# New larvae of Baetidae (Insecta: Ephemeroptera) from Espiritu Santo, Vanuatu

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Abstract

During the Global Biodiversity Survey "Santo 2006" conducted in Espiritu Santo, Vanuatu, mayfly larvae were collected in several streams of the island. This contribution deals with the larvae of Baetidae (Insecta: Ephemeroptera) that are represented by two species: *Labiobaetis paradisus* **n. sp.** and *Cloeon* sp. The presence of these two genera is not surprising as they both possess almost a worldwide distribution and constitute a great part of Australasian Baetidae diversity. Diagnoses of these two species are provided and their affinities are discussed.

Keywords: Australasia, *Cloeon erromangense*, *Labiobaetis paradisus*, mayflies, new species, Santo 2006, taxonomy.

Zusammenfassung

Im Rahmen der auf Espiritu Santo, Vanuatu, durchgeführten Biodiversitätserfassung "Santo 2006" wurden Eintagsfliegenlarven in verschiedenen Fließgewässern der Insel gesammelt. Der vorliegende Beitrag behandelt die Larven der Baetidae (Insecta: Ephemeroptera), die mit zwei Arten vertreten sind: *Labiobaetis paradisus* **n. sp.** and *Cloeon* sp. Der Nachweis beider Gattungen ist nicht überraschend, da diese eine nahezu weltweite Verbreitung besitzen und einen großen Anteil der Diversität australasiatischer Baetidae ausmachen. Die beiden Arten werden beschrieben, beziehungsweise eine Diagnose gegeben, und Unterschiede zu anderen Formen werden diskutiert.

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## 1 Introduction

At present, 40 species within 12 genera of Baetidae are described from the Australasian realm, with 19 species recorded from Australia and 17 species from New Guinea (Gattolliat & Nieto 2009, Webb & Suter 2010). Other reports of Baetidae are from the Fiji islands where 12 species belonging to three different genera were recorded (Flowers 1990). These species remained undescribed and their generic attribution provisional. Three species were placed in the "*Baetis molawinensis* group", which corresponds to the present generic concept of *Labiobaetis/Pseudocloeon* (for a detailed discussion see Fujitani et al. 2005 and Gattolliat et al. 2008). Baetidae were considered as absent from New Zealand and New Caledonia. However, larvae of *Cloeon* were collected in recent samplings in standing waters of New Caledonia (N. Mary-Sasal, unpublished data); the process of colonisation of the island remains unclear and could be related to human activities.

From Vanuatu, so far only a single species of Baetidae, *Cloeon erromangense* Kimmins, 1936 was described. Kimmins (1936) reported this species from the island Erromango. Vanuatu, formerly known as New Hebrides, is composed of 83 islands that are mainly of volcanic origin. The archipelago is situated in the south-western Pacific Ocean, located about 1750 km east of Australia and New Guinea, and 500 km north-east of New Caledonia. The present land surface of Vanuatu originated from late Pliocene-Pleistocene volcanism and from the growth of Pleistocene coral reef platforms combined with uplifting, less than 2 million years ago (Mueller-Dombois & Fosberg 1998). This geologically rather young age together with a remote and isolated geographical position accounts for its comparatively poor mayfly fauna.

During the scientific expedition "Santo 2006" (for a narrative of this expedition see Bouchet et al. 2008), new material of Ephemeroptera was collected on Espiritu Santo by one of us (AHS) in November 2006. From this material, *Caenis vanuatensis* Malzacher, 2007 (Caenidae) was already described (Malzacher & Staniczek 2007). Among the larval material collected during this field trip were also two species of Baetidae, namely one species of *Cloeon* and one new species of *Labiobaetis*. Both of these species are dealt with in this contribution.

Acknowledgements

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## 2 Materials and methods

All material was collected in November 2006 during the scientific expedition "Santo 2006" that was conducted to sample and identify the fauna and flora of Espiritu Santo. The larvae were collected mainly by kick-sampling and sweeping of riparian vegetation in the lower reaches of several streams close to the shore. All material was stored in 80 % EtOH.

Photograph series with different focal depths were made from larvae using a Leica DFC320 digital camera on a Leica Z16 APO Macroscope and subsequently processed with Leica LAS software to obtain photographs with extended depth of field. The combined photographs were then digitally enhanced using Adobe Photoshop CS3.

