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New Faunal Records from A World Heritage Site in Danger: Rennell Island, Solomon Islands[1]

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Abstract: Remote oceanic islands have high potential to harbor unique fauna and flora, but opportunities to conduct in-depth biotic surveys are often limited. Furthermore, underrepresentation of existing biodiversity in the literature has the potential to detract from conservation planning and action. Between 18 and 29 October 2018, we surveyed the terrestrial vertebrates of East Rennell, a UNESCO World Heritage Site in Solomon Islands. We documented 56 species, including 15 squamates, 13 mammals, and 38 birds, and present four new vertebrate records for the island: Stephan's emerald dove (*Chalcophaps stephani*), Maluku myotis (*Myotis moluccarum*), littoral skink (*Emoia atrocostata*) and brahminy blindsnake (*Indotyphlops braminus*). East Rennell was designated a World Heritage site for its significant on-going ecological and biological processes, and importance for the study of island biogeography. The new records presented here provide evidence that continued field studies combined with DNA analysis will continue to uncover even greater endemic biodiversity. Rennell is currently experiencing major habitat destruction in parts of the island that are not under World Heritage protection, and we anticipate collateral damage will likely extend into protected areas. Our survey also underscores the incredible vertebrate biodiversity that stands to be lost unless conservation actions and local community needs are intertwined to promote beneficial outcomes on both fronts.

Keywords: biodiversity, biogeography, bird, conservation, habitat destruction, mammal, Rennell, squamate, vertebrate

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Solomon Islands represent one of the most geologically complex archipelagos on Earth, consisting of a double chain of six main islands surrounded by nearly a thousand smaller islands, all of which are purely oceanic in origin. This geologic and geographic complexity is reflected in the archipelago's biological diversity, which forms part of the East Melanesian Islands Biodiversity Hotspot (https://www.cepf.net/our-work/biodiversity-hotspots/east-melanesian-islands). This hotspot comprises high species-level diversity for both plants and animals, many of which are found nowhere else in the world (Mittermeier et al. 2004). The archipelago's unique geological and biological diversity have formed the foundation of numerous theoretical concepts in evolutionary biology and island biogeography (e.g., Mayr 1942, Wilson 1961, MacArthur and Wilson 1967, Mayr and Diamond 2001), many of which provide a framework for empirical hypothesis testing to this day (e.g., Manthey et al. 2020, Richmond et al. 2021).

Rennell Island is situated to the southwest of the main Solomon Islands chain, 181 km south of Guadalcanal Island and 168 km southwest of Makira Island (Wolff 1969; Figure 1). It is the largest uplifted coral atoll in the world, estimated to have been raised at the end of the Pliocene, ca. 2.5 million years ago (Grover 1958, Wolff 1969). Rennell harbors the 155 km^2 brackish Lake Te-Nggano (also referred to in the literature as Tegano, Tungano, and Tengano), a remnant of the atoll's former lagoon that now represents the largest enclosed waterbody in the Pacific (Wolff 1969). The island supports a high number of endemic species, including 10 plants, seven land snails, one bat, one snake, and as many as four lizards (McCoy 2006). Among the island's avifauna, 54% of birds are endemic at the species or subspecies level (37 breeding land and freshwater bird species, six endemic species, 14 endemic subspecies) (Filardi et al. 1999). Lake Te-Nggano has played an important evolutionary role in producing biological oddities such as an endemic sea snake (*Laticauda crockeri*) and a cohort of Australasian waterbirds unique within Solomon Islands, some of which are endemic at the subspecies level (e.g., Australian White Ibis *Threskiornis molucca pygmaeus* and Australasian Grebe *Tachybaptus novaehollandiae rennellianus*).

In 1998, approximately one third of the island (encompassing Lake Te-Nggano and surrounding land, and a marine zone extending 3 km offshore) was designated as a United Nations Scientific and Cultural Organisation (UNESCO) World Heritage Site. This designation was in recognition of significant on-going ecological and biological processes, and importance of the site for the study of island biogeography. It was also the first site added under customary ownership and management. Western scientific study of the island commenced in 1906, led by Charles M. Woodford. Although Woodford was an accomplished naturalist, his visit resulted in just a single bird specimen (the type specimen of Woodford's White-eye *Woodfordia superciliosa*), and the first mention of *Threskiornis molucca* (then *Ibis strictipennis*) (North 1906, Woodford 1916). In 1927 Mr. G. A. V. Stanley was stationed on the island by Australia's University of Sydney and equipped with mammal collecting equipment by Ellis Le G. Troughton from the Australian Museum. Stanley subsequently forwarded a small collection that included the holotype of the endemic Rennell Flying Fox (*Pteropus rennelli*) (Troughton 1929). The Whitney South Sea Expedition made two visits in 1928 and 1930, during which the first thorough museum collections of birds—also including some mammals—were made (Mayr 1931). Squamates were first surveyed on the America Templeton-Crocker Expedition in June 1933 (summarized by Slevin 1934), followed by Volsøe in the mid- to late 1950s (Volsøe 1956, 1958), Wolff in the mid-1960s (Wolff 1969), and Michael McCoy and colleagues in the late 1970s and early 1980s (Cogger et al. 1987, McCoy 2006). The 1950s also saw major mammal collections for the Universitetets Zoologiske Museum, Copenhagen, via the Danish Rennell Expedition led by Torben Wolff in 1951, an expedition by Mr. and Mrs. J. D. Bradley in 1953, and another led by T. Monberg in 1958 (Hill 1962, 1968). The island was visited in

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1977, 1980, and 1981 by researchers studying the systematics and venom of the endemic krait *Laticauda crockeri* (Cogger et al. 1987, Heatwole et al. 2005, Heatwole et al. 2017). Filardi et al. (1999) published their findings from ornithological surveys in 1997 and summarized interim fieldwork by Bradley and Wolff (1958), Wolff (1973), and Diamond (1984). Finally, the American Museum of Natural History also holds a small collection of insectivorous bats made by M. LeCroy in 1999.

