CHANGES IN THE HINGE TEETH OF ARCACEANS FROM DEVONIAN TO RECENT

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ABSTRACT

The arcaceans first appeared during the middle Devonian Givetian Stage. Major diversification of this superfamily began in the Jurassic and has continued throughout the Cretaceous and Cenozoic. The hinge teeth have decreased in size and increased in number from Devonian to Recent.

The first pelecypods that appear to be true arcaceans occur in the middle Devonian Givetian Stage. Although many paleontologists have said that the cyrtodonts were the ancestors of the arcaceans, I agree with Morris (1967, p. 474), who said that this is not firmly established.

The type of hinge teeth possessed by arcaceans can be placed in three categories. The first group includes species with elongate teeth on either the posterior end or at both posterior and anterior ends of the dorsal border, which are parallel or nearly parallel to the dorsal border (Fig. 1a). These may be referred to as cucullaeid-type teeth. The side teeth may be long and few in elongate shells and shorter and more numerous in shells that are nearly as high as they are long. The second includes species with thick shells and very large side teeth that slope away from the dorsal border, which may be referred to as pseudocucullaeid-type teeth (Fig. 1b). Pseudocucullaeid-type teeth occur in shells that are squarish or rounded in outline. The third includes species with numerous small teeth throughout the hinge plate. These are true arcid-type teeth (Fig. 1c). Cucullaeid-type teeth undoubtedly gave rise to both pseudocucullaeid- and arcid-type teeth. Table 1 shows the ranges of genera and subgenera with these three types of teeth (data taken from Newell, 1969, p. N250-N269, and from many faunal monographs on fossil pelecypods).

The Paleozoic arcaceans have some variability in valve outline, ornamentation, and position of the beaks. The valve outline is commonly rectangular, resembling *Arca*, but a few species are almost as high as long and resemble *Cucullaea*. The beaks are commonly located toward the anterior end; in a few instances the beaks are located at or near the anterior end, giving the shell a mytiloid outline. Ornamentation may be lacking or may consist of concentric or radial ribs. There are always elongate posterior side teeth parallel to the

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Table 1. Geologic distribution of genera and subgenera of arcaceans with cucullaeid-type teeth (C), pseudocucullaeid-type teeth (P), and arcid-type teeth (A).

Geologic Period	No. of Genera and Subgenera		
	C	P	A
Neogene	2		48
Paleogene	3		29
Cretaceous	7	3	20
Jurassic	7		3
Triassic	3		1
Permian	1		
Pennsylvanian	2		
Mississippian	1		
Devonian	1		

dorsal margin, and sometimes there are also elongate anterior side teeth (Fig. 1a). Most Paleozoic arcaceans have been allocated to *Parallelodon* or *Grammatodon* and all of them appear to have been byssally attached to the substrate.

The Triassic arcaceans show little more variations than their Paleozoic ancestors (Table 1), but beginning in the Jurassic some stocks have a reduction of the size of the teeth and an increase in their number, resembling modern *Anadara, Noetia,* and *Glycymeris.* However, stocks having hinge teeth like *Parallelodon* and *Cucullaea* also proliferate in the Jurassic. The radiation of the arcaceans increases greatly in the Cretaceous. With the rise of the glycymeridids (Nicol, 1950a, p. 97), the limopsids (Oliver, 1981, p. 71), the Noetiinae (Newell, 1969, p. N261), and the Striarcinae (Newell, 1969, p. N263), there was a great increase in the number of genera and species of arcaceans having smaller teeth. Some short-lived stocks, such as *Arcullaea, Peruarca, Pettersia, Protarca,* and *Trigonarca,* also have a reduction in the size of the side teeth during the Cretaceous, and the hinge teeth of these groups of Cretaceous arcaceans take on a modern appearance. All of these aforementioned groups have a squarish or rounded outline. However, the cucullaeid-type of hinge teeth were still common, as is seen in such genera as *Idonearca* and *Nemodon.* There was an extreme development of the side teeth in three short-lived Cretaceous genera: *Dicranodonta, Lopatinia,* and *Pseudocullaea* (Fig. 1b). *Pseudocucullaea,* in particular, had a large thick shell and many side teeth that sloped away from the dorsal margin towards the ventral margin. This genus had a geographic distribution that included West Africa, northern South America, and the Caribbean. None of these three genera with greatly developed side teeth survived the Cretaceous Period. The arcaceans suffered a considerable amount of extinction near the end of the Cretaceous, when no less than 15 genera and subgenera disappeared. The casualties included arcaceans with large side teeth and those with small numerous teeth. Most of the genera and subgenera that became extinct at the end of the Cretaceous were short lived, but a few had geologic ranges that included Jurassic and older geologic periods.

