

A NEW SPECIES OF THE WHIP SPIDER GENUS *Weygoldtia* (Arachnida: Amblypygi: Charinidae) FROM CON DAO NATIONAL PARK, VIETNAM

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Received 24 February 2022; accepted 30 August 2022

ABSTRACT

A new species of the monotypic genus *Weygoldtia* Miranda, Giupponi, Prendini & Scharff, 2018 was described from Con Son island, southern Vietnam, namely *Weygoldtia condao* sp. nov. The new species is clearly distinguished from its congener *Weygoldtia davidovi* (Fage, 1946) by having more articles in the tibia and tarsus of leg I. A fragment of the cytochrome c oxidase subunit I (COI) gene is also provided for the new species. The K2P genetic distance of the COI between the new species and *W. davidovi* is 20%, and phylogenetic analysis also supported the new species.

Keywords: Soil biodiversity, taxonomy, COI, DNA barcode, new species, Vietnam.

Citation: Nguyen Thi Thu Anh, Phung Thi Hong Luong, 2022. A new species of the whip spider genus *Weygoldtia* (Arachnida: Amblypygi: Charinidae) from Con Dao National Park, Vietnam. *Academia Journal of Biology*, 44(3): 67–76. <https://doi.org/10.15625/2615-9023/16953>

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INTRODUCTION

Located in the tropical region of the Indo-China peninsula, Vietnam is expected to harbour rich biodiversity (Sterling et al., 2006). Over the decades, soil invertebrates have been ignored mostly in biodiversity investigations. Several groups including earthworms (Oligochaeta), spiders (Araneae), scorpions, centipedes (Chilopoda) and millipedes (Diplopoda) have been received more attention by some researchers, but have not well studied systematically.

Amblypygi is a member of Arachnida, and is known as “whip spiders”. This animal is characterized by a flattened, spider-like body form with raptorial pedipalps and extremely elongate antenniform first legs, without spinnerets and poison glands. Approximately 160 species in five families have been discovered and distributed globally (Rahmadi et al., 2011).

Currently, representatives of four families have been recorded in Southeast Asia including the family Charinidae with two genera (*Charinus* Simon, 1892 and *Sarax* Simon, 1892), the family Charontidae with two genera (*Charon* Karsch, 1879 and *Catageus* Thorell, 1889), the family Phryniidae with only one genus (*Phrynus* Lamarck, 1801), and the family Phrynichidae with only one genus (*Phrynichus* Karsch, 1879) (Harvey, 2003; Miranda et al., 2018).

In Vietnam, there are only two previously recorded species, *Sarax davidovi* Fage, 1946 (family Charinidae) and *Phrynichus orientalis* Weygoldt, 1998 (family Phrynichidae). However, since their original reports, there has been no updated information on their occurrences in Vietnam until Miranda et al. (2018) proposed a new monotypic genus, *Weygoldtia*, for a single species *Sarax davidovi* (family Charinidae). During our field expedition in Con Dao National Park (NP), the islands in Southern Vietnam, specimens of the genus *Weygoldtia* were collected (Fig. 1), and herein we describe it as new species.

MATERIALS AND METHODS

Whip spiders were collected manually by eye searching and handing (Górny & Grum 1993). All specimens were preserved in the ethanol 90% with detailed information. The morphological examination was performed under the microstereoscope Olympus SZX10. Colour images were taken with a Nikon camera lucida. Images were stacked using the Helicon Focus ver. 7.0, and grouped into plates using the Adobe Photoshop CS6. All terminology follows Rahmadi et al. (2010, 2011). Holotype and paratypes were housed in the Institute of Ecology and Biological Resources (IEBR).

The total DNA was extracted from a leg using the Qiagen DNeasy Blood & Tissue Kit. A 680 bp fragment of the COI gene was amplified using the universal primers LCO1498-HCO2190 (Folmer et al., 1994). PCR conditions for amplification of the COI gene were: initial denaturation at 95 °C for 2 min. followed by 36 cycles of 95 °C for 1 min, 42 °C for 45 sec, and 72 °C for 1 min, and a final extension at 72 °C for 5 min. Successfully amplified PCR products were purified using ExoSap IT, then sequenced on an Applied Biosystems automatic sequencer (ABI3130 XL) using the same primers used for the initial PCR as sequencing primers. COI sequences were assembled using ChromasPro ver. 2.1.8 and confirmed using BLASTN 2.6.0+ searches (Zhang et al., 2000). All nucleotide sequences are deposited in GenBank.

