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Morphological and systematic interpretation of some Late Cretaceous (Turonian-Santonian) irregular echinoids, Kopet-Dagh Basin, NE Iran

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Abstract

Abderaz Formation is one of the Upper Cretaceous formations in the Kopet-Dagh sedimentary basin. A stratigraphic section from the mentioned formation is selected for detailed systematic description with regard to echinoids. Numerous well preserved representatives of the families Mircrasteridae wright, 1857 and Echinocorythidae Lambert, 1920 are described from the Ghaleh-Zoo stratigraphic section in the Kopet-Dagh sedimentary basin, northwest of Shirvan township (NE Iran). The age of the fossil assemblage is determined as Turonian-Santonian based on four echinoid species: *Micraster* (*Micraster*) *coranguinum* Leske, 1778, *Micraster* (*Micraster*) *cortestudinarium* (Goldfuss, 1829), *Echinocorys gravesi* (Agassiz & Desor, 1847) and *Echinocorys* ex gr. *scutata* Leske, 1778.

Keywords: Echinoids; Late Cretaceous; Kopet-Dagh; NE Iran

Introduction

Irregular echinoids first appeared in the Early Jurassic and diversified markedly during the Cretaceous and Cenozoic, attaining a near-worldwide distribution. In the Turonian and Coniacian, the group was dominated by members of the orders Spatangoida and Holasteroida. The former is represented mainly by the genus *Micraster*, the latter by *Echinocorys* [21]. This study aims to present the results on the echinoids for the Abderaz Formation in the West of Kopet-Dagh sedimentary basin.

The Abderaz Formation (named after the village of Abderaz in southeastern Kopet-Dagh basin) was proposed by geologists of the National Iranian Oil Company [2 & 3]. According to the palaeontological investigations by Kalantari (1969) in the Sheikh and Zangulalu stratigraphic sections, the age is determined as Turonian-Santonian. The Abderaz Formation is represented by monotonous bluish-grey to light green-grey shales. It conformably overlies the Atamir Formation and is overlain by the Abtalkh Formation (figs. 2-3). In the eastern part of the Kopet-Dagh the formation attains a thickness of 500 m in the southeast (Shurijeh) and 1500 m in the northwest (Taher Abad). The formation is rich in foraminifera which indicate Turonian-Santonian age. The Turonian age is represented by 58 m of chalky limestones and

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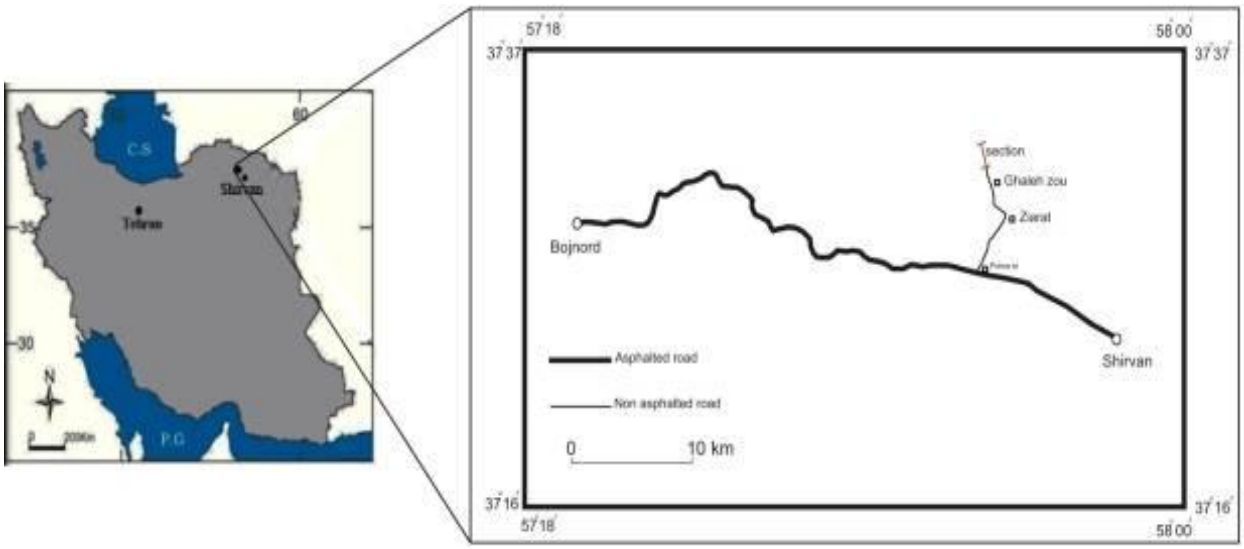


Figure 1. Location of the studied section in NE Iran

calcareous shales containing *Ataxophtagmium puschi*, *Frondicularia cordata*, *Globotruncana helvetica*, *Globotruncana imbricata*, *Globotruncana linneiformis* and *Marsonella turris*. As well, the Coniacian stage, 25 m thick is composed of marly limestones and calcareous shales, indicated by *Gavellinella costata*, *Globotruncana culverensis* and *Globotruncana schneegansi*. The grey marly limestones and black calcareous shales, about 750 m thick, are attributed to the Santonian on the basis of the following assemblage: *Globotruncana concavata carinata*, *Globotruncana lapparenti coronate*, *Globotruncana lapperenti lapperenti*, *Globotruncana fornicata*, *Neoflabellina ovalis* and *Stensioina exculpta* [29].

Geological setting

The NE active fold belt of Iran, Kopet-Dagh, is formed on Hercynian metamorphosed basement at the SW margin of the Turan Platform. The Kopet-Dagh region of NE Iran exposes rather complete Jurassic sections, which reach thickness of about 3000 m.

The belt is composed of about 10 km thick Mesozoic and Tertiary sediments (mostly carbonates) and like the Zagros, was folded into long linear NW-SE trending folds during the last phase of the Alpine Orogeny, in the Plio-Pleistocene time. No igneous rocks are exposed in Kopet-Dagh except for those in the basement in Aghdarband tectonic window [29].

The Shirvan area is a part of the Kopet-Dagh sedimentary basin which is located in northern Khorasan province. The Ghaleh-Zoo stratigraphic section is located 21 km northwest from Shirvan

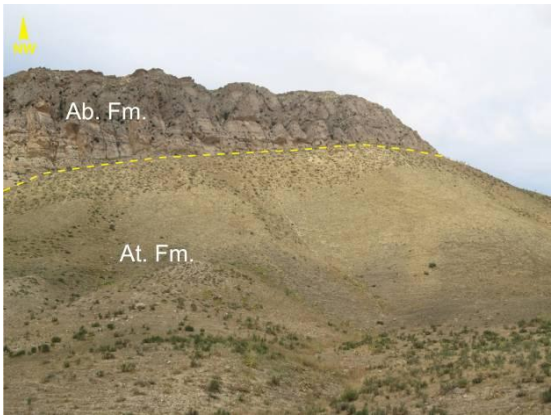


Figure 2. The gradual boundary between Atamir and Abderaz formations

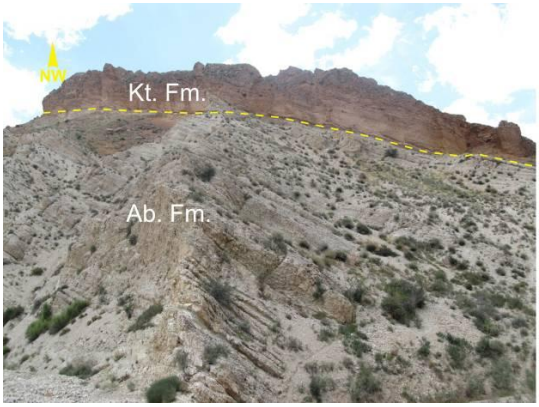


Figure 3. The gradual boundary between Abderaz and Kalat formations

township (37 31' 23''N and 57 47' 24''E). The Abderaz and Kalat formations are well-exposed in the studied area. In this study the Abderaz Formation is investigated in the Ghaleh-Zoo stratigraphic section with regard to echinoids (Fig.1).

Previous studies in the Middle East

In the Kopeh-Dagh region, the first study on the echinoderms of the Abderaz Formation (Turonian-Coniacian) was carried out by Vahidinia & Aryaei, 2000 and those of the Tirgan Formation by Hashemian *et al*., 2007. Likewise, a study on the Early Cretaceous echinoderms of central Iran was carried out by Yaghoubi *et al.,* (2008). The latest work on the Early Cretaceous echinoderms in the Kopet-Dagh basin (Tirgan Formation) is carried out by Taherpour Khalil Abad *et al.* (2011). In this report, some specious are attributed to *Toxaster* (i.e. *T. renevieri*, *T. collegnii*, *T. granosus*), *Heteraster* (i.e. *H*. cf. *delgadoi*) and *Loriolia*.

