

*Palaeobiology*

## Evolution Peculiarities of the Caucasian Late Cretaceous – Early Paleocene Echinoidea

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**ABSTRACT.** The Late Cretaceous epoch, together with the Danian age, are considered to be a very significant period in the history of the Earth's geological development. In the seas of that period there dwelled various fauna, including *Echinoidea*. The high level of their evolution is connected to the above-mentioned epoch (especially to its end). Evidently, in the Late Cretaceous-Early Paleocene there were appropriate conditions for the spread of *Echinoidea* in the water area of the Caucasus. Echinoid fauna of that period in the Caucasus is represented by four orders of the so-called "irregularities" - *Holectypoida*, *Cassiduloidea*, *Holasteroidea*, *Spatangoida* the latter two orders being distinguished for their high level of evolution. © 2010 Bull. Georg. Natl. Acad. Sci.

**Key words:** *Echinoidea*, paleobiology, evolution, Late Cretaceous, Early Paleocene.

In the history of the Earth's geological development the Late Cretaceous (about 95-65 million years ago) is considered to be one of the most interesting and significant epochs. It was the epoch of global transgressions when most of the Earth's surface was covered with a shallow epicontinental sea. The world ocean level at that period of time was about 650 m higher in comparison with the contemporary one [1, 2]. Actually, in conditions of general transgression the latitudinal and abyssal thermal zonality was not clearly defined. Besides, the sea water temperature was much higher than at present: at the midlatitudes – by 10°C, at the equator – by 3-5°C, at poles – by 8°C and at the ocean floor – by 8-10°C [3].

In the Late Cretaceous various fauna and flora dwelled in seas - pelagic organisms with chalkstone shells were among them (plankton foraminifers and coccolithophorids). It was these organisms that represented the calcium-carbonate supplying source and this epoch is known by well developed carbonate deposits, especially – by limestone ones (and of chalk -

among them - that is a very typical rock for this epoch) all over the earth.

I believe the thalassocratic nature of the Late Cretaceous greatly facilitated the versatile development of life (marine life in the first place). But at the end of this epoch there took place a vast extinction of bios - probably the most grandiose one among those known in the history of life development on the earth that gave peculiar expression to the end of this epoch.

Echinoid fauna, together with the other fossilized representatives of faunal groups that are widespread in most regions of the earth, is considered to prove the existence of rich and diverse life in the seas of the Late Cretaceous epoch. Caucasus is not an exception. It should be noted that the Late Cretaceous epoch, together with the Danian (the Early Paleocene) age, was the period of high development of echinoid fauna; it was the most important epoch among those that passed before and after the noted epoch.

The Late Cretaceous and Early Paleocene (Danian) *Echinoidea* of the Caucasus belong to the so-called,

“irregularities” (irregular echinoids) and is represented by four orders: *Holectypoida*, *Cassiduloida*, *Holasteroida*, *Spatangoida* (Table 1). Among them – *Cassiduloida* is characterized by discontinuous stratigraphic spread and occurs only in the Cenomanian, Turonian and Maastrichtian deposits. Representatives of the other three orders involve all the stages from Cenomanian to Danian inclusive [4]. In addition to the scanty spread *Cassiduloida* is represented rather modestly, by very few genera (in the Cenomanian – by *Nucleolites* and *Catopygus*, in the Turonian – by *Echinobrissus*, in the Maastrichtian – by *Catopygus* and *Oolopygus*). It should be also noted that the existence of *Cassiduloida* is not distinguished by a variety of species. As to *Holectypoida* in the Cenomanian of the Caucasus, it is represented by six genera: *Coenholectypus*, *Discoides*, *Dixonia*, *Camerogalerus*, *Conulus*, *Globator*. In the Turonian their quantity decreases to three (*Dixonia*, *Conulus*, *Globator*). In the Coniacian it is represented by *Conulus*, in the Santonian – by *Conulus*, *Globator*; in the Campanian – by *Conulus*, in the Maastrichtian – by *Conulus*, *Galerites* and in the Danian – by *Neoglobator*.