The final aligned COI dataset comprised a 627 bp fragment from 26 amblypygid samples (25 samples of three genera *Sarax*, *Weygoldtia* and *Charinus* (all in the family Charinidae) and one outgroup, *Phrynus longipes* (family Phryniidae)) (Table 1). The nucleotide frequencies of A, T, G, and C were 26.7%, 31.8%, 15.6%, and 25.9%, respectively. The GC content was 41.5%. The dataset contained 259 (41.3%) parsimony informative and 276 (44.0%) variable sites.

The K2P (Kimura 2 parameters) genetic distance was calculated in MEGA X (Kumar

et al., 2018). The phylogenetic tree was reconstructed using the Maximum Likelihood analysis with the best model chosen using ModelFinder (Kalyaanamoorthy et al., 2017)

performed in IQTREE ver.1.6.2 for Windows (Minh et al., 2020). The best model was TIM2+F+I+G4 with BIC score = 8004.181 and -lnL = 3832.705.

Table 1. Species voucher and GenBank accession number

No.	Species	Localities	Voucher	Accession number
1	<i>Weygoldtia condao</i> sp.nov.	Con Dao NP, Ba Ria Vung Tau province, Vietnam	IEBR-WhS.001	
2	<i>Weygoldtia condao</i> sp.nov.	Con Dao NP, Ba Ria Vung Tau province, Vietnam	IEBR-WhS.002	
3	<i>Weygoldtia condao</i> sp.nov.	Con Dao NP, Ba Ria Vung Tau province, Vietnam	IEBR-WhS.003	
4	<i>Weygoldtia</i> sp.	GENBANK		MT040912
5	<i>Weygoldtia davidovi</i>			MT040904
6	<i>Sarax</i> sp.3			MT040937
7	<i>Sarax buxtoni</i>			MT040898
8	<i>Sarax cochinchensis bispinosus</i>			MT040899
9	<i>Sarax</i> sp.			JN018110
10	<i>Sarax yayukae</i>			MT040944
11	<i>Sarax yayukae</i>			MT040945
12	<i>Sarax singaporeae</i>			MT040931
13	<i>Sarax brachydactylus</i>			MT040900
14	<i>Sarax cochinchensis</i>			MT040902
15	<i>Sarax rimosus isolate</i>			MT040923
16	<i>Sarax rimosus</i>			MT040924
17	<i>Sarax singaporeae</i>			MT040930
18	<i>Charinus sillami</i>			MT040929
19	<i>Charinus potiguar</i>			MT040921
20	<i>Charinus</i> sp.1			MT040901
21	<i>Charinus</i> sp.2			MT040907
22	<i>Charinus</i> sp.4			MT040917
23	<i>Charinus</i> sp.4			MT040918
24	<i>Charinus</i> sp.4			MT040919
25	<i>Charinus taboa</i>			MT040934
26	<i>Phrynus longipes</i>			KY017852

RESULTS

Taxonomy

Family Charinidae Quintero, 1986

Genus *Weygoldtia* Mirinda, Giupponi, Predini & Scharff, 2018

Weygoldtia Mirinda, Giupponi, Predini & Scharff, 2018: 25

Type species. *Sarax davidovi* Fage, 1946, by original designation.

Remarks. The monotypic genus *Weygoldtia* was created to accommodate only species, *Sarax davidovi* (Fage, 1946) distributed in Vietnam, Cambodia and Laos. This genus is easily recognized by the presence of a straight crest anterior to the lateral eyes and the longitudinal orientation of the rod sensilla on the tarsus of leg I (Miranda et al., 2018).