Specimens used for SEM were dissected and dehydrated through a stepwise immersion in ethanol and then dried by critical point drying. The mounted material was coated with a 20 nm Au/Pd layer, examined with a ISI-SS40 scanning electron microscope at 10 kV. Digital photographs were directly acquired by using DISS 5 software (point electronic) and subsequently processed with Adobe Photoshop CS3.

Holotype and a part of the paratypes of *Labiobaetis paradisus* n. sp. are housed in the Staatliches Museum für Naturkunde, Stuttgart, Germany (SMNS), remaining paratypes are stored in the Museum of Zoology, Lausanne, Switzerland (MZL) and the Muséum national d'Histoire naturelle, Paris, France (MNHN).

## 3 Results and Discussion

### 3.1 *Labiobaetis paradisus* **n. sp.** (Figs. 1–17)

Holotype, ♀ larva: Vanuatu, Espiritu Santo, Tasmate, Paé River S 15.21751° E 166.63316°, 140 m, 11.IX.2006, leg. A. H. Staniczek (SMNS).

Paratypes: 46 ♀ larvae, same data as holotype (SMNS, MZL, MNHN).

#### Etymology

The species epithet is derived from the Latin "paradisus" and used as a noun in apposition. It refers to the pristine native forest of Espiritu Santo that reminded us of an earthly paradise.

#### Description of larva

Length, fully grown female: Body 3.6–4.2 mm, cerci 3.5 mm, terminal filament 1.9 mm.

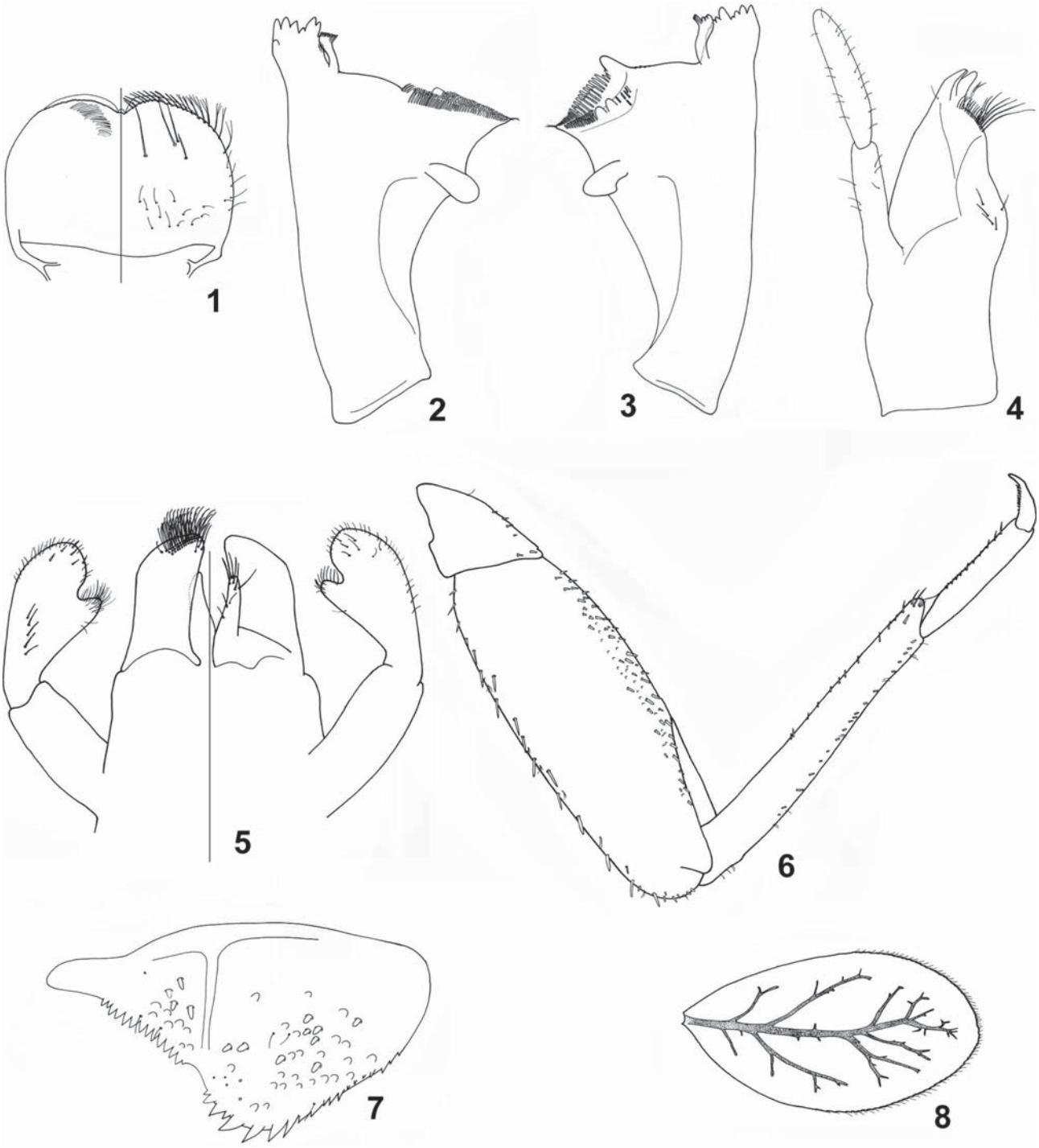
Colouration (Figs. 15–17): Head almost uniformly medium brown, with darker, vermiform marking on vertex and frons, border of sclerites yellow. Thorax medium brown with poorly marked yellowish pattern. Abdominal tergites uniformly medium brown, except tergite IX light brown. Abdominal sternites yellowish brown. Cerci yellow without dark stripe.