Despite this history of biological exploration, there is still much to learn about biological diversity and levels of endemism, both on Rennell and the broader Solomon Islands. Not only are comprehensive biodiversity inventories critical for advancing and testing evolutionary hypotheses, they are also imperative for understanding the effects of anthropogenic disturbance on these unique faunas, and to lay plans to conserve and manage imperiled species and habitats. Nowhere is this more pertinent than on Rennell Island. In recent years, West Rennell has faced a barrage of perturbances that include heavy commercial logging, bauxite mining, and a marine oil spill that have substantially degraded terrestrial and marine environments (Williams 2019, Foukona 2020, Kiddle 2020). In contrast, East Rennell still hosts large tracts of intact, mature forests (Wang et al. 2018), a result of local conservation efforts and its status as a UNESCO World Heritage Site. However, advancement of a long-term management plan for East Rennell and local incentivization for preserving the site's natural environment have not progressed beyond preliminary discussions (Kiddle 2020). In 2013, East Rennell was placed on the List of World Heritage in Danger due to the threats posed by: logging; invasive species; over-exploitation of coconut crab and other marine resources; climate change; and inadequate legislation, management planning and administration of the property.

We aimed to develop a modern inventory of East Rennell's terrestrial vertebrate fauna to provide a thorough and recent update on the island's biological diversity, particularly those species that are endemic or in states of decline. Limited biological monitoring of the island, combined with threats posed by logging, bauxite mining, invasive species, over exploitation of marine resources, and climate change, provided justification for pursuing this most recent survey. Furthermore, the absence of genetic material for DNA studies suggested that Rennell's unique biodiversity has likely been underestimated and raised the possibility of the loss of species to habitat destruction before even being known to science. We postulated that indigenous vertebrate species remained to be scientifically documented on Rennell, and that recent extractive industries had potentially introduced non-indigenous species known to have negative impacts on other Indo-Pacific islands.

MATERIALS AND METHODS

We visited Rennell Island from 18 to 29 October 2018, surveying areas in the East Rennell World Heritage Site, around Te-Nggano Village on the southwestern shore of Lake Te-Nggano (Figure 1). Habitats surveyed included village gardens and secondary forests around Te-Nggano Village, mature forests south of Te-Nggano Village, and coastal areas to the south of Te-Nggano Village (Anapuli Cave and Tuhugaga Beach). During our 12 days of fieldwork, we made daily observations of mammals (Lavery), squamates (Tigulu and Richmond), and birds (DeCicco, Andersen, and Moyle). Vertebrate voucher specimens were collected and deposited at the University of Kansas Natural History Museum (KU), Lawrence, Kansas (mammals, squamates, birds), and the Museum of Southwestern Biology (MSB), Albuquerque, New Mexico (birds). All specimens, tissues and audio recordings (birds and bats) are publicly available for further scientific research in accordance with the Nagoya Protocol (https://www.cbd.int/abs/about/). Data for these specimens are openly available via museum database aggregator websites such as *iDigBio* (www.idigbio.org) and *VertNet* (www.vertnet.org), as well as directly through the KU and MSB websites.

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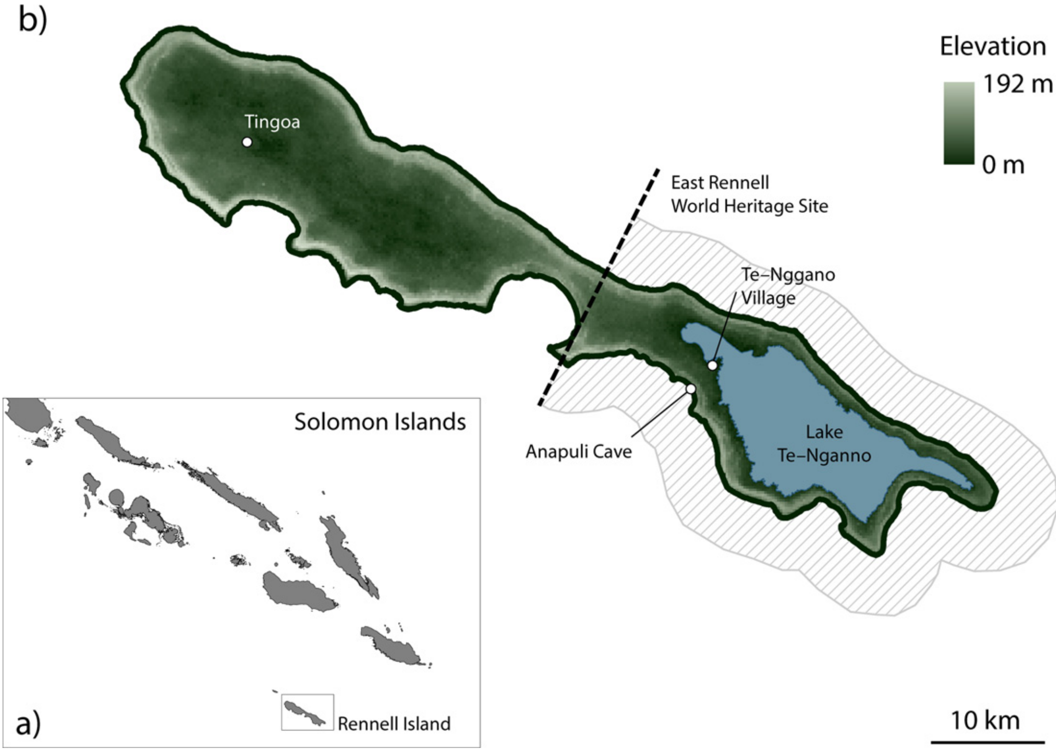

FIGURE 1. Locations of (*A*) Rennell Island and (*B*) East Rennell World Heritage Site, Lake Te-Nggano, Tingoa township, Te-Nggano Village, and Anapuli Cave.

Sampling Techniques: Birds

We documented avian diversity using observational methods (visual and auditory) and mist nets (12 × 2.6 m, either 32- or 36-mm mesh size). We made daily opportunistic audio recordings, deployed 10–20 mist nets, and compiled lists of bird species detected including relative abundance. Audio recordings (aimed at documenting characteristic bird vocalizations) were made with a Sound Devices MixPre-3 recorder and Sennheiser ME67 shotgun microphone with k6 power unit (DeCicco) and a Sound Devices MixPre-6 recorder and Telinga Pro 8 mark ii stereo parabola (Andersen). All audio recordings were archived at the Macaulay Library, Cornell University, and are accessible through the associated website (www.macaulaylibrary.org). Our observational data were archived in *eBird* and are freely available online (www.ebird.org). We used mist nets as our main method of capturing and collecting bird specimens from the variety of habitat types present at the study site. We prepared specimens as dried study skins or formalin-fixed anatomical specimens. From each specimen, we collected at least two genetic samples in the form of muscle tissue preserved in 95% ethanol. We took photographs of birds in the hand and described soft part coloration (a trait that is typically lost on dried study skins) and linked these images with each specimen through respective museum databases. If ectoparasites or endoparasites were found during specimen preparation, they were preserved in 70% ethanol, and deposited either at MSB (endoparasites) or Drexel University (ectoparasites).

