLAH 2013). The internal knob-like structure of the phallus is the most distinct character of *keboiwai*, whereas the other characters are less distinct due to variation within *raghava* (Malicky, pers. comm.).

**Description, male.** Holotype pinned, last abdominal segments cleared in 10% NaOH. Head brown, body and legs yellow. Basal segment of antennae light brown, about three times as thick as the 3<sup>rd</sup> segment terminally, about as long as head. Further antennal segments yellowish, joints very narrowly black in the proximal half. Antenna about 2,5 times longer than forewing. Spur formula 0-2-2. Forewing length 6.6 mm. Wings light yellowish, anastomosis darkened, small dark spots situated on veins and vein joints (Fig 3e).

**Male genitalia** (Figs. 3a-d). Tergum VII partly covered with honeycomb structure as well the whole tergum VIII. Base of tergum VIII notched (Fig. 3a). Segment IX laterally oblique,

subtriangular. Upper part of tergum X digitate, laterally downward curving, widened, blunt apex (Fig 3b). Superior appendages very narrow before the knob-like apex (Fig. 3c). Lower part of segment X membranous, as long as the upper part. Inferior appendages basally wide in ventral view, the apical half about third of the basal width: in lateral view with a lobe at the apex. Inner faces of inferior appendages populated with more or less inwards turned, spine-like setae (Fig 3d). Ventral face of inferior appendages, except the apex, covered with mainly backwards directed longer setae. Phallus about as long as segment IX, apically curved downwards, internal structure small knob-like (perhaps partly transparent), phallobase reaching dorsally close to phallus tip (Fig. 3b).

**Material.** Holotype, ♂ and Paratypes 2 ♂: Indonesia, Bali, Gianyar, Tukad Pakerisan, WGS84 8°31'11.0"S, 115°18'28.3"E, 171 m a.s.l. LED light trap, 8.XII.2019, small river, stony constructed slope, Marko Jaakkola & Ari Wekku Sääski leg. The holotype (specimen identifier: JSLK-BALI-T001) and paratype (specimen identifier: JSLK-BALI-T002) will be deposited in the Natural History Museum of Helsinki, Finland. The museum references are: <http://id.luomus.fi/GZ.50795> (holotype) and <http://id.luomus.fi/GZ.50796> (paratype). The second paratype (specimen identifier: JSLK-BALI-T012) is deposited in the research collection of prof. Hans Malicky, Lunz am See Austria.

**Etymology.** The species is named after the mythic Balinese character Kebo Iwa.

### Species annotations

*Chimarra* nr. *aram* MALICKY, 2008

Two males and one female *Chimarra* specimens with reddish-brown furred head and body were found on the Lombok sites. The males have three teeth on the inner face of the inferior appendages, which suggests a relation with the Sumatran species *aram*. However, a more detailed analysis has not yet been done.

*Adicella kanake* MALICKY & CHANTARAMONGKOL, 2002

The species is described from Thailand and Sumatra (MALICKY et al. 2002), and reported e.g. from Lombok (MALICKY et al. 2016), but not from Bali before (MALICKY et al. 2014). One male was found at site 8.

*Oecetis* cf. *hemerobioides* (MCLACHLAN, 1866)

*O. kyparissos* MALICKY, 2005 is the only species of *O. hemerobioides* group known from Bali hitherto. However, *O. hemerobioides* is reported from Lombok (MALICKY et al. 2016). Two males from site 1 in Bali were examined in details and compared with the drawings in the Atlas of Southeast Asian Trichoptera (MALICKY 2010). The shape of the dorsal humps of the inferior appendages seemed to be something between of those of *O. kyparissos* and *O. hemerobioides* and the shape of the inferior appendages in the ventral view perhaps even closer to *hemerobioides*. With our current limited experience on the group, there remains some unclarity with the species identification.

*Triaenodes* cf. *pelias* MALICKY, 2005

Two female *Triaenodes* specimens were found (sites 4 and 8) in this study. *T. pelias* is the only known species of this genus from the nearby islands (MALICKY et al. 2014) and the wing pattern described in the Atlas of Southeast Asian caddisflies equals well. However, there remains some unclarity, if *T. pelias* occurs in Bali, probably until its males are found or genetic tools are used.

Calamoceratidae sp.

