

The genus *Chaerilus* Simon, 1877, in Vietnam with the description of a new species found in a volcanic cave (Scorpiones, Chaerilidae)

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<http://zoobank.org/E41C63AE-E5F0-4006-9044-0D720734D49A>

(Accepté le 8.I.2020 ; publié le 20.III.2020)

Abstract. – In recent years, an increasing number of species belonging to the genus *Chaerilus* Simon, 1877, have been described from Vietnam. Among these, only one, *Chaerilus pathom* Lourenço & Pham, 2014, was collected in a limestone cave. A new species of *Chaerilus*, also collected in a cave, is described here. *Chaerilus chubluk* n. sp. was collected in Co Cave, a volcanic cave which belongs to the Krong No Volcanic cave system. The scorpion was collected 408 m from the cave entrance and found under a rock. It represents the first scorpion to be found in a volcanic cave in Vietnam, and probably in the world. The comparative study of the new species with other *Chaerilus* species also described from Vietnam, suggests, as in previous cases, that different species do not show very strong morphological differences, but rather correspond to micro-endemic populations.

Résumé. – Le genre *Chaerilus* Simon, 1877, au Viêt Nam, avec la description d'une nouvelle espèce provenant d'une grotte volcanique (Scorpiones, Chaerilidae). Dans les années récentes, un nombre considérable d'espèces appartenant au genre *Chaerilus* Simon, 1877, ont été décrites pour le Vietnam. Parmi ces espèces seule une, *Chaerilus pathom* Lourenço & Pham, 2014, a été collectée dans une grotte karstique. Une nouvelle espèce de *Chaerilus*, également collectée dans une grotte est décrite à présent. *Chaerilus chubluk* n. sp. a été collecté dans une grotte volcanique, Co Cave, laquelle appartient au système des grottes volcaniques appelé Krong No. Le scorpion a été collecté à 408 m de l'entrée de la grotte, sous une pierre. La nouvelle espèce représente le premier cas d'un scorpion collecté dans une grotte volcanique au Vietnam et probablement dans le monde. L'étude comparative de la nouvelle espèce avec d'autres espèces du genre décrites du Vietnam suggère, comme pour des cas précédents, que les différentes espèces de *Chaerilus* affichent des faibles différences morphologiques, mais correspondent plutôt à des micro-populations endémiques.

Keywords. – Scorpion, taxonomy, micro-endemic population, Co Cave.

As already outlined in several previous publications (e.g. LOURENÇO, 2011a, 2012a, 2019; LOURENÇO & DUHEM, 2010; LOURENÇO & PHAM, 2014; LOURENÇO & ZHU, 2008; LOURENÇO *et al.*, 2010), the family Chaerilidae remains poorly-studied among extant scorpions. The genus *Chaerilus* Simon, 1877, was originally created to accommodate *Chaerilus variegatus* Simon, 1877, a species described from Java (SIMON, 1877). Subsequently, several other species have been described from the Indonesian islands and nearby geographic regions such as Malaysia and Singapore. The majority of these descriptions were based on very limited material, and on weak and/or unclear diagnostic characters. In many cases they were not properly illustrated or even not illustrated at all. This confused situation lead to several cases of misidentifications by early authors (e. g. KRAEPELIN, 1894; POCKOCK, 1899; FAGE, 1933, 1936, 1944). Moreover, the status of several species described from Southeast Asia and in particular from Vietnam requires a number of remarks.

In a poorly documented revision of the genus, KOVAŘÍK (2000) defined 18 species as valid, but at least clarified the identity of one population of Southern Vietnam (previously Indochina), originally misidentified by FAGE (1933, 1936, 1944), as *Chaerilus celebensis* Pocock, 1894, *Chaerilus rectimanus* Pocock, 1899, and/or *Chaerilus variegatus* Simon, 1877, and described *Chaerilus petrzelkai* Kovařík, 2000. A few years later this species was properly redescribed and illustrated by LOURENÇO & ZHU (2008) who also described a new species, *Chaerilus vietnamicus* Lourenço & Zhu, 2008.