Meanwhile, from elsewhere some species such as *Heteraster musandamensis* (Aptian age) and *Heteraster* aff. *couloni* (index for Hauterivian-Barremian age) are reported from upper Musandam limestone [14], *Heteraster oblongus* of the Early Aptian [5], in the United Arab Emirates. *Toxaster radula, Toxaster lamberti, Toxaster dieneri* and *Toxaster collegnoi* have been reported from the Aptian of Risan Aneiza Formation [1] in Egypt, *Heteraster oblongus* is reported from the Barremian of Qishn Formation [13] in Yemen; *Heteraster oblongus* from Sarmord Formation in North Iraq, *Toxaster retusus* from Turkmenistan [4], *Heteratser delgadoi* from the Palmyrides chain in Central Syria [1] and *Heteraster renngarteni* from Central Syria [35].

Materials and Methods

Echinoderms are marine, solitary and usually benthic animals. They were diverse in shapes (in ambulacra, genital plates and etc.) in this phylum from the Early Paleozoic. Echinoderms are characterized by the presence of an ambulacral system. This organ helps the animal in food obtaining, the vascular system, the respiratory system, as well as organs for locomotion. The system starts at the surface with an opening known as the hydropore, or with a perforated calcareous madrepore plate.

Water which circulates through the ambulacral system not only provides the organism with oxygen, but also moves microscopic particles of food towards the mouth. Water penetrates this to the water vascular system, gradually passing into the radial canal in order to be taken into the every part of the body. Echinoderms developed an internal calcareous skeleton, the so-called theca, which consist of fixed plates or plates of $CaCO_3$ connected by joints. The name of this entire phylum is based on the fact that there are usually numerous spines sticking through the skin and covers the calcareous skeleton to appear on the surface. Living representatives of the echinoderms are subdivided into five classes and of these the subphyla Blastozoa, Crinozoa and Echinozoa are particularly important for paleontology [15].

The material studied comprises almost 150 specimens and have been analyzed biometrically. Most of the specimens studied were collected by the author and are now housed at the Department of Geology, Mashhad Branch, Islamic Azad University, Mashhad, Iran and used the IAUM (Islamic Azad University, Mashhad Branch) as the prefix abbreviation.

Systematic Descriptions

The systematic is given following the latest concepts by Smith (1984), Smith & Wright (1999, 2000, 2003) and descriptive terminology by Durham & Wagner

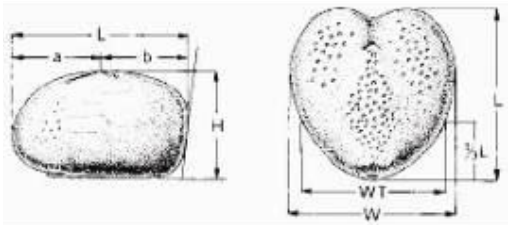


Figure 4. Basic measurements in the genus *Micraster* Agassiz, 1836; L – length of the test (in mm); W – width of the test (in mm); H – height of the test (in mm); WT – width of the test measured at one third from posterior edge (in mm); AA – anal angle (in degrees); a – distance from central point of apical disc to anterior edge (in mm); b – distance from central point of apical disc to posterior edge (in mm) (Olszewska-Nejbert, 2007).

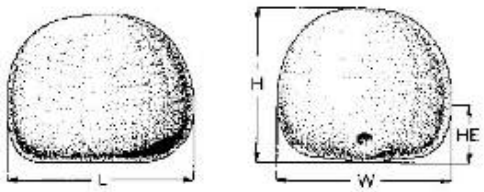


Figure 5. Basic measurements in the genus *Echinocorys* Leske, 1778; L – length of test; W – width of test; H – height of test; HE – height of ambitus (Olszewska-Nejbert, 2007).

(1966) and Olszewska (2007). Also, in the systematic paleontology studies, the biometric parameters are calculated in order to describe the genus and specious in the best way. The results of these calculations are described in the biometric calculation part.

Order SPATANGOIDA Agassiz, 1840
Infraorder MICRASTERINA Fischer, 1966
Family MICRASTERIDAE Lambert, 1920
Genus *Micraster* Agassiz, 1836

Micraster was a deposit feeder. Test morphological features show an adaptation to a very fine-grained sediment [19, 27 & 28]and an infaunal mode of life. *Micraster* (*Gibbaster*) is more pyramidal in shape with subanal protofasciole, and the periproct is situated relatively low. These characters indicate a seminfaunal mode of life similar to recent *Spatangus raschi* Loven [20].

Diagnostic Features: Test cordiform with anterior sulcus; posterior face truncate. Apical disc central; ethmophract; with four gonopores. Anterior ambulacrum in shallow sulcus from apex to peristome. Pore-pairs differentiated aborally; small, round with strongly raised interporal knob. Other ambulacra forming straight, shallowly sunken petals aborally; pore-pairs elongate; perradial line grooved in type species. Peristome close to anterior margin; facing forward and partially or completely covered by the labral plate in oral view. Labral plate longitudinally elongate; sternal plates symmetic; episternal plates not narrowing. Periproct at top of steeply truncated posterior face. Aboral tuberculation of uniform small tubercles set in a fine groundmass of granules. Subanal fasciole present; ovate (Fig. 4).

Remarks: This is one of the best known Cretaceous echinoids and has formed the basis for classic microevolutionary studies. Stokes (1975), Ernst (1970, 1972), Maczynska (1968) and Fouray (1981) deal in depth with the taxonomy of many of the Cretaceous species. Nichols (1959) made a classic analysis of the mode of life of Micraster. Micraster differs from Gibbaster in having pores in the frontal ambulacrum that are differentiated (non-petaloid) and presumably associated with funnel-building tube-feet. Isaster and Cyclasterhave an apical disc with three gonopores, whereas Micraster always has four. Mokotibasterdiffers in having almost no posterior truncate face and the periproct is subambital. Pseudogibbaster is more inflated and has a peristome that faces downwards, not forwards.

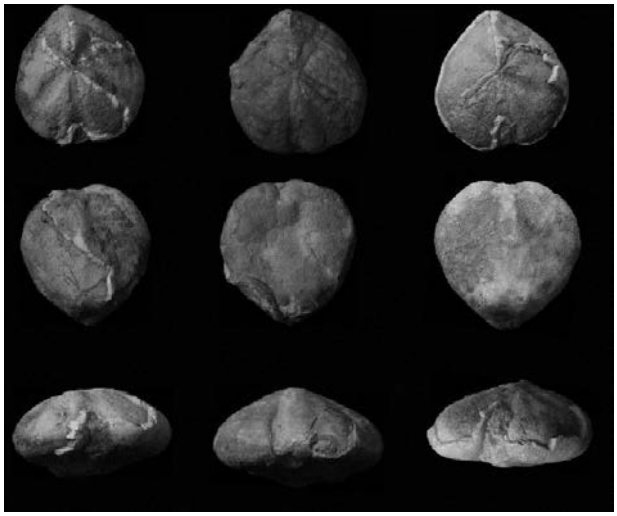
Biometric calculations: The characters which are measured and abbreviations used for representatives of this family are shown in tables 1-6.

Occurence: The genus *Micraster* first occurs in the Cenomanian (Devon, England, e.g. Smith 1988) and ranges through Paleocene (Danian) of Europe [23], Mediterranean region, Asia (Georgia, Mangyshlak and Kopet-dagh), Madagascar, and Cuba.

