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A CITIZEN SCIENCE CASE STUDY TO CHART INDONESIAN BIODIVERSITY: UPDATING THE DIVING BEETLE FAUNA OF BALI (COLEOPTERA: DYTISCIDAE)

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ABSTRACT

We present new data on the geographical distribution of 16 species of diving beetles collected by an Indonesian citizen scientist in Bali. *Copelatus oblitus* Sharp, 1882, *C. regimbarti* Branden, 1884, *C. sumbawensis* Régimbart, 1899, and *Hydroglyphus laeticulus* (Sharp, 1882) are recorded for the first time from the island. We summarize what is known about the species' distributions and habitats in Indonesia and beyond, and provide distribution maps and photographs of the sampling sites and habitus of the species. This work serves as a best practice template between individual local citizen scientists with local and international scientists.

Key words: Bali, diving beetles, new locality data, species identification

INTRODUCTION

In 2017, Suprayitno et al. presented a practical workflow that enables citizen scientists in locations that are comparably remote from major science infrastructure to engage with a global community of citizen scientists interested in the same field, as well as with professional scientists. The specific field of interest was freshwater entomology, the location of the island of Bali, situated in the heart of the megadiverse Indonesian Archipelago. The methodology, in short, is to utilize locally available technology (handphone, laptop, internet) and social media to document freshwater organisms on Bali, collected as a purely recreational activity. Then, use that same technology to contact and establish cooperation with professional scientists of the national Indonesian natural history collections (Museum Zoologicum Bogoriense, MZB), as well as with taxonomic experts globally (Suprayitno et al., 2017). This work has generated moderate general interest among scientists of different disciplines, being cited 24 times as of December 01, 2022.

Here, we provide a follow-up study as a proof of concept in terms of sustainability. Significant collections of aquatic Coleoptera have been donated by Suprayitno to the MZB,

pre-sorted to putative species. At MZB, they were mounted and labeled, further sorted, and then studied by a visiting taxonomist during a biodiversity exploration and training project (Michael Balke, Foreign Research Permit S/2875/E5/E5.4/2019). Few representative species and specimens were loaned for dissection, further identification and photography abroad. For these species, we provide a wealth of new locality data from Bali, as well as photographs to aid future species identification. Our study should motivate more such projects. This will help to chart Indonesia's extraordinary biodiversity on the one hand and establish fruitful, efficient, and inexpensive international cooperation on the other hand.

MATERIALS AND METHODS

The beetles were studied with a Leica (Wetzlar, Germany) MZ M205C stereomicroscope at 10–100x. Habitus images 1C, 1F, and 1I were taken with a Canon EOS 5 DS camera fitted with a Canon MPE65 macro lens. The camera was attached to a Stackmaster macro rail (Stonemaster: www.stonemaster-onlineshop.de, Linkenheim-Hochstetten, Germany) for image stacking. Illumination was with 3 Stonemaster LED-Segments SN-1. Image stacks were assembled using Helicon Focus software (method A) and cleaned using Adobe Photoshop CS6 software. The other habitus images were taken with a Leica DMC5400 camera with L.A.S. 4.13.0 software attached to a Z6 APO Macroscope (all from Leica Microsystems, Switzerland). The Illumination was with a Leica LED3000 RL.

The studied specimens are deposited in:

MZB – Museum Zoologicum Bogoriense, Zoology Division, Indonesian Institute of Sciences, Cibinong, West Java, Indonesia.

RESULTS

Subfamily Agabinae Thomson, 1867

***Platynectes* sp. (*P. octodecimmaculatus*-complex) (Figure 1A)**

Platynectes octodecimmaculatus (W.S. Macleay, 1825): 31 (orig. descr.); Hendrich & Balke 1995: 46 (faunistics).

Taxonomic note: Southeast Asian species of *Platynectes* are currently under taxonomic revision. It has not yet been established which of the many available names has to be used for the Balinese species.

New localities (53 exs): BALI_NS_2016_36: 6 exs, Karangasem, Ds Sindu wati, Sidemen, 450 m, -8,4554, 115,4646, 25.vi.2016, Suprayitno; BALI_NS_2016_20: 11 exs, Karangasem, Jl. Karangasem-Seraya, 170 m, -8,4177, 115,6885, 16.vi.2016, Suprayitno; BALI_NS_2016_61: 3 exs, Karangasem, unnamed road - Bunutan-Abang, 100 m, -8,3604, 115,6643, 14.iv.2016, Suprayitno; BALI_NS_2016_16: 2 exs, Karangasem, Jl. Karangasem - Seraya, 350 m, -8,4107, 115,6815, 15.vi.2016, Suprayitno; BALI_NS_2016_41: 4 exs, Tabanan, Jl. Pekutatan - Pupuan, 760 m, -8,3146, 114,9425, 16.xi.2016, Suprayitno; BALI_NS_2016_35: 1 ex., Buleleng, Ds Selat, Sukasada, 180 m, -8,1746, 115,0669, 31.v.2016, Suprayitno; BALI_NS_2016_13: 6 exs, Singaraja, Singaraja, 450 m, -8,1928, 115,0664, 29.ix.2016, Suprayitno; BALI_NS_2016_08: 14 exs, Buleleng, Desa Tambakan, 1200 m, -8,2020, 115,2408, 8.ix.2016, Suprayitno; BALI_NS_2017_57: 6 exs, Tabanan, Ds Pajahan, Pupuan, 530 m, -8,3460, 114,9974, 26.i.2017, Suprayitno.

Distribution. Bali, other than that, needs to be investigated based on a taxonomic revision (Figs 4C, 8A).

Biological aspects. A species that is found in streams with clear water (Fig. 4F) or in puddles at the side of streams, side arms or rest pools (Figs. 5A, 6D) of temporary streams, with little water movement, often with grasses and debris.

Note. Catalog numbers: MZB Cole 175.001–175.053.

Subfamily Copelatinae Branden

***Copelatus oblitus* Sharp, 1882 (Figure 1B)**

Copelatus oblitus Sharp, 1882: 582 (orig. descr.); Hendrich et al. 2004: 118 (taxonomy, faunistics, ecology); Atthakor et al. 2018: 95 (faunistics); Sheth et al. 2018: 255 (taxonomy); Nilsson & Hájek 2022: 60 (Catalog); Jiang et al. 2022: 265 (descr., faunistics).

Copelatus andamanicus Régimbart, 1899: Satô 1983: 35 (taxonomy); 1985: 58 (descr., faunistics); 1990: 81 (taxonomy).

New localities (30 exs): BALI_NS_2016_17: 2 exs, Karangasem, Jl. Karangasem - Seraya, 250 m, -8,4265, 115,6610, 2.vi.2016, Suprayitno; BALI_NS_2017_59: 1 ex., Karangasem, Jl. Karangasem - Seraya, 10 m, -8,3677, 115,7014, 18.ii.2017, Suprayitno; BALI_NS_2016_14: 10 exs, Bangli, Tangkup Waterfall - Tembuku, 470 m, -8,4494, 115,3879, 9.x.2016, Suprayitno; BALI_NS_2017_58: 3 exs, Karangasem, Jl. Karangasem - Seraya, 100 m, -8,4078, 115,6984, 17.ii.2017, Suprayitno; BALI_NS_2016_01: 5 exs, Klungkung, Jl. Raya Aan - Banjar Rangkan, 200 m, -8,5146, 115,3799, 25.viii.2016, Suprayitno; BALI_NS_2016_12: 7 exs, Tabanan, Baturiti, 830 m, -8,3257, 115,1950, 24.ix.2016, Suprayitno; BALI_NS_2016_27: 2 exs, Badung, Jl. Tambakbayuh, Ds Pererenan, Mengwi, 30 m, -8,6264 115,1357, 22.vii.2016, Suprayitno.

Distribution. This widespread Oriental species occurs from the Indian Subcontinent, southern China, Ryukyus and Taiwan, through continental Southeast Asia to Sarawak (Satô, 1985, 1990; Hendrich et al., 2004; Atthakor et al., 2018; Sheth et al., 2018; Jiang et al., 2022) (Fig. 8B). **First record from Bali.**

Biological aspects. The species is usually found among leaf litter, roots and submerged plants in very small, temporary, shallow puddles in or near forested areas (see, e.g., Hendrich et al. 2004) (Figs. 4A, B; 6E, F).

