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DESCRIPTION OF AN EARLY KIMMERIDGIAN CRINOID ASSOCIATION FROM CENTRAL ITALY

For the first time an Early Kimmeridgian cyrtocrinid crinoid fauna is described. The fauna, coming from Campo al Bello, Mt. Nerone (Central Apennines, Italy), is constituted by some hundred specimens mainly pertaining to the most common Tethys families of dadocrinids (sensu Nicosia, 1991): namely phyllocrinids and eugeniocrinitids; among them a new species is described as *Apsidocrinus nicosiai*. A secondary component made by few specimens of hoyacrinids and sclerocrinids is also present.

KEY WORDS: *Biochronology, Crinoids, Cyrtocrinina, Eudesicrinina, systematics, Jurassic, Kimmeridgian, Italy.*

PAROLE CHIAVE: *Crinoidi, Cyrtocrinina, Eudesicrinina, sistematica, Giurassico, Kimmeridgiano, Italia.*

Introduction

Up today, in the palaeontological literature, a description of a Kimmeridgian cyrtocrinid crinoid fauna is completely lacking. Only a single species was described as *Hoyacrinus sincerus* Delogu & Nicosia, 1986, nominal type of the monotypic genus.

Recently, we were able to find a very rich Kimmeridgian cyrtocrinid crinoid fauna at Campo al Bello, in the north-east side of Mount Nerone, in the Central Apennines (Italy) (Fig. 1), outcrop well known in the geological literature (Cecca, *et al.*, 1990). The fauna was recovered from a very thin siliceous level cropping out just at the base of the upper portion of the Fosso Bugarone Fm. The level, Early Kimmeridgian, in age, directly overlies a Bajocian hard-ground surface.

Some hundred cups and brachials, generally well preserved, of several species constitute the crinoid fauna. Also the accompanying fauna is abundant in the level and it is composed of corals, bivalves, brachiopods, cephalopods (ammonites, aptychi, belemnites and ryncholithes). Besides, some fish-teeth were found.

Systematics

The systematics here used is that recently proposed by Nicosia (1991). All the material described in this paper is stored in the Palaeontological Museum of the "La Sapienza" University of Rome (Italy), labelled as NS 6/...

Subclass ARTICULATA Zittel, 1879
Order DADOCRINIDA Nicosia, 1991
Suborder CYRTOCRININA Sieverts-Doreck, 1952
emend. Nicosia, 1991

This suborder, that includes almost all the post-Toarcian species, includes crinoids with cups formed by radials only, with more or less high and lance-shaped interradial projections.

Family Phyllocrinidae Jaekel, 1907

Diagnosis: The crinoids of this family are characterised by cups formed of five radials with small and deeply set articular radial facets for the arms. Interradial projections are relatively high and sub-triangular in transversal section. Ventral cavity is relatively small.

Two genera: *Phyllocrinus* Orbigny, 1850 and *Apsidocrinus* Jaekel, 1907.

Genus *Phyllocrinus* Orbigny, 1850
(type species: *P. malbosianus* Orbigny, 1850)

Diagnosis: Small crinoids characterised by cups with generally high interradial projections and small articular radial facets for the arms. Each projection is sub-triangular in cross section with vertex inwardly directed. The radial facets are very small and deeply set between the interradial projections. Each articular facet is characterised by two articular surfaces: one aboral and one other adoral, separated by a distinct

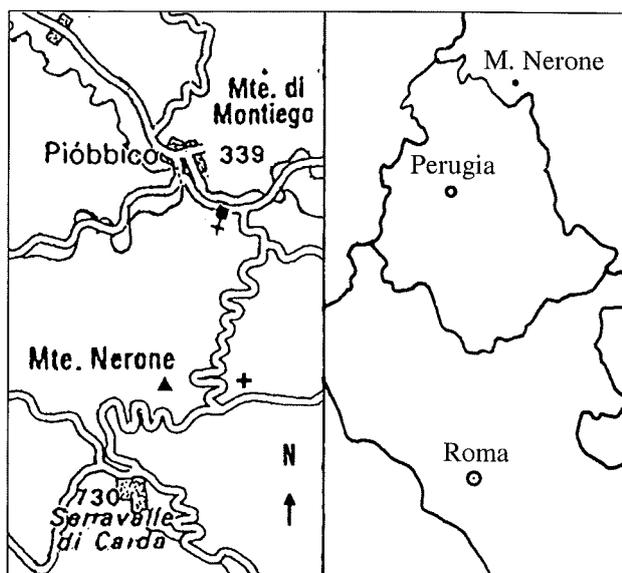


Fig. 1 – Map of the area from which the fossils were found. The asterisk shows the outcrop (scale 1:315.000).

– Mappa dell'area da cui provengono i fossili qui descritti. L'asterisco indica l'affioramento (scala 1:315.000).

fulcral ridge. The aboral surface, half-moon shaped and outward sloping, is very small and with a central ligament pit. The adoral surface, wider and sub-vertical, is characterised by two deep conical muscle fossae. The hole of the axial canal is well evident and placed near the fulcral ridge. The ventral cavity is small and circular. The dorsal side is entirely occupied by the articular surface for the stem; generally it is deep and with radial crenulae and a central hole.

Remarks: The cups of *Phyllocrinus* differ from those of *Apsidocrinus* overall in the smaller sizes of their interradial projections. Besides, the distal part of these interradial projections is outward sloping.

Phyllocrinus is a long-lasting and largely widespread genus, found within Bajocian to Early Cretaceous sediments.

Phyllocrinus furcillatus Speden, 1959
(Fig. 2; Pl.1, fig. 1)

1959 *Phyllocrinus furcillatus* sp. n. - Speden, p. 150, Pl. 20, figs. 1-4.

1974 *Phyllocrinus belbekensis* sp. n. - Arendt, p. 118, Pl.14, figs. 1-21.

1979 *Phyllocrinus belbekensis* Arendt - Pisera & Dzik, p. 824, text. fig. 11 d; Pl.4, fig. 1.

1984 *Phyllocrinus belbekensis* Arendt - Zitt & Michalik, p. 605, text. figs. 2-4; pl.1, figs. 1-2; pl.2; pl. 3, figs. 1-2; Pl. 4; Pl. 5; Pl. 6, figs. 1-2; Pl. 7, figs. 1-3.

1987 *Phyllocrinus stellaris* Zareczny - Gluchowski, p. 32, Pl. 12, figs. 1-4, 6; Pl. 13, figs.1-4, 6.

1987 *Phyllocrinus pieninensis* sp. n. - Gluchowski, p. 34, Pl. 14, figs. 1-6.

