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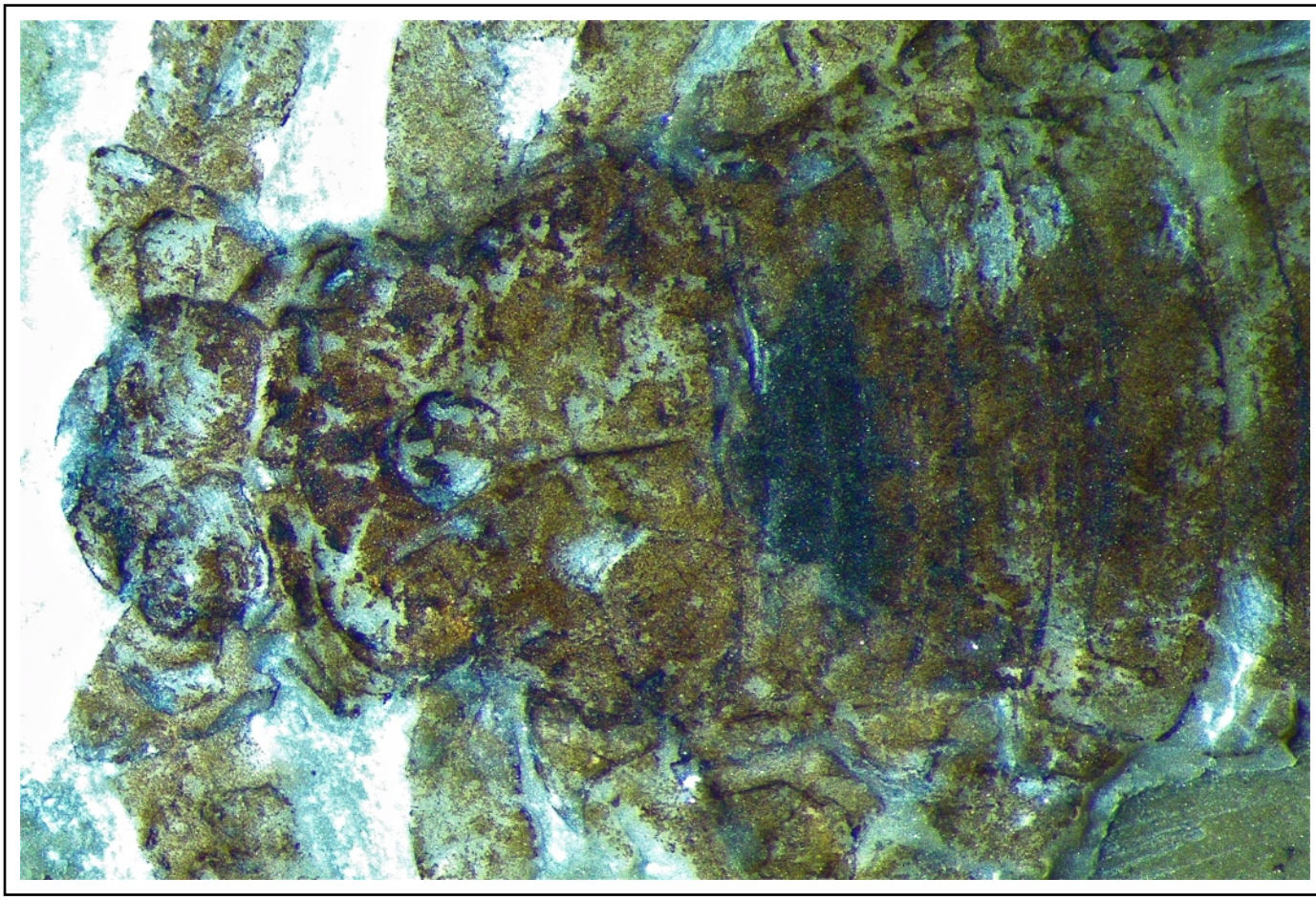

Volume 10
Numéro 24

Mai 2022

ISSN : 2269 - 6016
Dépôt légal : Mai 2022

Faunitaxys

Revue de Faunistique, Taxonomie et Systématique morphologique et moléculaire

ZooBank : http://zoobank.org/79A36B2E-F645-4F9A-AE2B-ED32CE6771CC

Directeur de la publication, rédacteur, conception graphique et PAO:
Lionel Delaunay

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La parution de *Faunitaxys* est apériodique

Faunitaxys est indexé dans / ***Faunitaxys*** is indexed in:
- Zoological Record
Articles and nomenclatural novelties are referenced by:
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Imprimée sur les presses de SPEED COPIE, 6, rue Tréfilerie, F- 42100 Saint-Etienne

Imprimé le 05 mai 2022

https://doi.org/10.57800/faunitaxys-10(24)

A new family, genus and species of fossil scorpion from the Meride Limestone (Middle Triassic) of Monte San Giorgio (Switzerland)

FABIO MAGNANI (1, 3), RUDOLF STOCKAR (1, 4) & WILSON R. LOURENÇO (2,*)

(1) Dipartimento del territorio, Museo cantonale di storia naturale, Viale Carlo Cattaneo 4, 6900 Lugano, Switzerland.