Note. Catalog numbers: MZB Cole 175.054 –175.083.

***Copelatus regimbarti* Branden, 1884 (Figure 1C)**

Copelatus fragilis Régimbart, 1883: 232 (orig. descr.) preoccupied by Sharp 1882: 40, objective synonym of *Copelatus regimbarti* Branden, 1884: 86.

Copelatus regimbarti Branden, 1884: 86, as replacement name for *Copelatus fragilis* Régimbart, 1883: 232; Nilsson & Hájek 2022: 60 (Catalog).

New localities (6 exs): BALI_NS_2016_20: 1 ex., Karangasem, Jl. Karangasem-Seraya, 170 m, -8,4177, 115,6885, 16.vi.2016, Suprayitno; BALI_NS_2016_17: 4 exs, Karangasem, Jalan Karangasem – Seraya (1), 250 m, -8.426531, 115.661005, 2.vi.2016; BALI_NS_2016_49: 1 ex., Klungkung, Unname road, Pejukutan, Nusa Penida, 17.xii.2016, -8.773398, 115.606964, Suprayitno.

Distribution. The species was described and is so far, only known from Java; however, it seems to be widespread on Lesser Sunda Islands (Balke et al., unpublished data) (Fig. 8C). **First record from Bali.**

Biological aspects. The beetles were collected from a deep-water pond with clear water (Fig. 4C), caught when they moved to the surface for fresh air.

Note. Catalog numbers: MZB Cole 175.084–175.088.

***Copelatus sumbawensis* Régimbart, 1899 (Figure 1D)**

Copelatus sumbawensis Régimbart, 1899: 304 (orig. descr.); Nilsson & Hájek, 2022: 54 (Catalog).

Copelatus javanus Régimbart, 1883: Hendrich & Balke 1995: 45 (misidentification).

New localities (34 exs): BALI_NS_2016_05: 15 exs, Karangasem, Jl. Buana Giri – Duda Timur, 530 m, -8,4505, 115,4950, 30.viii.2016, Suprayitno; BALI_NS_ 2017_52: 1 ex., Klungkung, Besan – Dawan, 90 m, -8,5181, 115,4548, 5.i.2017, Suprayitno; BALI_NS_2016_20: 4 exs, Karangasem, Jl. Karangasem-Seraya, 170 m, -8,4177, 115,6885, 16.vi.2016, Suprayitno; BALI_NS_2016_36: 1 ex., Karangasem, Ds Sindu wati, Sidemen, 450 m, -8,4554, 115,4646, 25.vi.2016, Suprayitno; BALI_NS_2016_61: 3 exs, Karangasem, unnamed road – Bunutan-Abang, 100 m, -8,3604, 115,6643, 14.iv.2016, Suprayitno; BALI_NS_2016_16: 4 exs, Karangasem, Jl. Karangasem – Seraya, 350 m, -8,4107, 115,6815, 15.vi.2016, Suprayitno; BALI_NS_2016_17: 1 ex., Karangasem, Jl. Karangasem – Seraya, 250 m, -8,4265, 115,6610, 2.vi.2016, Suprayitno; BALI_NS_2016_18: 1 ex., Karangasem, Jl. Karangasem – Seraya, 270 m, -8,4217, 115,6690, 4.vi.2016, Suprayitno; BALI_NS_2017_58: 2 exs, Karangasem, Jl. Karangasem – Seraya, 100 m, -8,4078, 115,6984, 17.ii.2017, Suprayitno; BALI_NS_2016_35: 2 exs, Buleleng, Ds Selat, Sukasada, 180 m, -8,1746, 115,0669, 31.v.2016, Suprayitno.

Distribution. Lesser Sunda Islands from Bali east to Sumbawa. It is previously erroneously reported from Bali by Hendrich & Balke (1995) under the name *C. javanus* (Fig. 8D). **First formal record from Bali.**

Biological aspects. In Bali, this species was found in rest water from the rain with very little water on sandy soil and grass on the side by the roadside. It can also be found in rest water pools of otherwise dry streams (Figs. 4C, F; 5A).

Note. Catalog numbers: MZB Cole 175.089–175.122.

***Copelatus tenebrosus* Régimbart, 1880 (Figure 1E)**

Copelatus tenebrosus Régimbart, 1880: 210 (orig. desc.); Régimbart, 1899: 296 (taxonomy); Satô 1983: 36 (taxonomy); 1985a: 61 (descr., faunistics); Balke & Hendrich, 1995: 44 (faunistics, ecology); Hendrich et al. 2004: 118 (faunistics, ecology); Sheth et al. 2018: 257 (taxonomy); Hendrich et al., 2019: 122 (faunistics, ecology); Nilsson & Hájek, 2022: 61 (Catalog); Jiang et al., 2022: 272 (descr., faunistics).

New localities (27 exs): BALI_NS_2016_34: 1 ex., Badung, Sedang Village, Abiansemal, 120 m, -8,5642, 115,2375, 29.ii.2016, Suprayitno; BALI_NS_2016_22: 10 exs, Gianyar, Batubulan, 30 m, -8,6230, 115,2674, 16.ii.2016, Suprayitno; BALI_NS_2016_26: 1 ex., Karangasem, Jl. Amed, Desa Bunutan, 10 m, -8,34659, 115,6699, 13.iv.2016, Suprayitno; BALI_NS_2016_51: 5 exs, Gianyar, Jl. Yudistira – Batubulan, 40 m, -8,6249, 115,2762, 31.xii.2016, Suprayitno; BALI_NS_2016_27: 3 exs, Badung, Jl. Tambakbayuh, Ds Pererenan, Mengwi, 30 m, -8,6264, 115,1357, 22.vii.2016, Suprayitno; BALI_NS_2016_37: 7 exs, Klungkung, Tukad Yeh Unda River, 6 m, -8,5617, 115,4302, 5.ii.2016, Suprayitno.

Distribution. One of the most widespread *Copelatus* species. It occurs from the Indian Subcontinent, southern China and Japan, through Southeast Asia to the Northern Territory, and Queensland in Australia (Satô, 1985; Balke & Hendrich, 1995; Hendrich et al., 2004, 2019; Sheth et al., 2018) (Fig. 8E).

Biological aspects. *Copelatus tenebrosus* inhabits different kinds of standing waters in the open, exposed areas, such as pools, ponds and irrigation ditches. The species is often attracted to light and is the most common species of the genus, which can be found in deforested and cultivated areas in Southeast Asia. In Indonesia (Bali), Vietnam, Thailand, and the Philippines, it was also recorded from paddy fields (Yano et al., 1983; Hendrich & Balke, 1995) (Figs. 4D; 6E).

Note. Catalog numbers: MZB Cole 175.122–175.148.

***Copelatus uludanuensis* Hendrich & Balke, 1995 (Figure 1F)**

Copelatus uludanuensis Hendrich & Balke, 1995: 45 (orig. descr.); Nilsson & Hájek 2022: 50 (Catalog).

New locality (1 ex.): BALI_NS_2017_56: 1 ex., Tabanan, Jl. Bantas - Pajahan - Pupuan, 500 m, -8,3458, 114,9944, 26.i.2017, Suprayitno.

Distribution. Endemic to Bali (Fig. 8F).

Biological aspects. The species is most probably associated with forested places on Bali highlands. Near Bedugul, numerous type specimens have been collected in rest pools of a temporary and shaded stream filled with rotten leaves and twigs (Fig. 4E). At that spot, the species co-occured with numerous specimens of *Platynectes* (*octodecimmaculatus*-complex), a few *Copelatus sumbawensis* and single specimens of *Lacconectus punctipennis* and *Sandracottus mixtus* (Blanchard, 1843) (Balke & Hendrich, 1995).

Note. Catalog number: MZB Cole 177.311.

