Revue de Paléobiologie, *Genève* (décembre 2020) 39 (2): 413-420 ISSN 0253-6730

Gastropods from the Sceltrich beds of Monte San Giorgio (Meride Limestone, Ladinian, Canton Ticino, Switzerland)

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Abstract

For the first time gastropods from the Meride Limestone (Ladinian) are documented. The material was collected from the outcrop Valle di Sceltrich at Monte San Giorgio (Southern Alps, Ticino, Switzerland) in the newly discovered Sceltrich beds. The taxa include *Cryptonerita*? sp., *Coelostylina stotteri* and *Omphaloptycha* cf. *marianii*. The findings represent the first identifiable Ladinian gastropods so far described from this UNESCO Fossillagerstätte and document the occurrence of several taxa of the clades Neritimorpha and Caenogastropoda from the Meride Limestone.

Keywords:

Gastropods, Middle Triassic, Ladinian, Meride Limestone, Sceltrich beds, Southern Alps, Switzerland.

1. INTRODUCTION AND GEOLOGICAL SETTING

The Middle Triassic carbonate succession of Monte San Giorgio (Switzerland-Italy; Fig. 1A, B) 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; Kuhn-Schnyder, 1974; Bürgin *et al.,* 1989; Etter, 2002) 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, reaching the westernmost South-Alpine domain in late Anisian times. 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; Etter, 2002; Stockar, 2010; Stockar *et al.,* 2013). The Middle Triassic succession (Fig. 1B) starts with fluvio-deltaic deposits (Bellano Formation, Illyrian; Sommaruga *et al.,* 1997), unconformably overlying Lower Triassic transitional clastic deposits (Servino, Induan, see Frauenfelder, 1916; Sciunnach *et al.*, 2015), in turn onlapping an erosional unconformity at the top of a Lower Permian volcanic basement. The upper Anisian sediments indicate the progressive transgression of a shallow epicontinental sea and the related expansion of carbonate platforms (Lower San Salvatore Dolomite, see Zorn, 1971) north of an emerged land area, which is nowadays covered by the Po Plain (Picotti *et al.*, 2007). While in the north and in the east shallow-water sedimentation continued during the latest Anisian and Ladinian, in the Monte San Giorgio area the formation of an intraplatform basin with restricted circulation resulted in the deposition of the Besano Formation, the San Giorgio Dolomite and the Meride Limestone. The Besano Formation ("Grenzbitumenzone", see Frauenfelder, 1916) directly overlies the Lower San Salvatore Dolomite and at the Swiss locality Mirigioli it is composed of a 16 m thick alternation of black shale and laminated dolostone. Its uppermost part includes the Anisian/Ladinian boundary (Brack & Rieber, 1993; Brack *et al.*, 2005). Most of the spectacular vertebrate fossils together

Submitted July 2020, accepted September 2020
Editorial handling: L. Cavin
DOI: 10.5281/zenodo.4460698