1989 *Phyllocrinus belbekensis* Arendt - Castellana, Manni & Nicosia, p. 71, text. fig. 1; Pl. 1, figs. 1 a-c.

1992 *Phyllocrinus furcillatus* Speden - Manni, Nicosia & Szabó, p.128, text. fig. 10; Pl.3, fig. 3.

1995 *Phyllocrinus furcillatus* Speden - Manni & Nicosia, p. 313, text. fig. 31.

Description: Small crinoids characterised by cups subpentagonal in outline. The external surface of these cups is smooth, with sutures between the radials slightly impressed.

The lance-shaped interradial projections are sub-triangular in cross-section, and slightly sloping inwards and not very high.

The radial facets, of phyllocrinid type, are deeply set between the interradial projections and surrounded by a more or less wide and flat lip. A high *septum* separates each facet from the ventral cavity. This cavity, circular in outline, is small and moderately deep.

The dorsal side, sub-circular to pentagonal, is entirely occupied by a small cylindrical cavity. In this cavity, moderately shallow, there is the articular surface for the stem. This surface is characterised by a central hole.

Remarks: The presence of a wide lip running each radial facet permits us to classify, with no doubt, these cups as cups of *P. furcillatus*. In fact, no other phyllocrinid species shows this character.

In our specimens the crenulae of the articular surface for the stem are not evident, probably because do not preserved. Besides the articular elements of the radial facet are not clear. The cups of our specimens are very small in size, the biggest cup is about 5 mm wide and 3.5 mm high. They probably below to juvenile specimens.

P. furcillatus is widespread, known from Bajocian to Valanginian sediments of Europe, New Zealand and Crimea.

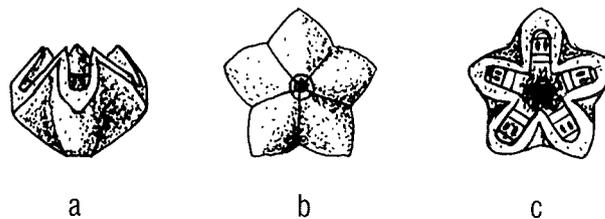


Fig. 2 – Reconstruction of a cup of *Phyllocrinus furcillatus* Speden, 1959.

a: lateral view, b: dorsal view, c: ventral view (x 3.5).

– Ricostruzione di una teca di *Phyllocrinus furcillatus* Speden, 1959.
a: norma laterale, b: norma dorsale, c: norma ventrale (x 3.5).

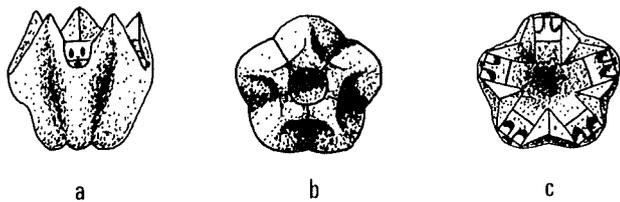


Fig. 3 – Reconstruction of a cup of *Phyllocrinus* sp.
a: lateral view, b: dorsal view, c: ventral view (x 3.5)

– Ricostruzione di una teca di *Phyllocrinus* sp.
a: norma laterale, b: norma dorsale, c: norma ventrale (x 3.5).

Material: More than 50 specimens, labelled as NS 6/ 800-815.

***Phyllocrinus* sp.**

(Fig. 3; Pl. 1, fig. 2; Pl. 2, fig. 4)

1987 *Phyllocrinus stellaris* Zareczny, 1876 - Gluchowski, p. 32; Pl. 12, fig. 5.

Description: Crinoids characterised by cups star-shaped to sub-pentagonal in outline. The external surface of these cups is smooth, with sutures between the radials evident. Each cup, relatively high, is tapered in the lower part.

Lance-shaped interradial projections are sub-triangular in cross-section, and slightly sloping inwards, wide but not high. Sutures between the radials not evident along their inner vertex.

The radial facets, of phyllocrinid type, are deeply set between the interradial projections. A high *septum* separates each facet from the ventral cavity. This cavity, circular in outline, is small and moderately deep with the sutures between the radials not evident.

The dorsal side, star-shaped, is entirely occupied by a circular cavity. This cavity, cylindrical and moderately shallow, is characterised by a central hole.

Remarks: Our specimens differ from those described by Gluchowski (Pl. 12, fig. 5, 1987) as *P. stellaris* Zareczny, 1876 overall in the presence of a small concavity below the interradial projections.

Moreover our specimens differ from those of *P. furcillatus* Speden, 1959, an other species with cups characterised by not high interradial projections, mostly because without a lip around the radial facets.

The cups of *P. sabaudianus* Pictet & Loriol, 1858, differ from our those in the higher and slender interradial projections. In our cups these projections are not high also in the mature specimens (we consider mature the largest cups). On the other hand, all the other characters seem similar. It is also possible that the here described specimens pertain to a different eco-

morphotype of *P. sabaudianus*. For that reason, at the moment, we prefer to leave these specimens in open nomenclature, waiting for new studies.

Material: About 80 specimens, labelled as NS 6/ 816-836.

***Phyllocrinus sabaudianus* Pictet & Loriol, 1858**
(Fig. 4; Pl. 1, fig. 3)

1858 *Phyllocrinus sabaudianus* sp. n. - Pictet & Loriol, p. 52, Pl.11, fig. 13.

1879 *Phyllocrinus sabaudianus* Pictet & Loriol - Loriol, p. 240, Pl. 29, figs. 31-32.

1925 *Phyllocrinus vadaszi* sp. n. - Jekelius, p. 61, Pl. 2, fig. 14, fig. 14 a.

1974 *Phyllocrinus sabaudianus* Pictet & Loriol - Arendt, p. 120, text. figs. 9, 15 e-i, 22; Pl. 17, figs. 1-18; Pl. 18, fig. 4.

1995 *Phyllocrinus sabaudianus* Pictet & Loriol - Manni & Nicosia, p. 313, text. fig. 30.

Description: Crinoids characterised by squared cups and sub-pentagonal in outline. Each cup is tapered in the lower part. The external surface is smooth and the sutures between the radials well evident. The interradial sides are a little concave.

The lance-shaped interradial projections are sub-triangular in cross-section and very high. These projections are sloping inwards, but very sloping outwards in their distal part. To note their inner side is subvertical but with the distal part sloping outwards.

The radial facets, of phyllocrinid type, are deeply set between the interradial projections. A high *septum* separates each facet from the ventral cavity. This cavity, circular in outline, is small and moderately deep, with the sutures between the radials not impressed.

