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A CONTRIBUTION TO THE PALEONTOLOGY OF ECHINOIDS: THE GENUS ECHINOCYAMUS VAN PHELS. FROM THE SEDIMENTS OF YUGOSLAVIA & GREECE (MIDDLE EOCENE TO RECENT)*

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A B S T R A C T

The authors of this paper have undertaken a study of the genus **Echinocyamus** v.PH. from the Middle Eocene to the present, coming from the sediments of Yugoslavia and Greece. The purpose is: the detailed record of its morphology, the presentation of the structure of its systems and its evolutionary course in relation to the ecological conditions during the above mentioned time-span in both areas.

Σ Υ Ν Ο Ψ Η

Αντικείμενο της εργασίας αυτής είναι η μελέτη του γένους **Echinocyamus** v.PH. από το μέσο Ηώκαινο μέχρι σήμερα. Μελετώνται είδη προερχόμενα από τις αποθέσεις: 1. της Γιουγκοσλαβίας (Μ. Ηωκαίνου και Μ.Μειοκαίνου) και 2. της Ελλάδας (Μ.Ηωκαίνου και Πλειοκαίνου -σήμερα). Αναφέρονται τα μορφολογικά, τα εξελικτικά και τα Παλαιοοικολογικά χαρακτηριστικά του γένους **Echinocyamus**.

I. INTRODUCTION

The first appearence of the genus **Echinocyamus** is pointed in the terminal Upper Cretaceous sediments (Senonian) with the species **E.kamrupensis** GUPTA (MORTENSEN,Th.,1948).

Echinocyamus extended eastwards throught the Tethys sea and appeared in a lot of areas in abundance from the Middle Eocene to the present.

The recent species known living in the Mediterranean sea is **E. pusillus** (MULL.).

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*ΣΥΜΒΟΛΗ ΣΤΗ ΠΑΛΑΙΟΝΤΟΛΟΓΙΑ ΤΩΝ ΕΧΙΝΟΕΙΔΩΝ : ΤΟ ΓΕΝΟΣ **ECHINOCYAMUS** van PHELS. ΣΤΑ ΙΖΗΜΑΤΑ ΤΗΣ ΓΙΟΥΓΚΟΣΛΑΒΙΑΣ ΚΑΙ ΤΗΣ ΕΛΛΑΔΑΣ (ΜΕΣΟ ΗΩΚΑΙΝΟ - ΣΗΜΕΡΑ).

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The genus **Echinocyamus** can be used as an index of paleotemperature, but not of paleobathymetry, because of its variation of distribution (MORTENSEN, TH., 1943. TORTONESE, E. 1949).

The test of **E.pusillus** (MULL.), coming from different areas of Greece (Pliocene to recent), has been used (MANZE et al.1979 ; RICHTER, 1979) in purpose of giving their paleotemperature (17-19°C) during the above mentioned time-span.

The genus **Echinocyamus** occured in Yugoslavia in the Middle Eocene and the Middle Miocene (Badenian), whereas its occurence in Greece, as it is known uptoday, is in the Middle Eocene, Pliocene, Pleistocene to recent (but not in Miocene sediments).

II. THE MATERIAL OF THE STUDY

In this investigation a number of individuals coming from Yugoslavia and Greece from various stratigraphical stages was determined.

1. In Yugoslavia (fig.1)

1.1. Middle Eocene

The oldest representatives of **Echinocyamus** in Yugoslavia came from the Middle Eocene limestone of the city Sutivan (island Brac', fig.1,1). The following species are determined : **E.affinis** (DESM.), **E.cambonensis** COTT., **E.pomeli** COTT. and **E.vasseuri** COTT. (fig.2).

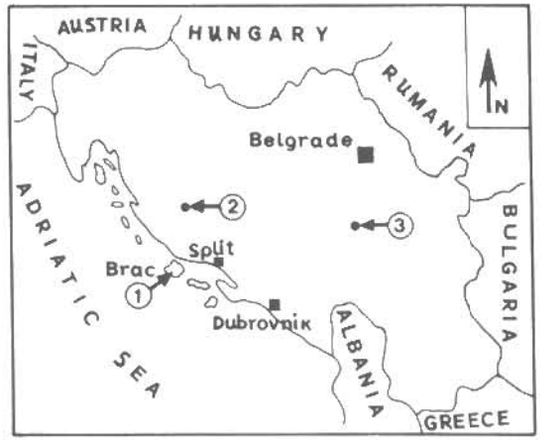


Fig.1. Locations of the findings of **Echinocyamus** in Yugoslavia (1.Island Brac', 2.Dalmatia, 3.Serbia).

1.2. Liburian Strata

In the mid-way of the area of Dalmatia (fig.1,2) CHOROWICZ, J. and ROMAN, J.(1970)recognized the species **E.affinis** (DESM.) into the Liburian strata lying below the limestone with **Alveolina** of the Middle Lutetian. The individuals of this locality have the following dimensions : length: 7mm , width:6,5mm.

