Revista Ibérica de Aracnología, nº **32** (30/06/2018): 31–36.
Grupo Ibérico de Aracnología (S.E.A.). ISSN: 1576 - 9518.

A NEW SPECIES OF *CHARON* (AMBLYPYGI: CHARONTIDAE) FROM ORCHID ISLAND (TAIWAN)

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Abstract: Lanyu Island, also known as Orchid Island, is a small volcanic islet off the south-eastern coast of Taiwan. It is part of the Luzon volcanic arc and shares its floral kingdom with Luzon Island (Philippines). Lanyu, Lutao Island and the south-eastern coast of Taiwan are a link between the Holarctic and Palearctic floral kingdoms. This particularity reflects on its fauna,which has a high endemism rate. A new species of *Charon* from Lanyu Island is herein described which differs from the other known species by the number of trichobothria on the distitibia of the leg IV and by the pedipalp spination. This record highlights the peculiar biota inhabiting Lanyu island and its closer links to the Luzon's arc rather than to Taiwan's main island.
Key words: Amblypygi, Charontidae, whip spiders, systematics, new species, Lanyu Island, Taiwan.

Una especie nueva de *Charon* (Amblypygi: Charontidae) de la Isla de las Orquídeas (Taiwán)
Resumen: La isla de Lanyu, también conocida como Isla de las Orquídeas, es un pequeño islote volcánico frente a la costa sureste de Taiwán. Es parte del arco volcánico de Luzón y se inscribe en el mismo reino florístico que la isla de Luzón (Filipinas). Lanyu, la isla de Lutao y la costa suroriental de Taiwán forman un nexo entre los reinos florísticos Holártico y Paleártico. Esta particularidad se refleja en su fauna, que tiene un alto número de endemismos. Aquí se describe una especie nueva de *Charon* de la isla de Lanyu, que difiere de las otras especies conocidas por el número de tricobotrios de las distitibias del cuarto par de patas y por la espinación de los pedipalpos. Esta especie ilustra la peculiaridad de la biocenosis de Lanyu y su conexión con el arco de Luzón, más estrecha que con la isla principal de Taiwán.
Palabras clave: Amblypygi, Charontidae, amblipigios, systematics, especie nueva, isla de Lanyu, Taiwán.

Taxonomy/Taxonomía: *Charon ambreae*, **sp. n.**

Introduction

Lanyu Island, also known as the Orchid island, is a small volcanic islet of 48.5 km² (Takhtajan 1986) off the Southeastern coast of Taiwan Island (Fig. 1). Lanyu and Lutao Islands are separated from Taiwan by deep oceanic trenches, and the two islands plus the coastal range of Taiwan, represent the northern part of the Luzon volcanic arc.

Taiwan has two recognized floristic kingdoms: the southernmost portion (Hengchun peninsula) and two islets to the east of Taiwan (Lanyu and Lutao), which belongs to the Paleotropical kingdom and the rest of Taiwan belonging to the Holarctic kingdom (Takhtajan 1986). The first group may be considered collectively to represent the eastern section of the zone of confluence between the so-called East Asian floristic region and the Malesian floristic region (Hsieh, 2002). Lanyu island, possesses the northernmost tropical forest in East Asia (Chen & Tso, 2004; Chao *et al.,* 2010). It is composed of a high proportion of tropical-related species (66–73%; Liu & Lin, 1978) and have relatively dense vegetation layer.

Previous expeditions focusing on the diversity of selected groups (mainly vertebrates and flowering plants), spider diversity (Chen & Tso, 2004; Yoshida *et al.,* 2000) and termites (Li *et al.,* 2008) have revealed that Orchid Island's fauna and flora contain components that are unseen in Taiwan but are common in the Philippines (Shen, 1998). During any of these expeditions, whip spiders were found, but were never studied (Rahmadi *et al*., 2011).

In the Luzon archipelago, which main land is about 350 km off the Taiwanese coast, only *Sarax brachydactylus* (Simon, 1892) and *Charon grayi* (Gervais, 1842) are known (Harvey 2003; Rahmadi *et al.,* 2011).

