

Discovery of a new intertidal trapdoor spider of the genus *Idioctis* (Araneae: Barychelidae), with a generic range extension to Taiwan

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Abstract. Most spiders are exclusively terrestrial with only some groups venturing into aquatic habitats, and only a handful of representatives colonizing the marine intertidal zone. Here, we describe a new intertidal trapdoor spider species, *Idioctis parilarilao* sp. nov., from southern Taiwan and Green Island (Lutao). The original DNA barcode enables species delimitation between different populations from Taiwan and the morphologically closest species, *Idioctis xmas*, from Christmas Island, Indian Ocean. These analyses reveal that all populations from Taiwan, including Green Island, are conspecific, and are distinct from *Idioctis xmas*. Given the lack of representation of other species in public databases, our COI gene tree should be seen as preliminary, but it does support the monophyly of the genus *Idioctis*. As the genus was not previously known from East Asia, our discovery vastly extends the distribution range of *Idioctis* and the family Barychelidae. Given the tectonic and volcanic specifics of the history of Taiwan and Green Island, and the direction of the known oceanic currents, we provide a preliminary explanation of the biogeographic and diversification history of intertidal spiders in the region.

Keywords: Mygalomorphae, East Asia, biogeographic hypothesis, dispersal, marine intertidal

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Spiders are a mega-diverse group of almost exclusively terrestrial species. Their evolution has only rarely led them to venture into aquatic habitats. For example, species of the pisaurid genus *Dolomedes* Latreille, 1804, so called fishing or raft spiders, inhabit freshwater habitats, and the Eurasian water spider, *Argyroneta aquatica* (Clerck, 1757) (Dictynidae), is obligately aquatic (Crews et al. 2020). Rarer still are spider groups whose lifestyles are in part marine. Only a handful of such species are known, and these ecologies have mostly evolved independently in the family Dictynidae O. Pickard-Cambridge, 1871 (Crews et al. 2020), several salticid genera (e.g., *Hakka* Berry & Prószyński, 2001) (Ono 2009), the anyphaenid genus *Amaurobioides* O. Pickard-Cambridge, 1883 (Ceccarelli et al. 2016), the desid genera *Desis* Walckenaer, 1837 and *Cambridgea* L. Koch, 1872 (Crews et al. 2020), as well as the populations of *Oedignatha scrobiculata* Thorell, 1881 (family Liocranidae Simon, 1897) found in Australia (Northern Territory and islands in Coral Sea; personal observations by Robert Raven). Among mygalomorph spiders, despite several taxa inhabiting near-marine river banks (e.g., *Moggridgea rainbowi* (Pulleine, 1919) (Migidae); see Harrison et al. 2016, 2017) and trees (*Sason* Simon, 1887 (Barychelidae)); see Schwendinger 2003), only species of the barychelid genus *Idioctis* L. Koch, 1874 venture into marine-intertidal habitats and can build their burrows below the marine high tide line (Abraham 1924; Raven 1988, 1994; Churchill & Raven 1992). These intertidal spiders build burrows with trapdoors in various near-tidal or intertidal habitats (Table 1) (Raven 1988; Churchill & Raven

1992). Their retreat is closable and the silk evidently impermeable to salt water, thus preventing the seawater from entering the burrow at high tide (Abraham 1924). *Idioctis* has rarely been documented, and populations are currently known only from various Indian Ocean and Pacific Ocean landmasses (Raven 1994; World Spider Catalog 2022).

L. Koch (1874) described the genus *Idioctis* with *I. helva* L. Koch, 1874 from Fiji as its type species. L. Koch (1874) classified it as a barychelid due to it having long claw tufts, oval carapace, larger anterior lateral eyes, and spiny leg patellae III and IV. Hogg (1901) and Rainbow (1914, 1920) have described and incorrectly assigned to the genus three Australian species, *I. palmarum* Hogg, 1901, *I. ornata* Rainbow, 1914, and *I. papuensis* Rainbow, 1920. *Idioctis palmarum* was subsequently transferred to *Idiommatia* Ausserer, 1871 and eventually to *Ozicrypta* Raven, 1994 by Raven (1985, 1994). *Idioctis ornata* and *I. papuensis* were transferred to *Arbanitis* L. Koch, 1874 (Idiopidae) by Main (1977, 1985) and *Arbanitis papuensis* was eventually proposed as a *nomen dubium* by Rix et al. (2017). Simon (1903) later amended Hogg's (1901) incorrect description of the labium and sternum. Abraham's (1924) description of *I. littoralis* Abraham, 1924 from Singapore included the first documentation of its intertidal habitat and behavior. Main (1982) transferred *Idiommatia sordida* Rainbow, 1898 to *Idioctis* while Raven (1994) eventually transferred the species to *Nihoia* Churchill & Raven, 1992 and proposed the species name as a *nomen dubium* as the holotype was juvenile. Narrowing down on diagnostic characters of *Idioctis* and related taxa, Raven (1988)

Table 1.—List of all ten *Idioctis* species and their habitats. Species with male descriptions are marked with “*”.

Species	Habitat	Reference
<i>Idioctis eniwetok</i> *	Under rocks of lowland forest	Raven, 1988
<i>Idioctis ferrophila</i>	Ironstone boulders	Churchill & Raven, 1992
<i>Idioctis helva</i> *	Mangrove roots and coral rocks	Churchill & Raven, 1992
<i>Idioctis intertidalis</i>	Littoral zones	Benoit & Legendre, 1968; Churchill & Raven, 1992
<i>Idioctis littoralis</i>	Mangrove roots	Abraham, 1924
<i>Idioctis marovo</i>	Limestone beach rocks and root of coconut trees	Churchill & Raven, 1992
<i>Idioctis talofa</i>	Larva rocks on beach	Churchill & Raven, 1992
<i>Idioctis xmas</i>	Holes on coral boulders	Personal observations by Robert Raven
<i>Idioctis yerlata</i>	Mangroves and loose coral rubble	Churchill & Raven, 1992
<i>Idioctis parilarilao</i> sp. nov.	Holes on coral boulders	This paper

described three new species from the Marshall and Caroline Islands, Christmas Island, and Hawaii. He also placed the monotypic genus *Atrophonysia* Benoit & Legendre, 1968 from Madagascar as a synonym of *Idioctis* (Raven 1988). Churchill and Raven (1992) described and diagnosed four new *Idioctis* species from New Caledonia, Samoa, the Solomon Islands, and northeast Australia with novel diagnostic characteristics, such as the morphology of preening combs, the number of thorn spines on patella III, and the cheliceral rastellum. Based on the diagnostic characters, they separated *I. hawaiiensis* Raven, 1988 from *Idioctis* and established a new genus *Nihoa*. They also documented variation in the female vulva, which, due to unknown males of most species (Table 1), remains an important feature in identifying species. Barrion & Litsinger (1995) described a new *Idioctis* species from the Philippines, but Raven (2000) synonymized it with *Rhianodes atratus* (Thorell 1890).

