# New Records of Butterflies (Lepidoptera) from the Federated States of Micronesia with Remarks on Geographic Variation in *Hypolimnas bolina* (Linnaeus)

Donald W. Buden, W. J. Tennent


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# New Records of Butterflies (Lepidoptera) from the Federated States of Micronesia with Remarks on Geographic Variation in *Hypolimnas bolina* (Linnaeus)[1]

*Donald W. Buden*[2] *and W. J. Tennent*[3]

**Abstract:** New locality records are given for 10 species of butterflies from 10 islands and island groups (atolls) within the Federated States of Micronesia (FSM). All the species recorded are widespread in the Pacific and in many cases farther afield. We report the first record of *Badamia exclamationis* from Kosrae (the second for the FSM) and the first record of *Catopsilia pomona* from Chuuk State. *Danaus plexippus* is intermittently distributed in the FSM but often observed where the introduced ornamental *Calotropis gigantea* is common. *Hypolimnas bolina* was one of the most frequently encountered species during this study. The extent of variation in coloration and pattern within local populations of *H. bolina* in the FSM and adjacent areas of Oceania suggests that use of subspecies names is probably unwarranted.

The butterfly fauna of the Federated States of Micronesia (FSM) is incompletely known; many of the smaller and more remote islands have never been surveyed, and samples from others are limited to a few specimens collected during brief visits, often ancillary to other studies. Schreiner and Nafus (1997) summarized records for greater Micronesia, including the Mariana Islands, Caroline Islands (which include the FSM), and Marshall Islands, but they presented locality records for the FSM only as from one or more of the four states (Yap, Chuuk, Pohnpei, and Kosrae), without mentioning specific islands. Buden and Miller (2003) added new records for the island of Pohnpei, and Buden et al. (2005) furnished additional records for islands in Chuuk, Pohnpei, and Kosrae States, including many of the outlying atolls. Tennent's (2006) annotated checklist of the butterflies of Oceania updated all records for the FSM. Later, and in the hitherto most recent study on butterflies of the FSM, Buden and Tennent (2011) added records for some of the outer islands of Yap State, including Fais Island and Ngulu, Ulithi, and Woleai Atolls. The study reported here adds further new locality records from throughout the FSM, including many islands not previously surveyed with respect to their butterfly faunas (see Table 1). These islands are depauperate in comparison with the larger and more readily accessible islands and landmasses immediately to the west, and they have attracted relatively little attention from biologists. But an understanding of Pacific biogeography and a proper assessment of its biodiversity is incomplete without knowledge of the plants and animals that populate these remote and miniscule outposts of land.

## *Study Area*

The FSM is an independent island nation under a Compact of Free Association with the United States of America. The four states, Yap, Chuuk (formerly Truk), Pohnpei, and Kosrae, include hundreds of small islands that, together with the Republic of Palau immediately to the west, make up the Caroline

[1] Manuscript accepted 24 June 2016.

[2] Division of Natural Sciences and Mathematics, College of Micronesia-FSM, P.O. Box 159, Kolonia, Pohnpei, Federated States of Micronesia 96941.

[3] Department of Entomology, The Natural History Museum, London SW7 5BD, United Kingdom.

[4] Corresponding author (e-mail: don_buden@comfsm.fm).