Nevertheless, as exposed in recent papers (PHAM *et al.*, 2017; LOURENÇO, 2019) the precise situation of the *Chaerilus* species of Vietnam remains somewhat ambiguous. In fact, in the last 10/15 years several publications on the Chaerilidae were produced; from one side by KOVAŘÍK (2012) and KOVAŘÍK *et al.* (2014, 2015), and from another side as the results of the official collaboration between French and Vietnamese groups (LOURENÇO, 2011a, b, 2012a, 2019; LOURENÇO & PHAM, 2014). KOVAŘÍK (2012) and KOVAŘÍK *et al.* (2014, 2015) descriptions of new species are often unclear, and not necessarily well illustrated. Moreover, any attempts to revise these species is totally hampered by the fact that types are, in most cases, deposited in private collections not accessible to academic scientists in general. Besides, there is no evidence that the specimens described by these authors, have been legally collected in Vietnam. As already clearly exposed by PHAM *et al.* (2017), to collect specimens in Vietnam, authors need to obtain a sampling permit from ‘Vietnam Administration of Forestry’, and to take these specimens abroad, one needs to get an exporting permit from ‘CITES authorities of Vietnam’. The laws in this country are quite severe concerning illegal collecting of zoological specimens, and there are no records attesting the deliverance of legal permits to the collectors cited in KOVAŘÍK (2012) and KOVAŘÍK *et al.* (2014, 2015) publications. It is not impossible that data about the collecting sites, dates and names of collectors may be biased by the uncertain origins of the described material.

Official cooperation programs do exist between French and Vietnamese groups, represented mainly by the Muséum national d’Histoire naturelle in Paris and the Vietnam Academy of Science and Technology in Hanoi. This cooperation had led to a number of very interesting discoveries concerning several scorpion families. The present description of a new cave species of *Chaerilus* is also part of this cooperative program. The new species represents the first scorpion ever found in a volcanic cave in Vietnam.

METHODS

The new species was collected during the inventory projects lead by Dr Pham D. Sac and Mrs Tran T. Hang in Co Cave located in Dray Sap, Krong No district, Dak Nong province in Vietnam. These projects are associated with the preparation of a doctoral thesis by Mrs Tran T. Hang. Illustrations and measurements were made with the aid of a Wild M5 stereo-microscope with a drawing tube (camera lucida) and an ocular micrometer. Measurements follow STAHNKE (1970) and are given in mm. Trichobothrial notations follow VACHON (1974) and morphological terminology mostly follows HJELLE (1990).

RESULTS

CHECKLIST OF THE *CHAERILUS* SPECIES RECORDED FROM VIETNAM

This list is based on PHAM *et al.* (2017); see also map (fig. 1). The following species are maintained (a priori) as valid for Vietnam, however, those indicated with an (***) could not be examined, because they are deposited in private collections. Consequently, a final opinion