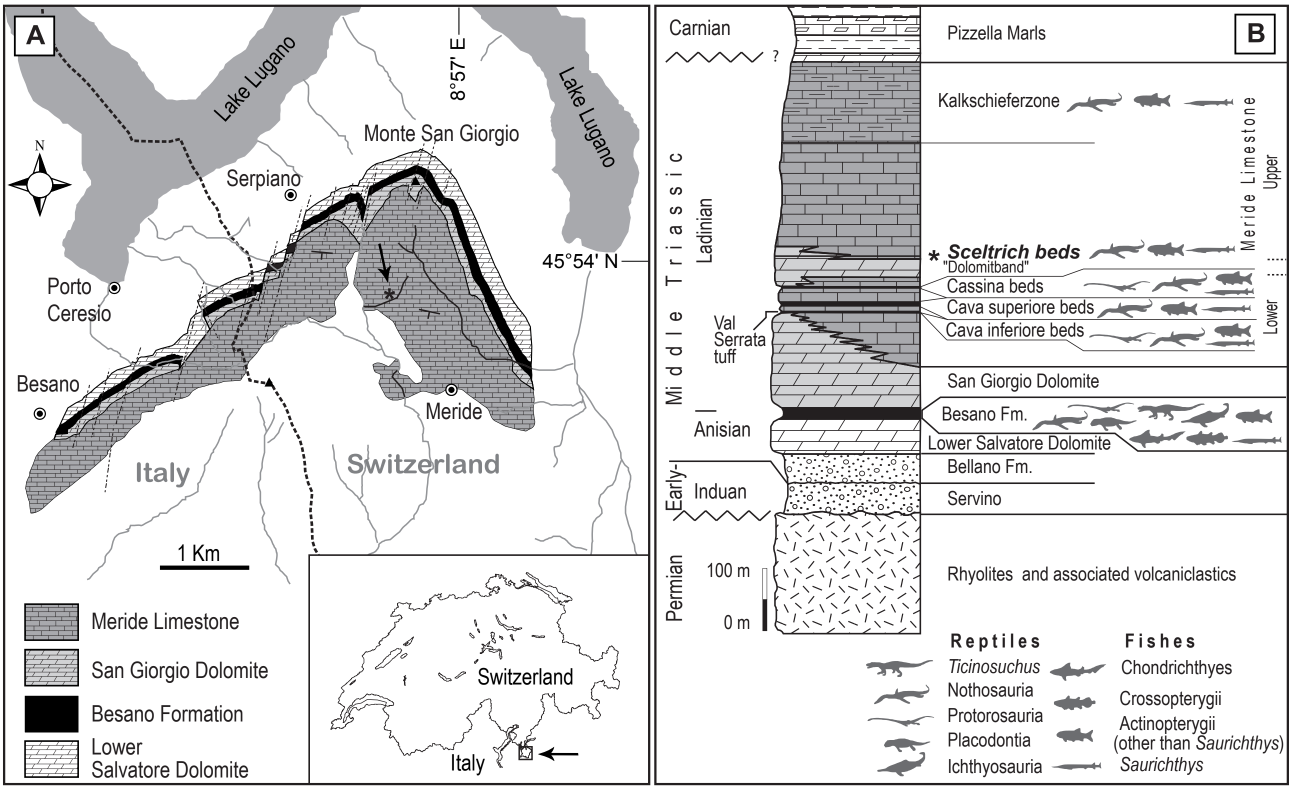

Fig. 1: A – Location map of the Monte San Giorgio showing the Middle Triassic carbonate succession and the Valle di Sceltrich excavation site (asterisk). B – Stratigraphic section of the Middle Triassic sediments in the Monte San Giorgio area with the classic fossil-vertebrate levels and the stratigraphic position of the Sceltrich beds. From Stockar *et al.* (2013), modified.

with important index invertebrate fossils come from this formation, which also yielded the only fossil gastropods so far described from Monte San Giorgio (Bassani, 1886; Pieroni & Furrer, 2020). The Besano Formation grades upwards into the San Giorgio Dolomite and the Meride Limestone, together constituting a 614 m thick sequence in total. Recent studies (Stockar, 2012; Stockar *et al.*, 2013) showed that 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"). The Lower Meride Limestone consists of well-bedded micritic limestone, laminated limestone and volcaniclastic layers. Three fossiliferous intervals, informally known as "Cava inferiore beds", "Cava superiore beds" and "Cassina beds", mainly consist of finely laminated limestone and yielded different vertebrate fossil assemblages (e.g. Peyer, 1931; Sander, 1989; Furrer, 1995; Stockar, 2010; Stockar & Renesto, 2011). The top of the Lower Meride Limestone is defined by a very discontinuous dolostone horizon ("Dolomitband", see Frauenfelder, 1916) resulting from late diagenetic dolomitization cutting across the stratification of the Meride Limestone (Stockar, 2012; Stockar *et al.*, 2013). The overlying Upper Meride Limestone is a sequence of alternating well-bedded micritic limestone and marlstone. The uppermost part comprises the 120 m thick "Kalkschieferzone" (Senn, 1924), made up of thinly-bedded, mostly laminated, limestone and marlstone with peculiar faunas of fishes, crustaceans and insects (e.g. Wirz, 1945; Furrer, 1995; Lombardo *et al.*, 2012; Montagna *et al.*, 2019). Finally, the following Carnian regressive phase resulted in the formation of sabkha-type depositional environments and in the related sedimentation of evaporites (Pizzella Marl, see Furrer, 1995).

