

**Some Gastropods from the Trichinopoly Group  
Tamil Nadu, India and their Relation to those  
from the American Gulf Coast**

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**Abstract**

37 species of gastropods from the Trichinopoly Group in the Ariyalur area of Tamil Nadu, southern India are re-evaluated and, in part, newly described. They are compared with members of other faunas that lived in the Late Cretaceous, especially that of the American Gulf Coast. Many of the Indian species from Coniacian and Santonian times have close relation with those which lived in the Cretaceous Gulf of Mexico (near the northern shore of the mid-Atlantic Tethys Ocean) at Late Campanian-Maastrichtian time. The others have relation to those of various regions like California, South Africa and Europe, but these do not appear to be closer than the American connections. *Astraea siranattamensis*, *Crommium siranattami*, *Lirpsa garudamangalami*, *Profusinus indicus*, *Gyrodes garudamangalami*, *Bellifusus indicus* and *Lemnicolittorina kuthurensis* represent new or newly defined species, and the genera *Profusinus* and *Trichifusus* are newly erected.

**Keywords:** Gastropods, Taxonomy, Trichinopoly Group, Coniacian - Santonian, Palaeoecology, American Gulf Coast.

**INTRODUCTION**

Stephenson (1941) stated that although quite a number of genera are common to the Cretaceous System of the Cauvery basin in southern India and the Gulf Coast area of the USA, there are no species in common to both the localities. The fauna in general were considered not very closely related. The only exception was seen in *Strombus unctatus* from near Ariyalur and *Pugnellus densatus* from the Gulf Coast. Sohl (1964) also suggested that the gastropod fauna of southern India had neither generic nor specific relation to the Gulf Coast fauna. But he also stated that the proportional representation by families found within them is similar.

Newly collected gastropods from the area west of Ariyalur in the Tiruchirapalli district of Tamil Nadu are here compared with the species from Mississippi and Tennessee, and in addition to those from the Umzamba Formation of South Africa. Due to the availability of this new material, a more

detailed study can be undertaken rather than merely comparing with descriptions and illustrations presented by Stoliczka (1868), even though his illustrations are very useful. The comparisons made demonstrate that the Coniacian to Santonian, and perhaps also early Campanian, fauna of the Trichinopoly Group of southern India are rather similar to the late Campanian to Maastrichtian fauna of the North American Gulf Coast.

Gastropods were collected from several localities, one near Garudamangalam, another near Kulakkalnattam, several from Kuthur, and some from the vicinity of Sirinattam; all these villages are situated to the west and southwest of Ariyalur in the district of Tiruchirappalli (Trichinopoly) in Tamil Nadu, and all are from the Kulakkalnattam and Anaipadi Formations of the Trichinopoly Group.

### GEOLOGY OF THE TRICHINOPOLY GROUP

The Trichinopoly Group has received its name from Blanford (1862) after the Tiruchirappalli town that was named Trichinopoly by the British. This town actually lies outside the outcrop area of the Cretaceous rocks, but the area of the group is largely part of the Tiruchirappalli district. The beds of the Trichinopoly Group are found in the south of the outcrop area near the village Garudamangalam, well exposed in the *nalas* to the south between Garudamangalam and Anandapuram. The strata are exposed in a 4 km. wide zone to the north extending upto the northernmost outcrop area near the town of Veppur.

The rocks of the Trichinopoly Group measure about 400 m in average thickness and are considered to have been deposited during the Coniacian and Santonian time (Govindan and Ravindran, 1996). One may divide the group into two formations, Kulakkalnattam and Anaipadi Formations (Sundaram and Rao, 1986). Kulakkalnattam Formation is very rich in fossils and has plenty of silicified wood. The formations are separated from each other by the Sirinattam Conglomerate that is well exposed near the village of Sirinattam. The sediments of the Kulakkalnattam Formation have formed during a continuous subsidence with a break at its top, marked by a renewed spread of conglomerates from the crystalline foreland across the basin. Sedimentation continued through the Anaipadi Formation. The depositional environment was that of initially open marine and later of coastal sedimentation, with indistinct, badly exposed gradation into the base of the Ariyalur Group.

The localities having well preserved fossil fauna to be described here, are from the *nalas* just to the north of Garudamangalam, about 1.5 km to the east of Kulakkalnattam next to the road leading to Sattanur, on the fields just to the northwest of Kuthur, in the usually dry river bed near Sirinattam, and further up in the river bed south of Karampiyam. The stratigraphically lowest position is near Garudamangalam, succeeded by those to the northeast of

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Kulakalnattam, which is in a similar position to Kuthur. This lies stratigraphically below Siranattam, which again has a position about 40 m below Karampiyam. Thus, the first three fossil localities belong to the Kulakalnattam Formation and the last two to the Anaipadi Formation.

With the beginning of the Trichinopoly Stage, pebbles of the crystalline basement were spread over the dry plains by rivers and creeks and finally by the transgressive sea eroding and covering the sedimentary rocks of the Uttatur Group as well as the crystalline basement. The youngest sediments of the Uttatur, according to Venkatachalapathy and Ragothaman (1995), are of early to late Turonian age, as determined with the help of foraminiferal assemblages. According to Sundaram and Rao (1986), the Kulakalnattam Formation is 266 m thick, a measurement that is derived from the subsurface drill hole of the Oil and Natural Gas Corporation near Ariyalur. This thickness can certainly not be generalized for the whole area of outcrop, since both in the north and in the south, the Trichinopoly Group appears to become reduced in thickness, and may even disappear, and sediments of the Uttatur Group may be directly overlain by sediments of the Ariyalur Group.

The Kulakalnattam Formation is named after the village Kulakalnattam that lies about 18 km to the west of Ariyalur. The same rocks have also received the name Paravai Formation (Narayanan, 1977), after the Paravai village to the southwest of Veppur and north of Ariyalur which lies on the crystalline basement, and Cretaceous sediments begin just to the east of it. Thus, the older name of Kulakalnattam for the formation fits better, since the Trichinopoly Group is the exposed with its conglomeratic base only about 2 km to the west of the Kulakalnattam village which rests on Kulakalnattam Formation.

A basal conglomerate, called the Kottarai Conglomerate marks a slightly angular unconformity. It separates the top of the Uttatur Group from the base of the Trichinopoly Group. The Kottarai Conglomerate is well exposed near the Kottarai village, about 11 km northwest of Ariyalur. In the *nalas* just to the west of the village, the top of the Karai Formation of the Uttatur Group consists of sandy and strongly bioturbated beds that have commonly been riddled by roots. This fossil soil demonstrates the presence of a terrestrial intermission and a time of non-deposition. There is also a minor unconformity developed between the first megacycle ranging from the Aptian-Albian time to late Turonian (Uttatur Group) (Venkatachalapathy and Ragothaman, 1995) and the second megacycle ranging from the Coniacian to Santonian, perhaps even into the Campanian time (Trichinopoly Group).

The Kottarai Conglomerate is more or less well developed and bears fewer pebbles in the north near Kunnam (about 15 km NW of Ariyalur) than near Kottarai and in the south near Garudamangalam (about 21 km SW of Ariyalur). This Kottarai conglomerate is overlain by sandy and marly beds intercalated with some dark grey limestone beds containing many fossils. In these limestone layers, large ammonites as well as silicified wood are

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preserved. The rich fossil-bearing locality at Garudamangalam lies on beds which are not far above the Kottarai Conglomerate and are mainly sandy in composition. The limestone is commonly mined and used as building stone and has characteristic thick shelled bivalves or dense packing of turritellid gastropods.

In the *nalas* west of Kunnam (about 12 km NW of Ariyalur on the main road), the unconformable position of the Karai Formation of the Uttatur Group is expressed by erosional channels. They are sand filled, commonly containing shell beds. Some crossbeds have fish-bone pattern reflecting intertidal depositional conditions. The sand is rich with quartz pebbles and more rarely, well rounded pebbles of crystalline rock of up to 10 cm in diameter, and with intraclasts of the reworked Karai Formation. Among the shells, there are also some rare representatives of rudists of the type of *Radiolites* which apparently lived nearby on hardground surfaces. More quiet beach sands nearby were the living place of inoceramids that became preserved with both valves still in contact. Pebbles have served as holdfasts to cementing oysters, corals, serpulid worms, and have become bored by clionid sponges. Ammonites together with *Nautilus* as well as gastropods are present. Wood has disintegrated leaving the tubes that were formed by the teredinid bivalves that lived in it. Among the other bivalves, pinnids are common, as well as pectinids. The limestone beds just above the unconformity are often dominated by the shells of a single species. Oysters dominate some beds, while in others *Plicatula* is almost the only component. A *Glycymeris*-like arcid forms the bulk of the shell in other banks, and some beds are characterized by an *Inoceramus*, also bearing two-valved shells.

About 1.5 km east of Kulakkalnattam just south of the road to Pilimisai in the *nalas* a 30 m thick portion of Kulakkalnattam Formation is exposed. Most of the common types of lithofacies that can be found in the formation are developed in this short section. Intercalations of beds with rich fauna dominated by oysters or rhynchonellid brachiopods indicate a changing shallow water environment with more or less open marine conditions. Marly and fine sandy beds have rhynchonellid brachiopods as major faunal components, underlain by sandy marl with many usually small sized oysters. Below these beds follow a series of highly bioturbated dirty silty sandstones and sandy marls that are soft and intercalated in a 1-4 m distance by concretion-bearing beds. Concretions consist of sandy limestone and measure up to 1 m in diameter. They are usually of irregular, but rounded shape, contain cracks in their centre or may show a concentric construction. Fossils are usually preserved in these concretions, while next to them they are rare. Aside from gastropods described below, *Pinna*-like bivalves, pholadomyiids, commonly fully grown thick shelled exogyrid, some heterodonts, and rare trigoniid bivalves are present (Kortum, 1995). Nautiloids and the ammonites *Mesopuzosia indopacificum* (Kossmat, 1898), *Placenticerias tamulicum* (Blanford, 1862), *Kossmaticeras recurrens* (Kossmat, 1897), *Tetragonites*

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*epigonum* (Kossmat, 1895), *Anagaudryceras involutum* (Stoliczka, 1865), *Phylloceras subalpinum ellipticum* (Kossmat, 1895), *Menambonites anapadensis* (Kossmat, 1898), *Damesites sugata* (Forbes, 1846) and *Lewesiceras vaju* (Stoliczka, 1865) were found by us and determined by H. Klinger of Cape Town. Some beds also contain wood, others hold much pyrite, which has always been transformed into iron-oxides. Due to this, gypsiferous layers have formed within the more marly-clay rich sandbeds, and a red to reddish brown colouration became characteristic of the more marly and clay-rich beds in this sequence.

Similar beds are exposed in the fields between Kuthur and the river, which hold rich fauna of cephalopods and gastropods. But the ammonite fauna differs somewhat with *Damesites sugata*, *Mesopuzosia indopacificum*, *Menambonites anapadensis*, and *Tetragonites epigonum* also being present. In addition *Puzosia orientalis* Matsumoto, 1854 and *Kossmaticeras theobaldianum* (Stoliczka, 1865), *Gaudryceras varagurense* (Kossmat, 1895), and *Gaudryceras vertebratum* (Kossmat, 1895) are also found. From this fossil-bearing strata Radulovic and Ramamoorthy (1998) described some brachiopods like the rhynchonellid *Cretirhynchia plicatiloides* (Stoliczka, 1865) and five terebratulids and considered the strata to have a Campanian age.

The Anaipadi Formation (Sundaram and Rao, 1986) received its name from the Anaipadi village to the west of Ariyalur (about 19 km west of Ariyalur and about 4 km NE of Garudamangalam) that actually lies on the beds of Kulakkalnattam Formation. Anaipadi Formation is exposed about 1.5 km to the east of Anaipadi. According to Sundaram and Rao (1986), Anaipadi Formation measures 164 m in thickness in the well drilled by the ONGC near Ariyalur. The base of this formation is formed by the Siranattam Conglomerate that is well exposed just to the west of the village Siranattam. Here the ammonites are *Platyceras tamulicum*, *Damesites sugata*, *Mesopuzosia indopacificum*, *Kossmaticeras theobaldianum*, and, in addition *Peroniceas dravidicum* Kossmat 1895 (det. H. Klinger). Siranattam Conglomerate separates Anaipadi Formation from the Kulakkalnattam Formation and is an indication of the migration of beach deposits within the deposition of the sediments of the Trichinopoly Group in the basin. Pebbles are derived from the crystalline basement to the west as well as from the Dalmiapuram and Veppur limestones which covered the shore and coast deposits of lower Uttatur Group, and are of Aptian/Albian age. This clearly indicates a phase of erosion and structural unrest connected to a regression that has appeared within the depositional history of the Trichinopoly Group. The beach formed by these pebbles was also the depositional locality for many larger and smaller tree trunks, most of which had been the home of wood-boring bivalves.

Siranattam Conglomerate is overlain by a series of sands and silty sands intercalated with concretionary layers that hold fossils. Some beds bear inoceramids, others oysters and a third type is rich with gastropods and

ammonites. Larger and smaller usually bored tree trunks are common in layers. Intraclast beds demonstrate a deposition near the coast. A shallow water layer in a position just (3m) below a clearly recognized with beach deposits and about 40 m above Siranattam Conglomerate bears rich gastropod fauna including some pleurotomariids, caenogastropods, others along with pinnid bivalves trigoniids, several heterodonts, large ammonites and *Nautilus*. The ammonites collected here at Kamapinan fossil location was determined by Klinger as *Placenticerias tamulicum*. In the upper portion, these beds have been deposited in a shallow open sea grading into beach sands with hardgrounds and reworked beachrock found to the northwest of the village Karampinan in the same river bed (that continues to Siranattam). Channels may have quartz pebbles at the base some of which are hardly rounded and rather fresh. The channel beds also are filled with quartz pebbles of up to 1 cm diameter and rounded to angular intraclasts of coarse quartz sandstone representing reworked beach rock. The beach deposits with encrusting worm-tubes and oysters are overlain by shell debris holding many fragments of inoceramid shells and some uneroded pseudorapanid shells. At the close of the exposure and its uppermost beds consist of sand with concretions holding large inoceramids of up to 30 cm diameter as well as tree trunks of up to 2.5 m length and 40 cm width which have been densely settled by wood-boring teredinids. According to a determination by K.-A. Tröger, the inoceramid is close to *Cordiceramus paraheberti* Sornay that had been described from Madagascar, and its age most probably is Santonian. Trichinopoly Group grades into Sillakudi Formation of the Ariyalur Group, which has not been studied in detail and is also very badly exposed. This Sillakudi Formation of probable Campanian age (Govindan et al. 1996) is mainly sandy and was deposited in the marine environment. Good outcrops are seen again in the Kallankurichchi Formation which begins with a conglomerate, containing pebbles of crystalline rocks.

**REEVALUATION OF THE GASTROPODS OF THE  
TRICHINOPOLY GROUP COLLECTED DURING  
THE FIELD SEASON, 1995**

**SYSTEMATIC PALAEOLOGY**

Subclass : ARCHAEOGASTROPODA

Superfamily : PLEUROTOMARIOIDEA

Genus : *Pterotrochus* Fischer 1885

The low conical shell consists of whorls which are separated from each other by deep sutures. The selenizone lies in the middle of the whorl and is fairly wide and ornamented by spiral lirae as is the whole shell. Whorls are convex but with a rounded corner to the base that is evenly rounded into the open umbilicus.

The shell is reaching a size of one slightly over Karampiyam.

The low conical shell is other by indistinct portion of the whorl. Whorls are weakly flat and has an open

The shell is a reaching a size of are from Kuthur.

Remarks: The shells are badly preserved by displaying the suture compaction in most presence and absence of recognized species encountered below pleurotomarians is on crust-forming a

The solid shell is lowly trochiform. species from New

Diagnosis: A dextrally coiled shell with gutter-like short horizontal whorl. The aperture consisting of rows

*Pterotrochus* sp.

(Pl. 1, Fig.1)

The shell is as described for the genus, consisting of about 7 whorls and reaching a size of almost 5 cm in height and 5.5 cm in width. Two specimens, one slightly compressed at the base, are from Kuthur. One specimen is from Karampiyam.