The dorsal side, star-shaped, is occupied in its central part by a cavity. This cavity is moderately shallow and cylindrical, and characterised by a central hole.

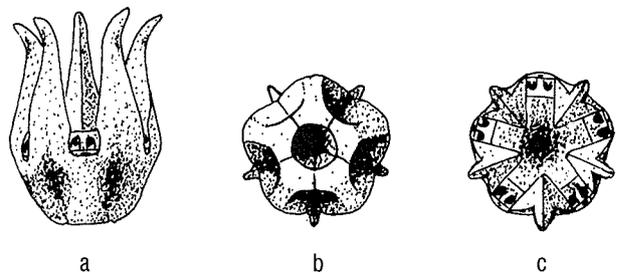


Fig. 4 – Reconstruction of a cup of *Phyllocrinus sabaudianus* Pictet & Loriol, 1858.

a: lateral view, b: dorsal view, c: ventral view (x 3.5).

– Ricostruzione di una teca di *Phyllocrinus sabaudianus* Pictet & Loriol, 1858.

a: norma laterale, b: norma dorsale, c: norma ventrale (x 3.5).

Remarks: These specimens of *P. sabaudianus* differ from those of *P. furcillatus* overall in the absence of a lip around each radial facet and in the general morphology and sizes of the cup.

Our specimens are very similar to those here described as *Phyllocrinus* sp., but with interradial projections very higher.

Often, in our specimens the distal part of interradial projections is broken: for that reason their sloping outwards is not always evident.

This species is known from Oxfordian to Barremian sediments of Europe and Crimea.

Material: 50 specimens, labelled as NS 6/ 837-847.

Genus *Apsidocrinus* Jaekel, 1907
(type species: *A. remesi*, Jaekel, 1907)

Diagnosis: Large crinoids characterised by cups with very high interradial projections and small articular radial facets for the arms. Distally the interradial projections are very developed above the ventral cavity. The radial facets, of phyllocrinid type, are deeply set between the interradial projections. The ventral cavity is small and circular in outline.

The dorsal side is entirely occupied by a cylindrical cavity. In this cavity there is the articular surface for the stem. This surface, circular, is characterised by articular crenellae and by a central hole.

Remarks: The cups of this genus differ from those of *Phyllocrinus* overall in the general shape and in the general size (bigger) of the interradial projections.

Apsidocrinus up today is known from Tithonian to Barremian sediments of Europe and Turkey.

***Apsidocrinus nicosiai* sp. n.**
(Fig. 5; Pl. 1, figs. 4-6)

Description: Crinoids with cups subcircular to penta-lobate in outline. External surface covered with small grains. Sutures between the radials are a little evident.

The interradial projections are sub-triangular in cross-section, and stout, wide and high. Their external side is convex. Ventrally these projections are subvertical while distally they sloped outwards.

The radial facets, of phyllocrinid type, are deeply set between the interradial projections. A high and wide *septum* separates each facet from the ventral cavity. This cavity, circular in outline, is very small and moderately deep. Besides this cavity is rapidly closed by the interradial projections.

The dorsal side, sub-circular, is entirely occupied by a large cylindrical cavity. This cavity, moderately shallow, is characterised by a central cylindrical hole.

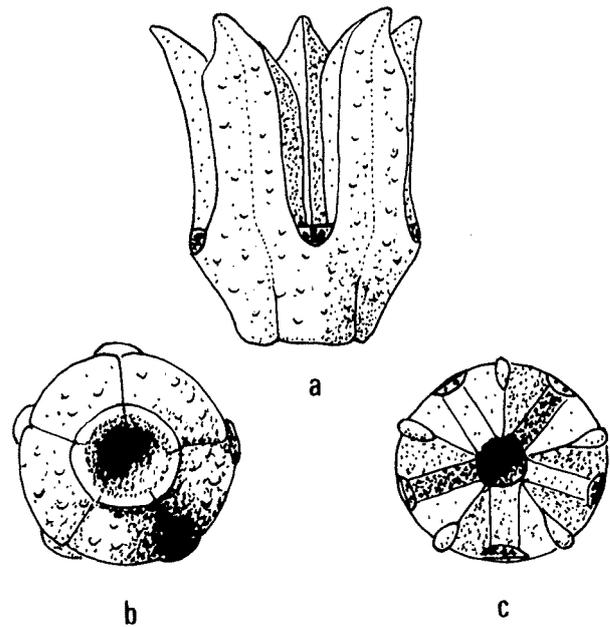


Fig. 5 – Reconstruction of a cup of *Apsidocrinus nicosiai* sp. n. a: lateral view, b: dorsal view, c: ventral view (x 3.5).

– Ricostruzione di una teca di *Apsidocrinus nicosiai* sp. n. a: norma laterale, b: norma dorsale, c: norma ventrale (x 3.5).

Remarks: The description of the main characters of this new species is almost complete. In some specimens the distal part is also slightly sloping outwards and it seems covered by small grains.

Due to the general morphology of the cup, the specimens of this new species can be confused with those of *Phyllocrinus*. But, because of the type of interradial projections (wide, stout and developed above the ventral cavity) these cups pertain to *Apsidocrinus*.

A. nicosiai sp. n. differs from *A. cyclamen* (Remes, 1902), *A. remesi* Jaekel, 1907, *A. brassovianus* (Jekelius, 1915) overall in the general morphology of the interradial projections (not concave and without a clear spine distal). Our species differs from *A. moeschi* (Zittel, 1870) overall because without a lower skirt. Besides *A. nicosiai* sp. n. differs from *A. yanini* (Arendt, 1974) and *A. skalkyensis* Zitt, 1978 in the general shape of the cup and interradial projections.

This new finding seems to be very important from a phylogenetic point of view, because it could represent the first step of the evolutionary trend from *Phyllocrinus* to *Apsidocrinus*. In fact, the interradial projections of this new species are little differentiate from those of *Phyllocrinus*: they are stouter, closed the ventral cavity and last their wall are subvertical.

Type Locality: Campo al Bello, in the east side of Monte Nerone (PS), Central Apennines, Italy.

Material: 12 specimens, labelled as NS 6/ 848-859.

Holotype: The specimen labelled as NS 6/848 (Pl. 1, fig. 6).

Derivatio nominis: In honour of our friend Umberto Nicosia.

Family Hoyacrinidae Delogu & Nicosia, 1986

Diagnosis: Crinoids with almost similar phyllocrinid characters. In fact the crinoids of this family are characterised by cups with five radials, very low interradial projections (developed ventrally) and small articular facets for the arms (almost similar to the phyllocrinid type). The ventral cavity is small, deep and cylindrical. The lower part of the cup is very tapered.

