COILING IN SCAPHOPODA

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The author has formerly investigated the nature and causes of coiling and uncoiling of shells in some groups of Ammonites, Brachiopods and Foraminifera. Here the coiling of the tusk shells or scaphopods reported in the geology of India and adjoining countries has been studied. Shells from Permian to recent show coiling from straight to highly curved and intermediate forms.

The author has observed that these coilings do not bear any evolutionary significance as they do not follow a trend, neither different workers on these fossils have attributed any specific importance to the coiling of scaphopods.

The geological history of scaphopoda is as follows in India, Burma and Pakistan:

Antale sp. ind. Diener (1911), no figure given; *locality*—Southern Shan States, Burma; *age*—Fusulina Limestone, Permian.

Dentalium sp. Reed (1927), Fig. 4, Pl. 20, transverse section only; *locality*—Yun-nan, Burma; *age*—Lower Permian (Artinskian).

Plagioglypta herculea Konninck *sp. in* Waagen (1880), Figs. 1, 2, 3, Pl. XVI; *locality*—Salt Range, Pakistan; *age*—Middle Productus Limestone (Middle Permian).

Plagioglypta cf. prisca Münst. Reed (1925), no figure given; *locality*—Yarkhun valley, Chitral, Gilgit and the Pamirs; *age*—Lower Permian.

Dentalium sp. M. Healey (1908), Figs. 60 and 61, Pl. IX; *locality*—Napeng Beds, Burma; *age*—Upper Trias to Rhaetic.

Antale glabratum Stoliczka (1868), Figs. 24, 25, Pl. 27; *locality*—Utatur, South India; *age*—Uppermost Albian to Upper Cenomanian.

Dentalium crassulum Stoliczka (1868), Fig. 21, Pl. 27; *locality*—Trichinopoly, South India; *age*—Uppermost Albian to Upper Cenomanian.

Antale arcotinum Forbes *sp. in* Stoliczka (1868), Fig. 23, Pl. 27; *locality*—Trichinopoly, South India; *age*—Valudayur group (Lower Campanian).

Fustiaria parvula Stoliczka (1868), Fig. 22, Pl. 27; *locality*—Pondicherry, South India; *age*—Valudayur group (Lower Campanian).

Dentalium hanguense Cox (1930), Figs. 12 and 13, Pl. 21, from Hangu Shale of Palaeocene and Eocene of Sind, Pakistan.

Dentalium vredenburgi Cossmann and Pissarro (1909), Fig. 23, Pl. III, from Jhirak of Uppermost Ranikot (Landedian) of Pakistan.

Dentalium junghuhni K. Martin *in* Cotter (1938), no figure given, from Sinju stage of Burma, Oligocene, from Surma series of India (Lower Miocene), from Kama and Padaung stages of Burma (Oligocene-Miocene).

Actually it is not the intention here to establish the geological history of scaphopods in India and adjoining countries but to investigate if the role of coiling in scaphopods was in any way governed by its evolutionary effects. It has been observed, to the contrary, that all degrees of forms, for example, straight, highly curved and intermediate shells showing different degrees of curvatures, occur haphazardly in different geological horizons and these uncoiled and coiled forms of scaphopods do not obey any systematic trend.

Coming to recent forms, we have both straight as well as highly curved shells as the two extremes and then many forms of intermediate degrees of curvature. For example, amongst the recent Japanese shells, *Dentalium* (*Fissidentalium*) *hungerfordi* Pilsbry and Sharp, Fig. 2, Pl. 127, reported by Shintaro Hirase (1936), is a perfect straight shell, where the length of the shell is 78 mm and the diameter is 6 mm. From Japan, an example of highly curved shell is *Dentalium* (*Dentalium*) *hexagonum* Gould, which has a length of 60 mm and a diameter of 5·8 mm.

Amongst the geological forms, *Dentalium hanguense* Cox, Figs. 12 and 13, Pl. XXI, shows straight shells, which is of Palaeocene and Eocene Age. In further older forms, *Plagioglypta herculea* Konninck *sp. in* Waagen, Fig. 1, Pl. XVI, is a tall and little curved shell, showing a nice reconstruction, where the degree of coiling has been measured by the method explained later, as 16 degrees.