(2) Muséum national d'Histoire naturelle, Sorbonne Universités, Institut de Systématique, Evolution, Biodiversité (ISYEB), UMR7205-CNRS, MNHN, UPMC, EPHE, CP 53, 57 rue Cuvier, 75005 Paris, France.
– E-mail : wilson.lourenco@mnhn.fr
– ZooBank : http://zoobank.org/58448BD6-79D7-46CE-AFDD-91EFF2B7D4EF – Orcid : https://orcid.org/0000-0002-2386-363X

(3) – E-mail : fabio.magnani@ti.ch
– ZooBank : http://zoobank.org/76A9E6FC-0D52-4D81-AB9F-F8DA890E53BA – Orcid : https://orcid.org/0000-0002-5982-7278

(4) – E-mail : rudolf.stockar@ti.ch
– ZooBank : http://zoobank.org/F7CCCBC2-F469-4AA6-B1F0-E60687886D95 – Orcid : https://orcid.org/0000-0003-1805-3891

* Correspondence.

Keywords:

scorpion;
fossil;
Ladinian;
Middle Triassic;
Meride Limestone;
Southern Alps;
new family;
new genus;
new species;
description.

Abstract. – One new family, genus, and species of fossil scorpion are described from the Meride Limestone (Ladinian, Middle Triassic) of Monte San Giorgio (Southern Alps). This new discovery brings further evidence for the recovery of terrestrial forms of scorpions, following the Late-Permian mass extinction. The new fossil family proposed at present can, once again, be classified within extant familial groups; in this case the superfamily Chactoidea (sensu Lourenço). These results reinforce the proposition that modern scorpions may belong to lineages present at least for 240 Myr.

Magnani F., Stockar R. & Lourenço W. R., 2022. – A new family, genus and species of fossil scorpion from the Meride Limestone (Middle Triassic) of Monte San Giorgio (Switzerland). *Faunitaxys*, 10(24): 1 – 7.

DOI: https://doi.org/10.57800/faunitaxys-10(24)

ZooBank: http://zoobank.org/3404F63F-4334-4AF1-A036-FD06AD8B8FA4

Received: 29/03/2022 – *Revised*: 06/04/2022 – *Accepted*: 07/04/2022

Introduction

As already suggested in previous papers (Carvalho & Lourenço, 2001: Lourenço & Gall, 2004), on account of the problematic mineralization of cuticles in terrestrial habitats, scorpions can be considered as rare in the palaeontological record. A number of fossils have been discovered since the Palaeozoic period, but the number of known cases from the Triassic, Jurassic and Cretaceous can be considered minor (Sissom, 1990; Jeram, 1994a). Previously, five known occurrences during the Triassic and two in the Jurassic were reported by Sissom (1990). Subsequently discoveries confirmed the presence of scorpion fossils for the Cretaceous period (Carvalho & Lourenço, 2001), but most were found exclusively in amber (e. g. Lourenço, 2001, 2002, 2003, 2016). Finally, the Fossil-Lagerstätten of the Upper Buntsandstein of NE France, known as the Grès à Voltzia Formation, brought two remarkable discoveries for the palaeontological history of scorpions (Lourenço & Gall, 2004). In the present study a new element found in the Meride Limestone, Monte San Giorgio, Middle Triassic of Southern Alps, leads to the description of a new family, genus and species. This new element, once again, can be associated to extant familial groups and seems particularly distinct from previously described fossils from the Triassic, including those from the Grès à Voltzia Formation. Even the recently proposed new fossil, equally found in the Ladinian sequence of Monte San Giorgio Lagerstätte, yet in the slightly older Besano Formation (Viaretti et al., 2020), appears as totally different since its shows markedly affinities with the family Protobuthidae Lourenço & Gall, 2004.

Material and methods

The description of the new family, genus and species is based on a single specimen, stored at the Museo cantonale di storia naturale (Lugano, Switzerland), collection number MCSN 8613.
The fossil material was mechanically prepared with the aid of sharpened steel needles. The specimen was studied under a stereomicroscope Leica M80 equipped with a camera lucida. The drawings were made directly on the fossil. The photographs were taken with a Sigma Quattro H digital camera. Detailed photographs of some anatomical structures were taken with a Leica IC90E digital camera attached to the Leica M80 stereoscope.
The schematic drawings provided are an interpretation of what was observable. Measurements follow Stahnke (1971) and are given in mm. Cheliceral notations follow Vachon (1963) and trichobothrial notations are those of Vachon (1974). Other morphological terminologies mostly follow Hjelle (1990). Trichobothria are definitely recorded when their bothria (areoles) can be observed.