The dorsal side is entirely occupied by the dorsal cavity, small, deep and cylindrical.

Only one genus: *Hoyacrinus* Delogu & Nicosia, 1986.

Genus *Hoyacrinus* Delogu & Nicosia, 1986

(Type species: *H. sincerus* Delogu & Nicosia, 1986)

Diagnosis: Cups characterised by low interradial projections and small articular facets for the arms. The interradial projections are not high and are developed overall ventrally. The radial facets are small, and almost similar to those of phyllocrinid type. The ventral cavity is small, deep and cylindrical. The lower part of the cup is very tapered. The dorsal side is entirely occupied by the dorsal cavity, small, deep and cylindrical.

Remarks: The cups of this genus differ from those of *Phyllocrinus* and *Apsidocrinus* overall in the lower height of the interradial projections, and from those of eugeniocrinitids in the very smaller radial facets for the arms.

Up today this genus is known coming only from Kimmeridgian sediments of Italy with one species: *H. sincerus* Delogu & Nicosia, 1986.

Hoyacrinus sincerus Delogu & Nicosia, 1986 (Fig. 6; Pl. 2, fig. 10)

1986 *Hoyacrinus sincerus* sp. n. - Delogu & Nicosia, p. 3, text. figs. 1-2.

1995 *Hoyacrinus sincerus* Delogu & Nicosia, 1986 - Manni & Nicosia, p. 315, text. figs. 34-35.

Description: The cups are small, low and interradially lobate. The external surface is smooth. Each cup is characterised by not high interradial projections and by small articular facets for the arms.

The interradial projections, very low in respect to the height of the cup's body, are up side down cone-shaped. These projections are placed above very developed outwards interradial lobe.

The radial facets are small and almost similar to those of phyllocrinid type, and are deeply set between the interradial projections.

The ventral cavity, circular in outline, is small, deep and cylindrical. The lower part of the cup, below the radial facets, is very tapered.

The dorsal side, small, is entirely occupied by the dorsal cavity. This cavity, circular in outline, is small and cylindrical.

Remarks: Only few specimens are characterised by radial ridge near the dorsal side, as already underlined Delogu & Nicosia (1986).

This species up today is known only coming from Kimmeridgian sediments of Central Apennines (Central Italy): Case Canepine (PG), Gola del Furlo (PS), Pieia (PS) and Polino (TR).

Material: 13 specimens, relatively well preserved, labelled as NS 6/860-872.

Family Eugeniocrinitidae Roemer, 1855

Diagnosis: The crinoids of this family are characterised by cups formed of five radials, with wide and large radial facets, and more or less high interradial projections. The primiaxillars are generally modified.

Five genera: *Eugeniocrinites* Miller, 1821; *Fischericrinus* Castellana, Manni & Nicosia, 1989; *Lonchocrinus*

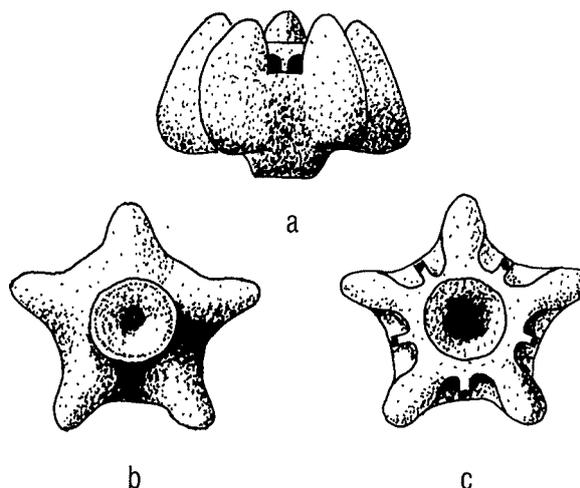


Fig. 6 - Reconstruction of a cup of *Hoyacrinus sincerus* Delogu & Nicosia, 1986

a: lateral view, b: dorsal view, c: ventral view (x 3.5).

- Ricostruzione di una teca di *Hoyacrinus sincerus* Delogu & Nicosia, 1986

a: norma laterale, b: norma dorsale, c: norma ventrale (x 3.5).

crinus Jaekel, 1907; *Remisovicrinus*, Arendt, 1974 and *Strambergocrinus* Zitt, 1979.

Eugeniocrinites Miller, 1821

[type species: *E. caryophyllites* (Schlotheim, 1813)]

Diagnosis: Crinoids characterised by wide radial facets separated by high to very low interradial projections. The radial facets are wide and low to high. Their aboral surface, very small, is characterised by a small ligament fossa, with a very small ligament pit; their adoral surface, sub-vertical, is characterised by two wide interarticular ligament fossae and two wide muscular fossae. A ridge separates these two last types of fossa, more or less parallel to the fulcral ridge. The fulcral ridge, well evident, separates the aboral surface from the adoral one.

The ventral cavity is sub-conical, and very wide and deep. The dorsal side moderately wide is completely occupied by a wide articular surface for the stem, with a central hole of the axial canal. The primiaxillars (second primibrachials) are modified by a wide and high spear-head-shaped median prolongation.

Remarks: This genus includes several species rather different among them and not always homogeneous, it is hoped its revision will clear up their exact relationships (Manni *et al.*, 1996).

From phyllocrinids differs overall in the wider radial facets and from psalidocrinids in the less developed interradial projections.

Species of this genus are known from Bajocian to Early Cretaceous from Europe and Crimea. The species *E. himalayensis* Gupta & Webster, 1980 and *E. formosus* Gupta & Webster, 1980 probably do not come from Himalayas but from Europe (see Manni, Nicosia & Tinozzi, 1996).

Eugeniocrinites alpinus (Ooster, 1865)

(Fig. 7; Pl. 2, figs. 8-9)

1879 *Eugeniocrinus rimatus* sp. n. - Loriol, p. 218, Pl. 18, fig. 89.

1879 *Eugeniocrinus dyonisi*, Ooster, *in schedis* - Loriol, p. 222, Pl. 19, figs. 1-2.

Description: Large crinoids characterised by cups sub-pentagonal to lobate in outline. The external surface is smooth, but the sutures between the radials are well evident. The body of the cup is high in respect to that of the interradial projections.

The interradial projections are trapezium-shaped in cross-section, and moderately high and large; their distal part is hook-shaped toward the ventral cavity.