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Sampling Techniques: Mammals

We surveyed Rennell's mammals using mist nets, active searches of caves, echolocation recordings, rodent traps, and spotlighting. Bats were captured at night using black 16 mm mesh, 12 m × 2.5 m nylon mist nets (Ecotone Series 1000, Sopot, Poland). Nets were set within primary forests, gardens and village environs suspended on ropes up to 20 m above the ground and spanning roads, or natural gaps, creeks or 'flyways' to maximize the number of species and individuals recorded. Surveys commenced before dusk and finished at dawn. Bats were also caught inside caves in mist nets or by handheld nets. Rodent traps were set in linear transects on the forest floor or opportunistically around villages and baited with peanut butter. We used an Anabat Walkabout (Titley Scientific, Brendale, QLD Australia) to record the echolocation calls of bats in free flight. Recordings were identified to species level using the guide prepared by Pennay and Lavery (2017). We also spotlighted for mammals when checking mist nets, and on dedicated spotlight transects. Between two and four observers scanned the forest canopy and understory on foot using LED headlamps (Led Lenser, H14R 1,000 lumens, Solingen, Germany). We preserved vouchers as wet specimens by fixing whole animals in 10% formalin and later transferring to ethanol, a tissue sample was preserved in DNA/RNA Shield (Zymo Research, Irvine, CA, USA). Ectoparasites collected from the specimens were accessioned into the collections of the Field Museum of Natural History, Chicago, USA, to be curated by Dr Carl Dick at the University of Western Kentucky.

Sampling Techniques: Squamates

We used trapping transects and visual encounter surveys to document squamates. Individual adhesive traps (~22 cm *L* × ~13 cm *W*) are the type used to ensnare rodents and can non-lethally capture lizards as they contact the adhesive surface (e.g., Victor® Mouse Glue Boards). We removed live specimens by applying vegetable oil to the parts of the body in contact with the board, which degrades the adhesive and does not harm the animal. Each transect consisted of 10–25 georeferenced stations spaced 50 m apart and were checked every 30–40 minutes after being deployed. Stations consisted of three traps positioned (1) on the ground, (2) on a fallen log (perch ~1.0 m of the ground), and (3) on a tree trunk (>1.5 m above ground). This configuration ensured captures of lizard species with different behavioral ecologies, with captures recorded according to the transect number, trap station, and trap location. We surveyed three main transects (T1–T3), all generally tracking the forest trail from the village of Te-Nggano south to the coastline at Tuhugaga. T1 was closest to the village, T2 was roughly halfway between Te-Nggano and the coast, and T3 extended from the cliff face down to the beach at Tuhugaga. The three transects spanned all habitat types, from highly disturbed garden areas to primary forest.

Visual encounter surveys consisted of turning over rocks, disarticulating felled logs, peeling bark off trees, raking through leaf debris, and searching up in the trees. Visual surveys took place during the day and at night in all weather conditions, except during heavy down pours. We recorded GPS coordinates for capture points and incidental sightings.

We preserved a proportion of individuals from each survey site as voucher specimens following the general protocol of McDiarmid (1994). Specimens were euthanized using an intracardial injection of MS-222 (trichloro-2-methyl-2-propanol; 1 teaspoon/1 L water) following Conroy et al. (2009). We recorded length (snout-to-vent) and mass measurements prior to removing liver tissue for DNA, and photographed representatives of all species. We stored tissue samples in 95% ethanol and fixed all specimens in 10% buffered formalin (900 ml water, 100 ml formaldehyde, 1.5 teaspoon/L magnesium carbonate [buffer]).

Trapping transects also allowed us to survey for presence/absence of the yellow crazy ant *Anoplolepis gracilipes*, an invasive species known to have adverse ecological impacts on other Pacific Islands (Holway et al.

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2002, O'Dowd et al. 2003). This ant has been introduced to numerous islands in the Caribbean, Indian Ocean (Seychelles, Madagascar, Mauritius, Réunion, the Cocos Islands, and the Christmas Islands) and in the Pacific (New Caledonia, Hawai'i, French Polynesia, Okinawa, Vanuatu, Micronesia and the Galapagos Archipelago) (McGlynn 1999, Holway et al. 2002, Wetterer 2005).

RESULTS

We recorded 56 species of vertebrates between 18 and 29 October 2018, including 15 squamates (12 terrestrial species, one sea turtle, and two sea snakes), 13 species of mammal, and 38 species of birds (Supplementary Table S1). Our observations included all described endemic birds, squamates, and mammals (Supplementary Table S1). Annotated notes on previously known, important species documented during the survey period are presented in the Supplemental File.

The majority of the 38 species of birds detected were in gardens and secondary and primary forests around Te-Nggano Village. Two species were seen only along the airstrip in Tingoa Village (Whimbrel *Numenius phaeopus* and Sharp-tailed Sandpiper *Calidris acuminata*). We found all 20 described endemic species and extant endemic subspecies: six endemic species of forest birds, four endemic subspecies of waterbirds associated with Lake Te-Nggano, and 10 endemic subspecies of forest birds (Supplementary Table S1). We found all extant endemic species and subspecies to be relatively numerous with Island Thrush (*Turdus poliocephalus*), Rennell Starling (*Aplonis insularis*), and Melanesian Flycatcher (*Myiagra caledonica*) being the rarest, the last of which we detected only two individuals. There are four species known from Rennell Island that we did not detect (apart from seabirds, migrants, and vagrants): Pacific Black Duck (*Anas superciliosa*, locally extinct), Grey Teal (*Anas gracilis*, extirpated endemic subspecies), Eastern Barn Owl (*Tyto javanica*, rare resident), and a nightjar (*Caprimulgus* sp.) reported by Filardi et al. (1999). Of these, the Black Duck and Grey Teal are likely extirpated as there are no recent observations of either species. It is likely that the nightjar, first reported from Rennell Island by Filardi et al. (1999), was not detected by us due to our survey methods (e.g., lack of driving the road at night in search of nocturnal species) or time of year—Filardi et al. surveyed in June.

