

## A MIOCENE MARINE FAUNA FROM ZULULAND

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[PLATES VIII-XII]

## ABSTRACT.

A Burdigalian (Lower Miocene) marine fauna from Uloa, Zululand, is described. It is of warm-water environment and indicates, in comparison with the modern fauna, a slow rate of organic evolution for the region. It is Indo-Pacific in type, comparing very closely with Tertiary faunas of East Africa and India, but is at variance with Tertiary faunas from the Cape Province.

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## I. THE DISCOVERY AND FIELD RELATIONS OF THE DEPOSIT.

In July, 1952, a brief announcement of the discovery of some large fossilized shark's teeth appeared in the *Sunday Tribune*, and, as I have learned subsequently, a few such teeth and fossil shells were lodged in the Durban Museum by Mr. J. Dowling.

The occurrence was later brought to my notice by Dr. A. Martin, Director of the Sugar Experiment Station, Mt. Edgecombe, who delivered to the University of Natal two blocks of richly fossiliferous sandstone (later found to be typical of the Uloa deposit) which were instantly recognized to contain *Pectens* of a Miocene type. Laboratory study produced one or two other genera of mollusca, and several genera of foraminifera.

I then took the first opportunity to collect personally at the site from which Dr. Martin's specimens had come. Examples of seventy-nine species, not counting foraminifera, were recovered. A second trip in December netted additional species, raising the total of metazoan species to 103. Further collecting will undoubtedly yield additional records, indeed, several years may elapse before the possibilities of the site are exhausted.

Nevertheless, the results to hand have led to such clear and interesting conclusions regarding the nature and affinities of the fauna, and of the conditions surrounding its preservation, that the time has come for a first report.

The site of the discovery (Fig. 1) is at Uloa, by the Umfolozi River about seven miles from the sea, where a cutting (Pl. VIII, Fig. 1) has recently been made for a small cane railway which there crosses the river at a high-level bridge. The richly fossiliferous sandstone is admirably exposed in the new cutting (Pl. VIII, Fig. 2) whence it dips seaward at an angle of less than one degree to the hill Sapolwana, rather more than a mile away. The elevation above sea-level at the cutting is 100 feet.