Genus : *Leptomaria* Deslongchamps 1865

The low conical shell consists of whorls which are separated from each other by indistinct sutures. The selenizone is narrow and lies in the central portion of the whorl. The shell is ornamented by spiral lirae and fine axial collabral lirae as well as some axial undulations forming a cancellate pattern. Whorls are weakly convex with an acute corner to the base, which is almost flat and has an open umbilicus.

*Leptomaria* sp.

(Pl.1, Fig. 2)

The shell is as described for the genus, consisting of about 6 whorls and reaching a size of about 3 cm in height and 4 cm in width. Four specimens are from Kuthur.

*Remarks:* The pleurotomarian species from Kuthur and Karamapiyam are badly preserved. They clearly demonstrate their belonging to this group by displaying the selenizone on the middle part of the whorl. Due to some compaction in most individuals, the shape is not preserved well and only the presence and absence of a distinct sutural depression distinguishes both recognized species. Actually, it is quite possible that the 7 individuals encountered belong to three of four species. The presence of large pleurotomarians is also evidenced from hard surfaces on which they browsed on crust-forming animals.

## Superfamily : TROCHOIDEA

Family : TROCHIDAE

Genus : *Astraea* Röding 1798

The solid shell with inner nacreous layer has a spined periphery and is lowly trochiform. The type is *Astraea heliotropium* Martyn 1758, a recent species from New Zealand.

*Astraea siranattamensis* n. sp.

(Pl.1, Figs.3-5)

*Diagnosis:* An *Astraea* with spinous periphery, rounded whorls and low dextrally coiled shell with spiral ornament of tubercule rows. Six to seven gutter-like short hollow spines feature the peripheral angulation of the last whorl. The apertural dorsal shell portion is ornamented by about 25 axial ribs consisting of rows of tubercles and the base is covered by about 12 spiral

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*Description:* The three cm wide and 1.7 cm high shell is lowly coiled with rapidly increasing rounded whorls that have an upper angulation forming a rounded corner that bears spines. The shape is lowly turritiform with deep sutures and oval almost round whorl diameter. The ornament consists of rounded tubercles forming spiral rows of which three are present above the irregular but rounded corner and six are present below it on the whorls and six more delicate ones on the rounded base and here fused to granulated lirae. The corner forms the upper peripheral edge and along it six or seven hollow spines are present, which have been broken off and probably represented short gutter like structures which were narrowly open in front.

*Difference:* No similar shell has been encountered in the late Cretaceous of the U.S. Gulf Coast. A very similar *Astraea*-like species with more spiral striae in its ornament and a narrower umbilicus is found in the Campanian of the Tresp Basin in northern Spain with *Astraea guerini* Bataller 1945. The general shell shape and shell ornament resembles that of the type species of *Astraea* and its predecessor *Astraea bicarinata* Suter 1917 from the Oligocene of New Zealand (Beu and Maxwell 1990, Pl. 14,ij).

*Type locality:* Siranattam about 5 km west of Ariyalur, Tamil Nadu.

*Type level:* Trichinopoly Group, Coniacian/Santonian of South India.

*Name Derivative:* A shell like an *Astraea* named for its location of occurrence in Siranattam.

*Holotype:* The illustrated specimen is deposited in the collection of the Geologisches-Paläontologisches Institut, Hamburg University Nr. 4201

Subclass : NERITIMORPHA

Superfamily : NERITOIDEA

Family : NERITIDAE

Genus : *Otostoma* d'Archiac 1859

The globose shell has a depressed spire and rapidly expanding more or less unicarinate whorls. The ornament consists of axial and tuberculated axial ribs above the periphery and by spiral axial elements below the periphery. The semilunar aperture is reduced by a thickened inner lip and has an inner lip with denticles. The type is *Otostoma rugosa* Hoeninghaus 1865 from the European Maastrichtian according to Kase (1984). According to Wenz (1938, Fig.1020) the genotype is *Otostoma ponticus* d'Archiac 1859 from Anatolia with evenly dented inner lip, which is not seen on the illustration of the type.

*Otostomia coralina* (Stoliczka, 1868)

(Pl.1, Fig.6.)

The rounded shell is as wide as high (1.5 cm) and consists of 3,5 convex whorls of the teleoconch succeeding the protoconch. The spire is depressed and whorls are rapidly expanding and slightly angulate. The protoconch is

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not preserved. The ornament of the teleoconch has about 22 axial ribs of the apical side of the body whorl that on the flanks continue in a row of nodules where they are crossed by about 10 spiral elements. Where both cross each other, tubercles are found. In addition, there is a very fine lamellar pattern of regular growth increments. The aperture is of hemispherical shape with a broad septum formed by the inner lip. The material studied consists of only one specimen from Kuthur.

*Remarks:* The absence of a peripheral spiral ridge differentiates *Otostoma coralina* from *Otostoma rugosa* which has such a ridge and a more pronounced angulation of the whorl. This species has been called *Nerita coralina* by Stoliczka (1868). Similar shells with non-denticulate inner lip have been coined *Lyosoma* by Sohl (1963). Kase (1984) described Japanese species from the late Lower Cretaceous like *O. japonicum* Nagao 1934 which is closely related to the Portuguese species *Nerita (Otostoma) antonii* Choffat 1902 from the Middle Cretaceous. From the Gosau *Otostoma hörnesana* Zekeli 1851 is known, and Kase (1984) also considers *Otostoma (Lyosoma) weinzetteli* Rahman 1967 from the Upper Cenomanian of Tirol and related forms to belong to the genus *Otostoma*. Also *Desmieria douvillei* Vidal, 1917 from the Maastrichtian of Spain and *Nerita divaricata* (Stoliczka, 1868) from the Maastrichtian of India represent similar shells.

Subclass : CAENOGASTROPODA

Order : CERITHIIMORPHA

Superfamily : CERITHIOIDEA

Genus *Voysa* Stephenson 1952

The turreted shell has noded sculpture of spiral ribs and a wide siphonal notch in the outer lip of the aperture, but no actual canal. The inner lip may conceal a narrow umbilical slit, and growth lines are curving reflecting a narrow sinus in the posterior portion of the outer lip. The genotype is *Voysa planolata* Stephenson 1952 from the Cenomanian of Texas.

*Voysa cf. scalaroideum* (Forbes, 1846)

(Pl. 1, Figs. 7,8.)

*Cerithium (Exelissa?) scalaroideum* Forbes; Stoliczka, 1868, pl. 15, figs.6,7.

According to Stoliczka, the cylindrical cerithioidean shell is ornamented by 12 to 16 radial ribs that are crossed by four spiral lirae forming rounded tubercles where they cross (Stoliczka, 1868, pl. 15, Figs.6,7). A very similar shell as that described and illustrated by Stoliczka, but with only three spiral ridges, present in its ornament occurs in Kuthur. Here, the shell is about 1.2 cm high, has about 7 whorls of the teleoconch, and whorls are shorter than wide. The ornament consists of about 25 axial ribs, and there is also a very fine pattern of spiral liriation aside from the three spiral ribs. The aperture extends into a short gutter-like siphon, and the base is flattened. Two specimen are from the locality Kuthur.

*Remarks:* Similar species are not found in the American Gulf Coast occurrences in Texas or Mississippi (Stephenson, 1941; Sohl, 1960; Dockery 1993), but can be encountered among the gastropods of the Campanian fauna at Torallola in the Tremp basin in northern Spain. Stephenson (1952) created the genus *Voysa* which can encompass also the species from India. *Voysa planolata* resembles the Indian *V. scalarioideum* in shape and ornament, but usually has four spiral lirae, while the specimen from Kuttur have three spiral lirae. Thus, the Indian species is close to Cenomanian species from the Gulf Coast, which apparently no longer lived in that area during later times.

"*Cerithium*" *kuthurensis* n. sp.  
(pl. 1, Figs. 9, 10)

*Diagnosis:* The turreted shell with apical angle of about 13 degrees has straight sides and a flattened base. The ornament consists of axial ribs present on the flanks and not on the base and four spiral ribs, the anterior-most of which lies at the corner to the base, and the third of which forms a peripheral keel. The suture lies in an asymmetrical depression next to the fourth spiral rib, and the base is ornamented by three spiral lirae. Ornament forms a cancellate pattern of 12 collabral ribs, and the spiral ribs with tubercles present at crossing points. The aperture is angular and low and provided with a short anterior siphonal funnel. With 19 whorls the shell measures about 2 cm in height.

*Description:* In addition to the diagnosis it can be remarked that nothing is known about the protoconch, and the aperture is fractured in all 5 specimens from Kuthur.

*Holotype:* The figured specimen represents the holotype, and there are four more individuals present, preserved with Nr. 4202 in the GPLUM collection, Hamburg-University.

*Type locality and type level:* Kuthur near Ariyalur on the fields next to the river from the beds of the upper Kulakkalnattam Formation of Trichinopoly Group.

*Name Derivative:* A species with cerithioid shell that was found at Kuthur.

*Remarks:* Stephenson (1941, Pl.54, Fig.10) described a *Cerithium* sp. from the late Cretaceous of Texas which resembles "*Cerithium*" *kuthurensis* in general shape and in the type of ornamentation. Especially the groove between keel and suture on the whorl are similar in both species, while ornament is less cancellate in the species from Texas. But also a shell described as *Cerithiella nodoliratum* Wade 1926 by Dockery (1993, Pl.24, Figs.3-4) from Campanian Coffee Sand in Mississippi has a similar ornament, but wider apical angle. Here the protoconch is preserved, but it does not place the species in the genus *Cerithiella* as analysed by Nützel (1998). In the case of *C. kuthurensis* it cannot be stated whether this species belongs to *Cerithium*, *Cerithiopsis* or even *Turritella*, as long as the protoconch and the

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aperture are not clearly known. But a relation to the *Cerithium* sp. from the Maastrichtian Navarro Group in Texas appears likely because of the similarities in ornament, shape and in size.

Genus : *Pseudomelania* Pictet and Campiche 1862

The shell is slender, conical with oval aperture without siphonal notch. Growth lines are sinuous. The type species is *Pseudomelania gresslyi* Pictet and Campiche 1862 representing a shell very much like the one here described from the Cretaceous of India (Wenz, 1938, Fig. 881).

*Remarks:* *Pseudomelania* was placed with the Subulitioidea, Pseudomelaniidae by Wenz (1938) or to the Pyramidellidae by Woods (1906), but the place of this Mesozoic genus is still unknown. Modern Potamididae are similar in shell shape (Thiele, 1931; Houbriek, 1991), but *Pseudomelania* has no apertural siphon which is usually found among the former. Pseudomelaniidae are more conical than most Turritellidae, but the sinuous growth line of *Pseudomelania undosa* closely resembles that of *Turritella* sp. from the Trichinopoly Group and noted in modern representatives of that later genus.

Species *Pseudomelania undosa* (Forbes 1846)

(pl. 2, Figs. 1, 2)

The turreted shell usually consists of at least nine whorls of the teleoconch and measures about 9 cm in length and 2.4 cm in width, with apical angle about 22 degrees. Some larger shells with even one more whorl reached a height of about 11 cm. The last whorl shows irregular growth increments and growth interruptions that are evidence for a growth of the last whorl on an old and fully grown individual. The whorls are almost as wide as high in later shell portions and a little wider than high in the early whorls, with sutures well incised. The early whorls are slightly convex and later become more flattened. The greatest convexity lies in the anterior third of the whorl and the posterior two thirds are flattened and curve gradually into the suture. The base is rounded. The aperture is of oval outline but angular posteriorly. The columella is solid, and lips are thickened. Ornament consisting of about 13 rounded axial ribs on juvenile whorls with sinuous outline reflecting a low depression in the upper half of the outer lip and a low lobe in the lower half of that lip. There is also a fine spiral liration. In the latest whorl sinuous growth increments dominate the ornament. Five specimens were studied from Garudamangalam, four from Siranattam, and two from Kuthur.

*Remarks:* *Pseudomelania undosa* from Garudamangalam, Siranattam and Kuthur is quite similar to *Pseudomelania sutherlandi* Baily 1855 from the Umzamba Formation in South Africa that was originally described as member of *Chemnitzia* by Baily 1855 and redescribed as belonging to *Pseudomelania* by Woods (1906). Griesbach (1871) connected it to *Chemnitzia undosa* Forbes 1846 from the Trichinopoly Group of Tamil Nadu, but found it to have a smaller apical angle. This is not the case, and both

species from Umzamba and from the area of Ariyalur are very similar to each other. They differ only in the weaker ornament present in the African species. Similar species are also known from the Late Cretaceous of southern France.

Family : TURRITELLIDAE

One variable species of the Turritellidae was recognized which, in several layers of the Trichinopoly Group occurs in great numbers.

Genus : *Turritella* Lamarck 1799 (Griesbach, 1871)

The slender turreted shell consists of numerous whorls which are usually ornamented by spiral lirae and curved growth lines. The aperture is rounded or somewhat angular without siphonal notch. The type is the living *Turbo terebra* Linné 1758 from the Indo-Pacific near the Philippines.

*Turritella cf. dispassa* Stoliczka, 1868  
(pl. 2, Figs. 3, 4)

The small shell is turritiform with about 12 whorls about 2.5 cm long with apical angle about 19°. A larger specimen from Garudamangalam may also belong here and consists of at least 14 whorls and was about 6 cm high. Its ornament has been eroded, but growth lines are clearly sinuous as in the smaller specimen of this species. Whorls are flattened, but slightly convex near the sutures. Their surface is ornamented with spiral costae, every second or third being slightly stronger than the other, and all or some of them are granulated. The ornament of spiral ribs is quite variable among the different specimens, but usually there are five spiral ribs to be seen on the whorls of the spire. Growth lines of strongly sinuous course are well expressed in more grown specimens from about the eighth whorl onward. In Kuthur fifteen ~ 3 cm long shells were collected with more flattened whorls, sides and ornament of 2 to 3 main spiral lirae that have 1 to 5 finer lirae between them. But they are rather variable and probably represent only variations of the same species encountered in the locality Garudamangalam (about 20 specimen were studied) from Kulakkalnattam Formation of the Trichinopoly Group.

*Remarks:* The individuals of *Turritella cf. dispassa* from Kuthur usually have less strong growth lines and more spiral lirae than *T. cf. dispassa* from Garudamangalam. In contrast to *Turritella vertebroides* Morton 1834 from the Campanian/Maastrichtian of Texas, the Indian species have few (2-3) larger spiral lirae on each whorl than the species from the Gulf Coast (4-5 lirae). But Stephenson (1941, Pl. 53, Figs. 4-13) described a number of varieties or subspecies of this Campanian to Maastrichtian species from Texas. Comparison with *Turritella* from the Ripley Formation (Sohl, 1964) and the older Coffee Sand (Dockery, 1993) reveals, that in a general way *Turritella vertebroides* Morton 1834 and *T. hilgardi* (Sohl, 1960) from the Maastrichtian and *T. chapelvillensis* (Dockery, 1993) from the Campanian are



Fig. 1. *Pterotrochus* sp. i  
Fig. 2. *Leptomaria* sp. w  
Fig. 3, 4, 5. *Astraea sira*  
shell.  
Fig. 6. *Otostomia coralli*  
Fig. 7, 8. *Voysa scalara*  
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Fig. 9, 10. "*Cerithium*"  
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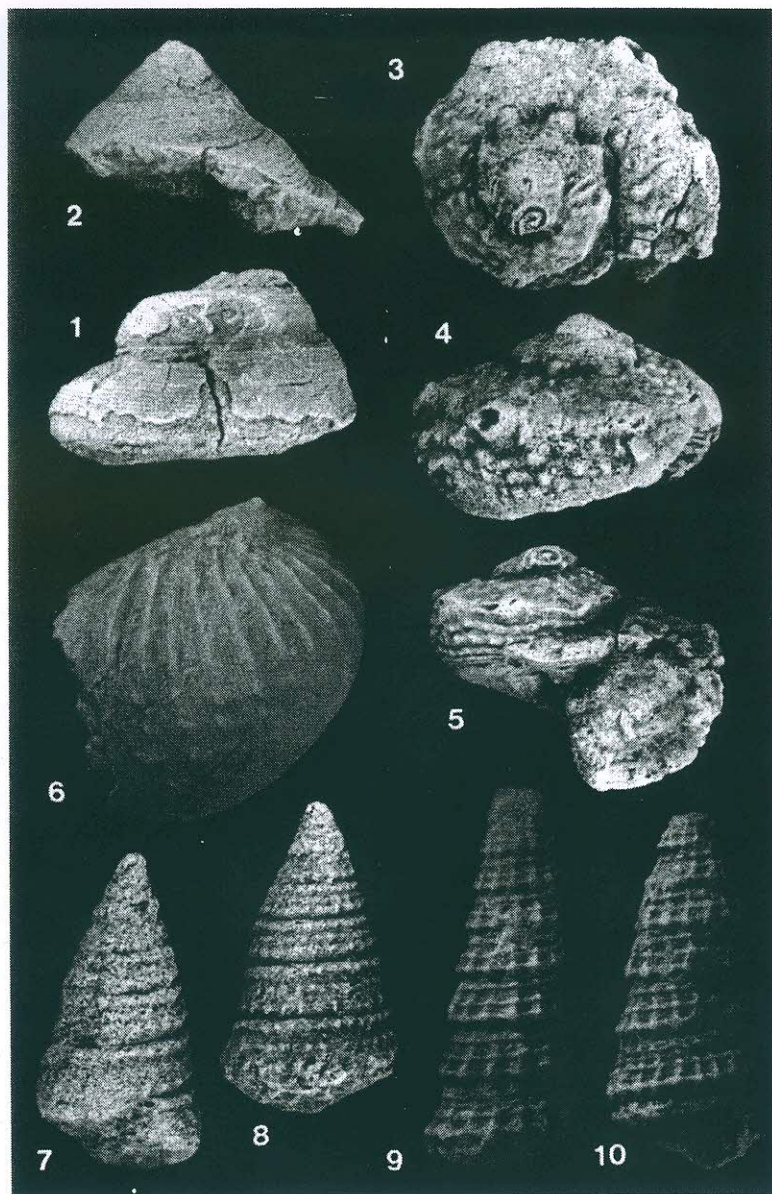


Plate 1.