Geological framework

The Middle Triassic carbonate succession of Monte San Giorgio (Switzerland-Italy; Fig. 1) has been inscribed in the UNESCO World Heritage List (WHL) because of its unique paleontological value. It is, in particular, world-famous for the exceptionally well-preserved fossil fishes and marine reptiles (e.g. Rieber 1973a;

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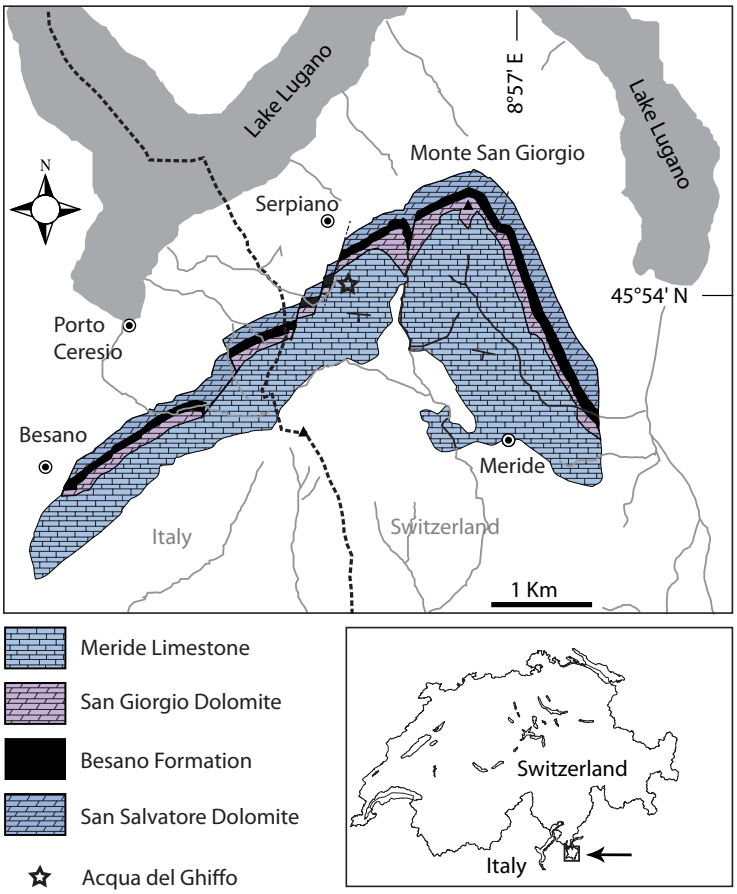

Fig. **1**. Map of the Monte San Giorgio area (Ticino, Southern Switzerland), showing the carbonate Anisian-Ladinian sequence together with the Acqua del Ghiffo locality (modified from Stockar, 2010).

Kuhn-Schnyder 1974; Rieppel 2019) and for the detailed age-diagnostic ammonoid and bivalve record provided by the Besano Formation across the Anisian/Ladinian boundary (e.g. Rieber 1969, 1973b). The Monte San Giorgio fossil-Lagerstätte belongs to the western termination of the Southern Alps. In Middle Triassic times, the South-Alpine domain was situated at a northern intertropical latitude of about 15-18° (Muttoni et al. 2004) and was strongly influenced by monsoonal circulation (Preto et al. 2010). This passive continental margin, open to the western Neo-Tethys, was progressively submerged by a long-term transgression from the east. The marginal location of the Monte San Giorgio basin resulted in a peculiar sedimentary succession and in at least temporarily dysoxic to anoxic bottom water conditions (e.g. Bernasconi 1994; Röhl et al. 2001; Stockar 2010; Stockar et al. 2013). The Middle Triassic succession (Fig. 2) starts with fluvio-deltaic deposits (Bellano Formation, Illyrian; Sommaruga et al. 1997), unconformably overlying Lower Triassic transitional clastic deposits (Servino, Induan – Olenekian; Frauenfelder 1916; Sciunnach et al. 2015), in turn onlapping an erosional unconformity at the top of a Lower Permian volcanic basement. The following upper Anisian sediments indicate the progressive transgression and to the initiation of carbonate platform growth (Lower San Salvatore Dolomite; Zorn 1971). During the latest Anisian and the Ladinian, although shallow-water sedimentation continued in the north, an intraplatform basin opened in the area of the Monte San Giorgio, which led to the deposition of the Besano Formation, the San Giorgio Dolomite, and the Meride Limestone. The Besano Formation ("Grenzbitumenzone"; Frauenfelder 1916) directly overlies the Lower San Salvatore Dolomite and is composed of a 16 m thick alternation of black shales and laminated dolostone. Its uppermost part includes the Anisian/Ladinian boundary (Brack et al. 2005). The Besano Formation grades upwards into the San Giorgio Dolomite and the Meride Limestone, together constituting a 614-m thick sequence in total. The San Giorgio Dolomite results from early and late diagenetic dolomitization, the latter cutting across stratification and affecting the original limestone in an irregular pattern up to a major volcaniclastic bed ("Val Serrata tuff". Stockar et al. 2013). The overlying about 500 m thick Meride Limestone (Wirz, 1945) begins with the lower Meride Limestone, which is up to 150 m thick and is interpreted as a sequence of lime mud turbidites (Furrer, 1995). The lower Meride Limestone includes three fossil vertebrate levels: Cava inferiore, Cava superiore and Cassina beds, each yielding different vertebrate assemblages (e.g. Peyer 1931, Sander, 1989; Furrer, 1995; Stockar 2010) and consisting of finely laminated limestone and marl with intercalated volcanic ash layers. The top of the lower Meride Limestone is defined by a very discontinuous dolostone horizon ("Dolomitband"; Frauenfelder, 1916).