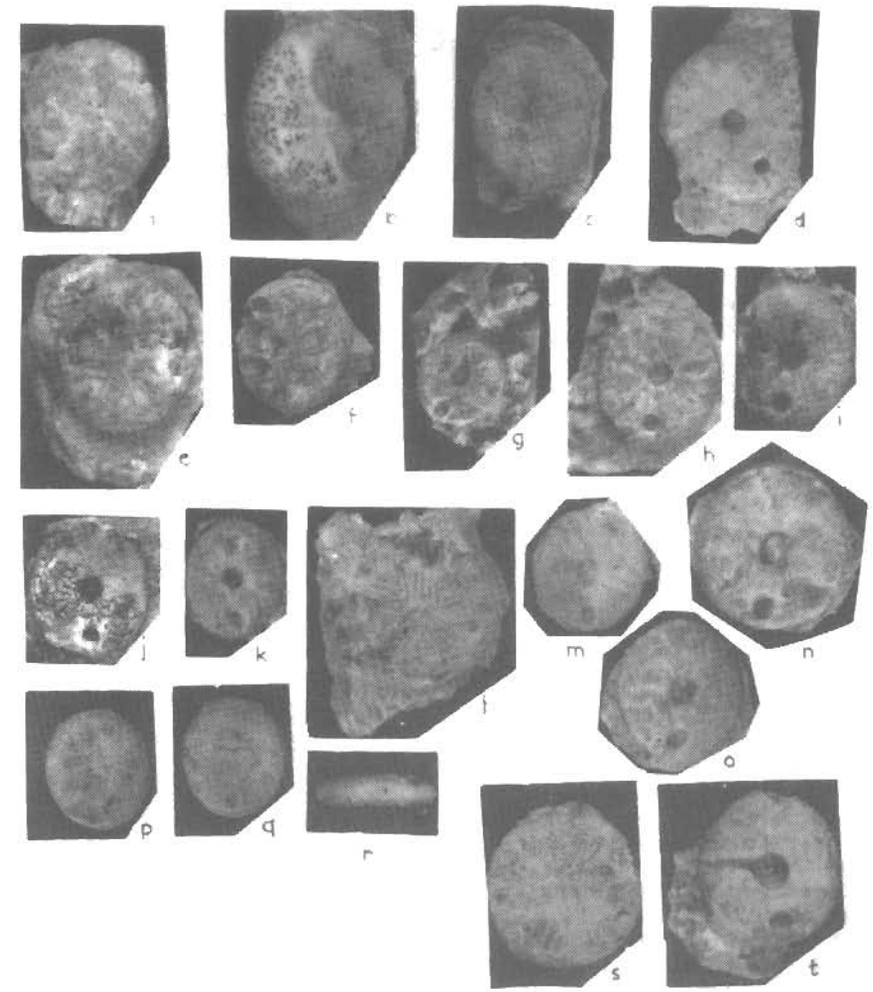


Fig.2. The species of **Echinocyamus** from the Middle Eocene of Yugoslavia .a-d : **E.affinis** (DESM.); e-h : **E.cambonensis** COTT. ; i-o : **E.pomeli** COTT. ; p-t : **E.vausseri** COTT.

1.3. Middle Miocene

From a material of the Middle Miocene (Badenian) sediments of Serbia (fig.1,3) (exact locality is not known) the following species were determined : **E.pusillus** (MULL.) and **E.pseudopusillus** COTT. (Fig.3).

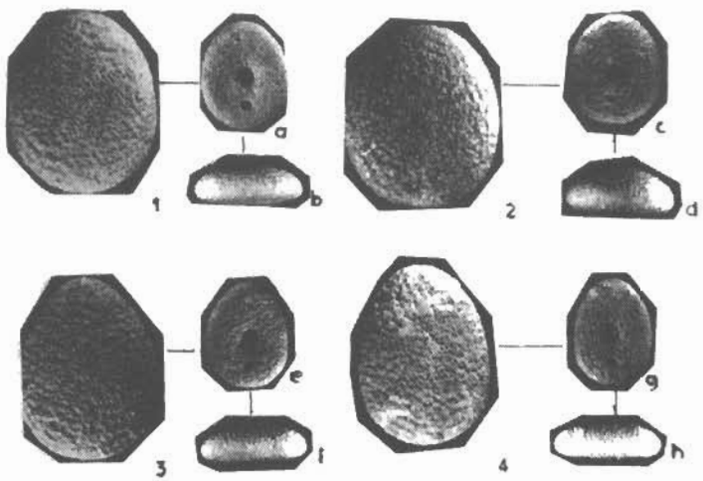


Fig.3. **E.pusillus** (MULL.) (1,2) and **E.pseudopusillus** COTT. (3,4) of the Middle Miocene (Badenian) sediments of Serbia, X5(a.c.e.g : oral view ; X3 ; b.d.t.h : profile , X3).

2. In Greece (fig.4)

2.1. Middle Eocene

Echinocyamus affinis (DESM.) is recognized into the neritic sedimentation of the Klokova unit (village Rhiza, fig.4_1) with planctonic Foraminifera of the Middle Eocene (Upper Lutetian-early Priabonian) (after FLEURY, J.-J. 1980). This species is very well conserved and abundant in the black (bitumen) limestone of this unit.

The dimensions of this species are :
Lenght : 10 mm, width : 9 mm, height : 5 mm (fig.5).

2.2. Pliocene

The occurence of the species **E.pusillus** (MULL.) in the pliocene marls of the locality Ag.Marina (island Aegina, fig.4_2) is well known (A. MARCOPOULOU-DIACANTONI, 1967, p. 379,398) (fig.6).

E.pusillus (MULL.) is mentioned from the pliocene sediments of the island Rhodos (fig.4_3) (in A. MARCOPOULOU-DIACANTONI, 1967).