Comparing to its congeners within the family Charinidae, *Weygoldtia* clearly differs from *Charinus* and *Sarax*, in the number of trichobothria on distitibia IV and the presence of one or two setae on the base of the cleaning organ on pedipalp tarsus.

***Weygoldtia condao* sp. nov. (Figs. 1-7)**

Material examined

Holotype. 1 male (IEBR-WhS.001) Ba Ria Vung Tau province, Con Dao NP, Con Son island, on the way to Ong Dung Beach, natural forest, 8.7003N-106.5964E, 27–28 October 2020, col. Nguyen Thi Thu Anh.

Paratypes. 1 male (IEBR- WhS.002), 4 juveniles (IEBR- WhS.003), 2 juveniles (IEBR- WhS.004) same data as for holotype.

1 female, 1 juvenile (IEBR- WhS.005) same locality, on the way to Ong Dung Beach, 8.70528N-106.59158E, 37m a.s.l., 7 Nov. 2019, col. Nguyen Thi Thu Anh.

Diagnosis. The species is very similar to its generic congener, *Weygoldtia davidovi*, but differs in number of dorsoventral spines of pedipalpal femur (5 vs. 4), the number of spines of pedipalpal patella, and the number of trichobothria (sc with 7 and sf with 8 trichobothria vs. sc with 6 or 7 and sf with 7 or 8 trichobothria).

Etymology. Named after the Con Dao National Park where types were found.

Description

Carapace darkish-brown (greenish brown), centrally with reddish brown marks; pedipalp yellowish-brown with reddish-brown spines and tarsus. Legs II–IV yellowish-

brown to light brown, except patella dark brown. Abdomen greenish brown as carapace on dorsum, but yellow on ventrum, with a pair of spots on each tergite.

Carapace (Figs. 2A, 3A): Width about 1.3–1.5 times its length; surface finely granulate, without setiferous tubercles, with several short setae in frontal area. Flange wide and bent upwards. Axial line distinctly running from median eyes to central spot, then to posterior margin of carapace. In central spot, a triangular sulcus present, reaching to 1/4 each lateral side of carapace. On each side of carapace, four short, deep and wide sulci present. All lateral and posterior margins slightly bent upwards (or slightly convex).

Eyes (Figs. 2A, 3A–3B): median eye small, round on black, triangular tubercle without apical setae, antero-laterally directed. Lateral eyes closely located to the corner of lateral and anterior margins of carapace, standing on brownish tubercle, consisting of three single, small eyes, frontal one not visible from dorsal view.

Chelicera (Figs. 4A,B): Dorsal surface of basal segment not smooth, with several fine setae while ventral margin densely setose. Basal segment with 4 teeth: the lower-largest one, the upper-most bicuspid with upper cusp larger than lower one; inner surface with several setae in vertical row; outer surface with one small tooth opposite of bicuspid tooth, ventrally with several setae near proximal margin. Movable article densely setose dorsally; ventral margin with 6 teeth, the first and second teeth largest and subsequent teeth getting smaller distally.

Sternum (Figs. 2B, 3D): First sternite (= tritosternum) elongate, with paired apical setae and laterally several shorter setae (except two longer) than apical setae. Second and third sternites rounded, respectively with 3–4 and 2 setae, respectively. Fourth sternite (= metasternum) with 4–6 setae.

Pedipalp (Figs. 2, 4–6): Strong and slender. Trochanter with 3 spiniform tubercles (one big and two smaller, clearly visible on

ventral view), and several setae along antero-dorsal margin and antero-ventral margin.

Femur: anterodorsal margin with 4 major spines (length $F2 > F3 = F4 > F1$), one minor spine (**ms**) between distal margin and F4, several setiferous/tiny tubercles; antero-ventral margin with 4 major spines (length $Fa2 > Fa3 > Fa1 > Fa4$), one minor spine (**ms**) between distal margin and Fa4, and several minor setiferous/tiny tubercles.