Head: Pedicel of antenna without distolateral process (Fig. 17). Labrum (Fig. 1) rounded, with an anteromedial emargination, dorsally with one submedian, long, simple seta, and laterally to it another two long, simple setae and one medium-sized, simple seta. Short, thin, simple setae scattered on proximal half of labrum; distal margin bordered with feathered setae. Canine of right mandible (Fig. 2) with two partially fused incisivi each with 4 denticles; inner margin of inner incisivus with a row of very thin setae; stout prostheca apically with small rounded denticles; margin between prostheca and mola smooth, without setae; tuft of setae at apex of mola reduced to two small setae. Left mandible (Fig. 3) with two partially fused incisivi, outer incisivus with 4 denticles, inner incisivus with 3 denticles; stout prostheca apically with small denticles and a comb-shaped structure; margin between prostheca and mola distally crenulate; tuft of setae at apex of mola reduced to two setae. Maxilla (Figs. 4, 10) with a medioapical row of relatively short setae, basal end of row with seven long setae; posterior side of lacinia mediobasally with a row of 4 medium-sized setae, medially to this row a single small seta is present close to the medial margin of lacinia; palp 2-segmented, segment II without distomedial concavity. Hypopharynx (Fig. 11): Posterior side of lingua with median projection, covered with dark, stout setae. Labium (Fig. 5) with glossae clearly shorter than paraglossae; glossae slender in apical half and basally broad, with only a few setae laterally and apically; paraglossae stout, apically flattened, with 3–4 rows of stout setae. Labial palp 3-segmented, segment I slender, subequal to segments II and III combined; segment II with a small, thumb-like distomedial projection covered with numerous thin setae, on posterior side with a row of five long setae; segment III subconical, with scattered short thin setae and a few stouter setae.

Thorax: Hind wing pads absent (Fig. 9). Trochanter of foreleg (Fig. 6) with a few short, stout setae. Forefemur dorsally with a row of medium-sized, apically rounded setae; apex with short setae; ventral margin with abundant, short, stout setae, villopore absent. Foretibia dorsally with a row of tiny, stout setae; ventrally with a few short setae, longer and more abundant apically, tibiopatellar suture present. Foretarsus almost bare dorsally; ventral margin with a row of pointed setae increasing in length toward

the apex; tarsal claw (Fig. 14) with a single row of about 12 teeth; subapical setae absent. Middle and hind legs similar to foreleg but with reduced setation.

Abdomen: Tergites slightly shagreened, with setae, numerous scales and scale bases (Fig. 13); posterior margin with triangular spination (Fig. 12). Sterna with scales and

