

## Two new species of coastal *Atyphella* Olliff (Lampyridae: Luciolinae)

NATALIE A. SAXTON<sup>1,3</sup>, GARETH S. POWELL<sup>1</sup>, GAVIN J. MARTIN<sup>1</sup> & SETH M. BYBEE<sup>1,2</sup>

<sup>1</sup>Department of Biology, Brigham Young University, Provo, UT, USA

<sup>2</sup>Monte L. Bean Museum, Brigham Young University, Provo, UT, USA

<sup>3</sup>Corresponding author. E-mail: [natalie.a.saxton@byu.edu](mailto:natalie.a.saxton@byu.edu)

### Abstract

Additional work on the islands of Vanuatu has improved our understanding of the actual diversity of South Pacific coastal fireflies. Prior to recent fieldwork in Vanuatu, the only known lampyrid from Vanuatu was *Atyphella aphrogeneia* (Ballantyne), a coastal species also found in Papua New Guinea. After further examination, we determined that specimens from Vanuatu formerly classified as *Atyphella aphrogeneia* actually belong to an undescribed species. New species, *Atyphella maritimus* Saxton and Powell and *Atyphella marigenous* Saxton and Bybee, are described from specimens collected in Vanuatu. An updated key for coastal *Atyphella* in the South Pacific is provided.

**Key words:** Fireflies, taxonomy, marine, Vanuatu

### Introduction

*Atyphella* Olliff was originally described for three Australian species, the genus was placed within the Lampyrinae based on the head being covered by the pronotum (Olliff 1890). The validity of *Atyphella* was subsequently questioned by Lea (1909) who found *Atyphella* too morphologically similar to *Luciola* Laporte to constitute a separate genus. McDermott agreed with Lea's assessment and treated *Atyphella* as a synonym of *Luciola* (McDermott 1964, 1966). Later, Ballantyne, in Calder (1998) reestablished *Atyphella*. This reestablishment was then supported by morphological phylogenetic analyses testing the generic limits of Luciolinae in the Australian and South Pacific regions (Ballantyne & Lambkin 2000, 2001, 2009, 2013). As it stands, *Atyphella* is comprised of about 28 species (Ballantyne et al. 2019). *Atyphella* can be distinguished from other Luciolinae by the visible lateral lobes of the aedeagus when viewed ventrally that contract apically, the absence of aedeagal features such as lobes or projection, and the absence of modifications to ventrite 6 (ventrite 7 according to Ballantyne 2008) (Ballantyne 2008, Ballantyne and Lambkin 2009).

There are two confirmed instances of fireflies inhabiting coastal habitats, putative *Photinus* Laporte larvae collected in Jamaica and *Atyphella aphrogeneia* (Ballantyne) from Papua New Guinea (McDermott 1953; Ballantyne & Buck 1979). Both larvae and adults of *A. aphrogeneia* were collected on coastal rocks and the males' behavior and flash patterns were observed by Lloyd (1973). Additional specimens of *A. aphrogeneia* were collected by E.L. Cheeseman in Vanuatu (Ballantyne & Lambkin 2009). Ballantyne & Buck (1979) discussed the unique evolutionary history of *A. aphrogeneia* as well as potential for additional species within this lineage throughout the South Pacific.

Recent expeditions to Vanuatu have resulted in the collection of fresh material. This material has greatly increased our understanding of the diversity of coastal fireflies in the South Pacific. Specimens were collected on three islands including: Efate, Malekula, and Espiritu Santo. Adult males were keyed out using Ballantyne & Lambkin (2009) and found to resemble *Atyphella aphrogeneia* due to dorsal coloration, thickening of elytral apices, and the coastal habitat (Ballantyne & Buck 1979; Ballantyne & Lambkin 2009). After further inspection, consistent morphological differences between recently collected material and *A. aphrogeneia* were found which constitutes the description of two new species of coastal *Atyphella*.