The radial facets, large and eugeniocrinitid type, are slightly sloping outwards. The ventral cavity is

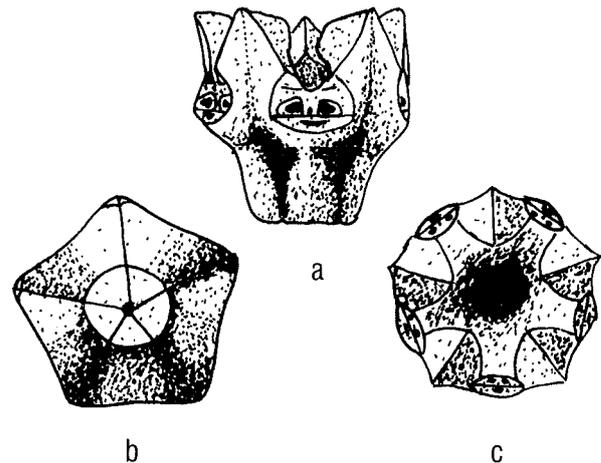


Fig. 7 - Reconstruction of a cup of *Eugeniocrinites alpinus* (Ooster, 1865).

a: lateral view, b: dorsal view, c: ventral view (x 3.5).

- Ricostruzione di una teca di *Eugeniocrinites alpinus* (Ooster, 1865).
a: norma laterale, b: norma dorsale, c: norma ventrale (x 3.5).

large, deep and conical with sutures between the radials well evident.

The lower part of the cup, below the radial facets, is tapered. The dorsal side is entirely occupied by a very shallow dorsal cavity. In this cavity, small and circular in outline, there is the articular surface for the stem. This surface is characterised by a central hole for the axial canal.

Remarks: Our specimens of *E. alpinus* are very similar to those of *E. rimatus* and *E. dyonisi* showed by Loriol (1879). In reality our specimens differ in the outline of the dorsal side that is subpentagonal. Unluckily Loriol showed only few specimens of these two species, so we do not know their morphological variability. Due to it, we can not compare all characters of our specimens with those of the specimens showed by Loriol.

In this outcrop *E. alpinus* is the largest species. Its most distinctive characters are the large radial facets and the stout and not too high interradial projections.

Some specimens are slightly sloped laterally. In mature specimens, the largest, the sides of the interradial projections are sloping outwards whereas the smaller, presumably juvenile specimens, have straight sides.

This species differs from the other species of this outcrops overall in the type and in larger sizes of radial facets cups.

It is the first time that in Central Apennines are found so many specimens of eugeniocrinitids.

Material: 55 specimens, labelled as NS 6/873-895.

Genus *Lonchocrinus* Jaekel, 1907
(type species: *E. dumortieri* Loriol, 1882)

Diagnosis: Presumed second primibrachial (primiaxillar), characterised by a very long medial spine placed between the two distal articular surfaces. The proximal surface is synostosomal type. Often the brachial body is characterised by two lateral keels.

Remarks: Jaekel (1907) based this genus only on axillars, considered by definition second primibrachials. Loriol (1879, 1882-84) described axillars with long spine as *Phyllocrinus gracilis* Loriol, 1879 and *Eugeniocrinus dumortieri* Loriol, 1882. In recent time, Arendt (1974) assigned some cups to *Lonchocrinus*. Pisera & Dzik (1979) described a new cup as cup of *Lonchocrinus*. Gluchowski (1987) and Manni, Nicosia & Szabó (1992), following the thought of Pisera & Dzik, assigned similar cups to *Lonchocrinus*. Anyway a critical revision is necessary for a correct systematic interpretation. For this reason we prefer described in this paper the cups and the axillars separately. This genus is known from Bajocian to Early Cretaceous sediments of Europe.

***Lonchocrinus* sp.**

(Fig. 8; Pl. 2, figs.1-3)

1995 *Lonchocrinus* sp. - Manni & Nicosia, p. 310, text. fig. 22.

Description: Axillary brachials characterised by a very long dorsal spine. The brachial have two lateral keels. The aboral spine, circular in section, is slightly sloping outwards and, in its distal part, is sloping rapidly in the oral side. Besides, where is sloped, the thickness is wider. Small grains cover the external side of this spine.

The lower side of the body is occupied by the articular surface for the first primibrachial, of synostosomal

type. This surface is smooth, a little concave and with an eccentric hole.

In the upper side of the brachial body, there are two articulations for the arms, slightly sloping inwards, separated by a low ventral rhomboidal process. The articular fossae are deep and circular.

The inner side of the brachial body is concave, with an Y-shaped groove.

Remarks: These axillars generally are preserved with the spine broken in the distal part. The brachial body as well as the angle of slope have a wide dimensional variability. The small specimens (probably juvenile) are characterised by a straight spine whereas the larger specimens (probably mature) show curved and longer extensions.

The muscular articular surfaces are not clear, due to the bad preservation of the articular elements.

The axillars showed by Loriol (1879, Pl. 19, fig. 9-9a, fig. 10; 1882-84, Pl. 14, figs. 7-9a) as *Phyllocrinus gracilis* Loriol, 1879 and *Eugeniocrinus dumortieri* Loriol, 1882 differ in the less slope. Besides, the axillars showed by Arendt (1974) and Gluchowski (1987) as *Lonchocrinus stazsici* Pisera & Dzik, 1979, *L. pskaiborensis* Arendt, 1974 and *L. magnispinosus* Arendt, 1974 are broken so that we are not able to compare the slope and the morphology of their spine with those of our specimens.

It is also worth of note the presence of a fragmentary specimen (NS 6/910) showing the first primibrachial fused to a second primibrachial (first axillar).

Material: some hundred specimens, labelled as NS 6/896-920.

"*Lonchocrinus*" sp. sensu Pisera & Dzik, 1979

(Fig. 9; Pl.2, figs. 5-6)

Description: Small crinoids characterised by stout and oblique cup, sub-circular in outline. The external surface of the cup is smooth, with sutures between the radials well evident. Each radial plate is low and dorsally convex.

The interradial projections, trapezium-shaped in cross-section, are very low. Their inner side is flat.

The radial facets, large and wide, are sloping outwards. Each facet is separated from one other by the interradial projections.

The ventral cavity, subpentagonal in section, is wide, deep and conical. The dorsal side is wide and entirely occupied by the dorsal cavity. Such cavity, wide and circular in section, is entirely occupied by the articular surface for the stem.