Although recent mygalomorph phylogenetic studies have not included *Idioctis* (Opatova et al. 2020), the genus continues to be listed as a member of Barychelidae Simon, 1889. The genus contains nine valid species distributed in the equatorial Indo-Pacific region, most of which are found on isolated oceanic islands (Fig. 1) (World Spider Catalog 2022). Authors have hypothesized that such widespread, yet disjunct distribution patterns might result from occasional long-distance rafting events (Raven 1988; Buzatto et al. 2021) followed by speciation in isolation. In this study, we extend the known distribution of *Idioctis* to include Taiwan. We report a new species, *Idioctis parilarilao* sp. nov., from southern Taiwan and Green Island (Lutao), which is about 3,000 km away from the nearest known locality of *Idioctis* in Singapore. We provide taxonomic details including a species delimitation analysis with newly sequenced DNA barcodes.

METHODS

Taxon sampling and anatomy.—Specimens examined in this study were collected by hand during low tide at night and preserved in 70% ethanol. Measurements and photography were done with a Leica M125 stereomicroscope with a micrometer. The measurements of palps consist of femur, patella, tibia and tarsus while those of legs consist of femur, patella, tibia, metatarsus and tarsus. All measurements are given in millimeters. Variation values are given as “mean \pm standard deviation”. Four legs of each freshly collected specimen were removed and preserved in 95% ethanol for DNA extraction. Most vouchers were deposited at the Department of Life Sciences, National Chung Hsing University (vouchers coded ABARA), and the Taiwan Endemic

Species Research Institute (vouchers coded TESRI). The type specimens will be deposited at Biodiversity Research Museum, Academia Sinica, Taipei, Taiwan (vouchers coded ASIZCH). We include one specimen of *Idioctis xmas* deposited at the Queensland Museum (voucher code: QM-S18682) for phylogenetic analyses. The specimen was collected by P. Davie in 2011 at Greta beach, Christmas Island and is preserved in 75% ethanol. We removed one leg from the specimen and transferred the tissue to 95% ethanol for further DNA extraction. Abbreviations used: AER, anterior eye row; ALE, anterior lateral eye; AME, anterior median eye; MOA, median ocular area; PER, posterior eye row; PLE, posterior lateral eye; PME, posterior median eye.

DNA barcode sequencing.—Genomic DNA was extracted for the amplification of the barcode fragment (cytochrome *c* oxidase subunit I: COI) using FavorPrep™ Tissue Genomic DNA Extraction Mini Kit (Favorgen Biotech, Pingtung, Taiwan), Puregen Core Kit A, or QIAamp DNA Micro Kit (Qiagen, Valencia, CA, USA). Polymerase chain reaction (PCR) mixtures (25 μ l) contained 12.5 μ l of master mix, 0.5–1 μ l of each forward and reverse primer (10 pm/ μ l), 9–9.5 μ l of distilled water and 1–2.5 μ l of genomic DNA. A final concentration of 1.5 mM MgCl₂ was used for all reactions. Sequence amplification protocols start at 94°C for 2 minutes followed by 35 cycles of 30–50 seconds of denaturation at 94°C, 30–50 seconds of annealing at 46–52°C, and 30–50 seconds of polymerizing at 72°C. See Supplemental File 1 for primer sequences and additional information on PCR protocols (online at <https://doi.org/10.1636/JoA-S-22-020.s1>).

PCR products were sent to the Genomics Center for Clinical and Biotechnological Applications of National Core Facility for Biopharmaceuticals (Taipei, Taiwan), BioSci & Tech. Co., Ltd. (New Taipei, Taiwan), and Macrogen Europe B.V. (Amsterdam, Netherlands) for purification and sequencing. All sequences were edited and aligned in Geneious Pro 5.6.7 and uploaded to GenBank (see Table 2 for the accession numbers).

Species delimitation.—Aside from the sequences of *Idioctis*, we obtained representative sequences of other barychelid genera available on GenBank (Table 2). We used sequences of Theraphosidae (Table 2) as outgroups based on the results of the latest mygalomorph phylogeny (Opatova et al. 2020) (see Supplemental File 2, online at <https://doi.org/10.1636/JoA-S-22-020.s2> for the data matrix). For the species delimitation analyses, we first performed Assemble Species by Automatic Partitioning (ASAP) (Puillandre et al. 2021) following a Kimura 2 parameter genetic distance substitution model (Kimura 1980) with threshold distance

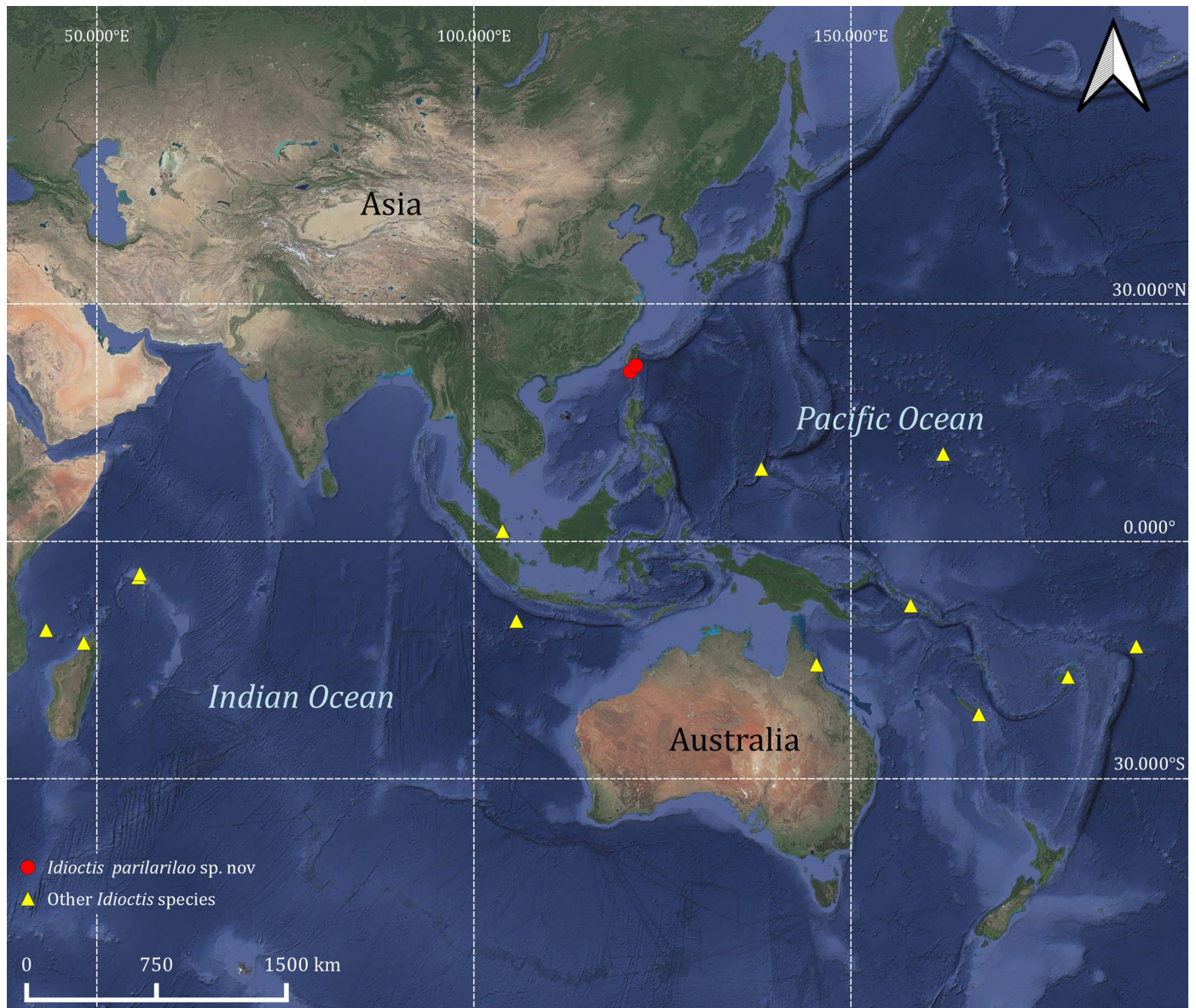


Figure 1.—The known localities of *Idioctis parilarilao* sp. nov. (red circles) and other *Idioctis* species (yellow triangles) (modified from Churchill & Raven, 1992).