We obtained 165 audio recordings (163 of 23 bird species and two recordings of Rennell Flying Fox (*Pteropus rennelli*) that are archived at Macaulay Library (www.macaulaylibrary.org). We obtained the first archived audio recordings of the song of Rennell Starling (*Aplonis insularis*) and Rennell White-eye (*Zosterops rennellianus*), and just the second recordings of a number of species (e.g., Silver-capped Fruit-Dove *Ptilinopus richardsii cyanopterus*, Rennell Whistler *Pachycephala feminina*, Bare-eyed White-eye *Woodfordia superciliosa*, and Rennell Starling *Aplonis insularis*). We obtained the first recordings of the following four endemic subspecies: Pacific Kingfisher (*Todiramphus sacer amoenus*), Song Parrot (*Geoffroyus heteroclitus hyacinthinus*), Melanesian Flycatcher (*Myiagra caledonica occidentalis*), and Island Thrush (*Turdus poliocephalus rennellianus*). Finally, we provide the first recordings from Rennell Island of 12 species including a newly discovered population of Stephan's Emerald Dove (*Chalcophaps stephani*).

We recorded almost all mammals previously documented on Rennell Island. However, two species went undetected. Both were echolocating bats — fawn leaf-nosed bat (*Hipposideros cervinus*) and large-eared sheath-tail bat (*Emballonura dianae*). These two species are widespread and relatively common in Solomon Islands, but both can be difficult to capture in mist nets. Anapuli Cave was an important site where we recorded seven of 11 bat species previously known from Rennell. Echolocation reference calls were recorded for all species trapped at this location. We also observed Diadem leaf-nosed bat (*Hipposideros diadema*) foraging near our accommodation at Te-Nggano Village and recorded passive echolocation reference calls.

Of the 15 species of squamates documented, four were snakes (in three genera) and the remaining 10 were lizards (five were skinks from three genera, four were geckos from three genera, and one was a monitor). Four of

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the 15 species are endemic to Rennell, including two undescribed species of lizard (one skink [*Cryptoblepharus* sp.] and one gecko [*Lepidodactylus* sp.]), both previously documented by McCoy (2006).

New Faunal Records

Chalcophaps stephani (Aves: Columbidae), Stephan's Emerald Dove — A single adult female in breeding condition (ovary 15 × 20 mm, largest ovum 8 × 8 mm and vascularized, oviduct enlarged; skull 100% ossified, no bursa) was captured in a 12 m mist net in secondary forest ca. 2 km northwest of Te-Nggano Village (S 11.702°, E 160.394°, elev. 23 m). This individual was photographed and prepared as a study skin (KU 134529) with associated genetic sample (KU 35586, duplicated at MSB:Bird:55531). We obtained audio recordings on 23, 24, 27, and 28 October of at least two additional individuals giving the typical, repeated low-frequency song (ML 134503371, ML 134503811, ML 136526651, ML 136529391, ML 141715181). All detections (single bird captured and multiple individuals heard) were in mixed secondary and mature forest to the northwest and southwest of Te-Nggano Village. We can find no mention in the literature of *Chalcophaps stephani* occurring on Rennell Island (see Mayr 1931, Wolff 1969, Filardi et al. 1999, Dutson 2011).

Chalcophaps stephani is distributed from Sulawesi, through New Guinea, the Bismarck Archipelago, and the Solomon Islands south to Makira Island (Gibbs et al. 2001, Dickinson and Remsen 2013). All Solomon Island populations have been assigned to subspecies *mortoni* (Dickinson and Remsen 2013) distributed from Nissan Island north of Bougainville south to Makira Island (Gibbs et al. 2001, Dutson 2011), but explicitly not on Rennell (Dutson 2011). There are two additional species in the genus *Chalcophaps*: *C. longirostris* occurs in Timor, Australia, parts of New Guinea, Temotu, Vanuatu, and New Caledonia (Dickinson and Remsen 2013) and *C. indica* occurs in the Greater Sundas, Philippines, and southeastern Asia (Dickinson and Remsen 2013). Molecular data (mitochondrial and nuclear; KU unpubl. data) roughly support this current parsing of the complex into three species.

The Rennell specimen matched well in plumage female specimens of *C. stephani* from elsewhere in Solomon Islands (e.g., KU 111368 from Kohingo Island, New Georgia group; KU 131764 from Malaita Island). The Rennell specimen differed in many aspects of plumage from female specimens of *C. indica* from the Philippines housed at KU and from descriptions of female *C. longirostris* (e.g., Dutson 2011, Pratt and Beehler 2015, del Hoyo et al. 2019). Mitochondrial DNA (mtDNA) sequence data (GenBank Accession: MZ508289) suggested that the Rennell specimen was closely related to populations on Makira, being identical in mtDNA sequence of subunit 2 of the *NADH* gene (ND2) to the specimen KU 133607 from Makira. Pairwise differences between the Rennell specimen and those of *C. longirostris* and *C. indica* were much greater. Based on morphological and molecular data, we suggest that this recently discovered Rennell population of *C. stephani* be recognized as the subspecies *mortoni* with a distribution throughout Solomon Islands, now including Rennell Island.

Myotis moluccarum (Mammalia: Vespertilionidae), Maluku myotis — We caught four Maluku myotis (two males and a female carrying young) in Anapuli Cave. The taxonomy of Southwest Pacific *Myotis* is in need of revision. Flannery (1995) identified the range east of New Guinea as including Nissan, New Britain, New Ireland, Normanby and Sudest (Papua New Guinea); Choiseul and New Georgia (Solomon Islands); and Malakula (Vanuatu) and placed them in *M. adversus*. Cooper et al. (2001) subsequently examined the molecular phylogeny of specimens from Indonesia ($n = 2$ samples), Australia ($n = 21$), mainland New Guinea ($n = 2$), and Vanuatu ($n = 1$) using the mitochondrial genes Cytochrome *b* and ND2. The authors concluded Australian specimens and one New Guinea specimen were monophyletic to the exclusion of Indonesian *M. adversus* and best regarded as *M. macropus*. The second New Guinea and Vanuatu speci-

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mens were each paraphyletic (ND2 data only), with the New Guinea specimen tentatively placed in *M. moluccarum*. The affinity of the single Vanuatu specimen was not discussed. Pending further assessment, we treat the Rennell Island specimens as *M. moluccarum*, alongside other range extensions from Makira and Vangunu (T. Lavery unpubl. data). External morphological measurements for adult Rennell specimens were as follows (reported in mm): head-body 44.9–50.6 (mean = 47.9); forearm 41.0–42.6 (mean = 41.8); hindfoot 9.7–10.4 (mean = 10.0); ear 12.1–13.8 (mean = 13.2); weight 8.3–9.0 g (mean = 8.7).