Remarks: This description is not complete, because we have found only two specimens. We believe these

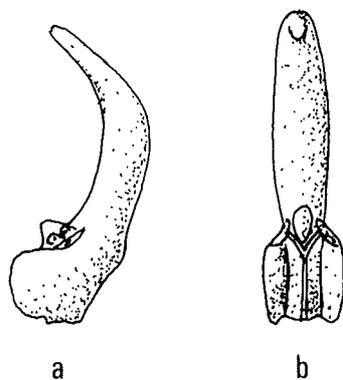


Fig. 8 - Reconstruction of an axillary brachial of *Lonchocrinus* sp.
a: lateral view; b: ventral view (x 3.5).

- Ricostruzione di una ascellare di *Lonchocrinus* sp.
a: norma laterale; b: norma ventrale (x 3.5).

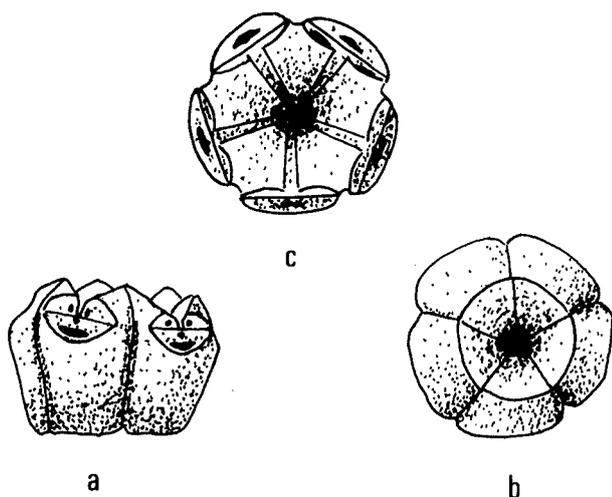


Fig. 9 – Reconstruction of a cup of "*Lonchocrinus*" sp.
a: lateral view, b: dorsal view, c: ventral view (x 3.5).

– Ricostruzione di una teca di "*Lonchocrinus*" sp.
a: norma laterale, b: norma dorsale, c: norma ventrale (x 3.5).

two cups, due to their small sizes, pertain to juvenile specimens.

Because our specimens are used and too small (probably juvenile specimens) it is practically impossible to compare them with the specimens already described in the literature (Pisera & Dzik, 1979; Gluchowski, 1987; Manni, Nicosia & Szabó, 1992).

It is the first time that cups of this "genus" are found in Italy. Up today, this type of cup was known from Poland (Pisera & Dzik, 1979; Gluchowski, 1987) and Hungary (Manni, Nicosia & Szabó, 1992).

Material: Only 2 specimens, labelled as NS 6/921-922.

Holdfasts (Fig. 10)

Description: The holdfasts, of discoidal type, are characterised by a wide disc-shaped basal expansion. Their outlines are irregular, with well evident but short digitations.

The upper side, generally smooth, is more or less raised: at the top there is the stem scar. This scar is characterised by a circular depression, not too deep, with several radial crenulae. The crenulae are limited only to the external side.

The lower side is obviously xenomorphic and it could be more or less concave and, sometimes, also very irregular.

Remarks: This type of holdfast, for its dimensions, might pertain to some species of large cyrtocrinids:

probably *Eugeniocrinites* or *Apsidocrinus* that are present in the outcrop.

The morphology of this type of holdfast is very common: for example *Aspidocrinus digitatus* Hall, 1858 a Lower Devonian crinoid, is characterised by a holdfast with a very similar general morphology. Our type differs overall because less digitised and shorter.

Material: 10 specimens, labelled as NS 6/923-930.

Suborder EUDESICRININA Manni & Nicosia, 1990

Crinoids characterised by cups composed by basals and radials or only by radials. The cups frequently show oblique cup-axis. The radial facets are very wide and large and often one of them is wider in respect to the others. The ventral cavity generally is very reduced. Some genera are stemless.

Family Sclerocrinidae Jaekel, 1918

Diagnosis: The genera of this family can have cups constituted by basals and radials or by radials only. Generally the cup-axis is oblique. The radial facets are wide and large. No true interradian projections. The brachials are low and stout.

Three genera: *Paragammarocrinites* Jäger, 1982; *Gammarocrinites* Quenstedt, 1857; *Pilocrinus*, Jaekel, 1907.

Gammarocrinites Quenstedt, 1856

[type species: *G. compressus* (Goldfuss, 1826-33)]

Diagnosis: These crinoids are characterised by cups with stout radials and large radial facets. Each radial facet is characterised by a wide aboral surface, with a well evident ligament pit; the adoral surface is

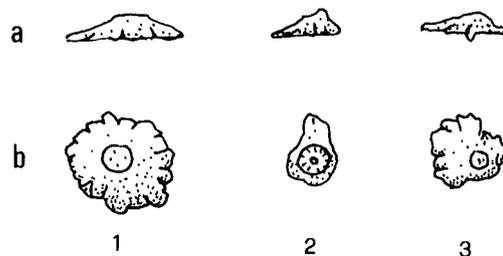


Fig. 10 – Holdfasts.

a: lateral view; b: upper view (x 1).

1: specimen NS 6/923; 2: specimen NS 6/924; 3: specimen NS 6/925.

– Radici.

a: norma laterale; b: norma superiore (x 1).

1: esemplare NS 6/923; 2: esemplare NS 6/924; 3: esemplare NS 6/925.

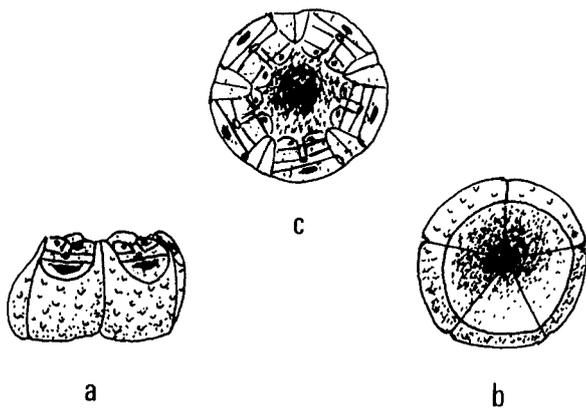


Fig. 11 – Reconstruction of a cup of *Gammarocrinites* sp.
a: lateral view, b: dorsal view, c: ventral view (x 3.5).

– Ricostruzione di una teca di *Gammarocrinites* sp.
a: norma laterale, b: norma dorsale, c: norma ventrale (x 3.5).

characterised by two flat and wide interarticular ligament fossae and two small muscle fossae. A clear fulcral ridge separates these two articular surfaces. The cup-axis generally is oblique. No true interrarial projections. The ventral cavity is very small to moderately small.