Fig. 1. *Pterotrochus* sp. in lateral view with 5.5 cm wide shell.

Fig. 2. *Leptomaria* sp. with juvenile shell that measures 2.2 cm in width.

Fig. 3, 4, 5. *Astraea siranattamensis* n. sp., holotype seen from different views of the 3 cm wide shell.

Fig. 6. *Otostomia coralina* (Stoliczka, 1868) in lateral view with 1.5 cm high shell.

Fig. 7, 8. *Voysa scalaroideum* (Forbes, 1846) in apertural and lateral view of the 1.2 cm high shell.

Fig. 9, 10. "*Cerithium*" *kuthurensis* n. sp. in lateral view with 19 mm high shell and in apertural view of the 10 mm high holotype.

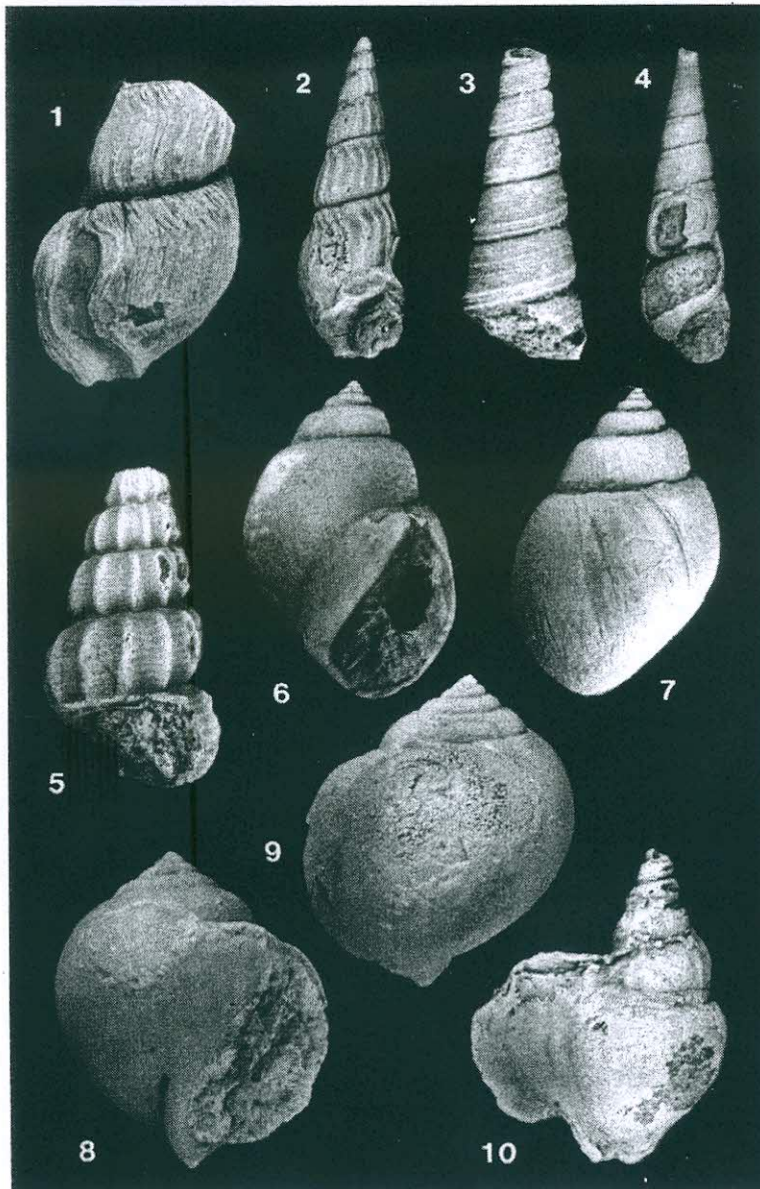


Plate 2.

- Figs. 1, 2. *Pseudomelania undosa* (Forbes, 1846) with the last whorl of a fully grown individual from Siranattam with 3.5 cm wide shell, and a juvenile shell from Garudamangalam with 7 cm high shell.
- Figs. 3, 4. *Turritella cf. dispassa* Stoliczka, 1868 with 2 cm high shell from Kuthur and 6 cm high shell (7) from Garudamangalam.
- Figs. 5. *Confusiscala shutanurensis* (Stoliczka, 1868) with 2 cm high shell from Kulakkalnattam.
- Figs. 6, 7. *Pseudamaura nobilis* (Stoliczka, 1868) in apertural and lateral view of the 5.2 cm high shell from Garudamangalam.
- Figs. 8, 9. Species *Crommium siranattami* n. sp. from Siranattam with 2.5 cm high shell of the holotype.
- Fig. 10. *Latiola papilionacea* Goldfuss 1844 (Stoliczka, 1868) with 2,5 cm high shell from Kulakkalnattam.

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similar in regard to ornament and flattened shell surfaces, but differ in the finer details of the ornament.

Both species of *Turritella* from the Umzamba Formation in South Africa differ by having many simple spiral ribs in one case, and in the other case having 2-3 spiral keels and fine spiral threads between them (Woods, 1906, Pl.24, Fig.12; Rennie, 1930, pl.38, Fig.12).

Order : CTENOGLOSSA (Ptenoglossa)

Superfamily : JANTHINOIDEA

Family : Epitoniidae

Genus : *Confusiscalca* deBoury 1909

The type species is *Scala dupiniana* Orbigny from the Cretaceous of France (Wenz, 1938, Fig. 2343). The slender turritiform shell consists of about ten rounded whorls with a keel at the periphery of the base which becomes almost totally concealed by succeeding whorls. Ornament consists of nearly straight rounded collabral ribs, separated by broadly rounded interspaces, and both are crossed by fine rounded spiral ribs of different width separated by linear grooves. This may be the same genus as *Punctiscalca* de Boury 1890.

*Confusiscalca shutanurensis* (Stoliczka, 1868)

(pl. 2, Fig. 5)

The slender turritiform shell is quite large and has an apical angle of 30°. It consists of ten or eleven convex, rounded whorls, with a rounded indistinct keel along the periphery of the smooth base. This keel is totally concealed by succeeding whorls. The ornament consists of 10 to 14 stout, rounded collabral and axial ribs which are nearly straight. The ribs are separated by broadly rounded interspaces, and both are crossed by about 10 rounded spiral ribs of about equal width separated by rounded and equally wide grooves visible on the whorls of the spire. There may be finer spiral striae between these. Growth lines are fine and straight. The shell is up to 6 cm high and 2.8 cm wide. A young specimen from Kulakkalnattam and eight partly to fully grown specimens from Kuthur were studied.

*Remarks:* *Scala ornata* (Woods, 1906) from the Umzamba Formation in South Africa is similar, but differs in regard to the number of axial ribs, which are more than in *S. shutanurensis* and in the fine spiral ribs, which are more regular in the later. Woods (1906) also found similarities with *Scala decorata* (Roemer) from the Late Cretaceous of Sachsen (Germany) and *Scala dupiniana* d'Orbigny from France, but also noted that the later have more inflated whorls. *Punctiscalca meaniea* (Dockery, 1993) from Coffee Sand Formation of Mississippi is very similar to the large *Confusiscalca shutanurensis* from India (Dockery, 1993, Pl.26, Fig.14), but apparently did not grow to such a large size.

Family : PSEUDAMAURIDAE

Genus : *Pseudamaura* Fischer 1885



Fig. 4. Shell of a fully grown individual from Garudamangalam with

shell from Kuthur and 6 cm

high shell from Kulakkalnattam. Fig. 7. Lateral view of the 5.2 cm

high shell of the

shell with 2.5 cm high shell from

The naticoid shell is egg-shaped and rather large and thick shelled. Whorls are rounded or somewhat flattened, and the last whorl is large and egg shaped. The aperture is simple, and inner and outer lip are commonly thickened. The umbilicus is lacking, or a small slit and the aperture is almost oval in outline or spindle shaped. Genotype is *Natica bulbiformis* Sowerby, 1832 from the Gosau (Late Cretaceous) of the northern Alps (Kowalke and Bandel, 1996, Pl. 6, Figs. 3-6).

*Pseudamaura nobilis* (Stoliczka, 1868)  
(pl. 2, Figs. 6, 7)

? *Pterodonta nobilis* Stoliczka 1868, p.43, pl.5, Figs.2, 5

The large sized high spired elongated naticoid shell has about 7 whorls when fully grown. Sutures are channeled in juvenile whorls and later become step-like with a flat or concave area between sutures and the rounded whorl sides. The spire is not quite as high as the last whorl (seen in frontal view), and ornament consists only of growth lines that form a regular dense pattern on early whorls, later become more irregular and less conspicuous. The surface otherwise is almost smooth, and only in well preserved specimen has an indistinct spiral ornament of shallow grooves and wide flattened ridges between them. The umbilicus is closed. The aperture is almost oval in outline or spindle shaped slightly oblique with commonly thickened but simple lips. The callus of the inner lip is usually thick, commonly forming a pad in the posterior portion. Fully grown shells are up to 6 cm high and 4 cm wide, measured on the 10 individuals from Garudamangalam. There is quite a bit of variation in shell size and also in growth line pattern. The later may be strong and irregular or weak and regular. Three specimens are from Kuthur and two from Siranattam.

*Remarks:* Similar is *Pseudamaura lepta* Sohl 1964 representing a species from the Coffee Sand (Sohl, 1964, Pl.55, Figs.3-5; Dockery 1993, Pl. 20, Figs.5,6), but it lacks the subsutural ramp. *Amaurellina stephensoni* (Wade, 1926) from the same Coffee Sand Formation closely resembles *Pseudamaura nobilis* in general shell shape, but differs by being more delicate and not having a callus pad (Dockery, 1993, Pl. 20, Figs.7,8). *Pseudamaura lirata* (Wade, 1926) from Coon Creek (Sohl, 1960, Pl. 17, Figs. 20,21,23) also differs from *P. nobilis* by having a thinner shell and smaller size. *Pseudamaura lyrata* Sowerby 1831 from beds of about the the same age of the Gosau (northern Alps) is related to *P. nobilis*, but has no spiral ornament (Kowalke and Bandel, 1996, Pl.6, Figs. 3-6). *Pseudamaura bulbiformis* Sowerby 1832 as illustrated by Akers and Akers (1997) from the Albian of Texas is quite similar to *P. nobilis*, differing mainly regarding the less thickened inner lip.

Genus : *Crommium* Cossmann 1888

The shell is globose with moderately elevated spire that may have a

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*Crommium siranattami* n. sp.

(pl. 2, Figs. 8, 9)

*Diagnosis:* As in description of the genus, the species has a smooth globular shell with slightly concave spire and a callus covered inner lip that extends anteriorly to the slit-like umbilicus.

*Description:* The shell is about 2.5 cm high and almost as wide and consists of about 6 whorls which are smooth and well rounded. The spire takes only about one fifth of shell height. The aperture has a thickened margin with rounded columellar portion, and there is a slit like umbilicus.

*Type locality:* Siranattam, with 3 specimens.

*Holotype:* The illustrated specimen represents the holotype. preserved with No. 4203 in the GPLUM collection, Hamburg University.

*Type level:* Lower Trichinopoly Group, Siranattam Conglomerate between Kulakkalnattam Formation and Anaipadi Formation.

*Name Derivative:* This species of *Crommium* has been collected at Siranattam.

*Difference:* The type species of the genus, *C. willemetii* has more tabulate shoulders and fine spiral striae, while *C. siranattami* is smooth and has well rounded shoulders. Among the different species of *Crommium* described by Marincovich (1977) from the Paleogene of the North American West Coast *Crommium andersoni* Dickerson 1914 and *C. pinyonensis* Dickerson 1914 are similar in shape and size. While the former has a shorter spire, the latter as a slightly less evenly rounded whorl body as is found in *C. siranattami*, which is also quite a bit older.

*Remarks:* A *Crommium* from the Eocene of the Paris basin has a protoconch that is not that of a naticid, but belongs to the Pseudamauridae (Bandel, *in prep.*). Thus, the assumption of Wenz (1938) and also of Marincovich (1977) that *Crommium* represents a naticid neomesogastropod is not correct. In case of *Crommium siranattami*, the protoconch is not preserved well enough to decide clearly to which group it may belong. But its close similarity to Cretaceous and Paleogene Pseudamauridae (Kowalke and Bandel, 1996) make its placement within that group more likely.

Superfamily : STROMBOIDEA

(pl. 2, Fig. 10, pl. 3, Fig. 1)

Four species have been described by Kiel and Bandel (1998, *in prep.*). Of these *Latiala papilionacea* Goldfuss 1844 has a shell of 2.5 cm height and 2.7 cm width of nine whorls of which the first four whorls are smooth, the later ones show 12-16 ribs. In addition there are fine spiral lirae and

and thick shelled. The whorl is large and the outer lip are commonly the aperture is almost *bulbiformis* Sowerby, from the Alps (Kowalke and

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pl. 5, Figs. 2, 5

shell has about 7 whorls and later become rounded and the rounded whorl (seen in frontal view), a regular dense pattern less conspicuous. The preserved specimen has 1 wide flattened ridges almost oval in outline thickened but simple lips. The spire forming a pad in the middle high and 4 cm wide, 1 cm. There is quite a bit of ornamentation. The later may be specimens are from Kuthur

1964 representing a *Pseudamaura* 3-5; Dockery 1993, Pl. 1. *naurellina stephensoni* closely resembles *Pseudamaura* by being more delicate (Figs. 7, 8). *Pseudamaura* 17, Figs. 20, 21, 23) also shell and smaller size. But the the same age of *Pseudamaura* has no spiral ornament *Pseudamaura bulbiformis* (197) from the Albian of only regarding the less

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occasionally varices. The wing-like outer lip of the adult consists of the rostrum that is turned towards the thickened wing. (pl. 2, Fig. 10) This species also occurs in the Umzamba Formation, South Africa, besides in Kulakkalnattam of the Trichinopoly Group. The other species belonging to this genus is *Latiala? tegulata* (Stoliczka, 1868) with the shell consisting of more than six whorls and the spire slightly higher than the body whorl. Ornament consists of axial ribs, and the wing of the outer lip of the aperture is attached to the penultimate whorl. It was found at Garudamangalam.

Also *Perissoptera cf. parkinsoni* (Mantell, 1822) was found, originally described by Stoliczka (1868, pl.2, Figs. 5-8) as *Alaria parkinsoni* with spire and body whorl of equal height and ornament of 13-15 ribs per volution which are not continuous onto the body whorl. It has a bilobed outer lip with a wing that is attached to the suture of the penultimate whorl. The shell is about 3 cm high and more than 2 cm wide. One specimen is from Kulakkalnattam.