Patella: antero-dorsal margin with 4 major spines (P1, P2, P3, P4) not equal in size ($P1 > P2 > P3 > P4$), several minor spines, several setiferous tubercles and small tubercles. These three major spines located on more than half of pedipalpal patella length distally. In addition, 1 minor spine present between P1 and distal margin of patella, the length of minor spine less than half of P1 length, but equal to P2; and 1 tiny spine present between P4 and proximal margin; antero-ventral margin with 4 major spines (length $Pa2 > Pa3 > Pa1 = Pa4$), several setiferous tubercles and small tubercles, a tiny spine between Pa3 and Pa2, Pa3 and Pa4, and Pa4 and proximal margin.

Tibia with several setiferous tubercles, outer surface roughened and several setae on

inner surface; antero-dorsal margin with two major spines, basal spine less than half as long as distal one; antero-ventral margin with a major spine.

Tarsus completely divided (claw clearly demarcated by articulation), antero-dorsal margin with 3 spines: basal and medial spines short, about equal in length and close to each other (space between them about basal diameter of medial spine), distal spine slightly longer than basal and medial spine; tarsus with densely hairy cleaning organ ventrally; apotele present.

Legs (Figs. 1, 7): Femora of legs I–IV not smooth, densely microgranulated, with small tubercles/setiferous tubercles. Tibia and tarsus of leg I with 33 and 52 segments, respectively; tibiae of legs II and III two-segmented; basitibiae of leg IV four-segmented, the fourth segment with 2 trichobothria (value in parentheses: ratio of the distance from the trichobothrium to the proximal margin of the segment against the length of the segment), bt1 (0.28) and bt2 (0.29); distitibiae of legs II–IV each with 22 trichobothria: 8 sf, 7sc, 1bc, 1sbc, 1sbf, 1stc, 1tc and 1 tf.

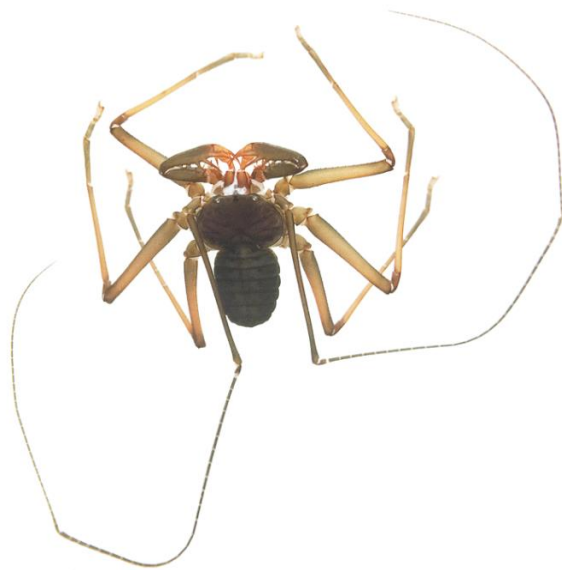


Figure 1. *Weygoldtia condao* sp. nov. from Con Dao National Park. Habitus. No scale