Remarks: This is a typical Late Jurassic - Early Cretaceous genus. It is very diffused in Europe, overall in the Central Europe. From a palaeoecological point of view, gammarocrinitids are ubiquitous and adapted to live in environments with medium-high energy.

***Gammarocrinites* sp.**
(Fig. 11; Pl. 2. fig. 7)

Description: Small crinoid characterised by cup with cup-axis a slightly sloped. Small grains cover the external surface. The external sutures between the radials are clear. Very small and low interrarial projections separate each radial facet from one other.

The radial facets for the arms, of sclerocrinid type, are wide with articular elements a little evident. The ventral cavity is small and circular in outline.

The dorsal side is entirely occupied by the dorsal cavity. This cavity is wide and not deep.

Remarks: Due to the bed preservation of this specimen, many characters are not well evident and then we are not able to describe them.

Material: Only one specimen, labelled as NS 6/931.

Conclusions

The above described crinoid association is typical for the Tethyan Late Jurassic, being constituted by *Phyllocrinus*, *Hoyacrinus*, *Lonchocrinus*, *Eugeniocrinites* and *Gammarocrinites* which belong to the most typical Jurassic genera. The majority of these genera have a wide stratigraphic range. Only *Hoyacrinus sincerus* is restricted to the Kimmeridgian (Delogu & Nicosia, 1986).

The most common genus is *Phyllocrinus* with three species and more than two hundred specimens, while the other genera are only represented by one species each. But it is known that *Phyllocrinus*, among Jurassic dadocrinid genera, is the genus that shows the wider diffusion and often it is the genus more frequent in many outcrops.

In respect to the other Late Jurassic outcrops of Central Apennines, the studied association differs overall in the very conspicuous number of eugeniocrinitids specimens. In fact, while usually specimens of *Eugeniocrinites* are very rare to find, in our outcrop more than 50 cups of this genus were collected.

Besides, we recognised for the first time a cup of a gammarocrinitid coming from the Kimmeridgian sediments of the Central Italy and cups of "*Lonchocrinus*" sp. in Italy. Latest we found also the earliest *Apsidocrinus* species: *A. nicosiai* sp. n.

From the ecological point of view, the presence of cups of "*Lonchocrinus*" sp. and *Gammarocrinites* sp. with cup-axis sloped laterally is very interesting. According to Zitt (1983) the slope of the cup-axis is due to the presence of constant one-way currents. So, these genera must be considered true rheophilic crinoids. On the contrary, *Eugeniocrinites*, *Phyllocrinus* and *Apsidocrinus* are genera that, for their stout and high interrarial projections, must be considered adapted to live in an environment with of slightly turbulent water, and then must be considered more or less completely rheophobic.

Then, following the scheme proposed by Ausich (1980) and Gluchowski (1987) the crinoid community here investigated may be subdivided into two level-niches, in respect to the sea bottom, and three type-niches, in respect to sea current (Fig. 12). The first level includes the species with very short stem, as the more delicate *Phyllocrinus* that lived elevated about few centimetres above the sea bottom. In this seawater level the water is generally stagnant (type 1). *P. furcillatus* and *Phyllocrinus* sp., with low interrarial projections and minute size, probably were the phyllocrinid species able to live in this niche.

The second level includes the wider crinoids with more or less long stem, as *Eugeniocrinites*, *Apsidocrinus* and probably *Hoyacrinus* and the larger *Phyllocrinus*. In this second level, the seawater can be characterised occasionally by weak currents (crinoid type 2). *E. alpinus*, with not too high interrarial projections but

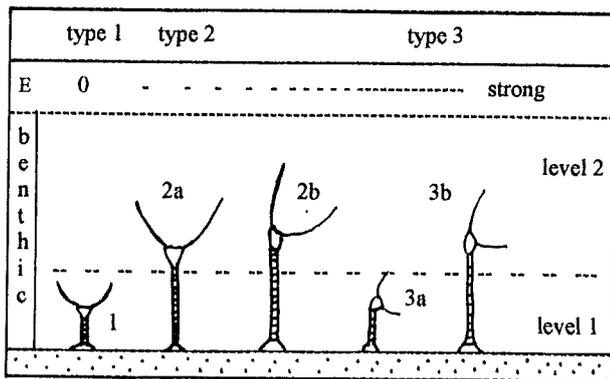


Fig. 12 - Scheme of the levels and niches identified for this association (see text).

1: small phyllocrinids; 2a: eugeniocrinitids, apsidocrinitids, hoyacrinids and larger phyllocrinids; 2b: *Eugeniocrinites alpinus*; 3a: gammarocrinitids; 3b: "*Lonchocrinus*" sp.; E: energy of sea currents (from 0 to strong).

- Schema delle livelli e nicchie identificate per questa associazione (vedere il testo).

1: piccoli phyllocrinidi; 2a: eugeniocrinitidi, apsidocrinitidi, hoyacrinidi e grossi phyllocrinidi; 2b: *Eugeniocrinites alpinus*; 3a: gammarocrinitidi; 3b: "*Lonchocrinus*" sp.; E: energia delle correnti marine (da 0 ad alta).

wide sizes, and *A. nicosiai* sp. n. with very high and stout interrarial projections were probably the species among the present one the most adapt to live in this niche. *P. sabaudianus*, with high interrarial projections, and *H. sincerus*, with low interrarial projections but with stout cup, probably were also able to live in

this niche. It also worth of note that some our cups of *E. alpinus* are characterised by a cup-axis a little sloped: it testify that the specimens of this species probably were able to live also in niches with constant current, probably into a transitional niche, between type 2 and type 3.

But in the second level there are also the crinoids with oblique cups that are able to live in niches with persistent currents (type 3). *Gammarocrinites* and «*Lonchocrinus*» sensu Pisera & Dzik, 1979 probably lived in this niche. In fact, their oblique cups testify the presence of constant currents.

Very interesting it is also the finding of holdfasts. These structures generally encrust a hard bottom, as rocky bottoms, shells and every hard surface. It is possible to find holdfasts both in life position that scattered in the sediments. In this last case, as in this our outcrop, it is necessary their detachment from hard bottom. However to find holdfasts is not common. Besides, because we found several holdfasts, it is reasonable to think that not too far from our outcrop there were one or more crinoid prairies.

In conclusion, it is possible to hypothesise, considering that the sediments of Campo al Bello outcrop were deposited along a slope of a high structural, that components of this fauna lived in differentiated facies and that only after their death they were transported along a same slope.

Acknowledgements - We thank Umberto Nicosia for the useful discussions.