set above 0.05. Then, we obtained a COI gene tree through a maximum likelihood analysis in RAxML (Stamatakis 2014) on the CIPRES Science Gateway portal (Miller et al. 2010) with 100 bootstrap replicates using the program's rapid bootstrapping algorithm, and with sequences partitioned by codon. Based on the gene tree, we ran a Bayesian implementation of the Poisson tree analysis under maximum likelihood and Markov chain Monte Carlo (bPTP) (Zhang et al. 2013).

RESULTS

We obtained four original *Idioctis* COI sequences, of which three *Idioctis parilarilao* sp. nov. were from Taiwan (two from Kenting and one from Green Island) and one *Idioctis xmas* was from Christmas Island. Two sequences contained 660 base pairs and two had 1075 base pairs. In species delimitation analyses, we

used these original sequences along with sequences of barychelid and theraphosid outgroups (Fig. 2). The ML analysis (Fig. 2) suggests that the four *Idioctis* individuals are monophyletic with strong nodal support. The analysis also groups *Idioctis* with other barychelid genera albeit with low support. Both ASAP and bPTP suggest that *Idioctis parilarilao* sp. nov. is a distinct species, not conspecific with *Idioctis xmas* from Christmas Island. However, with genetic distances around 3% populations of *Idioctis parilarilao* sp. nov. show molecular structure indicative of a limited gene flow between Kenting and Green Island.

DISCUSSION

The COI gene tree in this study is the first test of the phylogenetic relationships between *Idioctis* and other barychelid genera. Compared to its sister family Theraphosidae (Opatova et al. 2020),

Table 2.—List of sequences used in this study and their GenBank accession numbers.

GenBank accession number	Family	Species
JN018198	Theraphosidae	<i>Coremiocnemis cunicularia</i>
JN018126	Theraphosidae	<i>Cyriopagopus schioedtei</i>
KY017966	Theraphosidae	<i>Harpactirella</i> sp.
MK234712	Theraphosidae	<i>Lasiadora difficilis</i>
MK270577	Theraphosidae	<i>Poecilotheria regalis</i>
KJ744636	Barychelidae	<i>Aureocrypta</i> sp.
KJ744805	Barychelidae	<i>Aureocrypta</i> sp.
KJ745197	Barychelidae	<i>Idiommata blackwalli</i>
KJ745205	Barychelidae	<i>Idiommata</i> sp.
KJ745505	Barychelidae	<i>Idiommata</i> sp.
MW199723	Barychelidae	<i>Mandjelia</i> sp.
KY017602	Barychelidae	<i>Synothele arrakis</i>
KJ744598	Barychelidae	<i>Synothele</i> sp.
KJ745084	Barychelidae	<i>Synothele</i> sp.
KJ745108	Barychelidae	<i>Synothele</i> sp.
MN433230	Barychelidae	<i>Synothele</i> sp.
KJ745343	Barychelidae	<i>Synothele</i> sp. “ <i>xkarara</i> ”
ON023721	Barychelidae	<i>Idioctis parilarilao</i> sp. nov.
ON023723	Barychelidae	<i>Idioctis parilarilao</i> sp. nov.
ON023724	Barychelidae	<i>Idioctis parilarilao</i> sp. nov.
ON023722	Barychelidae	<i>Idioctis xmas</i>

the phylogenetic relationships within Barychelidae are poorly studied. Considering that Barychelidae are one of the few mygalomorph families containing inter-tidal organisms (Raven 1988), reconstructing the barychelid phylogeny should help inform the evolution of intertidal behaviors, as well as transoceanic dispersal patterns. There is reason to believe that not all mygalomorphs, despite living in burrows or funnels, are poor dispersers (Raven 1986; Buzatto et al. 2021). For example, phylogeographic studies of Migidae Simon, 1889 have posited that the African lineage *Moggridgea* O. Pickard-Cambridge, 1875 colonized Australia via a single transoceanic dispersal event long after the breakup of the continents (Harrison et al. 2016, 2017). Main’s (1957) study on the occurrences of the halonoproctid species *Conothele malayana* (Doleschall, 1859) also hypothesizes the spiders have reached isolated lands via episodes of aerial dispersal.

While never empirically tested, species of the genus *Idioctis* may be among the mygalomorphs with good dispersal abilities since they have managed to colonize isolated islands, probably via isolated rafting events (Raven 1988; Buzatto et al. 2021). Our finding of a new species in Taiwan adds credibility to this hypothesis. Both Taiwan and Green Island were formed *de novo* by tectonic collisions and subsequent volcanic activities isolated from any continent (Sibuet & Hsu 2004). Although Taiwan and continental East Asia are believed to have been connected during the last glacial maximum (Sibuet et al. 1995; Kimura 2000), there is no record of any barychelid species in continental East Asia

