A New Species of *Ischnura* from Rota (Odonata: Coenagrionidae), and a Discussion of Zygopteran Zoogeography in the Insular Tropical Pacific[1]

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Abstract. - *Ischnura luta* n.sp. is described from the island of Rota in the Northern Marianas. This species is superficially similar to *Ischnura ezoin* Asahina from the Bonin Islands, but may be easily distinguished from this and all other Micronesian *Ischnura* species by the structures of the male genitalia. The key characters of this species are illustrated, and its biogeographic significance is discussed in the overall context of damselfly distribution patterns in the tropical Pacific.

INTRODUCTION

Compared to other Micronesian and Polynesian island groups, the Mariana archipelago does not have an extensive Odonata fauna. Lieftinck (1962) recorded 14 taxa, mostly from Guam and Saipan. Of these, two Anisoptera (*Anax piraticus* Kennedy and *Agrionoptera insignis guamensis* Leiftinck) were the only endemic taxa listed. Among the Zygoptera, Lieftinck recorded only a pair of widespread indigenous species, *Ischnura aurora aurora* (Brauer) and *Agriocnemis femina femina* Brauer. It is therefore notable that during the course of recent faunal surveys in the Northern Marianas, an undescribed species of *Ischnura* damselfly was discovered on the island of Rota. This new species, *Ischnura luta*, is described herein and represents the only zygopteran endemic in the Mariana archipelago. The signficance of this discovery and a general overview of zoogeographic patterns presented by damselflies in the insular tropical Pacific is discussed below.

Ischnura luta, new species

Description. - Male (Fig. 5). Total length 33.5–34.0 mm; abdomen length 28.5 mm; fore wing length 18.0 mm; hind wing length 17.0 mm.

Labrum and mouthparts pale yellow. Head mostly black (Fig. 3); gena and ventral halves of labrum and clypeus yellow; anterolateral angles of frons yellow; postocular spots blue; postgena yellow; antennae yellow; eyes dark brown dorsally, light red ventrally.

Prothorax black (Fig. 4), anterodorsal margin, posterolateral angles, and lateral spots above coxal cavities blue; mesinfraepisternum black, with blue spots dorsally and at posteroventral angle; mesepisternum uniform black; mesepimeron, metepimeron, and metainfraepisternum blue, with sutures black.

Wings with pterostigma brown, diamond-shaped, subtending a single cell, of similar size and shape in both fore and hind wings; quadrangle of fore and hind wings roughly similar in size and

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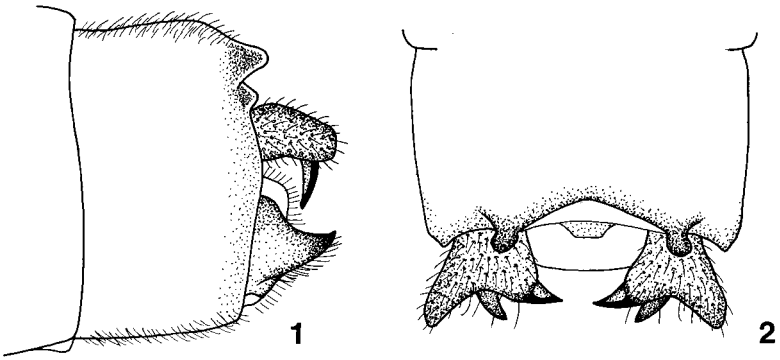


Figures 1–2. *Ischnura luta* n. sp., male terminal abdomen, showing shape of cercus and paraproct. **1**. Lateral view. **2**. Dorsal view.

shape, that of hind wing more symmetrical, with cubital side relatively less elongate and medial side relatively shorter than that of forewing; medio-anal link bent; Riii arising slightly basal to fifth cross vein beyond nodus; arculus arising slightly distal to second antenodal; IA arising slightly basal to ac.

Coxae light blue with black on basal margin; trochanters yellow; femora yellow ventrally, with dorsum and spines black; tibiae black with yellow basally and ventrally; tarsi brown; claws yellow with apices black.

Abdomen: Segment I black, with posterodorsal margin and ventrolateral margin blue and blue spot laterally; segment II black, with blue spots at posteroventral angles and paler ventrally; segments III–VII bronzy green dorsally, with anterior and posterior margins darker, and yellow ventrally with a narrow brown midstripe; segments VIII–IX blue; segment X black dorsally and laterally, yellow ventrally; appendages black.