*Anchura securifera* (Forbes, 1846, pl. 3 Fig. 1) was described as *Aporrhais* by Stoliczka (1868, pl.2, Fig.1) has 6-9 volutions with the spire a little higher than the body whorl. Ornament consists of axial ribs crossed by spiral cords, the upper of which continues into the posterior spur of the wing of the outer lip. The outer lip expands into a forking wing and is ornamented with lobes. The shell is more than 4 cm high, and about 3,5 cm wide, and closely resembles *Anchura neubaueri* (Riedel, 1932) from the Mungo River of Cameron in western Africa. *A. securifera* was found to be common in Kulakkalnattam and Garudamangalam.

#### Order : NEOMESOGASTROPODA

Superfamily : CAPULOIDEA

Family : TRICHOTROPIDAE

Genus : *Lirpsa* Stephenson 1952

According to Stephenson (1952) the genus is characterized by a relatively short spire, rapidly expanding whorls, a single, sharp and prominent keel-like spiral rib, subquadrate aperture, and sinuous umbilicus. The shell is very much like that of living *Trichotropis* Broderip and Sowerby 1829 in shape, but with a more or less regular ornament of axial ribs and fine spiral lirae, ribs or rows of tubercles. The type is *Lirpsa cornuata* from the Woodbine Formation in Texas.

*Remarks:* *Trichotropis* has similar shell shape, but differs by not having an ornament of axial ribs crossed by spiral liration. *Trichotropis bicarinata* Sowerby 1825 from the Pacific Ocean near Japan representing the type of the genus is a medium sized (2-4 cm high), turbinate shell with a narrow umbilicus and a pointed anterior terminus of the columella. The aperture is anteriorly channeled, and sculpture consists of two spiral keels having oblique growth line striae between them (Abbott, 1974, Fig. 1516). *Pyropsis* has an ornament very similar to that of *Lirpsa*, but differs by having a lower spire

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#### *Trichotropis koninc*

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and more regular ornament shapes. The rather similar *Pyropsis cancellata* differs by a lower spire and more regular ornamental pattern. *Turbinopsis* Conrad 1860 differs in not having a body carination (Sohl, 1960).

According to Bandel and Riedel (1994), the Trichotropidae represent filter feeding taenioglossate Caenogastropoda which bear a scaphoconcha. The limpet shape distinguishes the *Capulidae* Fleming 1822 from Trichotropidae as suggested by Yonge (1962). The Trichotropidae have an operculum throughout life while the operculum is lost after metamorphosis in the former.

*Lirpsa garudamangalami* n. sp.

(pl. 3, Fig. 2, 3)

*Trichotropis konincki*, Müller, 1851; Stoliczka, 1868, p.158, pl.13, Figs.7-9.

*Diagnosis:* The shell with relatively short spire and rapidly expanding whorls bears a single keel-like spiral rib on the periphery, and a second smaller spiral rib is present at the edge to the base. The carinae are spinose where they intersect growth rugae. Spiral threads are present as well. The body whorl is higher than the spire. The aperture is subquadrate, and the umbilicus sinuous.

*Description:* The medium sized usually 2-3 cm high but exceptionally 4 cm high umbilicate shell has a strongly carinate spire and bicarinate body whorl. The shell is up to 2.8 cm wide and consists of up to 6 rapidly increasing whorls. The body whorl is somewhat higher than the spire. The carinae are spinose where they intersect the growth rugae which are arranged as regular axial ribs of which about 25 are present on each whorl. These ribs can be arranged rather regularly or quite irregularly, or may be absent on the apical top. They are always found between both keels on the sides, and spiral threads are usually present as well. The whorl above and below the upper carina is flattened, and the lower, weaker carina forms the edge at the base. The last whorl has a broad, short siphonal notch. The aperture is strongly oblique and of angular shape. The narrow umbilicus has a sharply raised margin that may be spinose at the intersection with growth rugae.

Individuals of *Lirpsa garudamangalami* are rather variable in shape, with some having almost equal carinae, others with rather weak anterior carina and strong posterior one. Similarly the ornament varies from strong axial ribs to individuals with only growth lines present as axial ornaments, and with well developed spiral liration and with nearly absent spiral liration.

*Type locality:* Garudamangalam with 24 specimens and two specimens from Kulakkalnattam.

*Holotype:* The individual illustrated in Fig. 3 is the holotype, deposited in the collection of the GPLUM, Hamburg.

*Type level:* Lower Trichinopoly Group, Kulakkalnattam Formation.

*Difference:* *Lirpsa garudamangalami* resembles *L. cornuata* from the Cenomanian Woodbine Formation in Texas, but differs by having more whorls (6 instead of 4) and axial ribs in its ornament. *Lirpsa teres*

(Stephenson, 1952) from the same Woodbine Formation is more slender and less ornamented than *L. garudamangalami*. *Trichotropis mississippiensis* (Sohl, 1960) has a more narrow umbilicus and more distinct spiral liration than *Lirpsa garudamangalami* which is very similar to *T. konincki* Müller 1851 from the Campanian of Aachen and Vaals in western Europe. The Indian species differs by being higher and having an ornament of spiral lirae. *Trichotropis squamosa* Gabb 1876 from the Goffee Sand of Mississippi (late Campanian) described by Dockery (1993, Pl.17, Figs. 11,12) has the distance between the two marginal carinae about the same as the distance between the lower carina and the umbilical margin, while this distance is greater in *L. garudamangalami* from India, but also on the holotype from Black Creek formation in North Carolina figured by Stephenson (1941, 1952). Here the distance between lower carina and the umbilical margin is twice that between the marginal carinae.

Genus : *Cantharulus* Meek 1876

The 3-4 cm high shell is of ovate fusiform shape with moderately high spire and whorls well separated by deep sutures. The ornament consists of axial ribs and spiral lirae or ribs. The body whorl is rounded with elongated base, and the aperture is ovate with rounded simple outer lip, and columellar lip forming a bump before onset of the short siphonal canal. There is no posterior canal of the aperture, and growth lines swing back at the suture. The genotype is *Fusus vaughani* Meek and Hayden from the Fox Hill Group in Dakota, USA according to Wenz (1938, Fig.3411), and from Missouri according to Rennie (1930).

*Remarks:* *Cantharulus* is like *Lomirosa* Stephenson 1941 in general shell shape, but differs from it by having spiral ridges on the shoulder, while *Lomirosa* has only fine spiral ornament (Stephenson, 1941, Pl. 67, Figs.18, 19; Sohl, 1964 Pl. 24, Figs. 13, 19). Both have rounded protoconchs of the cancellariid or trichotropid type.

Stoliczka (1868, Pl.11, Figs. 15-17) placed *Cantharulus eximia* from Tamil Nadu in the genus *Hindsia* Adams and Adams, 1853 (= *Nassaria* Link 1807) which represents a modern member of the Buccinidae from the Bay of Bengal. Rennie (1930) placed *Cantharulus kaffraria* in the genus *Tritonidea* Swainson 1840, which according to Wenz (1938) represents a synonym to *Pollia* Sowerby 1834. The latter is based on *Cantharus (Pollia) undosus* Linneus 1758 from the Indopacific. *Cantharulus* is considered a subspecies to *Cantharus* Röding 1798 by Wenz (1938) based on modern *Buccinum tranquebaricus* Gmelin from Tranquebar.

*Cantharulus eximia* (Stoliczka, 1868)

(pl. 3, Fig. 4, 5)

*Hindsia eximia* Stoliczka, 1868, p. 135, Pl.11, Figs. 15-17

*Pollia pondicherriensis* Stoliczka, 1868, p. 127, Pl.11, Figs.15-17

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There are 12-14 axial ribs crossed by 4-5 strong spiral ribs and one smaller stria between each of them visible on the whorls of the spire. With six whorls the shell is about 1.5 cm high, and fully grown it measures more than 3 cm in height and 2 cm in width. The thickened inner lip leaves a fissure near the anterior end of the siphonal canal which is curving to the left. The height of the spire is variable, but about equal to that of the last volution. The axial ribs form tubercles where they cross the spiral ribs. While the axial ribs end before reaching the base the spiral lirae cover the whole of the last whorl. There is no subsutural collar, and there are two spiral lirae in the shoulder which are more delicate than the others. The aperture is roundish extending into a short siphon anteriorly and a narrow fissure-like canal posteriorly. Two specimens are from Kuthur.

*Remarks:* *Cantharulus eximia* is a somewhat more slender than *Cantharulus vaughani* from the USA, but otherwise quite similar. *Cantharulus cretaceum* Müller 1851 from the Aachen Greensands is also of similar size Holzapfel 1888, but more slender, and ornament consists of about 15 radial ribs instead of about 13 which are also crossed by alternating smaller and larger spiral ribs, just as is the case in *C. eximia*. *C. kaffraria* (Rennie, 1930) from the African Umzamba Formation and *C. cretaceum* differ from *C. vaughani* by having axial ribs inclined toward the right, while those of the genotype are straight and parallel to the axis, as is the case in *Cantharulus eximia*. The later also closely resembles *Peristernia conica* from Cameroun as described by Riedel (1932).

Genus : *Profusinus* n. gen.

*Diagnosis:* The shell resembles that of *Fusinus* (*Barbarofusinus*) Grabau and Shirmer 1909 illustrated by Wenz (1938, Fig. 3581) and Abbott (1974, Fig. 2517) from the North American West Coast. The shell is spindle-shaped elongated with median siphonal canal and ornament of rounded ribs, crossed by small, sharply raised spiral cords. The columellar lip is callus glazed and smooth. The type is *Profusinus indicus* (= *Tritonidea requienia* d'Orbigny) of Stoliczka (1868).

*Difference:* The genus *Euthriofusus* Cossmann 1901 as suggested to include the *Euthriofusus? mesozoicus* Wade 1917 with long siphonal canal and *Euthriofusus? convexus* (Wade, 1926) has a very similar shell to the species described here from India. Both these are from Ripley Formation in Tennessee (Sohl, 1964, Pl. 31, Figs. 27, 28, 33-36). The type of *Euthriofusus* Cossmann 1901 from the Miocene of France (Wenz, 1938, Fig. 3552) has a very long siphon. The ornament is dominated by spiral ribs in this *Fusus burdigalensis* Basterot 1825.

*Name Derivative:* The Cretaceous gastropod of a *Fusinus*/*Euthriofusus* like shape is renamed into *Profusinus*, indicating an early *Fusinus*-like shape of the shell, but unknown relation to modern Neo- or Neomesogastropoda.

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.11, Figs. 15-17  
7, Pl. 11, Figs. 15-17

*Profusinus indicus* n. sp.

(pl. 3, Fig. 6, 7)

*Tritonidea requienia* d' Orbigny; Stoliczka, 1868, p. 124, Pl. 11, Figs. 8, 9

**Diagnosis:** The species is like the genus and has a medium sized about 3,5 cm high shell that is ornamented with about 10 rounded axial ribs which are restricted to the periphery. The surface is covered by sharply crested spiral lirae.

**Description:** The shell consists of about 7 whorls, is 35 mm high and 25 mm wide. The suture is accompanied by a depression below it onto which the bulging axial ribs do not extend. These rounded ribs are best developed on the periphery and end at the shell constriction. The shell base continues evenly convex into the whorl sides and is covered by spiral lirae. The illustrated specimen is the only one found at Kuthur.

**Difference:** *Profusinus convexus* Wade 1926 from Ripley Formation in Tennessee is very similar in size and shape to *P. indicus* which differs by having stronger axial ribs. *Euthriofusus? mesozoicus* Wade 1917 differs by having a much longer siphonal canal (Sohl, 1964). The genus *Tritonidea* Swainson 1840 represents a synonym to the genus *Polliia* Sowerby 1834 which is based on a species that lives now and belongs to the Buccinidae. Wenz (1938) considered it to represent a subgenus to *Cantharus* Röding 1798 which is also based on a living species that is rather similar in shape to the late Cretaceous *Profusinus*.

**Holotype:** The illustrated specimen, deposited with No. 4204 in the collection of GPLUM, University of Hamburg.

**Type locality:** Kuthur.

**Type level:** Upper Kulakkalnattam Formation, Trichinopoly Group.

**Remarks:** Among modern Neogastropoda and Neomesogastropoda there are several genera that have species resembling *Profusinus*. A closer comparison with any of these will only be possible, when the protoconch is known and compared.

## Superfamily : NATICOIDEA

## Subfamily : Gyrodinae Wenz 1938

The naticiform shell has a flattened spire and smooth or delicately lirated spiral ornament crossed by inclined growth lines. The body whorl is large with more or less wide umbilicus that is not covered by callus of the inner lip (Wenz, 1938). Usually the umbilicus is accompanied by an umbilical ridge that separates it from the rounded base.

Genus : *Gyrodes* Conrad 1860

The subglobose, low spired shell has a deep umbilicus with crenulate and sharp umbilical margin and is crenulated near the suture. Characteristic to *Gyrodes* is the angular or keeled margin of the open umbilicus, which

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remains free of callus deposits. Growth lines near the suture are notched in the subgenus *G. (Gyrodes)* and not notched in the subgenus *G. (Sohlella)*. The aperture is oval in outline and inclined. The callus of the inner lip is thin. The genotype is *Natica (Gyrodes) crenatus* Conrad 1860 from the Ripley Formation, Mississippi USA.

*Gyrodes (Gyrodes) garudamangalami* n. sp.  
(pl. 3, Fig. 8, 9)

**Diagnosis:** The shell is slightly wider than high, with low spire. The suture is accompanied by a narrow notch forming a narrow ribbon that accompanies the flattened shoulder, which ends in an angular corner to the evenly rounded sides of the whorls. The umbilicus is wide and of conical shape. Crescentic ribs ornament the flattened shoulder and the margin of the umbilicus.

**Description:** A shell with 5 whorls is about 2.5 cm wide and almost as high. The suture is accompanied by a slightly concave flattened shoulder that ends in an edge with the well rounded whorl sides. The edge is crenulated with short rounded crescentic ribs orienting their concavity backwards. These end at the edge but reappear at the rounded corner to the wide umbilicus that has smooth inner walls featured only by growth lines. The aperture is obliquely suboval with a narrow notch next to the suture. Two specimens are from Garudamangalam, the holotype measuring 2 cm in width and in height, and the smaller individual measures 1.8 cm in height and 1.8 cm in width.

**Name Derivatives:** A *Gyrodes* from the locality Garudamangalam.

**Holotype:** The illustrated specimen (Pl. 3, Figs. 8, 9), is deposited in the collection of the GPLUM, Hamburg University, Number 4205.

**Type locality:** Kuthur.

**Type levels:** Upper Kulakkalnattam Formation, Trichinopoly Group.

**Difference:** *Gyrodes garudamangalmi* resembles *Gyrodes dowelli* White 1889 from California (Popenoe et al. 1987, Fig.4 - 1,5,7). But the Indian species is smaller than *G. dowelli* that measures with four whorls more than 4 cm in diameter. *G. garudamangalami* also has a sharper edge at the shoulder and may have a slightly wider umbilicus. It also differs from *Gyrodes supraplicatus* Conrad 1859 from the Maastrichtian of Mississippi by its smaller size and the posterior edge, but otherwise is very similar (Sohl, 1960, Pl. 16, Figs. 1-5). *Gyrodes major* from Coon Creek (Sohl 1960, Pl.16, Figs. 6,7,10) and from Coffee Sand (Dockery, 1993, Pl.20, Figs. 13,14) also has noded ridges and even a similar sharp edge at the upper flank, but is larger and may be a little lower in general shape. Aside from the smaller size *G. garudamangalami* from the Santonian of India is close in general shell shape to *Gyrodes major* (Wade, 1926) from the late Campanian of Mississippi (USA), but differs by having a subsutural ribbon.

**Remarks:** According to Bandel (*in prep.*) *Gyrodes garudamangalami* is a member of the subgenus *Gyrodes (Gyrodes)* since it has the characteristic

124, Pl. 11, Figs.8, 9

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feature of this taxon consisting in the subsutural ribbon that is the result of the filling of the posterior apertural notch during shell growth. Such a feature is not present in the other subgenera of the genus *Gyrodes*.