In the Late Cretaceous epoch and the Danian age there were especially widespread, so-called, “cordiform Echinoidea” – *Holasteroida* and *Spatangoida*; however, in this case the Campanian, Maastrichtian and Danian ages are mainly meant. It is precisely to these three ages that “the lion’s share” of the representatives of the above mentioned Echinoidea orders falls, while in the ages, preceding the Campanian their number is much fewer. In the Cenomanian of the Caucasus there is known one genus of *Holasteroida* and one of *Spatangoida* (*Holaster* and *Epiaster* respectively). In the Turonian, out of *Holasteroida* there occur: *Sternotaxis*, *Cardiotaxis*, *Echinocorys*, *Infulaster*; while out of *Spatangoida* – *Micraster* and *Hemiaster*. In the Coniacian four genera of *Holasteroida* are known – *Cardiaster*, *Sternotaxis*, *Echinocorys*, *Infulaster*; *Spatangoida* is represented by one genus – *Micraster*. It is noteworthy that in the Coniacian age in the Caucasus there is a kind of downfall in the Echinoidea evolution – only 10 species of 6 genera are known and *Holectypoida* and *Spatangoida* are represented only by one genus for each of them, while *Cassiduloida* does not occur at all. In the Santonian *Holasteroida* and *Spatangoida* are represented by three genera for each, so out of *Holasteroida* there occur: *Cardiotaxis*, *Echinocorys*, *Paronaster*; while out of *Spatangoida* – *Micraster*, *Isomicraster*, *Hemiaster*. In the Campanian there are known eight genera for each of the above-mentioned orders; so out of *Holasteroida* there occur:

*Echinocorys*, *Galeola*, *Offaster*, *Paronaster*, *Stegaster*, *Seunaster*, *Guettaria*, *Pseudoffaster*, while out of *Spatangoida* – *Micraster*, *Isomicraster*, *Ovulaster*, *Cyclaster*, *Hemiaster*, *Coraster*, *Orthaster*, *Turanglaster*. The Maastrichtian is especially rich in cordiform Echinoidea. In the deposits of this age there occur nine genera of *Holasteroida* (*Cardiaster*, *Echinocorys*, *Offaster*, *Hemipneustes*, *Stegaster*, *Seunaster*, *Guettaria*, *Pseudoffaster*, *Galeaster*) and six genera of *Spatangoida* (*Micraster*, *Cyclaster*, *Coraster*, *Orthaster*, *Homoeaster*, *Isomicraster*). As for the Danian, in this period the Caucasian seas were inhabited by representatives of six genera of *Holasteroida* (*Echinocorys*, *Ieronia*, *Galeaster*, *Basseaster*, *Garumnaster*, *Pseudogibbaster*) and six – of *Spatangoida* (*Cyclaster*, *Isopneustes*, *Hemiaster*, *Coraster*, *Orthaster*, *Homoeaster*). It must be noted that Maastrichtian clearly differs from the above-mentioned ages by great variety of the species composition.

The vertical (age-related) dynamics of the Late Cretaceous and Early Paleocene (Danian) echinoid fauna in the Caucasus shows that in the Maastrichtian it reaches the maximum of its development. Factually the same takes place all over the earth [5]. Besides, it is noteworthy that 6 among the 13 known genera of Echinoidea at the Danian stage in the Caucasus, appear just in the Danian age and only 6 out of 19 genera possibly cross the boundary between the Maastrichtian and Danian. This fact undoubtedly points to the vast extinction of organisms that took place at the above-mentioned boundary all over the planet [6].

All the foregoing material seems to show distinctly that during the whole Late Cretaceous epoch and the Danian age there were quite appropriate conditions for the existence and spread of Echinoidea in the water areas of the Caucasus. It may be said especially about the Campanian, Maastrichtian and Danian ages and out of echinoid fauna – about *Holasteroida* and *Spatangoida*. In my view, this significant fact has its explanation. It is known that at the beginning of the Campanian there developed the global transgression of meridional direction that apparently brought warm water to the Caucasian seas from southern latitudes (the ocean Tethys is meant) which in its turn favored carbonate sedimentation. It will be recalled that factually the whole Upper Cretaceous and Danian, especially the Campanian-Maastrichtian-Danian stages are represented by carbonate strata. Carbonate sedimentation in the above mentioned epoch was also much facilitated by the rapid spread (so-called “plankton explosion”) of plankton limestone algae (coccolithophorids) and

Table 1.

Stratigraphical distribution of the Caucasian Late Cretaceous-Early Paleocene Echinoidea