The specimen described herein comes from the lower part of the Cava superiore beds, a 10 m thick interval of very fine laminated bituminous limestone, only interrupted by volcanic-ash layers (bentonite) and micritic limestone, displaying

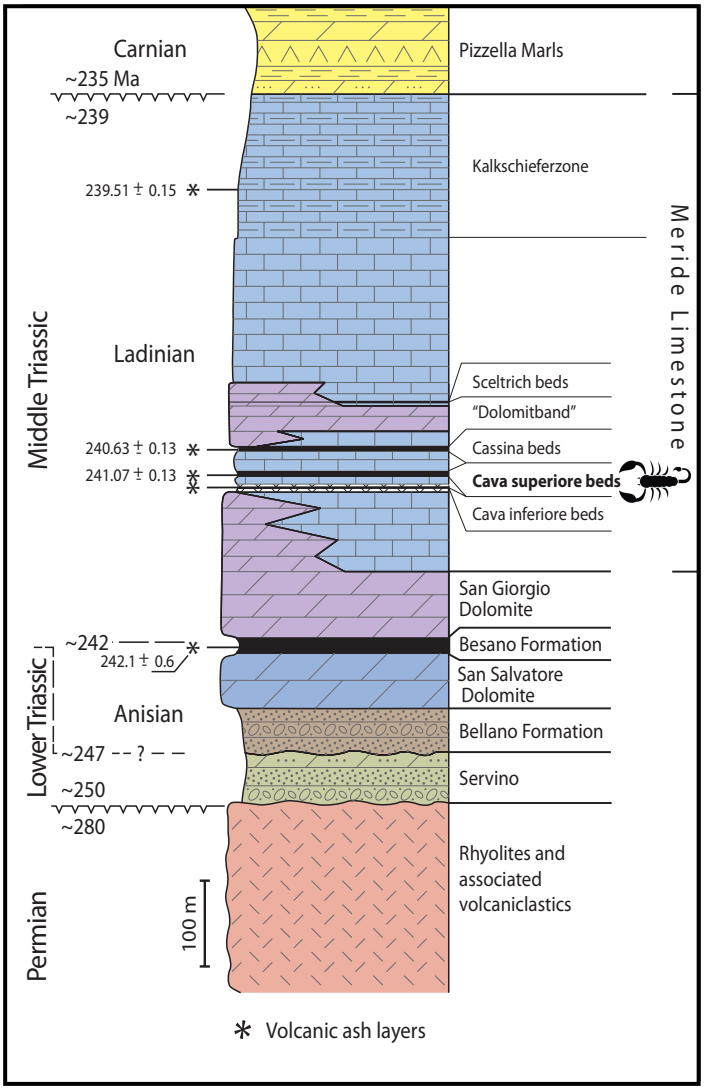

Fig. **2**. Stratigraphic column of the Monte San Giorgio area. The finding level of the new specimen is indicated. Stratigraphy after Commissione scientifica transnazionale Monte San Giorgio 2014, modified. U-Pb ages after Stockar et al. (2012).