In the rich Neogene Fauna of the region Palekastro (2km S of Neapoli city, SE Peloponnisos, fig.4_4), consisting of conglomerate and sands collected by N. SYMEONIDES, we determinate the presence of the species **E.pusillus** (MULL.).

Fig.4. Locations of the findings of **Echinocyamus** in Greece. 1.Rhiza village (Unit Klokova). 2.Island Aegina. 3.Island Rhodos. 4.Palekastro (Neapolis, Peloponnissos). 5.Neapolis Vion. 6.Korinthos canal 7.Ireon. 8. Island Pyrgoussa. 9.Island Karpathos. 10.Island Armathia. 11.Island Agistri. 12.Island Crete. 13.Rio-Antimio.

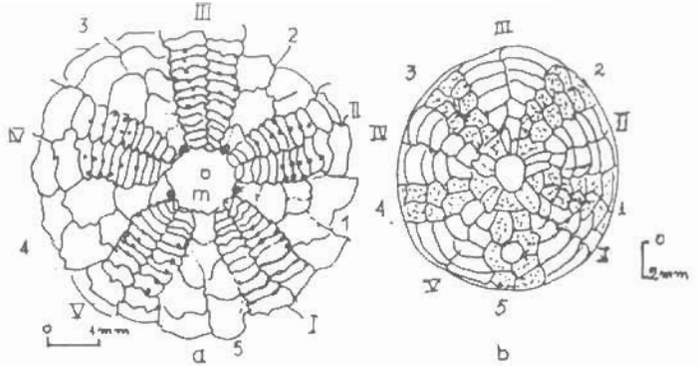


Fig.5. **E.affinis** (DESM.) from Klokova Unit (Village Rhiza). a.Aboral face with the apical system, m.madreporite plate. b.Oral face. Stippled : Interambulacral plates.

2.3. Plio-pleistocene

In the sediments of the region Neapolis Vion (SE Peloponnisos, fig.4_8) consisting of grey, marly sandstone and sands the species **E.pusillus** (MULL.) was determined.

KERAUDREN(1967) confirms that the sediments in 8km WNW of the city of Neapolis belong to the calabrian stage and this datation based on the characteristic fossil **Arctica islandica** . We believe that the sediments of Neapolis are of the Plio-Pleistocene stage (A. MARCOPOULOU-DIACANTONI, 1977).In the same sediments RICHTER (1976) found the species **E.pusillus** (MULL.).

In the sediments of Pliocene and Pleistocene of the island Agistri[1] (SW of the island Aegina, fig.4_{11}) the species **E.pusillus** (MULL.) and **E.circularis** CAP. are recognized. (fig.7).

The dimensions of the species of the island Agistri are the following (L = length, l = width, h = height).

E.pusillus (MULL.) : L = 12mm, l = 10mm, h = 4mm, l/L = 0.83 ; h/L = 0.33

E.circularis CAP. : L = 4mm, l = 3mm, h = 1mm, l/L = 0.75 ; h/L = 0.25

REMARK : We consider that the species **E.studeri** (SISM.' cited by COMASCHI-CARIA, I.(1972, tav.XLIV, f.6) may be synonymous to **E.pusillus** (Mull), because of its dimensions and the development of its ambulacra.

2.4. Pleistocene

A great number of individuals of the genus **Echinocyamus** is found in the sediments of Pleistocene in different regions of Greece (see table I, fig.4_9,4_{10},4_{12},8,9).

1.Material offered by the geologist D.Anastassiadou.

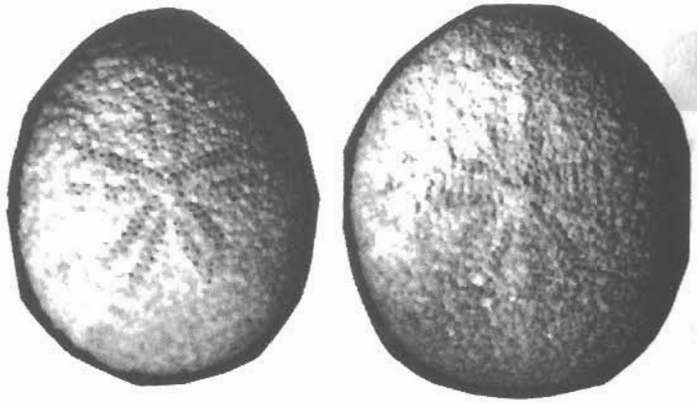
Fig.6. **E.pusillus** (MULL.) X5. Island Aegina. a.Aboral face. b.Oral face. c.Aboral face X5.

Fig.7. **E.pusillus** (MULL.) X5.Pleistocene, Island Agistri. a.Aboral view. b.Oral view c.Oral interior view.