The genus *Charon* consists of five species known in the Indo-Pacific Region (Harvey, 2003; Harvey & West, 1998; Rahmadi *et al.,* 2011). Three are known from Northern- and Northeastern Australia and Christmas island: *Charon gervaisi* Harvey & West, 1998, *Charon oenpelli* Harvey & West, 1998, and *Charon trebax* Harvey & West, 1998. *Charon forsteri* Dunn, 1949 is known from the Solomon islands and the fifth species, *Charon grayi* (Gervais, 1842) is known from Indonesia (Java, Maluku, Sumbawa), Malaysia, Palau, Papua New Guinea, Philippines, Singapore and Solomon islands (Harvey, 2003) and seems to be a species complex (Harvey & West, 1998; Weygoldt, 2002). As it was discussed in Harvey & West (1998), *Charon* species' need a detailed taxonomic and phylogenetic study, but the species described in the current contribution differs greatly enought, both morphologically and geographically, from the other known species of the genus to be described as new.

This new species appears to be very common on the island. Within 17 days, 4 specimens (in addition to the collected material) were observed on several locations (Fig. 4) (Bourgeois, com. pers. 2017). Specimens were observed in anthropic areas (restaurant wall, and old abandoned traditional habitations) as well as in the primary forest on large rocks.

Material and Methods

Pictures were taken with an EOS 5D II Canon DSLR and a 100 mm macro F/2.8 L IS UMS Canon lens, lighten with a 580 EXII Canon Cobra flash. The designation terms for the pedipalps segments follow Harvey and West (1998), i.e. coxa, trochanter, femur, patella, tibia and tarsus. The counting of

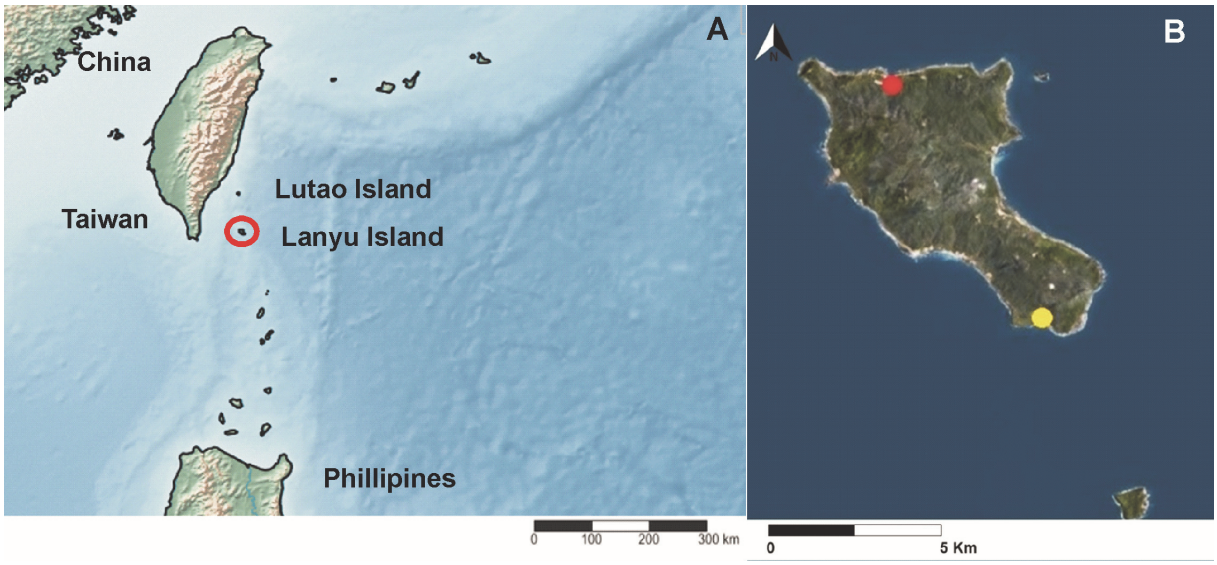


Fig.1A: Location of Lanyu Island in the Pacific Ocean. **1B**: Map of Lanyu Island with collecting sites. Holotype locality (yellow circle: 22°00'21.6''N, 121°34'52''E), paratype locality red circle (location: 22°04'46.5"N 121°31'54.8"E). Source: 1A, made with www.simplemappr.net. 1B, modified from Géoportail (https://www.geoportail.gouv.fr/).