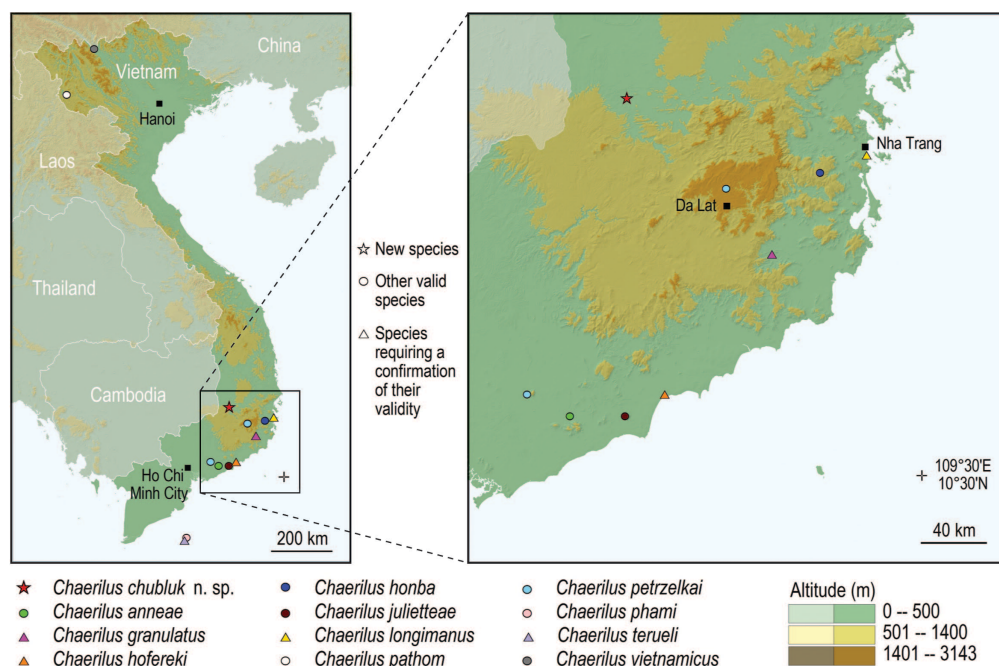


Fig. 1. – Map of Vietnam showing the known records of chaerilid scorpions for the country.

can only be expressed after new studies of the type material or at least of topotypes which will allow better descriptions with proper illustrations.

* Possible cases of misidentification.

** Valid species.

*** Species requiring a confirmation of their validity.

Family **Chaerilidae** Pocock, 1893

Genus **Chaerilus** Simon, 1877

Chaerilus truncatus Karsch, 1879*

Chaerilus celebensis Pocock, 1894*

Chaerilus petrzekai Kovařík, 2000**. – Type locality: Dong Nai province, Vinh Cuu district, Ma Da forest (10°56'N 107°21'E); Lam Dong province, Lang-Biang mountain (12°02'N 108°26'E).

Chaerilus vietnamicus Lourenço & Zhu, 2008**. – Type locality: Lao Cai province, Lao Cai city, Dong Tuyen commune (22°31'N 103°56'E).

Chaerilus juliettae Lourenço, 2011**. – Type locality: Binh Thuan province, Ta Kou mountain (10°49'N 107°53'E).

Chaerilus phami Lourenço, 2011**. – Type locality: Ba Ria-Vung Tau province, Con Son island (8°42'N 106°36'E).

Chaerilus anneae Lourenço, 2012**. – Type locality: Binh Thuan province, Ta Kou mountain (10°49'N 107°53'E).

Chaerilus terueli Kovařík, 2012***. – Type locality: Ba Ria-Vung Tau province, Con Son island (8°42'N 106°36'E). According to Rossi (2018) however, the status of *C. terueli* can be considered as dubious. Consequently, this author regarded *Chaerilus terueli* Kovařík, 2012, as a junior synonym of *Chaerilus phami* Lourenço, 2011.

Chaerilus hofereki Kovařík, Král, Kořínková & Reyes Lerma, 2014***. – Type locality: Binh Thuan province, Phan Thiet city (10°56'N 108°06'E).

Chaerilus pathom Lourenço & Pham, 2014**. – Type locality: Dien Bien province, Dien Bien district, Pa Thom commune (21°16'N 103°08'E).

Chaerilus longimanus Kovařík & Lowe, 2015***. – Type locality: Khanh Hoa province, Nha Trang city (12°12'N 109°12'E).

Chaerilus granulatus Kovařík, Lowe, Hoferek, Forman & Král, 2015***. – Type locality: Ninh Thuan province, Ninh Son district (11°41'N 108°41'E).

Chaerilus honba Lourenço, 2019**. – Type locality and coordinates: Khanh Hoa Province, ca. 60 km from Nha Trang, Cam Lam, Suoi Cat, Hon Ba, alt. 1535m (12°06'N 108°84'E).

TAXONOMIC TREATMENT

Chaerilus chubluk n. sp. (fig. 2-14)

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HOLOTYPE: pre-adult ♂, Vietnam, Co Cave, Dray Sap, Krong No district, Dak Nong province (12°31'8.193"N 107°53'38.711"E), 379 m, 12.IV.2019, *Pham D. Sac & Tran T. Hang*; specimen collected 408 m from cave entrance, found under a rock (fig. 15). Co Cave is a volcanic cave which belongs to the Krong No volcanic cave system. Holotype will be deposited in the collections of the Vietnam National Museum of Nature of the Vietnam Academy of Science and Technology.