T A B L E I

REGIONS	KORINTHOS CANAL					CAP IREON					D O D E C A N I S S O S										CRETE(1)				
											PYRGOUSSA					KARPATHOS					ARMATHIA				
DIMENSIONS	L°	l°	h°	l/L	h/L	L°	l°	h°	l/L	h/L	L°	l°	h°	l/L	h/L	L°	l°	h°	l/L	h/L	L°	l°	h°	l/L	h/L	L°	l°	h°	l/L	h/L
SPECIES																														
E.pusillus (MULL.)	9	7	25	0,87	0,31	12	10	4	0,83	0,33	13	11	4	0,85	0,35	9	7	3	0,87	0,37	10	9	4	0,90	0,40	9	8	4	0,88	0,40
						10	8,5	4	0,85	0,40	10	9	3	0,90	0,30															
						7	6	2	0,85	0,30																				
						5,5	5	1,5	0,90	0,30																				
						3,5	3	1	0,86	0,30																				
E.pseudopusillus COTT.	4	3	1	0,75	0,25	5	4	1,5	0,80	0,30	5	3,5	1,5	0,70	0,30															
						4	1	1	0,75	0,25																				
E.circularis CAP.	2	2	1	1	0,50	7	7	3	1	0,42																				
						5	5	2	1	0,40																				

1. Material coming from the locality Ag. Antonios (N.Crete, province Mirabelou) offered by N.Mourtzas (Thesis in prep).



a b

Fig.8. The species of the pleistocene sediments of Greece.
a. **E.pusillus** (MULL.) X15. Korinthos canal.
b. **E.pusillus** (MULL.) X5. Pyrgoussa.

The specimens of Cap Ireon (fig.4,7) and Korinthos can (fig.4,6) are covered (aboral and oral face) by thick and equ tubercles and the madreporite plate is elevated.

In the specimens of the island Pyrgoussa[1] (fig.4,8) observed a number of 10-11 pores on the ambulacra I-IV and 12- pores on the ambulacra V.

Concerning to the age of the sediments of Korinthos can they correspond to Paleotyrrhenian (Mindel-Riss Interglaci period) after FREYBERG, 1973, whereas the sediments of Cap Ire are considered as Neotyrrhenian (Riss-Wurm Interglacial perio after RICHTER (1974) and SCHRODER (1975).

2.5. Pleistocene to recent

The species **E.pusillus** (MULL.) is recognized in a ri material with Corals, Bryozoans, Foraminifera etc. of the dra gings operated at Rio-Antirio canal[2].

Some of the specimens have the following dimensions:
L_1=6mm, l=5mm (l/L_1=0.83), h=2mm (h/L_1=0.33)
L_2=5mm, l=4mm (l/L_2=0.80), h=1.5mm (h/L_2=0.30)

REMARKS : The peristome is larger (3:1) than the periproct, which oval to circular in shape, close to the margin of the test on t third plate from the margin. Because of the tubercu-lation all t surface of the test became rough.

RICHTER (1979) mentioned the recent species of **E.pusil** (MULL.) from the lake Vouliagmeni, near the cap Ireon.

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1. Material offered by Prof. E.Davis (Agriculture University of Athens.
2. Material offered by the Sedimentologist Dr. G. Kalpakis.

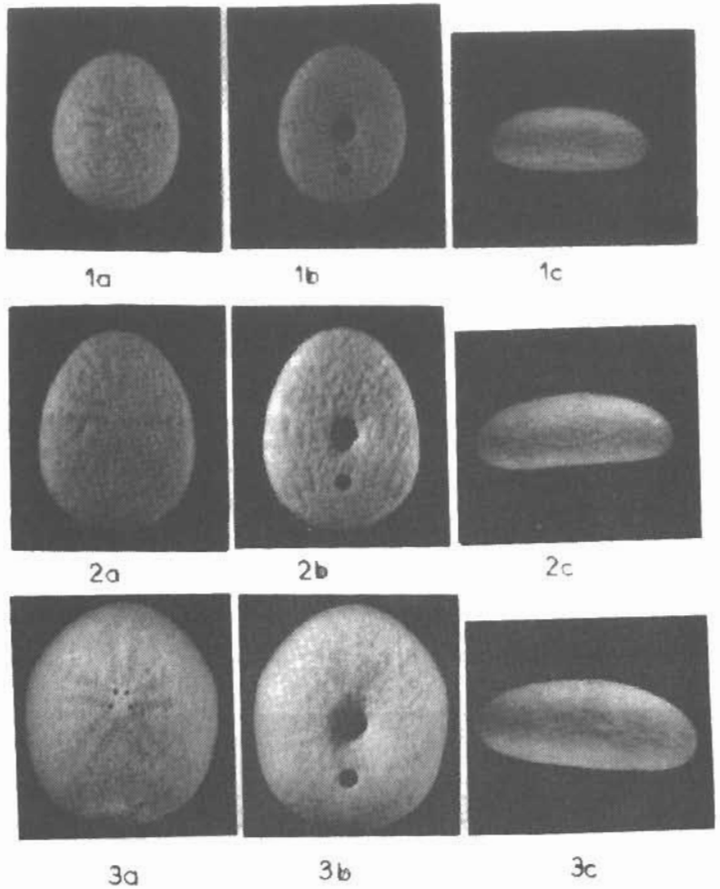


Fig.9. Pleistocene species of **Echinocyamus** from Cap Ireon.
1. **E.pusillus** (MULL.) X5; 2. **E.pseudopusillus** COTT. X7; 3. **E.circularis** CAP. X12; (a: aboral face; b: oral face; c: profile).

III. SOME MORPHOLOGICAL FEATURES OBSERVED ON THE GENUS ECHINOCYAMUS

1. SHAPE OF THE TEST

The body shape of the genus **Echinocyamus**, found in outcrops of Yugoslavia and Greece, has a variation in the relative values of its dimensions, leading to cylindrical and ovoid forms in outline, elongate anteriorly (**E.pseudopusillus** COTT.) on the one hand, or subpentagonal usually ellipsoidal forms (**E.pusillus** (MULL.)) and circular forms (**E.circularis** CAP.) on the other hand (fig.9).