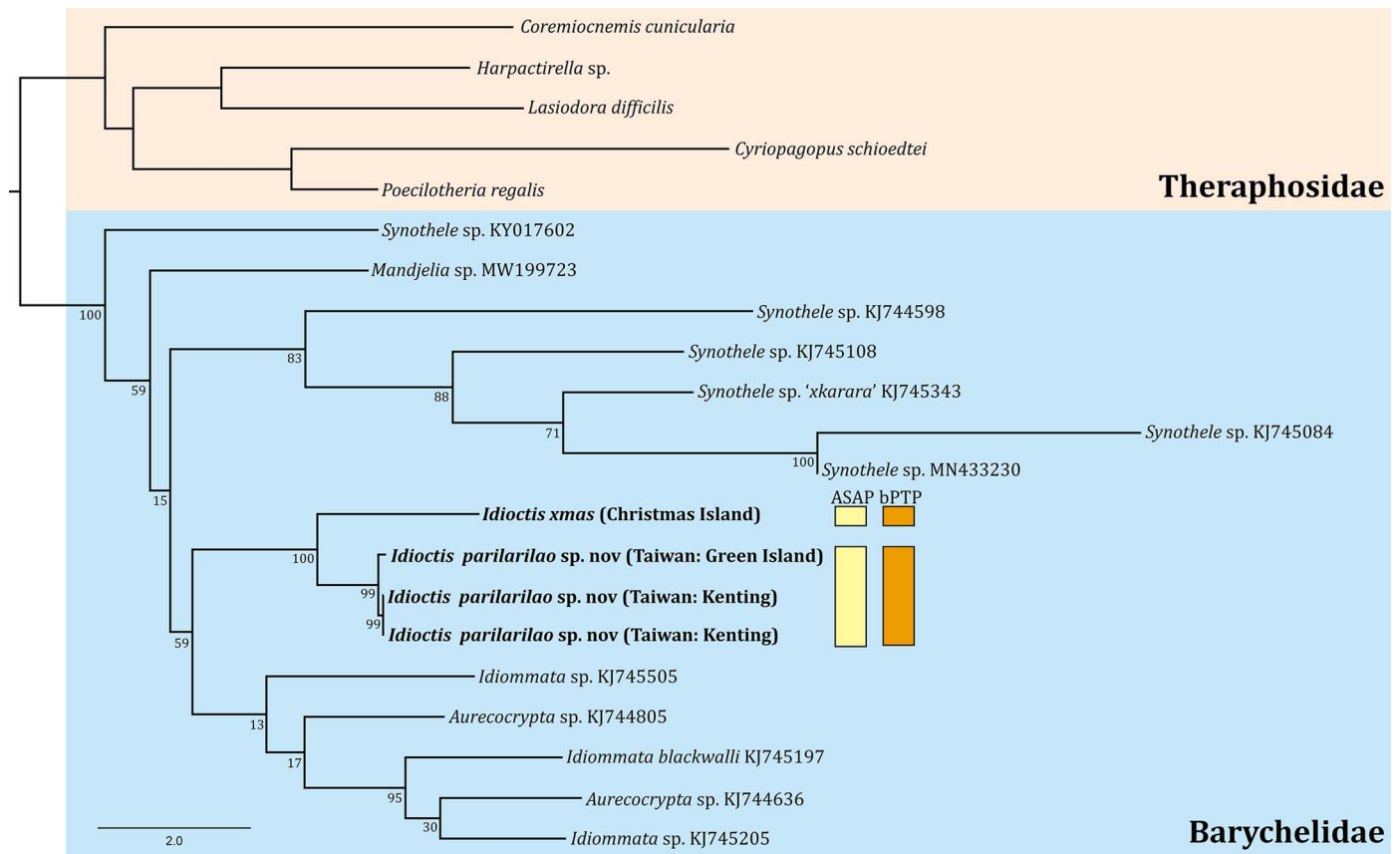


Figure 2.—ASAP and bPTP species delimitation analyses based on COI sequences indicate that all *Idioctis parilarilao* sp. nov. from Taiwan are conspecific and distinct from *Idioctis xmas* on Christmas Island.

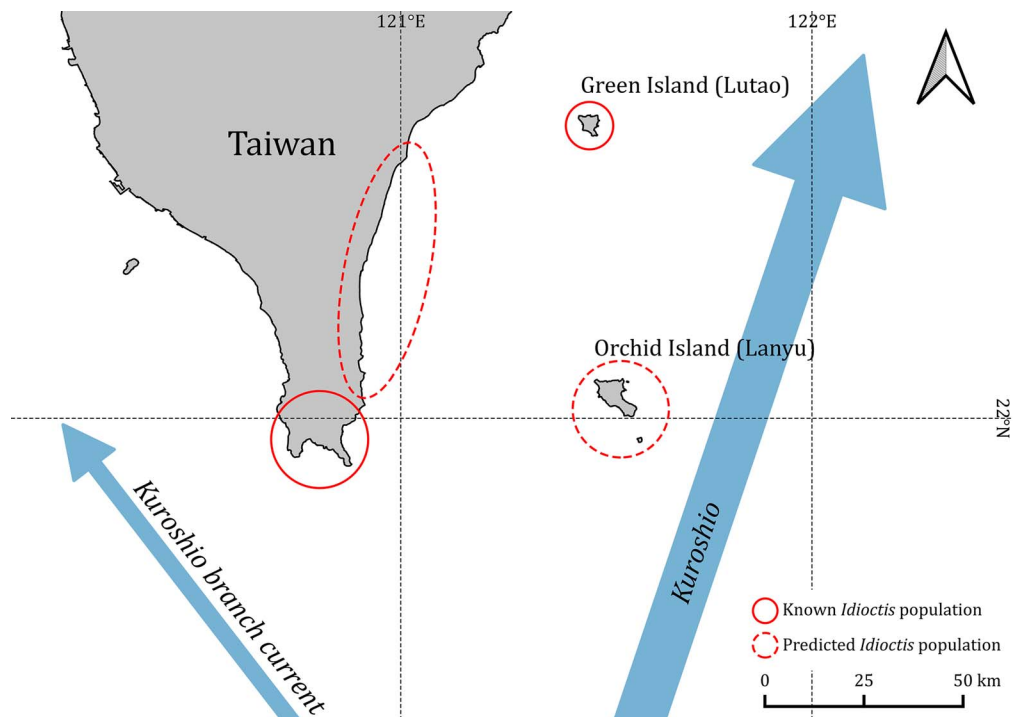


Figure 3.—Known and predicted *Idioctis parilarilao* sp. nov. populations in Southern Taiwan following the hypothesized dispersal scenarios in the discussion. The direction of Kuroshio current is modified from Jan et al. (2002).

(World Spider Catalog 2022). Considering *Idioctis parilarilao* sp.nov. is the only barychelid species known and described in Taiwan and in East Asia, *Idioctis* must have reached Taiwan during one or more episodes of long-distance dispersal followed by speciation.

Considering the contemporary distribution patterns (Fig. 1) and the hypothesized dispersal biology, *I. parilarilao* sp. nov. may have dispersed to Taiwan and Green Island from the south via the Kuroshio Current. Having its origin in the western equatorial Pacific and ending in Japan, the Kuroshio Current brings tropical marine (Kuriwa et al. 2014; Okada et al. 2015), or even terrestrial organisms (Lin et al. 2002; Yang et al. 2018; Yeh et al. 2018) to the north. Kuroshio flows past the east coast of Taiwan and the two offshore islands, Green Island and Orchid Island (Lanyu) (Fig. 3) (Jan et al. 2002). As such this current would have substantial influence on the species that accumulate on these three islands (Chen & Shashank 2009; Kuriwa et al. 2014; Yeh et al. 2018; Keshavmurthy et al. 2019; Kang et al. 2020). An example is the flightless weevil genus *Pachyrhynchus* from the Taiwan-Luzon volcanic belt. Yeh and colleagues' (2018) experiment revealed that the larvae of the weevil could survive in the fruit of its host plant after seven days of rafting in seawater. This, together with a phylogeographic study suggesting their northward steppingstone colonization from Luzon to Iriomote (Tseng et al. 2018), suggest that Kuroshio serves as one of the main pathways for dispersal of these weevils. *Idioctis* may disperse in a similar way, perhaps rafting on debris with ocean currents. Based on the above dispersal scenarios, we predict that more populations of *I. parilarilao* sp. nov. may be discovered on Orchid Island and the east coast of the Hengchun Peninsula (Fig. 3). Plausibly, one might also expect the discovery of additional *Idioctis* species in the Philippines.