Diagnosis. – Adults probably show a small or moderate size when compared to other species of the genus. The pre-adult male holotype is 18.1 mm in total length. General coloration yellow-brown to reddish brown, marked intensely with variegated brownish spots. Carapace moderately narrowed toward the anterior edge; almost acarinate and weakly granulated; anterior margin moderately emarginated; furrows shallow. Metasomal carinae moderately to strongly marked; ventral carinae absent from segments I and II, weakly marked on segment III; latero-ventral and ventral carinae on segment V composed of spinoid granules. Telson with pear-like shape; aculeus weakly curved. Dentate margins of fixed and movable fingers with 9-10/11 rows of granules. Fingers strongly curved. Pectinal tooth count 6-7 in male holotype. Genital operculum plates have an oval to rounded shape. Trichobothriotaxy of type B, orthobothriotaxic.

It seems important to confirm that the specimen of *Chaerilus chubluk* n. sp. did not fluoresce under UV lamp, as all the other *Chaerilus* species tested up to now. This, once again, confirms the interesting discovery by LOURENÇO (2012b).

Description. – Coloration basically yellow to reddish brown, intensely marked with brownish variegated spots. Carapace yellowish with dark spots which are better marked on the anterior area. Tergites yellow intensely marked with brownish confluent spots. Metasomal segments yellow with brownish variegated spots. Telson yellow with diffused brownish variegated spots; aculeus reddish. Chelicerae yellow intensely marked with brownish variegated spots; fingers dark at the base and yellow at their extremity; teeth reddish. Pedipalps reddish yellow, marked with brownish spots; femur more intensely spotted than patella and chela, dark brown; fingers, including dentate margins, reddish. Legs yellow with brownish variegated spots. Venter yellow; sternites and sternum with diffused brownish spots; coxapophysis, genital operculum and pectines pale yellow to almost white, without any spots.

Carapace moderately narrowed anteriorly; anterior margin moderately emarginated; almost acarinate and moderately to weakly granulated; furrows shallow. Two pairs of lateral eyes, and one pair of moderate median eyes, about twice the size of lateral eyes; median eyes anterior to the centre of the carapace.

Tergites with some minute granulations, almost smooth; carinae obsolete.

Sternum pentagonal, much longer than wide; genital operculum plates with an oval to rounded-shape. Pectinal tooth count 6-7 in male holotype. Sternites smooth without granules including on VII; spiracles small and oval to round-shaped; carinae absent from VII. Metasomal segments I and II wider than long; segments III and IV slightly longer than wide; V markedly longer than wide. Carinae moderately granular; ventral carinae absent from segments I and II; weakly marked on segment III; dorsal carinae with some spinoid granules on segments I-IV; latero-ventral and ventral carinae on segment V composed of some spinoid granules.