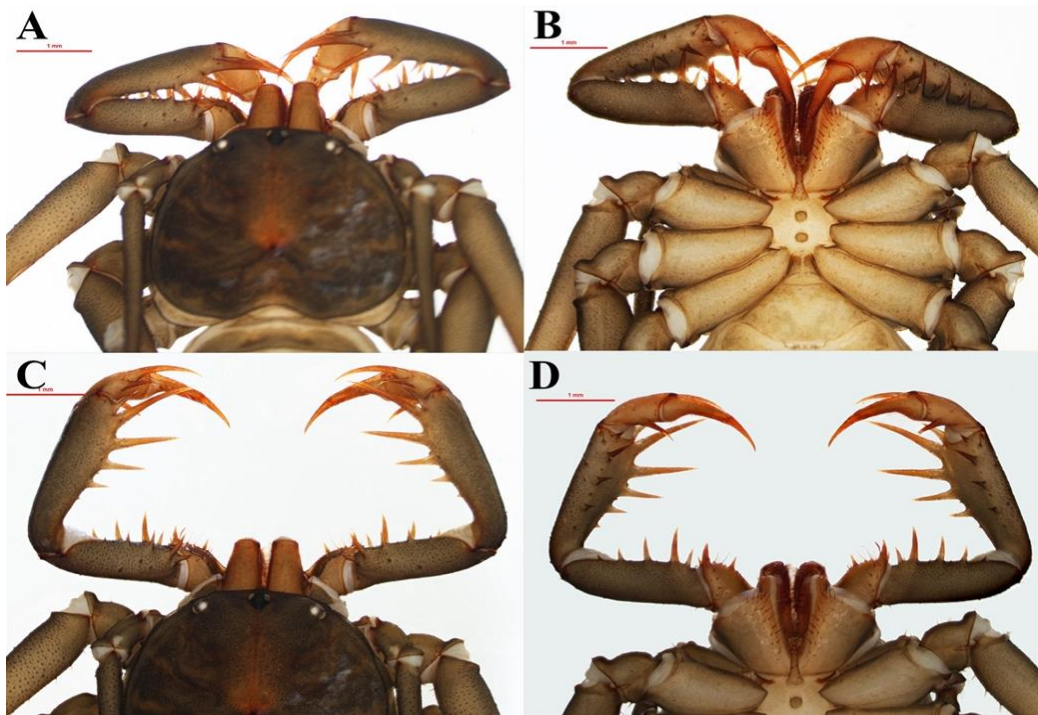


Figure 2. *Weygoldtia condao* sp. nov. from Con Dao National Park. Anterior body, dorsal view (A), ventral view (B). Patella, dorsal view (C), ventral view (D). Scale bar = 1 mm

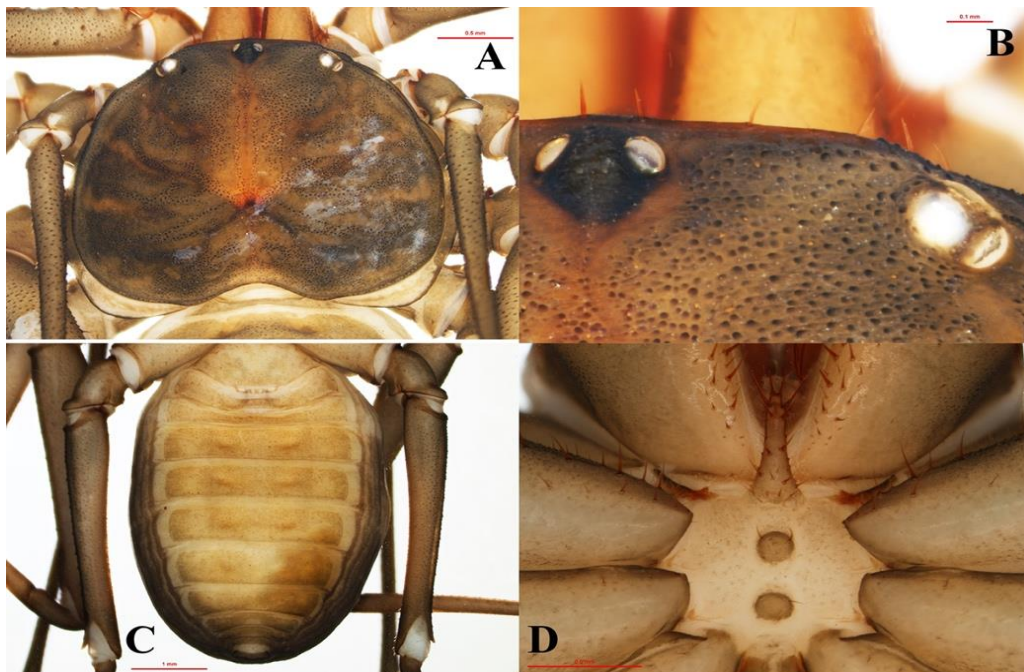


Figure 3. *Weygoldtia condao* sp. nov. from Con Dao National Park. Capapace, dorsal view (A). Medium eyes, dorsal view (B). Abdomen, ventral view (C). Sterna, ventral view (D). Scale bar = 0.5 mm for A and D, = 1 mm for C, and = 0.1 mm for B