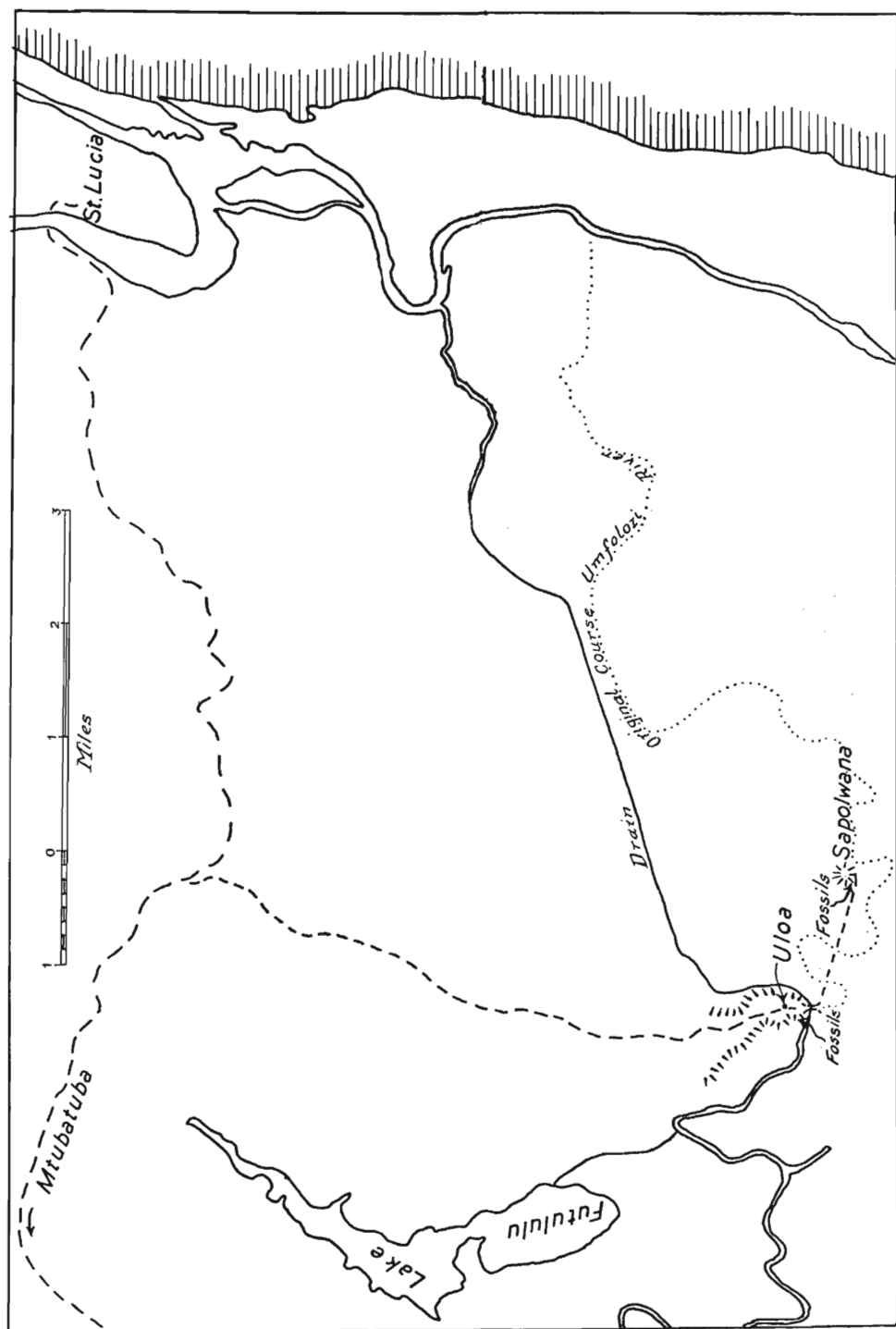


FIG. 1—Locality map. Miocene fossil deposit, Uloa, Zululand.

The lowest beds in the exposed section are marls, or yellow, sandy clays, which appear in the hillside overlooking the westward flats surrounding Lake Futululu. They are overlain by the fossiliferous sandstone, 20-30 feet in thickness, in which the fossils are crowded together, notably a characteristic "*Pecten*", *Aequipecten uloa* n.sp. which is the index fossil for the deposit and is present in thousands. Succeeding yellow sands intersected in the road-cut above the cane railway are also probably marine in origin, but so far have yielded no fossils. At least 20 feet thick, their total thickness is unknown, for they are cut through by an old channel of the Umfolozi River that is infilled with greyish, fluviatile sands, including a basal conglomerate in the deepest part of the old channel. The whole section is overlain by later sand, leached and grey, 10 feet thick, and with an ironstone layer 2 to 3 feet through. This sand maybe of Pliocene or Pleistocene age. A capping of sub-soil, 2 feet, and of soil 1 foot thick, completes the section exposed.

The fossiliferous bed represents a Miocene sandbank near the mouth of the river, and across it browsed hordes of shellfish of both vegetarian and carnivorous habits. So abundant was the animal life that traces of petroleum appeared in the matrix when some of the fossils were cleaned. This record is especially interesting as test-borings for oil are at present being made into beds of similar age at Inharrime, north of Lourenço Marques.

That the sandbank was littoral in situation is suggested by the types of animal found fossil, and also by the occurrence of numerous pebbles amid the fossils, brought in presumably by the ancestral Umfolozi River. Rock types among the pebbles include: Older Granite, two types of ancient quartzite, reddish fine-grained Table Mountain Sandstone, Karroo shale of the silicified Lebombo or Zululand type, and much Stormberg Basalt. All these formations are found within a few miles to the westward. Additional evidence for regarding the fossiliferous horizon as littoral is provided by two reddened horizons, one at the top of the bed, that suggest temporary emergencies, though the coloration is sometimes distributed between the two horizons.

## II. NATURE AND GEOGRAPHICAL RELATIONS OF THE FAUNA.

The foraminifera are reserved for specialist study, but preliminary investigation has revealed the following genera, identified by Mr. P. G. Biesiot of Moçambique Gulf Oil or by me: *Lagena*, *Nodosaria*, *Globigerina*, *Textularia*, *Amphistegina*, *Cancris*, *Cibicides*, *Eponides*, *Operculinella* (?), *Quinqueloculina* and *Rotalia*.

