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Article

First record of the genus *Polydiadema* Lambert, 1888 (Echinoidea) in the Jurassic of Italy

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Parole chiave

- Echinoidea
- Polydiadema
- Giurassico inferiore
- Nord-est Italia

Key words

- Echinoidea
- Polydiadema
- Lower Jurassic
- North-eastern Italy

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Summary

Well preserved regular echinoids, recently collected from the Lower Jurassic Rotzo formation of Monte Roite (Trento, Northern Italy), are here attributed to *Polydiadema depressum* (Agassiz in Agassiz & Desor, 1846). A specimen shows a part of the lantern, which was so far unknown in the genus *Polydiadema* Lambert, 1888: the lantern is of the Stirodont type, with teeth T-shaped in cross section. Also the spines have not been described yet for the species: they are thin, with crenulate articular surface and the stalk is ornate by fine longitudinal costae. *Polydiadema depressum* lived in a shallow-water muddy environment, associated with bivalves, gastropods and small brachiopods. The geo-stratigraphic distribution of this species, so far known from the Middle Jurassic (Aalenian-Bathonian) of Western Europe, is extended to the upper Sinemurian-lower Pliensbachian of Italy.

Riassunto

Alcuni echinoidi regolari ben conservati recentemente raccolti nella formazione di Rotzo (gruppo dei Calcari Grigi) di Monte Roite (Trento), vengono attribuiti a *Polydiadema depressum* (Agassiz in Agassiz & Desor, 1846). Si tratta della prima segnalazione del genere *Polydiadema* Lambert, 1888 nel territorio nazionale. Uno degli esemplari conserva una parte dell'apparato masticatore, che non era ancora stato descritto per questo genere (Smith & Kroh, 2011): la lanterna è del tipo Stirodonte, con ampio foramen magnum e denti che mostrano una sezione a "T". Anche le spine non erano note in questa specie: sono corte e sottili, la base è crenulata e lo stelo è ornato da sottili coste longitudinali; le spine primarie sono molto più sviluppate di quelle impiantate sui granuli. Gli esemplari studiati costituiscono la testimonianza fossile più antica di *P. depressum*, che era sinora nota solo nel Giurassico medio (Aaleniano-Bathoniano) dell'Europa occidentale. I calcari marnosi di Monte Roite sono stati infatti datati al Sinemuriano superiore - Pliensbachiano inferiore (Giurassico inferiore) in base allo studio delle associazioni dei foraminiferi bentonici (Fugagnoli, 2004). L'ambiente di vita era costituito da fondali fangosi di bassa profondità, nella zona subtidale, dove questo echinoide viveva come epibionte associato a bivalvi e gasteropodi, piccoli coralli e al brachiopode *Lychnothyris rotzoana* (Schauroth, 1865).

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Introduction

The genus *Polydiadema* Lambert, 1888 is known from the Lower Jurassic to the Cretaceous. It was widespread above all in Western Europe, where it was represented by at least seventeen species (see Smith & Kroh, 2011, for an overview). It has been cited also from the Oxfordian (Upper Jurassic) of Switzerland (de Loriol, 1871) and the Cretaceous of North Africa (Gregory, 1911), Middle East (Agassiz, in Agassiz & Desor, 1846) and Texas (U.S.A.; Smith & Rader, 2009).

The good preservation of the specimens under study from the Lower Jurassic of Monte Roite in the Province of Trento (Fig. 1) enables to describe some morphological details which were still unknown in this species, such as the lantern and the spines, and to provide information about the associated fauna and the life environment.

Material and methods

The two specimens described in this paper are housed at the Museo Civico "D. Dal Lago" of Valdagno (Province of Vicenza), with the repository number MCV.20/02 and MCV.20/03. They are represented by complete tests missing the apical disc; one of them shows a part of the lantern and of the primary and secondary spines. Three additional specimens from the same locality have been examined in a private collection.

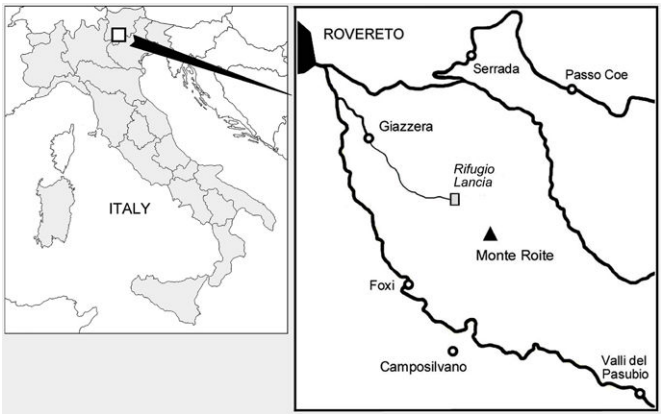

Fig. 1 *- Location map of the finding locality: Monte Roite, in the Province of Trento. / Mappa con l'ubicazione della località di ritrovamento: Monte Roite (Trento).*