***Lacconectus punctipennis* Zimmermann, 1928 (Figure 1G)**

Lacconectus punctipennis Zimmermann, 1928: 387 (orig. descr.); Brancucci, 1986: 145 (revision); 2002: 29 (descr., faunistics); Hendrich & Balke, 1995: 46 (faunistics, ecology); Brancucci & Hendrich, 2005: 284 (faunistics, ecology); Nilsson & Hájek, 2022: 75 (Catalog).

Lacconectus punctipennis Zimmermann, 1929: 14 (orig. descr.) preoccupied by Zimmermann 1928: 387; objective synonym of *Lacconectus punctipennis* Zimmermann, 1928b: 387.

New localities (2 exs): BALI_NS_2016_35: 1 ex., Buleleng, Ds Selat, Sukasada, 180 m, -8,1746, 115,0669, 31.v.2016, Suprayitno; BALI_NS_2016_36: 1 ex., Karangasem, Ds Sindu wati, Sidemen, 450 m, -8,4554, 115,4646, 25.vi.2016, Suprayitno.

Distribution. Sunda Islands Sumatra, Java, Borneo (Brunei, Sabah) and Bali (Brancucci, 1986, 2002; Brancucci & Hendrich, 2005) (Fig. 9A).

Biological aspects. The species is most probably associated with the forest. The adults can be collected in very small and shallow puddles or pools filled with rotten leaves and twigs (Figs. 4F, 5A). Near Bedugul, a single specimen has been collected in a larger rest pool of a temporary stream (Balke & Hendrich, 1995).

Note. Catalog numbers: MZB Cole 175.149–174.150.

Subfamily Hydroporinae Aubé

***Agnoshydrus barong* (Hendrich, Balke & Wewalka, 1995) (Figure 1H)**

Allopachria barong Hendrich, Balke & Wewalka in Hendrich & Balke, 1995: 38 (orig. descr.).

Agnoshydrus barong (Hendrich, Balke & Wewalka, 1995): Wewalka, 2000: 126 (n. comb.); Nilsson & Hájek, 2022: 195 (Catalog).

New localities (14 exs): BALI_NS_2017_64: 1 ex., Karangasem, Jl. Gegelang - Manggis, 150 m, -8,4832, 115,4895, 24.viii.2017, Suprayitno; BALI_NS_2021_123: 2 exs, Buleleng, Kayuputih - Kec. Banjar, 400 m, -8,2661, 115,0236, 18.ix.2021, Suprayitno; BALI_NS_2021_126: 5 exs, Buleleng, Desa Gitgit - Kec. Sukasada, 860 m, -8,2082, 115,1371, 24.ix.2021, Suprayitno; BALI_NS_2021_128: 6 exs, Karangasem, Jl. Gegelang - Manggis, 150 m, -8,4832, 115,4895, 9.ix.2021, Suprayitno.

Distribution. Endemic to Bali (Fig. 9B).

Biological aspects. The first specimens of this rarely collected species were found by digging in volcanic soil gravel beside a shaded and permanent stream with clear water among numerous specimens of *Allopachria quadripustulata* (Hendrich & Balke, 1995). This habitat in Monkey Forest Ubud has been strongly degraded by wastewater from the adjacent tourist industry. Subsequently, additional specimens were collected under similar circumstances, by digging into the rocky / gravelly ground at the edge of small creeks (Figs. 5B, C).

Note. Catalog number for the specimen from BALI_NS_2017_64: MZB Cole 175.151, other specimens in Suprayitno's collection in Bali.

***Allopachria quadripustulata* Zimmermann, 1924 (Figures 1I & 2D)**

Allopachria quadripustulata Zimmermann, 1924: 195 (orig. descr.); Hendrich & Balke, 1995: 41 (redescr., faunistics); Wewalka 2000: 101 (descr., revision); Suprayitno et al., 2017: 11 (faunistics, ecology); Nilsson & Hájek, 2022: 197 (Catalog).

New localities (33 exs): BALI_NS_2016_09: 1 ex., Karangasem, Manggis, 40 m, -8,484924, 115,528523, 10.ix.2016, Suprayitno; BALI_NS_2016_25: 1 ex., Bangli, Ds. Penida Kelod - Tembuku, Tukad Cepung Waterfall, 500 m, -8,4401, 115,3869, 20.ix.2016, Suprayitno; BALI_NS_2018_68: 1 ex., Karangasem, Jl. Gegelang - Manggis, 450 m, -8,4832, 115,4895, 16.x.2018, Suprayitno; BALI_NS_2020_70: 5 exs, Tabanan, Jl. Raya Pupuan, Sanda - Pupuan, 530 m, -8,3630, 115,0342, 7.vii.2020, Suprayitno; BALI_NS_2020_80: 1 ex., Jembrana, Berangbang - Negara, 220 m, -8,2902, 114,6192, 7.viii.2020, Suprayitno; BALI_NS_2021_110: 1 ex., Tabanan, Pajahan - Pupuan, 500 m, -8,3512, 114,9956, 30.v.2021, Suprayitno; BALI_NS_2021_111: 1 ex., Karangasem, Jl. Gegelang - Manggis, 450 m, -8,4832, 115,4895, 5.vi.2021, Suprayitno; BALI_NS_2021_118: 18 exs, Tabanan, Pajahan - Pupuan, 480 m, -8,3513, 114,9939, 7.ix.2021, Suprayitno; BALI_NS_2021_120: 2 exs, Tabanan, Pajahan - Pupuan, 500 m, -8,3471, 114,9945, Suprayitno; BALI_NS_2021_132: 2 exs, Badung, Petang - Badung, 500 m, -8,3801, 115,2136, Suprayitno.

Distribution. Indonesia: Sumatra, Siberut, Bali, Flores (Hendrich & Balke, 1995; Wewalka, 2000; Suprayitno et al., 2017) (Fig. 9C).

Biological aspects. In the Monkey Forest of Ubud, specimens were collected in floating mats of roots in a shaded and permanent stream with clear water. At that time, the species was

collected together with three species of *Neptosternus* Sharp, 1882 and *Agnoshydrus barong* (Hendrich & Balke, 1995). This site was revisited by Suprayitno several times but without beetle observations which might be due to heavy pollution of the stream. A similar habitat was encountered in Manggis at locality BALI_NS_2016_09 (Suprayitno et al., 2017), as well as in the new localities provided here (Figs. 5B, C).

Note. All *Allopachria quadripustulata* specimens in Suprayitno's collection in Bali.