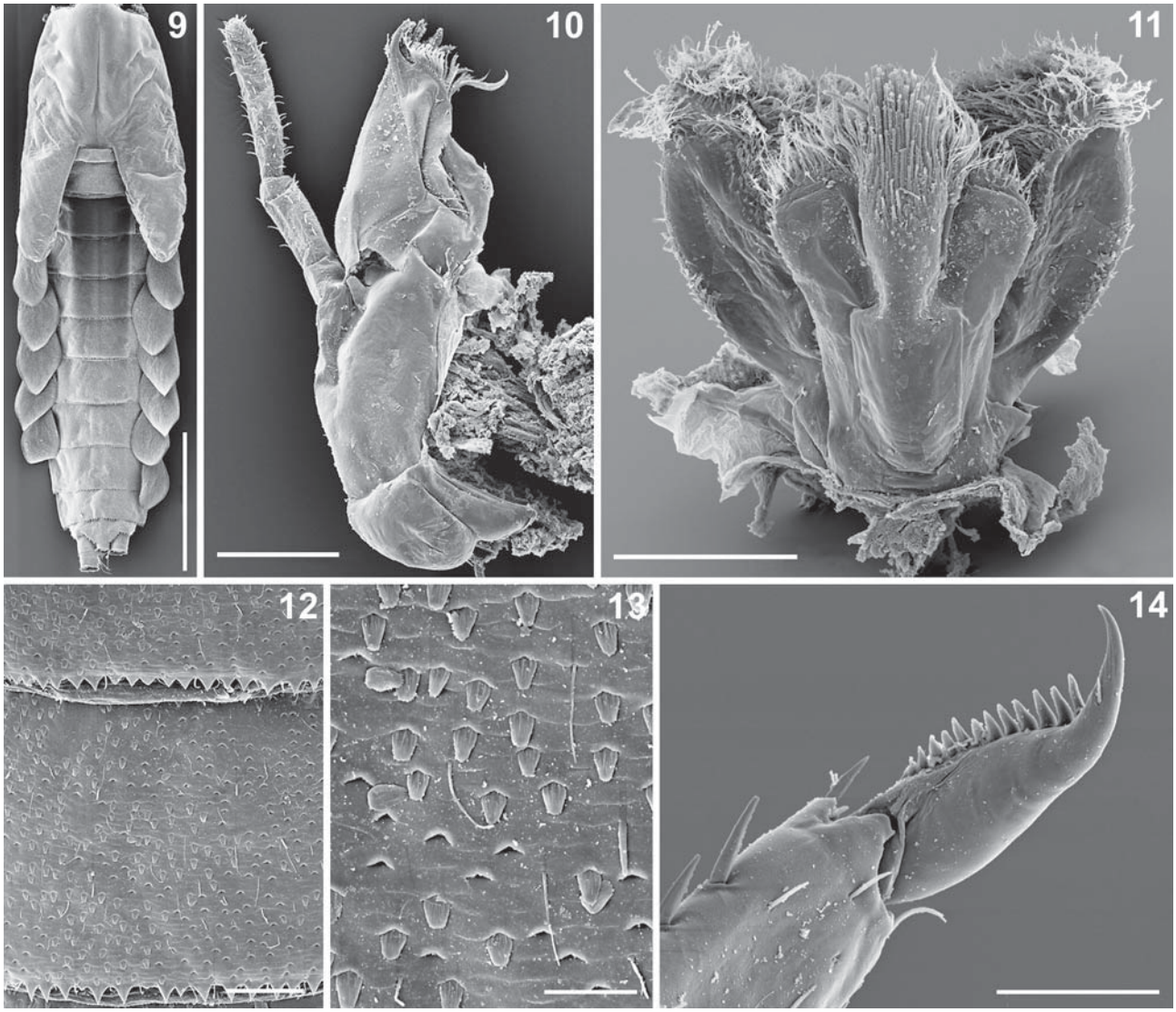



**Figs. 1–8.** *Labiobaetis paradisus* n. sp., larva. – **1**. Labrum (left half: posterior view; right half: anterior view). **2**. Right mandible (posterior view). **3**. Left mandible (posterior view). **4**. Right maxilla (posterior view). **5**. Prementum of labium (left half: posterior view; right half: anterior view). **6**. Right foreleg (anterior view). **7**. Paraproct. **8**. Gill IV.