*Gyrodes (Sohlella) tenellus* Stoliczka 1868

(pl. 4, Figs. 1, 2)

The shell is wider than high, with a spire composing almost one fourth of its total height. The suture is accompanied by a shallow groove that forms the tabulate shoulder. Whorl profile is obliquely rounded with a slight concavity adjacent to the shoulder. The umbilical margin is rounded biangulate with steeply sloping medium-wide umbilicus. The suture is bordered by a flattened narrow and distinct shoulder, but bears no trace of a notch. The aperture is subovate with a straight inner lip that forms the right wall of the conical umbilicus. The outer lip has an angle anteriorly, is thin and widely rounded. The deep umbilicus is bordered by obscure ridges. The surface of the whorl has distinct growth increments which are strongly oblique backwards and best developed in the umbilicus. Growth lines reflect the oblique outer lip of the aperture, that bears a straight inner lip and a rounded outer lip, both of which are thin.

A single specimen from Kulakkalnattam is very well preserved, measures 18 mm in width and is 16 mm high. Two specimens from Garudamangalam are about as high as wide and have more rounded shoulders and measure 17 mm across. A single specimen from Sirinattam is 17 mm wide and 15 mm high.

*Remarks:* *Gyrodes tenellus* is very similar to *Gyrodes (Sohlella) quercus* Popenoe, Saul and Susuki 1987 from the Coniacian to Santonian of California. It actually may represent the same species, but perhaps, has a slightly more narrow umbilicus. Very similar species are also *Gyrodes spillmani* Gabb 1861 and *Gyrodes subcarinatus* Stephenson 1941 (Stephenson, 1941, Pl.52, Figs. 20-26). *G. tenellus* fits in the description of *G. subcarinatus* from the Navarro group of Texas as described by Stephenson (1941, Pl.52, Figs.22-26). Also *Gyrodes tenellus* Stoliczka 1868 as described by Rennie (1930) from the Umzamba Formation (Santonian) of the Indian Coast of South Africa apparently is rather similar, especially when compared with the specimen from Garudamangalam. It also resembles *Gyrodes acutimargo* Roemer from Aachen Greensand in western Germany.

Order : NEOGASTROPODA

Family : PYRIFUSIDAE

Genus : *Pyrifusus* Conrad 1858

The low spired pyriform shell has sub-shouldered whorls. Its ornament consists of spiral cords and transverse costae. The shell has a spire of less or half shell height. The aperture is elongated and posteriorly notched with a straight or curved siphonal canal and smooth columella. The type to the genus



Fig.1. *Anchura securifer*

Figs. 2, 3. *Lirpsa garuda*  
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Figs. 4, 5. *Cantharulus* c  
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Figs. 6, 7. *Profusinus ind*  
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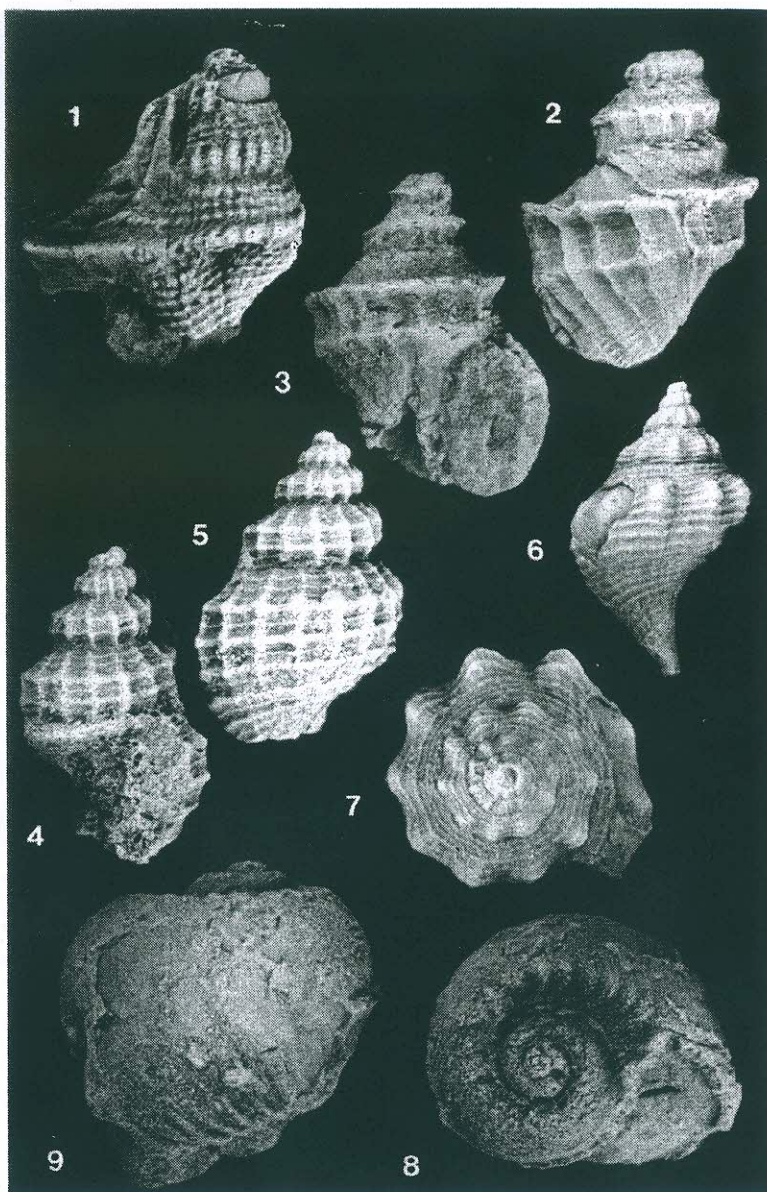


Plate 3.

- Fig.1. *Anchura securifera* (Forbes, 1848) in Stoliczka 1868 with a 4 cm high shell.  
Figs. 2, 3. *Lirpsa garudamangalami* n. sp. in lateral view of a 2.8 cm high shell and in apertural view of the 3 cm high holotype from Garudamangalam.  
Figs. 4, 5. *Cantharulus eximia* (Stoliczka, 1868) in apical and lateral view of the 12 mm high shell.  
Figs. 6, 7. *Profusinus indicus* n. sp. in lateral and apical view of the 3.5 cm high and 2.5 cm wide holotype.  
Figs. 8, 9. *Gyrodex (Gyrodex) garudamangalami* n. sp. in lateral and apical view of the 2 cm high and wide holotype.

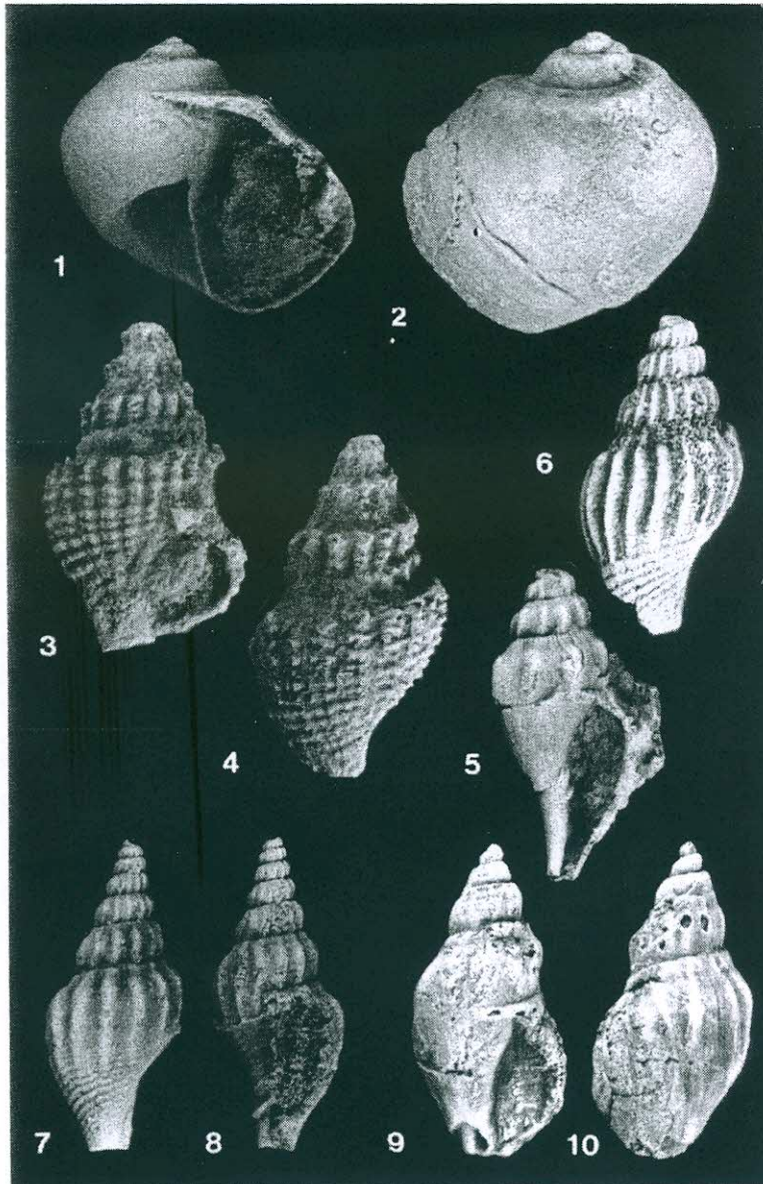


Plate 4.

- Figs. 1, 2. *Gyrodes (Sohlella) tenellus* Stoliczka 1868 in apertural and lateral view of the 18 mm wide shell from Kulakkalnattam.
- Figs. 3, 4. *Pyrifusus (Beisselia) oldhamianus* (Stoliczka, 1868) in apertural and lateral view of the 3.7 cm high shell.
- Figs. 5, 6. *Bellifusus indicus* n. sp. with a 4 cm high shell from Garudamangalam representing the holotype and a 18 mm high juvenile shell from Kuthur (b).
- Figs. 7, 8. *Trichifusus reussianus* (Stoliczka, 1868) in lateral and apertural view of a 2.2 cm high shell.
- Figs. 9, 10. *Cryptorhytis attenuata* (Stoliczka, 1868) in apertural and lateral view of the 6 cm high shell from Kulakkalnattam.

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is *Pyrifusus subdensatus* Conrad 1858 from Owl Creek, Mississippi (Sohl, 1964, Pl.24, Figs.1-4). In the subgenus *Pyrifusus* (*Beisselia*) Holzapfel 1888 the spire amounts to about half of total shell height. Ornament consists of coarse transverse ribs that are strong at the shoulder but end below the periphery and on the collar above. Spiral ornament is weak on the broad subsutural collar and strong below. The aperture is posteriorly notched, anteriorly drawn out to a wide short siphonal canal that twist to the left. The subgenotype is *Koения speciosa* Holzapfel 1888 from the Senonian greensands of Vaals (Wenz, 1938, Fig. 3746).

*Remarks:* The shell of *P. (Beisselia)* resembles that of *Pyrifusus* s.s., but has a higher spire. The original from Vaals is very similar to the type of *Pseudorapa* (Holzapfel, 1888) as can be noted when Figs. 3746 and 3079 in Wenz (1938) are compared. *Deussenia* Stephenson 1941 can either be regarded as synonym or can be differentiated from *Beisselia* by a less constricted base. According to Holzapfel (1888) *Beisselia* differs from *Volutoderma* only by the lack of plications on the columella.

*Pyrifusus (Beisselia) oldhamianus* (Stoliczka, 1868)  
(pl. 4, Figs. 3, 4) P. 129

*Trophon oldhamianum* Stoliczka 1868, pl.11, Fig.13

According to Stoliczka (1868) the whorls are deeply and broadly excavated along the suture with an almost flattened subsutural collar ornamented with growth lines. The flanks of whorls are ornamented by numerous axial ribs forming tubercles with the shoulders. Stoliczka (1868, pl.11, Fig.13) based this species on a fragmentary shell from the Trichinopoly group. The rather characteristic shape is recognized from two shells found at the locality in Kuthur. They have about 20 broad axial ribs which continue across the whorl sides and end in the siphon. On the whorls of the spire they are crossed by 3-4 spiral ribs and on the body whorls by about 13 such subequal ribs. At cross-points granules are formed, and the ones on the shoulder represent short gutter-like spines with their open sides toward the aperture. One shell is about 4 cm high and 2.2 cm wide. The other represents a fragment of a larger shell and indicates that the species grew to at least 7 cm shell height.

*Remarks:* *P. oldhamianus* has similarly tuberculated shoulders as found in *Beisselia speciosa* (Holzapfel, 1888), but a somewhat shorter spire and little longer body. It is quite similar to *Pyrifusus ejundicus* Sohl, 1964 (Sohl, Pl. 24, Figs. 22,25) from Ripley Formation, but seems to have denser ornament. *Pyropsis subdensatus* Conrad, 1858 from Ripley Formation has more rounded outline and fewer ribs (Sohl, 1964, pl. 24, Figs.1-4). None of the species from the American Gulf Coast have gutter-like spines on the upper edge. With exception of the gutter spines of *P. oldhamianus* of India *Deussenia travisiana* Stephenson 1941 from the Campanian/Maastrichtian of Texas is extremely similar in shape and ornament (Stephenson, 1941, pl.63, Figs.5-8).



and lateral view of the 18 mm  
apertural and lateral view of  
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(b).  
apertural view of a 2.2 cm high  
and lateral view of the 6 cm

Genus : *Bellifusus* Stephenson 1941

The medium sized fusiform shell has a spire of not quite as high as the length of the aperture. Whorls are generally inflated above midheight constricted posteriorly to a transversely wrinkled collar, and bear a sharp to well rounded shoulder. The ornament consists of strong collabral transverse ribs that end on the basal slope and spiral cords and lirae that cover the surface or are restricted to the lower body slope. The aperture is sublenticular with moderately long siphonal canal. The columella is slightly twisted with a strong plication anterior to one or two weaker folds. Genotype: *Odontofusus curvicostata* Wade 1926 from Coon Creek, Tennessee.)

*Bellifusus indicus* n. sp.

(pl. 4, Figs. 5, 6)

*Fasciolaria rigida* (Baily, 1855) Stoliczka, 1868, p. 109, pl.10, Figs.10-16.

**Diagnosis:** The about 4 cm high and 2 cm wide fusiform shell is about of equal length of the spire and the body whorl. The subsutural collar is prominent, and whorls are convex with ornament of about 14 axial ribs in early whorls 9-10 ribs on late whorls and spiral cords that are stronger on the lower body slope.

**Description:** According to Stoliczka (1868), the medium sized (about 4 cm high and 2 cm wide) fusiform shell has a spire of almost half total shell height. The whorls are contracted along the suture and produced anteriorly into a long canal. Whorls are inflated above midheight constricted posteriorly to a transversely wrinkled collar, and bear an angular, but rounded shoulder. The ornament consists of about 14 strong collabral transverse ribs (in early whorls) that end on the basal slope and spiral cords and lirae that cover the surface and are slightly stronger on the lower body slope. The aperture is sublenticular with moderately long straight siphonal canal. The columella is slightly twisted with a strong plication anterior to one to three weaker folds. Only the lower stronger columellar fold is visible in the aperture the others appear further inward on the columella.

Several specimens from Garudamangalam indicate that there are about 9-10 axial ribs and two strong columellar plication far anterior in the aperture. The spiral liration is strong, and there are 4-5 of them visible on the whorls of the spire, about 13 feature of the body whorl. A shell with 7 whorls is 4 cm high and 2 cm wide. One fully grown and one juvenile specimen are also from Kuthur, in addition to several fragments that may belong to this species.

**Difference:** *Bellifusus* is characterized by the wrinkled subsutural collar, the strong collabral transverse ribs and the twisted plicate columella which is smooth in *Pyrifusus*. *Voluta rigida* Baily 1855 from the Santonian/Campanian of the South African Umzamba Formation differs from *Bellifusus indicus* by being larger, more slender, and having no columellar plications, and thus belongs to the genus *Pyrifusus*. *Bellifusus indicus* is rather similar to the genotype of *Bellifusus* from the American Ripley Formation. There are

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Genotype: *Odontofusus*  
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few and even less than 12 axial ribs present on late whorls of the teleoconch, but spiral lirae are more prominent in *B. indicus* than in *B. curvicostatus* (Sohl 1964, Pl.25, Figs. 23,24, Pl.26, Figs.18,19,23,24). *Bellifusus angulicostata* Sohl, 1964 (Sohl 1964, Pl.25, Figs.21,22) from Ripley Formation also has about the same apical angle and sharp crested anterior portions of the radial ribs.

*Holotype*: Geological-Palaeontological Department, Hamburg University. Nr. 4206.