## Material and methods

Specimens examined are deposited in the following institutions:

ANIC Australian National Insect Collection, Canberra, AUS

BPBM Bernice P. Bishop Museum, Honolulu, Hawaii, USA

BYU Monte L. Bean Museum, Provo, Utah, USA

JELC James E. Lloyd Personal Collection, Gainesville, Florida, USA

NHM National History Museum, London, UK

USNM United States National Museum of Natural History, Washington, DC, USA

Specimens were examined using Olympus SZ61 and Olympus MVX10 microscopes (Olympus, Tokyo, Japan). Specimen images were generated using a Canon EOS 5DS R camera (Canon, Tokyo, Japan) with a 65mm lens for dorsal and lateral shots and 200mm lens with a 10X objective lens (Mitutoyo, Kawasaki) for genitalia and frontal shots using Version 10 (Phase One, Copenhagen, Denmark). Zerene Stacker (version 1.04) was used to generate images from stacked photos (Zerene Systems LLC, Richland, WA, USA). Composite plates were made and edited using Adobe Photoshop (Adobe Systems, San Jose, CA, USA).

All morphological characters for adults, except ventrite numbering, were described following Ballantyne and Lambkin (2013). Here, ventrites were counted beginning with the first visible segment following Branham and Archangelsky (2000). Dissections of male genitalia were completed on specimens preserved in 95% EtOH and briefly allowed to dry. For each dissection, the aedeagus was removed from the specimen and mounted on an archival cardstock point using acid-free glue underneath the pinned specimen.

Holotype data label is given verbatim with (/) to indicate line breaks and (//) to indicate separate labels. Label data for paratypes and other material examined is summarized. Holotype and Paratype labels were printed on red and yellow card stock respectively. Depositories for both holotypes and paratypes are indicated below.

## Results

### Family Lampyridae Rafinesque, 1815

### Subfamily Luciolinae Lacordaire, 1857

### Tribe Luciolini Lacordaire, 1857

### Genus *Atyphella* Olliff, 1890

Type species: *Atyphella lychnus* Olliff, 1890

### *Atyphella maritimus* Saxton & Powell, sp. nov.

(Figs. 1B, E, H; 2B)

**Type material. Holotype. male** (Fig. 1A): // Vanuatu: Malekula Is. / Brenwe, -16.1105 / 167.3314, 22.v.2018 / coll. S. Bybee & G. Powell // (BYU). **Allotype female** (Fig. 2E): // Vanuatu: Malekula Is. / Brenwe, -16.1105 / 167.3314, 22.v.2018 / coll. S. Bybee & G. Powell // (BYU). **Paratypes** (61 males): (4 ANIC, 3 BYU, 4 NHM, 4 USNM) Vanuatu: Malekula Is. / Brenwe, -16.1105 / 167.3314, 22.v.2018 / coll. S. Bybee & G. Powell // (5 ANIC, 9 BYU, 5 NHM, 5 USNM) Vanuatu: Malekula Is. / Tenmaru, -16.0290 / 167.1728, 24.v.2018 / coll. S. Bybee & G. Powell // (20 BYU) Vanuatu: Santo Is. / Ipayato, -15.6296 / 166.8541, 4.vi.2018 / coll. S. Bybee & G. Powell // (3 BYU) Vanuatu: Santo Is. / Lowerie, -15.1598 / 166.9511 1.vi.2018 / coll. S. Bybee & G. Powell // (4 BYU) Vanuatu: Santo Is. / Lowerie, -15.1598 / 166.9511 5.vi.2018 / coll. S. Bybee & G. Powell //

**Other material examined.** New Hebrides (=Vanuatu): Malekula Atchin Island, vi. 1929, L. Cheesman, 3

males; Malekula Atchin Island, iii.1930, L. Cheesman, 1 male (NHM); Malekula, 1 male (BPBM, per image in Ballantyne and Lambkin 2009).

**Diagnosis.** *Atyphella maritimus* is distinguished from all other South Pacific *Atyphella*, except *A. aphrogeneia* and *A. marigenous* by the thickened elytral apices in conjunction with a dark median marking on the pronotum (see Ballantyne and Lambkin 2009). *Atyphella maritimus* resembles *A. aphrogeneia* and *A. marigenous* but differs in the following ways; excavation on frons shallow (frons deeply excavated in *A. marigenous*); pronotum broadly rounded (pronotum with weakly obtuse, anterior angles in *A. aphrogeneia*); base of scutellum with dense punctation (punctation larger, but less dense in *A. marigenous* and *A. aphrogeneia*); weak elytral costae (more pronounced elytral costae in *A. marigenous*).