Order	Genus	Cenom.	Tur.	Con.	Sant.	Camp.	Maast.	Danian.
Holectypoida	Coenholectipus Desor	++++						
	Discoides Leske	++++						
	Dixonia Wagner et Durham	++++	++++					
	Camerogalerus Quenstedt	++++						
	Conulus Leske	++++	++++	++++	++++	++++	++++	
	Globator Agassiz	++++	++++	----	++++			
	Neoglobator Endelman							++++
Cassiduloida	Galerites Lamarck						++++	
	Nucleolites Lamarck	++++						
	Echinobrissus Braynius		++++					
	Catopygus Agassiz	++++					++++	
Holasteroida	Oolopygus d'Orbigny						++++	
	Holaster Agassiz	++++						
	Sternotaxis Lambert		++++					
	Cardiaster Forbes			++++	----	----	++++	
	Cardiotaxis Lambert		++++	++++	++++			
	Echinocorys Leske		++++	++++	++++	++++	++++	++++
	Ieronia Seunes							++++
	Galeola Leske					++++		
	Offaster Desor					++++	++++	
	Hemipneustes Agassiz						++++	
	Paronaster Airaghi				++++	++++		
	Stegaster Pomel					++++	++++	
	Seunaster Lambert					++++	++++	
	Guettaria Gauthier					++++	++++	
	Pseudoffaster Lambert					++++	++++	
	Spatangoida	Infulaster Desor		++++	++++			
Galeaster Seunes							++++	++++
Basseaster Lambert								++++
Garumnaster Lambert								++++
Micraster Agassiz			++++	++++	++++	++++	++++	
Isomicraster Lambert					++++	++++	++++	
Epiaster d'Orbigny		++++						
Pseudogibbaster Moskvina								++++
Ovulaster Cotteau						++++		
Cyclaster Cotteau						++++	++++	++++
Isopneustes Pomel								++++
Hemiaster Desor			++++	----	++++	++++	----	++++
Coraster Cotteau						++++	++++	++++
Orthaster Moskvina					++++	++++	++++	
Homoeaster Pomel						++++	++++	
Turanglaster Solov. et Mel.					++++			

unicellular animals (plankton foraminifera). It is assumed that the sea-bottom, covered with fine carbonate silt, represented the best living condition for *Echinoidea*; in the first place this refers to *Holasteroida* and *Spatangoida* here, for it is representatives of these groups that are considered to be lovers of carbonate silt ground. Accordingly the wide development of such kind of sea-bottom conditioned the rapid evolution of *Holasteroida* and *Spatangoida*. Besides, it should be noted that the representatives of these groups dwelled

not only on the surface of the silt ground (epifauna) but within it too (infauna). As for *Cassiduloida* and, to some extent, *Holectypoida*, they liked comparatively coarse, sandy bottom and mostly occur in the Cenomanian and rarely in Turonian and Maastrichtian terrigenous or terrigenous-carbonate facies.

Thus, during this long geological time-interval the Late Cretaceous-Early Paleocene Echinoidea has undergone progressive evolution, attaining culmination in the Maastrichtian age.

პალეობიოლოგია

## კავკასიის გვიანცარცულ-ადრეპალეოცენური ექინოიდების ევოლუციური თავისებურებანი

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(წარმოდგენილია აკადემიის წევრის მ. კაკაბაძის მიერ)

ნაშრომში განხილულია საკითხი კავკასიის გვიანცარცულ-ადრეპალეოცენური (დანიური) ექინოიდების ევოლუციური განვითარების შესახებ.

კავკასიის გვიანცარცულ-ადრეპალეოცენური ექინოიდები წარმოდგენილია 4 რიგით — *Holactypoida*, *Cassiduloida*, *Holasteroida*, *Spatangoida*, რომლებიც მოიცავენ ყველა სართულს სენომანურიდან დანიურის ჩათვლით. ამ ფაუნის ასაკობრივი დინამიკა გვიჩვენებს, რომ მათი განვითარების მაქსიმუმი მასტრიხტულ საუკუნეზე მოდის. ფაქტობრივად, ასეთივე სურათი გვაქვს პლანეტარული მასშტაბითაც. მასალის ანალიზი საშუალებას იძლევა დავასკვნათ, რომ კავკასიის აკვატორიაში ექინოფაუნის განვითარებისათვის კარგი პირობები იყო კამპანურ, მასტრიხტულ და დანიურ საუკუნეებში. ვფიქრობ, რომ ეს განაპირობა კამპანურ საუკუნეში დაწყებულმა მერიდიონალურმა გლობალურმა ტრანსგრესიამ, რომელმაც სამხრული განედებიდან (იგულისხმება ოკეანე ტეთისი) კავკასიის ზღვებში თბილი წყალი მოიტანა. ექინოიდები კი, როგორც ცნობილია, თბილი ზღვების ბინადარნი არიან.

## REFERENCES

1. *I.M. Hancock, E.G. Kauffman* (1979), *J. Geol. Soc.*, **136**: 175-186.
2. *I.M. Hancock* (1990), *Proc. Geol. Ass.*, **100**(4): 565-594.
3. *R.W. Fairbridge* (1970), In: *Carbonatnye porody*, I: 357-386, M. (in Russian).
4. *G. Gongadze* (1994), In: *Materialy IV Resp. Konf.*, Tbilisi: 131-132 (in Russian).
5. *M.M. Moskvina, A.N. Solovyov, L.G. Endelman* (1980), In: *Razvitie i smena bespozvonochnykh na rubezhe mezozoya i kainozoya*, 116-117, M. (in Russian).
6. *G. Gongadze* (1996), *Bull. Georg. Acad. Sci.*, **154**, 3: 388-390.

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