Emoia atrocostata (Squamata: Scincidae), Littoral Skink — Of the 10 species of lizards known from Rennell, two occurred exclusively in the eulittoral zone (intertidal or foreshore area) at Tuhugaga Beach. Both were reported previously by McCoy (2006), but one of the two, *Emoia atrocostata*, was documented in error based on a specimen at the California Academy of Sciences (CAS 72204) that was collected on Bellona, rather than Rennell (reported in Brown 1991). We recorded four incidental sightings and had five trap captures of *E. atrocostata* on limestone karst or directly on the sand in the eulittoral zone, with many of the trap stations becoming completely inundated at high tide (but removed prior to inundation). *Emoia atrocostata* was found in close association with the undescribed species of *Cryptoblepharus*, but the two appeared to segregate themselves among the dispersed karst outcrops along the shoreline.

Indotyphlops braminus (Squamata: Typhlopidae), Brahminy Blindsnake — The second previously undocumented reptile was the brahminy blindsnake *Indotyphlops braminus*, a small fossorial blindsnake that is presumed to be widely introduced to Pacific islands by humans. The three individuals captured on this survey were all collected under leaf and branch litter in an active garden within the village grounds. The species was known by some of the local children but regarded as an earth worm rather than a snake.

Invasive Species Detection

The risk of invasion by non-native species was one key justification for placing East Rennell on the list of World Heritage in Danger. Providing absence data during these surveys was thus perhaps of equal importance as presence data for certain invasive species. Numerous widespread invaders in Oceania have high potential to be introduced to Rennell, and cause damage to the indigenous terrestrial fauna. These include the Yellow Crazy Ant *Anoplolepis gracilipes*, Giant African Snail *Achatina fulica*, Cane Toad *Rhinella marina*, and the Brown Treesnake *Boiga irregularis*. We did not detect *A. gracilipes* on any sticky board transects (as expected if present) and did not record any of the remaining four species during visual surveys. However, we made numerous observations of the large Asian Forest Centipede *Scolopendra subspinipes* during night surveys, most often on tree trunks or large felled logs.

We also observed several non-native mammal species that are of concern for birds, lizards, and snakes, including the Black Rat *Rattus rattus*, domestic cat *Felis catus*, and domestic dog *Canis familiaris*. We detected *R. rattus* on all night surveys and they were common in our living quarters. At least three *F. catus* and several *C. familiaris* were observed in the immediate vicinity of the village, but they were never encountered outside of this area, presumably because of food subsidies provided by humans and the lack of fresh surface water.

DISCUSSION

The large size, geographic isolation, and limited study on the fauna of Rennell Island suggested that probability of discovering undocumented biodiversity was high for this study. Even over a short period of time in a limited part of the southeastern end of the island, we still recorded new species of birds, mammals, and squamates. This reinforces the need for continued field studies at this World Heritage site, especially given the pace and extent of habitat destruction in West Rennell, the lack of preserved tissues for DNA studies,

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and the probable loss of 'hidden' biodiversity that remains to be discovered through DNA analysis (Yang and Rannala 2010, Solís-Lemus et al. 2015).

Specimens and tissue samples collected from this work are now being used to better understand the evolutionary distinctiveness and sources of the fauna on Rennell. For example, one of the scincid lizards collected during this survey (*Cryptoblepharus* sp.) is the only member of the genus found in Solomon Islands and it only occurs on Rennell. This begs the question of how and why it established a population on Rennell alone, and where its ancestral source is located. At least some clue may come from the present-day human population on Rennell, which is descended from Polynesians that migrated from the Wallis and Futuna Islands where a widespread species of *Cryptoblepharus* is known to occur (Gill 1995). DNA sequence data will help us better understand where in the evolutionary 'puzzle' such species fall and will likely reveal more diversity that merits species-level recognition. Such data can also be used to trace routes of dispersal to the island, which is important for mitigating the spread of invasive species.

None of the four species documented for the first time on Rennell (one lizard, one snake, one bird, and one bat) were surprising or unexpected. *Emoia atrocostata* is broadly distributed across western Pacific Islands and Indo-Australasia, with a unique lineage (i.e. subspecies) endemic to Solomon Islands and Vanuatu (Brown 1991, Richmond et al. 2021). The species is widely regarded as a habitat specialist because it occurs exclusively in the littoral zone along the coastline, and prior documentation from nearby Bellona suggested that its discovery on Rennell was only a matter of time and opportunity. Similarly, the Brahminy Blindsnake *I. braminus* is a wide-ranging terrestrial snake species and the most frequently introduced parthenogenic reptile in the world (Bomford et al. 2009, Wallach 2009). It is easily transported in the soil and root masses of agricultural and ornamental plants due to its small size and fossorial habits, and it is often mistaken as an earthworm when excavated.

Chalcophaps stephani occurs on nearly all islands in the Solomon archipelago, and its presence on other remote islands (including Nissan Is.) is evidence of its high dispersal ability. Prior to this survey, the species had been recorded from the adjacent islands of Guadalcanal and Makira to the north, and its congener *C. longirostris* occurs on islands to the southeast of Rennell. These patterns suggested that its absence from the Rennell 'stepping stone' was likely because researchers had not observed it, rather than being a true gap in the distribution of the genus. Given the high level of endemism on Rennell among other avian taxa, we found it surprising that mtDNA could not distinguish it from adjacent populations. Another possible explanation—although perhaps an unlikely one—is that this Rennell population is newly colonized. The identical ND2 sequence from populations on Makira Island are at least suggestive of this scenario, which also conveniently absolves prior surveys from having missed this species on Rennell.