2. LOCATION AND AGE

The fossiliferous interval yielding the specimen described herein belongs to the lowermost part of the Upper Meride Limestone and was informally introduced as "Sceltrich beds" in Stockar (2012) and Stockar *et al*. (2013). Its age is assigned to the transition interval between the *P. gredleri* and *P. archelaus* Ammonoid Zones (*sensu* Brack & Rieber, 1993) of the Ladinian Stage (Stockar *et al.*, 2012). After a first exploration in 2010 yielding the first fossils from this horizon (Stockar, 2012), two small bed by bed excavations on a surface of around 6 and 10 square meters respectively were started in 2012 by the Museo cantonale di storia naturale

(MCSN, Lugano) under the direction of the second author. The site is located on the northern bank of a small creek (Valle di Sceltrich; Swiss National Coordinates: 716'910/84'370; Fig. 1A), northwest of the Meride village. The fossiliferous interval consists of a 30 cm thick sequence of prevailing organic-rich laminated limestone (up to 3.1% TOC) intercalated between thick-bedded marly limestone, the latter being the most typical lithology of the Upper Meride Limestone. In the Valle di Sceltrich area, this fossiliferous horizon lies around 2.5 m above the "Dolomitband". At places, the laminated limestone bears storm-generated concentrations of platform-derived skeletal grains and thin-shelled bivalve pavements (Stockar, 2012; Stockar *et al.*, 2013). Benthic microbial activity accounts for the microfabrics observed in the laminated limestone (including clotted-peloidal micrite and amorphous organic matter showing EPS-like structures) as well as for the geochemical signature being characterized by high hydrogen indices and prevailing Type-II (Type I) kerogen (Stockar *et al.*, 2013). Preservation of such a labile lipoid-rich organic material requires anoxic/lower dysoxic bottom-water conditions (Stockar *et al.*, 2013 and references therein). Lower dysoxic conditions were able to allow episodic seafloor colonization by thin-shelled opportunistic posidonioid bivalves (*Peribositra* Stockar, 2012; Stockar *et al.*, 2013). On the other hand, both lower dysoxic and anoxic bottom-water conditions ruled out higher macrobenthos, including scavengers, and resulted in complete oxygen depletion within the sediment. This allowed the fine laminated fabric to be preserved.
So far, the excavation carried out in the Sceltrich beds yielded a rich vertebrate fossil fauna (mostly articulated fishes and rare sauropterygian reptile bones and teeth (López-Arbarello *et al.*, 2016, 2019), along with invertebrate fossils and terrestrial plant remains. Invertebrate fossils include the above-mentioned posidonioid bivalves, crustaceans (mysidaceans, decapods and rare cycloids. Stockar & Garassino, 2013) and the gastropods described herein.

3. THE FOSSIL RECORD OF GASTROPODS FROM MONTE SAN GIORGIO

Findings of benthic molluscs other than opportunistic bivalves adapted to oxygen-depleted bottom-waters (Schatz, 2005) are very rare from the Monte San Giorgio intraplatform basin. Very recently, the only identifiable gastropods were documented from Anisian beds belonging to the lower and middle section of the Besano Formation (Pieroni & Furrer, 2020). They were assigned to the genera *Worthenia* (*Humiliworthenia*), *Frederikella*, *Trachynerita* and *Omphaloptycha,* thus documenting the occurrence in this basin of the clades Vetigastropoda, Neritimorpha and Caenogastropoda.

4. MATERIAL AND METHODS

All the described fossil material comes from bed 2 of the Sceltrich beds, lying 3 cm below the top of this fossiliferous sequence and consisting of dark, organic-rich laminated limestone (TOC 3.1% in weight). The fossils are preserved as internal molds sometimes partially covered by shell remains (MCSN 8591). Preparation was carried out mechanically with the aid of vibrotools (Chicago Pneumatic CP9361 air scribe with Krantz W795 modified head bearing Krantz W797 pointed steel chisels) and sharpened steel needles. The specimens were studied under a Leica M80 stereomicroscope and the photographs were taken with a Canon PowerShot SX200 IS camera equipped with Canon Zoom lens 12x IS 50-60 mm and with an Olympus UC50 camera mounted on an Olympus SZX12 stereoscope.
The studied material is housed in the palaeontological collection of the Museo Cantonale di Storia Naturale in Lugano (Switzerland) (MCSN).