The larva was morphologically identified as a calamoceratid (det. Peter Wiberg-Larsen). The only species of this family reported from Bali is *Ganonema fuscipenne* (ALBARDA, 1881) (MALICKY et al. 2014), so it is possible the larva belongs to this species.

### Discussion

The collecting sites at Bali were mostly brooks or small rivers situated on low-lands. The environment was often densely populated, but the immediate vicinity of the smaller brooks was often in more or less natural condition. The number of species ranged from 3 to 11 per night, which was a fairly expected range compared with the known fauna of the islands and using one light trap only. The most frequently recorded species, *Oecetis tripunctata* (5 sites), *O. klakahanus* (4), *Chimarra thienemanni* (4), and *Cheumatopsyche kraepelini* (4) may be considered common in South East Bali.

Both the described new species were collected on site 1 at 171 m a.s.l., which – despite or because – of old human constructions seemed a good site for many leptocerids. The new species are morphologically associated with the known species from Sumatra, Borneo and the SE Asian continent, likely speciated through the isolation provided by the disjointed chain of the islands.

### Acknowledgements

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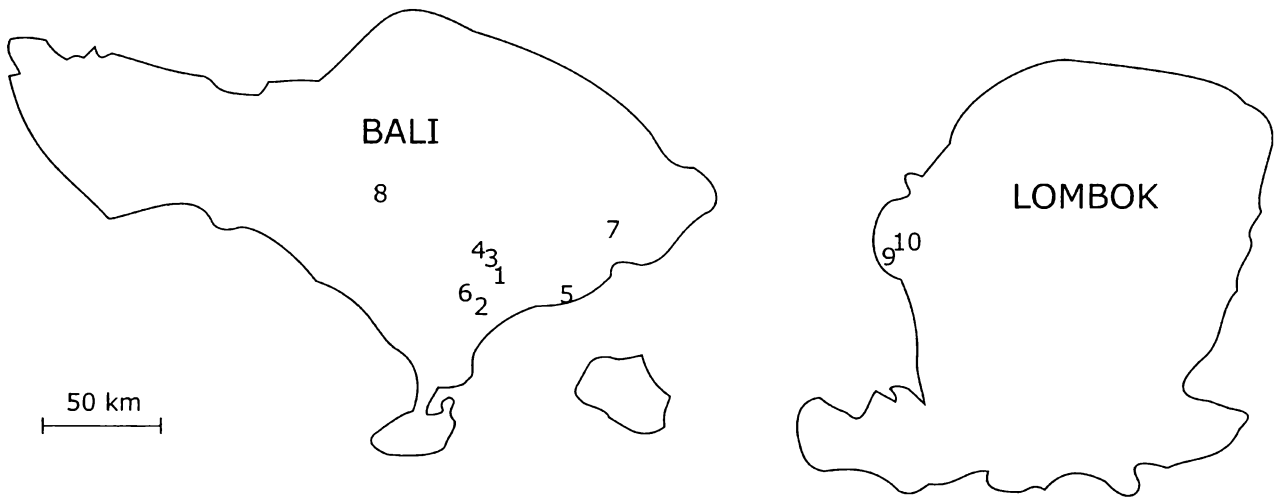
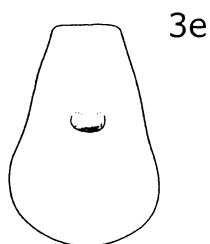
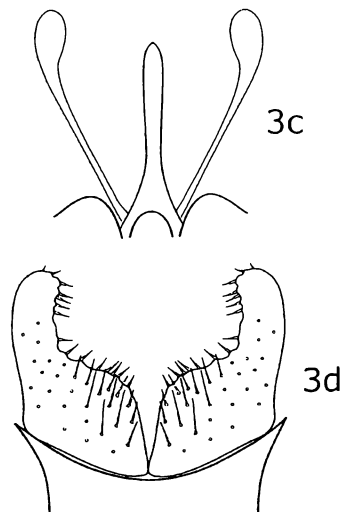
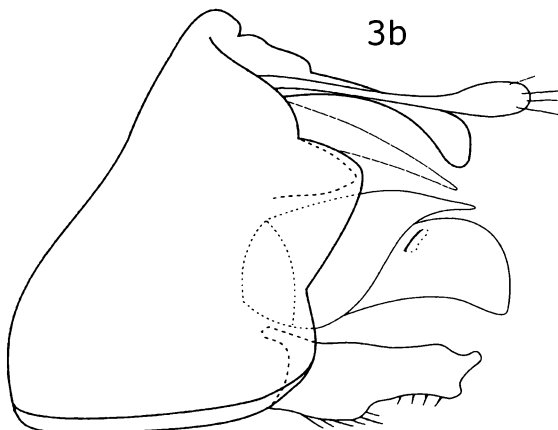
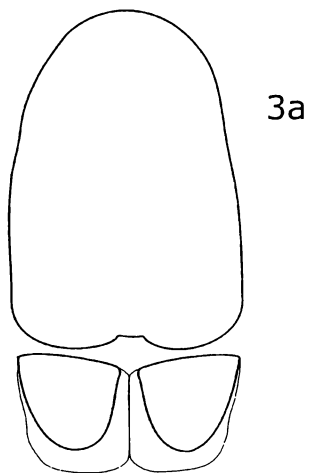
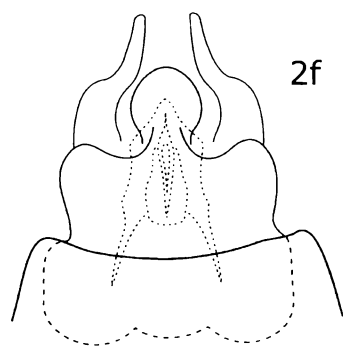
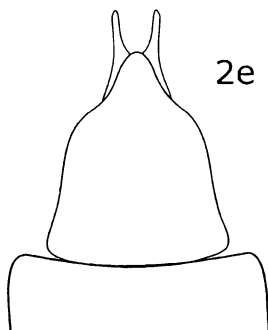
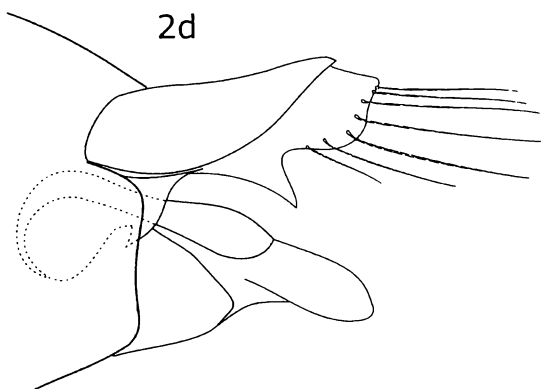
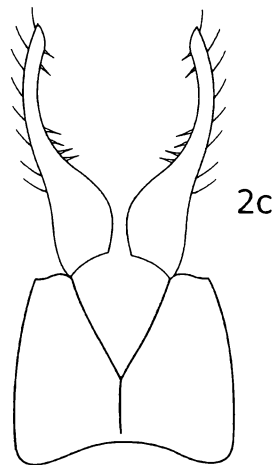
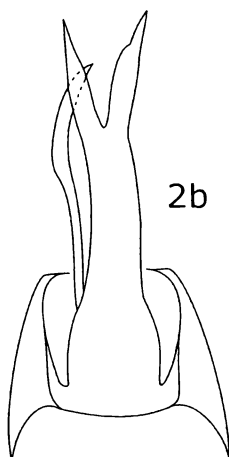
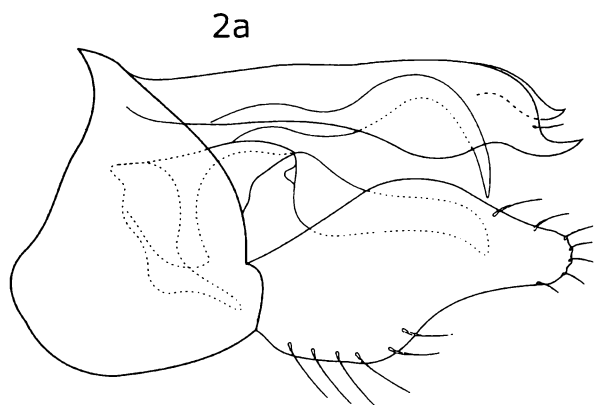


Figure 1. Map of Bali and Lombok. Numbers indicate the collecting sites.