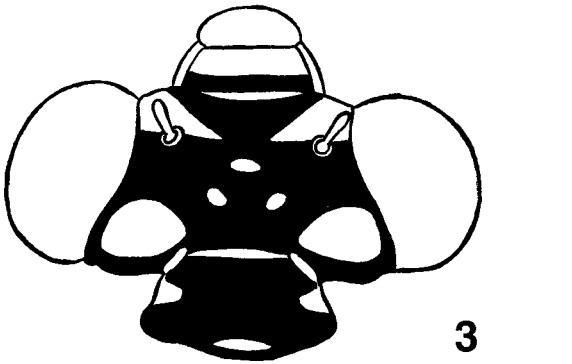
Dorsal margin of abdominal segment X with acute, spine-like angles (Figs 1, 2). Cercus deeply bifurcate, with dorsal bifurcation arising mesally and strongly curved ventrally (Figs. 1, 2). Paraproct with small spine on mesal surface (Fig. 1). Penis of male secondary genitalia with terminal segment bearing a pair (1+1) of bifurcate hooks, the distal process of each hook approximately 3X the length of the basal process, both processes slender and curving; middle segment of penis roughly hexagonal in shape as viewed ventrally, bearing a small apically bifurcate process posteromedially.

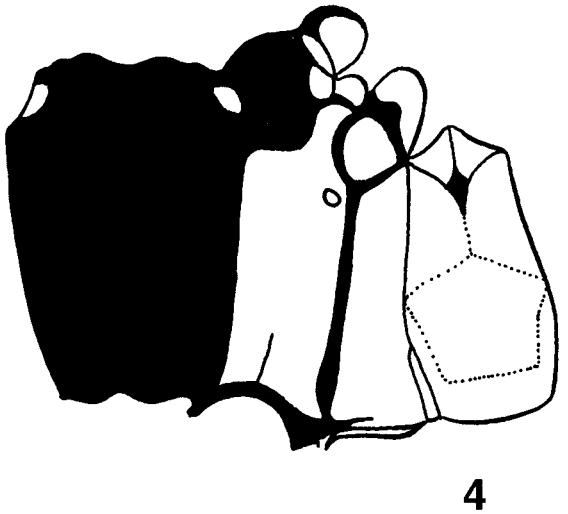
Female (Fig. 6). Total length 34.0 mm; abdomen length 26.5 mm; fore wing length, 20.1 mm; hind wing length 19.0 mm.

Slightly smaller than male, with color pattern almost identical. Ventral half of eyes bright yellow. Coxae and anterior spot on mesinfrepisternum yellow. Mesepimeron and metepimeron pink. Dorsal half of all abdominal segments black, ventral half yellow.

Etymology. - Named for the island of Rota, which is pronounced and originally spelled by the native Chamorro people as “Luta”.

Discussion. - *Ischnura luta* n. sp. is clearly distinct from any other *Ischnura* species known in Micronesia. It is similar in general size and coloration to *I. ezoin* (Asahina), which is endemic to the Bonin Islands, but may be easily distinguished by the shapes of the male caudal appendages. In *I. luta* the cercus (or superior appendage) bears a slender, tapering interior vertical tooth that descends subapically as viewed from the side (Fig. 1), while in *I. ezoin* this same vertical tooth arises apically as seen from the side, and is much broader in overall form (see Fig. 20 in Asahina, 1952). The paraproct (or inferior





Figures 3–4. *Ischnura luta* n. sp., male, color patterns. **3**. Head. **4**. Thorax.

appendage) is similar between the two species, having a roughly triangular form when viewed laterally and tapering to a sharp point, but in *I. ezoin* this structure is much more elongate, greatly exceeding the tip of the cercus, while in *I. luta* the lengths of the paraproct and cercus are subequal (Figs. 1, 2).

Three remaining species of *Ischnura* are known from Micronesia (Lieftinck, 1962), but *I. luta* can also be easily separated from these as well. On the basis of their blue and black coloration pattern, males of *I. luta* may be distinguished from the much smaller and more widespread *I. aurora* (Brauer), in which the thoracic coloration in males is green and black and the abdomen is red. Similarly, color pattern will also separate males of *I. luta* from those of *I. senegalensis*, in which the thoracic coloration is green and black, the

abdomen black dorsally and dark yellow laterally, and blue coloration is present only on abdominal tergite VIII (versus tergites VIII and IX in *I. luta*). In addition, the pterostigmas of the fore and hind wings are similarly colored and nearly the same size in *I. luta*, whereas they are dissimilar in size and color in *I. senegalensis*, and the male genital structures of the two species are quite divergent, the paraproct being small in *I. senegalensis* and greatly exceeded by the acuminate cercus. Finally, *I. luta* may be distinguished from *I. heterosticta* (Burmeister), which ranges from Australia as far north as Palau (Lieftinck, 1959), by the structure of the male cercus, which as noted previously is roughly triangular and tapers to an acute point as viewed laterally in *I. luta*, but is blunt and possesses 2–5 spines in *I. heterosticta*; the paraprocts of the two species are by contrast rather similar in lateral view (see Fig. 13j in Lieftinck, 1962).