The fauna as here studied is metazoan and comprises 103 species covering a wide range of major groups: corals, polyzoa, brachiopoda, pelecypoda, gastropoda, cirripedia, crustacea and vertebrata. In variety of fauna and number of species Uloa is, indeed, the most important Tertiary locality so far discovered in East or South Africa. The discoveries have conferred fossil lineages upon several Natalian shells, e.g., *Scapharca natalensis* which has an ancestor in *S. prae-natalensis*. Other species have been found to extend back without vital change, so that no significant differences could be found between the fossil and recent forms. The number of such long-surviving forms is

indeed large, twenty-one, with sixteen others where the recent and fossil forms, though not identical, are very closely allied. There are few parts of the world where so high a proportion of species is common to lower Miocene deposits and to modern seas. In the New Zealand region, for instance, scarcely any early-Miocene species are still living, and there is a much greater richness of Tertiary species than appears here. The explanation apparently lies in environment. The Zululand fauna is a warm-water fauna, the waters lacking in phosphate, and the numbers and variety in the fauna are relatively low and the rate of organic evolution correspondingly slow. In New Zealand, with its cold Antarctic waters, these factors are reversed, and the rate of evolution and richness and variety of the molluscan faunas are correspondingly high. As evidence of the warm-water nature of the Uloa fauna may be quoted the genera, represented by species of large size: *Tonna*, *Conus*, *Ficus*, *Scapharca*. Three species described as new are typical of this: *Tonna nkulunkulu*, *Ancilla ntombazana*, and *Scapharca prae-natalensis*.

Of the 103 metazoan species here recorded, twenty species (seven pelecypods, and thirteen gastropods) are described as new to science, not an unduly high proportion in so novel an assemblage, in a region where so few Tertiary forms have been described hitherto. Fossil species, we may note in passing, commonly show greater range of variation than modern species because, as Joysey suggests, they are accumulated over a period during which physical conditions, *e.g.*, temperature, salinity, concentration of oxygen and trace elements, food supply and so forth may vary widely. All holotypes are catalogued and lodged in the special study collections of the Geology Department, University of Natal, Durban.

As frequently happens (*e.g.*, in the Tertiary of Mozambique and East Africa), the pelecypods are numerous within each species, whereas the gastropods are often known from but one or two specimens. Unless collections are very carefully made, therefore, these latter are apt to be overlooked.

The fauna is Indo-Pacific in type. A glance at the distribution tables (*q.v.*) shows that: (a) the chief comparison is with the living Natal-Zululand coastal fauna; (b) comparison in the next degree is with the Miocene and Pliocene faunas of East Africa (the similarity is especially strong in the echinoids and the pelecypods); (c) a strong connection exists also with the Miocene (Gaj) beds of North-Western India and the Miocene of Burma, less so with Ceylon and Madagascar; (d) a diminishing connection exists with Java; (e) the species *Baryspira impi* and *B. shaka*, with *Kaitoa islandicus* show a remote, and possibly independent, connection with New Zealand. The reference of the well-known *Pecten vasseli* to the Neozelanic genus *Sectipecten* supports this remote connection.

Analogies with the Mediterranean region are not strong, and in this the fauna agrees with other Tertiary faunas from the Indian Ocean region. Both Vredenburg for India and Cox for East Africa have noted a mild influx of Mediterranean types for a short while during the Oligocene, so that, as Cox (1930, p. 104) remarks, "Although the majority of the species found in the Indian Ocean in Miocene times did not inhabit the Mediterranean Ocean, a number of very characteristic forms were common to the two regions." In 1929

he wrote of the Pliocene and Recent mollusca, "We find little evidence of any Mediterranean element in the fauna of these deposits of the Red Sea" and "the number of species common to the Red Sea and the Mediterranean at the present day is small."

In modern times the Natal-Zululand region is a boundary zone between the faunas and floras of tropical Africa and of the Cape. The same is true of the marine fauna which, wholly tropical in Moçambique, is succeeded through Pondoland by the forms typical of the Cape coasts. The deposit at Uloa reveals that these conditions are long established. Discussion of Bullen Newton's list (1913) of fossil mollusca from Redhouse, near Port Elizabeth, which is re-listed here for comparison (an asterisk indicates Recent also): *Ostrea atherstonei*, *O. redhousiensis*, *Melina* cf. *Gaudichaudi*, *Glycymeris pilosa* (now *G. austroafricana*)\* *Chamelea schwarzi*, *C. rogersi*, *Ventricola verrucosa*,\* *Tivela baini*, *Cardium edgari*, *Macoma orbicularis*,\* *Tellina* cf. *perna*,\* *Schizodesma spengleri*,\* *Voluta africana* (now *V. ponderosa*)\* *Ancilla glandiformis*,\* *Bullia annulata*,\* *Melapium patersonae*, *Pirenella stowi*, shows that only three species *Glycymeris austroafricana*, *Voluta ponderosa* and *Ancilla glandiformis* are common to the two regions. While it is true that the age of this Eastern Province fauna is probably not Mio-Pliocene but Pliocene, the difference between it and the Uloa fauna is emphasised by the fact that not only species but 50 per cent. of the genera are unknown at Uloa. Bullen Newton concluded, indeed, that the Redhouse fauna was allied to the European and Mediterranean, with some South American links. As we have already emphasised, the East African Miocene faunas have little in common with their Mediterranean contemporaries and it is with the East African shells that the Zululand fauna agrees. *Carcharodon megalodon* has been recorded from the Cape by Haughton, and gives another species common to the two localities, but the record of this wide-ranging and powerful shark means little for comparative purposes.