Finer testing of the biogeographical scenarios of marine mygalomorphs are impeded by an absence of physiological and behavioral data. So far, the long-distance rafting hypotheses in marine mygalomorphs have only been inferred from phylogeographic studies (Harrison et al. 2017; Buzatto et al. 2021). However, their abilities and the possibilities of rafting and surviving in seawater have not been tested. On the other hand, marine mygalomorphs present highly disjunct distribution ranges (Raven 1988; Churchill & Raven 1992), which in other marine-related organisms are usually continuous along their dispersal pathway. Such disjunct distributions also increase the difficulties in stating testable biogeographic hypotheses. To date, our knowledge of these unique spiders is still limited. More surveys and studies on their ecology, behavior, physiology, and phylogeny should be followed to test and facilitate further biogeographic and phylogeographic hypotheses.

TAXONOMY

Family Barychelidae Simon, 1889

Genus *Idioctis* L. Koch, 1874

Atrophonysia Benoit & Legendre, 1968. Synonymized by Raven, 1988

Type species.—*Idioctis helva* L. Koch, 1847. Koch described the type species from Ovalau Island, Fiji. The species also inhabits Lotu Island, Fiji (Churchill & Raven 1992).

Diagnosis.—*Idioctis* differs from all other known barychelids by the combination of the following characters: the pale and pattern-less abdomen dorsally (Figs. 4A–B, 5A), the narrow sternum which is about 1.5 times longer than wide (Fig. 4C), the presence of a cheliceral rastellum (Figs. 4D, 5B), the short and trapezoidal eye group (Fig. 4E) (Raven 1988, 1994; Churchill & Raven 1992).

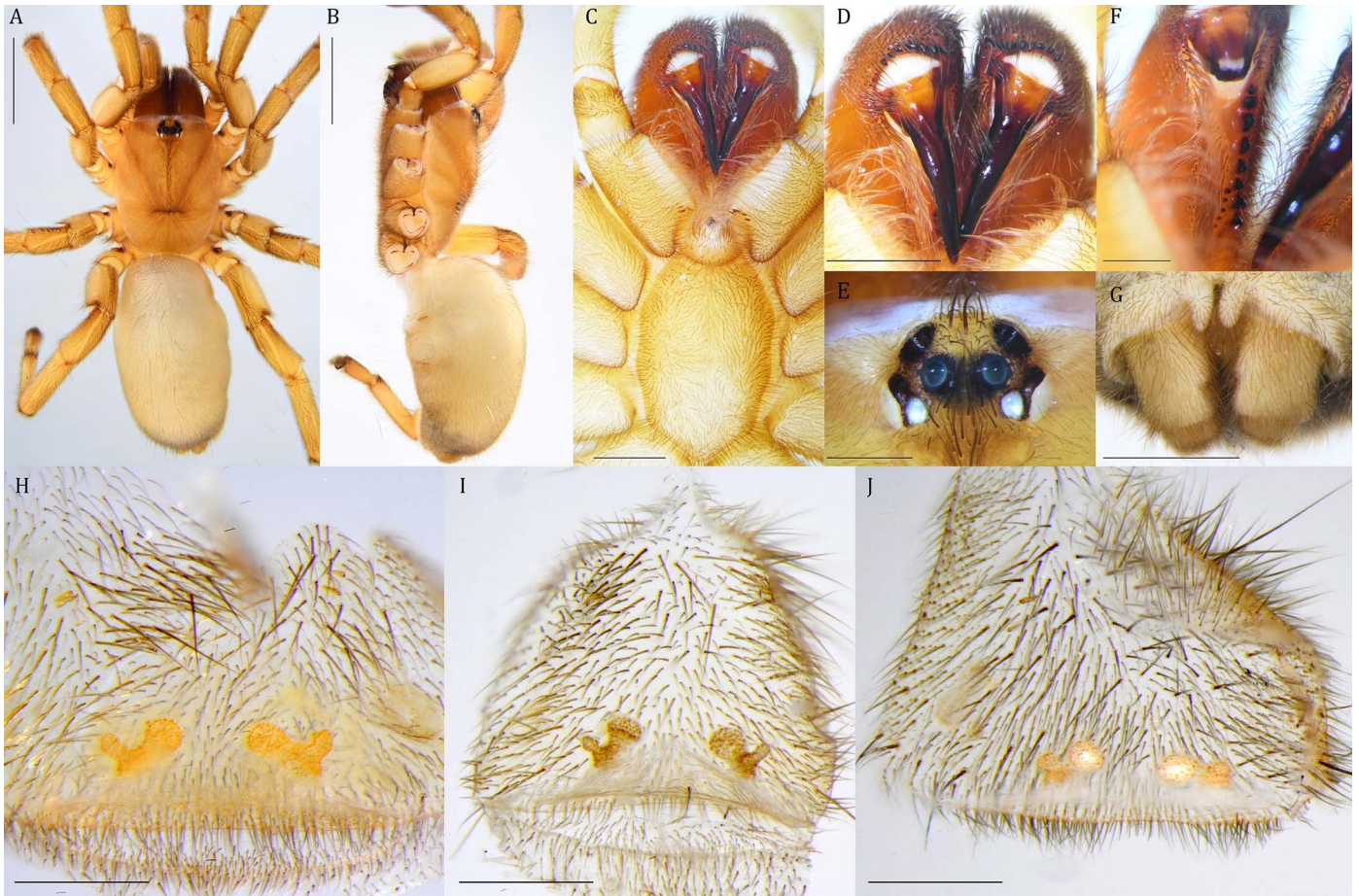


Figure 4.—*Idioctis parilarilao* sp. nov. A–H, female holotype (voucher code ASIZCH000106): A. dorsal view. B. lateral view. C. sternum and chelicera, ventral view. D. chelicera, ventral view showing the rastellum. E. eye mound, dorsal view. F. chelicera, ventral view showing the promarginal and basomesal teeth. G. spinnerets, ventral view. H. vulva, dorsal view. I. vulva of female paratype (ASIZCH000107), dorsal view. J. vulva of female from Green Island (TESRI-Ar5761), dorsal view. Scale bars: A, B, 3 mm; C, D, G, 1 mm; E, F, H, I, J, 0.5 mm.