**Description. Holotype.** Male. Overall, body parallel-sided, length 9.8mm, width measured at elytral humeri 3.7mm. **Coloration:** Elytra and head dark brown to black, pronotum notably lighter, light brown with disc darker (Fig. 1E, H). Venter lighter than pronotal margins, becoming darker apically but before the light organ. Sculpturing on dorsal body surfaces moderately shiny beneath pubescence; pubescence fine and gold in color. Legs tan at base, darkening distally. **Head:** 2.4mm at widest point (center of eyes), eyes large, black; frons depressed, depression broad, widening and becoming shallow towards clypeus, red apunctate region at narrowest point of depression, setae long and golden on frons; antennae filiform, light brown gradually becoming lighter in color distally; scape about 0.3mm long, antennomeres 2–11 broadly uniform in length and about half as long as scape; mandibles sickle-shaped, reddish brown, darker toward pointed apices; apical maxillary palpomere enlarged, widest almost at base, apex rounded, longer than wide; apical labial palpomere longer than wide, similar to that of apical maxillary palpomere but smaller and thinner, half as long as apical maxillary palpomere. **Pronotum:** 2.3mm long, 3.4mm wide, pronotal width slightly less than humeral width; margins light brown, basal third subparallel, broadly rounded anteriorly, weakly explanate, hind angles almost at right angles; disc dark brown, dorsal surface with dense punctation, with dark median region not reaching either anterior or posterior margins, median area of dorsal surface somewhat convex. **Scutellum:** trapezoidal with dense punctation, dark brown with thin, lighter lateral and posterior margins. **Elytra:** 7.4mm long, dark brown almost black, parallel-sided; punctures dense, not as large as that on pronotum, unevenly spaced; epipleuron developed as ridge along margin, widest at humeri, narrowing posteriorly, weakly developed towards apex; Costae somewhat pronounced, becoming less defined apically. **Abdomen:** Ventrites 1–4 tan, becoming darker anteriorly, fat body visible at margins of ventrite 2 to ventrite 4; light organ occupying all of ventrite 5–6. **Legs:** Dark brown except for pale coxae, trochanters, and basal half of femora; dark marking present on metacoxae. **Aedeagus:** 1.3mm long, 0.7mm wide, slender (Fig. 2B); median lobe slightly longer than lateral lobes; posterior end of lateral lobes curve toward each other; lateral margins of lateral lobes symmetrical, tapering to apex, and rounded, diverging anteriorly; lateral lobes more sclerotized ventrally before apical fourth; median lobe apex rounded and ventrally excavated.

**Variation.** Males: Length 8.7–10.3mm (n=10), width 2.9–3.3mm (n=10). Pronotum of some specimens lighter in color. Depression on frons sometimes deeper with apunctate region larger. Female: Length, allotype 12.9mm, width 4.7mm. Females similar to males, pubescence more dense on elytra; head is noticeably smaller and covered entirely by pronotum. Eyes much smaller, depression on frons also less developed. Ventral surface overall lighter, without darker patch on metasternite, instead small cloudy darker region on ventrites 1–2. Fat tissue visible through entire ventrites 1–6. Abdomen enlarged.

**Distribution.** *Atyphella maritimus* is known from the islands of Malekula and Santo, Vanuatu.

**Etymology.** In reference to the habitat this taxon is found in, the specific epithet for this species is derived from the Latin term for coastal.