Fig. 2 *- Panoramic view of the southern slopes of Monte Roite, with indication of the finding locality (red arrow). / Panoramica del versante meridionale del Monte Roite, con indicazione del punto di ritrovamento (freccetta rossa).*

Morphological abbreviations (Table 1): D= test diameter; Da= diameter of the apical disc; Dp= diameter of the peristome; nA and nIA= mean number of plates present in an ambulacral and in an interambulacral column, respectively; WA/WIA= ratio between the width of an ambulacral and an interambulacral area measured at the ambitus; Wp/Hp= ratio between the width and the height of an interambulacral plate at the ambitus.

Finding locality

The studied specimens have been collected at Monte Roite (Trento, Fig. 2), from the Rotzo formation (Bosellini & Broglio Loriga, 1971), dated to the upper Sinemurian-lower Pliensbachian (Lower Jurassic) by Fugagnoli (2004) on the basis of the foraminifer association. The Rotzo formation belongs to the Calcari Grigi group, which is about 400 m thick in central-western part of the Trento Platform, in particular between Monte Pasubio and Folgaria (Avanzini et al., 2007). In this area the Rotzo formation lies above the Calcare Oolitico di Loppio and is topped by the Oolite di Massone and the Tenno formations. The depositional environment in the Calcari Grigi group is typical of a shallow-water carbonate platform. In particular, the Rotzo formation corresponds to subtidal environments, with low gradient deposition ramps and internal lagoons bordered by oolithic shoals; the lithology is mainly made of bioclastic carbonate mud and marly limestones, disposed in asymmetric cycles (Avanzini et al., 2007). After Masetti et al. (1998) the marly limestones are indicative of a mainly low-energy setting.

At Mote Roite the echinoids were collected from the marly limestones, associated with bivalves, gastropods (represented above all by *Aptixiella* and *Pseudonerinea*), small corals and the brachiopod *Lychnothyris rotzoana* (Schauroth, 1865). The fossils are often found in concentrations due to tempestites (Barbieri & Grandesso, 2007).

Systematic palaeontology

The systematic follows Kroh & Smith (2010).

Order Phymosomatoida Mortensen, 1904
Family Emiratiidae Ali, 1990
Genus *Polydiadema* Lambert, 1888

[= *Trochotiara* Lambert, 1901, p. 236, type species *Diadema priscum* Agassiz, 1840; = *Aplodiadema* de Loriol, 1902, p. 49, type species *Pseudodiadema langi* Desor, 1856; = *Girardema* Vadet, 1993, p. 88, type species *Diadema depressum* Agassiz, in Agassiz & Desor, 1846].

Type species: *Diadema priscum* Agassiz, 1840, p. 21, by original designation.

Remarks: The families Emiratiidae and Phymosomatidae have an identical apical disc structure and a rather similar tuberculation style. The two specimens under study belong to the Emiratiidae, which differ from the Phymosomatidae in having perforate tubercles and diadematid-style plate compounding (with all elements reaching the perradius). Both of these character states are primitive with respect to Phymosomatidae, and so this grouping is considered as probably paraphyletic by Smith & Kroh (2011).

The genus *Polydiadema* is actually considered as senior synonym with the genus *Trochotiara* Lambert, 1901, in Smith & Kroh (2011) and Kroh & Mooi (2019).

Polydiadema is distinguished from *Diplopodia* in having uniserial zones of pore-pairs adapically. *Tiaromma* differs in having quadrigeminate plating adapically. *Colpotiara* has simple ambulacral plating adorally without primary tubercles (Smith & Kroh, 2011).

Several species have been included in this genus (see Smith & Kroh, 2011 and Echinologia, 2020, for an overview).

Distribution: Lower Jurassic (Toarcian) to Upper Cretaceous (Cenomanian) of Europe, North Africa, Middle East and U.S.A.

Polydiadema depressum (Agassiz in Agassiz & Desor, 1846)
Figs. 3-4

Type material: Holotype (Q56) housed in the Neuchâtel Museum, upper Bajocian of Sainte Honorine, Normandie (France).

Material studied: Two specimens (MCV.20/02 and MCV.20/03), D= 15 and 16 mm respectively; Calcari Grigi Formation, Lower Jurassic (upper Sinemurian - lower Pliensbachian), Monte Roite near Trento (North-eastern Italy). Three additional specimens from the same locality have been examined in a private collection.