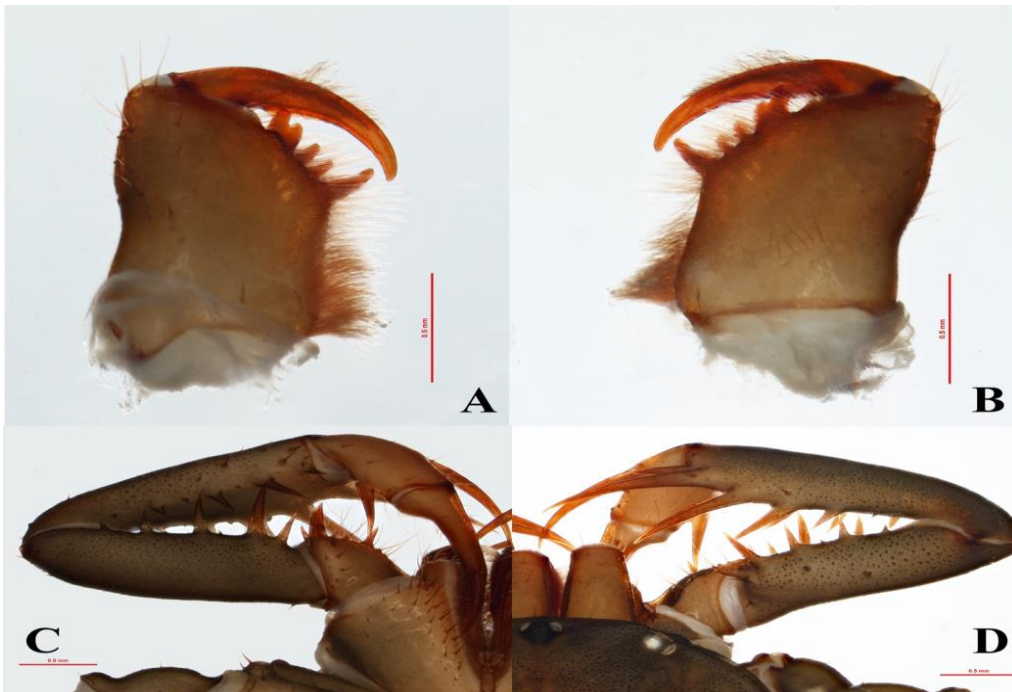


Figure 4. *Weygoldtia condao* **sp. nov.** from Con Dao National Park. Chelicera, left lateral view (A), mesal view (B). Right pedipalp, ventral view (C), dorsal view (D). Scale bar = 0.5 mm