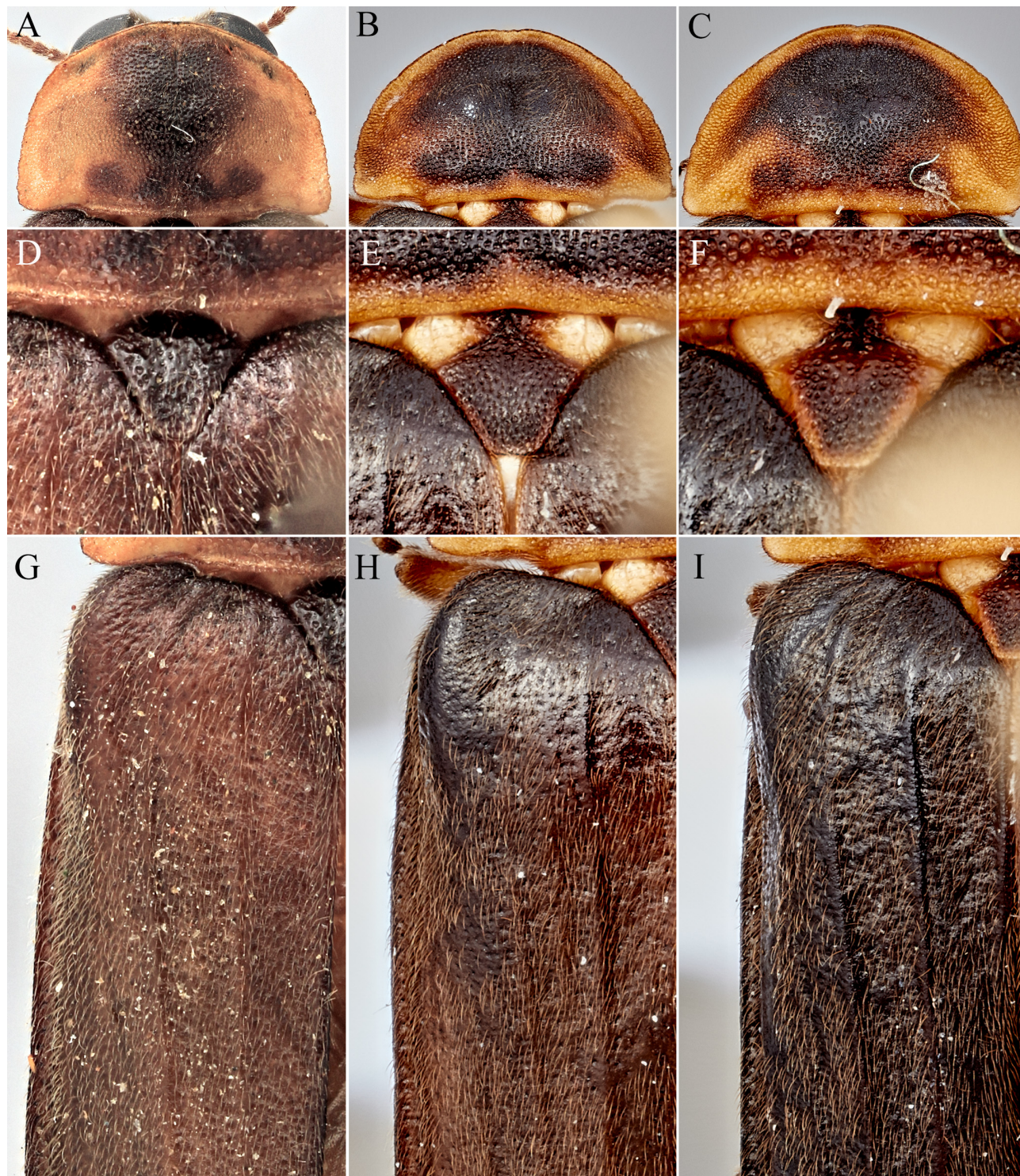
**Biology.** *Atyphella maritimus* was collected on volcanic rock outcroppings subject to high tide and frequent waves from the Pacific Ocean. Larvae were observed to inhabit the crevices of these rocks with despite regular sprays of salt-water and individuals were often seen clinging to wet rocks. Adult males were caught flying out over these rocks and climbing on the same rocks as females collected. Only at one locality did we observe a second species of firefly belonging to the genus *Magnalata* which allowed us to infer the relationship of the males and females here. Additionally, various instars were collected at all locations suggesting that this species reproduces year-round. Nine larvae were collected from Malekula, Tenmaru and completely submerged in salt-water for fourteen hours with a 100 percent survival rate, suggesting that the larvae of this species are at least partially marine and able to withstand being submerged during high tide. The similar biology and morphology of this species to *Atyphella aphrogeneia* and *Atyphella marigenous* suggests that these species are closely related.