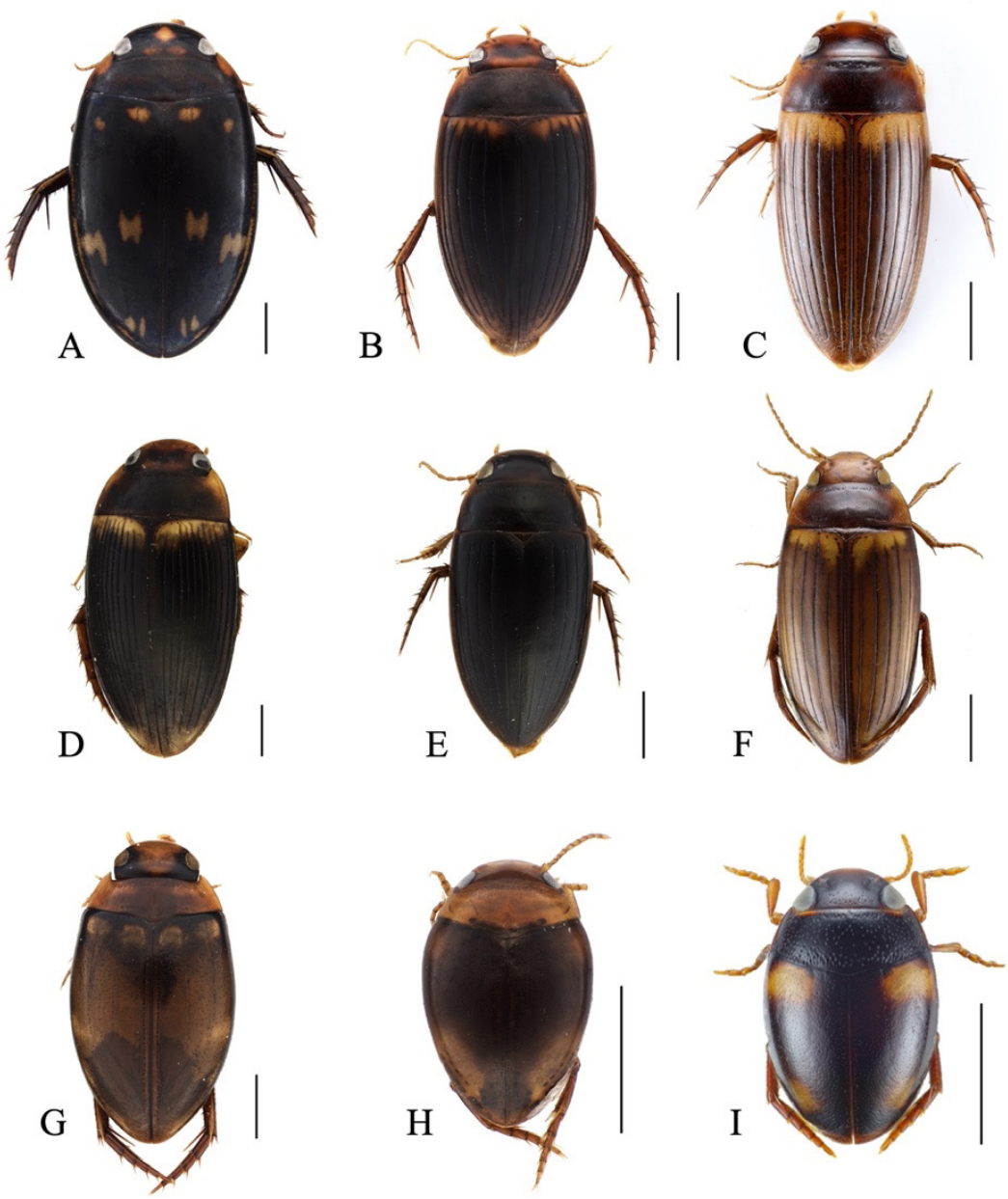

Figure 1. A: *Platynectes* sp.; **B**: *Copelatus oblitus* Sharp, 1882; **C**: *Copelatus regimbarti* Branden, 1885; **D**: *Copelatus sumbawensis* Régimbart, 1899; **E**: *Copelatus tenebrosus* Régimbart, 1880; **F**: *Copelatus uludanuensis* Hendrich & Balke, 1995; **G**: *Lacconectus punctipennis* Zimmermann, 1928; **H**: *Agnoshydrus barong* (Hendrich, Balke & Wewalka, 1995); **I**: *Allopachria quadripustulata* Zimmermann, 1924. Scale bars = 1 mm.

***Hydroglyphus laeticulus* (Sharp, 1882) (Figures 2A, B, 3A)**

Bidessus laeticulus Sharp, 1882: 354 (orig. descr.).

Hydroglyphus laeticulus Sharp, 1882: Biström, 1988: 14 (n. comb.); Nilsson & Hájek, 2022: 115 (Catalog).

New localities (170 exs): 1 ex. BALI_NS_2016_46: Denpasar, Jl. Pantai Serangan 2, 10 m, -8,7378, 115,2429, 12.xii.2016, Suprayitno; BALI_NS_2017_63: 58 exs, Karangasem, Jl. Melasti, Purwakerti, Abang, 50 m, -8,3303, 115,6375, 11.iv.2017, Suprayitno; BALI_NS_2022_160: 111 exs, Karangasem, Jl. Melasti, Purwakerti, Abang, 50 m, -8,3303, 115,6375, 27.i.2022, Suprayitno.

Distribution. It is a little-known, yet highly characteristic species, which has so far been only reported based on the type material from Thailand (Bangkok) and Indonesia (Sulawesi: Makassar) (see Sharp, 1882) (Fig. 9D). **First record from Bali.**

Biological aspects. In Bali, the species was found on open land with water from the rain and a lot of small stones, some grass, very close to the black sand beach in the direction to Lombok Island / Bali Straight. Possibly slightly brackish water. In this locality, there is no freshwater in the ground, so local villagers rely on water from a pipeline (Figs. 5E, F, 6A, B).

Note. Catalog numbers for specimens from BALI_NS_2017_63: MZB Cole 175.152–175.209. Specimens from BALI_NS_2022_160 still in collection Suprayitno in Bali.

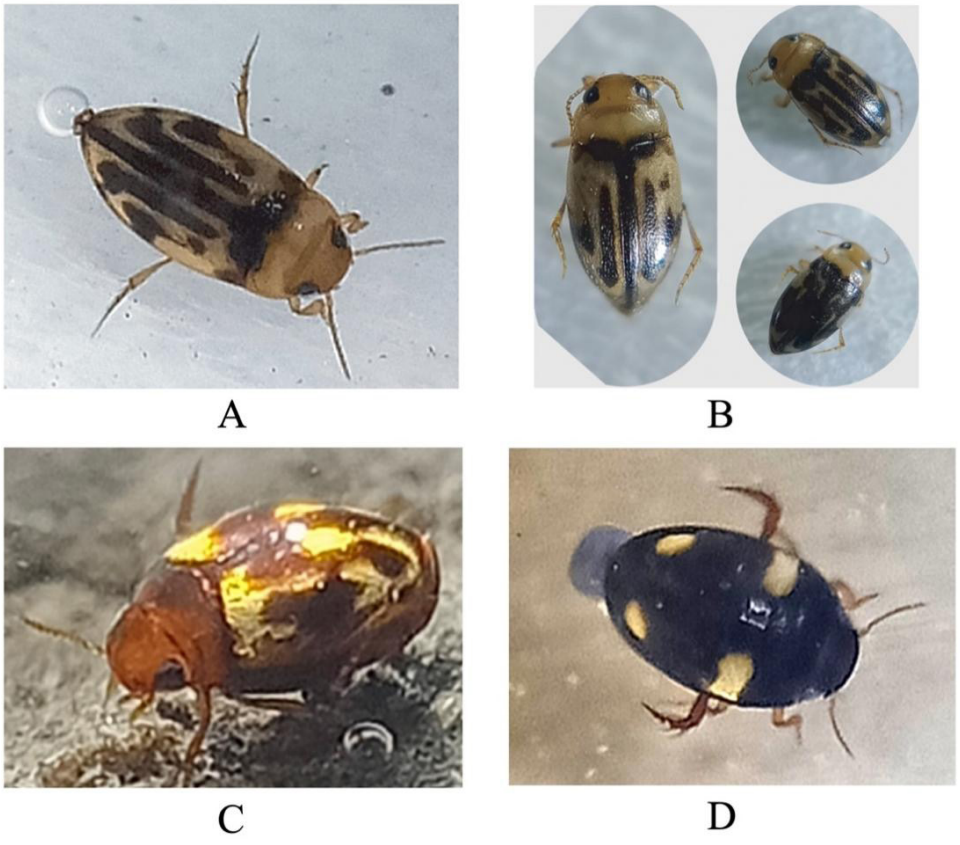

Figure 2. A, B: *Hydroglyphus laeticulus* (Sharp, 1882); C: *Microdytes elgae* Hendrich, Balke & Wewalka, 1995; **D**: *Allopachria quadripustulata* Zimmermann, 1924 from Bali. Life specimens, fotos taken by Suprayitno with his mobile phone equipped with clip on macro lens.

***Hyphydrus lyratus lyratus* Swartz, 1808 (Figure 3B)**

Hyphydrus lyratus Swartz in Schönherr, 1808: 29 (orig. descr.).

Hyphydrus lyratus lyratus Swartz, 1808: Biström, 1982: 21 (revision); Hendrich & Balke, 1995: 37 (faunistics, ecology); Hendrich et al., 2004: 116 (faunistics, ecology); Nilsson & Hájek, 2021: 204 (Catalog).