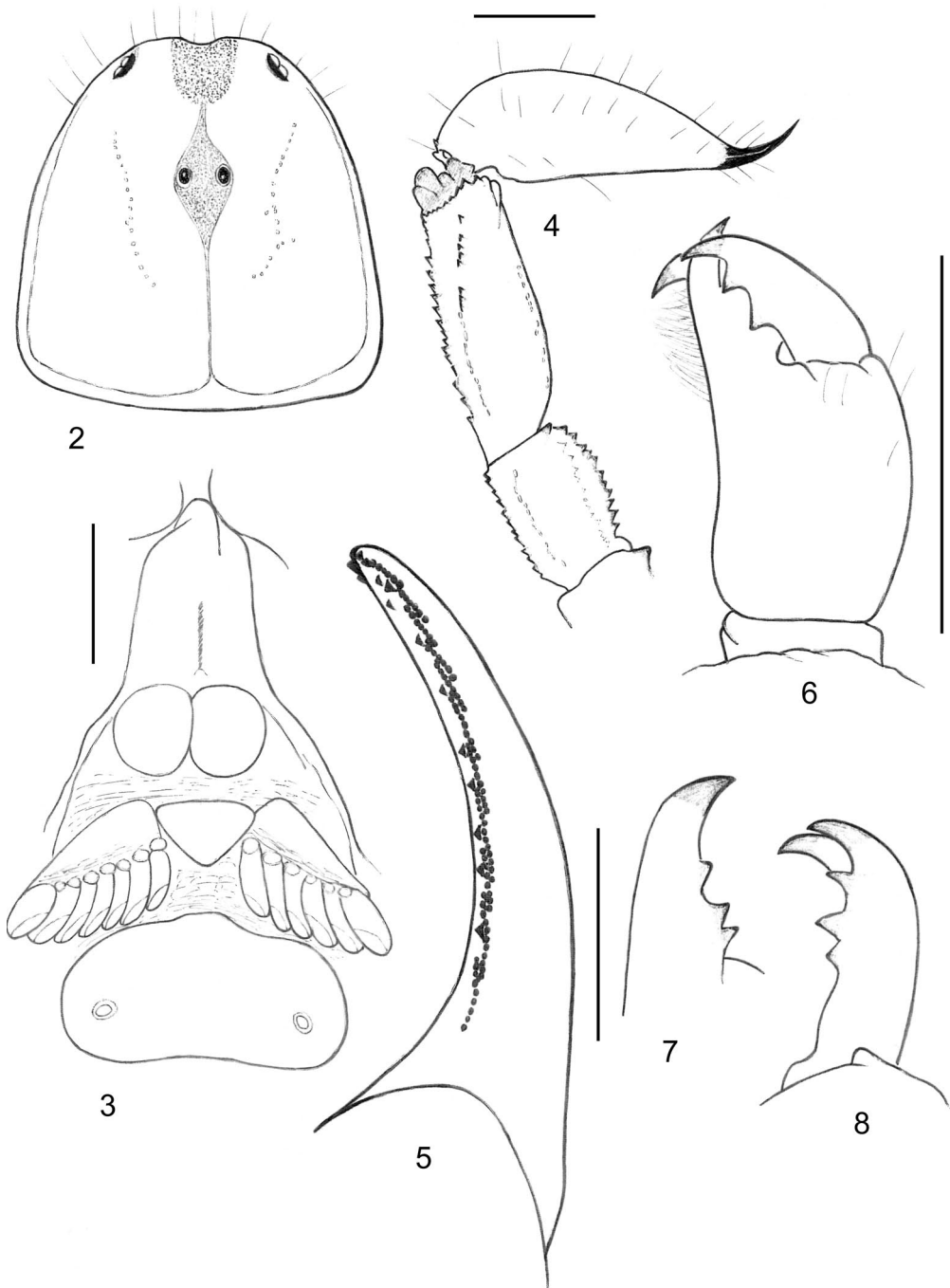


Fig. 2-8. – *Chaerilus chubluk* n. sp., ♂ holotype. – 2, Carapace, dorsal aspect. – 3, Ventral aspect, showing sternum, genital operculum, pectines and sternite III with spiracles. – 4, Metasomal segments IV and V and telson, lateral aspect. – 5, Cutting edge of fixed finger showing series of granules. – 6, Chelicera, dorsal aspect. – 7-8, Fixed and movable fingers in detail. Scales: 1 mm.

Vesicle moderately elongated with a pear-like shape, almost smooth; *aculeus* short and weakly curved.

Pedipalps not elongated; femur with five carinae; internal with a few spinoid granules. Patella with 6-7 vestigial carinae. Chela weakly enlarged and with 7-8 moderately marked carinae; internal with some spinoid granules. Tegument weakly granular. Fixed and movable fingers shorter than manus and strongly curved, with 9-10/11 rows of granulations on the dentate margins. Chelicerae characteristic of the family Chaerilidae (VACHON, 1963).

Trichobothriotaxy of type B; orthobothriotaxic (VACHON, 1974); femur with 9 trichobothria, patella with 14, and chela with 14. Legs with pedal spurs moderately to strongly developed. Tarsi with two rows of setae.

Hemispermaphore remains unknown.