*AtypHELLa marigenous*, Saxton & Bybee, sp. nov.

(Figs. 1C, F, I; 2C)

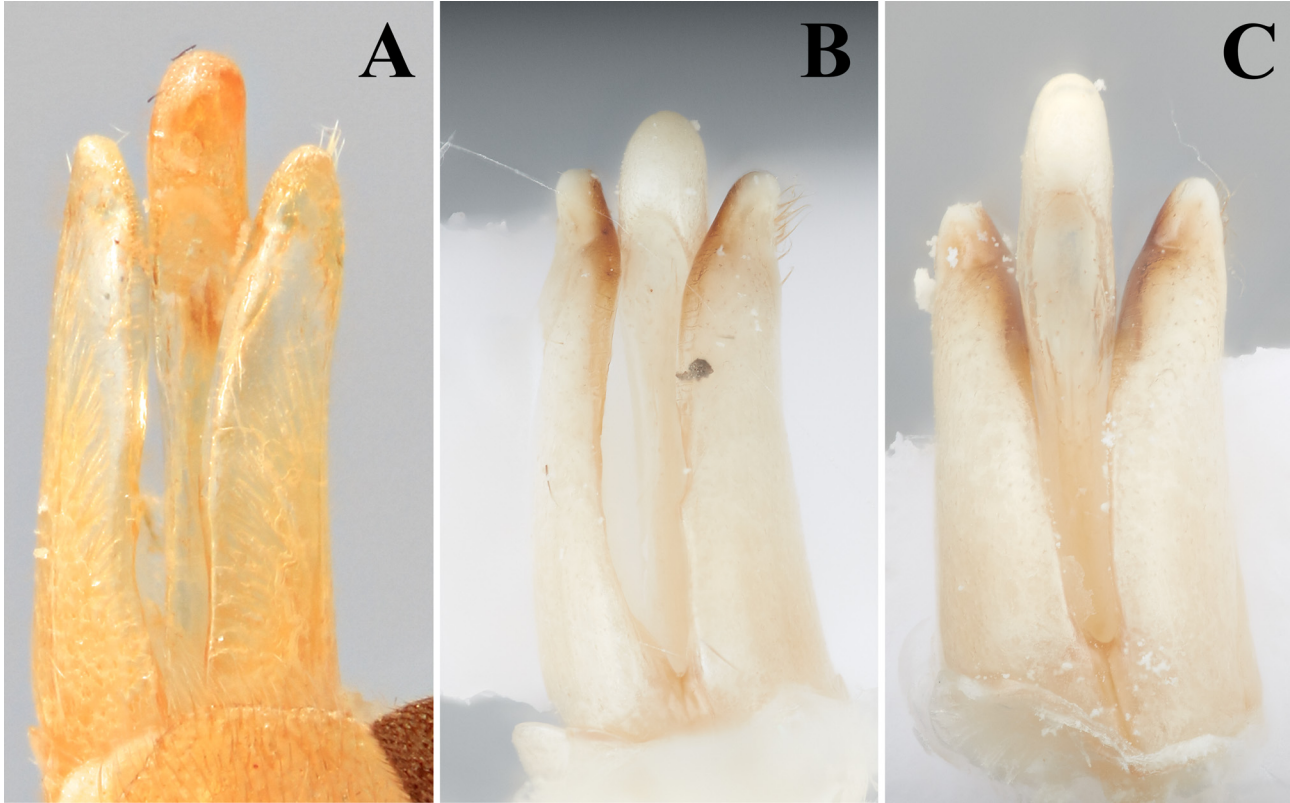
**Type material. Holotype male** (Fig. 1D): // Vanuatu: Efate Is. / 1999 Devil's Point Rd., -17.6841 / 168.2536, 12.vi.2018 / coll. S. Bybee & G. Powell // (BYU). **Paratypes** (7 males): (2 ANIC, 2 BYU, 1 USNM) Vanuatu: Efate Is. / 1999 Devil's Point Rd., -17.6841 / 168.2536, 12.vi.2018 / coll. S. Bybee & G. Powell // (2 NHM) Vanuatu: Efate Is. / Epule, -17.5714 / 168.4702, 13.vi.2018 / coll. S. Bybee & G. Powell //