In profile the test is more or less flattened and its

height is usually lower than half of its length (tabl.I). This low profile could be an adaptation giving stability in currents on either rocky or sedimentary substrata.

The ambitus, which lies relatively low down is more or less rounded in outline. This rounded outline might suggest that **Echinocyamus** did not have one particular direction of locomotiom.

Internal supports (pillars) have been observed in some specimens of the genus **Echinocyamus**, giving to the test a great resistance to the external factors and differenciate it from the other genus (**Fibularia**) of the same family (Fibulariidae) lacking of pillars.

2. SIZE OF THE TEST

The size of the body for a great number of individuals of **Echinocyamus** ranges from minute forms (1mm) to elongated forms (13mm).

The predominant forms of **Echinocyamus pusillus** (MULL.), coming from the Pleistecene sedimens of the island Pyrgoussa (W of the island Nissyros, Dodecanissos, Greece) are relatively larger and flatter than those from the other localities of both studied areas. (Meansurments : Length (L)=13mm, width (l)=11mm and height (h)=4,5mm).

3. APICAL SYSTEM

The apical system is sometimes in a central position aborally and usually found on the anterior part of the test, rarely towards to the posterior one. It is of the monobasal system consisting of the madreporite plate, pentagonal in shape with a single pore. At the edges of the madreporite plate 4 genital and 4 ocular pores have been observed.

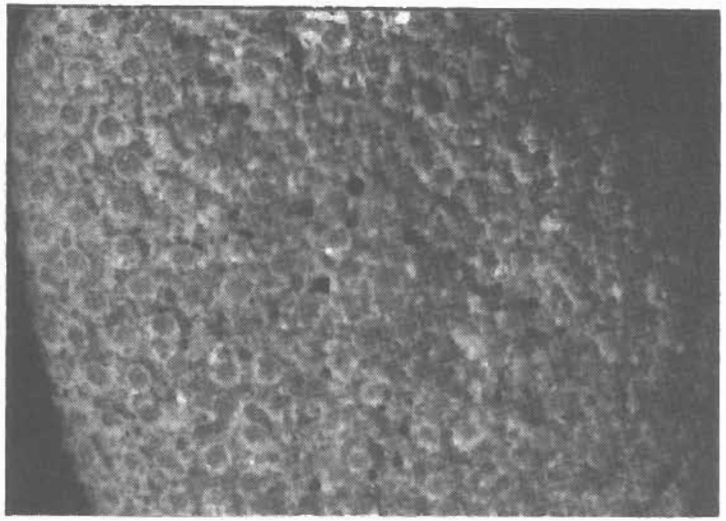


Fig.10. Apical system of the **Echinocyamus pseudopusillus** COTT.X25. Strong tuberculation. female. Ireon.

The limits between genital and ocular plates are not so visible. In some individuals of the species **E.pusillus** (MULL.) from different outcops of Greece especially, a variation in the dimensions of the genital pores is distinguished.

MORTENSEN, T. (1948, p.159) reports the opinion of MARX (1929) concerning the sexual dimorphism of the Echinoids understanding by the longer and narrower genital tubes of the male than those of the female in which they are short and conical.

In our specimens this dimorphism may be sexual : the females have larger genital pores than the males ones (fig.9,10).

Ireon. Female.

4. AMBULACRA - INTERAMBULARCA

The ambularca are in biserial column of plates. They have rather rectilinear form, open towards the terminal point and they don't reach to the ambitus. They have also small and circular to oblique pores usually 6-9 or 11 in pairs.

The interambulacra are composed of two columns of alternating plates except orally (at the peristome) where the first interambulacrum plate is a single and largest one.

5. INFUDIBULUM

The infudibulum has the jaw apparatus (Aristotle's lantern). Oral face is almost horizontal and that's why the infudibulum is not deep (fig.11,13).

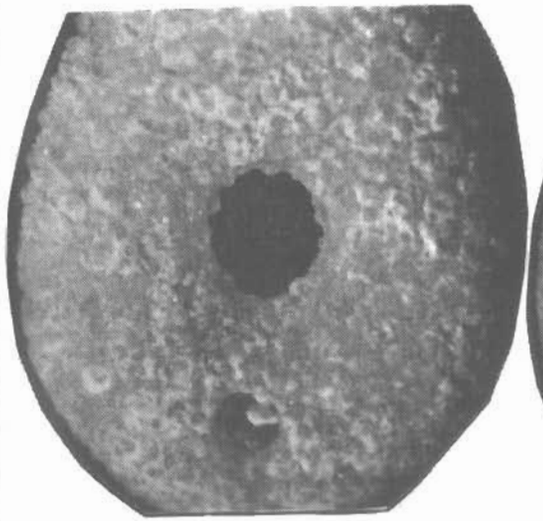


Fig.11. Oral face of the **E.pseudopusillus** COTT.X20 showing the fused auricles. Korinthos canal.