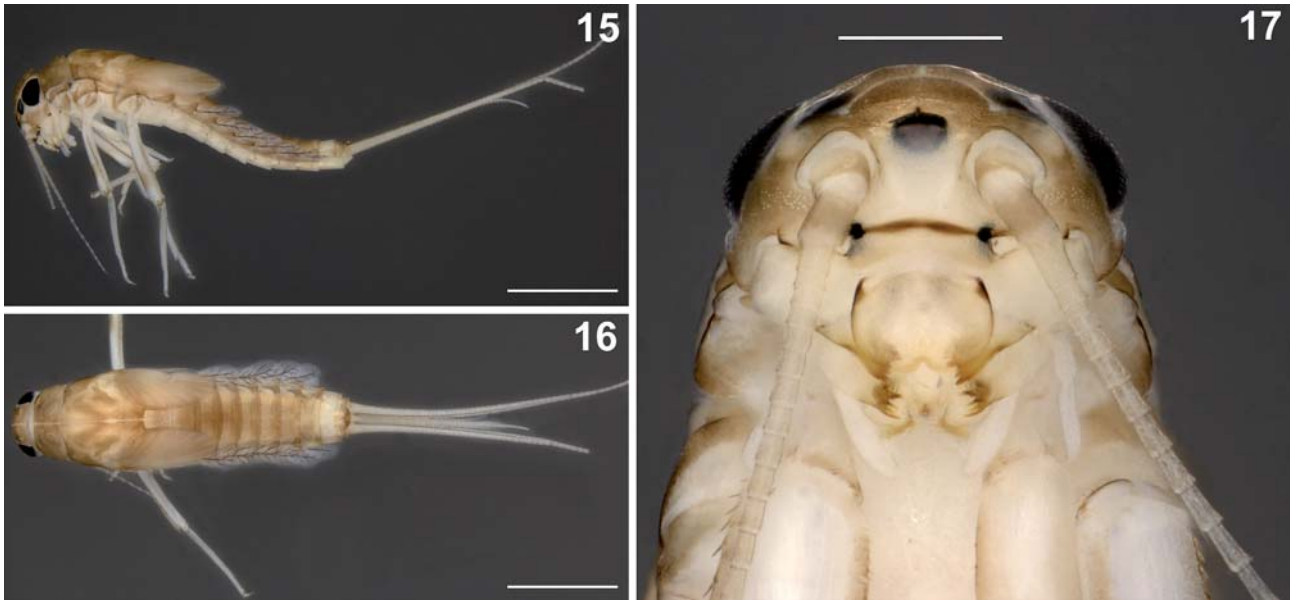
scale bases; posterior margin smooth, without spines. Gills present on abdominal segments II–VII (Fig. 9), distally serrated, tracheation dark brown, well-developed (Fig. 8). Paraproct with scale bases and scales, margin with 7–10 stout, pointed spines and a few short, pointed spines laterally; posterolateral extension with scales and scale bases, 12–14 stout, pointed spines along the margin (Fig. 7).

## Differential diagnosis

*Labiobaetis paradisus* n. sp. has a very reduced number of simple long setae on the dorsal face of labrum, a small thumb-like distolateral projection on segment 2 of the labial palp, a reduced setation of the dorsal margin of femora, and a tuft of thin setae at the base of the right mandibular incisors. This combination of characters allows the identification of *Labiobaetis paradisus* n. sp. and its distinction from other related species. As in all Australasian species of *Labiobaetis*, hind wings and gills I are absent in *L. paradisus* n. sp., and the dorsal face of the labrum presents only simple long setae apicolaterally. *Labiobaetis paradisus* n. sp. presents a maxillary palp without excavation and strong dark setae at the apex of the median




**Figs. 9–14.** *Labiobaetis paradisus* n. sp., larva – **9**. Thorax and abdomen (dorsal view). **10**. Right maxilla (posterior view). **11**. Hypopharynx (posterior view). **12**. Tergite IV. **13**. Scales, scale bases and setae on tergite IV. **14**. Tarsal claw of left foreleg. – Scale lines: 100 µm (10), 80 µm (9, 11), 60 µm (12), 40 µm (14), 20 µm (13).




**Figs. 15–17.** *Labiobaetis paradisus* n. sp., larva – **15**. In toto (lateral view). **16**. In toto (dorsal view). **17**. Head (ventral view). – Scale lines: 2 mm (15, 16), 0.5 mm (17).

projection of the lingua; these characters are also present in most of the Australasian species. This species is morphologically rather similar to the Australian species *Pseudocloeon hypodelum* Lugo-Ortiz & McCafferty, 1999, but differs notably by the spination of the paraproct (fig. 18 in Lugo-Ortiz et al. 1999) and the shape of the right and left mandibular incisivi (figs. 11 and 12 in Lugo-Ortiz et al. 1999). *Labiobaetis paradisus* n. sp. also shares similarities especially in the mouthparts and legs with *Pseudocloeon multum* (Müller-Liebenau, 1984), but *P. multum* has an antennal process and maxillary palp segment 2 with an excavation (Müller-Liebenau 1984).

