



CRINOIDS, ASTEROIDS AND OPHIUROIDS IN RELATION TO THE BOUNDARY

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Fossil echinoderms were given considerable importance by Desor (1847) among his arguments for establishing the Danian as the uppermost stage of the Cretaceous System. They have continued to be emphasized during later discussions on the Cretaceous/Tertiary boundary and the affinities of the Danian. According to Nielsen (1919), the crinoid *Cyathidium holopus*, together with the Stylasterida, formed a modern element not belonging to a Mesozoic fauna. On the other hand, Ravn (1925) considered the Danian echinoderms to form a distinctly Cretaceous element of the fauna.

Today such argument will hardly be considered relevant, and there is no accepted codex on the fixation or change of a stratigraphic boundary. But we may still ask: How is the Cretaceous/Tertiary boundary reflected in the evolution and distribution of echinoderms? This question may be illustrated by Table 1-3, showing the fossil record of all genera of crinoids, asteroids and ophiuroids found in the Maastrichtian, Danian and Paleogene as well as genera presumed to have been there since they are recorded on both sides of this interval.

When the genera of crinoids and asteroids are considered (Table 1-2), it is quite obvious that the Maastrichtian/Danian boundary is of minor influence to this echinoderm fauna. The echinoderms form a very common faunal element on both sides of this boundary, and virtually all genera found in the Maastrichtian are represented by closely allied species in the Danian. On the other hand the Danian/Selandian boundary is distinctly reflected in the evolution and distribution of these echinoderms. The rich fauna of echinoderms is abruptly terminated at the Danian/Selandian boundary, not only in northern Europe, but universally. There are a few, uncertain survivors in the Selandian of Denmark, but they may well be redeposited Danian specimens. A unique locality where several Danian survivors, including some echinoderms, are found is the Vincentown formation in New Jersey, which has been

Table 1						
Crinoid genera						
xx = present						
pp = presumed						
vv = only Vincentown						
	Pre-Maastr.	Maastrichtian	Danian	Paleogene	Neogene	Recent
<i>Austinocrinus</i>	xx	xx				
<i>Jaekelometra</i>	xx	xx	xx			
<i>Amphorometra</i>	xx	xx	xx			
<i>Placometra</i>	xx	xx	xx			
<i>Nielsenicrinus</i>	xx	xx	xx	pp		
<i>Semiometra</i>	xx	xx	pp	xx		
<i>Bourgueticrinus</i>	xx	xx	xx	vv		
<i>Cyathidium</i>	xx	xx	xx	pp	xx	xx
<i>Chladocrinus</i>	xx	pp	pp	xx	pp	xx
<i>Isocrinus</i>	xx					xx
<i>Monachocrinus</i>	pp	xx	xx	pp	pp	xx
<i>Dunnicrinus</i>		xx				
<i>Doreckicrinus</i>		xx	xx			
<i>Isselicrinus</i>		xx	xx	xx	xx	
<i>Hertha</i>		xx	xx	pp	xx	
<i>Democrinus</i>		xx	xx	xx	pp	xx
<i>Metacrinus</i>		pp	pp	xx	pp	xx
<i>Bruennichometra</i>			xx			
<i>Bathycrinus</i>			xx	pp	pp	xx
<i>Cainocrinus</i>				xx		
<i>Vicetiametra</i>				xx		
<i>Microcrinus</i>				xx		
<i>Conocrinus</i>				xx	xx	
<i>Discometra</i>				xx	xx	
<i>Conometra</i>				xx	xx	
<i>Palaeantodon</i>				xx	xx	
<i>Himerometra</i>				xx	pp	xx
<i>Nemaster</i>				xx	pp	xx