Habitat. - The Mariana archipelago is 805 km long with a total land area of approximately 1010 sq km and can be divided into two tectonically and chronologically distinct island arcs (Siegrist and Randall 1992). The older island arc is comprised of the four main islands (Guam, Rota, Tinian, and Saipan) plus two small, uninhabited islands (Aguijan and Farallon de Medinilla). They are constructed primarily of uplifted limestone with volcanic intrusions. The oldest limestone has been dated to the middle Eocene (43 my; Siegrist and Randall 1992). The younger and more northern island arc is primarily volcanic and dates to the early Pleistocene (1.3 my; Siegrist and Randall 1992). It is comprised of nine small islands, and lesser islets, banks and reefs.

Rota is the smallest and highest of the four main older islands, covering 85 sq km with several limestone terraces building to a large plateau or sabana on the western half of the island. The upper elevation of the sabana is ca 500 m, with steep limestone cliffs that drop 100–300 m. The southern face of this terrace gives rise to the five perennial streams on the island. All these streams derive their water from springs and seeps along the face of the sabana terrace at the limestone-basalt interface. The central branch of the westernmost stream derives its water from a limestone cave (Talakhaya) that also serves as a major water supply for the island population. Specimens of *Ischnura luta* were collected in the vicinity of the water cave and its associated stream.

None of the other four perennial streams were surveyed, nor were several known permanent seeps that might also harbor this damselfly. Other water sources on Rota (ponds and reservoirs) have been surveyed, thus is appears likely that this species is restricted to the spring and stream habitats on the southern part of the island.

The limestone Mariana islands north of Rota have been surveyed, at least superficially (Leiftinck, 1962). However, only Saipan has spring and stream habitat similar to the Talakhaya area on Rota (Pacific Islands Ecoregion Coastal Ecosystems Program Proposal 1996). The more northern and volcanic Mariana islands have not been surveyed but do not have freshwater wetland habitat that would support *Ischnura luta*. What is striking is that *I. luta* has never been collected on Guam, although this is the largest of the Mariana islands, having over 50 rivers and streams and an extensive series of springs that would appear to provide suitable habitat. Guam is also the best sampled of all the Mariana Islands, having had resident entomologists for almost 50 years. Thus it appears that *I. luta* has a remarkably small distribution, being restricted to the Talakhaya watershed on the island of Rota.

Material examined. - Holotype, male: MARIANA ISLANDS, Rota, Talakhaya, Water Cave Stream, 1–2 April 1996, A. Asquith and S. Miller (BPBM 16,342). Paratypes: 1 male, 1 female, same data as holotype (BPBM).

ZOOGEOGRAPHY

The damselfly fauna of the Pacific Basin is notable for its locally endemic radiations of Coenagrionidae, including those on Samoa (*Ischnura*, 5 species, plus 2 small endemic genera), Fiji (*Melanesobasis*, 7 species, and *Nesobasis*, 24 species), Ponape (*Teinobasis*, 5 species) and Hawaii (*Megalagrion*, 23 species). Although these coenagrionid faunas are intermixed with other elements more typical of Melanesia (*Drepanosticta*, *Austrolestes*) on islands such as Palau and Fiji, the fauna of the insular Pacific islands east of the Tonga Trench and Palau is composed exclusively of species in the family Coenagrionidae, with five genera putatively represented: *Ischnura*, *Pseudagrion*, *Teinobasis*, the endemic Marquesan *Bedfordia*, and the endemic Hawaiian *Megalagrion*.

Native species of *Ischnura* are found throughout Polynesia and Micronesia, and two introduced species have also become established in Hawaii (Polhemus and Asquith, 1996). Although most of this vast Pacific distribution is dominated by a single widespread species, *Ischnura aurora*, local radiations of endemic species have arisen in Polynesia, on the Society Islands of Tahiti, Rapa, Bora Bora and Raiatea (Kimmins, 1929; Needham, 1932; Lieftinck, 1966), and a local radiation of five insular endemics is also present in Samoa. In Micronesia the local endemism in *Ischnura* is much less developed. Until the discovery of *R. luta* in the Marianas, the only precinctive *Ischnura* known from this part of the Pacific was *I. ezoin* on the Bonin Islands.