Morphometric values (in mm) of the male holotype. – Total length (including telson), 18.1. Carapace: length, 2.7; anterior width, 1.5; posterior width, 2.9. Mesosoma length, 5.3. Metasomal segments. I: length, 1.0; width, 1.3; II: length, 1.1; width, 1.2; III: length, 1.2; width, 1.1; IV: length, 1.3; width, 1.0; V: length, 2.3; width, 0.9; depth, 0.9. Telson length, 3.2. Vesicle: width, 1.1; depth, 1.0. Pedipalp: femur length, 2.3, width, 1.0; patella length, 2.6, width, 1.1; chela length, 5.1, width, 1.5, depth, 1.3; movable finger length, 2.6.

Etymology. – Specific name refers to the Chu B'Luk volcano which produced the cave system in which the new species was found and is placed in apposition to the generic name.

Relationships. – *Chaerilus chubluk* sp. n. shows morphological similarities with the species of the *Chaerilus variegatus* group, as defined by LOURENÇO (2011a) but can be distinguished from the other species of this group, known from south-east Asia and in particular from Vietnam, by a combination of characters: (i) a heavily spotted pigmentation on body and appendages, but largely absent from the ventral aspect, in particular from coxapophysis, genital operculum and pectines; only the sternum shows some diffuse pigments, (ii) pedipalp chela fingers with 9-10/11 rows of granulations, (iii) pectines with 6-7 teeth, a number only similar to that of *C. juliettae*, a species, however which belongs to a distinct group, the *truncatus* species-group, (iv) carapace with a better marked emargination.

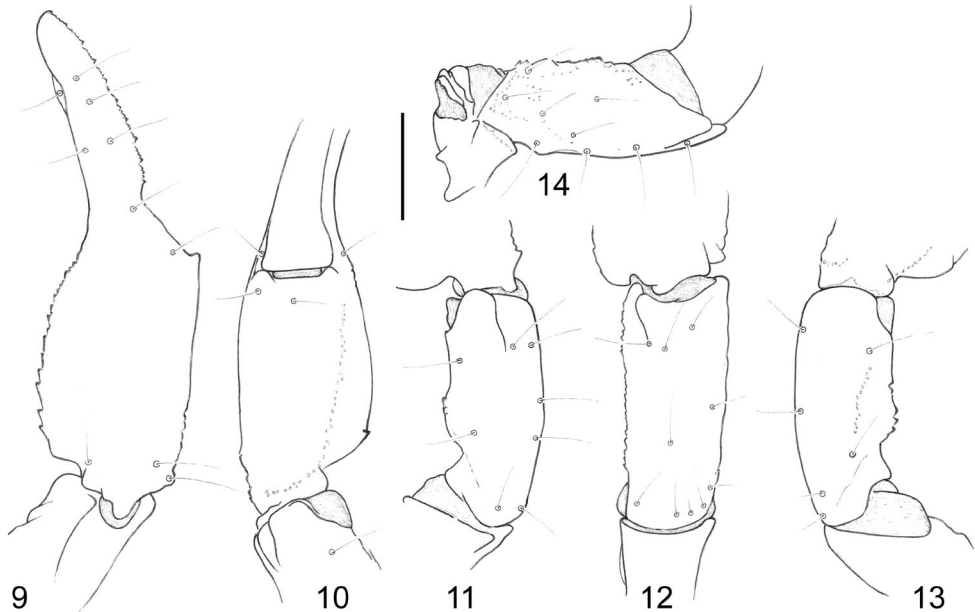


Fig. 9-14. – *Chaerilus chubluk* n. sp., ♂ holotype, trichobothrial pattern. – 9-10, Chela: 9, dorso-external aspect; 10, ventral aspect. – 11-13, Patella: 11, dorsal aspect; 12, external aspect; 13, ventral aspect. – 14, Femur, dorsal aspect. Scales: 1 mm.



Fig. 15. – *Chaerilus chubluk* n. sp., ♂ holotype alive in Co Cave.