Micraster (*Micraster*) *coranguinum* Leske, 1778

(Pl. 1, figs. 1, 3; Pl. 2, Fig. 2, Pl. 3, Fig. 1; Pl. 4, figs. 1, 3; Pl. 5, figs. 1-3; Pl. 7, Fig. 1)

1734 *Spatangus Coranguinum* (*a*) *Anglicum*; J.T. Klein, p. 33, pl. 23, figs A, B.
1778 *Spatangus Coranguinum* Var. a *Anglicum*; N.G. Leske, p. 221, pl. 23, figs C, D.
1829 *Spatangus coranguinum* Lamarck; A. Goldfuss, p. 157, pl. 48, fig. 6.
1853 *Micraster coranguinum* Agassiz; A. D'Orbigny, p. 207, pl. 867, figs ?1-?8; pl. 868, figs ?3, ?4.
1869 *Micraster coranguinum* Agassiz; G. Cotteau & J. Triger, p. 326, pl. 55, figs 5-10.
1874 *Spatangus* (*Micraster*) *coranguinum*; F.A. Quenstedt, p. 644, pl. 87, figs 28, ?33.
1876 *Micraster coranguinum* Agassiz; G. Cotteau, p. 501, pl. 83, figs 4,5.
1878 *Micraster coranguinum* Klein; TH. Wright, p. 271, pl. 62, figs 1-3, 5.
1959 *Micraster coranguinum* Klein; M.M. Moskvin, p. 281, text-fig. 94; pl. 20, fig. 2.
1964 *Micraster coranguinum* (Klein); G.N. Dzhabarov, p. 55, pl. 18, ?fig. 2.
1966 *Micraster coranguinum* (Klein); G. Ernst, p. 124.
1966 *Micraster* (*Micraster*) *coranguinum* (Leske); A.G. Fischer, p. U581, text-fig. 467,2.
1968 *Micraster coranguinum* (Klein); S.S. Mnczyska, p. 108, text-pl. 2, figs 1, 2; text-pl. 3, fig. 3; pl. 3, figs 1-3.
1968 *Micraster coranguinum* (Klein); S.I. Pasternak & *al.*, p. 221, text-fig. 49; pl. 50, figs 1-4.
1969 *Micraster coranguinum* (Klein); L. Cayeux, p. 37, pl. 1, figs 5-9.
1974 *Micraster coranguinum* Leske; G. Ernst & M.-G. Schulz, p. 30, text-figs 7, 8b-c, 9d-e; pl. 1, fig. 3; pl. 2, fig. 2.
1974 *Micraster coranguinum* (Klein); O.V. Savchinskaya, p. 328, pl. 113, figs 7-10.
1975 *Micraster coranguinum* (Leske); R.B. Stokes, p. 64, text-fig. 29d; pl. 2, figs 1-3.
1993 *Micraster coranguinum* (Leske); E.P.F. Rose & N.E. Cross, text-figs 1, 5, 6.
1994 *Micraster coranguinum* (Leske); N.E. Cross &



Pl.1 (Scale bar 5 cm)
1a-c (Dorsal view, Ventral view, A): *Micraster coranguinum* (Leske, 1778). Sample No. MQ116
2a-c (Dorsal view, Ventral view, A): *Micraster cortestudinarium* (Goldfuss, 1829). Sample No. MQ125
3a-c (Dorsal view, Ventral view, A): *Micraster coranguinum* (Leske, 1778). Sample No. MQ139

Pl.2 (Scale bar 5 cm)
1a-c: *Micraster cortestudinarium* (Goldfuss, 1829). Sample No. MQ110
2a-c: *Micraster coranguinum* (Leske, 1778). Sample No. MQ164
3a-c: *Micraster cortestudinarium* (Goldfuss, 1829). Sample No. MQ119

E.P. F. Rose, text-fig. 1.
2002 *Micraster coranguinum* (Leske); A.B. Smith & C. W. Wright, p. 293, pl. 60, figs 6-8.
2007 *Micraster* (*Micraster*) *coranguinum* (Leske); D. Olszewska-Nejbert, Pl. 3, Fig. 3.

Pl.3 (Scale bar 5 cm)
1a-c: *Micraster coranguinum* (Leske, 1778). Sample No. MQ121
2a-c: *Micraster cortestudinarium* (Goldfuss, 1829). Sample No. MQ129
3a-c: *Micraster cortestudinarium* (Goldfuss, 1829). Sample No. MQ152

Type specious: *Spatangus coranguinum* (*a*) *anglicum* (Leske, 1778).

Material: From the total collected samples, 24 samples belong to this specimen.

Description: The size and thickness of the test is medium, the total shape is elliptical to heart-shape. From the side view, it is long and partly high and has a sharp dip in the anterior view. The side view is concave and the anterior groove is partly profound. The petals are shallow. The adoral side is granular in the both side of the plastron. Plastron is embossed and is covered by labrum. Tubercles are small in the aboral side and are big in the adoral side. The aperture is near to the anterior ridge. Periproct is circular generally. Tubercles are covered the interambulacra. Sub-anal fasciol is existing. The average of W/L*100 is equal to 97.68 and its median is 98.11 which is an evidence for its circular form and is more close to this form rather than *Micraster* (*Micraster*) *cortestudinarium*. Also, the average of a/b*100 is equal to 105.79 and its median is 100 which shows that the apical system is not central and a little far from the center.

Pl.4 (Scale bar 5 cm)
Micraster coranguinum (Leske, 1778)
1a-c: Sample No. MQ163
2a-c: Sample No. MQ127
3a-c: Sample No. MQ149

Pl.5 (Scale bar 5 cm)
Micraster coranguinum (Leske, 1778)
1a-c: Sample No. MQ148
2a-c: Sample No. MQ118
3a-c: Sample No. MQ167

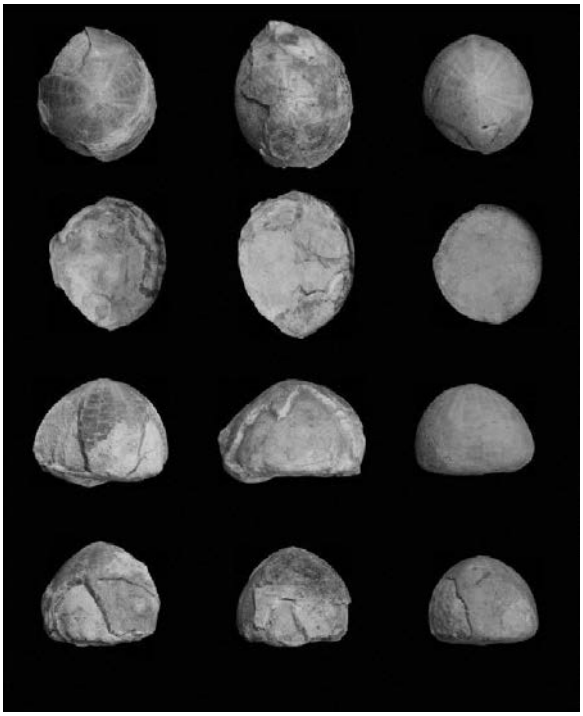
Pl.6 (Scale bar 5 cm)
Micraster cortestudinarium (Goldfuss, 1829)
1a-c: Sample No. MQ143
2a-c: Sample No. MQ102
3a-c: Sample No. MQ134

Pl.7 (Scale bar 5 cm)
1a-c: *Micraster coranguinum* (Leske, 1778), Sample No. MQ122
2a-c: *Micraster cortestudinarium* (Goldfuss, 1829), Sample No. MQ151
3a-c: *Micraster cortestudinarium* (Goldfuss, 1829), Sample No. MQ157

Remarks: *Micraster* (*M.*) *coranguinum* is closest to *M.* (*M.*) *bucailli* but is, however, more oval in outline and, more importantly, differs in peristome and labrum features.

Occurrence: Late Coniacian (Magadiceramus subquadratus Zone) at Shakh-Bogota and ?Middle Coniacian at Sulu-Kapy. This species is widespread in the North European Province: Late Coniacian-

Pl.8 (Scale bar 5 cm)
Echinocorys ex. gr. *scutata* (Leske, 1778)
1a-d: Sample No. EQ102
2a-d: Sample No. EQ103
3a-d: Sample No. EQ112



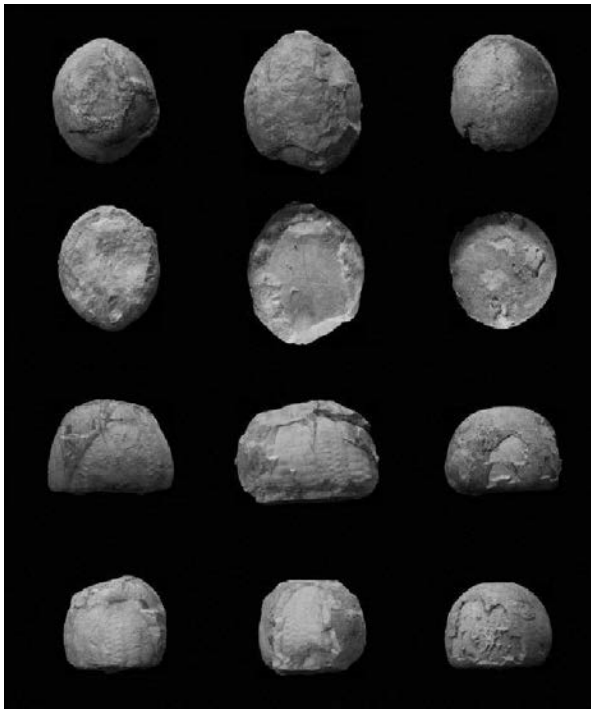
Pl.9 (Scale bar 5 cm)
Echinocorys ex. gr. *scutata* (Leske, 1778)
1a-d: Sample No. EQ111
2a-d: Sample No. EQ110
3a-d: Sample No. EQ113

Santonian of England, France, and Germany; Coniacian of western Ukraine and Donbass; Late Coniacian-Santonian of Northern Caucasus and Kopet-Dagh; Santonian of Poland (Kraków area). Known also from the Late Coniacian- Santonian of the northern periphery of the Mediterranean Province (Georgia).