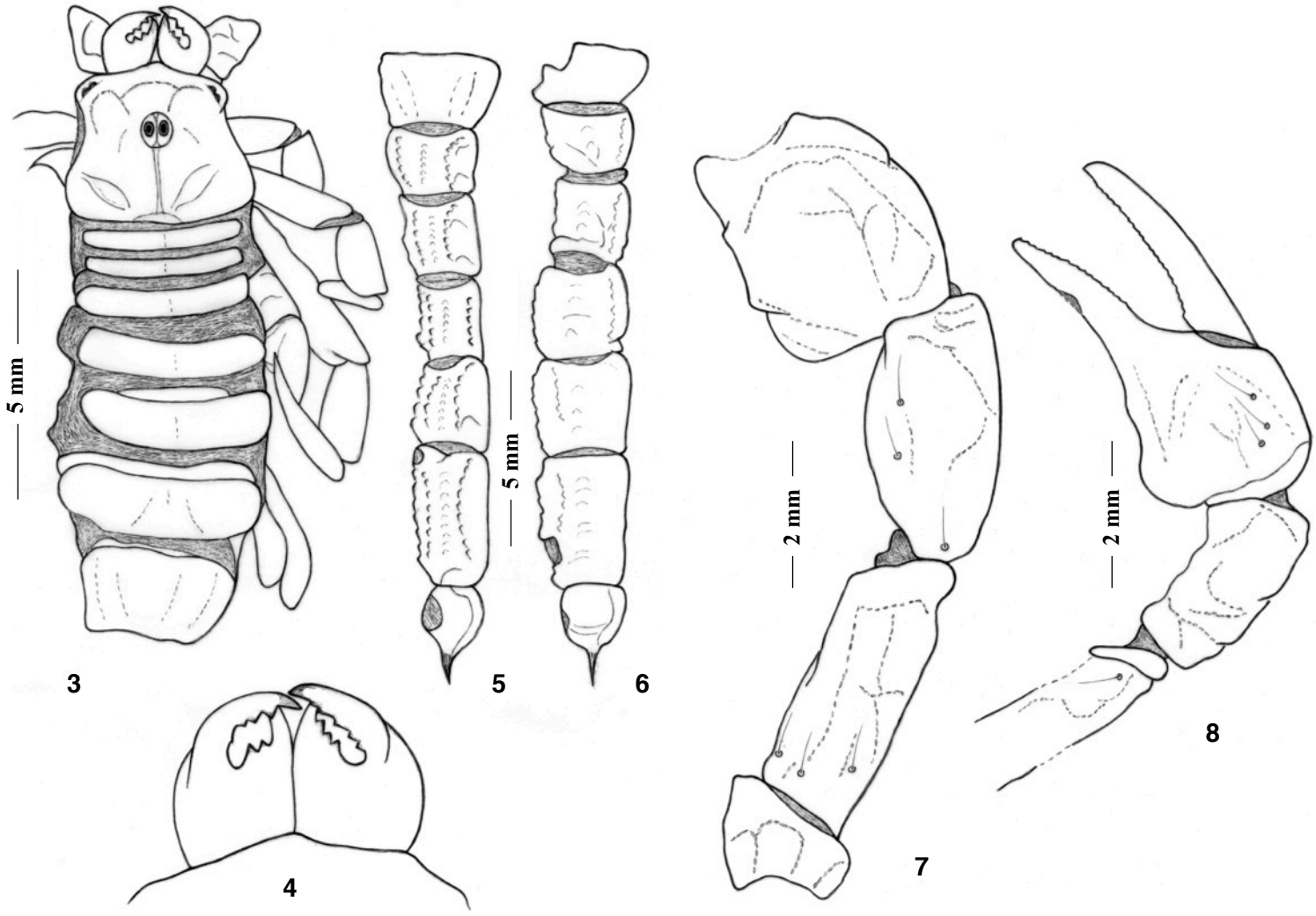

Fig. **3**-**8**. *Protochactas furreri* **sp**. **n**., holotype.

3. Chelicerae, carapace with eyes, tergites and legs (part). **4**. Chelicerae in detail.
5-**6**. Tergite VII, metasomal segments I to V and telson, showing carinae (5, part and 6, couterpart).
7-**8**. Right and left pedipalps with some visible trichobothria and carinae (7, part and 8, counterpart).

sometimes normal graded calcarenite at the base (Furrer 1999, 2001). The fossiliferous sequence was excavated in 1928 and 1997–2004 by teams from the University of Zurich at the locality Acqua del Ghiffo (Fig.1), where the specimen reported here was found on April 13, 2021 by one of the authors (FM). The site is located on the western flank of Monte San Giorgio (WGS 84 coordinates 45°54'21''N, 8°55'55" E), northwest of the village of Meride.

Vertebrate fossils are the small pachypleurosaurid *Neusticosaurus*, the larger sauropterygian *Ceresiosaurus* and rare actinopterygian fishes belonging to the genera *Saurichthys*, *Eosemionotus, Ticinolepis*, and *Besania* (Peyer 1931, Bürgin 1999, López-Arbarello et. al. 2016, 2019). Rare finds of ammonoids (*Arpadites* cf. *arpadis*), small gastropods, *Spirorbis*, *Halicyne*, the echinoid *Serpianotiaris hescheleri*, insects (Coleoptera, Odonata) and land plants (*Voltzia* and *Equisetites*) complete the fossil assemblage (Furrer 1999, 2001, 2003).