Myotis moluccarum has a specialist foraging strategy that involves capturing insects and aquatic organisms from the surfaces of waterbodies by trailing its enlarged feet over the water and scooping them up (Flannery 1995). This strategy may render the species more capable or likely to undertake migrations over oceanic barriers between islands. The species is patchily distributed in Melanesia from mainland New Guinea to Aore, off Espiritu Santo, Vanuatu (Flannery 1995). However, it is probably far more widespread than currently realized, as recent surveys on Makira and Vangunu, Solomon Islands have detected this species for the first time in both instances.

Confirmation that the vast majority of vertebrate species previously recorded on Rennell still persist, suggests these faunas may have at least some resilience to the human-mediated disturbance on Rennell over the past ~50 years. However, we have no robust data on individual species to indicate whether populations are stable, increasing, or in decline. Moreover, industrial scale disturbance has rapidly escalated over the past decade and there is often a delay in the

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severity and extent of damage on any given island biota. All bird populations appeared to be healthy in the areas of East Rennell Island surveyed, except for possibly Melanesian Flycatcher. We are unaware of comparable surveys from fragmented forests of west Rennell, but we assume that species typically limited to intact primary forests (e.g., Island Thrush) are likely rarer or absent from these disturbed areas. From our work, it appears that the conservation measures of the Te-Nggano and Hutuna communities in East Rennell have so far been successful in maintaining healthy populations of the island's bird species.

Threats Posed by Invasive Species

The UNESCO East Rennell *Desired state of conservation for removal of the property from the List of World Heritage in Danger* calls for invasive species to be identified and minimized, and for biosecurity measures to be enacted to prevent new introductions. Although our surveys were not focused on invasive species detection, our lack of observations for several key species known to cause significant damage on Pacific islands (e.g., *Rhinella marina*, *Boiga irregularis*, *Achatina fulica*, and *Anoplolepis gracilipes*) (Fritts and Rodda 1998, Lever 2001, 2003, Pikacha et al. 2015) was encouraging. *Rhinella marina* is toxic to most animals if ingested and consumes a variety of prey (e.g., small rodents, squamates, birds, and various invertebrates, Lever 2001). The species is well-established on Guadalcanal and is therefore a concern for Rennell, although the general absence of amphibians on Rennell suggests the limestone karsts are not conducive to amphibian reproduction. *Boiga irregularis* naturally occurs on other islands in the Solomon chain (including Guadalcanal), but has never been detected on Rennell. Given its well-known capacity for incidental transport via air and ship cargo (Rodda and Savidge 2007), Rennell's indigenous birds, squamates, and mammals may be at risk of predation should the snake be introduced to the island. Similarly, *A. fulica* and an invasive strain of Coconut Rhinoceros beetle (*Oryctes rhinoceros*) have strong potential to be introduced due to their prevalence on Guadalcanal and the frequency of potential vectors arriving to Rennell (ships or aircraft) (Kiddle 2020).

Whilst we provided at least some evidence that invertebrate invaders common to other Pacific Islands have not become established on East Rennell, we cannot exclude the possibility that that they may be present in other more disturbed parts of the island with greater air and ship traffic, and that over time they could spread to the east. However, we did make numerous observations of the Asian Forest Centipede *Scolopendra subspinipes* during night walks along all squamate-trapping transects. Effects of *S. subspinipes* on small terrestrial fauna are unknown, but the species is a voracious predator with toxic venom and feeds mostly on vertebrates, including squamates, rats, bats, and insects (Undheim and King 2011).

The apparent arrival of *R. rattus* with logging ships was first raised by the UNESCO in 2012. Since then, the species has rapidly become a major social and environmental issue and is negatively impacting subsistence agriculture. *Rattus rattus* was commonly seen on our spotlighting transects and damage to coconuts and food crops was readily apparent. *Rattus rattus* is a major threat to island endemic birds (Harper and Bunbury 2015, Duron et al. 2017) including Rennell's five endemic species, as well as to squamates. The viability of *R. rattus* eradication from Rennell was considered as part of a conservation project led by the non-government organisation BirdLife International. However, it was deemed to be neither socially nor financially feasible for Rennell, in part because of the risk of continued re-introduction by commercial logging and mining activities.

Conservation Implications

Our documentation of new faunal records comes at a critical turning point in the environmental management of Rennell Island. East Rennell was designated a World Heritage Area in 1998 as the largest raised coral atoll in the world, and for its on-going ecological and biological processes. As our

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results attest, Rennell continues to present opportunities for biological discovery, as well as playing an important role for the science of island biogeography. It is a crucial stepping-stone in the migration and evolution of western Pacific faunas (especially avifauna), and Lake Te-Nggano is a unique formation that continues to provide an environment for the evolution of endemic taxa. However, since 2006, West Rennell has been progressively exploited for timber, and more recently, minerals (Allen and Porter 2016). Commercial logging is rapidly depleting primary forests and two mining companies (Asia Pacific Investment Development and Bintan) are actively mining Bauxite (Wang et al. 2018). Bauxite mining involves removal of substrate for wholesale shipment and processing in China. As an uplifted atoll, Rennell consists mostly of limestone karst reliant on limited topsoils for supporting productive forests. Removal of Rennell's thin topsoil represents irreparable damage to the island's geology that will likely hinder the regeneration of forests for thousands of years. Most importantly, it significantly reduces the abilities of communities to subsist on garden-grown produce and increases reliance on store-bought foods, and a monetary income (Kiddle 2020).

There is a strong sentiment in East Rennell that the World Heritage designation has done little to improve livelihoods, produce financial gains, or advance aspirations of local communities (Smith 2011). Efforts to increase legal protection for East Rennell, such as declaring it a protected area under national legislation and approving the site's management plan, have not advanced beyond preliminary stages (Kiddle 2020). Persistent threats posed by human activity and wavering community support for the World Heritage designation now place the site in jeopardy. The long-term protection of East Rennell from extractive industries is thus in a precarious state unless certain incentives and management actions can be enacted (Allen and Porter 2016). If the scale of logging and mining occurring in West Rennell were to spread across the remainder of the island, it would surely endanger endemic species, and potentially result in the loss of species yet to be described (Allen and Porter 2016, Kiddle 2020).