Micraster (*Micraster*) *cortestudinarium* (Goldfuss, 1829)

(Pl. 1, Fig. 2; Pl. 2, figs. 1, 3; Pl. 3, figs. 2-3, Pl. 4, Fig. 2; Pl. 6, figs. 1-3; Pl. 7, figs. 2-3)

1829 *Spatangus cortestudinarium* A. Goldfuss, p. 156, pl. 48, fig. 5.
1874 *Spatangus cortestudinarium*; F.A. Quenstedt, p. 646, pl. 87, fig. 30.
1876 *Micraster cortestudinarium* Agassiz; G. Cotteau, p. 498, pl. 83, figs 1-3.
1878 *Micraster cortestudinarium* Goldfuss; TH. Wright, p. 335, pl. 76, figs 1, 2.
1889 *Micraster* cf. *cortestudinarium* Goldfuss; A. Fric, p. 99, fig. 126.
1899 *Micraster cortestudinarium* Goldfuss; A.W. Rowe, p. 534, pl. 35, figs iii, v.
?**1934** *Micraster cortestudinarium* Goldfuss; H. Andert, p. 76, pl. 18, figs 19, 20.
1959 *Micraster cortestudinarium* Goldfuss; M.M. Moskvin, p. 280, text-fig. 93; pl. 19, fig. 2; pl. 20, fig. 1.
1964 *Micraster cortestudinarium* (Goldfuss); G.N. Dzhabarov, p. 50, pl. 17, fig. 2.
1964 *Micraster carinatus* G.N. Dzhabarov, p. 53, pl. 18, fig. 1.
1967 *Micraster decipiens* (Bayle); L. Cayeux & O. Devilloutreys, p. 30, pl. 2, figs 7, 7a, 7b, 7c, 7B, 7Ba, 7Bb; pl. 3, figs 7C, 7Ca.
1968 *Micraster cortestudinarium* (Goldfuss); S.I. Pasternak & *et al*., p. 219, text-fig. 48; pl. 49, figs 5-9.
1970c *Micraster* (*Micraster*) *cortestudinarium* (Goldfuss); G. Ernst, pl. 17, fig. 3.
1972 *Micraster cortestudinarium* (Goldfuss); G. Ernst, pl. 5, fig. 2.
1974 *Micraster cortestudinarium* Goldfuss; O.W. Savchinskaya, p. 327, pl. 113, figs 1-6.
1975 *Micraster cortestudinarium* Goldfuss; R.B. Stokes, p. 67, text-fig. 29h.
1975 *Micraster decipiens* (Bayle); R.B. Stokes, p. 68.
1977 *Micraster decipiens* (Bayle); R.B. Stokes, p. 810, pl. 108, figs 1-4.
1978 *Micraster decipiens* (Bayle); F. Robaszynski, pl. 1, figs 1-4.
1981 *Micraster decipiens* Bayle; M. Fouray, p. 38, pl.



Pl.10 (Scale bar 5 cm)
Echinocorys gravesi.(Agassiz and Desor,1847)
1a-d: Sample No. EQ104
2a-d: Sample No., EQ105
3a-d: Sample No., EQ106

3, figs 8-10.
1984 *Micraster decipiens* (Bayle); B. David & M. Fouray, p. 469, figs 7, 9.
1985 *Micraster decipiens* (Bayle); M. Fouray & B. Pomerol, pl. 1, figs 3, 6, 9; pl. 2, figs 2-5.
1991 *Micraster decipiens* (Bayle); R. Tarkowski, p. 130, pl. 27, fig. 1.
2002 *Micraster cortestudinarium* (Goldfuss); A.B. Smith & C.W. Wright, p. 293, pl. 60, figs 4, 5.
2007 *Micraster* (*Micraster*) *cortestudinarium* (Leske); D. Olszewska-Nejbert, Text-figs 50-52; Pl. 24, Figs 1-4; Pl. 25, Figs 1-4; Pl. 26, Figs 1, 2.

Type specious: Lectotype, designated by Stokes (1975), is the specimen illustrated by Goldfuss (1829, pl. 48, fig. 5 a-c) under the name of *Spatangus cor testudinarium*. Possible source localities, according to Goldfuss (1829), are Quedlinburg, Coesfeld and Maastricht. Wood & *et al*. (1984) noted that the sediment preserved inside one syntype, i. e. recrystallised chalk, indicates a provenance either from the Anglo-Paris Basin or from the chalk of Lüneburg. A provenance from Quedlinburg may be excluded [34].

Material: From the total collected samples, 20 samples belong to this specimen.

Description: Generally, the size of the test is medium but some are bigger in size. The test is rather thick and generally is in heart-circular shape and rarely in circular-trapezoidal or heart-elliptical shape. The anterior side is rounded and has a rather dip groove. Petals are groove and different is length. There is a groove between the pore pairs. The shape of these pore pairs are oval to elongated oval. The aperture is located with space from the anterior ridge by an embossed ridge. The interambulacral area is covered by tubercles uniformly. Tubercles on the adoral side are bigger and compressed as well on the plastron but the ones on the adoral, are smaller. Peri-plaston plates are sandy and granular. Peristome is ovate and covered by labrum and is located farther than anterior. Periproct is circular to elliptical in shape. In some samples, the sub-anal fasciol is developed and make a closed circle. The average of W/L*100 is equal to 96.86 and its median is 97.07 which is an evidence for its circular form. Also, the average of a/b*100 is equal to 95.15 and its median is 100 which shows that the apical system is not central and a little far from the center.

Remarks: *Micraster* (*M.*) *cortestudinarium* differs from *M*. (*M*.) *leskei* and *M*. (*M*.) *normanniae* in being more circular-cordate in shape. Its maximum width is located more posteriorly and its tuberculation is better developed. On the aboral side, the tubercles are larger and more densely spaced. The type of interporiferous area is "inflated"; this does not occur in *M*. (*M*.) *leskei*, nor in *M*. (*M*.) *normanniae*, which also lack a euamphisternal plastron. Only the semiamphisternal type 2 plastron appears in all three cited taxa. In such cases, other characters, such as shape of test, "granular" periplastronal zone, or "inflated" interporiferous area, permit to distinguish *M*. (*M*.) *cortestudinarium*, which also has a much larger madreporite, considerably larger than other genital plates, whereas the madreporite of *M*. (*M*.) *leskei* and *M*. (*M*.) *normanniae* is similar or slightly larger in size to other genital plates [21].
Order HOLASTEROIDA Durham & Melville, 1957
Infraorder MERIDOSTERNATA Loven, 1883
Family ECHINOCORYTHIDAE Wright, 1857
Genus *Echinocorys* Leske, 1778

Table 1. Biometric data and simple ratios for *Micraster* (*Micraster*) *cortestudinarium* (Goldfuss, 1829)

Number of specimen	L (mm)	W (mm)	H (mm)	WT (mm)	a (mm)	b (mm)	W/L *100	H/L *100	H/W *100	WT/W *100	a/b *100
MQ110	50	50	20	33	25	25	100.00	40.00	40.00	66.00	100.00
MQ152	40	36	15	25	20	20	90.00	37.50	41.67	69.44	100.00
MQ132	53	52	23	38	27	27	98.11	43.40	44.23	73.08	100.00
MQ157	48	47	20	37	25	23	97.92	41.67	42.55	78.72	108.70
MQ102	51	48	22	38	27	27	94.12	43.14	45.83	79.17	100.00
MQ143	49	53	23	34	29	22	108.16	46.94	43.40	64.15	131.82
MQ125	53	51	21	39	28	26	96.23	39.62	41.18	76.47	107.69
MQ127	45	43	21	34	24	22	95.56	46.67	48.84	79.07	109.09
MQ129	39	33	19	25	20	20	84.62	48.72	57.58	75.76	100.00
MQ155	53	53	17	36	30	26	100.00	32.08	32.08	67.92	115.38
MQ134	49	52	21	37	25	25	106.12	42.86	40.38	71.15	100.00
MQ133	61	61	30	39	30	35	100.00	49.18	49.18	63.93	85.71
MQ109	51	46	26	30	27	27	90.20	50.98	56.52	65.22	100.00
MQ153	62	62	30	39	32	31	100.00	48.39	48.39	62.90	103.23
MQ137	46	43	21	30	25	23	93.48	45.65	48.84	69.77	108.70
MQ161	65	65	25	41	33	33	100.00	38.46	38.46	63.08	100.00
MQ119	52	50	18	35	30	25	96.15	34.62	36.00	70.00	120.00
MQ151	35	33	18	22	20	15	94.29	51.43	54.55	66.67	133.33
MQ146	51	47	24	29	25	25	92.16	47.06	51.06	61.70	100.00
MQ123	47	47	20	29	24	24	100.00	42.55	42.55	61.70	100.00