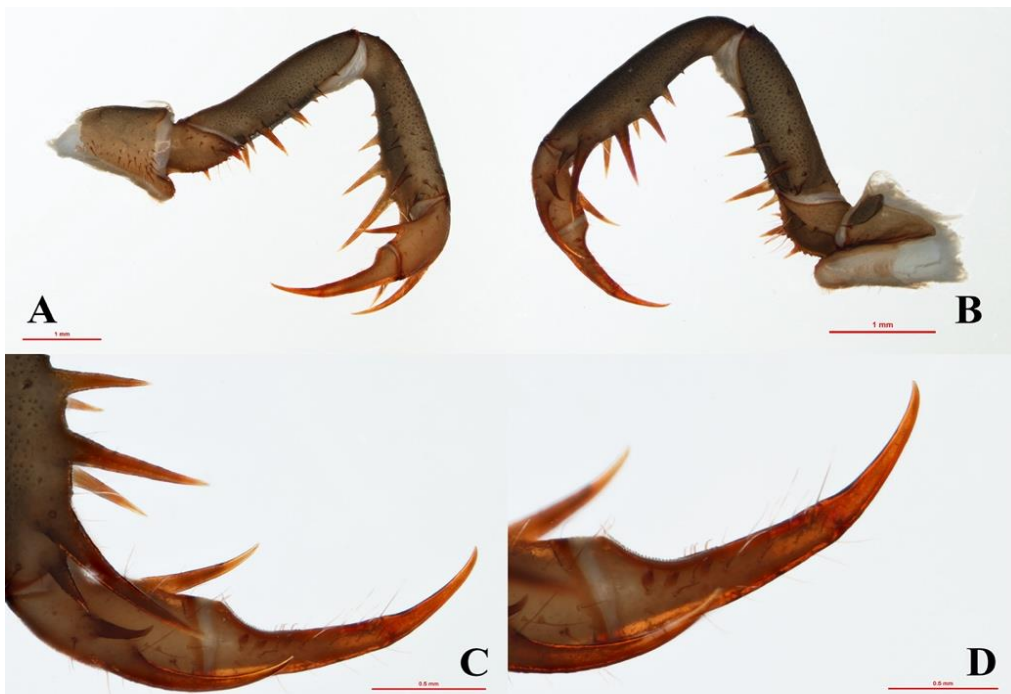


Figure 5. *Weygoldtia condao* **sp. nov.** from Con Dao National Park. Right pedipalp, lateral view (A), mesal view (B), tarsus, mesal view (C, D). Scale bar = 1 mm for A and B, = 0.5 mm for C and D

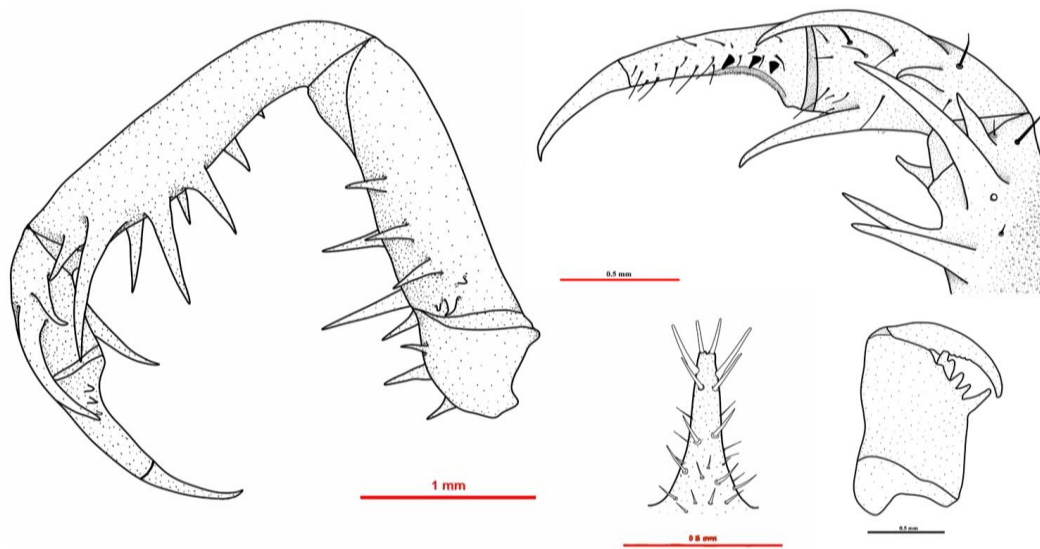


Figure 6. *Weygoldtia condao* sp. nov. from Con Dao National Park. Right pedipalp, mesal view (A). The distal part of right pedipalp, mesal view (B). Tritosternum, ventral view (C). Chelicera, lateral view (D). Scale bar = 1 mm for A, and = 0.5 mm for B–D



Figure 7. *Weygoldtia condao* sp. nov. from Con Dao National Park. Distitibia of leg IV (A). The fourth segment of the basitibia of leg IV (B). Tarsus of leg IV (C, D). Scale bar = 0.5 mm

Tarsi of legs II–IV four-segmented; length of the first segment equal to the total length of three subsequent segments, the

second segment with light yellow transverse line; fourth segment without oblique slit; pulvilli present.

Genitalia (Fig. 3C): Covered ventrally with genital operculum slightly concave apically, paired with 2 tubes projecting medially.

Male: Similar to female, without distinct sexual dimorphism.

Molecular analysis

The new species has a close COI identity with *Weygoldtia* sp. (GenBank: MT040912) of 97.4%. This close identity suggests they are

the same species. Both new species and *Weygoldtia* sp. have the K2P genetic distance of 20.0% with *W. davidovi* (MT040904).