5. SYSTEMATIC PALAEONTOLOGY

Subclass Neritimorpha Koken, 1896
Superfamily Neritoidea Rafinesque, 1815
Family Neritariidae Wenz, 1938
Subfamily Neritariinae Wenz, 1938
Genus *Cryptonerita* Kittl, 1894b
Type species: *Cryptonerita elliptica* Kittl, 1894b

***Cryptonerita*? sp.**
Fig. 2A, Fig. 3

Material: MCSN 8591
Description: Turbiniform to egg-shaped shell broadly globular with a low spire. Shell wider than high and almost smooth, except for the straight prosocline growth-lines. Whorls rapidly increasing and separated by incised sutures. Whorl outline rounded and convex. Sutures strongly impressed. Ornament consisting only of regularly numerous fine growth lines, nearly orthocline. A fine spiral lineation may form with the growth lines a pattern of fine reticulate sculpture. The aperture is not observable. The specimen MCSN 8591 comprises 2.5 whorls and it is 9.2 mm high and 10.4 mm wide, with pleural angle of about 100°. The specimen is preserved in lateral view on a limestone slab, slightly deformed, with some fragments of shell on the internal mold and around it.
Remarks: The present specimen closely resembles originals of *Cryptonerita elliptica* Kittl, 1894b from the Esino Limestone as illustrated by Kittl (1899, pl. 2, fig. 15; Naturhistorisches Museum Wien, NHMW 1969/1199). *Cryptonerita elliptica* is the type species of *Cryptonerita*. The original type specimen of *C. elliptica* comes from the Marmolada Limestone. The generic