spines follows Weygoldt (2000), *i. e.* the spines on the pedipalp patella are counted distally to proximally, and proximally to distally for the femur. Spermatophore organ names follows Giupponi & Kury (2013). Ventral spines are written in Roman numbers and dorsal spines in Arabic numbers. The first letter of the name of the segment is placed before the number of the spine. The surface sculpture follows the terms of Harris (1979). All labels were written in verbatim format, *i.e.* written as on the label.

The GPS coordinates were obtained using Google maps, and follows the WGS 84 system.

All specimens are stored in 70% Alcohol, and held in the collections of the National Museum of Natural Science (NMNS) in Taiwan.

Results

Family Charontidae Simon, 1892

Genus *Charon* Karsh, 1879

GENUS DIAGNOSIS: Tarsi II-IV with arolium; Cleaning organ with a row of setae proximally, inner or median row of the chelicera bearing four denticules; Antero dorsal margin of the pedipalp tibia with two large spines of almost equal size followed distally by one spine (which can be reduced during post embryonic growth) and pedipalp tarsus undivided (Harvey & West 1998; Rahmadi *et al.* 2011; Weygoldt 2000)

KEY TO THE SPECIES OF *CHARON*:

1. Basitibia IV with three segments; distitibia IV with 20 trichobothria..... ***Charon trebax*** Harvey and West 1998
− Basitibia IV with four segments; distitibia IV with more than 20 trichobothria..... 2
2. Pedipalp tibia with two spines in its dorsal margin; distitibia IV with 22-25 trichobothria..... 3
− Pedipalp tibia with three spines in its dorsal margin; distitibia IV with more than 25 trichobothria..... 4
3. Pedipalp patella with four antero dorsal and four antero ventral large spines ; distitibia IV with 25 trichobothria. ..... ***Charon forsteri*** (Dunn 1949)
− Pedipalp patella with five large antero dorsal and six large antero ventral spines ; distitibia IV with 22 trichobothria ..... ***Charon ambreae*** **n. sp.**
4. Ventral margin of the pedipalp tibia with three spines; distitibia IV with 26 trichobothria; eyes reduced in size. ..... ***Charon oenpelli*** Harvey & West 1998
− Ventral margin of the pedipalp tibia with two spines; distitibia IV with more than 30 trichobothria; well develop eyes 5
5. Pedipalp patella with eight antero dorsal spines and eight antero ventral spines ; distitibia IV with 36 trichobothria .....***Charon grayi*** (Gervais 1842)
− Pedipalp patella with six antero dorsal spines and six antero ventral spines ; distitibia IV with 30..... .....***Charon gervaisi*** Harvey & West 1998.

Charon ambreae **sp. nov.**

Fig. 2-4

DIAGNOSIS: *Charon ambreae* differs from all other species of the genus by having 22 trichobothria on the distitibia IV and by the presence of five major spines on the antero dorsal margin of the pedipalp patella. It differs from *C. grayi, C. gervaisi* and *C. trebax* by having two spines on the dorsal side of the pedipalp tibia, while the new species have three; and it differs from *C. oenpelli* by having two spines on the ventral side of its pedipalp tibia.

TYPE MATERIAL: Holotype: 1♂: Lanyu Island, 2015, 22°00'21.6'' N, 121°34'52'' E. Lee J.- D. *leg.* (NMNS). Paratype: 1♀: Lanyu Island, Terrace of a restaurant, 22°04'42.6"N 121°31'52.1"E, vi.2015, Bourgeois A. *leg.* (NMNS).

DESCRIPTION MALE HOLOTYPE, habitus in Figs. 2A and B. **Carapace**: reniform, eye tubercles black, median eyes and tubercle well developed; lateral eyes well developed. Anterior margin of carapace with 20 setae. Fovea deeply impressed, surrounded by round bumps. Fovea located at 1/3 of the carapace length; carapace granulated on the anterior part; from the fovea to the lateral eye tubercles granulated stripes separating well-defined smooth areas on the rest of the carapace.