Table 2						
Asteroid genera						
xx = present						
pp = presumed						
vv = only Vincentown						
	Pre-Maastr.	Maastrichtian	Danian	Paleogene	Neogene	Recent
<i>Arthraster</i>	xx	xx				
<i>Metopaster</i>	xx	xx	xx			
<i>Aspidaster</i>	xx	xx	xx			
<i>Chomataster</i>	xx	xx	xx			
<i>Valettaster</i>	xx	xx	xx			
<i>Stauranderaster</i>	xx	xx	xx	xx		
<i>Coulonia</i>	xx	pp	pp	xx		
<i>Lophidiaster</i>	xx	xx	xx	xx	xx	
<i>Pycinaster</i>	xx	xx	xx	xx	xx	
<i>Ophryaster</i>	xx	xx	pp	pp	xx	
<i>Teichaster</i>	xx	xx	xx	xx	xx	
<i>Astropecten</i>	xx	xx	xx	xx	xx	xx
<i>Calliderma</i>	xx	pp	pp	xx	pp	xx
<i>Hippasteria</i>	xx	pp	pp	xx	pp	xx
<i>Paragonaster</i>	xx	pp	pp	pp	xx	xx
<i>Henricia</i>	xx	pp	pp	pp	pp	xx
<i>Sphaerodiscus</i>	xx	pp	pp	pp	pp	xx
<i>Linckia</i>	xx	pp	pp	pp	pp	xx
<i>Solaster</i>	xx	pp	pp	pp	pp	xx
<i>Odontaster</i>	xx	pp	pp	pp	pp	xx
<i>Asterias</i>	xx	pp	pp	pp	pp	xx
<i>Benthopecten</i>	pp	pp	pp	pp	pp	xx
<i>Recurvaster</i>		xx	xx	vv		
<i>Ceramaster</i>		xx	xx	xx	pp	xx
<i>Pseudarchaster</i>				xx	xx	xx
<i>Echinaster</i>				xx	pp	xx

Table 4								
Crinoid species in Denmark								
xx = present in Denmark								
?? = uncertain or redeposited								
oo = not in Denmark								
	Pre-Maastr.	Lower Maastr.	Upper Maastr.	Lower Danian	Middle Danian	Upper Danian	Post-Danian	
<i>Austinocrinus bicoronatus</i>	x	x						
<i>Bourgueticrinus brydonei</i>	oo		xx					
<i>Democrinus dubius</i>	xx		xx					
<i>Placometra laticirra</i>	oo	oo	-	xx		xx		
<i>Nielsenicrinus agassizii</i>		xx						
<i>Bourgueticrinus tenuis</i>		xx						
<i>Hertha pygmaea</i>		xx						
<i>Issellicrinus buchii</i>		xx	xx					
<i>Issellicrinus stelliferus</i>		xx	xx					
<i>Isocrinus lanceolatus</i>		xx	xx					
<i>Bourgueticrinus constrictus</i>		xx	xx					
<i>Bourgueticrinus hagenowi</i>		xx	xx					
<i>Amphorometra conoidea</i>		xx	xx					
<i>Hertha plana</i>		xx	xx	xx	xx	xx		
<i>Hertha mystica</i>		xx		xx	xx	xx		
<i>Democrinus gisleni</i>		xx	xx			xx		
<i>Bourgueticrinus bruennichinielsenii</i>		xx	xx	xx		xx	oo	
<i>Nielsenicrinus rosenkrantzi</i>			xx					
<i>Monachocrinus regnelli</i>			xx	xx	xx	xx		
<i>Cyathidium holopus</i>			oo		xx		oo	
<i>Dorockicrinus miliaris</i>				xx				
<i>Bruennichometra parvicava</i>				xx				
<i>Doreckicrinus convexus</i>				xx	xx	xx		
<i>Nielsenicrinus fionicus</i>				xx	xx	xx		
<i>Isocrinus divergens</i>				xx	xx	xx		
<i>Isocrinus echinatus</i>				xx	xx	xx		
<i>Amphorometra semiglobularis</i>				xx	xx	xx		
<i>Isocrinus campanularis</i>				xx		xx		
<i>Bathycrinus windi</i>				xx		xx		
<i>Issellicrinus paucicirrhous</i>				xx	xx	xx	??	
<i>Bourgueticrinus danicus</i>				xx	xx	xx	??	
<i>Democrinus maximus</i>				xx	xx	xx	??	
<i>Jaekelometra faxensis</i>					xx			
<i>Bruennichometra danica</i>					xx			
<i>Amphorometra bruennichi</i>					xx	xx		
<i>Bruennichometra granulata</i>					xx	xx		
<i>Isocrinus longus</i>						xx		
<i>Nielsenicrinus obsoletus</i>						xx	??	