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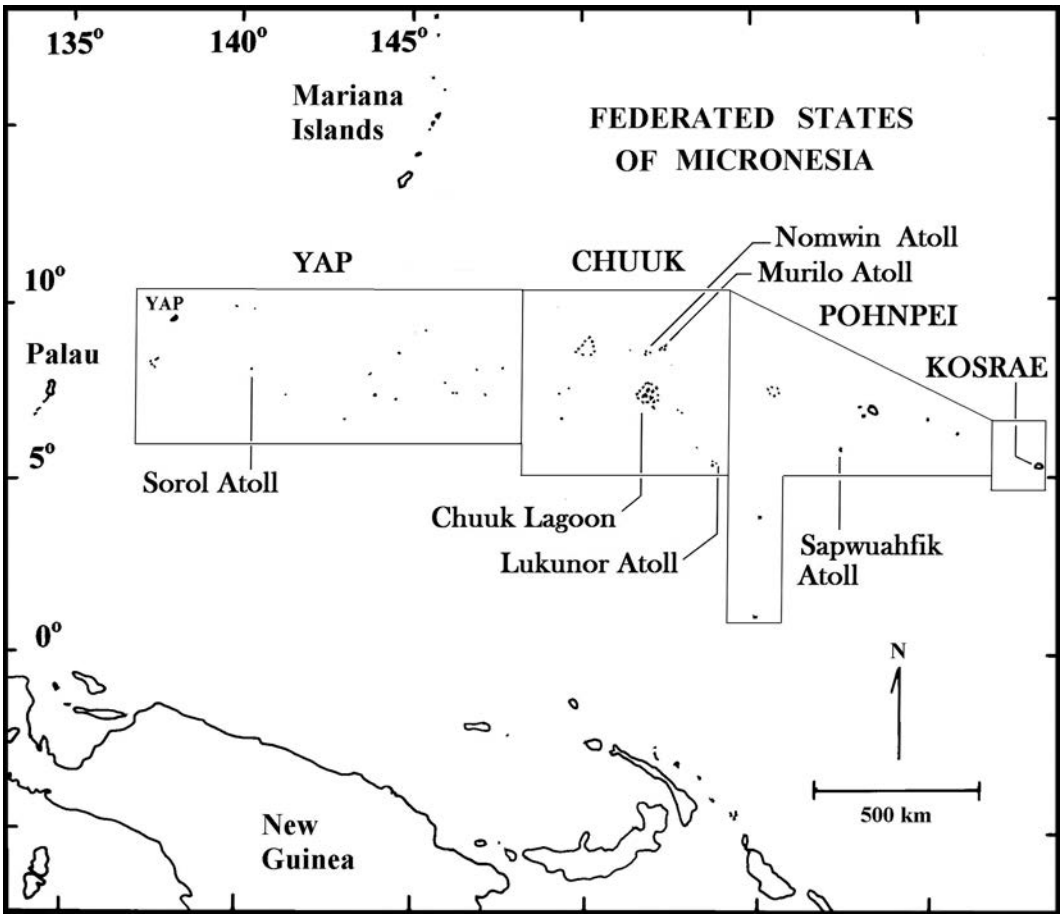


FIGURE 1. Localities for new records of butterflies from the Federated States of Micronesia.

Islands chain in the western Pacific Ocean (Figure 1). Tropical rain forest greatly modified by centuries of human activity (especially during World War II) covers much of the slopes of the high, volcanic islands (maximum elevation about 790 m on Pohnpei), and mangroves typically border the coastlines. Coconut (*Cocos nucifera*) forest predominates on the low (about 3–4 m above sea level), coralline islands and is often bordered by coastal strand and scrub, which are the only vegetation types on many of the smallest islands. A wide variety of ornamentals grows in and around the settlements, which are usually located along the coast. Mueller-Dombois and Fosberg (1998) described the vegetation types for these and other Pacific islands in detail.

## MATERIALS AND METHODS

With the exception of the record of *Badamia exclamationis* from Kosrae, provided by the late Gil Pettigrew, and examples of *Hypolimnas bolina* from Sapwuahfik Atoll collected by local residents, new locality records reported here are based on observations and specimens collected by D.W.B. For the most part these were obtained opportunistically during surveys of terrestrial vertebrates during the months of June, July, and August in the years

2007, 2009–2013 inclusive, and 2015. All specimens were sent to W.J.T., and vouchers have been deposited in the Natural History Museum, London (BMNH). Scientific names and sequence of species follow Tennent (2006) unless otherwise indicated.

## RESULTS

### SPECIES ACCOUNTS

### Family HESPERIIDAE

*Badamia exclamationis* Fabricius

This species ranges widely from southern and eastern Asia to the Indo-Australian Archipelago and the islands of the Pacific Ocean to as far east as the Marquesas Islands, French Polynesia (Schreiner and Nafus 1997, Vane-Wright and de Jong 2003, Tennent 2006). Records from Micronesia are sporadic. Schreiner and Nafus (1997) recorded it from Palau, the Mariana Islands, and the Marshall Islands, and Buden and Miller (2003) reported the first and hitherto only record for the FSM based on a collection of nine adults and observations of larvae and pupae, all on Pohnpei, in association with *Terminalia catappa* trees during 2001 and 2002.