## Discussion

*Labiobaetis* (= *Pseudocloeon* sensu Lugo-Ortiz et al. 1999) is widespread and very diversified in the Australasian and Oriental realms with 10 and 13 described species, respectively (Lugo-Ortiz et al. 1999). *Labiobaetis* is present in Australia (3 species) and New Guinea (6 species); the closest report is from Fiji with three undescribed species. The presence of this genus in Vanuatu is therefore not surprising.

The larvae of *L. paradisus* were mostly collected from overhanging riparian vegetation in the lower reaches of Paé River. At the time of collecting it was a small creek with low water current and measured water temperatures of up to 28 °C. The fact that all collected specimens are of female sex points to the possibility that this species could have a parthenogenetic mode of reproduction.

## 3.2 *Cloeon* sp.
(Figs. 18–23)

### Material examined

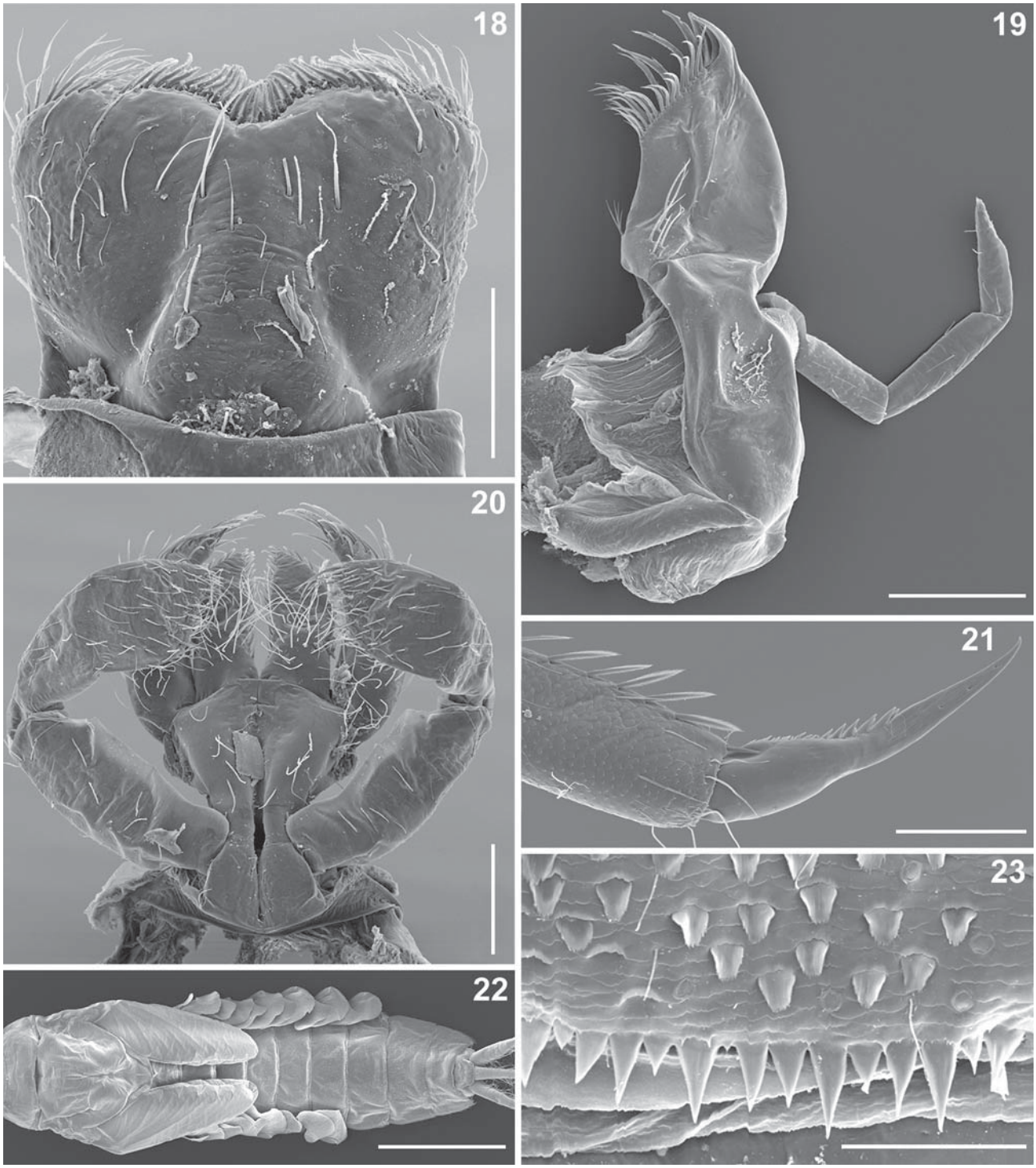
Tasmate, Paé River S 15.21751° E 166.63316°, 140 m, 11.XI.2006, 1 larva, leg. A. H. Staniczek (SMNS). – Tasmate, Mamasa River, S 15.21343° E 166.67004°, 39 m, 9.XI.2006, 2 larvae, 1 larval exuvia and 1 female subimago (reared), leg. A. H. Staniczek (SMNS).