Genus : *Trichifusus* n. gen.

*Diagnosis*: The fusiform shell with long siphon has a narrow subsutural ribbon only on late whorls and is ornamented by broad axial ribs and fine spiral ribbons. The inner lip bears three folds of which the anterior one is the strongest. The type is *Trichifusus reussianus* (Stoliczka, 1868).

*Name Derivative*: Combination of a *Fusus*-like shell from the Trichinopoly Formation.

*Difference*: *Dolicholaturus torquatus* (Sohl, 1964) from Ripley Formation, USA is very similar in shape and ornament, but differs by having only two plications on the inner lip. Since it is quite unlikely that *Dolicholaturus torquatus* really belongs to the genus *Dolicholaturus* with living genotype, *Trichifusus reussianus* can not be placed in this genus. *Trichifusus reussianus* was originally described as member of the genus *Latirus* Montfort 1810 by Stoliczka (1868) who also expressed a close resemblance with *Fusus reussi* Zekeli 1852 from the Gosau deposits.

*Trichifusus reussianus* (Stoliczka, 1868)

(pl. 4, Figs. 7, 8)

*Latirus reussianus* Stoliczka, 1868, pl.10, Figs.1-4.

The about 2 cm high shell with 3 columellar folds has a spiral angle of about 50° when fully grown (Stoliczka, 1868, pl.10, Fig.1-4). Two specimen from the locality near Kuthur are about 2.2 cm high and 1 cm wide consisting of about 7 whorls. The subsutural ribbon is very indistinct and developed as depression covered by the same kind of ornament as is seen next to it, but in the last whorl the ribbon becomes wider and more clearly developed. Ornament consists of about 13 strong axial ribs which are continuous into the suture and terminates on the siphonal column. The axial ribs are crossed by numerous spiral ribbons which also cover the siphon. The apical angle of the first 5-6 whorls is smaller (about 30°) than in later whorls where it increases to about 50° in the last whorl. The flanks of the shell, therefore, appear concave. The aperture is lenticular, subovate with an inner lip callus bearing one strong anterior plication and two weaker posterior ones.

*Remarks*: *T. reussianus* from India is intermediate in shape between *Bellifusus* and *Drilluta*, but in contrast to these has a much narrower, and in early whorls rather indistinct subsutural ribbon. Of the Ripley Formation

109, pl.10, Figs.10-16.

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species *Dolicholaturus torquatus* Sohl 1964 from Owl Creek appears to be the closest species to *Trichifusus reussianus*.

Genus : *Cryptorhytis* Meek 1876

The medium sized fusiform shell has posteriorly constricted whorls, a relatively long siphonal canal and several oblique plaits that occur relatively high on the columella, but are not visible at the aperture. Genotype: *Gladius ? cheyennensis* Meek and Hayden 1860 from US Interior.

*Remarks:* The species of this genus are probably closely related to *Ornopsis* (Sohl, 1964), but the columellar plication is not so sharp and oblique and there is usually one more present than in *Bellifusus*. In shell shape *Cryptorhytis* closely resembles *Aliofusus*, but the three columellar folds are clearly distinctive, and *Aliofusus* tends to have a more sharply developed periphery.

*Cryptorhytis attenuata* (Stoliczka, 1868)

(pl. 4, Figs. 9, 10)

*Scapha attenuata* Stoliczka, 1868, pl.6, Figs. 4, 5.

According to Stoliczka (1868, Pl.6, Figs.4,5) the elongated fusiform shell with apical angle of 45° to 50° consists of about 7 whorls, is up to 6 cm high, and 2.7 cm wide. The subsutural collar is well developed, and the last whorl is about as high or a little higher than the spire. Ornament consists of 8-9 strong axial ribs on each whorl that form tubercles at the periphery and end below. Fine spiral ridges feature the shell surface indistinctly. The elongated aperture continues in a slightly flexed siphonal canal and a posterior short channel. The columellar lip has three or four folds. A rather large individual of what should be a *Cryptorhytis attenuata* from Kulakkalnattam measures 6 cm in height and has plications on the inner lip. Seven individuals were found at Garudamangalam and one from Kulakkalnattam.

*Remarks:* *Cryptorhytis attenuata* is more slender than *Cryptorhytis gravida* which has a relatively shorter spire and is of broader shape.

*Cryptorhytis gravida* (Stoliczka, 1868)

(pl. 5, Figs. 1, 2)

*Scapha gravida* Stoliczka, 1868, p. 82, Pl.6, Fig.6.

The elongated fusiform shell consists of about 7 whorls, is up to 4 cm high and 2 cm wide with well developed subsutural collar and last whorl about as high or a little higher than the spire. Ornament consists of 8-9 strong axial ribs on each whorl that form tubercles at the periphery and die out below. Fine spiral ridges feature the shell surface indistinctly. The elongated aperture continues in a slightly flexed siphonal canal and a posterior short channel. The columellar lip has two or three folds.

An individual from the Trichinopoly Group at Kulakkalnattam was about 5 cm high and 2 cm wide with the spire about one third of the body

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The medium-length has posterior canal of moderate ornament is dominant and spiral sculptured angular posteriorly, left. The columella based on *Paleopsep* (Sohl, 1964, Pl.28, 1 inflated and rounded ornament, and less

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whorl (as in the frontal view in Fig. 4 in Stoliczka as well) and with the apical angle increasing with growth. The shell consists of about 5 whorls of the teleoconch, and folds on the columellar lip are rather indistinct.

*Remarks:* *Cryptorhytis grandidata* (Stoliczka, 1868) from Kulakkalnattam is of broader shape and has a relatively shorter spire than *C. attenuata* from Garudamangalam that has three to four plications on the inner lip. *Cryptorhytis nobilis* (Wade, 1926) from Coon Creek in Tennessee is slightly smaller than *C. attenuata* from Garudamangalam, but otherwise could represent the same species (Sohl, 1964, pl. 32, Figs.2,3). *Ornopsis (Pornosis) modica* Sohl, 1964 is a little wider and has similar ornament, but only one plication on the columellar lip (Sohl, 1964, pl. 29, Figs.4-7). *Odontobasis sulcata* Sohl 1964 (Sohl, 1964, pl.23, Figs.1-4) is similar in general shell shape, and two plications bordering the siphonal canal, but differs in regard to the stronger ornament of spiral ribbons.

Stoliczka (1868, pl.6, Figs.4,5) described these species from the Trichinopoly Group near Kulakkalnattam and Garudamangalam as members of the genus *Scapha* and, thus, as representative of the Volutinae among the modern Neogastropoda. But Cretaceous members of the Volutidae are characterized by a large protoconch (Bandel *in prep.*) which is not noted in case of any *Cryptorhytis* that is known.

#### Genus : *Paleopsephaea* Wade, 1926

The medium-sized fusiform shell with a spire about half total shell length has posteriorly constricted whorls and tapers anteriorly to a siphonal canal of moderate length. A subsutural collar is indistinct and narrow. The ornament is dominated by strong collabral transverse ribs on the swollen body, and spiral sculpture may be present. The aperture is lanceolate, acutely angular posteriorly, and the siphonal canal slightly curved and inclined to the left. The columella generally bears three oblique plications. The genus is based on *Paleopsephaea mutabilis* (Wade, 1926) from Coon Creek, Tennessee (Sohl, 1964, Pl.28, Figs.1-6). *Paleopsephaea* differs from *Bellifusus* by its less inflated and rounded whorls, lack of subsutural collar, more subdued ornament, and less strongly constricted whorls.

#### *Paleopsephaea assimilis* (Stoliczka, 1868)

(pl. 5, Figs. 3, 4)

*Fasciolaria assimilis* Stoliczka, 1868, p. 110, Pl. 10, Fig. 6.

Two shells from Kuthur and Siranattam resemble Stoliczka's illustrations on Pl. 10, Fig. 6, but also Pl. 10, Fig. 11. In the later case it was considered to represent a *Fasciolaria rigida*. There are up to 10 axial ribs in the three early whorls of the teleoconch, about 18 in the fourth or fifth and about 14 in the later sixth or seventh whorl. The individuals found are up to 3.5 cm high and have a spire about as high as the last whorl with slender siphon and three strong plicae on the inner lip of the aperture. A subsutural ribbon is quite

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distinct and ornamented with axial ribs. It forms only a subsutural depression without growth lines indicating a filled canal.

*Remarks:* The more rounded upper whorl portion, the continuation of the axial ribs onto the subsutural ribbon, the larger number of ribs distinguish *Paleopsephaea assimilis* from *Bellifusus indicus*. *P. assimilis* has a more distinct subsutural groove than is present in *Trichifusus reussianus*.

✓ *Paleopsephaea latisepta* (Stoliczka, 1868)  
(pl. 5, Figs. 5, 6)

*Volutilithes latisepta* Stoliczka, 1868, p.93, pl. 9, Figs.1, 2.

The up to 6 cm high and 3.3 cm wide slender fusiform shell with a spire about half total shell length has posteriorly constricted whorls and is anteriorly tapering to a siphonal canal of moderate length. The ornament is dominated by 8-10 sinuous collabral ribs on the swollen body. These ribs are continuous below the sutures and continue across the slight depression that delimits the subsutural collar to end in the suture. The aperture is lanceolate, acutely angular posteriorly with a narrow canal, and siphonal canal is straight. The columella bears three oblique plications of which the anterior most is the strongest. Two specimens are from Siranattam and three from Kulakulnattam.

*Remarks:* The absence of clearly visible spiral ridges of the ornament differentiates *Paleopsephaea latisepta* from *P. assimilis*. The Indian species is very similar to the Gulf Coast *P. mutabilis* (Sohl, 1964, Pl.28, Figs.1-6) regarding shell shape, size, ornament, features of the siphonal canal, and the columellar lip. The American species also has only faint traces of spiral ornament and three oblique columellar plicae. *P. mutabilis* is slightly more slender.

Subfamily : Volutoderminae Sohl, 1964.

The *Voluta*-shaped more or less elongated fusiform shell of members of this subfamily is provided with a more or less high spire. The aperture is elongated and narrow with a notch posteriorly, and a long broad siphonal canal anteriorly. The volutid or conoid shape is developed in *Gosavia* s.s. and rather elongated shape in *Volutoderma*. *Gosavia* and *Volutoderma* have a broad subsutural collar and usually three, often more, rarely less oblique columellar plaits. Stephenson (1941) included the similar *Volutomorpha*, *Volutoderma* and *Longoconcha* jointly with the rather differently shaped *Paleopsephaea* in the family Volutidae. Sohl (1964) also included *Volutoderma*, and *Volutomorpha* in the Volutidae, subfamily Volutoderminae, while Wenz (1938) had placed them in the Volutidae, subfamily Pholidotominae including also *Gosavia*. Sohl's classification scheme is here preferred, with inclusion of the genus *Gosavia*, but the Volutoderminae are no longer considered to belong to the Volutidae, since they do not have the characteristic simple and large protoconch of this taxon (Bandel, *in prep.*). The Volutoderminae are

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considered to represent a subfamily of the Pyrifusidae which represent a Cretaceous family of uncertain relation to modern Neogastropoda.

Genus : *Gosavia* Stoliczka 1865

The shape of the shell resembles that of a *Conus*. A notch of the posterior outer lip lies next to the suture. The ornament consists of spiral striation and short axial ribs on the angular shoulder. The callus of the inner lip bears many small plications, with the three lower ones being the strongest. The genotype is *Voluta squamosa* from the Gosau deposits (Northern Alps). *Carota* and *Volutomorpha* have more rounded flaps than found in *Gosavia* with more cone-like shell. An even more rounded shell could grade into shapes as found in *Ficulopsis*. Stoliczka (1868) included *Mitra limburgensis* Binkhorst in the relation of *Gosavia*, even though it has plaits only in the centre of its columellar lip.

*Gosavia indica* Stoliczka, 1868

(pl. 5, Figs. 7, 8)

*Gosavia indica* Stoliczka, 1868, Pl.6, Figs. 3, 7, 8.

The shell has an elevated spire and consists of 6-7 whorls with the last one amounting to two-thirds of total height of about 6 cm. The sutures are deep and 12-15 tubercles feature the rounded keel. Ornament consists of spiral striae. The aperture is narrow and straight with the posterior outer lip deeply notched. The inner lip is plaited over its entire extent. The upper of the 8-9 plaits are thin and distant and anterior ones become thick and strong. In the newly collected and studied specimen only the three anterior plaits were found. The seven specimens from Garudamangalam are up to 6 cm long and less than 3 cm wide.

*Remarks:* *Gosavia squamosa* has the keel ornamented with numerous and small tubercles, while *Gosacia indica* has stronger but fewer tubercles here. Plicae on the columella differ from those of *Carota* with only three plicae. *Volutoderma stoliczkana* is more slender and larger than *Gosavia indica*.

Genus : *Volutoderma* Gabb 1877

The large elongated fusiform shell has a more or less high spire. The whorls are constricted posteriorly and may be shouldered. Their ornament consists of spiral cords and strong transverse ribs. The aperture is elongated and narrow with a notch anteriorly and a long broad siphonal canal. Three columellar plications are present on the inner lip. According to Sohl (1964) the genotype is *Fusus navarroensis* Gabb from the late Cretaceous of California, while according to Holzapfel (1888) the genotype is *Voluta elongata* d'Orbigny from the Cretaceous of France. According to Steward (1927) the genus is based on *Fusus averilli* Gabb from California. The genera *Longoconcha* and *Volutomorpha* from the Ripley Formation differ from

*Volutoderma* by having a glazed surface as extension of the callus of the inner lip, while the outer shell of *Volutoderma* remains free of callus-deposits. *Volutoderma* was not noted among the species of the Ripley Formation in Mississippi and Tennessee. *Volutoderma zitteliana* (Holzapfel, 1888) from Vaal Greensands of Middle Europe is a characteristic representative of the genus (Wenz, 1938, Fig. 3739).

Species *Volutoderma stoliczkana* Dall 1907

(pl. 5, Figs. 9, 10)

*Fulguraria elongata* Stoliczka, 1868, p. 87, pl.7, Fig.7.

*Volutoderma (Rostellinda) stoliczkana* Dall, 1907.

*Volutoderma (Rostellinda) stoliczkana* Wenz, 1938, p.1312, Fig.37.

The elongated, subcylindrical shell has an evenly tapering spire of one-third to one-fifth the total shell length, depending on the stage of growth of the shell. The body whorl is rounded with a subsutural constriction ornamented by strongly imbricate growth lines in young stages of teleoconch growth, in later stages it becomes more elongated. The sculpture is dominated by wide-spaced spiral cords that cross weakly developed wide axial ribs which are present on the periphery, but terminate on the flanks as well as before reaching the subsutural collar. The aperture is elongated and channeled posteriorly and expanded anteriorly, slowly grading into a narrow siphonal canal. The inner lip is covered by callus that spreads somewhat onto the body. In older individuals the callus forms a thick pad covering the posterior portion of the inner lip while the glaze of the anterior portion of the inner lip is thin. The columella bears three or more strong plications. A shell from Kulakkalnattam is 9 cm high and 3.5 cm wide. From Garudamangalam 8 individuals have been collected, the largest of which measures more than 7 cm in height and is 3 cm wide.

*Remarks:* A species described as *Fulguraria elongata* by Stoliczka (1868, Pl.7) which later was renamed *Volutoderma stoliczkana* from India is very close to members of the genus *Volutomorpha* as known from Ripley Formation, but has no glaze on the outside of the shell. Stoliczka noted much variations in shell form among the individuals of *Volutoderma stoliczkana* from India. If the same variation in the American *Volutomorpha* would be developed, the different species recognized at the moment could perhaps merge, and the result would be a rather variable species quite similar to the Indian species. *Volutomorpha mutabilis* Wade 1926 from Ripley Formation is quite variable in itself (Sohl, 1964) as well as very common, just like the Indian *Volutoderma stoliczkana*. Members of the genus have also been described from Europe, but need to be rechecked. The genus *Fulguraria* Schumacher 1810 (= *Fulguraria* Cossmann 1899) is based on a modern species from the Chinese Sea (Wenz, 1938, Fig. 3770), with lecithotrophic embryonic development and belonging to the Volutidae.