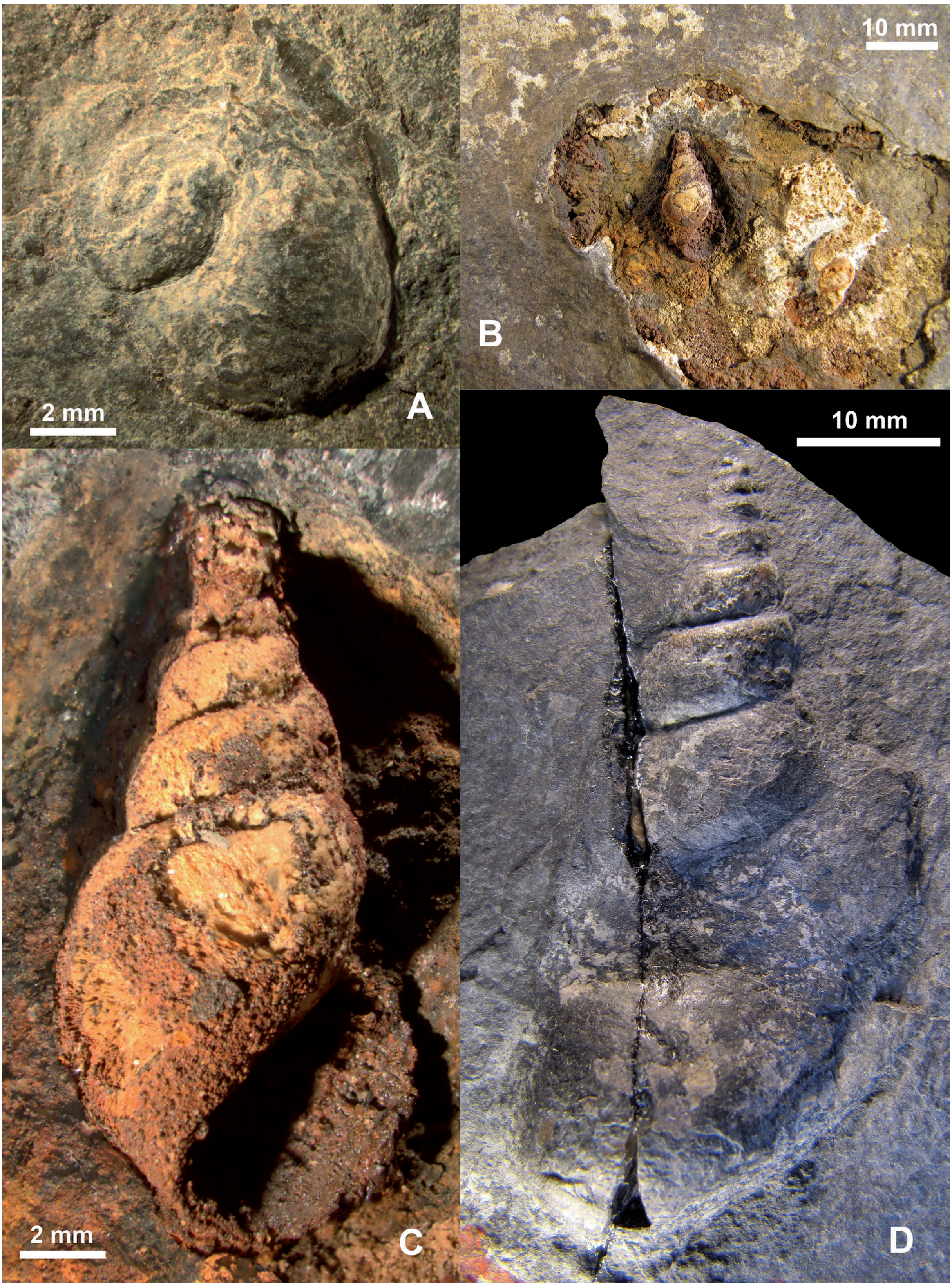

Fig. 2A: MCSN 8591, *Cryptonerita*? sp. Abapertural view.
Fig. 2B: Stone slab with two specimens of *Coelostylina stotteri* (Klipstein, 1843): MCSN 8592 (left), MCSN 8593 (right). Apertural view.
Fig. 2C: MCSN 8592, best preserved specimen of *Coelostylina stotteri* (Klipstein, 1843). Apertural view.
Fig. 2D: MCSN 8594, *Omphaloptycha* cf. *marianii* Kittl, 1899. Abapertural view.

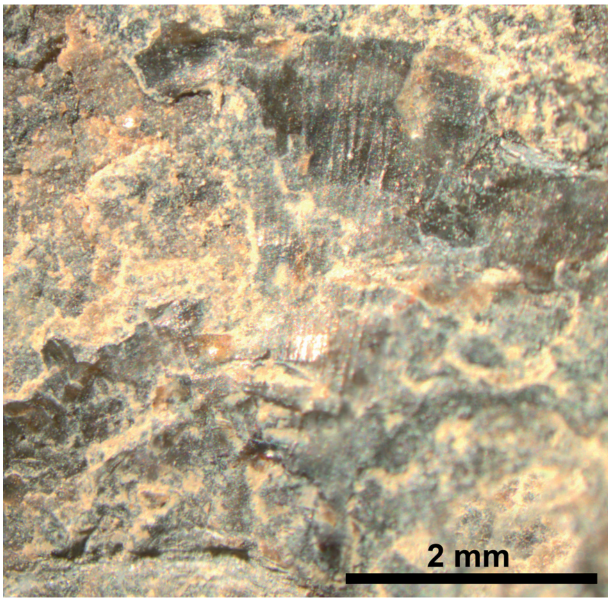

Fig. 3: MCSN 8591, *Cryptonerita*? sp. Detail of shell remains with growth lines.

assignment of the present specimen from the Sceltrich beds is uncertain because of preservation on slab. In the present specimen are not well observable the pleural and apical angle, the shape of the aperture with internal and external lip, and the umbilical region.