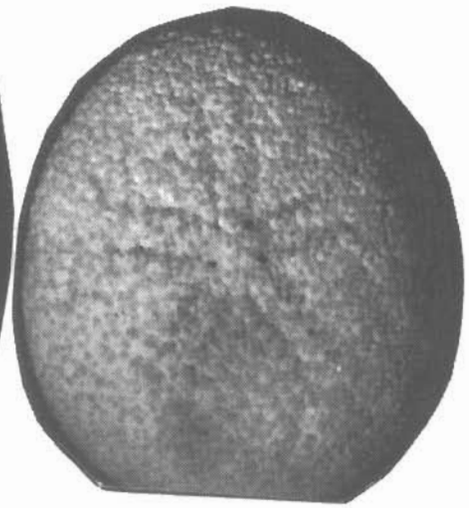


Fig.12. Aboral face of the **E.circularis** CAP. X18. female. Korinthos canal.

6. PERISTOME

The peristome, relatively, larger than the periproct, circular or subpentagonal in outline is situated centrally on the oral face, which is a little sunken towards the peristome.

Echinocyamus is burrower and microphage. It lives usually in relatively grainy sediments from which it feeds.

7. PERIPROCT

The periproct lies on the oral face, posterior to the peristome. It is circular or oval in outline, transversally smaller than the peristome.

In the Eocene species, generally, the periproct is situated close to the posterior margin, whereas in the Neogene species is in a half distance between the posterior margin and the peristome. This character is not stable, because in **E.linearis** CAP. recorded from the Middle Miocene (Badenian) of Poland (MACZYNSKA, S. 1977, p.197) the periproct is close to the margin, whereas in **E.circularis** CAP. and **E.pseudopusillus** COTT. from the same locality and date, the position of the periproct is in the half distance between margin and peristome.
It could be suggested that there is an evolutionary relation among these species of **Echinocyamus** (**E.pusillus**, **E.pseudopusillus** and **E.circularis**) and that **E.linearis** CAP. is more primitive than the others (An hypothetical lineage, fig.17).

In the pleistocene species the periproct is in the mid-distance, between peristome and margin, as well as in the recent species can be observed, presenting a very large and circular in outline periproct.

8. TUBERCULATION

There is a great density and frequency of tubercles, covering all the test of **Echinocyamus**, without range, but stongly developed. Adoral tubercles are slightly smaller than adapical ones. They are perforate and crenulate.

IV. EVOLUTION OF THE GENUS ECHINOCYAMUS

An approach to the evolution of the genus **Echinocyamus** is based on a rich material coming from Eocene to recent from Yugoslavia and Greece on one hand and from the literature on the other hand. (KIER,P.1966,1969; HYMAN,H.1955; SMITH,A.1984 etc.) The following observations allow us to have some considerations about the evolutionary trends of the genus **Echinocyamus** :

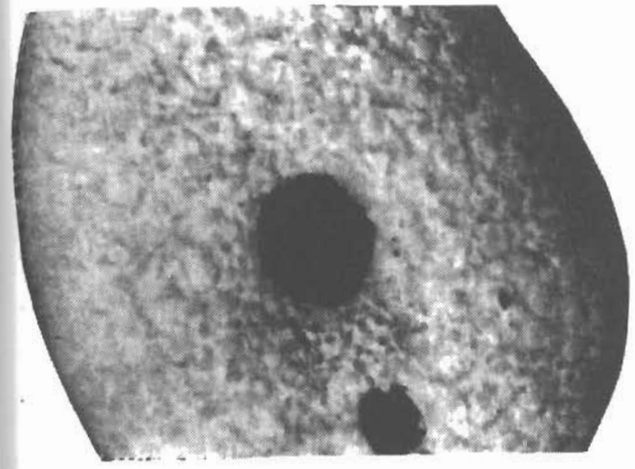
1. **The dimensions** : The most typical feature of this genus is its very small test. The length (anterior - posterior) in our samples varies from 2mm to 13mm. After MORTENSEN T.(1948) the recent specimens reach the 20mm in length. The measurements of the Eocene species (1-8mm) show that the oldest species of **Echinocyamus**, known in both areas studied, are smaller than those of the Neogene (2-10mm) or Pleistocene (2-13mm) and the recent ones (2-20mm).

2. **The morphology** : The species of **Echinocyamus** have not a great modifications in morphology during the Eocene-recent time-span.

Only, some small modifications have been observed on :

a) Dimensions of the periproct : On the same species, coming of the Eocene, the periproct is smaller than the peristome and this difference is very great. Also, the periproct of the Eocene species is larger than that of the Neogene ones.

In **Echinocyamus**, the lack of internal supports of the Arist lantern is a character primitive correlated to the shape forms), but the observed fused auricles at the head of interamb are a specialized character.(after DURHAM, 1966, (fig.11,15,16).



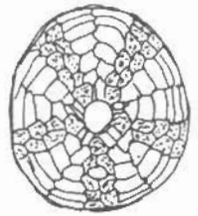


Fig.14. **Echingcyamus pusillus** (MULL.)X6. Oral face.(Stippled. Interambulacral plates).

Fig.13. Detailed oral face of **E.pusillus** (MULL.) X20. Korinthos canal.

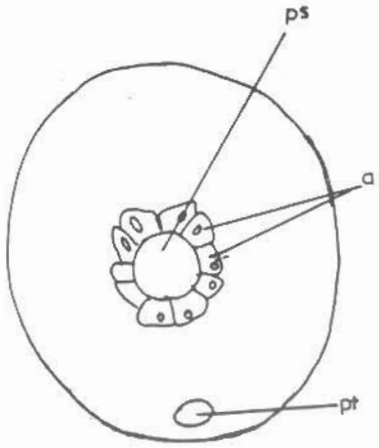


Fig.15. Position of the auricles X12. Oral view from interior, showing auricles (a). ps. peristome, st. periproct.