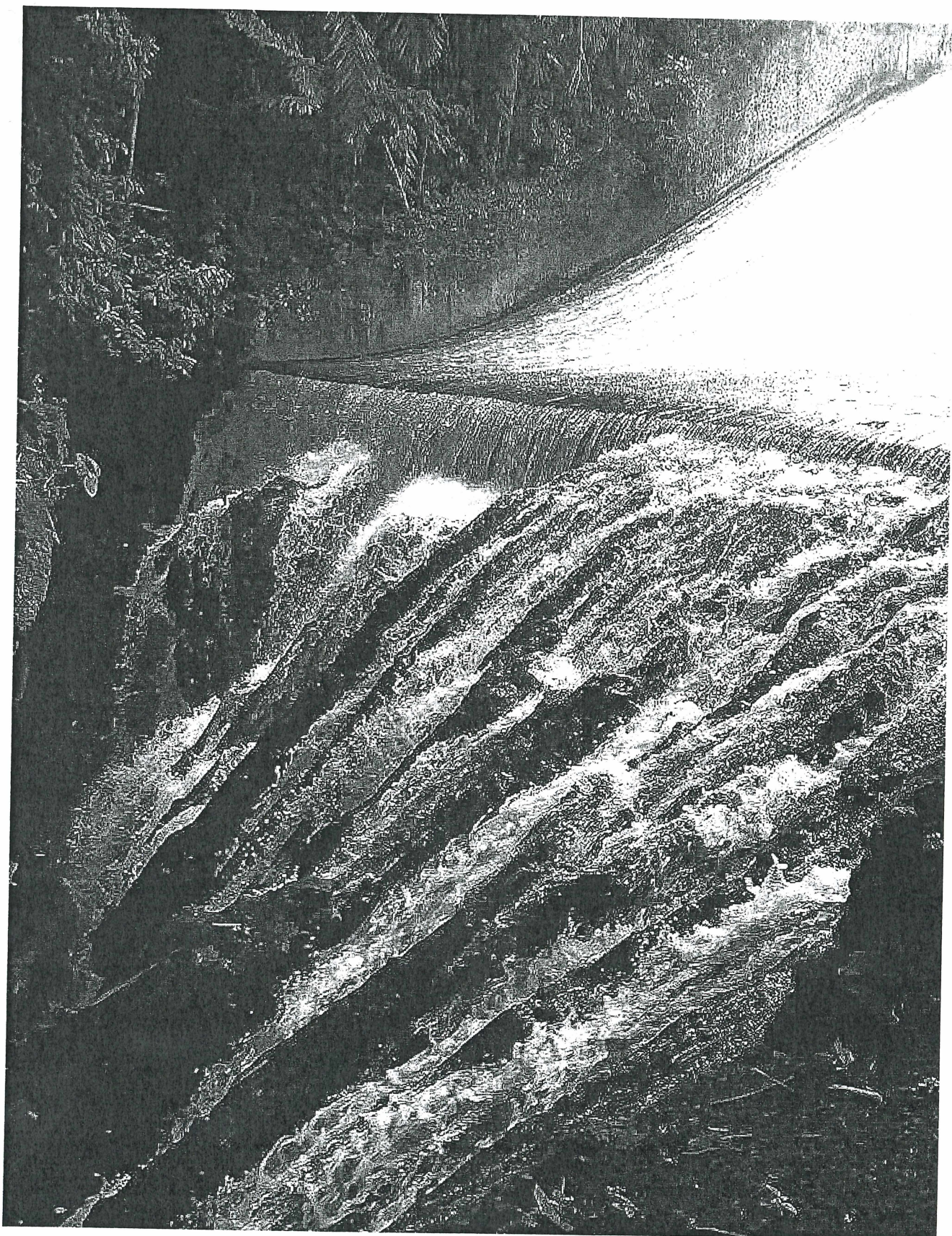
Figures 2a-f. *Leptocerus goagarbanus* sp. nov.; holotype male genital characters in 2a) lateral, 2b) dorsal and 2c) ventral view, female paratype characters in 2d) lateral, 2e) dorsal and 2f) ventral view.

Figures 3a-d. *Oecetis keboiwai* sp. nov.; holotype male 3a) tergum VII and VIII, 3b) genital characters in lateral, 3c) tergum X and superior appendages in dorsal, 3d) inferior appendages in ventral view, 3e) phallus in dorsal view, and 3f) forewing.





Tukad Pakerisan (site 1), the slow flowing part. Photo Ari Wekku Sääsäki.



Tukad Pakerisan (site 1), the fast running, constructed slope. Photo Ari Wekku Sääski.

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