Subclass Caenogastropoda Cox, 1960
Unassigned to superfamily
Family Coelostylinidae Cossmann, 1909
Genus *Coelostylina* Kittl, 1894a

Type species: *Melania conica* Münster, 1841

Coelostylina stotteri (Klipstein, 1843)

Figs. 2B-C

?1841. *Melania obovata* Münster, p. 94, pl. 9, fig. 17.
1843. *Melania Stotteri* Klipstein, p. 186, pl. 12, fig. 10.
?1849-50. *Chemnitzia obovata* Münster.– d'Orbigny, p. 184.
1849-50. *Loxonema Stotteri*.– d'Orbigny, p. 187.
1852. *Melania nympha* Münster.– Giebel, p. 556.
1852. *Melania tenuistriata* Münster.– Giebel, p. 557.
?1864. *Macrocheilus obovatus* (Münster).– Laube, p. 408.
1868. *Euchrysalis subovata* (Münster).– Laube, p. 43, pl. 25, fig. 7.
1868. *Chemnitzia obovata* Münster.– Laube, p. 30, pl. 24, fig. 4.
1868. *Euchrysalis Stotteri* (Klipstein).– Laube, p. 43, pl. 25, fig. 8.
1868. *Chemnitzia gracilis* Laube, p. 28, pl. 23, fig. 19.
1868. *Euchrysalis subtortilis* (Münster).– Laube, p. 44, pl. 25, fig. 1.
1884. *Melania texata* (Münster).– Quenstedt, p. 219, pl. 192, fig. 34, (?) fig. 36.
1894a. *Coelostylina* (*Pseudochrysalis*) *Stotteri* (Klipstein).– Kittl, p. 189, pl. 5, figs 22-31.
1905. *Coelostylina* (*Pseudochrysalis*) *Stotteri* (Klipstein).– Blaschke, p. 210, pl. 20, fig. 29.
1907. *Coelostylina Stotteri* (Klipstein).– Broili, p. 122, pl. 11, figs 19-22.
1908. *Omphaloptycha* cf. *stotteri* (Klipstein).– Häberle, p. 506.
1923-24. *Omphaloptycha stotteri* (Klipstein).– Assmann, p. 36, pl. 3, figs 40-41.
?1926. *Coelostylina Stotteri* var. *cincta* Reis, p. 114, pl. 2, figs 26-28.
1928. *Omphaloptycha stotteri* (Klipstein).– Schmidt, p. 268, textfig. 724a-b.
1937. *Omphaloptycha stotteri* (Klipstein).– Assmann, p. 89, pl. 17, figs 5-6.
1965. *Coelostylina stotteri* (Klipstein).– Yen, p. 270, pl. 8, fig. 5.
1978. *Coelostylina* (*Pseudochrysalis*) cf. *stotteri* (Klipstein).– Zardini, p. 45, pl. 29, figs 14a-b; pl. 30, figs 3a-b, 5a-b, 6a-b.

Material: MCSN 8592, MCSN 8593

Description: Conical and moderately high-spired shell. Whorls rounded and convex, smooth. Sutures clearly impressed. Growth lines not visible. Base conical, rounded and convex, holostomatous. Aperture rounded, oblique oval, clearly higher than wide. Due to the preservation, the indistinct slit-like umbilicus (partially filled by matrix) and the small callus are not well observable. Straight, oblique inner lip. Outer lip thin. The best preserved specimen MCSN 8592, on stone slab, comprises more than 5 whorls and it is, 18 mm high and 9 mm wide, with pleural angle of 36°. The last whorl is 10 mm high, while the spire is about 8 mm. The early whorls are poorly preserved. The shell is preserved as limonite and covers almost all the surface of the internal mold. A second specimen (MCSN 8593), probably belonging to the same species, is present on the same slab. It is smaller and very incomplete, showing a shell section with thin thickness conch.

Occurrence: This species was documented from the Anisian to the Lower Carnian of Alps. It has been reported from the Dolomites, the Lower Carnian of the San Cassiano Formation (Klipstein, 1843; Laube, 1868) and from the Late Ladinian (Blaschke, 1905; Broili, 1907) of the "Pachycardientuffe", a volcaniclastic unit of the Wengen Formation localized at Seiser Alm/Alpe di Siusi. *Coelostylina stotteri* has also been reported from the Anisian Lower Muschelkalk of Gogolin Beds (Germanic Basin, Upper Silesia, Poland, see Assmann, 1923-1924, 1937). Similar forms are present in the carbonatic platforms of the Northern Calcareous Alps in the Anisian/Ladinian lower Wetterstein-Formation (Alma, 1926; Reis, 1926). Yen (1965) reported it from a small brackish gastropod fauna from the Carnian Lunz Formation (Lower Austria).