New localities (15 exs): BALI_NS_2016_37: 6 exs, Klungkung, Tukad Yeh Unda River, 6 m, -8,5617, 115,4302, 5.ii.2016, Suprayitno; BALI_NS_2016_33: 4 exs, Denpasar, Jl. Pantai Serangan, Serangan, 10 m, -8,7321, 115,2354, 7.iii.2016, Suprayitno; BALI_NS_2017_63: 5 exs, Karangasem, Jl. Melasti, Purwakerti, Abang, -8,3303, 115,6375, 11.iv.2017, Suprayitno.

Distribution. Widespread in the Oriental and Australian zoogeographical regions. The nominotypical subspecies occurs from southern China through continental Southeast Asia and the Indonesian Archipelago to the northern part of Australia and Fiji (Biström, 1982) (Fig. 9E).

Biological aspects. This is a eurytopic species which can be collected in all kinds of open standing waters like paddy fields, irrigation ditches, fish ponds or flooded meadows (Figs. 4D; 5E, F). It is frequently collected in rest pools of temporary rivers and streams, too (Hendrich, pers. obs. in Australia). In Bali, at BALI_NS_2016_33, was collected in a cattle watering pond (Fig. 6C).

Note. Catalog numbers: MZB Cole 175.210–175.224.

***Microdytes elgae* Hendrich, Balke & Wewalka, 1995 (Figures 2C, 3C)**

Microdytes elgae Hendrich, Balke & Wewalka in Hendrich & Balke, 1995: 42 (orig. descr.); Wewalka, 1997: 23 (revision); Hendrich et al., 2004: 116 (faunistics, ecology); Miller & Wewalka, 2010: 134 (faunistics); Suprayitno et al., 2017: 32 (faunistics, ecology); Nilsson & Hájek, 2022: 210 (Catalog).

New localities (56 exs): BALI_NS_2017_57: 21 exs, Tabanan, Ds Pajahan, Pupuan, 530 m, -8,3460, 114,9974, 26.1.2017, Suprayitno; BALI_NS_2020_71: 5 exs, Buleleng, unnamed road, Sepang - Busungbiu, 600 m, -8,3041, 114,9202, 8.vii.2020, Suprayitno; BALI_NS_2016_07: 7exs, Tabanan, Jl. Raya Apuan Senganan, Baturiti, -8,3620, 115,1801, 4.ix.2016, Suprayitno; BALI_NS_2017_56: 23 exs, Tabanan, Jl. Bantas-Pajahan-Pupuhan, -8,3458, 114,9944, 26.i.2017, Suprayitno.

Distribution. Widespread in the Oriental Region from Bhutan and India Arunachal Pradesh, through Peninsular Malaysia and Singapore, to the Sunda Islands Bali, Lombok and Kalimantan (Wewalka, 1997; Hendrich et al., 2004; Miller & Wewalka, 2010) (Fig. 9F).

Biological aspects. It occurs in helocrenes and in rest or side pools of temporary or permanent, small shaded springs and low order streams; sometimes in dense root mats in the current of first order streams (Figs. 4E, 6D). The beetles usually hide beneath leaves and in the gravel under only a very thin film of water. They can be collected by using a small kitchen strainer or a forceps. Occasionally, it is found also in larger rest pools of springs rich in rotten leaves and debris (Hendrich et al., 2004; Suprayitno et al., 2017).

Note. Catalog numbers: MZB Cole 175.225 – 175.254.

Subfamily Laccophilinae Gistel

Laccophilus javanicus Régimbart, 1899 (Figure 3D)

Laccophilus javanicus Régimbart, 1899: 266 (orig. descr.); Brancucci, 1983: 252 (revision); Hendrich & Balke, 1995: 42 (faunistics, ecology); Hájek & Brancucci, 2015: 319 (revision); Nilsson & Hájek, 2022: 226 (Catalog).

New localities (60 exs): BALI_NS_2016_13: 6 exs, Singaraja, Singaraja, 460 m, -8,1928, 115,0664, 29.ix.2016, Suprayitno; BALI_NS_2016_16: 1 ex., Karangasem, Jl. Karangasem-Seraya, 350 m, -8,4107, 115,6815, 15.vi.2016, Suprayitno; BALI_NS_2016_20: 9 exs, Karangasem, Jl. Karangasem-Seraya, 170 m, -8,4177, 115,6885, 16.vi.2016, Suprayitno; BALI_NS_2016_35: 10 exs, Buleleng, Ds Selat, Sukasada, 180 m, -8,1746, 115,0669, 31.v.2016, Suprayitno; BALI_NS_2016_36: 16 exs, Karangasem, Ds Sindu wati, Sidemen, 450 m, -8,4554, 115,4646, 25.vi.2016, Suprayitno; BALI_NS_2016_61: 4 exs, Karangasem, unnamed road - Bunutan-Abang, 100 m, -8,3604, 115,6643, 14.iv.2016, Suprayitno; BALI_NS_2017_57: 14 exs, Tabanan, Ds Pajahan, Pupuan, 530 m, -8,3460, 114,9974, 26.i.2017, Suprayitno.

Distribution. Endemic to Java, Bali and Lombok (Brancucci, 1983; Hájek & Brancucci, 2015) (Fig. 10A).

Biological aspects. It is a stream associated species. The beetles were always found in clear lower order streams or their rest pools, shaded to some degree, usually with larger rocks and bottom of smaller stones and gravel, and often with layers of leaves on the bottom where the beetles like to hide (Figs. 4C, F; 5A; 6D). When swimming, the beetles are easy to spot due to their coloration.

Note. Catalog numbers: MZB Cole 175.255–175.313.

Laccophilus parvulus parvulus Aubé, 1838 (Figure 3E)

Laccophilus parvulus Aubé, 1838: 429 (orig. descr.).

Laccophilus parvulus parvulus Aubé, 1838: Brancucci, 1983: 355 (revision); Hendrich & Balke, 1995: 42 (faunistics, ecology); Hendrich et al., 2004: 117 (faunistics, ecology); Nilsson & Hájek 2022: 229 (Catalog).

New localities (107 exs): BALI_NS_2016_22: 4 exs, Gianyar, Batubulan, 30 m, -8,6230, 115,2674, 16.ii.2016, Suprayitno; BALI_NS_2016_27: 11 exs, Badung, Jl. Tambakbayuh, Ds Pererenan, Mengwi, 30 m, -8,6264, 115,1357, 22.vii.2016, Suprayitno; BALI_NS_2016_29: 13 exs, Badung, Jl. Raya Semat, Tibubeneng, Kuta Utara, 20 m, -8,6550, 115,1408, 19.vii.2016, Suprayitno; BALI_NS_2016_34: 2 exs, Badung, Sedang Village, Abiansemal, 120 m, -8,5642, 115,2375, 29.ii.2016, Suprayitno; BALI_NS_2016_37: 68 exs, Klungkung, Tukad Yeh Unda River, 6 m, -8,5617, 115,4302, 5.ii.2016, Suprayitno; BALI_NS_2016_39: 1 ex., Karangasem, Jl. Raya YehPoh - Manggis, 50 m, -8,4861, 115,5164, 5.vi.2016, Suprayitno; BALI_NS_2016_51: 5 exs, Gianyar, Jl. Yudistira - Batubulan, 40 m, -8,6249, 115,2762, 31.xii.2016, Suprayitno; BALI_NS_2017_55: 2 ex., Gianyar, Jl. Katiklantang, Desa Singakerta, Ubud, 200 m, -8,5151, 115,2489, 20.i.2017, Suprayitno; BALI_NS_2017_63: 1 ex., Karangasem, Jl. Melasti, Purwakerti, Abang, 50 m, -8,3303, 115,6375, 11.iv.2017, Suprayitno.

Distribution. Widespread in the Oriental Region. The nominotypical subspecies occurs on the Indian Subcontinent, the Malayan Peninsula, Indonesia and the Philippines (Brancucci 1983) (Fig. 10B).

Biological aspects. This is a eurytopic species which can be collected in all kinds of open standing waters like paddy fields, irrigation ditches or fish ponds. During the dry season, it can be found in rest pools of temporary rivers and streams, too. It is also frequently attracted to light sources (Figs. 4D; 5E, F; 6E; 7A).