Conclusions

The unique terrestrial fauna of Rennell Island appeared to be largely intact and thriving in the East Rennell World Heritage Site. Our work took the much-needed step to build an updated and comprehensive knowledge of the island's unique biota. Rennell's cultural and natural heritage is of such exceptional importance that it transcends national boundaries and represents common importance for present and future generations: https://worldheritage.gsu.edu/outstanding-universal-value. Our discovery of four new species for the island suggests that considerably more diversity likely remains to be uncovered once DNA sequence data can be collected and analyzed. Plans to integrate the needs of local communities with preservation of the site's Outstanding Universal Value require significant, further development to mitigate current threats to the island's fauna and flora (Kiddle 2020). Otherwise, the important results revealed as part of this, and other studies may one day be testament to nothing more than Rennell's lost contributions to ecological and biological processes, and former importance as a site for studying island biogeography.

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Literature Cited

Allen, M., and D. Porter. 2016. Managing the transition from logging to mining in post-conflict Solomon Islands. Extr. Ind. Soc. 3:350–358.

Bomford, M., F. Kraus, S. Barry, and E. Lawrence. 2009. Predicting establishment success for alien reptiles and amphibians: a role for climate matching. Biol. Invasions. 11:713–724.

Bradley, D., and T. Wolff. 1958. The birds of Rennell Island. Nat. Hist. Rennell Isl., Br. Solomon Isl. 1:85–120.

Brown, W. C. 1991. Lizards of the genus *Emoia* (Scincidae) with observations on their evolution and biogeography. Memoirs of the California Academy of Sciences No. 15. The California Academy of Sciences and the Christensen Research Institute, San Francisco, CA.

Cogger, H., H. Heatwole, Y. Ishikawa, M. McCoy, N. Tamiya, and T. Teruuchi. 1987. The status and natural history of the Rennell Island Sea Krait, *Laticauda crockeri* (Serpentes: Laticaudidae). J. Herpetol. 21:255–266.

Conroy, C. J., T. Papenfuss, J. Parker, and N. E. Hahn. 2009. Use of tricaine methanesulfonate (MS222) for euthanasia of reptiles. J. Am. Assoc. Lab. Anim. Sci. 48:28–32.

Cooper, S. J. B., P. R. Day, T. B. Reardon, and M. Schulz. 2001. Assessment of species boundaries in Australian *Myotis* (Chiroptera: Vespertilionidae) using mitochondrial DNA. J. Mammal. 82:328–338.

Diamond, J. M. 1984. The avifauna of Rennell and Bellona islands. Nat. Hist. Rennell Isl. Br. Solomon Isl. 8:127–168.

Dickinson, E. C., and J. V. Remsen Jr. 2013. The Howard and Moore Complete Checklist of the Birds of the World, 4th ed, Volume 1 Non-passerines. Aves Press Limited, Eastbourne.

del Hoyo, J., N. Collar, G. M. Kirwan, and E. F. J. Garcia. 2019. Brown-capped Emerald Dove (*Chalcophaps longirostris*). In: J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, eds. Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona (retrieved from https://www.hbw.com/node/467143 on 9 September 2019).

Duron, Q., E. Bourguet, H. De Meringo, A. Millon, and E. Vidal. 2017. Invasive rats strengthen predation pressure on bird eggs in a South Pacific island rainforest. Curr. Zool. 63:583–590.

Dutson, G. 2011. Birds of Melanesia: the Bismarcks, Solomons, Vanuatu and New Caledonia. Christopher Helm, London.

Filardi, C. E., C. E. Smith, A. W. Kratter, D. W. Steadman, and H.P. Webb. 1999. New behavioral, ecological, and biogeographic data on the avifauna of Rennell, Solomon Islands. Pac. Sci. 53:319–340.

Flannery, T. F. 1995. Mammals of the Southwest Pacific and Moluccan Islands. Reed Books, Chatswood, NSW.

Foukona, J. D. 2020. Solomon Islands. The Contemporary Pacific 32:595–605 [in English].

Fritts, T. H., and G. H. Rodda. 1998. The role of introduced species in the degradation of island ecosystems: a case history of Guam. Annu. Rev. Ecol. Syst. 29:113–140.

Gibbs, D., E. Barnes, and J. Cox. 2001. Pigeons and doves: a guide to the pigeons

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and doves of the world. Christopher Helm, London.

Gill, B. J. 1995. Notes in the land reptiles of Wallis and Futuna, south-west Pacific. Rec. Auckland Inst. Mus. 32:55–61.

Grover, J. C. 1958. The geology of Rennell and Bellona. The great uplifted atolls on the edge of the Coral Sea. Nat. Hist. Rennell, Isl., Br. Solomon Is. 3:103–119.

Harper, G. A., and N. Bunbury. 2015. Invasive rats on tropical islands: their population biology and impacts on native species. Global Ecol. Conserv. 3:607–627 [in English].

Heatwole, H., S. Busack, and H. Cogger. 2005. Geographic variation in sea kraits of the *Laticauda colubrina* complex (Serpentes: Elapidae: Hydrophiinae: Laticaudini). Herpetol. Monogr. 19:1–136.

Heatwole, H., G. Grech, and H. Marsh. 2017. Paleoclimatology, paleogeography, and the evolution and distribution of Sea Kraits (Serpentes; Elapidae; Laticauda). Herpetol. Monogr. 31:1–17.

Hill, J. 1962. A little-known fruit-bat from Rennell Island. In The natural history of Rennell Island, British Solomon Islands. Vol. 4. Danish Science Press, Ltd., Copenhagen.

———. 1968. Notes on mammals from the islands of Rennell and Bellona. Pages 53–60 *in* The natural history of Rennell Island, British Solomon Islands. Vol. 5. Danish Science Press, Ltd., Copenhagen.

Holway, D. A., L. Lach, A. V. Suarez, N. D. Tsutsui, and T. J. Case. 2002. The causes and consequences of ant invasions. Annu. Rev. Ecol. Syst. 33:181–233.

Kiddle, G. L. 2020. Achieving the desired state of conservation for East Rennell, Solomon Islands: progress, opportunities, and challenges. Asia and the Pacific Policy Studies 2020: 1–16.

Lever, C. 2001. The cane toad: the history and ecology of a successful colonist. Westbury Academic and Scientific Publishing, Otley, UK.

———. 2003. Naturalized reptiles and amphibians of the world. Oxford University Press, Oxford.