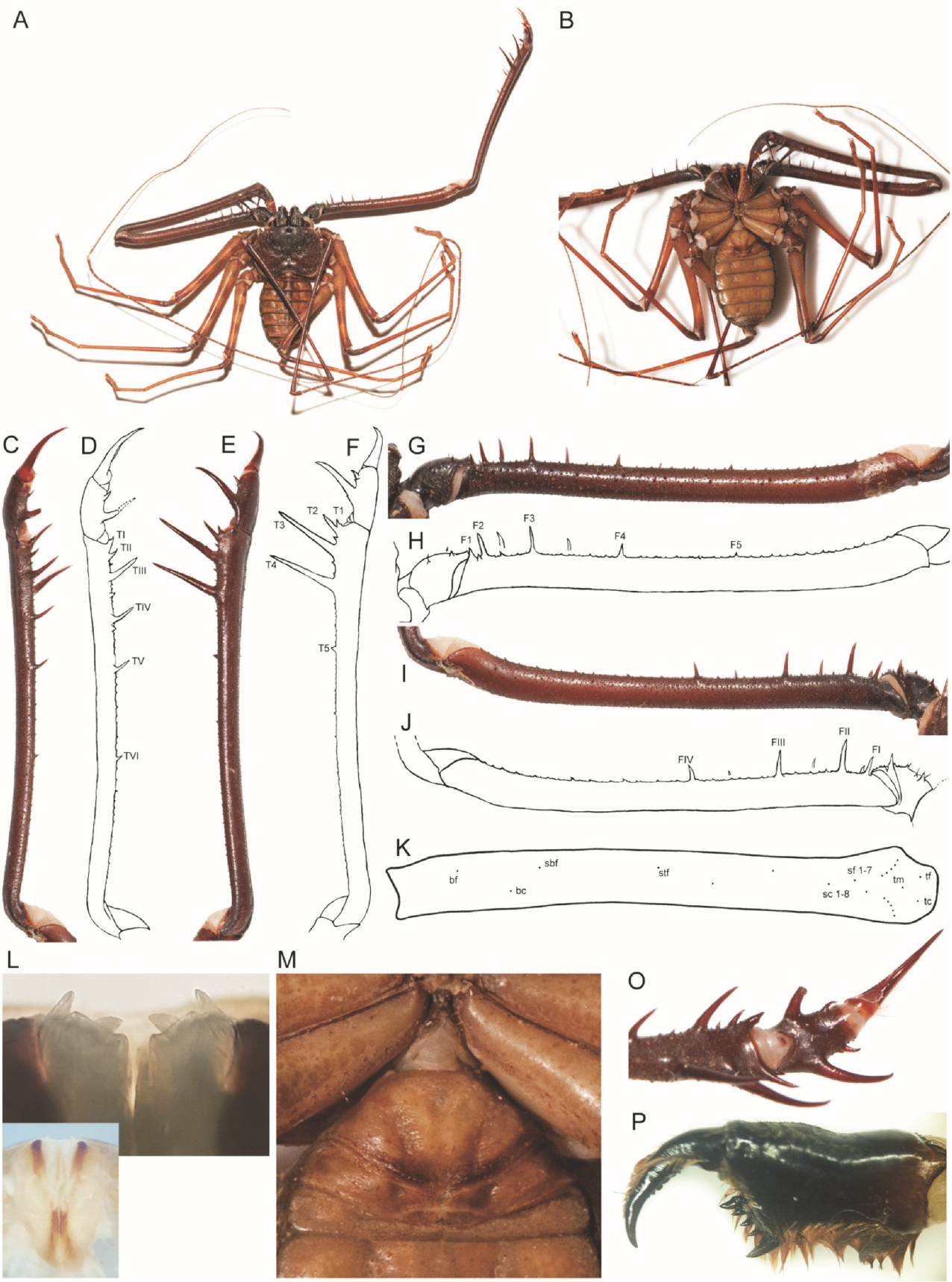


Fig. 2: male holotype: **A**: Habitus dorsal, **B**: Habitus ventral; **C – J**: right pedipalp: **C –F**: Tibia, metatarsus and tarsus: **C – D**: ventral side; **E – F**: Dorsal side; **G – J**: Femur: **G – H**: dorsal side; **I – J**: ventral side; **K**: distitibia of leg IV with details on the location of the trichobothrie (dots); **L**: Male gonopods; **M**: details of second sternite; **O**: Pedipalp metatarsus, tarsus and claw, inner side; **P**: Chelicera.