The age of the Cava superiore beds is assigned to the *P. gredleri* ammonoid zone (*sensu* Brack & Rieber 1993) of the Ladinian Stage. A 3-cm-thick volcanic-ash layer 1 m below the layer yielding the specimen described here resulted in a U-Pb age of 241.07 ± 0.13 Ma (Stockar et al. 2012).

Taxonomic comments

Since the major revision of Kjellesvig-Waering (1986) reprised by Sissom (1990), only a limited number of additions to the known Paleozoic fossils have been made by Jeram (1994a,b, 1998). Following the schema already used by Selden (1993), this author adopted the classification used by Stockwell (1989) in his unpublished PhD thesis. This author treats scorpions as a class Scorpionida, with three orders: Protoscorpiones, Palaeoscorpiones and Scorpiones, and in account of the extremely 'modern' general morphology of many fossils, he even suggested that these could probably be placed within recent superfamilies (Stockwell, 1989; Jeram, 1994a). In the catalog of the scorpions of the world, Fet et al. (2000), insist about the complicate task of dealing with the analysis and classification of scorpions at the class-order group levels, since the Code does not regulate names above the rank of family. They retain the system of Kjellesvig-Waering (1986) - with the family-group synonymies introduced later - as the only existing comprehensive system, but suggested that future reanalysis will almost certainly result in significant changes.

Systematic description

Order **Scorpiones** Koch, 1850 (1837)

Suborder **Neoscorpionina** Thorell & Lindström, 1885

Infraorder **Orthosternina** Pocock, 191

Superfamily **Chactoidea** Pocock, 1893 (*sensu* Lourenço, 2000)

Protochactidae new family, Lourenço, Magnani & Stockar

ZooBank: http://zoobank.org/3824F219-DAC3-457C-A65C-E7AE2E6847C3

Unlike several amber Cretaceous fossils (e. g. Lourenço, 2001, 2003, 2015a,b, 2018), previously described Mesozoic scorpion fossils from Jurassic and Triassic have not been assigned to any extant superfamily (Sissom, 1990). The first exception was the description of the family Protobuthidae (Lourenço & Gall, 2004). A careful analysis of several characters presented by the new fossil element described here led us to conclude that it can actually be placed in the superfamily Chactoidea *sensu* Lourenço (2000). The new fossil family proposed, Protochactidae fam. nov. shows a number of affinities with the Cretaceous fossil family Palaeoeuscorpiidae Lourenço, 2003, but equally with the extant families Euscorpiidae Laurie, 1896 and Chactidae Pocock 1893. A number of characters are however divergent and the geological horizon totally distinct from present environments; consequently the new fossil scorpion rather suggests a possible proto-element (*sedis mutabilis*) for these two families.

Etymology. – Familial name is an association of Proto (from Greek, which means first, original) and the family name Chactidae.

Diagnosis for the new family

Scorpion of small size with 27.0 mm in total length. The holotype is most probably an adult or pre-adult. Body and appendages rather bulk. Carapace rather smooth with the anterior margin slightly convex; presence of some vestigial carinae and some shallow furrows; median ocular tubercle conspicuous and slightly anterior to the centre of the carapace; median eyes moderate in size and separated by less than one ocular diameter; two pairs of conspicuous lateral eyes. Mesosomal tergites rather smooth with one vestigial median carinae; some weak carinae present on tergites VI and VII. Metasomal segments with strongly marked dorsal and sub-dorsal carinae; ventral carinae apparently absent. Telson with a globular vesicle, almost rounded and flattened dorso-ventrally; aculeus shorter than the vesicle and weakly curved; subaculear tubercle absent. Ventral characters are not observable. Trichobothrial pattern extremely incomplete, and only a few bothria can be detected; these suggest the fundamental type C (Vachon, 1974). The following trichobothria can be observed: 2-3 dorso-external on chela manus, namely **Db**, and two **Eb**; 2 dorsal and one internal on patella; 1 dorsal, 1 external and 1 internal on femur. Dentate margins of fixed finger probably composed of a single linear row of granules. Chelicera poorly observable, but 2-3 teeth on fixed finger and 3-4 on movable finger can be suggested (Vachon, 1963). Legs: tibial spurs not observable.

Type genus of the new family

Protochactas new genus, Lourenço, Magnani & Stockar.

ZooBank: http://zoobank.org/B0CAE711-B650-4BB4-ABAD-26F8326E4A8B

Type species. – *Protochactas furreri* **sp**. **n**., Lourenço, Magnani & Stockar.