On two separate occasions, during mid-September 2013, Gil Pettigrew observed large brown skippers on Kosrae: one on *T. catappa* in the vicinity of Sandy Beach Apartments in Tafansuk, at dusk, and the other in full daylight, flying around *Canna* plants in a private garden near the campus of the College of Micronesia. A larva photographed on *T. catappa* at the Sandy Beach site on 13 November 2013 was identified as a

TABLE 1

Summary of New Locality Records of Butterflies from the Federated States of Micronesia[a]

| | | Chuuk State | | | | | |
|---|---|---|---|---|---|---|---|
| Species | Sor | CLI | Nom | Mur | Luk | Sap | Kos |
| Hesperiidae | | | | | | | |
| *Badamia exclamationis* | | | | | | | + |
| Pieridae | | | | | | | |
| *Catopsilia pomona* | | +[b] | | | | | |
| Lycaenidae | | | | | | | |
| *Jamides* sp. (*bochus* group) | | | | | + | | |
| *Catochrysops panormus* | | | + | | | + | |
| *Lampides boeticus* | + | +[c] | + | | | + | |
| *Zizina labradus* | | +[d] | | | | | |
| *Zizula hylax* | | +[e] | | | | | |
| Nymphalidae | | | | | | | |
| Danaiinae | | | | | | | |
| *Danaus plexippus* | | +[f] | + | | + | | |
| Satyrinae | | | | | | | |
| *Melanitis leda* | | +[g] | | | | | |
| Nymphalinae | | | | | | | |
| *Hypolimnas bolina* | + | +[b] | SR[i] | + | | + | |

[a] Sor, Sorol Atoll, Yap State; CLI, Chuuk Lagoon Islands [with new island locality records in footnotes followed by records from Tennent (2006) enclosed in brackets]; Nom, Nomwin Atoll; Mur, Murilo Atoll; Luk, Lukunor Atoll; Sap, Sapwuahfik Atoll, Pohnpei State; Kos, Kosrae Island, Kosrae State.

[b] Udot, Uman.

[c] Fanapanges, Udot, [Dublon (=Tonoas)].

[d] Tol, Udot, [recorded only as "Chuuk Lagoon islands?" in Tennent (2006) and recorded from Moen (=Weno) in Yago et al. (2008)].

[e] Udot [Tol, Tarik, Moen (Weno), Dublon (=Tonoas)].

[f] Tol, Udot (SR), Weno [recorded in Tennent (2006) only as being from "Chuuk Lagoon islands?"].

[g] Udot, Uman, [Moen (=Weno), Dublon (=Tonoas)].

[h] Tol (including Polle, Patta, and Wonei), Fanapagnes, Romanum, Udot, [Tarik, Moen (=Weno), Dublon (=Tonoas)].

[i] SR, sight records only.

*B. exclamationis* by D.W.B. and confirmed by W.J.T.

Pettigrew collected two late-instar larvae on suckers growing on a *T. catappa* stump at Sandy Beach on 17 December 2013 and reared them on leaves from the same plant. The smaller of the two larvae formed a chrysalis on 20 December, with the adult emerging on 29 December. The other larva both pupated and emerged 1 day later than the first, on 21 and 30 December, respectively. The adults were photographed and preserved as vouchers, but the specimens were subsequently destroyed by insects; the photographs were not shared by Pettigrew before his death and are believed now to be lost. However, photographs of the larva observed 13 November 2013 remain to document the first record of *B. exclamationis* for Kosrae, and the second record for the FSM. *Badamia exclamationis* is a seasoned traveler with a very wide distribution; there is no reason to doubt its occurrence on Kosrae.

## Family Pieridae

*Catopsilia pomona* (Fabricius)

This species ranges widely from Madagascar eastward across southern Asia to Indo-Australia and the southwestern Pacific islands. Tennent (2006) recorded it in the FSM from Yap, Pohnpei, and Kosrae. One collected on a grassy slope on Uman Island on 1 August 2013 and three others collected on Udot Island on 8 August 2015 are the first records for Chuuk Lagoon islands (Figure 2) and Chuuk State. Many other white/yellow butterflies, probably this species (*C. pomona* is sexually dimorphic and individually variable), were observed on Udot as well as on Fanapanges and Tol Islands during July/August 2015, but their speed, erratic movement, and roughly unidirectional flight path made collection difficult. The Udot specimens were collected in close proximity to *Cassia alata* plants that were not yet in bloom.