Table 2. Simple statistics of biometric data and simple ratios for *Micraster* (*Micraster*) *cortestudinarium* (Goldfuss, 1829)

Statistic	L (mm)	W (mm)	H (mm)	WT (mm)	a (mm)	b (mm)	W/L *100	H/L *100	H/W *100	WT/W *100	a/b *100
Minimum value	35.00	33.00	15.00	22.00	20.00	15.00	84.62	32.08	32.08	61.70	75.00
maximum value	65.00	65.00	30.00	41.00	33.00	35.00	108.16	51.43	57.58	79.17	116.67
Mean value	50.00	48.60	21.70	33.50	26.30	25.05	96.86	43.54	45.16	69.30	95.15
Median	50.50	49.00	21.00	34.50	26.00	25.00	97.07	43.27	43.81	68.68	100.00
Standard Deviation	7.35	8.57	3.89	5.44	3.76	4.54	5.46	5.35	6.71	5.98	9.54

The genus *Echinocorys*, similar to *Micraster* belongs to deposit feeders although it, similar to *Plesiocorys*, is epibenthonic (Ernst & Seibertz 1977; Jagt & Michels 1994), living on soft, chalky substrate. Several characters, such as shape and tuberculation of the test, large wide flattened base, the lack of the anterior groove on the ambulacral III, and of the fascioles, and the character of ambulacral pores (indicating respiratory function) on the adoral side (Smith 1980a, b, 1988; Jagt & Michles 1994), confirm its epibenthic mode of life. This interpretation is not commonly accepted, and Kongiel (1949), e. g. suggested a burrowing mode of life of the genus, although based on weakly evolved tubercles on the aboral side of the test, rare asymmetric tubercles, and the lack of fascioles in *Echinocorys*, Kongiel (1949) suggested it to be an ineffective, shallow burrower. The shape of the test in the genus *Echinocorys* is particularly sensitive for lithofacies. In the material from Germany, from pure limy lithotopes, the genus is larger and higher on average than its representatives from marly limestones, or silty to arenitic limy marls (Ernst 1970b). test height decreases with relative increase of clay or sand content in the substrate. *Echinicorys* seems to have been much more sensitive to facies changes than infaunal *Micraster* (compare Ernst & Seibertz 1977).

Diagnostic Features: Test ovate with flat base and domed upper surface; no anterior sulcus. Apical disc relatively large; with four gonopores. All ambulacra flush, with small circumflexed pore-pairs adapically. Plastron meridosternous, with a single asymmetric sternal plate following the labrum. Subsequent plates biserial. Periproct inframarginal to oral. No enlarged primary tubercles aborally. No fascioles.

Remarks: The genus *Echinocorys* is rare in the Turonian. During the Coniacian- Maastrichtian the number of species and individuals considerably increased [13 & 26]. According to the opinion of several authors the genus *Echinocorys* represents a single large species complex in the Late Cretaceous of England.

Table 3. Matrix correlation of biometric data and simple ratios for *Micraster* (*Micraster*) *cortestudinarium* (Goldfuss, 1829)

Characters and Simple ratios	L	W	H	WT	A	b	W/L *100	H/L *100	H/W *100	WT/W *100	a/b *100
L	1	0.964	0.725	0.843	0.928	0.957	0.452	-0.194	-0.350	-0.332	-0.399
W		1	0.676	0.869	0.927	0.892	0.671	-0.219	-0.457	-0.364	-0.274
H			1	0.501	0.600	0.758	0.247	0.528	0.335	-0.379	-0.415
WT				1	0.829	0.785	0.581	-0.323	-0.509	0.139	-0.264
A					1	0.824	0.535	-0.268	-0.442	-0.297	-0.071
B						1	0.328	-0.109	-0.229	-0.290	-0.604
W/L*100							1	-0.203	-0.571	-0.287	0.199
H/L*100								1	0.918	-0.138	-0.042
H/W*100									1	-0.001	-0.112
Wt/W*100										1	0.021
a/b*100											1

Table 4. Biometric data and simple ratios for *Micraster (Micraster) coranguinum* (Leske, 1778)

Number of specimen	L (mm)	W (mm)	H (mm)	WT (mm)	a (mm)	b (mm)	W/L *100	H/L *100	H/W *100	WT/W *100	a/b *100
MQ163	46	47	20	35	27	21	102.17	43.48	42.55	74.47	128.57
MQ121	38	39	18	27	20	19	102.63	47.37	46.15	69.23	105.26
MQ118	43	44	23	29	22	21	102.33	53.49	52.27	65.91	104.76
MQ164	48	42	23	34	25	23	87.50	47.92	54.76	80.95	108.69
MQ147	37	38	20	28	19	19	102.70	54.05	52.63	73.68	100.00
MQ105	56	56	24	35	33	30	100.00	42.86	42.86	62.50	110
MQ160	53	52	25	35	27	27	98.11	47.17	48.08	67.31	100.00
MQ103	53	52	25	33	27	26	98.11	47.17	48.08	63.46	103.84
MQ150	49	45	25	32	25	25	91.84	51.02	55.56	71.11	100.00
MQ149	43	42	22	28	22	22	97.67	51.16	52.38	66.67	100.00
MQ139	56	56	26	35	30	27	100.00	46.43	46.43	62.50	111.11
MQ116	53	51	26	33	30	25	96.23	49.06	50.98	64.71	120
MQ148	39	34	24	22	21	18	87.18	61.54	70.59	64.71	116.66
MQ101	50	49	26	28	25	25	98.00	52.00	53.06	57.14	100.00
MQ145	42	42	27	26	25	25	100.00	64.29	64.29	61.90	100.00
MQ158	49	46	29	29	25	25	93.88	59.18	63.04	63.04	100.00
MQ138	47	47	29	31	29	23	100.00	61.70	61.70	65.96	126.08
MQ167	42	42	25	25	26	26	100.00	59.52	59.52	59.52	100.00
MQ106	52	50	30	34	27	27	96.15	57.69	60.00	68.00	100.00
MQ112	48	46	26	33	25	25	95.83	54.17	56.52	71.74	100.00
MQ173	45	45	25	28	25	25	100.00	55.56	55.56	62.22	100.00
MQ122	44	44	27	31	25	24	100.00	61.36	61.36	70.45	104.16
MQ117	49	47	23	35	25	25	95.92	46.94	48.94	74.47	100.00
MQ108	50	49	30	40	27	27	98.00	60.00	61.22	81.63	100.00

Wright (1864-1882) gave an extensive list of synonyms of this species under the informal (nomen nudum) name *Echinocorys vulgaris* Breynius. However, Olszewska-Nejbert [21] distinguished a few varieties within *Echinocorys*, and pointed out that some of the varieties have an important stratigraphical significance, because they commonly occur within the particular lithostratigraphical units in the Late Cretaceous of England.

Biometric calculations: The characters which are measured and abbreviations used for representatives of this family are shown in Tables 7-12.

Occurrence: Middle Turonian to Late Paleocene, worldwide.

Echinocorys gravesi (Agassiz & Desor, 1847)
(Pl. 10, figs. 1-3)

1847 *Ananchytes Gravesii* Desor; L. Agassiz & E. Desor, p. 135.
1870 *Annanchytes ovata* Lambert; F. Roemer, p. 312, pl. 34, fig. 2.
1903 *Echinocorys gravesi* Desor; J. Lambert, p. 48, pl.