### Diagnosis

Labrum (Fig. 18) quadrangular with scattered setae on dorsal face; margin with bifid setae apicolaterally and stout simple setae medially; maxillary palp 3-segmented (Fig. 19); labial palp with segment III clavate (Fig. 20). Tarsal claw elongated (Fig. 21), two ventral rows of teeth only present in the proximal of half of claw, proximal teeth tiny, distal teeth long and slender. Tergites shagreened with numerous scales and scale bases, distal margin with long triangular pointed spines (Fig. 23). Gills present on segment I–VII (Fig. 22); gills I–VI with two lamellae, upper lamella rounded and well tracheated but smaller than lower lamella; gill VII simple, subtriangular, broader than previous gills. Lateral margins of segments I–VII without lateral spines; segment VIII with 4–6 lateral spines; segment IX with 8–12 lateral spines.

### Discussion

The genus *Cloeon* has an almost worldwide distribution as it is only absent from the Neotropics (Gattolliat




**Figs. 18–23.** *Cloeon* sp., larva – **18**. Labrum (anterior view). **19**. Left maxilla (posterior view). **20**. Prementum of labium (posterior view). **21**. Tarsal claw of right hind leg. **22**. Thorax and abdomen (dorsal view). **23**. Scales, scale bases, setae and marginal spines of tergite II. – Scale lines: 1 mm (22), 100 µm (19, 20), 80 µm (18), 70 µm (21), 40 µm (23).

& NIETO 2009). With 73 species, it is one of the most diversified genera of Baetidae. Five species are recorded from Australia (SUTER 1986), three from Papua New Guinea (ULMER 1920, VAN BRUGGEN 1957), one from Polynesia (Samoa) (TILLYARD 1928) and one from Vanuatu (KIMMINS 1936). Unfortunately, most of the Australasian species are only known at the imaginal stage; only the Australian species *Cloeon fluviatile*, *C. paradieniensis* and *C. tasmaniae* were described at both larval and imaginal stages (SUTER 1986, 2000). Larvae of *Cloeon* sp. from Espiritu Santo clearly differ from these Australian species known at the larval stage: from *Cloeon fluviatile* and *C. paradieniensis* by the shape of the labial palp (Fig. 20) and the size of the denticles of the tarsal claws (Fig. 21), from *C. paradieniensis* and *C. tasmaniae* by the absence of stout setae at the apex of the maxillary palp (Fig. 19), and from all three species by the absence of lateral spines on tergum VII and the more abundant lateral spines on tergum IX.

*Cloeon erromangense* KIMMINS, 1936, was the sole species of Baetidae so far recorded from Vanuatu. It was found on Erromango, an island located about 300 km southeast of Espiritu Santo, and described from the male imago (KIMMINS 1936). As only male imagos of *Cloeon erromangense* and only larvae and a female subimago of *Cloeon* sp. from Espiritu Santo are known, there are no reliable morphological characters that allow a secure association of the material from the two islands. The similar size and the absence of colour pattern in male imagos do not allow the rejection of this association either. Because some species of *Cloeon* are known to have a wide distribution (GATTOLLIAT & RABEANTOANDRO 2002, MONAGHAN et al. 2005), larval specimens collected in Espiritu Santo could even be conspecific with one of the species from Papua New Guinea only known from adults. Only further extensive collections of all life stages of these species in the Australasian realm and their association with molecular methods could help to clarify these taxonomic uncertainties.

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