The phylogenetic diagram also indicated that the new species is separated from *Weygoldtia davidovi* with high support of bootstrap value (100%). Three genera, *Sarax*, *Charinus* and *Weygoldtia* were clearly separated from each other. *Weygoldtia* was a sister to *Charinus* (Fig. 8).

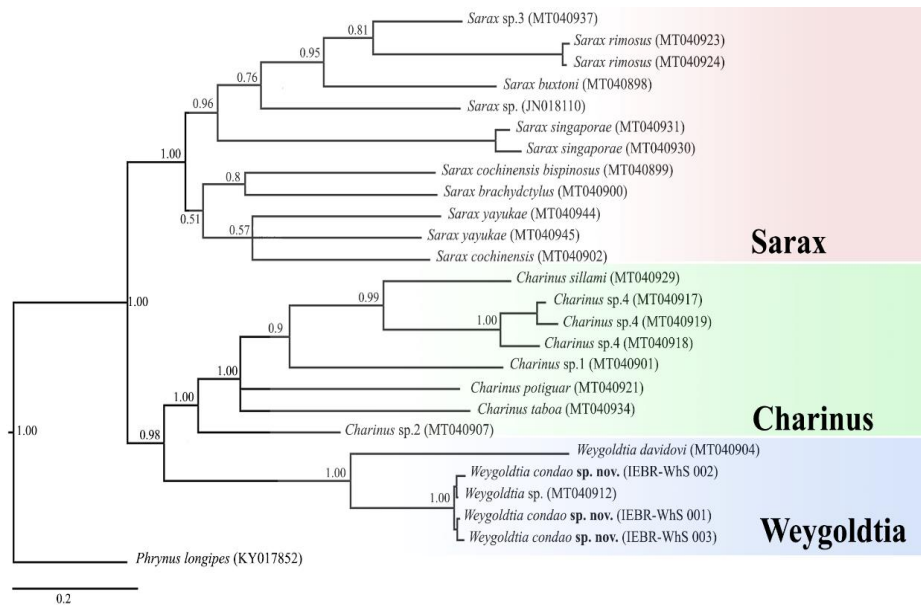


Figure 8. Phylogenetic diagram inferred from the 627 bp fragment of the COI gene using Maxilum Likelihood (ML) and Bayesian Inference (BI) analysis



Figure 9. Habitat of *Weygoldtia condao* sp. nov. from Con Dao National Park

Habitats. Natural forests are well protected in rather a low elevation range (ca. 20–40 m a.s.l.). All specimens were found on rocks or stones located in natural forests (Fig. 9). We often turned the rocks over to find the whip spiders. They were not observed to be on the soil surface.

DISCUSSION

Con Dao NP consisting of 16 small islands, of which, Con Son island is the largest one, is located in southern Vietnam. It is not too far from the mainland, the shortest distance is about 83 km. The nature of the Con Dao has well persevered with the dominance of evergreen tropical forests but is well studied. The fauna of soil invertebrates including arachnids has been poorly known. Not surprisingly, a new species has been discovered in this national park.

The genus *Weygoldtia* was created from *Sarax davidovi* (Fage, 1946), and it could be said that the genus is more related to the *Sarax* rather than to other its generic congeners, i.e. *Charinus* (Miranda et al., 2018). Our preliminary analysis indicated that *Weygoldtia* is very closed to *Charinus* with highly supported values of bootstrap and BI (100% and 1.00 bpp, respectively). The genus *Sarax* is more likely to be a sister of both *Weygoldtia* and *Charinus*.

The two *Weygoldtia* species can be distinguished by several characters as the number of articles in leg I, and the number of spines in pedipalp. These differences do not provide more evidences to support the genus *Weygoldtia*. It is, therefore, suggested that the diagnosis should keep as mentioned in Miranda et al. (2018).

Acknowledgements: We sincerely thank the Con Dao National Park for kindly providing collecting permission during our field expedition. The work is funded by the Vietnam Academy of Science and Technology under the grant VAST04.06/21–22.

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