Diagnosis for the new genus. – The same as for the new family.

***Protochactas furreri* sp**. **n**., Lourenço, Magnani & Stockar

(Fig. 3 - 14)

ZooBank: http://zoobank.org/CB86D102-AE88-4C4A-B8DC-1A0A491E4978

Type material. Holotype, MCSN 8613. Possibly an adult or pre-adult, in part and counterpart. Only the dorsal aspect is observable. Sex cannot be defined.

Type locality. – Monte San Giorgio, Acqua del Ghiffo, NW of the Meride village, Mendrisio (Canton of Ticino, Switzerland) (Fig. 1).

Type horizon. – Level 350 of the Cava superiore beds, lower Meride Limestone, early Ladinian (*P. gredleri* ammonoid zone), Middle Triassic of Southern Alps (Fig. 2).

Depositary. – Museo cantonale di storia naturale (MCSN, Lugano, Switzerland)

Patronym. – The species is named after Dr. Heinz Furrer, former curator at the Paleontological institute and museum of the University of Zurich, who in 1997-2004 led the first systematic excavations in the Cava superiore beds at Acqua del Ghiffo.

Diagnosis for the new species. – The same as for the new family.

Description

Coloration. – Globally brown to reddish-brown, with some zones slightly darker; it is uncertain however if this colour pattern is original or an artefact due to the preservation.

Morphology. – Prosoma: anterior margin of carapace weakly convex; tegument rather smooth with some vestigial carinae and furrows. Median ocular tubercle conspicuous and slightly anterior to the centre of the carapace; median eyes separated by about one ocular diameter; two pairs of lateral eyes can be observed. Mesosomal tergites rather smooth with one vestigial median carina. Tergites VI and VII with some weak carinae. Sternites not observable. Pectines not observable. Metasomal segment with strongly marked dorsal and sub-dorsal carinae; ventral carinae probably absent with a ventral aspect smooth. Telson smooth; vesicle with a round shape, flattened dorso-ventrally; aculeus slightly curved and shorter than vesicle; subaculear tooth absent. Chelicerae bulk with only a few teeth observable (Vachon, 1963). Pedipalps rather bulk, with chela-hand globular and chela-fingers short; femur probably pentacarinate; patella and chela with vestigial. Trichobothrial pattern extremely incomplete but recalling a possible 'basic' type C (Vachon, 1974). Chela manus with 2-3 trichobothria, **Db,** and 2 **Eb**. Patella with $\mathbf{d_1}$, $\mathbf{d_2}$, and **i**. Femur with **d**, **i** and **e** (Fig. 7-8). Dentate margins of fixed finger probably composed of a single linear row of granules. Legs: Ventral aspect of tarsi and spurs not observable.

Morphometric values (mm) of the holotype of *Protochactas furreri* **sp**. **n**.

– *Total length* (including telson) 27.0.

– *Carapace*: length, 3.1; anterior width, 2.9; posterior width, 3.5.

– *Mesosoma*: length, 6.8.

– *Metasomal segments*

I: length, 1.8; width, 2.0;
II: length, 2.1; width, 1.9;
III: length, 2.2; width, 1.8;
IV: length, 2.4; width, 2.4;
V: length, 3.0; width, 2.4.

– *Telson*: length, 3.1; width, 1.1.

– *Pedipalp* (right / left)

femur length, 2.8/2.7, width, 1.1/1.0;
patella length, 2.5/2.5, width, 1.1/1.3;
chela length, 5.3/5.4, width, 2.4/2.0;
movable finger length, 3.3/3.5.