Fig.16. The lantern in **Echinocyamus** X22having pyramids expanded aborally large wings and large posterior pyramids.

b) Position of the periproct : Usually, it is placed in the midway of the peristome and the margin. This occurs in the Neogene species whereas in the Eocene species the periproct is close to the margin. It is meanwhile a migration of the periproct to the peristome, during the Eocene -Neogene time-span. It can be explained as a character relative to the shape of the test :

The Eocene species, usually, have a pointed margin in outline anteriorly, whereas the Neogene species more or less moderately flattened have a rounded, rarely pointed margin in outline.

c) Shape of the aboral face : The Eocene species, known uptoday, have the aboral face absolutely flat : in the Neogene and Quaternary species this character varies from the flattened to a little inflated species. It is difficult to explain this morphology to the function. Summurizing, the modification of the dimensions, as well as the position of the periproct, probably, are depended on the feeding changing during the time. The morpho-functional analysis of the specimens allow us to consider a probably lineage of the 4 species : **E.pusillus** (MULL.), **E.pseudopusillus** COTT., **E.linearis** CAP. and **E.circularis** CAP.

V. THE PALEOECOLOGICAL CHARACTERISTICS OF ECHINOCYAMUS

Concerning to the habits and the life conditions of **Echinocyamus** there are a lot of data in the literature of Echinoids.

Echinocyamus, belonging to the family Fibulariidae lives, as well as its representatives, buried in the ground, usually in a muddy bottom. So, it would be explained (after MORTENSEN, 1948) its rarely presence recently in the aquaria, where the water is shallow, unfavorable environment for burying.

The species of **Echinocyamus** found in the Eocene limestone of the island Brac' (Yugoslavia), whithout any other accompagnied Fauna allow us to call this sediment "**Limestone with Echinocyamus**".

The same case occured in the clay sediments Middle Miocene (Badenian) of the basin Korytnica in Poland. According to MACZYNSKA, S.(1977,1979,1988) the sediments plenty of **Echinocyamus** are called "**Lumachelle with Echinocyamus**".

Both these examples, from Yugoslavia and Poland, could be explained as "ecological niches", only favorable for these small Echinoids, in Eocene (Yugoslavia) and Miocene (Poland).

In Greece, such in Eocene sediments, as in Pliocene and Pleistocene ones the species of **Echinocyamus** are present with a rich accompanied Fauna. This fact shows the differenciation of the life conditions among the other basins (Tethys:Greece and Paratethys:Yugoslavia, Poland etc.see also ALI et al.1986).

Echinocyamus pusillus lives today, often in a depth between 35 and 55m (NICHOLS 1959 in MORTENSEN,1948;MACZYNSKA 1977).

MACZYNSKA, S. (1979), describing **Echinocyamus** from NE Poland, considered that the sedimentation took place in a shallow (10-30m) warm sea of normal salinity.

In the Mediterranean basin, a subtropical fauna with affinities from the Atlantic basin is not a rare pheromenon (COTTREAU,1913 p.155). Already, **Echinocyamus**, as well as others Echinoids presents a great extention from Eocene to the Middle Neogene, when the seas were warm (20°C at least). At the terminal Neogene there is a dicrease or disappearance of some species of Echinoids due to the falling of the temperature, from N to S, in the Mediterranean basin. This changment of the temperature results the migration or disappearance of some species.

COTTREAU (1913, p.157) mentioned that **Echinocyamus**, as well as the genera : **Cidaris**, **Dodocidaris**, **Spatangus** and **Brissopsis** would not be used for the paleobathymetrical studies.

Recent **Echinocyamus pusillus** (MULL.) is a neritic species.

REMARKS:

Echinocyamus cannot be a good indicator of the depth, because of its various bathymetric distribution (COTTREAU, 1913) between 20 and 1886 m (KIER, 1966). It occurs, often, in the sediments with more or less fine detritus, in the littoral areas of France.

It is important that the morphology of **Echinocyamus** is of a highly specialization in relation to the adaptation to the environment and the ways of life (MORTENSEN,1948;SZORENYI,1952).

The thin tests of **Echinocyamus** shows a life into the mud, whereas the presence of the interior skeleton (pillars) suggests a great agitation of the water.

The fine spines, whithout differenciation, have a role protective, opposite to the agitation of the water. So, it is believed that **Echinocyamus** is not all the time buried, but sometimes comes from the bottom to the surface of the ground.

VI. LIVING AND FOSSIL SPECIES OF ECHINOCYAMUS OF THE MEDITERRANEAN BASIN

The number exact of the species of the genus **Echinocyamus** of the Mediterranean basin is not well known, during the Eocene-recent time-span.