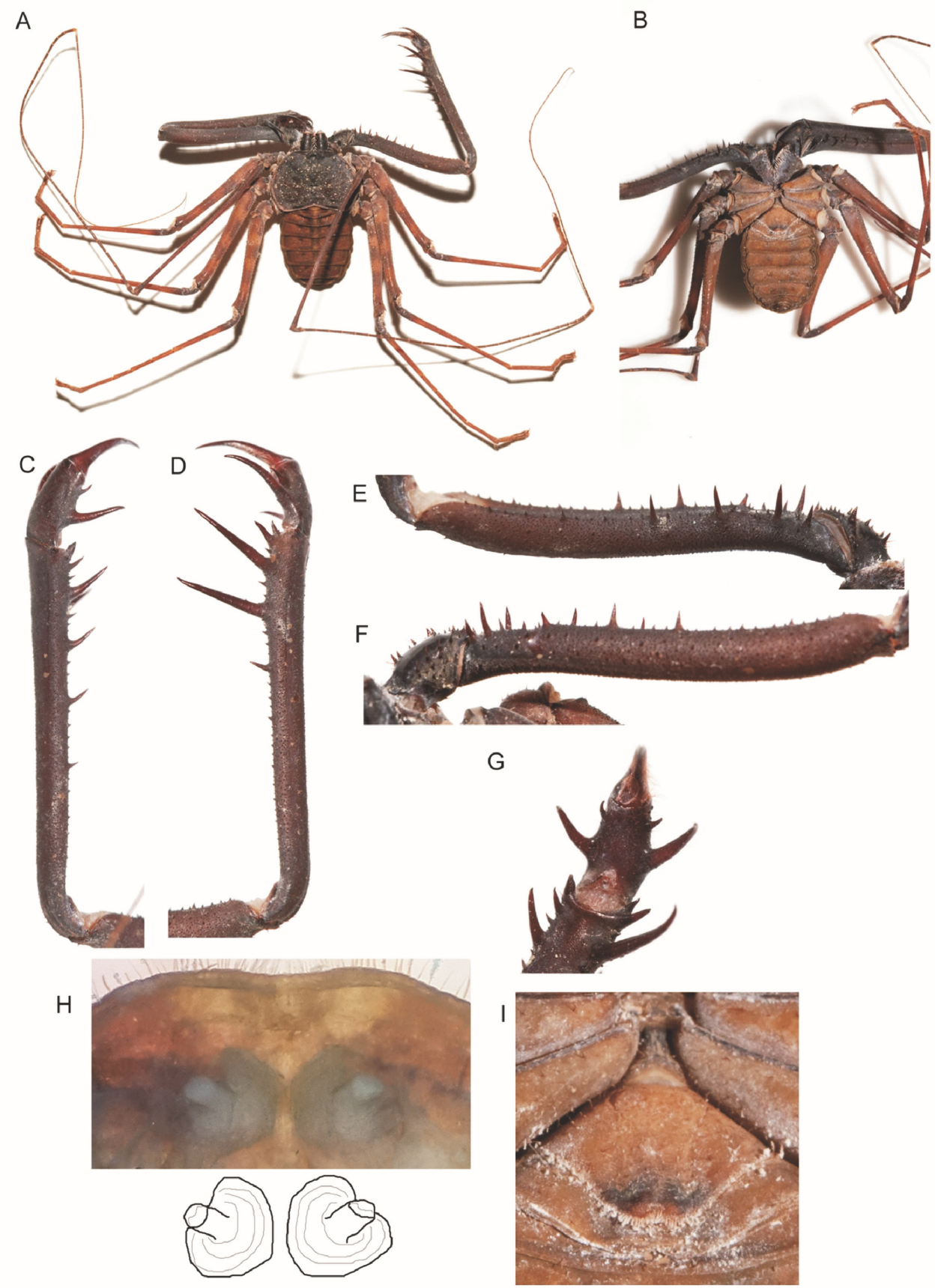


Fig. 3: Female paratype: Habitus, **A**: dorsal side; **B**: ventral side; **C – G**: right pedipalp: **C – D**: Tibia, metatarsus and tarsus: **C**: ventral side; **D**: Dorsal side; **E – F**: Femur: **E**: dorsal side; **F**: ventral side; **G**: Pedipalp metatarsus, tarsus and claw, inner side; **H**: Female gonopods; **I**: details of second sternite.



Fig. 4: Large female specimen observed on a rock escarpment at 3 meters high in the south of the Island. Picture courtesy of Alexis Bourgeois.

Sternum: tritosternum with a rounded base, projecting anteriorly between pedipalp coxa in an elongated, forked, tubercle a little over five times longer than wider, with many setae; second sternite about half the width of tritosternum, rounded, convex, anteriorly with two strong setae positioned centrally; third sternite rounded and convex, about the same size as second sternite, with two large setae positioned centrally.
Chelicera: basal segment: densely hairy on its anterior margin; bearing four internal teeth on antero lateral margin. Proximal tooth very large (about two times longer than wider), two median teeth – spine-like – about half size of proximal one; distal tooth about 2/3 of proximal tooth, trifid, with the median cusp larger. An external tooth on retro lateral margin, located in front of the distal internal tooth, measuring half of the median internal teeth, as long as wide (Fig. 2P). Claws bearing seven teeth. **Pedipalp:** Fig. 2 C-K. **Trochanter:** one spine and four spinelets on the antero ventral margin; one large spine and five spinelets on the latero ventral margin; four spinelets and four setiferous tubercles on the antero dorsal margin. **Femur:** Granulated**,** five