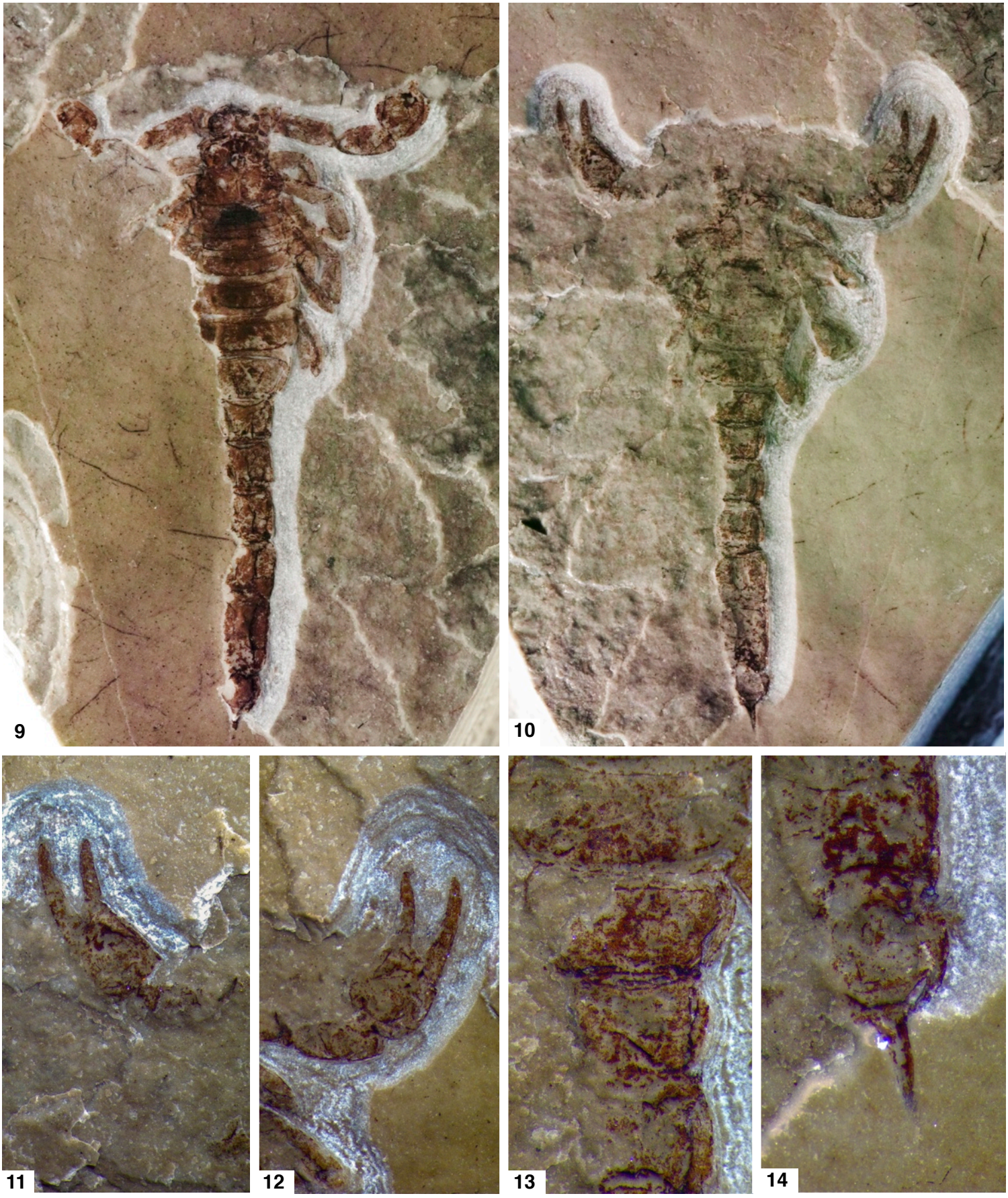

Fig. **9**-**14**. *Protochactas furreri* **sp**. **n**., holotype.

9-**10**. Habitus. **9** (part), **10** (counterpart). **11**-**12**. Left and right pedipalps (counterpart). **13**. Sternites VI and VII and metasomal segments I and II showing carinae (counterpart). **14**. Telson in detail (counterpart).

Acknowledgements

The authors are grateful to the Monte San Giorgio Foundation (Meride) and to the workers of the ECO 2000 forestry company, for their cooperation during the development project of the historical Acqua del Ghiffo paleontological site, by which this exceptional discovery came to light. Fieldwork and fossil preparation have been granted by the Dipartimento del territorio del Cantone Ticino and the Swiss Federal Office for the Environment.

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Résumé

Magnani F., Stockar R. & Lourenço W. R., 2022. – Une nouvelle famille, genre et espèce de scorpion fossile du Calcaire de Meride (Trias Moyen) du Mont San Giorgio (Suisse). *Faunitaxys*, 10(24): 1 – 7.

Une nouvelle famille, genre et espèce de scorpion fossile sont décrites du Calcaire de Meride, Trias Moyen du Monte San Giorgio dans les Alpes du Sud. Cette nouvelle découverte apporte un nouveau support à la restauration des formes terrestres de scorpion à la suite de la dramatique extinction de la fin du Permien. La nouvelle famille fossile proposée peut, une fois de plus, être classée dans une superfamille actuelle, celle des Chactoidea (sensu Lourenço). Ces résultats suggèrent ainsi l'existence de cette lignée depuis au moins 240 Ma.

Mots-clés. – Scorpion, fossile, Trias Moyen, Ladinien, Calcaire de Meride, Alpes du Sud, nouvelle famille, nouveau genre, nouvelle espèce, description.

Faunitaxys

Volume 10, Numéro 24, Mai 2022

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Illustration de la couverture : *Protochactas furreri* **sp**. **n**. Chelicerae, carapace and tergites I to III in detail.

Publié par l'Association Française de Cartographie de la Faune et de la Flore (AFCFF)