## Family Lycaenidae

*Jamides* cf. *J. bochus* Stoll

The taxonomy and assessment of species limits within the *Jamides bochus* species-group

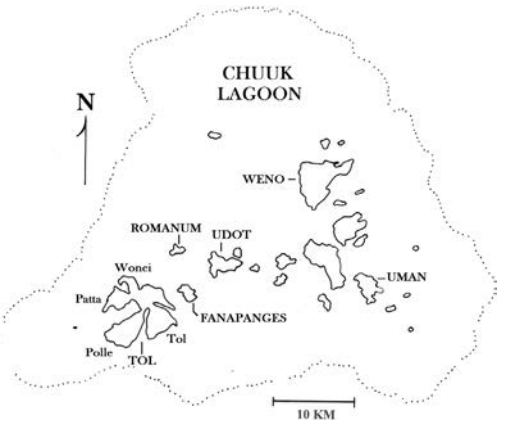


Figure 2. Localities for new records of butterflies within Chuuk Lagoon.

remain unresolved; more than 20 names have been proposed for populations in the Pacific islands (Tennent 2006). Tennent (2006) provisionally included the populations in Palau, Satawan Atoll, Chuuk, and Pohnpei Island under *J. b. palauensis* (Fruhstorfer). To the list of Chuuk State localities we add Lukunor Atoll, where it was observed frequently in weeds bordering a communal taro patch on Oneop Island in 2012; three specimens were collected, one each on 23 and 30 June and 14 July.

*Catochrysops panormus* (Felder)

This species occurs from Sri Lanka and India, through southern China, Malaysia, the Philippines, Indonesia, northern Australia, and New Guinea to Micronesia, the Solomons, New Caledonia, and Vanuatu. Buden and Miller (2003) reported *C. panormus* from the FSM and Caroline Islands for the first time based on a series of specimens collected on Pohnpei during 2000–2001. Earlier, Schreiner and Nafus (1997) recorded *Catochrysops amasea* Waterhouse & Lyell, 1914, from Palau, Yap, and Chuuk, but Tennent (2006) regarded several lycaenid species recorded by them as requiring confirmation and provisionally placed their Micronesian records of *C. amasea* with *C. panormus*. Tennent (2006) recorded *C. panormus* from Chuuk State, including Moen (Weno) Island in Chuuk Lagoon, Onoun Island on Namonuito Atoll, and

Houk Island (formerly Pulusuk Atoll); and from Pohnpei State, including Pohnpei Island and Nikalap Aru Island on Ant Atoll. The study reported here adds new locality records from Sapwuahfik Atoll, Pohnpei (a male on Ngatik Island in coastal strand on 27 July 2009 and a female on 5 August 2007); and Nomwin Atoll, Chuuk (two specimens collected in coastal strand on Nomwin Island on 13 July 2010).

*Lampides boeticus* (Linnaeus)
This species is almost cosmopolitan, occurring in Africa, Europe, Asia, Indo-Australia, and many islands throughout the Pacific. Schreiner and Nafus (1997) recorded it in the FSM as far east as Chuuk, but did not indicate on which island(s). The only hitherto specified island locality record for Chuuk Lagoon is a single specimen collected on Tonoas (Dublon) Island on 27 June 2003 (Buden et al. 2005, Tennent 2006). During the study reported here, *L. boeticus* was observed commonly in the lagoon islands on Fanapanges (seven collected) and Udot (two collected) in late July and early August, respectively. In addition, specimens representing new locality records elsewhere in the FSM were collected on Sorol Atoll, Yap (four on Sorol Island, 28 June 2011); Nomwin Atoll, Chuuk (two on Fonunu Island, 2 July 2010); and Sapwuahfik Atoll, Pohnpei (one on Ngatik Island, 5 August 2007). It was most common in coastal strand, mainly associated with *Vigna marina*, but was also encountered in weedy areas along roads and trails farther inland. No subspecies of *L. boeticus* are recognized, but several female specimens from Udot and Fanapanges Islands taken in 2015 appear quite distinctive, with a series of broad and prominent white postmedian markings on the upper surface of the hind wing.