Description (main biometric data are reported in Tab. 1):

- Test small, rather low (H= 40% D), flattened below and above and with rounded ambitus (Figs. 3c and 4b). Outline circular (Fig. 3a) to sub-pentagonal (Fig. 4a).
- Apical opening slightly smaller than half test diameter (mean Da= 40.5% D).
- One primary tubercle, similar in size, to each ambulacral and interambulacral plate; they are perforate and crenulate (Fig. 4d). Those in the ambulacra are distinctly smaller, above all aborally. There are no secondary tubercles.
- Ambulacra straight, very narrow adapically; pore-pairs uniform and undifferentiated; more or less uniserial at the ambitus, forming short phyllodes towards the peristome (Fig. 4c). Plating trigeminate, plate compounding diadematid in style, with the three elements reaching the perradius and overlapped by the primary tubercle, at the ambitus (Fig. 4f). There are 11 to 12 plates in each column.
- Interambulacral plates wider than tall (mean value of Wp/Hp= 1.75); the primary tubercle is centrally placed and diminishes in size adapically and adorally. Narrow interradial zone of small secondaries and granules widening a little adapically. The interradial zone is distinctly naked adapically (Fig. 4a). There are 10 to 11 plates in each column. The interambulacral areas are much wider than the ambulacral ones at the ambitus (mean value of WA/WIA= 0.50).
- Peristome about half test diameter (mean Dp= 43.5% D); buccal notches small but clearly marked and with raised lips (Figs. 3b, 4c).
- Spines slender, crenulate and finely longitudinally striated (Fig. 4e).
- Lantern Stirodont, with deep and V-shaped foramen magnum, short epiphyses and teeth T-shaped in cross section (Fig. 3b).

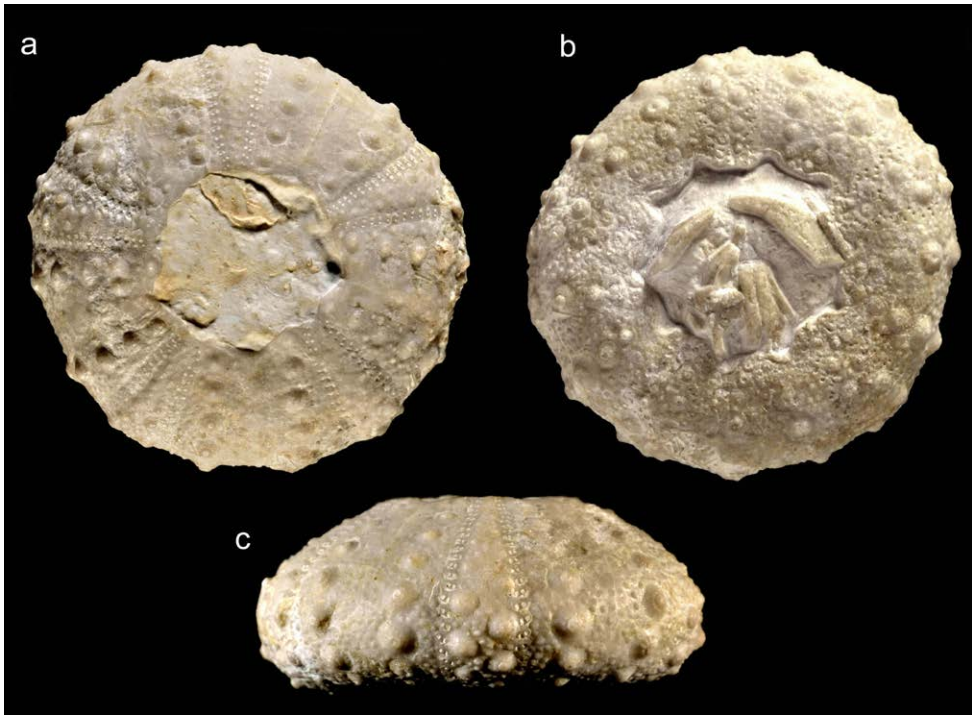

Fig. 3 - Polydiadema depressum *(Agassiz in Agassiz & Desor, 1846), Lower Jurassic of Monte Roite, specimen MCV.20/02, D= 15 mm: respectively aboral (a), oral (b) and lateral (c) views. /* Polydiadema depressum *(Agassiz in Agassiz & Desor, 1846), Giurassico inferiore di Monte Roite, esemplare MCV.20/02, D=15 mm: a) vista aborale, b) vista orale, c) vista laterale.*

Tab. 1 - Polydiadema depressum *(Agassiz in Agassiz & Desor, 1846): main biometric data of the two better preserved specimens under study from Monte Roite (Trento). The measures are reported in mm, the shape ratios are expressed as % of D. /* Polydidadema depressum *(Agassiz in Agassiz & Desor, 1846): principali dati biometrici dei due esemplari meglio conservati di Monte Roite (Trento). Le misure lineari sono in mm, i rapporti di forma sono espressi come % di D.*