*Fulguraria*

The elongated, subcylindrical shell has an evenly tapering spire of about one-third to one-fifth the total shell length, depending on the stage of growth of the shell. The body whorl is rounded with a subsutural constriction ornamented by strongly imbricate growth lines in young stages of teleoconch growth, in later stages it becomes more elongated. The sculpture is dominated by wide-spaced spiral cords that cross weakly developed wide axial ribs which are present on the periphery, but terminate on the flanks as well as before reaching the subsutural collar. The aperture is elongated and channeled posteriorly and expanded anteriorly, slowly grading into a narrow siphonal canal. The inner lip is covered by callus that spreads somewhat onto the body. In older individuals the callus forms a thick pad covering the posterior portion of the inner lip while the glaze of the anterior portion of the inner lip is thin. The columella bears three or more strong plications. A shell from Kulakkalnattam is 9 cm high and 3.5 cm wide. From Garudamangalam 8 individuals have been collected, the largest of which measures more than 7 cm in height and is 3 cm wide.

*Remarks:* The species described as *Fulguraria elongata* by Stoliczka (1868, Pl.7) which later was renamed *Volutoderma stoliczkana* from India is very close to members of the genus *Volutomorpha* as known from Ripley Formation, but has no glaze on the outside of the shell. Stoliczka noted much variations in shell form among the individuals of *Volutoderma stoliczkana* from India. If the same variation in the American *Volutomorpha* would be developed, the different species recognized at the moment could perhaps merge, and the result would be a rather variable species quite similar to the Indian species. *Volutomorpha mutabilis* Wade 1926 from Ripley Formation is quite variable in itself (Sohl, 1964) as well as very common, just like the Indian *Volutoderma stoliczkana*. Members of the genus have also been described from Europe, but need to be rechecked. The genus *Fulguraria* Schumacher 1810 (= *Fulguraria* Cossmann 1899) is based on a modern species from the Chinese Sea (Wenz, 1938, Fig. 3770), with lecithotrophic embryonic development and belonging to the Volutidae.

Sut

The fusiform shell is elongated and proportionally low. The subsutural collar is inclined rather steeply. The body whorl is more or less rounded with a spiral ornament of rounded ribs or strong plications. The subsutural plication is subenticular, produced, and may be straight or inclined. The aperture is broadly subovate and is slightly beveled. The columella is coiled, rounded smooth, and bears three or more strong plications. The siphon is low. Genera of the family Pyrifusidae, but low genera are *Pyropsis*.

*Volutoderma multistriata* (Stoliczka, 1868)

(pl. 5, Figs. 11, 12)

*Fulguraria multistriata* Stoliczka, 1868, p.89. Pl.8, Figs.1-3.

The elongated, slender fusiform shell has an evenly tapering spire of about one-third the total shell length. The body whorl is elongated, with conspicuous subsutural collar, rounded periphery and flat sided flanks. The subsutural constriction is ornamented by imbricate growth lines with one or few delicate spiral lirae in early whorls, which in later whorls are no longer present. The sculpture consists of eight to ten wide-spaced strong and rounded axial ribs which terminate before reaching the base and just posterior to the periphery before beginning of the subsutural collar. Spiral cords intersect these, 5-7 are visible on the spire and about 15 on the body whorl. The aperture is elongated and channeled posteriorly and expanded anteriorly, slowly grading into a narrow siphonal canal. The inner lip is thickly glazed over by callus, and the columella bears three strong plications. There may be one or two additional plicae posterior to these. A small individual is present from Kuthur, and a larger one, with a shell originally measuring about 9 cm in length and 3.5 cm in width is from Garudamangalam.

*Remarks:* The strong spiral ridges connected to wide axial ribs differ from *Volutoderma stoliczkana* with weak axial ribs and weaker spiral elements as well. *Gosavia indica* is much shorter and also *Volutoderma stoliczkana* has a shorter spire and higher shoulder. The type to *Volutoderma*, *V. averilli* (= *navarroensis*) Gabb from California is rather similar in general shape, but has a less pronounced subsutural collar and less strong axial ribs. Stoliczka (1868) described only fragmentary specimen, but due to their characteristic ornament they probably belong to the same species as the two specimens described here. The number of plicae on the columella appears to be three and not four as noted by Stoliczka.

## Subfamily : PYROPSINAE Stephenson 1941

The fusiform shell is shouldered and has peripherally swollen whorls and proportionally low spire that sometimes is almost flat. A broad subsutural collar or inclined ramp is present. Below the carinate and spinose shoulder the body is more or less roundly constricted to the siphonal canal. There is a spiral ornament of ribbons to strong cords connected to axial ornament of rounded ribs or straight ridges and may become obsolete. The aperture is sublenticular, produced anteriorly to a well developed siphonal canal that may be straight or inclined to the left. The columellar lip commonly begins with a swelling and is otherwise smooth or bears oblique plicae. The aperture is broadly subovate and posteriorly notched. The early ontogenetic shell is lowly coiled, rounded smooth. The protoconch is not high and pointed as in the Pyrifusidae, but low and rounded like that of *Weeksia* (Bandel, 1998). Typical genera are *Pyropsis* and *Napulus*.

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7, pl.7, Fig.7.

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188, p.1312, Fig.37.

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Genus : *Pyropsis* Conrad 1860

The medium to large-sized subpyriform shell has a low to very low spire, peripherally expanded whorls that are shouldered and strongly constricted anteriorly, and a long tapering siphonal canal. The ornament is dominated by noded spinose spiral cords. The aperture is thickened within the inner lip, covered by thick callus and a smooth columella. A broad swelling above the siphonal canal produces an umbilical chink at the upper edge of the columellar lip. The protoconch of the type to the genus *Tudicla* (*Pyropsis*) *perlata* Conrad 1860 from Mississippi is round topped and consists of two whorls which are somewhat raised above the plane of volution of the teleoconch (Sohl, 1964). The ornament of *Pyropsis* is less strong as that of the similar *Napulus*.

Species *Pyropsis nodifera* (Stoliczka, 1868)  
(pl. 6, Figs. 1, 2)

*Rapa nodifera* Stoliczka, 1868, p.153, pl.12, Figs.10-11

The spire of the subpyriform shell is peripherally shouldered, short and composed of a little more than three volutions of the teleoconch. The apical shoulder is flattened, even somewhat concave. Ornament consists by noded spinose spiral cords. Of these the one below the sharp angulation of the periphery is narrower than the fifth or seventh, and those further down on the base become smaller. The aperture has a straight to concave inner lip covered by callus and a smooth columella. The posterior canal is distinct, and the umbilical chink at the upper edge of the columellar lip is covered. Two specimens come from Garudamangalam, and seven are from Kuthur, and they are up to 3 cm wide and 3.5 cm high.

*Remarks:* The two species of *Pyropsis* from the Kulakkalnattam Formation were named *Rapa nodifera* and *Rapa cancellata* by Stoliczka (1868) who considered them to be related to *Murex* among the modern species. Sohl (1964) preferred the Xancidae/Vasinae as modern relation to *Pyropsis*. Wenz (1938) considered *Pyropsis* to represent a subgenus to the genus *Tudicla* Röding 1798 from the Pazific Ocean. *Tudicla* is based on the living species *T. spirillus* (Linné) from the Pazific Ocean and has a large sized protoconch (Wenz, 1938, Fig. 3715) and belongs to the Vasidae. Stephenson (1941) created a separate family Pyropsidae to encompass *Pyropsis* and related forms, but he did not present a diagnosis for this new taxon, which is based on *Pyropsis proxima* illustrated by Wade (1926, Pl. 27, Fig.8-10) and Sohl (1964, Pl. 33, Figs.7,10). Among the species from the Ripley Formation juvenile shells of *Pyropsis perornatus* Sohl, 1964 (Sohl, 1964, Pl.34, Figs.2-4,11,13) are the closest to *P. nodifera*, but the siphon is longer. *Pyropsis lanhami* Stephenson 1941 from the Campanian/Maastrichtian of Texas is close to *Pyropsis nodifera* (Stephenson, 1941, Pl.59, Figs 14-16). *P. nodifera* also resembles *Praesargana condoni* White 1889 in shape and ornament, but lacks the umbilical depression bounded by a fasciole.



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low to very low spire, and strongly constricted. The aperture is dominated by a broad swelling above the upper edge of the inner lip, and consists of two whorls of evolution of the shell less strong as that of

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in the Kulakkalnattam. *Stoliczka cancellata* by Stoliczka, 1868 among the modern species as modern relation to present a subgenus to the genus *Tudicla* is based on the shape and has a large sized shell. The Vasidae. Stephenson's compass *Pyropsis* and for this new taxon, which is 26, Pl. 27, Fig. 8-10) and in the Ripley Formation, Stoliczka, 1964, Pl. 34, Figs. 2-3. Stephenson is longer. *Pyropsis* is a Cretaceous of Texas is Figs 14-16). *P. nodifera* shape and ornament, but smaller.

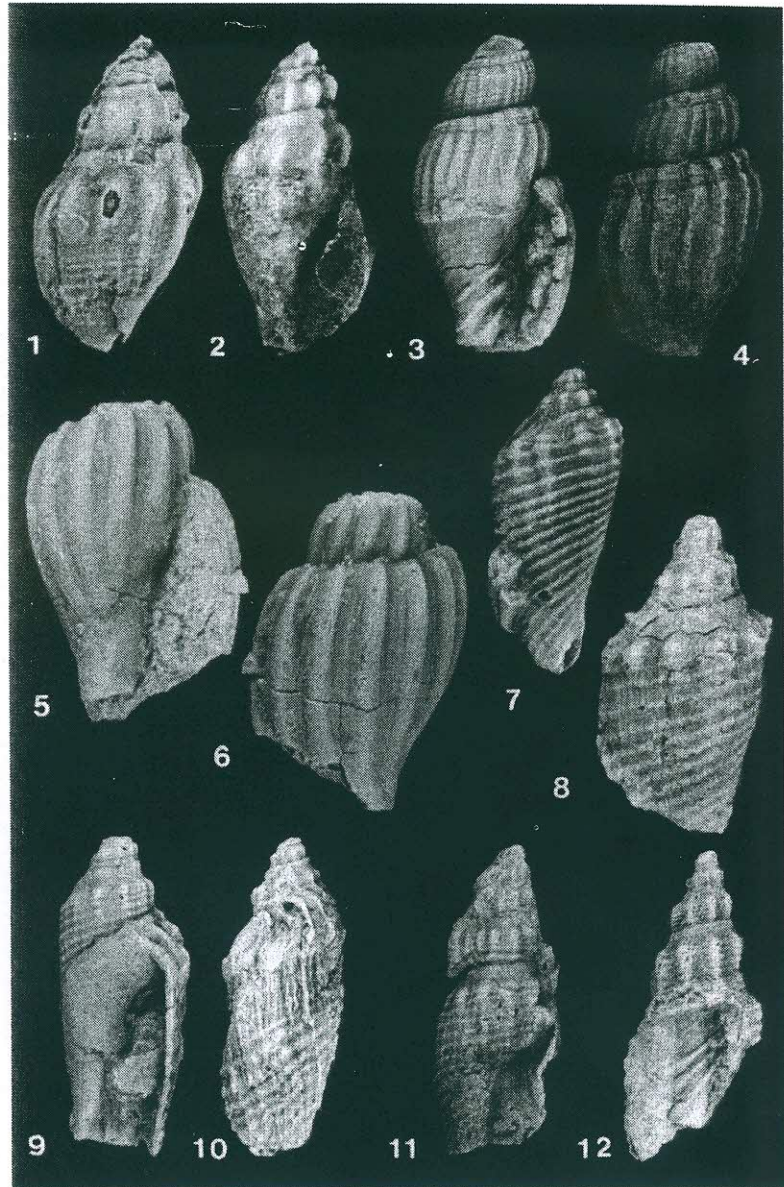
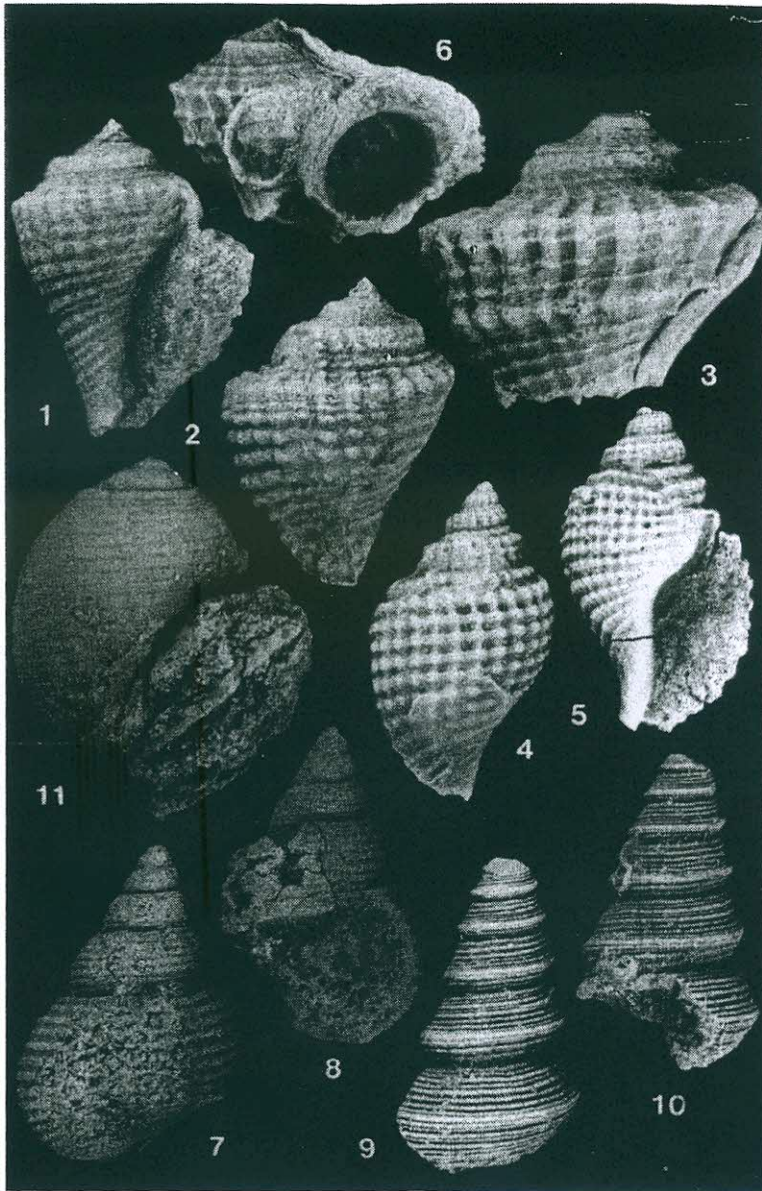


Plate 5.

- Figs. 1, 2. *Cryptorhytis gravida* (Stoliczka, 1868) in lateral and apertural view of the 5 cm high shell from Kulakkalnattam.  
Figs. 3, 4. *Paleopsephaea assimilis* (Stoliczka, 1868) in apertural and lateral view of the 2.8 cm high shell from Sirmattam.  
Figs. 5, 6. *Paleopsephaea latisepta* (Stoliczka, 1868) with a fragmentary shell of 3 cm height seen from the front and the back.  
Figs. 7, 8. *Gosavia indica* Stoliczka, 1868 with a 4.5 cm high shell and a 3.2 cm high shell from Garudamangalam.  
Figs. 9, 10. *Volutoderma stoliczkana* (Dall, 1907) with apertural and lateral view of the 6.5 cm high shell from Garudamangalam.  
Figs. 11, 12. *Volutoderma (Volutoderma) multistriata* (Stoliczka, 1868) with apertural view of a 7.7 cm high shell from Garudamangalam and a 3.7 cm high shell from Kuthur.



**Plate 6.**

- Figs. 1, 2. *Pyropsis nodifera* (Stoliczka, 1868) with 3.2 cm high shell from Kuthur.  
 Figs. 3. *Pyropsis cancellata* (Stoliczka, 1868) with 2.6 cm wide shell from Garudamangalam.  
 Figs. 4, 5. *Napulus excavatus* (Stoliczka, 1868) in lateral and apertural view of a 4.5 cm high shell.  
 Figs. 6. *Sargana eximia* (Stoliczka, 1868) in apertural view of a 3 cm wide shell.  
 Figs. 7, 8. *Lemniscolittorina kuthurensis* n. sp. in lateral view of the 2.3 cm high holotype and a 2 cm high frontal view.  
 Figs. 9, 10. *Arcotia indica* (Stoliczka, 1868) with a 11 mm high shell from Kuthur.  
 Fig. 11. *Oligoptycha ampla* (Stoliczka, 1868) with 1.7 cm high shell.