1, figs 12-15.
1959 *Echinocorys gravesi* Desor; M. M. Moskvin, p. 256, text-fig. 57; pl. 6, fig. 2 [=*Echinocorys* ex gr. *scutata* Leske].
1964 *Echinocorys sphaericus* (Schluter); G.N. Dzhabarov, p. 23, pl. 1, fig. 2; pl. 2, fig. 1.
1964 *Echinocorys gravesi* (Desor); G.N. Dzhabarov, p. 25, pl. 2, fig. 2 [=*Echinocorys* ex gr. *Scutata* Leske].
1964 *Echinocorys gravesi* (Desor) var. *moskvini*; G. N. Dzhabarov, p. 26, pl. 2, fig. 3; pl. 3, fig. 1[=*Echinocorys* ex gr. *scutata* Leske].
1967 *Echinocorys gravesi* (Desor); L. Cayeux & O. De Villoutreys, p. 36, pl. 3, fig. 9 [=*Echinocorys* ex gr. *scutata* Leske].
1972 *Echinocorys gravesi* (Desor); G. Ernst, pl. 3, fig. 3; pl. 6, fig. 2.
1974 *Echinocorys sphaericus* (Schluter); O.V. Savchinskaya, p. 321, pl. 103, figs 9-11.
1974 *Echinocorys gravesi* Desor; O.V. Savchinskaya, p. 321, pl. 103, figs 12-16 [=*Echinocorys* ex gr. *scutata* Leske].
1991 *Echinocorys gravesi* (Desor); R. Tarkowski, p. 129, pl. 28, fig. 1.
2007 *Echinocorys gravesi (*Agassiz & Desor); D. Olszewska-Nejbert, Text-figs 18, 19; Pl. 8, Fig. 3; Pl. 9, Figs 1, 2; Pl. 10, Figs 1, 2.

Type species: The holotype is specimen R 91 in the collection of Agassiz & Desor, from the Craie blanche of l'Oise, in the Neuchâtel Museum [21].

Material: From the total collected samples, 3 samples are belong to this specimen.

Description: The size of the test is medium to big. It is elliptical in shape and the aboral side is high and in helmet shape. The base of samples is broad and its plastron is slightly concave. The side profile is concave and is more concave in anterior side in compare with posterior side. The apical system is long. The pore pares are drop in shape and become narrow to the other pore pairs. Interambulacrals are few developed and are broader than ambulacrals. Ambitus is located higher than its normal place. Peristome is elliptical in the

Table 5. Simple statistics of biometric data and simple ratios for *Micraster (Micraster) coranguinum* (Leske, 1778)

Statistic	L (mm)	W (mm)	H (mm)	WT (mm)	a (mm)	b (mm)	W/L *100	H/L *100	H/W *100	WT/W *100	a/b *100
Minimum value	37.00	34.00	18.00	22.00	19.00	18.00	87.18	42.86	42.55	57.14	100
maximum value	56.00	56.00	30.00	40.00	33.00	30.00	102.70	64.29	70.59	81.63	128.57
Mean value	47.17	46.04	24.92	31.08	25.50	24.17	97.68	53.13	54.52	67.64	105.79
Median	48.00	46.00	25.00	31.50	25.00	25.00	98.11	52.74	53.91	66.31	100
Standard Deviation	5.39	5.38	3.06	4.14	3.23	2.93	4.19	6.36	7.19	6.24	8.71

Table 6. Matrix correlation of biometric data and simple ratios for *Micraster (Micraster) coranguinum* (Leske, 1778)

Characters and Simple ratios	L	W	H	WT	a	b	W/L *100	H/L *100	H/W *100	WT/W *100	a/b *100
L	1	0.939	0.480	0.739	0.847	0.822	-0.137	-0.436	-0.364	-0.093	0.072
W		1	0.404	0.731	0.860	0.819	0.209	-0.458	-0.503	-0.180	0.087
H			1	0.254	0.496	0.607	-0.213	0.575	0.575	-0.171	-0.127
WT				1	0.611	0.566	0.030	-0.456	-0.441	0.537	0.097
A					1	0.800	0.051	-0.257	-0.264	-0.188	0.352
B						1	0.028	-0.129	-0.152	-0.212	-0.278
W/L*100							1	-0.100	-0.437	-0.215	0.006
H/L*100								1	0.937	-0.131	-0.183
H/W*100									1	-0.051	-0.148
Wt/W*100										1	0.038
a/b*100											1

Table 7. Biometric data and simple ratios for *Echinocorys gravesi* (Agassiz & Desor, 1847)

Number of specimen	L (mm)	W (mm)	H (mm)	HE (mm)	W/L *100	H/L *100	H/W *100	HE/H *100
EQ105	73.00	61.00	51.00	28.00	83.56	69.86	83.61	54.90
EQ106	66.00	59.00	48.00	23.00	89.39	72.73	81.36	47.92
EQ104	69.00	56.00	47.00	22.00	81.16	68.12	83.93	46.81

anterior side and is less groove. Periproct is located in the ridge side and is generally rounded. The apical system is slightly flattened. Tubercles are too small and rarely can be finding in the aboral side but in the adoral side are bigger and visible. The ratio of HE/H*100 is >30.

Remarks: *Echinocorys gravesi* appears in the Middle Turonian and becomes commoner in the Late Turonian. Some forms, particulary earlier morphotypes of *E. gravesi*, are similar in shape to *Crassiholaster sphaericus* (Schluter); these occur in the *Inoceramus perplexus* Zone (early Late Turonian) in the Opole area. Forms found in higher up section (*Mytiloides scupini* Zone) in this area more closely resemble *E. gravesi* as reported by Lambert (1903, p. 48, pl. 1, figs 12-15). According to the report by Olszewska-Nejbert (2007), typical representatives of *E. gravesi* are recorded from the Late Turonian of Wolin and northern France (Pl. 10, Figs 1, 2). Dzhabarov (1964, p. 23, pl. 1, fig. 2; pl. 2, fig. 1) and Savchinskaya (1974, p. 321, pl. 103, figs 9-11) described convex specimens from the Late Turonian of Kopet-Dagh and Donbass, respectively, as *Echinocorys sphaericus*. According to Ernst (1972), these specimens appear to be early forms of *E. gravesi*.

Occurrence: Late Turonian (*Inoceramus perplexus* Zone) of Odra I and II, Bolko, and Folwark and coeval levels in Wolin. Also known from the Middle Turonian to Early Coniacian of Germany (Lower Saxony, Westphalia), and Late Turonian to Early Coniacian of England, France, Donbass, Kopet-Dagh, plus Early Coniacian of northern Spain.

Echinocorys ex gr. *scutata* Leske, 1778 (pl. 8-9)

1778 *Echinocorys scutatus* N.G. Leske, p. 111, pl. 15, figs. A, B.
1881 *Echinocorys vulgaris* Breynius, T. Wright (*partly*), p. 328, pl. 77, figs 1-11.
1903 *Echinocorys vulgaris* var. *scutatus* Leske; J. Lambert, p. 58.
1959 *Echinocorys gibbus* Lamarck; M.M. Moskvin, p. 256, text-fig. 56; pl. 6, fig. 1.
1959 *Echinocorys gravesi* Desor; M.M. Moskvin, p.

Table 8. Simple statistics of biometric data and simple ratios for *Echinocorys gravesi* (Agassiz & Desor, 1847)

Statistic	L (mm)	W (mm)	H (mm)	HE (mm)	W/L *100	H/L *100	H/W *100	HE/H *100
Minimum value	66.00	56.00	47.00	22.00	81.16	68.12	81.36	46.81
Maximum value	73.00	61.00	51.00	28.00	89.39	72.73	83.93	54.90
Mean value	69.33	58.67	48.67	24.33	84.71	70.24	82.96	49.88
Median	69.00	59.00	48.00	23.00	83.56	69.86	83.61	47.92
Standard Deviation	3.511885	2.516611	2.081666	3.21455	4.234652	2.328111	1.401635	4.387981

Table 9. Matrix correlation of biometric data and simple ratios for *Echinocorys gravesi* (Agassiz & Desor, 1847)

Characters and sample ratios	L	W	H	HE	W/L *100	H/L *100	H/W *100	HE/H *100
L	1	0.471	0.775	0.827	-0.627	-0.548	0.751	0.843
W		1	0.923	0.886	0.392	0.479	-0.228	0.872
H			1	0.996	0.007	0.103	0.165	0.993
HE				1	-0.080	0.017	0.250	1.000
W/L*100					1	0.995	-0.985	-0.109
H/L*100						1	-0.964	-0.012
H/W*100							1	0.278
HE/H*100								1

Table 10. Biometric data and simple ratios for *Echinocorys* ex gr. *scutata* (Leske, 1778)

Number of specimen	L (mm)	W (mm)	H (mm)	HE (mm)	W/L *100	H/L *100	H/W *100	HE/H *100
EQ102	79.00	66.00	54.00	22.00	83.54	68.35	81.82	40.74
EQ103	70.00	61.00	50.00	20.00	87.14	71.43	81.97	40.00
EQ112	57.00	49.00	38.00	17.00	85.96	66.67	77.55	44.74
EQ113	47.00	43.00	35.00	15.00	91.49	74.47	81.40	42.86
EQ115	54.00	45.00	38.00	20.00	83.33	70.37	84.44	52.63
EQ111	53.00	46.00	39.00	13.00	86.79	73.58	84.78	33.33
EQ110	58.00	45.00	39.00	23.00	77.59	67.24	86.67	58.97
EQ116	41.00	37.00	28.00	13.00	90.24	68.29	75.68	46.43