Eocene	: 11 species (France, COTTREAU, G.1889-1899) 4 species (Yugoslavia, in the present paper) 1 species (Greece, in the present peper)
M.Miocene	: 4 species (Poland, MACZYNSKA, S.1977)
Badenian	: 2 species (Yugoslavia, in the present paper)
Pliocene	: 3 species (Greece, in the present paper)
Plio-Pleistocene	: 3 species (Greece, in the present paper)
Pleistocene	: 3 species (Greece, in the present paper)
Recent	: All over the Mediterranean sea (**E.pusillus** (MULL.)) and E.Atlantic Ocean, Indo-Pacific. It doesn't occur in America waters (MORTENSEN, 1948, p.181). The deepest record for a living specimen is 124m (Red sea).
Note	: The species of **Echinocyamus** of the Tethys and Paratethhys for the Neogene sediments had been recorded by J. MITROVIC'-PETROVIC' and A. MARCOPOULOU-DIACANTONI 1986 (Tethys: 11 species and Paratethys: 4 species).

VII. CONCLUSIONS

1. After a detailed study of a great number of individuals of the genus **Echinocyamus** (Fibulariidae, Clypeastroida) coming from different outcrops of Yugoslavia and Greece from Middle Eocene to the present the following species have been determined :

1.1. **From Yugoslavia :**

-**E.affinis** (DESM.), **E.cambonensis** COTT., **E.pomelli** COTT. and **E.vausseri** COTT. (Sutivan, island Brac' and Dalmatia) in the sediments of Middle Eocene.
-**E.pusillus** (MULL.) and **E.pseudopusillus** COTT. (Serbia) in the Middle Miocene (Badenian) sediments.

1.2. **From Greece :**

-**E.affinis** (DESM.) (Rhiza, unit of Klokova) in the limestone of Upper Lutetian-Early Priabonian.
-**E.pusillus** (MULL.) in the Pliocene (Ag.Marina Aegina, Peleka stro, Agistri) ; in the Plio-Pleistocene (Neapolis-Peloponissos) ; in the Pleistocene (Agistri, Pyrgoussa, Armathia, Karpathos, Crete, Korinthos, Ireon, Rio-Antimio).
-**E.peudopusillus** COTT. in the Pleistocene (Korinthos, Ireon, Pyrgoussa).
-**E.circularis** CAP. in the Pleistocene (Korinthos, Agistri).

2. The species of the genus **Echinocyamus** have been studied from morphological, evolutionary and paleoecological point of view.

No essential modifications from Eocene to the present have been observed in the species of **Echinocyamus** but only some of them, probably due, to the paleoecological conditions.

A probable evolutionary lineage for the studied species has be given.

Echinocyamus can't be used as a good index for the paleobathymetry, but for the paleotemperature.

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ΠΕΡΙΛΗΨΗ - ΣΥΜΠΕΡΑΣΜΑΤΑ

Ι. Μετά από λεπτομερή μελέτη μεγάλου αριθμού ατόμων του γένους **Echinocyamus** (Fibulariidae, Clypeastroida), που προέρχεται από διάφορες περιοχές της Γιουγκοσλαβίας και της Ελλάδας, από το Μ. Ηώκαινο μέχρι σήμερα, προσδιορίσθηκαν τα παρακάτω είδη :

1. **Από την Γιουγκοσλαβία :**
   α. E.affinis (DESM.), **E.cambonensis** COTT., **E.pomeli** COTT. και **E.vausseri** COTT. (Sutivan της νήσου Brac' και Δαλματία) μέσα σε ιζήματα Μέσου Ηώκαινου.
   β. E.pusillus (MULL.) και **E.pseudopusillus** COTT. (Σερβία) μέσα σε ιζήματα Μέσου Μειοκαίνου (Βαδενίου).

2. **Απο την Ελλάδα :**
   α. E.affinis (DESM.) (Ριζα, ενότητα Κλόκοβας) μέσα σε Βιτουμενιούχους ασβεστολίθους Α.Λουτητίου - Κ.Πριαμπονίου.
   β. E.pusillus (MULL.) (Αγ. Μαρίνα Αίγινας, Παλαίκαστρο Λακωνίας, νησίδα Αγκίστρι) μέσα σε Πλειοκαινικά ιζήματα.
   γ. E.pusillus (MULL.) (Νεάπολη Λακωνίας) μέσα σε Πλειο - Πλειστοκαινικά ιζήματα.
   δ. E.pusillus (MULL.) (Αγκίστρι, Πυργούσα, Αρμάθεια, Ρίο - Αντίρριο, Κάρπαθος, Κρήτη, Κόρινθος, Ηραίο) μέσα σε Πλειστοκαινικά ιζήματα.
   ε. E.pseudopusillus COTT. (Κόρινθος, Ηραίο, Πυργούσα) μέσα σε Πλειστοκαινικά ιζήματα.
   στ. E.circularis CAP. (Κόρινθος,Αγκίστρι) μέσα σε Πλειστοκαινικά ιζήματα.

ΙΙ. Μελετήθηκαν τα είδη του γένους **Echinocyamus** από μορφολογική, εξελικτική και παλαιοοικολογική άποψη :
-Επισημάνεηκε ότι συσιώδεις μεταβολές δεν έχουν προκύψει από το Ηώκαινο μέχρι σήμερα. Μικρές μορφολογικές διαφορές παρατηρήθηκαν, που οφείλονται σε οικολογικές συνθήκες.
-Δίνεται η πιθανή εξελικτική σειρά των προσδιορισθέντων ειδών από Ηώκαινο - σήμερα.
-Το γένος **Echinocyamus** δεν είναι καλός δείκτης Παλαιοβαθυμετρίας, μπορεί όμως να χρησιμοποιηθεί για Παλαιοθερμοκρασίες.

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