Description.—*Carapace*: oval and narrow with distinct cervical grooves and fovea, a row of long bristles extends from the fovea to the eye range (Figs. 4A–B, 5A). *Sternum*: oval and narrow with its aspect ratio around 1.5 (Fig. 4C). *Idioctis eniwetok* Raven, 1988 has a relatively wider sternum which is only 1.3 times longer than wide (Raven 1988; Churchill & Raven 1992). *Chelicerae*: promarginal and basomesal teeth distinct. Chelicerae with a rastellum consisting of either one or multiple row(s) of thick conform spines located on the ventral side of the anterior mound of each chelicera (Figs. 4D, F, 5B). *Idioctis littoralis* Abraham, 1924 has a unique rastellum that consists of long spine-like setae rather than thick spines (Raven 1988; Churchill & Raven 1992). *Eye group*: short and trapezoidal. Eight eyes arranged in two rows, the anterior row procurved and the posterior row near straight (Fig. 4E) (Raven 1988; Churchill & Raven 1992). *Spinnerets*: two pairs, the posterior lateral spinnerets are larger and consist of three segments while the posterior median spinnerets have only one segment (Fig. 4G) (Raven 1988; Churchill & Raven 1992). *Female vulva*: two spermathecae, each is bilobed and oval or globe-shaped, the medial lobe is usually larger with a smaller lateral lobe branching from either its median or basal part (Figs. 4H–J, 5C). *Idioctis eniwetok* has an elongated medial lobe of the spermathecae (Raven 1988; Churchill &

Raven 1992). *Legs*: leg formula 4-1-2-3. Scopula full and entire on metatarsus and tarsus of palps, legs I, and II while separated by strong spines on leg III; scopula absent on leg IV. Prolateral side of the patellae III and IV have thorn spines. Patella III has more thorn spines (17–30) than patella IV (3–16) (Table 3; Figs. 6A, C). Each paired claw on all legs usually has one (females) or two (males) row(s) of teeth (Table 3). Preening combs absent in *I. ferrophila* Churchill & Raven, 1992, *I. helva*, and *I. talofa* Churchill & Raven, 1992 while present in all the other species (Table 3; Figs. 6B, D). Distoventral and prolateral edge of the male tibia I has two additional strong spines (Raven 1988; Churchill & Raven 1992). *Male palpal organ*: bulb squat with distinct embolus. Cymbium divided into two lobes, with thick setae at the tip (see Churchill & Raven, 1992; Raven, 1988).

Etymology.—L. Koch (1874) did not mention the meaning of the genus name in his original description. *Idioctis* seems to be a latinized Greek-rooted compound word. The first half “idio” (ἴδιο) refers to self, private, and alone; the rest “ktis” (κτισ) has the meaning of build, construction, and founder. Together, *Idioctis* (ἰδιόκτισ) would be “self-builder” in the sense of “one who builds by itself” or “one who builds its own stuff”.

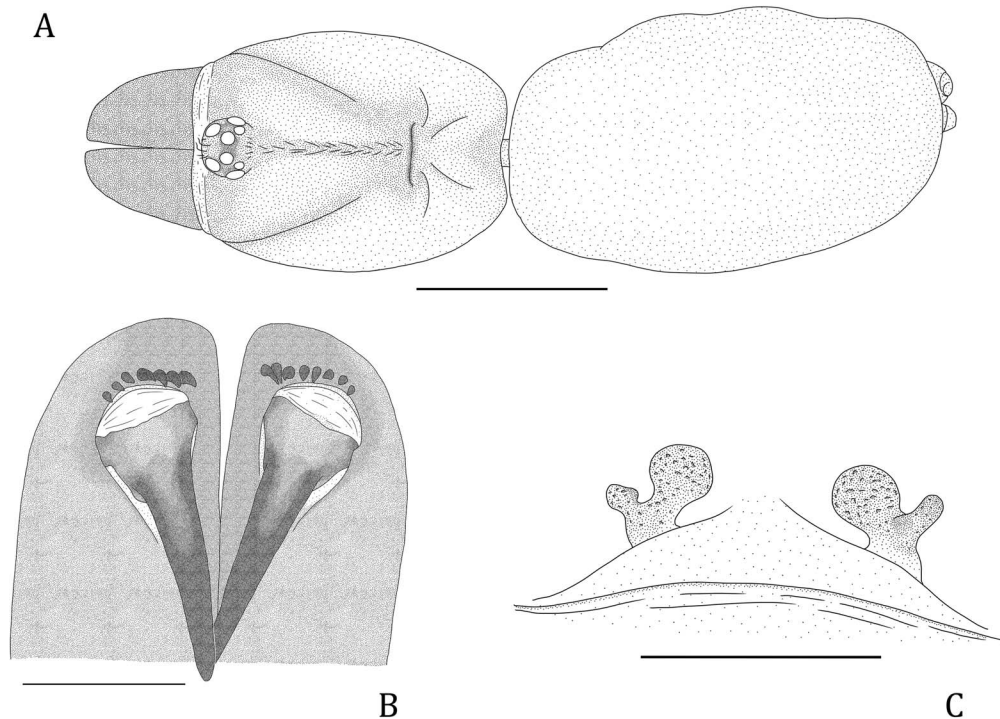


Figure 5.—*Idioctis parilarilao* sp. nov. A–B, female holotype (voucher code ASIZCH000106): A. dorsal view. B. chelicera, ventral view showing the rastellum. C. vulva of female paratype (ASIZCH000107), dorsal view. Scale bars: A, 3 mm; B, 1 mm; C, 0.5 mm.

***Idioctis parilarilao* sp. nov**

ZooBank ID: <http://zoobank.org/?lsid=urn:lsid:zoobank.org:act:193CA6C8-6109-4E52-B644-A16DE21E4A3A>
(Figs. 4–7)

Type material.—*Holotype female*. TAIWAN: *Pingtung County*: Kenting National Park, 21°60'00"N, 120°50'00"E, 30 April 2016, Ying-Yuan Lo (ASIZCH000106).

Paratype. 1 ♀, same data as holotype (ASIZCH000107).

Other material examined.—TAIWAN. *Pingtung County*: 1 ♀, same locality as holotype, 11 March 2017, Ren-Chung Cheng (ABARA00007). *Taitung County*: 1 ♀, Green Island, 22°40'00"N, 121°30'00"E, 20 October 2021, Yu-Chi Kung (TESRI-Ar5761).

Etymology.—The specific name *parilarilao* is a noun in apposition and refers to the name of the type locality in the indigenous Paiwan language. The same name refers to the tribe living in the southernmost part of Taiwan.

Diagnosis.—Females of *I. parilarilao* sp. nov. differ from those of *I. ferrophila*, *I. helva*, and *I. talofa* by the presence of preening combs on the distal ventral edge of metatarsi III and IV (Table 3; Figs. 6B, D) (Raven 1988; Churchill & Raven 1992). *Idioctis parilarilao* sp. nov. differs from *I. marovo* Churchill & Raven, 1992 and *I. yerlata* Churchill & Raven, 1992 by having sparser coniform spines on the rastellum and thorn spines on the patellae (Table 3; Figs. 4D, 5B, 6A, C) (Raven 1988; Churchill & Raven 1992). *Idioctis parilarilao* sp. nov. can be diagnosed from *I. eniwetok*, *I. intertidalis* (Benoit & Legendre, 1968), *I. littoralis*, and *I. xmas* Raven, 1988 by the morphology of the spermathecae: *I. parilarilao* sp. nov. has bilobed spermathecae with a globe-shaped medial lobe and a smaller, globe-shaped lateral lobe branching from the median part of the medial lobe (Figs. 4H–J, 5C), while *I. eniwetok*

has an elongated medial lobe; *I. intertidalis* has both lobes in long oval shapes and in similar sizes; *I. littoralis* has a lateral lobe branching from the basal part of the medial lobe; and *I. xmas*, despite presenting the most similar somatic characters to *I. parilarilao* sp. nov. (Table 3), has a thin and small lateral lobe of the vulva (Raven 1988; Churchill & Raven 1992).