*Zizina labradus* (Godart)
Micronesian populations of the genus *Zizina* have been variously recorded under the names *Z. otis* (Fabricius) and *Z. labradus* (Godart): see, for example, Schreiner and Nafus (1997) and Tennent (2006), respectively. In the most recent revision of the genus, Yago et al. (2008) synonymized *Z. labradus* with *Z. otis* and described its range as including Africa, Madagascar, southern Asia, the Indo-Australian region, and islands of the western Pacific. They applied the subspecies name *Z. o. labradus* to populations from Melanesia, Polynesia, and parts of Australia and treated specimens from the FSM (Chuuk State) as examples of the nominate subspecies. Tennent (2006) recorded this species (as *Z. labradus*) in the FSM from Yap, Chuuk, and Pohnpei, with the Chuuk record(s) being listed at that time only as "Chuuk Lagoon islands?." However, three of the samples examined by Yago et al. (2008) are recorded as being from Moen (Weno) Island. During the study reported here, additional examples were seen in Chuuk Lagoon on Weno (numerous specimens), with others being recorded for the first time on Tol (five specimens collected) and Udot (1), all during July and August 2015; they were especially numerous on well-groomed lawns. Nomenclature of this tiny lycaenid remains in question, and the species is retained here provisionally as *Z. labradus*.

*Zizula hylax* (Fabricius)
This widespread species is common throughout the Pacific islands, often in company with *Zizina labradus*, mentioned earlier. Tennent (2006) recorded it from the main islands of Yap, Pohnpei, and Kosrae, as well as from several islands in Chuuk Lagoon, and Satawan Atoll, Chuuk State. During the study reported here, it was encountered frequently in Chuuk Lagoon on Weno Island (two specimens collected) and was recorded for the first time on Udot Island (four collected in August 2015).

## Family Nymphalidae
## Subfamily Danainae

*Danaus plexippus* (Linnaeus)
This species occurs widely in tropical and subtropical regions throughout the world except Africa, where it seems to be absent. It has been recorded in all the FSM states (Tennent 2006). The only locality for Chuuk in Tennent's (2006) checklist is "Chuuk Lagoon islands?," indicating that specific localities are unknown but probably include at least one or more of the lagoon islands. During the study reported here, D.W.B. collected three

*D. plexippus* on a grassy, weedy hillside on Tol Island on 19 July 2015 and observed another in coastal scrub on Udot Island on 9 August 2015. In addition, two to three monarchs were observed daily on Weno Island in July and August over a period of about 2 weeks, excluding several days with heavy rains and strong winds. A pupa was photographed on a potted *Calotropis gigantea* plant outside the Truk Stop Hotel on Weno on 12 August 2015. All these records are from Chuuk Lagoon islands. Records of *D. plexippus* in Chuuk State outside the lagoon, and reported here for the first time, include Nomwin Atoll (two collected on Fanunu Island on 2 July 2010) and Lukunor Atoll (one collected on Likinioch Island on 20 June 2012).

### Subfamily Satyrinae

*Melanitis leda* (Linnaeus)
This species ranges from Africa eastward to India and southeastward to Australia and the islands of the southwestern Pacific. It occurs throughout much of greater Micronesia, being unrecorded only from the Marshall Islands (Schreiner and Nafus 1997). Previous records for Chuuk Lagoon include Tol, Dublon (Tonoas), and Moen (Weno) Islands (Tennent 2006). The study reported here adds Udot Island (one collected on 7 August 2015), and Uman Island (one collected on 1 August 2013). It is common in tall grasses on the high volcanic islands throughout the FSM (D.W.B., pers. obs.) but is unrecorded from the atolls.

### Subfamily Nymphalinae

*Hypolimnas bolina* (Linnaeus)
This species is the most widely distributed butterfly in the Pacific (Schreiner and Nafus 1997, Tennent 2006), and it was one of the most frequently encountered butterflies during the study reported here, being observed on more islands than any other species. Twenty-two specimens were collected from among six islands in Chuuk Lagoon, including first records for Tol (10 specimens, seven from Tol proper and one each from Polle, Patta, and Wonei areas), Fanapanges (1), Romanum (2), and Udot (6). Other new locality records for the FSM include Sorol Atoll, Yap (12 specimens: Sorol Island, 9 June–15 July 2011); Murilo Atoll, Chuuk (three specimens: Murilo Island, 3–7 July 2010); and Sapwuahfik Atoll, Pohnpei [35 specimens: Ngatik Island, 5–6 August 2007 (3), 2–3 April 2009 (2), and 23–28 July 2009 (30)]. On Ngatik Island, during six separate counts made while walking slowly along the circumferential road (a cart trail) and totaling 370 min over a period of 3 days (23–25 July 2009), D.W.B. recorded a total of 57 sightings of *H. bolina*, although some individuals may have been counted more than once. Fifty showed the characteristic male color pattern (black upper surface with purplish-white spots), and seven were of the more varied female pattern (see Discussion). The 7 : 1 male/female ratio was the same as that recorded during similar counts made on Ulithi Atoll, Yap, in December 2009 (Buden and Tennent 2011).