**FIGURE 1. A–I)** *AtypHELLa* spp. holotypes. **A–C)** dorsal pronotum: **A)** *A. aphrogeneia*, **B)** *A. maritimus*, **C)** *A. marigenous*; **D–F)** scutellum: **D)** *A. aphrogeneia*, **E)** *A. maritimus*, **F)** *A. marigenous*; **G–I)** left elytron, notice extent of costae **G)** *A. aphrogeneia*, **H)** *A. maritimus*, **I)** *A. marigenous*. *AtypHELLa aphrogeneia* holotype images are the property of © CSIRO.



**Diagnosis.** *Atyphella marigenous* is distinguished from all other South Pacific *Atyphella*, except *A. aphrogeneia* and *A. maritimus* by the thickened elytral apices in conjunction with a dark median marking on the pronotum (see Ballantyne and Lambkin 2009). *Atyphella marigenous* resembles *A. maritimus* and *A. aphrogeneia* but differs in the following ways: frons is deeply excavated (shallower in *A. maritimus* and *A. aphrogeneia*); pronotum broadly and continuously rounded (pronotum with weakly obtuse and anterior angles in *A. aphrogeneia*); base of scutellum with less dense and larger punctation (apex of scutellum with dense punctation at the base in *A. maritimus*); elytral costae pronounced (elytral costae less pronounced in *A. aphrogeneia* and *A. maritimus*).



**FIGURE 2.** A–C) *Atyphella* spp. dorsal view of aedeagus. **A)** *A. aphrogeneia* holotype, **B)** *A. maritimus* paratype, **C)** *A. marigenous* holotype. *Atyphella aphrogeneia* holotype images are the property of © CSIRO.

**Description. Holotype.** Male. Overall, body parallel-sided, length 10mm, width measured at elytral humeri 3.4mm. **Coloration:** Elytra and head dark brown to black, pronotum notably lighter, light brown with disc darker (Fig. 1C, I). Venter lighter than pronotal margins, becoming darker apically but before the light organ. Sculpturing on dorsal body surfaces moderately shiny beneath pubescence; pubescence fine and gold in color. Legs at base tan, becoming darker distally. **Head:** 2.3mm at widest point (center of eyes), eyes large, black; frons deeply depressed, depression narrow and deep, gradually widening and becoming shallow towards clypeus, small, red apunctate region at narrowest point of depression, setae long and golden on frons; antennae filiform, light brown at scape and second antennomere and becoming darker distally; scape about 0.3mm long, antennomeres 2–11 broadly uniform in length and about half as long as scape; mandibles broad, reddish brown, darker toward pointed apices; apical maxillary palpomere enlarged, widest almost at base, apex rounded, longer than wide; apical labial palpomere longer than wide, similar to that of apical maxillary palpomere but smaller and thinner, half as long as apical maxillary palpomere. **Pronotum:** 2.2mm long, 3.6mm wide, pronotal width slightly less than humeral width; margins light brown, basal third subparallel, broadly rounded anteriorly, weakly explanate, hind angles almost at right angles; disc dark brown, dorsal surface with dense punctation, with dark median region not reaching either anterior or posterior margins, median area of dorsal surface somewhat convex. **Scutellum:** trapezoidal with dense punctation, distance between punctures increasing anteriorly; brown with lighter lateral and posterior margins. **Elytra:** 7.9mm long, dark brown almost black, parallel-sided; punctures dense, not as large as that on pronotum, unevenly spaced; costae epipleuron developed as ridge along margin, widest at humeri, narrowing posteriorly, weakly developed towards apex; Costae well pronounced, becoming less distinct apically. **Abdomen:** Ventrites 1–4 tan, becoming darker anteriorly, fat body

visible at margins of ventrite 2 to ventrite 4; light organ occupying all of ventrite 5–6. **Legs:** Dark brown except for pale coxae, trochanters, and basal half of femora; dark marking present on coxae 3. **Aedeagus:** 1.4mm long, 0.6mm wide, slender, (Fig. 2C); median lobe slightly longer than lateral lobes; posterior end of lateral lobes run parallel; lateral margins of lateral lobes symmetrical, tapering to apex, and rounded, diverging anteriorly; interior margins of lateral lobes sclerotized from midpoint to apex; median lobe apex rounded and deeply ventrally excavated.