Genus *Omphaloptycha* (Ammon, 1893) Böhm, 1895
Type species: *Chemnitzia* (*Microschiza*) *nota* Ammon, 1893

***Omphaloptycha* cf. *marianii* Kittl, 1899**
Fig. 2D

cf. 1899. *Omphaloptycha marianii* Kittl, p. 140, pl. 14, fig. 13

Material: MCSN 8594
Description: Conical and moderately high-spired shell. Whorls rounded and convex, smooth. Early whorls slightly step-like with subsutural shoulder. Mature whorls more regularly rounded, inflated. Sutures distinctly impressed. Growth lines not visible. Last whorl about as high as wide, without peripheral angle. Base conical, rounded and convex, with a very short beak. Aperture not observable. The specimen MCSN 8594 comprises more than 7 whorls and it is 51.8 mm high and 22.7 mm wide, with pleural angle of 30°. The last whorl is completely detached from the spire, so the effective height was probably about 44 mm. The shell is preserved in lateral view on a fractured limestone slab.
Remarks: The species *Omphaloptycha marianii* was documented by Kittl (1899) only from the Ladinian Esino Limestone at Esino (Grigna, Lombardy). The present specimen is assigned to this species only tentatively. The gentle sculpture described by Kittl (1899) is not observable probably due to preservation.

6. TAPHONOMY AND ENVIRONMENT

The gastropods described herein occur scattered on bedding planes or within storm-generated concentrations of platform-derived skeletal grains. They reach sizes of up to 8 cm in size and sometimes affect the fine lamination of the embedding limestone. They may form clusters with co-occurring densely-packed skeletal grains of shallow-water benthic biota including dasycladacean algae, echinoderms, sponges, foraminifers and ostracods. Owing to the hostile bottom-water conditions, such benthic biota could not live on the seafloor of the intraplatform basin where the Meride Limestone was deposited. Instead they derive from neighbouring time-equivalent shallow-water carbonates of the Middle and Upper San Salvatore Dolomite and Esino Limestone. Macrofossils of molluscs were reported from the Middle and Upper San Salvatore Dolomite that crops out at Monte San Salvatore and Rasa di Varese, respectively North and West of Monte San Giorgio (Pieroni, 2011; Pieroni & Nützel, 2014; Zorn, 1971). This dolostone yielded gastropods belonging to genera such as *Omphaloptycha* and *Coelostylina* (Mariani, 1901; Airaghi, 1935) that are also present in the Sceltrich beds as described herein and in other formations (e.g. San Cassiano Formation, Pachycardientuffe). The Esino Limestone crops out further East and has yielded a very rich gastropod fauna (e.g. Kittl, 1899) containing also gastropods belonging to *Cryptonerita*, a genus that has so far never been reported from the San Salvatore Dolomite. In conclusion, the gastropods described herein must thus be regarded as allochthonous biota transported into the basin by storm events across the platform.

CONCLUSIONS

Ongoing excavations in the newly discovered Sceltrich beds fossiliferous interval of the Meride Limestone brought to light a fossil assemblage that allows improving knowledge about the gastropod fauna of Monte San Giorgio. The fossil findings represent the first identifiable ladinian gastropods so far described from this UNESCO Fossillagerstätte and document the occurrence in the Meride Limestone of the clades Neritimorpha and Caenogastropoda that were widespread in the Alpine Triassic carbonate platforms. The gastropod fauna must thus be regarded as allochthonous and swept into the basin by storm events across the adjoining platform.

ACKNOWLEDGEMENTS

We are in particular indebted to Neria Römer and Fabio Magnani, who brought to light the fossils described herein from the Sceltrich beds during the excavation carried out by the MCSN at Valle di Sceltrich locality in 2010 and 2019. F. Magnani skilfully prepared the specimens. Fieldwork has been granted by the Dipartimento del territorio del Cantone Ticino and the Swiss Federal Office for the Environment. Alexander Nützel (Bayerische Staatssammlung für Paläontologie und Geologie, Department of Earth and Environmental Sciences, Ludwig Maximilian University, Münich, Germany) is acknowledged for his constructive review.

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