256, text-fig. 57; pl. 6, fig. 2.
1964 *Echinocorys gravesi* (Desor); G.N. Dzhabarov, p. 25, pl. 2, fig. 2.
1964 *Echinocorys gravesi* (Desor) var. *moskvini*; G.N. Dzhabarov, p. 26, pl. 2, fig. 3; pl. 3, fig. 1.
1966 *Echinocorys scutatus* Leske; C.D. Wagner & J.W. Durham, p. U528, fig. 416,*8*.
1967 *Echinocorys gravesi* (Desor); L. Cayeux & O. De Villoutreys, p. 36, pl. 3, fig. 9.
1968 *Echinocorys* cf. *conicus* Agassiz var. *minor* Lambert; S.I. Pasternak & *et al*., p. 212, text-fig. 42; pl. 44, figs 6, 7.
1970 *Echinocorys scutata* Leske; N.B. Peake & R.V. Melville, p. 57, pl. 2, figs A, B.
1974 *Echinocorys gravesi* Desor; O.V. Savchinskaya, p. 321, pl. 103, figs 12-16.
1974 *Echinocorys* ex gr. *scutata* Leske; G. Ernst & M.G. Schulz, p. 36, text-figs 12, 13; pl. 4, figs 1-4.
2002 *Echinocorys scutata* Leske; A.B. Smith & C.W. Wright (pars), p. 287, text-fig. 13.1(A-D, I-J, K-L, O-P); pl. 59, figs 1, 2.
2003 *Echinocorys scutata* Leske; A.B. Smith & C.W. Wright (pars), p. 531, text-fig. 218; pl. 168, figs 1-4, pl. 169, fig. 5; pl. 170, figs 1-3, 8-9; pl. 171, figs ?1-?3, 4-9.
2007 *Echinocorys ex gr. scutata* Leske; D. Olszewska-Nejbert, Text-figs 18, 19; Pl. 8, Fig. 3; Pl. 9, Figs 1, 2; Pl. 10, Figs 1, 2.

Type species: Neotype figured by Peake & Melville (1970, pl. 2, figs A, B) is specimen NHM E.8721, from Fletcher's Pit, Gravesend, Kent, England; upper *Micraster coranguinum* Zone, Early Santonian.

Material: From the total collected samples, 8 samples belong to this specimen.

Description: The size of the test is various in samples. The shape is generally elliptical to sub elliptical and is completely rounded and concave in the anterior side but is less concave in the posterior side. Periproct is located in the ridge side and is generally rounded. Peristome is circular to elliptical in shape. In some samples, the regular tubercles are visible from the aperture to the ridge side. There are no tubercles on the aboral side or rarely are founded. The apical system is long. There is no labrum and fasciol. Ambitus is located higher than its normal place. The ratio of HE/H*100 is >30.

Remarks: Leske (1778) was the first to use the binomen *Echinocorys scutatus*, with masculine ending. Hayward (1940) corrected it to "*scutata*". Ernst & Schulz (1974) noted a wide range of variation in *Echinocorys* ex gr. *scutata*, first occurring in the Middle Coniacian. They distinguished several morphotypes and some of them regarded as formal subspecies (e.g. *Echinocorys scutata scutata* Leske, or *E. scutata vulgaris* Breynius), the others as morphotypes (e.g. "*planodoma*") only. Smith & Wright (2003) enclosed all specimens of *Echinocorys* from the Late Cretaceous of England under the name *Echinocorys scutata* and distinguished 11 informal forms (*scutata*, *planodoma* with extreme forms named *depressula*, *elevata*, *gravesii*, *cincta*, *pyramidalis*, *ovata*, *subglobosa*, *conica*, *vulgaris*, *depressa*).

Some of the forms illustrated by Smith & Wright

Table 11. Simple statistics of biometric data and simple ratios for *Echinocorys* ex gr. *scutata* (Leske, 1778)

Statistic	L (mm)	W (mm)	H (mm)	HE (mm)	W/L *100	H/L *100	H/W *100	HE/H *100
Minimum value	41.00	37.00	28.00	13.00	77.59	66.67	75.68	33.33
Maximum value	79.00	66.00	54.00	23.00	91.49	74.47	86.67	58.97
Mean value	57.38	49.00	40.13	17.88	85.76	70.05	81.79	44.96
Median	55.50	45.50	38.50	18.50	86.38	69.36	81.89	43.80
Standard Deviation	12.15	9.67	8.24	3.94	4.37	2.91	3.69	7.92

Table 12. Matrix correlation of biometric data and simple ratios for *Echinocorys* ex gr. *scutata* (Leske, 1778)

Characters and sample ratios	L	W	H	HE	W/L *100	H/L *100	H/W *100	HE/H *100
L	1	0.975	0.983	0.725	-0.444	-0.215	0.286	-0.181
W		1	0.982	0.588	-0.237	-0.093	0.157	-0.351
H			1	0.656	-0.350	-0.033	0.342	-0.291
HE				1	-0.803	-0.450	0.502	0.530
W/L*100					1	0.542	-0.652	-0.612
H/L*100						1	0.283	-0.550
H/W*100							1	0.223
HE/H*100								1

(2003) are similar to morphotypes distinguished in this paper e.g. form *vulgaris* (Smith & Wright 2003, pl. 170, figs 1, 3, 8); the other forms are different. *E. scutata* form *depressula* extreme form of *planodoma* (Smith & Wright 2003, pl. 169, fig. 5) is exactly similar to *E. scutata* morphotype "*vulgaris-planodoma*" (Pl. 14, figs 1-4) and is nearly similar to *E.* ex gr. *scutata* type *vulgaris* of Ernst & Schulz (1974, pl. 4, fig. 3). *E. scutata* form *subglobosa* [26] is exactly similar to "*scutata*" morphotype (Pl. 13, figs 1-3) and resembles *E.* ex gr. *scutata* type *scutata* of Ernst & Schulz (1974, fig. 12.1). *E. scutata* form *ovata* (Smith & Wright 2003, pl. 171, figs 7-9) seems to be similar to "*vulgaris-scutata*" morphotype (Pl. 15, figs 1, 2). Moreover, it is remarkable that *E. scutata* form *planodoma* by Smith & Wright (2003, pl. 169, figs 1-4) is different from the same form by Ernst & Schulz (1974, fig. 12.6- 7, pl. 4, figs 1, 2) and also by Olszewska-Nejbert (2007) in (Pl. 12, figs 1-3).

Occurrence: Early Coniacian (*Cremnoceramus* c. *crassus* Zone) at Shakh-Bogota, Middle and Late Coniacian at Sulu-Kapy, Shyrkala-Airakty and condensed Late Turonian-Coniacian of Azhirektoy and Besakty, plus Early Coniacian at Folwark. This species has also been reported from the Middle-Late Coniacian and Santonian of the North European Province (England, France, Belgium, Germany, western Ukraine, Donbass, ?northern Caucasus, Kopet-Dagh).

Ernst & Schulz (1974) described a very similar *Echinocorys* ex gr. *scutata* fauna from the Middle Coniacian to Middle Santonian from Lägerdorf, northern Germany, with an acme in the Late Coniacian and Early Santonian. At Lägerdorf, the morphotype "*striata*" succeeds the morphotype "*vulgaris*" during the Middle Santonian.

Results and Discussion

Echinoids faunal studies in the study area led to determination of 2 genus and 4 species. The recognized genus are *Micraster* and *Echinocorys*. Four species have been determined: *Micraster coranginum*, *M. cortestodinarium*, *Echinocorys gravesi* and *E. scutata*.

Descriptions and standard biometric parameters are done and calculated accurately by the statistic relations and various parametric data following the related charts and diagrams. Some essential data such as average ratio, minimum and maximum value, mean value, median, standard deviation and matrix correlation for each taxon are reported. According to the determined echinoids, the Turonian-Santonian age is suggested for the Abderaz Formation in the studied area.