**Variation.** Males: Length 9.6–10.2mm (n=6), width 3.1–3.4mm (n=6). Pronotum of some specimens lighter in color, some with wider disc. Antennae color in some specimens generally uniform. Female: unknown.

**Etymology.** In reference to this species habitat, the specific epithet for this species is derived from the Latin roots mar- referring to “the sea” and -genous meaning “the product of.”

**Biology.** *Atyphella marigenous* was collected on volcanic rock outcroppings extremely similar to those *A. maritimus* inhabit. Larvae were found in crevices on the rocks despite the frequent waves from the ocean. Larvae of all sizes were collected suggesting that this species reproduces year-round. Adult males were caught flying over these rocks, but no females were observed. The similar biology and morphology of this species to both *A. maritimus* and *A. aphrogeneia* suggest these species are closely related.

### Key to Coastal *Atyphella*

1. Pronotum with weak, obtuse, anterior angles (Fig. 1A). . . . . *Atyphella aphrogeneia* Ballantyne
- Pronotum broadly and continuously rounded (Fig. 1B, C) . . . . . 2
2. Lacking pronounced elytral costae (Fig. 1H); scutellum densely punctate at base (Fig. 1E) . . . . . *Atyphella maritimus* Saxton and Powell
- Presence of pronounced elytral costae (Fig. 1I); scutellum with less dense, larger punctation at base (Fig. 1F) . . . . . *Atyphella marigenous* Saxton and Bybee

### Discussion

Due to the difficulty in obtaining additional specimens of *A. aphrogeneia*, and the lack of fresh material from this species, it should be noted that several additional characters may be diagnostic, however, more work needs to be completed to confirm their usefulness in identification. The shape of the scutellum in *A. aphrogeneia* appears thin apically while *A. maritimus* and *A. marigenous* have a much broader apex of the scutellum. Additionally, the mandibles in *A. maritimus* are generally thinner and sickle-shape while in *A. marigenous* and *A. aphrogeneia* they appear shorter and more robust. The flash pattern of both new species is very rapid and greenish-yellow. All three species were collected on or near intertidal rock, an unusual habitat for lampyrids to have successfully colonized. Vanuatu *Atyphella* adults were observed patrolling over coastal rocks, occasionally being sprayed by nearby waves. On particularly windy evenings, adults typically flew between large rocks where the wind appeared to be less intense. The description of two new coastal *Atyphella* from Vanuatu in conjunction with *A. aphrogeneia* triples the number of confirmed coastal species, suggesting that this lineage is much more diverse than previously understood. Additional work in this region will likely yield further insight into the distribution and evolutionary history of this group.

### Acknowledgements

We would like to thank our Vanuatu government contact Donna Kalfatakvoli for her assistance in obtaining the required permits and visas in order to complete our research as well as all the local Vanuatuan landowners and guides who helped us. Max Barclay (NHM), Michael Geiser (NHM), Cate Lemann (ANIC), Marc Branham (University of Florida), and Jim Lloyd are thanked for providing access to specimens used in this study. We also thank Alexandra Duffy and the Commonwealth Scientific and Industrial Research Organization (CSIRO) for assistance with images. We are also grateful to the BYU undergraduates who assisted in the collection and preservation of specimens. Lastly, the authors thank the editor and two anonymous reviews for comments that greatly improved this manuscript. This research was funded through the National Science Foundation Division of Environmental Biology grants (#1265714 to SMB) (#1655981 to SMB), BYU Sant Grant, BYU Research Experience for Undergrads and the BYU Kennedy Center for International Studies.