## Discussion

None of the 10 species of butterflies for which we present new locality records for the FSM is endemic to the Caroline Islands or Micronesia; all are widespread in Oceania and often well beyond. Their widespread distribution among many small Pacific islands is indicative of their high level of vagility and their adaptation to limited resources in unstable environments that are subject to frequent anthropogenic and naturally induced change. All occur in coastal strand and scrub or in ruderal habitats and in gardens and ornamental plantings in or near settlements. Seven of the 10 occur on many of the small (often less than 0.5 $km^2$), low (3–4 m above sea level) coralline islets (motus) of the numerous widely scattered atolls. The three others (*Badamia exclamationis*, *Catopsilia pomona*, and *Melanitis leda*) are thus far known in the FSM only from among the main high volcanic islands but are usually common where they occur. The occurrence of *Danaus plexippus*, a renowned vagrant, is irregular within the region; it is most often observed in the vicinity of the introduced ornamental *Calotropis gigantea*.

*Geographic Variation in* Hypolimnas bolina

The recognition of several subspecies of *H. bolina* has been based largely on the variation in coloration and pattern in females. But recent studies have called into question the nomenclatural distinction of some of these populations. Female *H. bolina* have been studied and, in recent years, illustrated from various parts of the Pacific (Clarke and Sheppard 1975, Tennent 2002, 2009). More recently, Lachlan (2014) discussed and illustrated female *H. bolina* phenotypes collected at a single locality in Fiji. The males also vary but not to the same degree as females. Males collected during the study reported here are variable in body size and in the size of the white markings located subapically on the forewing and those in the center of the hind wing. They also vary in the degree of purple-mauve suffusion, which in some cases almost obscures the central spot on the hind wing.

Tennent (2006:82) recognized four subspecies of *H. bolina* in the Pacific: *H. b. nerina* (Fabricius), with a very wide distribution in the Southwest Pacific from the Northern Marianas, Palau, and Chuuk to the Solomons, New Caledonia, Vanuatu, and New Zealand; *H. b. rarik* von Eschscholtz, distributed in the Marshall Islands, Kiribati, and Tuvalu; *H. b. pallescens* (Butler), distributed in Tokelau, Fiji, Tonga, and the Samoas; and *H. b. otaheitae* (Felder), from the Cook, Society, and Austral Islands to the Tuamotus, Gambiers, and farther east. Difficulties were acknowledged with this arrangement, and it was questioned (Tennent 2006:181–182) whether characteristics could or should be formalized in subspecies names.

The remarkable variety of *H. bolina* female phenotypes observed and collected during this study illustrate the difficulty (perhaps the impossibility) of reliably assigning subspecies names to local populations in Micronesia based only or mainly on female phenotype. They range from being almost completely dark brown on the upper surface, with an obscure postmedian orange flush and restricted forewing subapical white spot, through the "*nerina*" phenotype prevalent in the Solomons, eastern islands of Papua New Guinea, and the southern islands of Vanuatu, to typical "*pallescens*" specimens that usually predominate in Fiji. In assessing variation in Pacific populations of *Junonia villida* (Fabricius), Vane-Wright and Tennent (2011) suggested that the many subspecies recognized by some authors might be due to phenotypic plasticity, with a variable morphology fundamentally dependent on local conditions rather than distinct subspecies. Our accumulated material from atolls and islands from a restricted geographical area in Chuuk and elsewhere, together with Lachlan's (2014) findings in Fiji, suggest that this may apply equally to *H. bolina*. It is certainly the case that, even in series, examples of *H. bolina* cannot be placed geographically with any degree of confidence.

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