major spines dorsally (F2=F3>F1=F4>F5); one little spine between F2 and F3 and many spinelets in between. Proximal spine F1 almost ½ the size of F2, distal spine F5 almost ½ the size of F4; ventrally bearing four large spines (FII>FIII>FI>FIV), presence of a fifth spine (FV) between the FIV and the distal margin, smaller spines at the base of FI and many spinelets; basal ventral spine (FI) almost ½ of second spine (FII); FIII almost ¾ of FII, distal spine (FIV) around ½ of FIII, FI almost ¾ of FIII. **Patella:** Granulated, five dorsal large spines, one extra small spine between P2 and P3, and another between P3 and P4; many spinelets; primary spine P3 and P4 very large (P5<P1<P2<P3=P4; TP5=3/4P1, P1=1/3 P2, P2=1/3 P3); six large ventral spines (PVI = 1/2 PI = PII, PI = 1/3 PIII, PIV = 1/2 PIII, PV = 2/3 PIV) with an extra small spine between PII and PIII, and one between PIII and PIV; many spinelets. **Tibia:** bearing two dorsal spines, distal one bifid at the base; distal spine about 1/4 the proximal; two ventral spines, distal about ¼ the proximal. **Tarsus:** elongate; dorsally densely hairy, including long setae above the cleaning organ; Ventral side of the distal claw densely hairy, inermous below the cleaning organ (Fig. 2O);
Abdomen: granulated and oblong, second sternite illustrated in Fig 2M.
Legs presence of many setae; length of I>III>II>IV; tibia I with 25 articles, tarsus I with 44 articles. Tarsi II, III, IV with four articles, bearing arolium at their terminal end; **Leg IV: basitibia**: divided into four pseudo-articles; **distitibia:** with 22 trichobothria (one bf, one bc, one sbf, one stf, seven sf, eight sc, one tm, one tf, one tc). (Fig. 2K). **Basitibia-distitibia length**: BT1>DT>BT3>BT2>BT4.