Table 5		Asteroid species in Denmark					
xx = present in Denmark ?? = uncertain or redeposited oo = not in Denmark							
		Pre-Maastr.	Lower Maastr.	Upper Maastr.	Lower Danian	Middle Danian	Upper Danian
<i>Metopaster tumidus</i>		xx					
<i>Chomataster spenceri</i>		xx					
<i>Ophryaster magnus</i>		xx					
<i>Pycinaster rasmusseni</i>		xx					
<i>Metopaster undulatus</i>		xx	xx				
<i>Recurvaster radiatus</i>		xx	xx				
<i>Teichaster favosus</i>		xx	xx				
<i>Chomataster wrighti</i>		xx	xx				
<i>Stauranderaster mixtus</i>		xx	xx				
<i>Lophidiaster pygmaeus</i>		xx	xx				
<i>Chomataster acules</i>		xx	xx		xx	xx	xx
<i>Valettaster ocellatus</i>		xx	xx		xx	xx	xx
<i>Metopaster poulsenii</i>				xx			
<i>Metopaster laevis</i>				xx			
<i>Pycinaster crassus</i>				xx			
<i>Metopaster kagstrupensis</i>					xx		
<i>Metopaster spenceri</i>					xx		
<i>Teichaster anchylus</i>					xx		
<i>Stauranderaster pyramidalis</i>					xx	xx	
<i>Metopaster planus</i>					xx	xx	xx
<i>Stauranderaster miliaris</i>					xx	xx	xx
<i>Stauranderaster speculum</i>					xx	xx	xx
<i>Lophidiaster punctatus</i>					xx	xx	xx
<i>Valettaster granulatus</i>					xx	xx	xx
<i>Recurvaster mammilatus</i>					xx	xx	xx
<i>Metopaster elevatus</i>						xx	
<i>Metopaster maculatus</i>						xx	
<i>Ceramaster granulatus</i>						xx	
<i>Teichaster retiformis</i>						xx	xx
<i>Pycinaster danicus</i>						xx	xx
<i>Pycinaster cornutus</i>							xx
<i>Metopaster carinatus</i>							xx
<i>Ceramaster dividius</i>							xx
<i>Pycinaster rosenkrantzi</i>							xx
<i>Astropecten postornatus</i>							xx
							oo

Table 6						
Ophiuroid species in Denmark						
xx = present in Denmark ?? = uncertain or redeposited oo = not in Denmark						
	Pre-Maastr.	Lower Maastr.	Upper Maastr.	Lower Danian	Middle Danian	Upper Danian
<i>Ophiura substriata</i>		xx				
<i>Ophiomusium subcylindricum</i>		xx	xx			
<i>Asteronyx ornatus</i>		xx	xx			
<i>Ophiura hagenowi</i>		xx	xx	xx		
<i>Ophiura serrata</i>		xx	xx	xx	xx	xx
<i>Ophiacantha danica</i>		xx		xx	xx	xx
<i>Amphiura senonensis</i>		xx	xx	xx		xx
<i>Ophiomusium danicum</i>					xx	oo

Echinoderms have been used as index fossils in the biostratigraphic subdivision of the Danian, and to some degree in the Maastrichtian. (Nielsen, 1937; Rosenkrantz, 1937; Rasmussen, 1950, 1961, 1965). They are common fossils in almost all facies and localities of the Maastrichtian and Danian in Denmark and this, combined with their restricted stratigraphic distribution and easy distinction, makes them useful in a subdivision of the Maastrichtian in two biozones and the Danian in three or four biozones. Table 4-6 show the fossil record of all species of crinoids, asteroids and ophiuroids found in the Maastrichtian and Danian of Denmark, arranged according to their first appearance.