MacArthur, R. H., and E. O. Wilson. 1967. The theory of island biogeography. Princeton University Press, Princeton, New Jersey.

Manthey, J. D., C. H. Oliveros, M. J. Andersen, C. E. Filardi, and R. G. Moyle. 2020. Gene flow and rapid differentiation characterize a rapid insular radiation in the southwest Pacific (Aves: *Zosterops*). Evolution 74:1788–1803.

Mayr, E. 1931. A systematic list of the birds of Rennell Island with description of new species and subspecies. Am. Mus. Novit. 486:1–29.

———. 1942. Systematics and the origin of species. Columbia University Press, New York.

Mayr, E., and J. Diamond. 2001. The birds of northern Melanesia: speciation, ecology & biogeography. Oxford University Press, New York.

McCoy, M. 2006. Reptiles of the Solomon Islands. Pensoft Series Faunistica 57: 212 pp.

McDiarmid, R. W. 1994. Preparing amphibians as scientific specimens. Appendix 4. Pages 289–297 *in* W.R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, eds. Measuring and monitoring biological diversity, standard methods for amphibians. Smithsonian Institution Press, Washington, DC.

McGlynn, T. P. 1999. The worldwide transfer of ants: geographical distribution and ecological invasions. J. Biogeogr. 26:535–548.

Mittermeier, R., P. Robles Gil, M. Hoffman, J. Pilgrim, T. Brooks, C. Mittermeier, J. Lamoreux, and G. da Fonseca. 2004. Hotspots Revisited. CEMEX, Mexico City.

North, A. J. 1906. Description of a new genus and species of honey-eater from Rennell Island, Solomon Group. Victorian Nat. 23:104.

O'Dowd, D. J., P. T. Green, and P. S. Lake. 2003. Invasional 'meltdown' on an oceanic island. Ecol. Lett. 6:812–817.

Pennay, M., and T. H. Lavery. 2017. Identification guide to bat echolocation calls of

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Solomon Islands & Bougainville. http://ausbats.org.au/bat-calls-of-solomon-islands/4593992119 (accessed 25 October 2019).

Pikacha, P. G., T. H. Lavery, and L. K. P. Leung. 2015. What factors affect the density of cane toads (*Rhinella marina*) in the Solomon Islands? Pac. Conserv. Biol. 21:200–207.

Pratt, T. K., and B. M. Beehler. 2015. Birds of New Guinea, 2nd ed. Princeton University Press, New Jersey.

Richmond, J. Q., H. Ota, L. L. Grismer, R. N. Fisher. 2021. Influence of niche breadth and position on the historical biogeography of seafaring scincid lizards. Biol. J. Linn. Soc. 132:74–92.

Rodda, G. H., and J. A. Savidge. 2007. Biology and impacts of Pacific Island invasive species. 2. *Boiga irregularis*, the Brown Tree Snake (Reptilia: Colubridae). Pac. Sci. 61:307–324.

Slevin, J. R. 1934. The Templeton Crocker Expedition to Western Polynesian and Melanesian Islands, 1933. No. 15. Notes on the reptiles and amphibians, with the description of a new species of sea-snake. Proc. Calif. Acad. Sci. 21:183–188.

Smith, A. 2011. East Rennell World Heritage Site: misunderstandings, inconsistencies and opportunities in the implementation of the World Heritage Convention in the Pacific Islands. Int. J. Heritage Stud. 17:592–607.

Solís-Lemus, C., L. L. Knowles, and C. Ané. 2015. Bayesian species delimitation combining multiple genes and traits in a unified framework. Evolution 69:492–507.

Troughton, E. L. G. 1929. A new fruit bat (*Pteropus rayneri* group) from the Solomons. Rec. Aust. Mus. 17:193–198.

Undheim, E. A., and G. F. King. 2011. On the venom system of centipedes (Chilopoda), a neglected group of venomous animals. Toxicon 57:512–524.

Volsøe, H. 1956. Herpetology of Rennell Island. Pages 121–134 *in* T. Wolff, ed. The natural history of Rennell Island, Brirish Solomon Islands. Vol. 1 (Vertebrates). Danish Sci. Press Ltd., Copenhagen.

———. 1958. Additional specimens of snakes from Rennell Island. Pages 227–228 *in* T. Wolff, ed. The natural history of Rennell Island, British Solomon Islands. Vol. 1 (Vertebrates). Danish Sci. Press Ltd., Copenhagen.

Wallach, V. 2009. *Ramphotyphlops braminus* (Daudin): a synopsis of morphology, taxonomy, nomenclature and distribution (Serpentes: Typhlopidae). Hamadryad 34:34–61.

Wang, M., G. He, N. Ishwaran, T. Hong, A. Bell, Z. Zhang, G. Wang, and M. Wang. 2018. Monitoring vegetation dynamics in East Rennell Island World Heritage Site using multi-senso and multi-temporal remote sensing data. Int. J. Digit. Earth 13:393–409.

Wetterer, J. K. 2005. Worldwide distribution and potential spread of the long-legged ant, *Anoplolepis gracilipes* (Hymenoptera: Formicidae). Sociobiology 45:77–97.

Williams, J. 2019. "There's Poison in the Sea": an oil spill fouls a Tropical Eden. The New York Times. https://www.nytimes.com/2019/04/26/world/asia/oil-spill-rennell-mining-solomons.html.

Wilson, E. O. 1961. The nature of the taxon cycle in the Melanesian ant fauna. Am. Nat. 95:169–193.

Wolff, T. 1958. The natural history of Rennell Island, British Solomon Islands. Volume 1 (vertebrates). Published on behalf of The University Copenhagen and The British Museum (Natural History), London.

———. 1969. The fauna of Rennell and Bellona, Solomon Islands. Phil. Trans. Roy. Soc. B 255:321–343.

———. 1973. Notes on birds from Rennell and Bellona Islands. Nat. Hist. Rennell Isl., Br. Solomon Isl. 7:7–28.

Woodford, C. M. 1916. Note on a remarkable Honey-eater (*Woodfordia superciliosa* North) from Rennell Island in the Western Pacific. Ibis 4:118–120.

Yang, Z., and B. Rannala. 2010. Bayesian species delimitation using multilocus sequence data. Proc. Natl. Acad. Sci. USA. 107:9264–9269.

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