Description (female holotype).—Total length 11.9; cephalothorax length 5.0, width 3.8; abdomen length 6.9, width 4.2. Length of palps and legs: palp 6.8 (2.5, 1.6, 1.5, 1.2); leg I 10.0 (3.1, 2.2, 2.1, 1.5, 1.1); leg II 9.3 (2.9, 2.0, 1.9, 1.4, 1.1); leg III 7.7 (2.2, 1.7, 1.5, 1.4, 0.9); leg IV 11.9 (3.0, 2.3, 3.0, 2.4, 1.2). Leg formula 4123. Posterior median spinnerets length 0.3. Posterior lateral spinnerets length 1.1. Carapace light brown, oval, and covered with thin, grayish setae. Fovea, thoracic groove distinct (Figs. 4A, 5A). Strong bristles arranged in lines extend from fovea to ocular region. Eight eyes ringed with black, and arranged in two rows, AER strongly procurved and PER almost straight. Several long bristles located between PME (Fig. 4E). Diameters of AME 0.16, ALE 0.26, PME 0.14, PLE 0.28; MOA length 0.36, anterior width of MOA 0.52, posterior width of MOA 0.70; interval of AMEs 0.20, interval of PMEs 0.42, interval of ALEs 0.16, interval of PLEs 0.02. Clypeus 0.08, light brown. Chelicerae chestnut brown and covered by setae and fine bristles, with eight promarginal teeth and five basomesal teeth (Fig. 4F). Left chelicera with rastellum that consists of eight short and strong coniform spines on the mound, arranged in a line with their bases touching (Figs. 4D, 5B). Maxillae yellowish brown with milky white anterior lobe and three to four cuspsules at the basal edge. Length of each maxilla is about 1.6 times its width. Labium yellowish brown, near triangular, width is about 1.5 times its length. Sternum narrow,

Table 3.—List of somatic characters of each *Idiopsis* species. Number of teeth on paired claw is present as claw I II III IV with variations in parentheses; ' represent one row of teeth, '' represent two rows of teeth, and - represent data unavailable.

Species	Sternum ratio (length/width)	Number of coniform spines in rastellum	Number of thorn spines (patella III/ IV)	Preening comb	Number of teeth on paired claw	Reference
<i>Idiopsis emiwetok</i>	1.30	11	18/3	present	4'4'2''1'	Raven, 1988
<i>Idiopsis ferrophila</i>	1.48	10	30/11	absent	5'-3'	Churchill & Raven, 1992
<i>Idiopsis helva</i>	1.50	10-14	18/9	absent	4(5)'4(5)'4(5)'4(5)'	Churchill & Raven, 1992
<i>Idiopsis intertidalis</i>	NA	11	NA	NA	4(6)'4(6)'3'0	Churchill & Raven, 1992
<i>Idiopsis littoralis</i>	1.51	6	21/10	present	5'-2'	Raven, 1988
<i>Idiopsis marovo</i>	1.47	10	25/10-16	present	2(4)'2(4)'2(4)'2(4)'	Churchill & Raven, 1992
<i>Idiopsis talofa</i>	1.65	11	18-20/9	absent	4'4'4'4'	Churchill & Raven, 1992
<i>Idiopsis xmas</i>	1.50	9-10	NA/6	present	3(4)''-0(1)'	Raven, 1988
<i>Idiopsis yerlata</i>	1.56	12-14	28-30/11-16	present	5(7)''-3'2'	Churchill & Raven, 1992
<i>Idiopsis parilarilao</i> sp. nov.	1.50-1.56	8-10	17-19/5-7	present	3(5)'3(4)'2(3)'0(3)'	This paper

oval and yellowish brown. Length of sternum is about 1.5 times its width (Fig. 4C). All legs yellowish brown covered with thick setae, and with several erect black setae and bristles arranged in a line on ventral metatarsus and dorsal femur to metatarsus. Scopulae full and entire on metatarsus and tarsus of palps, legs I, and II, while separated by strong spines on leg III; scopula absent on leg IV (Figs. 6B, D). Preening combs consist of eight long spines at the ventral edge of metatarsus III; whilst on leg IV are a row of short spines and long bristles (Figs. 6B, D). Seventeen thorn spines on prolateral patella of leg III and five tiny spines on basal patella of leg IV (Figs. 6A, C). Paired claws I and II with three teeth, claws III with two teeth while claws IV toothless; all teeth on each paired claws are in one row. Abdomen narrow, oval, without markings; both dorsum and venter yellowish-brown (Fig. 4A) becoming light greyish near spinnerets (Fig. 4G). Abdomen covered by light-yellowish setae with several additional long black setae. Vulva with two spermathecae, each with two lobes, one larger medial lobe, and one smaller lateral lobe branched from the median part of medial lobe, both lobes globe-shaped (Fig. 4H).

Male unknown.

Variation.—The following variation was measured in four females. Total length 10.9 ± 1.8 ; cephalothorax length 4.8 ± 0.2 , width 3.7 ± 0.4 ; abdomen length 6.1 ± 1.8 , width 3.8 ± 1.1 . Palp 6.8 ± 0.3 ; leg I 9.6 ± 1.0 ; leg II 8.8 ± 0.4 ; leg III 7.5 ± 0.4 ; leg IV 11.8 ± 0.2 . Diameters of AME 0.17 ± 0.03 , ALE 0.25 ± 0.02 , PME 0.13 ± 0.01 , PLE 0.27 ± 0.03 . Cheliceral pro-marginal teeth, seven to eight; retromarginal teeth, three to five; eight to ten coniform spines on rastellum. Thorn spines on prolateral patella III 17 to 19, IV from five to seven. The number of teeth on the paired claws are stable in all three specimens from Kenting while the one from Green Island has five teeth on claw I, four teeth on claw II, and three teeth on both claw III and IV. Variation of the vulva see Figs. 4H-J.

Natural history.—Cryptic, medium sized trapdoor spiders that inhabit the intertidal zone. Nocturnal, ambushing small arthropods at night during low tide (Fig. 6E). Tubular nests with trapdoors are built on large coral rocks or cliffs. Trapdoors usually combine coral sand, debris, and nearby algae, providing good camouflage (Fig. 6F). Nests are connected to naturally formed chambers or crevices that can preserve air for spiders during high tide (Fig. 7). Phenology largely unknown, although in October, large numbers of spiderlings with tiny trapdoors have been observed on the rock above the high tideline. Males have not been found despite revisiting the type locality several times in all seasons.

Remarks.—This is the first record of Barychelidae and *Idiopsis* from East Asia, and greatly extends their distribution range northward. In consideration of the accessibility of the type locality and possible collecting pressure serving the pet market, we have omitted the detailed locality and coordinates to shield this unique species.

Distribution.—Known only from the southern end of Taiwan (Kenting), and Green Island (Lutao) (Fig. 3).