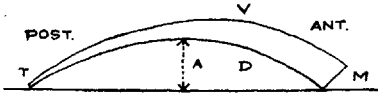

FIG. 1. Scaphopod shell characters. M = aperture, T = apex, V = ventral, D = dorsal, Post. = posterior, Ant. = anterior, A = arc.

The forms figured by Stoliczka from the Upper Cretaceous of South India show from straight to curved shells. *Dentalium crassulum* Stoliczka is a perfectly straight shell. *Fustiaria parvula* Stoliczka exhibits a curvature of 23 to 25 degrees.

Antale arcotinum Forbes *sp. in* Stoliczka shows the degree of coiling 37 degrees and *Antale glabratum* Stoliczka (Fig. 25) shows the curvature of 42 degrees.

The measurement of the 'arc' of a *dentalium* shell is as shown above and it is a measure of curvature determined by the distance in millimetres from a line connecting the apex and the aperture to the highest point above it in the dorsal or concave arch of the shell. By this method, if the aperture or the apex of the shell is broken or is not perfectly preserved, the measurement of the true *arc* of the shell will vary as the vertical height of the curve will get reduced.

The degree of curvature of *Fustiaria parvula* Stoliczka and *Antale glabratum* Stoliczka has been measured as follows: ABC is tangent to the ventral surface of the shell. Line at D on the dorsal surface of the shell is parallel to ABC. Angle ABDD^1 gives the required angle.

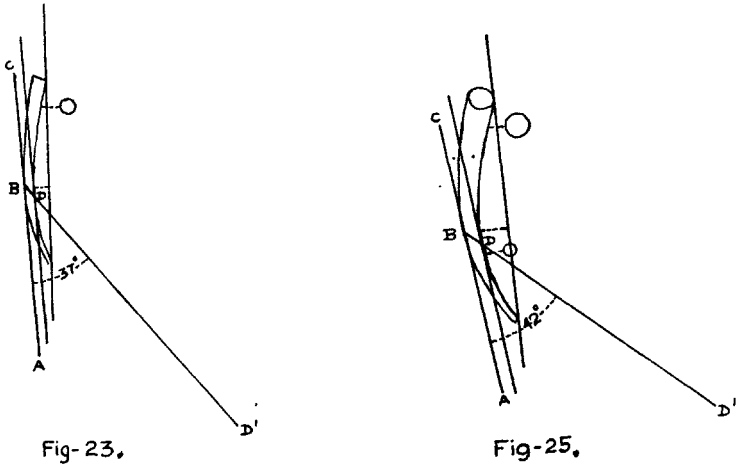

FIG. 2. Dentalium shells showing the measurement of the angle of curvature and the arc. *Antale arcotinum* Forbes *sp. in* Stoliczka. (Pl. 27, fig. 23. Lower Campanian. *Antale glabratum* Stoliczka. Pl. 27, fig. 25. Uppermost Albian to Upper Cenomanian.)

Dentaliums known better as tusk shells are degenerate gastropods which burrow obliquely in the sandy or muddy sea bottom from 5–100 fathoms shallow to very deep water. They burrow through the aperture which is the broad end of the shell and through the apex which is the narrow end, waste and genital products are ejected projecting into the water.

The variation in coiling which has been observed here to the maximum of 42 degrees in the fossil forms reported from India, Burma and Pakistan starting from uncoiled dentaliums, I think, should be attributed to different ecological conditions in the sea bottom. So far as I have observed, the outer ornamentation has been given more importance by different workers for specific or generic determinations than on the degrees of coiling or coiled or uncoiled nature of the shells. Stoliczka has appended a survey of the reported fossil as well as recent scaphopoda from different countries in his monograph

of Cretaceous gastropoda of Southern India, where he has not touched on the cause of coiling.

An interesting question which has arrested my attention is that what would be the maximum curvature shown by a tusk shell. The Monograph of the East-North American scaphopod mollusks by Henderson (1920), which was readily available in the GSI Library, was consulted very carefully for tracing out the maximum curved shells reported. In the monograph, the following two forms exhibit the maximum degrees of curvatures: *Dentalium laqueatum laqueatum* Verrill and *Entalina quadrata* Henderson. In each of these cases the degrees of curvatures are 45 degrees which have been termed in the latter case by the author as 'strongly curved'. So far as my present report goes the degrees of curvatures vary from 0 to 45 degrees, which is no doubt a tendency towards coiling and, from the surveys made, I am not yet in a position to guess whether the coiling is incipient or vestigial.

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