Genitalia: male holotype: Brown sclerotized regions on the distal end of the fistula. The LoL1 and the LoL2 sharp, the LoL1 being half of the size of the LoL2, posterodorsal LoD smaller than LoL1 and blunt. Spermatophore organ covered ventrally by the genital operculum. (Fig. 2L).
Color: in alcohol: Cephalothorax black in granulated zones and crimson on smooth area; Pedipalps and legs: brownish with three, transversal, light-brown stripes on the walking leg femora; Chelicera dark brown; Abdomen: light-brown, with longitudinal, median black stripe (Fig. 2A & B). Live: same as before but darker. Live habitus presented in Fig. 4.
Measurements (in mm): male holotype: Cephalothorax: length: 8.8, width: 11.9; Pedipalp: femur: 25, tibia: 26.3, basitarsus: 4.2, distitarsus and tarsal claw: 4.7.
Female paratype: Cephalothorax: length: 8.8, width: 11.3; Pedipalp: femur: 16.4, tibia: 18.2, basitarsus: 3.9, distitarsus and tarsal claw: 4.8.

FEMALE DESCRIPTION: Same as male, but with shorter pedipalps. Genitalia: gonopods rounded, with finger-like appendice projected backward. The distal side part of the appendice invaginated. Posterior margin of sternite with many hard setae. Illustrations in Fig. 3 A-I.

ETYMOLOGY: The species name is dedicated to Ambre Réveillion, daughter of the first author.

Discussion

The presence of this new species of *Charon*, highlight the influence of the Malesian floristic region (Hsieh, 2002) in the colonization of this small volcanic island. This supports the hypothesis suggested by Kano (1933, 1936) and Hidetoshi (1991) that the fauna is more related to the Philippines' rather than with the main island of Taiwan. A clear geographical and ecological separation is observable in several taxa, such as amphibians, reptiles and spiders. A genetic analysis conducted on rice frog (*Rana limnocharis* Gravenhorst, 1829*)* showed that there was significant genetic variations between the populations on the eastern part of Taiwan (including Lanyu and Lutao Island) and the ones of Taiwan main island (and Penghu island) (Toda *et al.*, 1998). The presence of high central mountainous formations (reaching up to 4000 meters) running from the northern to the southern ends along the major axis of Taiwan helps to separate these ecozones. Another worth citing exemple is the case of the grass lizards from the genus *Takydromus*, where this montaneous range acts similarly,

isolating closely related species (Lin *et al.*, 2002), and separating populations from Lanyu to Taiwain main's land

During glaciations events throughout the Pleistocene, and more recently at the end of the late Dali glaciation (15 000 years B.C.), Taiwan was probably connected to China's main land, allowing a potential colonisation by land (Huang, 1984; Shih *et al.*, 2005). However, being part of the Luzon volcanic arc, Lanyu and Lutao Islands dating from the mid-Miocene to the Pliocene and are surrounded by water ranging from 500 to 2000 m in depth (Bowin *et al*., 1978; Page & Suppe, 1981). Therefore, even at the height of the late Pleistocene glaciations, in which sea level was between 110 and 155 m lower than present levels (Huang, 1984; Liu & Ding, 1984; Zhang, 1984) it is highly unlikely that a land-bridge would have been created. Therefore, some form of over water dispersal remains the only plausible mechanism of colonization. (Creer *et al.,* 2001). Therefore, the presence of *Charon* in this island can be plausibly explained by rafting, like what probably happened to the freshwater crab species *Geothelphusa lanyu* that inhabit the island (Shih *et al*., 2005), or as the alleged case of colonisation by the Bamboo viper – *Trimeresurus stejnegeri* (Smidt, 1925) (Creer *et al.,* 2001). We can suppose that this new species, or maybe other-related species, might be present in Lutao island, along with the Hengchum Peninsula as they are related to the same area of confluence of two floristic regions (the so-called East Asian floristic region and the Malesian floristic region) (Hsieh, 2002). Further prospection should be made in those regions to have a better understanding on the Amblypygi fauna and ecology.

Acknowledgements

The authors would like to express their gratitude to Alexis Bourgeois and Otto Lee to have caught and let us examined the specimens after their expeditions on Lanyu island. The authors would also like to thank the editor, Michael Seiter and Mark Harvey for their precious comments which helped to improve this manuscript.

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