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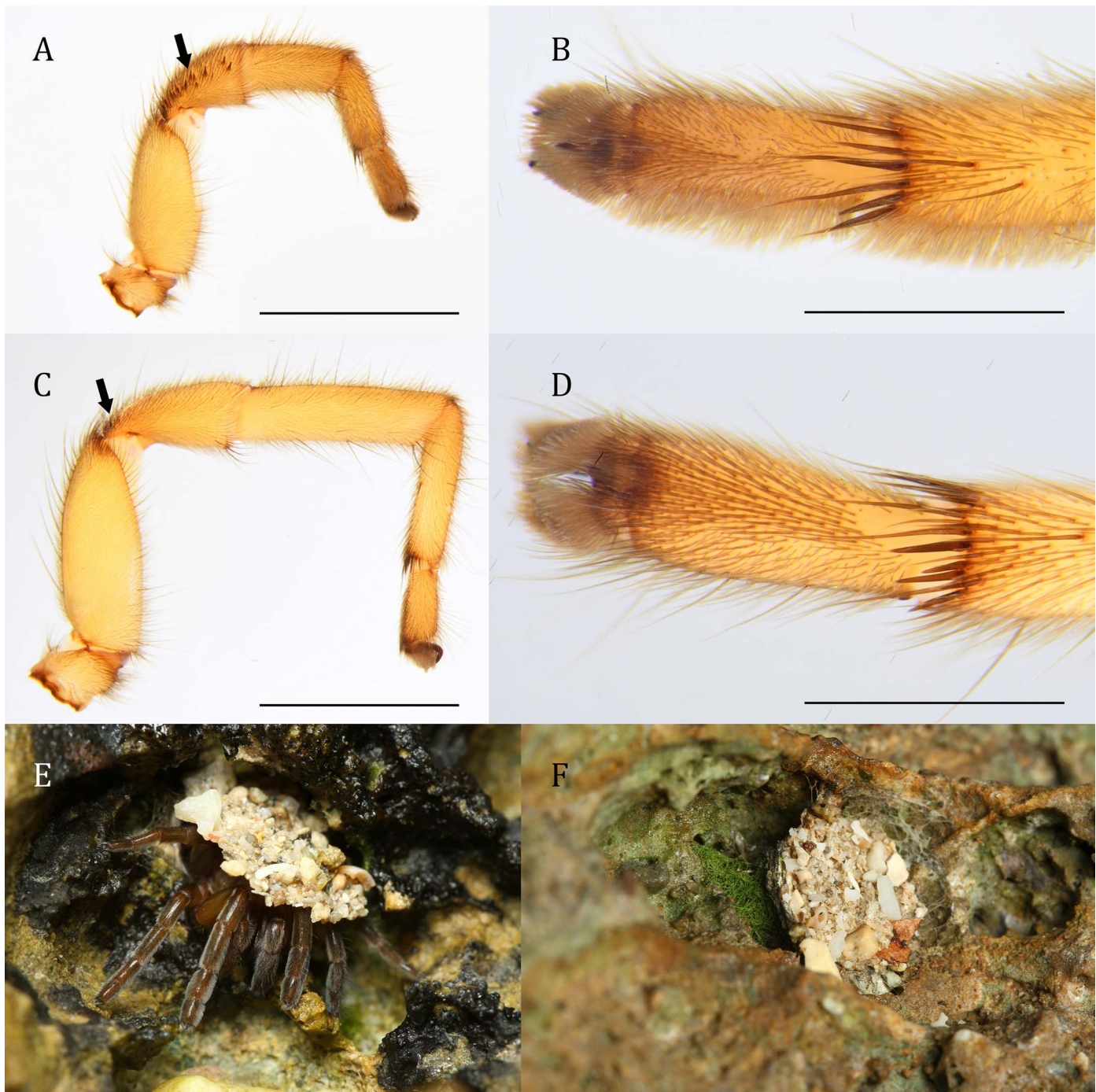


Figure 6.—*Idioctis parilarilao* sp. nov. A–D, female holotype (voucher code TESRI-Ar1705): A. left leg III, prolateral view showing the thorn spines (arrow). B. left metatarsus and tarsus III, ventral view showing the scopula and the preening comb. C. left leg IV, prolateral view showing the thorn spines (arrow). D. left metatarsus and tarsus IV, ventral view showing the scopula and the preening comb. E. *Idioctis parilarilao* sp. nov., in hunting position. F. trapdoor of a *I. parilarilao* sp. nov., containing nearby coral sand. Scale bars: A, C, 3 mm; B, D, 1 mm.

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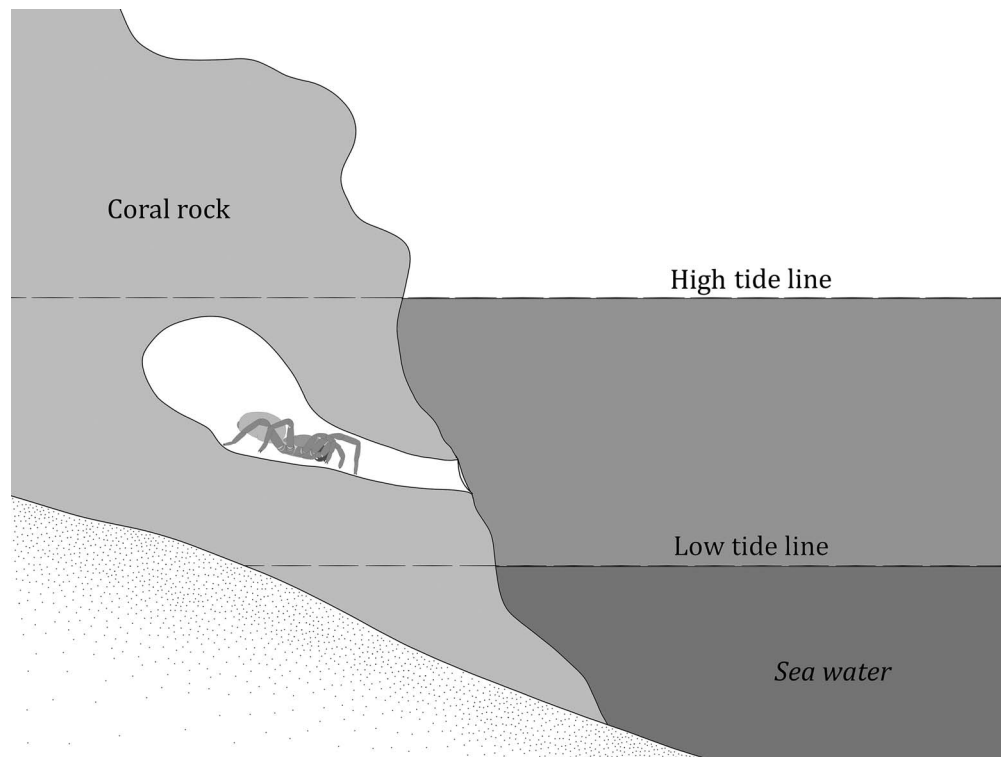


Figure 7.—Nest of *Idiopsis parilarilao* sp. nov and its surrounding environment.

SUPPLEMENTAL MATERIALS

Supplemental File 1.— Primer sequences and PCR information; online at <https://doi.org/10.1636/JoA-S-22-020.s1>

Supplemental File 2.— Aligned DNA sequence matrix, online at <https://doi.org/10.1636/JoA-S-22-020.s2>

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