Note. Catalog numbers: MZB Cole 175.346–175.450.

***Laccophilus ritsemae* Régimbart, 1880 (Figure 3F)**

Laccophilus ritsemae Régimbart, 1880: 209 (orig. descr.); Brancucci, 1983: 335 (revision); Hendrich & Balke, 1995: 42 (faunistics, ecology); Hendrich et al., 2004: 117 (faunistics, ecology); Nilsson & Hájek, 2022: 231 (Catalog).

New localities (34 exx): BALI_NS_2016_27: 15 exs, Badung, Jl. Tambakbayuh, Ds Pererenan, Mengwi, 30 m, -8,6264, 115,1357, 22.vii.2016, Suprayitno; BALI_NS_2016_34: 2 exs, Badung, Sedang Village, Abiansemal, 120 m, -8,564203, 115,237549, 29.ii.2016, Suprayitno; BALI_NS_2016_37: 17 exs, Klungkung, Tukad Yeh Unda River, 6 m, -8,5617, 115,4302, 5.ii.2016, Suprayitno.

Distribution. Andaman and Nicobar Islands; Sumatra, Java, Bali, Borneo, Philippines, possibly also Sulawesi and New Guinea (Brancucci, 1983).

Biological aspects. This is a eurytopic species which can be collected in all kinds of open standing waters like paddy fields, irrigation ditches or fish ponds (Figs. 4D; 6E). During the dry season it can be found in rest pools of temporary rivers and streams, too.

Note. Catalog number: MZB Cole 175.314–175.345.

***Laccophilus sharpi* Régimbart, 1889 (Figure 3G)**

Laccophilus sharpi Régimbart, 1889: 151 (orig. descr.); Brancucci, 1983: 347 (revision); Hendrich & Balke, 1995: 43 (faunistics, ecology); Hájek, 2003: 119 (faunistics); Shaverdo et al., 2021: 192 (faunistics); Nilsson & Hájek, 2022: 231 (Catalog).

New localities (71 exs): BALI_NS_2016_22: 6 exs, Gianyar, Batubulan, 30 m, -8,6230, 115,2674, 16.ii.2016, Suprayitno; BALI_NS_2016_26: 2 exs, Karangasem, Jl. Amed, Desa Bunutan, 10 m, -8,346592, 115,669913, 13.iv.2016, Suprayitno; BALI_NS_2016_37: 57 exs, Klungkung, Tukad Yeh Unda River, 6 m, -8,5617, 115,4302, 5.ii.2016, Suprayitno; BALI_NS_2016_51: 1 ex., Gianyar, Jl. Yudistira - Batubulan, 40 m, -8,6249, 115,2762, 31.xii.2016, Suprayitno; BALI_NS_2017_55: 3 exs, Gianyar, Jl. Katiklantang - Desa Singakerta - Ubud, 200 m, -8,5151, 115,2489, 20.i.2017, Suprayitno; BALI_NS_2017_59: 1 ex., Karangasem, Jl. Karangasem - Seraya, 10 m, -8,3677, 115,7014, 18.ii.2017, Suprayitno; BALI_NS_2017_63: 1 ex., Karangasem, Jl. Melasti, Purwakerti, Abang, 50 m, -8,3303, 115,6375, 11.iv.2017, Suprayitno.

Distribution. Widespread in the subtropical and tropical areas of Asia and Australia; it is recorded from the Arabian Peninsula to Northern Territory and Queensland in Australia (Brancucci, 1983; Shaverdo et al., 2021) (Fig. 10C).

Biological aspects. This is a eurytopic species which can be collected in all kinds of open standing waters like paddy fields, irrigation ditches or fish ponds. During the dry season it can be found in rest pools of temporary rivers and streams, too (Figs. 4D; 5E, F; 6F; 7A). It is also frequently attracted to light sources.

Note. 69 exs deposited in MZB: MZB Cole 175.451–175.519.

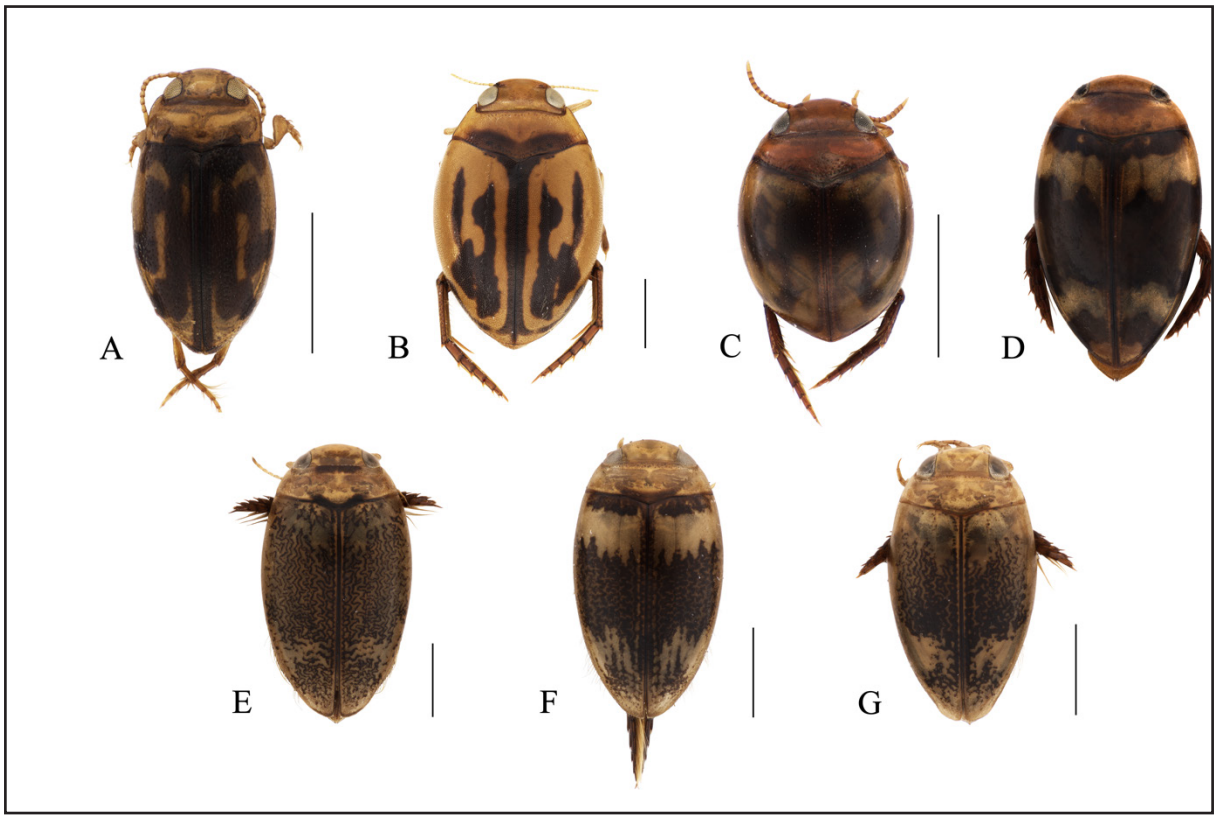

Figure 3. A: *Hydroglyphus laeticulus* (Sharp, 1882); **B**: *Hyphydrus lyratus lyratus* Swartz, 1808; **C**: *Microdytes elgae* Hendrich, Balke & Wewalka, 1995; **D**: *Laccophilus javanicus* Régimbart, 1899; **E**: *Laccophilus parvulus parvulus* Aubé, 1838; **F**: *Laccophilus ritsemae* Régimbart, 1880; **G**: *Laccophilus sharpi* Régimbart, 1889. Scale bars = 1 mm.

Figure 4. Collecting sites in Bali. A: BALI_NS_2016_14; B: BALI_NS_2016_14; C: BALI_NS_2016_20; D: BALI_NS_2016_37; E: BALI_NS_2017_56; F: BALI_NS_2016_36.