Coenagrion is currently recorded from insular Pacific only on the basis of the unrecognizable *C. melanoproctum* Selys, known from a single damaged specimen taken one hundred years ago somewhere in "Polynesia". Another species originally described in this genus, *Coenagrion interruptum* Needham from the Marquesas, was a homonym, and was subsequently reanamed and transferred to a separate genus, becoming *Bedfordia halecarpenteri* (Mumford, 1942). *Coenagrion* as a whole is a predominantly north temperate genus, with only a limited representation in Africa, South America, tropical Asia and Australia, and the alleged Pacific representatives are doubtfully congeneric with the remainder of the genus. Needham (1932) noted of his *C. interruptum* that "This species does not quite fit *Coenagrion*, and another new genus might with abundant precedents be erected for it, were it not that there are already too many undefinable genera in this part of the series." Needham's comments and Mumford's subsequent reclassification of *C. interruptum* clearly illustrate the tenuous generic classification of insular Pacific damselflies, and the consequent difficulties of accurately assessing the zoogeographic patterns represented among them.

Similarly, *Pseudagrion* is a genus that is highly diversified in the Paleotropical region, but is known to occur in the Pacific only as single scattered endemic taxa on Fiji, Samoa, Palau, and the Marquesas, with no apparent representation on any intervening island groups. This is a most illogical distribution, with only one highly disjunct species east of the Tongas and Marianas, and suggests that the Pacific species presently grouped within *Pseudagrion* may represent a polyphyletic assemblage. In particular, *P. demorsum* Needham (1933) from the Marquesas is morphologically abberant, and appears to represent a separate generic entity (see further discussion below). The overall level of endemism in the remaining Pacific members of this genus may also be overestimated, since *P. pacificum* from Fiji and *P. samoensis* from Samoa may be conspecific with the widespread and variable *P. microcephalum* (Donelly, in litt.).

We have examined the holotypes and associated material of both *Pseudagrion demorsum* and *Bedfordia halecarpenteri* (as *Coenagrion interruptum*) housed in the Bishop Museum, plus additional specimens determined by Needham, and have concluded that the two species are congeneric. Both of these taxa possess a distinctive ground plan to the male genitalia, with the terminal section of the superior appendage (cercus) being folded over and downward to form a massive, ventrally directed blade. This type of genitalic architecture is very different from that seen in the Papuan and western Pacific representatives of *Pseudagrion*, but very similar to that seen in *Ischnura aurora*, a species also present in the Marquesas, suggesting that the two endemic Marquesan taxa are insular derivitives from an *Ischnura* ancestor. At the same time, the female mesostigmal lamellae of these Marquesan species are quite distinct from those of *Ischnura*, bearing elevated, conical, setiferous tumescences to either side of the thoracic midline. Based these characters, we believe that *Bedfordia* is a good and distinct genus endemic to the Marquesas, and that both these species should be considered members of it; we defer any formal nomenclatural changes, however, pending the acquisition of further specimens, particularly the immature stages.

Unlike the preceeding genera, *Teinobasis* has a Micronesian distribution, with single island endemics on Palau and Truk, and a radiation of five insular endemics on Ponape; the genus is unknown in Polynesia. One of the Ponape endemics, *T. ariel*, is known to breed in the leaf axils of *Freycinetia* in a manner similar to several *Megalagrion* species on Hawaii (Polhemus and Asquith, 1996), and the gross morphology of the immatures is in both cases quite similar. This might suggest that the ancestor of the Hawaiian *Megalagrion* radiation could have been a phytotelmata breeder allied to *Teinobasis*, since the phytotelmata breeding habit could be extremely advantageous in terms of dispersal, allowing species to colonize islands where streams and ponds were not available, but an initial phylogenetic analysis of *Megalagrion* (Polhemus, 1997) has not supported this hypothesis.

In summary, then, there are two distinctive patterns of west to east Zygopteran radiation in the Pacific, an *Ischnura*-based pattern south of the equator in Polynesia, and a predominantly *Teinobasis*-based pattern in Micronesia north of the equator, the latter accompanied by limited local speciation within *Ischnura* as far east as the Marianas. If we assume that the Marquesan species of *Pseudagrion* has been incorrectly assigned to that genus, then we find that the *Pseudagrion* species are distributed as scattered single island endemics along the western margin of the Pacific Basin, on Fiji, Samoa, and Palau. This pattern indicates sporadic and incipient dispersal of *Pseudagrion* eastward from the Philippines and New Guinea, and implies that this genus is far less suited for long distance overwater dispersal than either the *Ischnura* or *Teinobasis* lineages, which have populated the remainder of the western tropical Pacific.

ACKNOWLEDGMENTS

We thank Dan Grout for his hospitality in Rota.

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Figure 5: *Ischnura luta* n. sp., male.

Figure 6: *Ischnura luta* n. sp., female.