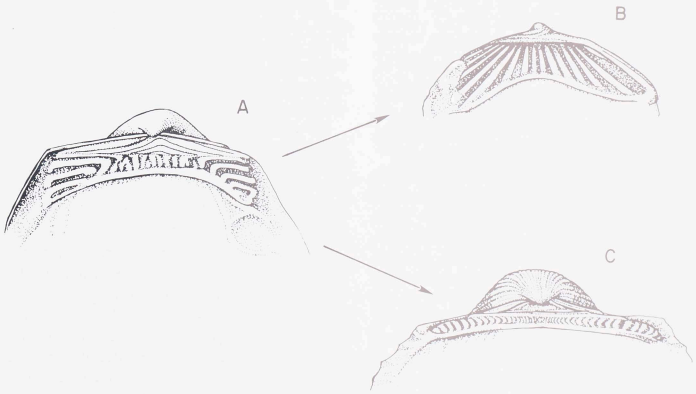

Figure 1. The three types of hinge teeth seen in fossil and living arcaceans: A, cucullaeid; B, pseudocucullaeid; C, arcid.

The genera of arcaceans with elongate side teeth in the Cenozoic are few in number, and these genera have few species. The living species of *Cucullaea,* which is an Indo-Pacific relict, has the side teeth and the hinge plate reduced in size (Nicol, 1950b, p. 339). However, Paleogene and Cretaceous cucullaeids have much larger side teeth and a massive hinge plate. The ventral border of living *Cucullaea* has fine crenulations, and many species of fossil cucullaeids had well developed denticulate margins. In living *Arca* the hinge teeth are reduced to fine crenulations. The most extreme example of reduction of hinge teeth is seen in the glycymeridid genus *Grandaxinaea.* This genus, which is confined to Australia and New Zealand, lacks teeth in large specimens (Nicol, 1950a, pl. 20, fig. 8), but the ligamental area is unusually high and large.

The question arises why the arcaceans have reduced the size of the teeth and increased their number from the inception of this superfamily in the Middle Devonian to the Recent. Thomas (1978, p. 335) has noted that the arcaceans do not have a strong ligament. A few large teeth would seem to be a more effective locking device than many small teeth, and it would seem that a strong locking device for the valves would have an adaptive advantage. This reduction of the size of the teeth occurs in both byssate and shallow-burrowing species, and it also occurs in elongate as well as square or rounded shells. Most byssate species lack crenulations on the ventral margin and most burrowing forms have them, but there are many exceptions. It is not apparent that crenulations on the ventral border replaced the large hinge teeth seen in Paleozoic and Mesozoic arcaceans. Another possible device for keeping the valves of some arcaceans in alignment is that the left valve overlaps the right valve along the ventral margin, as is seen in some cucullaeids and anadarines (Nicol, 1958, p. 62). The inequivalve condition is sometimes accompanied by different ornamentation on the two valves. Anadarines with inequivalved shells tend to have squarish outlines and comparatively thin shells. Perhaps the ligament has become larger and more efficient in most Cretaceous and Cenozoic species, and this structure has helped to keep the valves in proper alignment.

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