Figure 5. Collecting sites in Bali. A: BALI_NS_2016_36; B: BALI_NS_2021_128; C: BALI_NS_2021_128; D: BALI_NS_2021_118; E: BALI_NS_2017_63; F: BALI_NS_2017_63.

Figure 6. Collecting sites in Bali. A: BALI_NS_2016_33; B: BALI_NS_2017_57; C: BALI_NS_2016_27; D: BALI_NS_2017_59.

Figure 7. Collecting site in Bali. A: BALI_NS_2017_55.

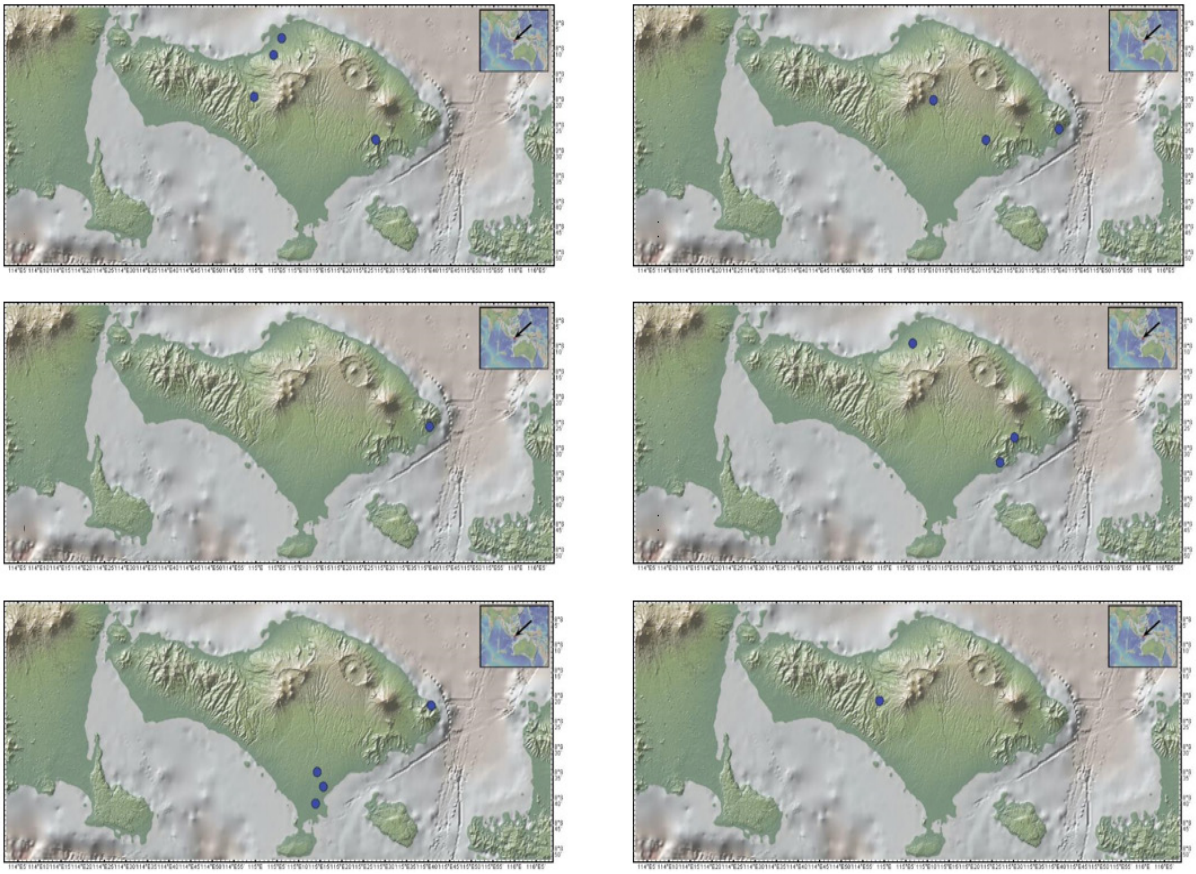

Figure 8. Distribution map of A. *Platynectes* sp.; B. *Copelatus oblitus*; C. *Copelatus regimbarti* ; D. *Copelatus sumbawensis*; E. *Copelatus tenebrosus* ; F. *Copelatus uludanuensis*. Blue dots represent distribution of the species.

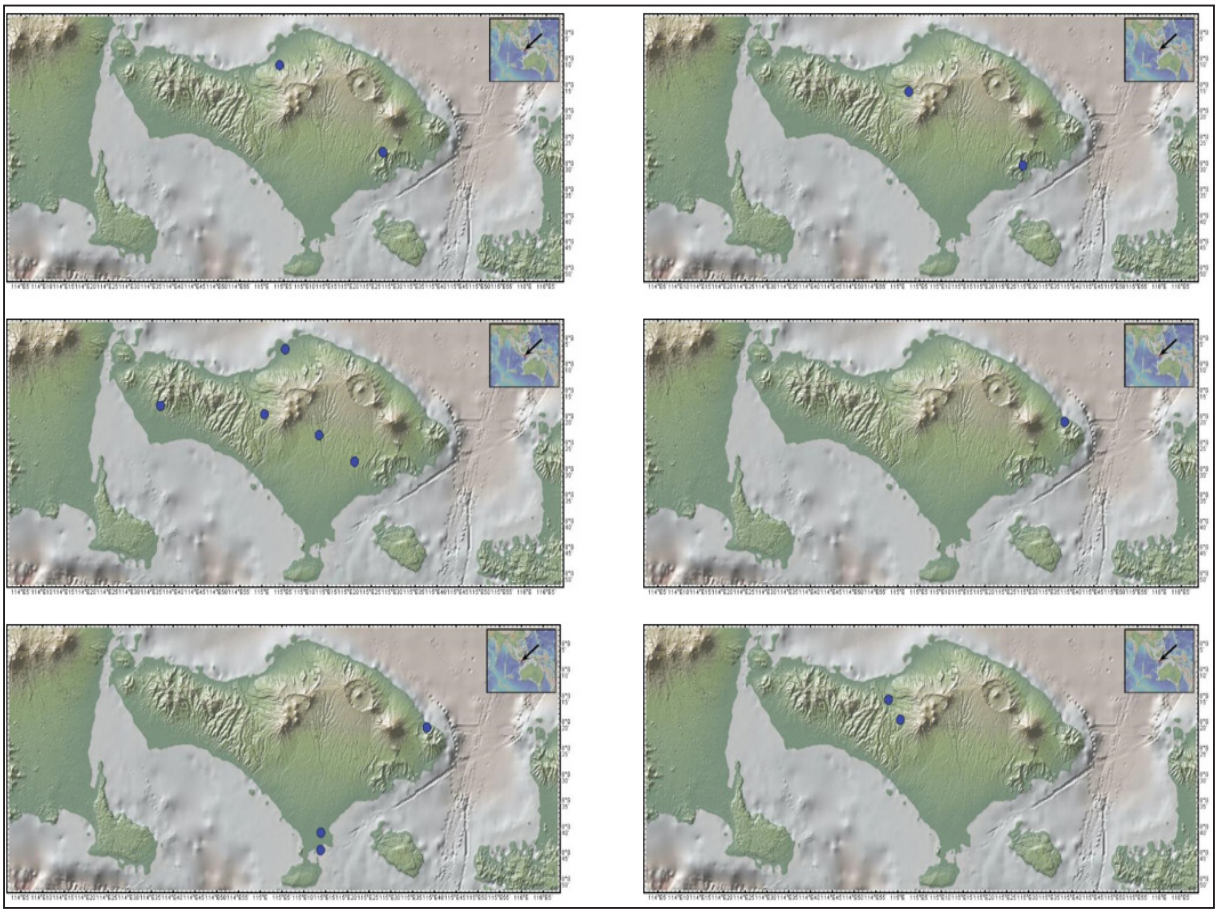

Figure 9. Distribution map of A. *Lacconectus punctipennis*; B. *Agnoshydrus barong*; C. *Allopachria quadripustulata*; D. *Hydroglyphus laeticulus*; E. *Hyphydrus lyratus*; F. *Microdytes elgae*. Blue dots represent distribution of the species.