Repository code	D	H	H/D	Da	Da/D	Dp	Dp/D	WA/WIA	Wp/Hp	nA	nIA
MCV.20/02	15	6	40	6	40	-	-	0.50	1.66	12	11
MCV.20/03	16	6.5	40.5	6.5	40.5	7	43.5	0.51	1.84	11-12	10-11

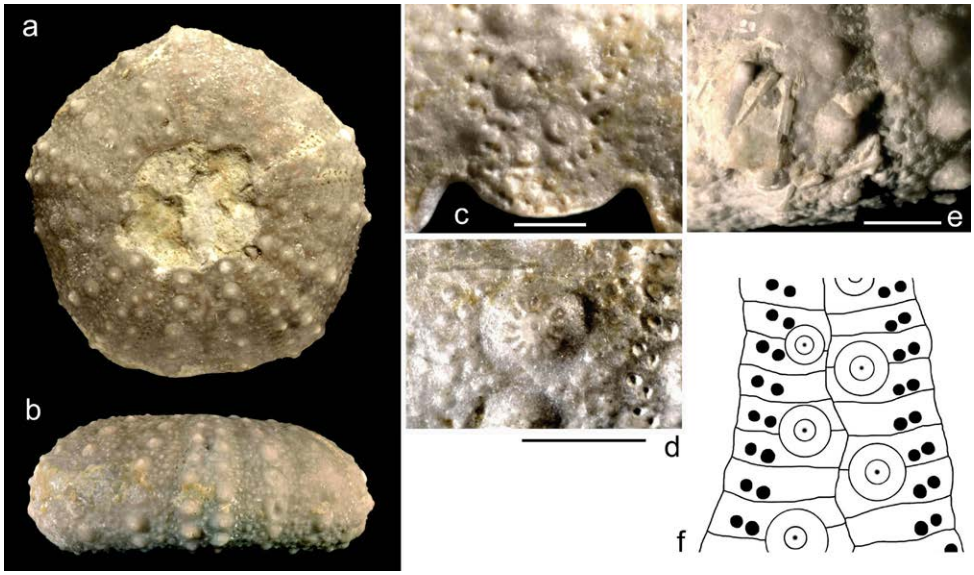

Fig. 4 - Polydiadema depressum *(Agassiz in Agassiz & Desor, 1846), Lower Jurassic of Monte Roite. Specimen MCV.20/03, D= 16 mm: a) aboral view, b) lateral view. Specimen MCV.20/02, D= 15 mm: c) close up view of the peristomial gill slits and the short phyllodes, d) close up of a crenulate and perforate interambulacral primary tubercle, e) primary and secondary spines, f) scheme of the ambulacral plate compounding. The scale bars equal 1 mm. /* Polydiadema depressum *(Agassiz in Agassiz & Desor, 1846), Giurassico inferiore di Monte Roite. Esemplare MCV,20/03, D= 16 mm: a) vista aborale, b) vista laterale. Esemplare MCV.20/02, D= 15 mm: c) dettaglio degli intagli peristomiali e dei fillodi, d) tubercolo primario, crenulato e perforato, e) spine primarie e secondarie, f) schema delle piastre ambulacrali. La barretta equivale a 1 mm.*

Remarks: After Smith & Kroh (2011) *Trochotiara homostigma* (Agassiz, in Agassiz & Desor, 1846) and *T. subcomplanata* (d'Orbigny, 1850), respectively from the Bajocian and Bathonian of France, are junior synonymous of *Polydiadema depressum.*

Polydiadema gurgitis (De Loriol, 1873), Aptian of France and Switzerland, differs by having some secondary tubercles in the ambulacra at the ambitus.

Polydiadema langii (Desor, 1856), Oxfordian of Spain, has only 7-8 plates in each ambulacral and interambulacral column; additionally, the primary tubercles decrease rapidly in size adapically.

Polydiadema mammillanum (Roemer, 1836), Kimméridgian of France and Switzerland: the primary tubercles in the ambulacral and interambulacral areas are similar-sized at the ambitus; additionally, there are small secondary tubercles in the interambulacra.

Polydiadema royeri (Cotteau, 1882), Oxfordian of France, has well developed secondary tubercles, forming vertical series in the interambulacra.

Polydiadema sculptilis (de Loriol, 1887), Aptian of Spain, has a smaller apical opening (Da= 25-30% D) and the primary tubercles rapidly decrease in size adapically.

Polydiadema trigeri (Cotteau, 1860), Aptian ofr France: in the ambulacra the primary tubercles are very small adapically, there are secondary tubercles on the oral face.

Distribution: Lower Jurassic (upper Sinemurian - lower Pliensbachian) of Northern Italy, Middle Jurassic (Aalenian-Bathonian) of Western Europe (Smith & Kroh, 2011).

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