SOMMARIO

Per la prima volta viene descritta una fauna tetisiana a crinoidi cyrtocrinidi riferibile al Kimmeridgiano inferiore. La fauna, che è stata rinvenuta a Campo al Bello, sulle pendici nordorientali di M. Nerone (PS), è costituita principalmente da alcune centinaia di teche e brachiali appartenenti ai più tipici generi di dadocrinidi tetisiani (*Phyllocrinus*,

Apsidocrinus, *Hoyacrinus*, *Eugeniocrinites* e *Lonchocrinus*) e secondariamente da alcune teche di eudesicrinidi (*Gammarocrinites*).

Dall'analisi di questa associazione sono state tratte interessanti considerazioni paleoecologiche.

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PLATE 1

- Fig. 1 – cup of *Phyllocrinus furcillatus* Speden, 1959. (x 3.5)
 a: lateral view, b: dorsal view, c: ventral view. Specimen NS 6/ 800.
 Fig. 2 – cup of *Phyllocrinus* sp. (x 3.5)
 a: lateral view, b: dorsal view, c: ventral view. Specimen NS 6/ 816.
 Fig. 3 – cup of *Phyllocrinus sabaudianus* Pictet & Lorient, 1858. (x 3.5)
 a: lateral view, b: dorsal view, c: ventral view. Specimen NS 6/ 837.
 Figs. 4-6 – cups of *Apsidocrinus nicosiai* sp. n. (x 3.5)
 Fig. 4 – a: lateral view, b: lateral view, c: dorsal view. Specimen NS 6/ 849.
 Fig. 5 – a: lateral view, b: lateral view. Specimen NS 6/ 850.
 §Fig. 6 – a: lateral view, b: lateral view, c: dorsal view. Specimen NS 6/ 848 (holotype).

TAVOLA 1

- Fig. 1 – teca di *Phyllocrinus furcillatus* Speden, 1959. (x 3.5)
 a: norma laterale, b: norma dorsale, c: norma ventrale. Esemplare NS 6/ 800.
 Fig. 2 – teca di *Phyllocrinus* sp. (x 3.5)
 a: norma laterale, b: norma dorsale, c: norma ventrale. Esemplare NS 6/ 816.
 Fig. 3 – teca di *Phyllocrinus sabaudianus* Pictet & Lorient, 1858. (x 3.5)
 a: norma laterale, b: norma dorsale, c: norma ventrale. Esemplare NS 6/ 837.
 Figg. 4-6: – teche di *Apsidocrinus nicosiai* n. sp. (x 3.5)
 Fig. 4 – a: norma laterale, b: norma laterale, c: norma dorsale. Esemplare NS 6/ 849.
 Fig. 5 – a: norma laterale, b: norma laterale. Esemplare NS 6/ 850.
 Fig. 6 – a: norma laterale, b: norma laterale, c: norma dorsale. Esemplare NS 6/ 848 (olotipo).



1a



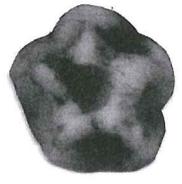
1b



1c



2a



2b



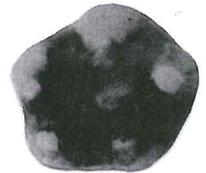
2c



3a



3b



3c



4a



4b



4c



5a



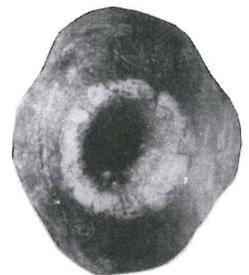
5b



6a



6b



6c

PLATE 2

- Figs. 1-3 – primiaxillar of *Lonchocrinus* sp. (x 3.5)
 Fig. 1 – lateral view. Specimen NS 6/ 896.
 Fig. 2 – ventral view. Specimen NS 6/ 897.
 Fig. 3 – dorsal view. Specimen NS 6/ 898.
 Fig. 4 – cup of *Phyllocrinus* sp. (x 3.5)
 a: lateral view. Specimen NS 6/ 817.
 Figs. 5-6 – cups of "*Lonchocrinus*" sp. (x 3.5)
 Fig. 5 – a: lateral view, b: dorsal view. Specimen NS 6/ 921.
 Fig. 6 – a: lateral view. Specimen NS 6/ 922.
 Fig. 7 – cup of *Gammarocrinites* sp. (x 3.5)
 Lateral view. Specimen NS 6/ 931
 Figs. 8-9 – cups of *Eugeniocrinites alpinus* (Ooster, 1865). (x 3.5)
 Fig. 8 – a: lateral view, b: dorsal view, c: ventral view. Specimen NS 6/ 873.
 Fig. 9 – a: lateral view, b: dorsal view, c: ventral view. Specimen NS 6/ 874.
 Fig. 10 – cup of *Hoyacrinus sincerus* Delogu & Nicosia, 1986. (x 3.5)
 a: lateral view, b: ventrale view. Specimen NS 6/ 860.

TAVOLA 2

- Figg. 1-3 – primascellare di *Lonchocrinus* sp. (x 3.5)
 Fig. 1 – norma laterale. Esemplare NS 6/ 896.
 Fig. 2 – norma ventrale. Esemplare NS 6/ 897.
 Fig. 3 – norma dorsale. Esemplare NS 6/ 898.
 Fig. 4 – teca di *Phyllocrinus* sp. (x 3.5)
 a: norma laterale. Esemplare NS 6/ 817.
 Figg. 5-6 – teche di "*Lonchocrinus*" sp. (x 3.5)
 Fig. 5 – a: norma laterale, b: norma dorsale. Esemplare NS 6/ 921.
 Fig. 6 – a: norma laterale. Esemplare NS 6/ 922.
 Fig. 7 – teca di *Gammarocrinites* sp. (x 3.5)
 Norma laterale. Esemplare NS 6/ 931
 Figg. 8-9 – teche di *Eugeniocrinites alpinus* (Ooster, 1865). (x 3.5)
 Fig. 8 – a: norma laterale, b: norma dorsale, c: norma ventrale. Esemplare NS 6/ 873.
 Fig. 9 – a: norma laterale, b: norma dorsale, c: norma ventrale. Esemplare NS 6/ 874.
 Fig. 10 – teca di *Hoyacrinus sincerus* Delogu & Nicosia, 1986. (x 3.5)
 a: norma laterale, b: norma ventrale. Esemplare NS 6/ 860.



1



2



3



4



5a



5b



6



7



8a



8b



8c



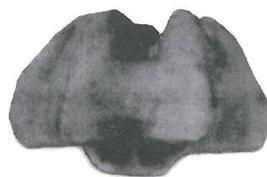
9a



9b



9c



10a



10b