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*Pyropsis cancellata* (Stoliczka, 1868)

(pl. 6, Fig. 3)

*Rapa cancellata* Stoliczka, 1868, p. 154, pl.13, Figs.1-4.

The spire is very short and flattened above, and the shell is constricted at its base. On the periphery there are two keels present, the upper one being the stronger. The ornament consists of granulated spiral ridges that are crossed by axial ones forming a more or less regular pattern of rectangles. Axial ribs form with the keels irregular tubercles, strongest on the upper keel. The aperture is angular elongated, and the posterior canal is narrow. The anterior siphonal canal is long, but usually broken off, and the inner lip is thickened. Shells are about 2.5 cm high and wide. Two specimens are from Siranattam and two from Garudamangalam.

*Remarks:* Stoliczka (1868) noted a similarity of *P. cancellata* with *Pyrula filamentosa* Binkhořst 1861 from the Late Cretaceous of Limbourg. While the shape of the shell is very close to that of the Ripley Formation species *Pyropsis proxima* Wade, and *P. perlata* Conrad (Sohl, 1964, Pl.33) the rectangular ornament resembles that of *Napulus* (Sohl, 1963, Pl.35). *Pyropsis nodifera* is of more rounded outline than *P. cancellata* and is higher than wide. *Rapa* Bruguière 1792 is a member of the Magilidae (=Coralliophilidae), representing a specialized group of the Muricoidea. Its type *Rapa rapa* (Linne) from the Philippines has no posterior apertural notch, but resembles *Pyropsis* in shell shape. The highly ornamented protoconch of Magilidae (Bandel et al. 1997) clearly indicates that it is only convergence that connects these coral eating muricids with *Pyropsis*.

Genus : *Napulus* Stephenson 1941

The medium sized low spired pyriform shell has a moderately long siphonal canal comprising about one third total shell length. The body whorl is well rounded, inflated, shouldered to subshouldered, and marked by wide-spaced strong spiral cords or ribbons, crossed by lower transverse ribs. The columella is smooth and straight. According to Stephenson (1941) *Napulus whitfieldi* Weller 1907 is the type to this genus, while Sohl (1964) selected *Napulus reesidei* Sohl, 1964 from Coon Creek, Tennessee because of better preservation. The character of the spire, and the shape of the long siphonal canal is similar between *Napulus* and *Pyropsis* (Sohl, 1964). *Napulus* has a plumper body whorl than *Pyropsis* and lacks the prominent peripheral angle.

*Napulus excavatus* (Stoliczka, 1868)

(pl. 6, Figs.4, 5)

*Neptunea excavata*, Stoliczka, 1868, p. 121, pl.11, Figs.1-3.

The pyriform shell has a moderately long siphonal canal and varies a good deal in shape. Some individuals have a more elongated, others a shorter spire. The ornament is somewhat variable too, with spiral cords, usually crossed by axial cords of equal width, and forming tubercles at crossing



shell from Kuthur.  
shell from Garudamangalam.  
lateral view of a 4.5 cm high

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points. This gives the surface a coarsely reticulated or cancellated appearance. There are 8-9 strong spiral ribbons, and about 24 more narrow axial ribs which form tubercles where crossing in addition to minor spiral lirae on the siphon. Commonly on worn specimens the ornament appears to consist of rows of tubercles, in others a pattern of rather regular squarish rectangles is found. The inner lip and columella is smooth and straight, and there is a very slight curvature of the siphon to the left. The shell with about five whorls of the teleoconch is almost 5 cm long and 3 cm wide. Five specimens from Kuthur were studied.

*Remarks:* *Napulus excavatus* intermediates in shape between *Morea* and American Gulf Coast species of *Napulus* regarding to the ornament and shape of the aperture. Regarding the characteristic twist of the columella to the left in *Morea* it differs. *Napulus fragilis* (Sohl, 1964) from Mississippi closely resembles *Napulus tuberculatus* (Stephenson, 1941) from Texas, and both closely resemble the Indian species. The protoconch of *N. fragilis* is erected and followed by teleoconch with two nodular keels. Similar is also *Napulus reesidei* from the Ripley Formation, which differs by being somewhat larger and a little more slender than *N. excavatus*. With the exception of the columellar fasciole *Napulus excavatus* also resembles closely *Morea marylandica* which is common in the American Gulf Coast Cretaceous. The similarity of *Napulus excavatus* from the Santonian-Campanian of Tamil Nadu with the stratigraphically younger *Napulus reesidei* from the Maastrichtian of the American Gulf Coast indicates a close relation and connection across the far distance between both fauna.

#### Subfamily : Sarganinae Stephenson 1923

The low spired subpyriform shell has anteriorly constricted whorls with a hollow spindle (large pseudoumbilicus). The aperture is posteriorly notched and anteriorly drawn out to a narrow curved siphonal canal. This pyrofusid posterior notch is connected to an apical narrow canal which creates a scalenoid subsutural collar. The ornament consists of axial and spiral elements commonly of equal width and often producing a granular to tubercular pattern. The protoconch is almost planispirally coiled and consists of one to few whorls. The flat topped Sarganinae are here represented by *Sargana* with short siphon and rounded tuberculate whorls. Of the Moreinae the genus *Schizobasis* with similar shell body as found in *Sargana* has a siphon that is twisted to the left, and *Praesargana* has a transitional shell to the Pyropsinae on one side and the Moreinae on the other.

#### Genus : *Sargana* Stephenson 1923

The low spired subpyriform shell has a vertically corrugated umbilicus and consists of up to four whorls. The spire is depressed, and the aperture subcircular with a narrow anterior canal and thickened lips. A posterior notch is formed by a narrow canal which creates a subsutural collar. The ornament

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of the adult shell consists strong spiral ribs, separated by wide rounded furrows, and by strong vertical ribs or growth increments. The protoconch is smooth, planispirally coiled and consists of well rounded whorls that do not overlap very much with their margins. The type is *Rapana stantoni* Weller 1907 from Nacatoch Sand of Texas. Here the ornament of the adult shell consists of seven strong spiral ribs. At the same level in the Ripley Formation of Mississippi and Tennessee this species is common (Sohl, 1963, 1964).

*Sargana eximia* (Stoliczka, 1868)

(pl. 6, Fig. 6)

*Tudicla eximia* Stoliczka 1868

The subpyriform shell with broad subsutural ramp forms a lowly conical stair-like spire and is about 3 cm high and 3 cm wide, consisting of about 4 whorls of the teleoconch. The body whorls embrace all other whorls. When fully grown the shell is provided with a thickened apertural margin. Four keel-like spiral ribs ornament the sides of the whorls, the upper of which forms the periphery. Four smaller spiral ribs ornament the flattened shoulder which has a narrow subsutural collar that extends onto the flattened flank of the former whorl. Axial ribs at regular interval form cancellated pattern with the spiral keels, and where ribs cross each other there is a small tubercle. The base is strongly constricted, and the rounded aperture forms anteriorly a narrow siphonal canal that is twisted to the left. The outer lip may be dented within and ends in a short posterior notch. The inner lip is thickened. The columella is widely excavated to form a pseudoumbilicus which is surrounded by a corrugated ridge of the former siphons. The only specimen of *Sargana exima* has been found near Siranattam.

*Remarks:* *Sargana eximia* differs from *Sargana stantoni* Weller 1907 from the Ripley Formation and *Sargana geversi* (Rennie 1930) from South Africa (Rennie 1930, Pl. 27, Figs. 17, 18, 19) by having a very regular reticulate ornament.

Subclass : Heterostropha

Order : ALLOGASTROPODA

Superfamily : MATHILDOIDEA

Genus : *Lemniscolittorina* Sohl 1960

The *Littorina*-like shell has rounded whorls and nodulose spiral ornament. The protoconch is smooth and sinistally coiled, while the teleoconch is dextral. The type is *Lemniscolittorina berryi* (Wade, 1926) from the Maastrichtian of the Ripley Formation of Coon Creek in Tennessee.

*Lemniscolittorina kuthurensis* n. sp.

(pl. 6, Figs. 7, 8)

*Diagnosis:* The shell with generic features has 6-7 broad spiral ribbons

on the whorl of the spire and 16-18 on the last whorl with growth lines crossing and forming a weak nodular appearance of the ribbons, which are separated from each other by grooves of about the same width. The base is rounded and not umbilicate, and the aperture is simple.

*Description:* A shell with 7 whorls of the teleoconch is 17 mm in height and 14 mm in width. The flanks of the whorls are weakly rounded, and the side forms a rounded corner at the base. Not fully grown shells show a narrow umbilical slit, while later on the umbilicus is closed. Eight specimens are from Kuthur.

*Difference:* *Lemniscolittorina kuthurensis* is larger than *L. berryi* and has more spiral ribs (Sohl, 1960, Pl.9, Figs. 29-31). It differs from *L. yonkersi* Dockery, 1993 by having a closed umbilicus and is also of larger size and has more ribs (Dockery, 1993, Pl.4, Figs 5,6). The protoconch is not known from *L. kuthurensis* while it is smooth and heterostrophic in the American species from the Campanian (Dockery, 1993, Pl.5, Figs.1-4) and the Maastrichtian (own data). *Gegania* Jeffreys 1884 with the genotype *Gegania pinguis* Jeffreys 1884 is a living species with turreted shell with globose rounded whorls and ornament with spiral lirae and weaker axial elements. The aperture is subovate, and the protoconch smooth and sinistrally coiled. It may be related to *L. kuthurensis*.

*Name Derivative:* This species of *Lemniscolittorina* is named according to the locality Kuthur where it was found.

*Holotype:* The illustrated specimen is Pl. 6, fig 7. It is deposited with Nr. 4207 in the collection of the GPLUM, Hamburg University.

*Type locality:* Kuthur.

*Type level:* Upper Kulakkalnattam Formation, Trichinopoly Group.

Genus : *Arcotia* Stoliczka, 1868

*Arcotia indica* Stoliczka, 1868

(pl. 6, Figs 9, 10)

*Arcotia indica* Stoliczka, 1868, pl. 16, Fig. 12.

This species has been introduced and illustrated by Stoliczka (1868, Pl. 16, Fig. 12). The conical turritiform shell with about 8 whorls measures 18 mm in height and 10 mm in width. Ornament is very characteristic with an acute keel on the widest part of each whorl in the lower third of the whorl and two larger sharp spiral ridges above it on the inclined flank, and several smaller ribs between these and below it and above the indistinct suture. Fine collabral growth lines cross the spiral ribs and form small rounded granules at crosspoints. The umbilicus is open, and the aperture rounded. Three specimens are from Kuthur, two larger, but not well preserved ones are from Garudamangalam. This latter one clearly demonstrates the hollow spindle.

*Remarks:* Wenz (1938) included *Arcotia* as synonym with *Mesalia* Gray 1842 which is not acceptable. *Mesalia* differs from *Arcotia* by not only being a modern species, but also by not having the characteristic keel and

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ornamental pattern of the Cretaceous genus. *Mesalia* is considered to represent a member of the Turritellidae. While *Arcotia* could well represent a member of the Mathildoidea, if the protoconch becomes known. *Mathilda ripleyana* Wade 1926 as known from the American Gulf coast at Campanian and Maastrichtian is quite similar in shape, but more slender and somewhat smaller than *Arcotia indica* (Dockery, 1993, pl.28, Figs.4-6).

Order : TECTIBRANCHIA

Genus : *Oligoptycha* Meek 1876

The globose shell has a depressed spire and ornament of incised spirals. The inner lip bears a strong anterior fold. The type is *Actaeon concinnus* Meek & Hayden 1854, that closely resembles *Oligoptycha corrugata* Sohl 1960 and *O. americana* Wade 1926, both from Ripley Formation.

*Oligoptycha ampla* (Stoliczka, 1868)

(pl. 6, Fig.11)

*Avellana ampla* Stoliczka, 1868, p.420, Pl.26, Fig.20.

There are about 4 whorls of the teleoconch which are separated from each other by an incised suture. The spire forms about a quarter of the total shell height. Ornament consists of linear spiral grooves, separated by broad flat interspaces, and crossed by fine growth lines. The whorl has about 16 such spiral depressions in addition to a subsutural ribbon. The aperture is narrow and pointed apically broad and round in front. It bears a single parietal fold. The protoconch is not preserved, but was heterostrophic. *Oligoptycha ampla* from the Trichinopoly Group at Siranattam are present in two incomplete, but fully grown specimens with 16 mm in height and 14 mm in width.

*Remarks:* Both American species of *Oligoptychia* described by Sohl (1960, Pl. 48) are much smaller, have fewer whorls and more spiral incisions. There is also a difference regarding the presence of a subsutural swelling that is present in the Indian species but not in the American ones. Two specimens from Siranattam are very similar to *O. americana*, which has fewer spiral incisions. These features are just like that of *O. corrugata* from the American Gulf Coast, but the Indian species is much larger, not 6 mm high but 16 mm and 14 mm wide. Very similar is *Eriptycha perampla* Woods 1906 (Woods, 1906, Pl. 51, Figs. 2a,b,c,d) with globose shell of about 12 mm height and 11 mm width consisting of four convex whorls of the teleoconch. The columella has a single anterior fold. *Eriptychia humboldti* Müller from Aachen in western Germany is also similar, but has more grooves in its ornament, and is a little higher. Woods (1906) suggested that the Indian *O. ampla* differs in regard to its ornament which he considered to be more regular in the African species. The specimen from Siranattam do not differ in this regard from the African species from Umzamba Formation (own observation).

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## RESULTS

Most of the gastropods discussed in this paper have been living on sandy marine bottom substrate, and only very few have preferred the hard substrate, as for example was the case in the two Pleurotomariidae and *Astraea*. In regard to their ecology, gastropods from southwestern India have been living in a similar way on shallow sandy fully marine bottom as those of the Ripley Formation and age equivalent strata along the northern shore of the Gulf of Mexico on the southern beaches of the North American continent. The cerithioideans *Voysa* and *Pseudomelania* may have lived in near-shore environment, perhaps even in brackish water conditions, and they have no relation to the species from Tennessee and Mississippi of Ripley Formation and Coffee Sand Formation. Others, like *Pseudamaura* must have lived in a similar environment and very widespread and occur also in the Gulf coast sand environment, where it became shore facies.

Practically all the other species have close similarity between Coniacian/Santonian Trichinopoly genera and species and Campanian/Maastrichtian Gulf Coast gastropods. This is quite amazing since both faunas are separated from each other not only by time, but also by a very large geographic distance. India during the time of Coniacian/Santonian was just beginning to separate from Madagascar and Antarctica and still had a position well south of the equator, while the Ripley Formation was deposited more or less in the same position of the American continent as it is now, well north of the equator in moderately warm climate.

The close relation is a good evidence for a rather intensive faunal exchange that must have occurred at least during Campanian time connecting faunas of the Southern Hemisphere with that of the Northern Hemisphere. It is quite likely that all of the similar species had planktotrophic larvae or at least very close relatives that had such a larva. They were, thus, able to migrate along oceanic pathways, but these should have been organized in such a way that larvae could cross deeper portions of the sea within the time of one or maximally a few weeks. Species must also have been able to cross tropical regions. The first indicates that there existed pathways along shelves not separated by deep oceanic portions of larger extent all the way from the disintegrating Gondwana continent to North America. The second gives evidence for the presence of localities with cooler, probably upwelling waters in the tropical portions of this migration path. These islands of cooler water in the shallow sea should have been distributed in such a way that species were able to metamorphose, grow to reproduction and shed larvae for at least extended periods in these resting points. This last feature is documented by the presence of a phosphatic facies belts found along the southern shores of the Tethys Ocean at Santonian and Campanian times (Arab Peninsula, Northern Africa, northern part of Brazil).

Migration pathways have been present, but are not known in their actual

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distribution. With the aid of a detailed systematic reevaluation of the gastropods, especially those that evolved rapidly during this time (Bandel, 1993; Bandel and Riedel, 1994), it should be possible to reconstruct these pathways. Gastropods represent an especially sensitive tool for such a reconstruction as soon as we know their protoconch and can make definite suggestions regarding their potential time of stay and mode of locomotion in the plankton. This has been quite impossible in case of the Indian fossils due to their mediocre preservation, but it is possible for most of their American close relatives found in Mississippi and Tennessee.

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