DISCUSSION

CHARACTERISTICS OF CO CAVE (BAT CAVE)

According to the results of the survey results performed up to March 2018, Co Cave (coordinates of the entrance: 12°31'8.193"N 107°53'38.711"E) is located 7452 m NW of Chu B'Luk volcano and is considered the least known cave of the C cave system to the northwest of this volcano. The Co outlet is located about 70 m south of the Dray Sap Landscape Special Use Forest. The topography of Co Cave area is quite flat, slightly rough (highly floating) in the upper part of the cave forming a thunderstorm-ledge running in the sub-latitude, coinciding with the development of Co Cave. The entrance of the cave has an altitude equivalent to the current topographic surface of the area; it is small in size and hidden under a tree so it is difficult to be detected (fig. 16). Basalt pits, dark gray, blocky structure distributed on the surface of this area are in most cases discrete blocks and boulders often pierced by the root system, what increases the level of cracking, especially around the area of the main cave (fig. 17-18). Movements in this area should be done with attention. The cave length is 575.5 m and the cave depth around 14.9 m. Co Cave entrance is only a narrow and rugged niche, about 2 m wide, the highest portion is only about 0.7 m-0.8 m. Consequently, the access to the cave is rather difficult.

The lava cave system of Chu B'Luk volcano is formed from basalt lava flow with high temperature (1000-1200°C) and low viscosity produced during the Chu B'Luk eruptions which occurred about 700,000 to 200,000 years before present. These events belong therefore to the period of Middle Pleistocene (Q12), Xuân Lộc Formation (12Q12 xl). The results of K/Ar absolute isotopic age analysis of fresh basalt samples collected on the ceiling of C6.1 cave and C2 cave walls have the results of 689,000 years and 668,000 years, respectively. Thus, the age of formation of Co Cave is expected to be of equal value (LA *et al.*, 2018).

CAVE SCORPIONS

Cave or, more precisely, true troglotic scorpions are globally rare. It was not until the late 1960s that the first truly troglotic scorpions were described from Mexican caves: *Typhlochactas rhodesi* Mitchell, 1968, and *Typhlochactas reddelli* Mitchell, 1968 (MITCHELL, 1968). Since

these initial discoveries, the available data on cave scorpions have been synthesized by certain authors, in particular LOURENÇO & FRANCKE (1985) and VOLSCHENK & PRENDINI (2008). The true troglotic scorpions discovered to date belong to the families Akravidae Levy, 2007, Chaerilidae Pocock, 1893, Diplocentridae Karsch, 1880, Euscorpiidae Laurie, 1896,



Fig. 16-17. – Co Cave. – 16, Main entrance, covered by the typical forest vegetation. – 17, Interior of the cave.

Hormuridae Laurie, 1896, Pseudochactidae Gromov, 1998, Typhlochactidae Mitchell, 1971, Troglotayosicidae Lourenço, 1998, Urodacidae Pocock, 1893 and Vaejovidae Thorell, 1876. These troglobitic species have been discovered mainly in North and South America, the Middle East, Madagascar, Christmas Island (Indian Ocean), Australia and Southeast Asia. For more detailed information see LOURENÇO & PHAM (2013).

A number of species of the family Chaerilidae had been reported inhabiting cave environments, and some were classified as true troglobitic elements (LOURENÇO & FRANCKE, 1985; VOLSCHENK & PRENDINI, 2008; LOURENÇO & ROSSI, 2019). However, the two *Chaerilus* species found in Vietnamese caves, *C. pathom* and the new species described here, are probably not true troglobitic elements, and show at least a much less degree of adaptation to caves than other scorpions from Vietnam such as those of the genus *Vietbocap* Lourenço & Pham, 2010, which show a total adaptation to cave life (LOURENÇO *et al.*, 2018).

ACKNOWLEDGEMENTS. – We are most grateful to Dr Lucienne Wilmé (Missouri Botanical Garden) for the preparation of the map (fig. 1) and to Dr La The Phuc for permission to use some of his photos. This research is funded by Vietnam National Foundation for Science and Technology Development (Nafosted) under grant number 106-NN.06-2015.38 and the Project TN17/T06 of the National Programme Tay Nguyen 2016–2020.

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