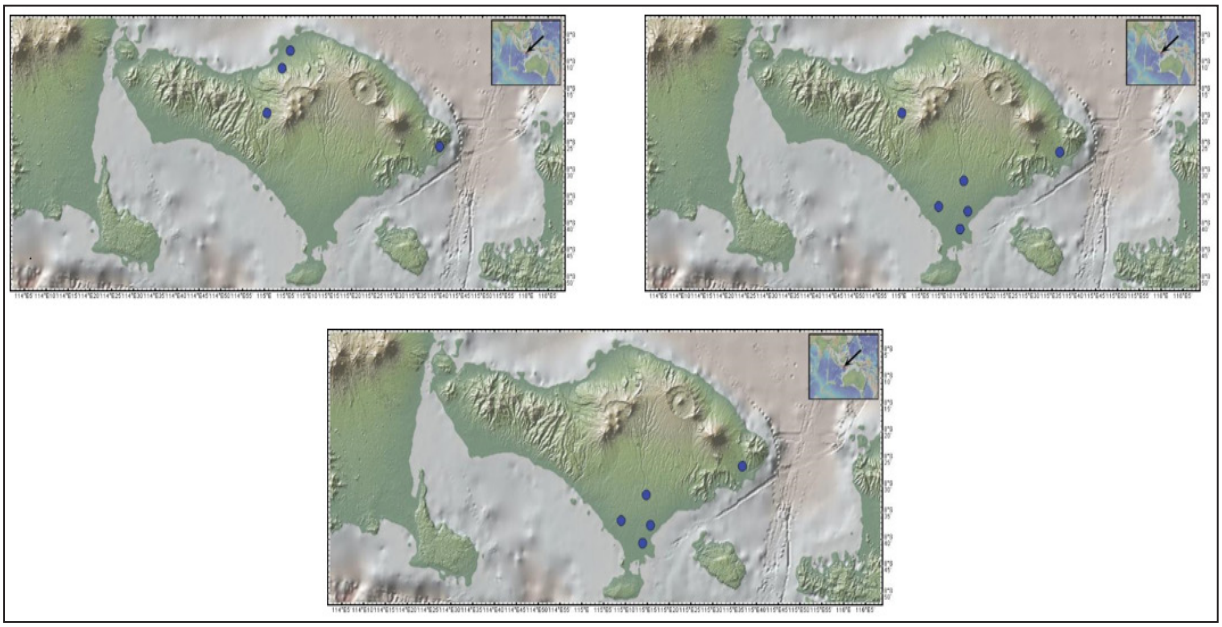

Figure 10. Distribution map of A. *Laccophilus javanicus*; B. *Laccophilus parvulus*; C. *Laccophilus sharpi*. Blue dots represent distribution of the species.

DISCUSSION

Suprayitno et al. (2017) provided faunistic data for nine Dytiscidae species from the island of Bali: the Hydroporinae species *Allopachria quadripustulata* and *Microdytes elgae*, as well as the Dytiscinae species *Cybister tripunctatus temnenkii*, *Eretes griseus*, *Hydaticus conjungens*, *Hydaticus fabricii*, *Hydaticus luczonicus*, *Hydaticus pacificus,* and *Sandracottus mixtus*. Here we add new data for *Allopachria quadripustulata* and *Microdytes elgae* as well as 14 other species of Laccophilinae, Copelatinae, and Agabinae. Altogether, these two papers provided new data on 23 species from Bali, including four species that have never been reported from Bali before (Hendrich & Balke, 1995; Suprayitno et al., 2017). The list of Balinese Dytiscidae (see appendix) now contains 38 species. As far as we can tell, based on the current state of specimen sorting and mounting, Suprayitno succeeded in collecting all of these except for three species (see appendix). For 12 species, there are new collecting data, but not all specimens have been mounted and identified. It will be the task for a future update, including the hundreds of specimens newly collected during the writing of this manuscript.

Our study here illustrates the high value of citizen science research, highlighting its main advantages: a cost-effective way of gathering data because citizen science can get relatively easy as well as frequent access to the collecting sites and have good knowledge of local conditions. Therefore, citizen science activities provide a mutual collaboration between highly science enthusiastic people and professional researchers that, on the other hand, are facing difficulties accessing local remote areas. Besides, citizen science can provide positive feedback to the enthusiast, not only that they can gain more knowledge but also that their work and hobby could be valued by science and further have an impact on education or conservation.

Diving beetles have been found in all limnic habitats on the island, from weakly salty shallow waters near the coast up to the rainforests of the mountain regions and in the crater lakes of the volcanoes. Large parts of the west of the island are still unexplored, so an increase in species number is to be expected. Many representatives of diving beetles are also endangered in Bali, as their habitats are increasingly restricted by human activities (deforestation, littering of rivers, ditches, swamps, pesticides, and insecticides in breeding waters). However, in this context, citizen science demonstrated its other great importance: it proved that the endemic *Agnoshydrus barong*, although probably gone extinct from its type locality in the Monkey Forest in Ubud, is still occurring upstream in Bali inland, and thus provided important data for its potential protection. On the other hand, two additional Balinese endemics, *Laccophilus baturitiensis* and *Neptosternus winkelmanni* remain a quest for future citizen science research – they are only known from the locus typicus on Bali and have not been found since then. The fourth species described originally from Bali, *Microdytes elgae*, is now known from numerous localities in Southeast Asia (Hendrich et al., 2004, and unpublished data).

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Appendix – Annotated List of Dytiscidae recorded from Bali

Underlined are treated herein or Suprayitno et al. (2017). Bold are species not found on Bali again to date. Asterisk * marks species which are endemic to Bali. ☺ Denotes species for which we here presented new data.

Agabinae

Platynectes sp. (*octodecimmaculatus*-complex) ☺

Copelatinae

Copelatus oblitus Sharp, 1882 ☺

Copelatus regimbarti Branden, 1884 ☺

Copelatus sumbawensis Régimbart, 1899 ☺

Copelatus tenebrosus Régimbart, 1880 ☺

Copelatus uludanuensis Hendrich & Balke, 1995* ☺

Lacconectus punctipennis Zimmermann, 1928 ☺

Cybistrinae

Cybister tripunctatus temnenkii Aubé, 1838

Dytiscinae

Eretes griseus (Fabricius, 1781)

Hydaticus conjungens Régimbart, 1899

Hydaticus fabricii (W.S. Macleay, 1825)

Hydaticus luczonicus Aubé, 1838

Hydaticus pacificus pacificus Aubé, 1838

Sandracottus hunteri (Crotch, 1872)

Hydroporinae

Agnoshydrus barong (Hendrich, Balke & Wewalka, 1995)* ☺

Allopachria quadripustulata Zimmermann, 1924 ☺

Clypeodytes sp.

Hydroglyphus baeri (Régimbart, 1895)

Hydroglyphus inconstans (Régimbart, 1892)

Hydroglyphus laeticulus (Sharp, 1882) ☺

Hydrovatus acuminatus Motschulsky, 1859

Hydrovatus fasciatus Sharp, 1882

Hydrovatus obtusus Motschulsky, 1855

Hydrovatus pudicus (Clark, 1863)

Hydrovatus seminarius Motschulsky, 1859

Hydrovatus subrotundatus Motschulsky, 1859

Hyphydrus lyratus lyratus Swartz, 1808 ☺

Leiodytes javanus (Régimbart, 1899)

Microdytes elgae Hendrich, Balke & Wewalka, 1995 ☺

Uvarus sp.

Laccophilinae

Laccophilus baturitiensis* Hendrich & Balke, 1995

Laccophilus javanicus Régimbart, 1899 ☺

Laccophilus parvulus parvulus Aubé, 1838 ☺

Laccophilus ritsemae Régimbart, 1880 ☺

Laccophilus sharpi Régimbart, 1889 ☺

***Neptosternus corporaali* Zimmermann, 1924**

Neptosternus hydaticoides Régimbart, 1877

Neptosternus winkelmanni* Hendrich & Balke, 1997