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References

1. Abdelhamid M.A. and Azab M.M. Aptian-Cenomanian Echinoids from Egypt. *Rev. Paleobiol.*, Geneve, **22(2)**: 851-876 (2003).
2. Afshar-Harb A. Geology of Kopet Dagh. *GSI* pub., Tehran (in Persian) (1994).
3. Afshar-Harb A. History of oil exploration and brief description of the geology of the Sarakhs area and the anticline of Khangiran. *Bull. Ir. Petrol. Ins.* (*BIPI*), **37**: 86-94 (in Persian) (1969).
4. Cecca F., Dhondt A.V., and Bogdanova T.N. The Aptian stratigraphy of the southern Tuarkyr (NW Turkmenistan, Central Asia). *Riv. Ital. Paleontolo. S*., **105(3):** 377-396 (1999).
5. Dunnington H.V., Wetzel R. and Morton D.M. Iraq, Mesozoic and Palaeozoic, Lexique stratigraphique international, *ASIE*, Paris, **10:** 333 pp. (1959).
6. Durham J.W. and Wagner C.D. Glossary of morphological terms applied to Echinoids. In: R.C. Moore (Ed.), *Treat. Invert. Paleontolo*. GSA and the University of Kansas; Boulder, Colorado, Part U, Echinodermata 3, **1:** 251-256 (1966).
7. Ernst G. and Seibertz E. Concepts and methods of Echinoid Biostratigraphy. In: E.G. K Auffman & J.E. Hazel (Eds), Con. *Biostrati*., 541-563 (1977).
8. Ernst G. Grundfragen der Stammesgeschichte bei irregularen Echiniden der nordwesteuropaischen Oberkreide. *Geologie. Jahrb*., BGR (A), **4:** 63-175 (1972).
9. Ernst G. Zur Stammesgeschichte und stratigraphischen Bedeutung der Echiniden-Gattung Micraster in der nordwestdeutschen Oberkreide. *Mitte. Geologi. Palaontolo.*, Institut der Universitat Hamburg, **39:** 117-135 (1970).
10. Fouray M. L'evolution des Micraster (Echinides; Spatangoides) dans le Touronien-Coniacien de Picardie Occidentale (Somme), Interet-biostratigraphique. *Annal. Paleontolo.*, Invertebres, **67:** 81-134 (1981).
11. Goldfuss A. Petrefacta Germaniae. Abbild-ungen und Beschreibungen der Petrefacten Deutsch-land und der angrenzenden Länder. *Arnz & Co*., Düsseldorf, **1:** 1-252 (1826-33).
12. Hashemian N. and Aryaei, A.A. Introduction of some species from Tirgan Formation, *1st Symposium of PSI*, 154-158 (2007).
13. Howarth M.K. and Morris N.J. The Jurassic and Lower Cretaceous of Wadi Hajar, southern Yemen, *Bull. NHM* (Geology), **54(1):** 1-32 (1998).

14. Hudson R.G.S. and Chatton M. The Musandam Limestone Jurassic to Lower Cretaceous of Oman Arabia. *Not. Memo. Moyen*., Paris, **7:** 69-93 (1959).
15. Ivanov M., Hrdlickova S. and Gregorova R. The complete encyclopedia of fossils, *Rebo. Pub*., 209-233 (2005).
16. Kalantari A. Foraminifera from the Middle Jurassic-Cretaceous successions of the Koppet-Dagh region (N.E. Iran), National Iranian Oil Company, *Geol. Lab. Pub*.**,** **3**:1-298 (1969).
17. Maczynska S.S. Echinoids of the genus Micraster L. Agassiz from the Upper Cretaceous of the Cracow-Miechow area. *Pra. Muz Zie*., **12:** 87-168 (1968).
18. Mouty M., Al-Maleh A. Kh. and Laban H.A. Le Crétacé moyen de la chaîne des Palmyrides (Syrie centrale), *Sci. Mus. Nat. Pub*., 429-443 (2003).
19. Nichols D. Changes in the chalk heart-urchin Micraster interpreted in relation to living forms. *Philos. Trans. Roy. Soc*., London, **242:** 347-437 (1959a).
20. Nichols D. Mode of life and taxonomy in irregular sea-urchins. Function and taxonomic importance. *Syst. Ass. Pub*., **3**: 61-80 (1959b).
21. Olszewska-Nejbert D. Late Cretaceous (Turonian-Coniacian) irregular echinoids of western Kazakhstan (Mangyshlak) and southern Poland (Opole), *Acta Geol. Pol*., **57(1):** 1-87 (2007).
22. Smith A. and Batten D.J. Fossils of the Chalk. *John Wiley & Sons Pub*. 374 (2002).
23. Smith A.B. and Jeffery C.H. Maastrichtian and Palaeocene echinoids: a key to word faunas. *Palaeontol*., **63:** 1-406 (2000).
24. Smith A.B. and Wright C.W. British Cretaceous echinoids. Part 5. Holectypoida, Echinoneoida, Monograph of the *Pal. Soc*., London, 343-390 (1999).
25. Smith A.B. and Wright C.W. British Cretaceous echinoids. Part 6. Neognathostomata (Cassiduloids), Monograph of the *Pal. Soc*., London, 391-439 (2000).
26. Smith A.B. and Wright C.W. British Cretaceous echinoids. Part 7. Atelostomata, 1. Holasteroida, Monograph of the *Pal. Soc*., London, 440-568 (2003).
27. Smith A.B. Echinoid Palaeobiology, *George Allen & Unwin*, London 1-190 (1984).
28. Smith A.B., Monks N.E.A. and Gale A.S. Echinoid distribution and sequence stratigraphy in the Cenomanian (Upper Cretaceous) of southern England. *Proceedings of the Geol. Ass*., **117**: 207-217 (2006).
29. Stocklin J. and Setudehnia A. Stratigraphic Lexicon of Iran, Report No.18., *GSI*, Tehran, Iran (1991).
30. Stokes R.B. The echinoids Micraster and Epiaster from the Turonian and Senonian of England. *Paleontol*., **20(4):** 805-821 (1977).
31. Stokes R.B. Royaumes et provinces fauniques du Cretace etablis sur la base d'une etude systematique du genre Micraster. *Memo. Mus. NH*., nouvelle serie C**,** **31:** 1-94 (1975).
32. Taherpour Khalil Abad M., Aryaei A.A., Ashouri A.R. and Ghaderi A. Introducing some echinoderms from the Tirgan Formation, Kopeh-Dagh Basin, NE of Iran, *Geop*., **1:** 83-94 (2011).
33. Vahidinia M. and Aryaei A.A. The Echinids studies of the Abderaz Formation in the Eastern regions of Kopet Dagh basin, *4th symposium of the GSI*, 44-45 (2000).
34. Wood C.J., Ernst G. and Rasemann G. The Turonian-Coniacian stage boundary in Lower Saxony (Germany) and adjacent areas: the Salzgitter-Salder Quarry as a proposed international standard section. *Bull. GSD*, **33 (1-2):** 225-238 (1984).
35. Villier L., Neraudeau D., Clavel B., Neumann Ch. and David B. Phylogeny of Early Cretaceous Spatangoids (Echinodermata: Echinoidea) and taxonomic implications, *Paleontol*., **47**(2): 265-292 (2004).
36. Yaghoubi T., Aryaei A.A., Ghaderi A. and Ashouri A.R. Some species of Early Cretaceous Echinoderms in Southwest of Gonabad, Iran, *2nd Symposium of PSI*, 152-155 (2008).

Morphological and systematic interpretation of some Late Cretaceous (Turonian-Santonian) irregular echinoids, Kopet-dagh Basin, NE of Iran

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توصیفات سیستماتیک و ریخت شناسی برخی از خارداران نامنظم اواخر کرتاسه (تورونین– سانتونین)، حوضه رسوبی کپه داق، شمال شرق ایران

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چکیده

سازند آبدراز، یکی از سازندهای کرتاسه بالایی در حوضه رسوبی کپه داق می باشد. به منظور توصیف سیستماتیک دقیق خارداران در سازند مذکور، برش چینه شناسی از این سازند انتخاب و مورد بررسی قرار گرفت. در این پژوهش، تعداد قابل ملاحظه ای از خارداران متعلق به خانواده‌های Mircrasteridae wright, 1857 و Echinocorythidae Lambert, 1920، از برش چینه شناسی قلعه زو در حوضه رسوبی کپه داق، شمال غرب شهرستان شیروان، شمال شرق ایران توصیف می‌شوند. مجموعه جانوری فوق مشتمل بر جنس ها و گونه هایی همچون: Micraster (Micraster) coranguinum Leske, 1778, Micraster (Micraster) cortestudinarium (Goldfuss, 1829), Echinocorys gravesi (Agassiz & Desor, 1847) and Echinocorys ex gr. scutata Leske, 1778 می باشند. مجموعه جانوری شناسایی شده، سن تورونین- سانتونین را برای برش چینه شناسی مورد مطالعه پیشنهاد می کند.

واژه‌های کلیدی: خارداران؛ کرتاسه بالایی؛ کپه داق؛ ایران