## References

- Ballantyne, L.A. & Buck, E. (1979) Taxonomy and behavior of *Luciola (Luciola) aphrogeneia*, a new surf firefly from Papua New Guinea. *Transactions of the American Entomological Society*, 105 (2), 117–137.
- Ballantyne, L.A. & Lambkin, C. (2000) Lampyridae of Australia (Coleoptera: Lampyridae: Luciolinae: Luciolini). *Memoirs of the Queensland Museum*, 46 (1), 15–93.
- Ballantyne, L.A. & Lambkin, C. (2001) A new firefly, *Luciola (Pygoluciola) kinabalua* sp. n. (Coleoptera: Lampyridae), from Malaysia, with observations on a possible copulation clamp. *Raffles Bulletin of Zoology*, 49 (2), 363–377.
- Ballantyne, L.A. (2008) *Pygoluciola satoi*, a new species of the rare S. E. Asian firefly genus *Pygoluciola* Wittmer (Coleoptera: Lampyridae: Luciolinae) from the Philippines. *Raffles Bulletin of Zoology*, 56 (1), 1–9.
- Ballantyne, L.A. & Lambkin, C. (2009) Systematics of Indo-Pacific fireflies with a redefinition of Australasian *Atyphella* Olliff, Madagascan *PhoturoLuciola* Pic, and description of seven new genera from the Luciolinae (Coleoptera: Lampyridae). *Zootaxa*, 1997 (1), 1–188.  
<https://doi.org/10.11646/zootaxa.1997.1.1>
- Ballantyne, L.A. & Lambkin, C.L. (2013) Systematics and phylogenetics of Indo-Pacific Luciolinae fireflies (Coleoptera: Lampyridae) and the description of new genera. *Zootaxa*, 3653 (1), 1–162.  
<https://doi.org/10.11646/zootaxa.3653.1.1>
- Ballantyne, L.A., Lambkin, C.L., Ho, J.-Z., Jusah, W.F.A., Nada, B., Nak-Eiam, S., Thancharoen, A., Wattanachaiyingcharoen, W. & Yiu, V. (2019) The Luciolinae of S.E. Asia and the Australopacific region: a revisionary checklist (Coleoptera: Lampyridae) including descriptions of three new genera and 13 new species. *Zootaxa*, 4687 (1), 1–174.  
<https://doi.org/10.11646/zootaxa.4687.1.1>
- Branham, M.A. & Archangelsky, M. (2000) Description of the last larval instar and pupa of *Lucidota atra* (GA Olivier 1790) (Coleoptera: Lampyridae), with a discussion of abdominal segment homology across life stages. *Proceedings of the Entomological Society of Washington*, 102 (4), 869–877.
- Calder, A.A. (1998) Coleoptera: Elateroidea. In: Wells, A. (Ed.), *Zoological Catalogue of Australia* 29.6. CSIRO Publishing, Melbourne, pp. 1–248.
- Lea, A.M. (1909) Revision of the Australian and Tasmanian Malacodermidae. *Transactions of the Entomological Society of London*, 1909, 45–251.
- Lloyd, J.E. (1973) A firefly inhabitant of coastal reefs in New Guinea (Coleoptera: Lampyridae). *Biotropica*, 5 (3), 168–174.  
<https://doi.org/10.2307/2989809>
- McDermott, F.A. (1953) Glowworms in a marine littoral habitat in Jamaica. *Entomological News*, 64, 89–90.
- McDermott, F.A. (1964) The Taxonomy of the Lampyridae (Coleoptera). *Transactions of the American Entomological Society (1890)*, 90 (1), 1–72.
- McDermott, F.A. (1966) Lampyridae Pars. 9. In: Junk, W. & Schenkling, S. (Eds.), *Coleopterorum Catalogus*. W. Junk, Berlin, pp. 98–118.
- Olliff, A.S. (1890) New species of Lampyridae, including a notice of the Mt. Wilson fire-fly. *The Proceedings of the Linnean Society of New South Wales*, Series 2, 4, 643–653.  
<https://doi.org/10.5962/bhl.part.15062>