Comparison with Tertiary faunas from South-West Africa enforces the distinction already made. Only two species, *Ostrea prismatica* and *Streptosiphon pyriformis* are common to the east and west coasts of Southern Africa in the Miocene. The existing distinction between the Indian Ocean and the Cape molluscan faunas is therefore long-enduring, since the opening of the mid-Tertiary at least.

### III. THE AGE OF THE DEPOSIT AND ITS CORRELATION WITH SIMILAR DEPOSITS ELSEWHERE.

The age of the deposit may be taken as Burdigalian, or early Miocene. Generally speaking, the fauna has more in common with modern faunas than it has with faunas of Eocene aspect. The following points seem significant: of the foraminifera, Mr. P. G. Biesiot advises that the assemblage, which lacks index fossils, is similar to that recovered at Inharrime, north from Lourenço Marques. The fauna of the Inharrime sandstone is deemed to be latest Oligocene or earliest Miocene in age.

The echinoids are of Oligocene rather than Pliocene aspect.

In the mollusca, we have already noted the relative abundance of living species, *e.g.* *Conus litteratus*, *Ancilla glabrata*, *Tonna luteostoma*, *Architectonica perspectiva*, *Chlamys senatoria*, which seems rather high for an early Miocene deposit, but this relatively high percentage we have seen to be offset largely by the relatively slow rate of evolution in a warm and equable environment. (May we point also to the survival of coelacanth fishes in these waters !).

*Per contra*, there is an almost total absence so far of many genera now abundant on our coast: *Cymatium*, *Terebra*, *Mitra*, *Marginella*, *Epitonium*, *Columbella*, *Bulla*, several of which are, however, abundant in the Miocene of the India-Burma province.

The Pectens as a whole are of Miocene and later aspect. Smooth forms are plentiful as *Amussium*, and such forms are often or typically found in Miocene strata, *e.g.* the well-known *Lentipecten hochstetteri* of New Zealand, which is generically distinct from *Amussium* as it lacks internal ribs. Swarming of *Pecten* species is a phenomenon familiar in the Miocene of several regions (*e.g.* California); it is rare before this date. *Scapharca* is a warm-water genus rare before the Miocene. Certain of the species of *Conus* (*haughtoni* and *proliferata*) seem to be especially of Oligocene and Miocene types.

The presence of *Carcharodon megalodon* is presumptive of a Miocene age, though the worn condition of the teeth might, according to Davies, indicate a Pliocene age.

The fauna is unmistakably older than the Pliocene fossils from the Farsan Islands, Oizan and Kamaran Island in the Red Sea described by Cox (1931).

The fauna may be regarded as contemporaneous with the faunas described from Pemba and from Kenya by Cox, and with the Inharrime fauna from Moçambique. All these are regarded by Cox as Burdigalian in age. The internal evidence of the Uloa fauna agrees with such a correlation.

The chief contribution hitherto upon Cainozoic mollusca from South Africa is Bullen Newton's paper in the Records of the Albany Museum for 1913. The difference between the fauna from the Eastern Province which he described and that recorded herein has already been commented upon, and ascribed in large measure to the presence of distinct faunal provinces. But I am inclined also to the belief that the Redhouse fauna is younger than the Mio-Pliocene date that Bullen Newton ascribed to it, and is truly Pliocene. The only species common to the two regions (p. 63) are known to range from early Miocene to Recent.

#### IV. GEOMORPHOLOGICAL IMPLICATIONS OF THE DEPOSIT.

The deposit has interesting implications from the geomorphological point of view. As already stated, it is situated some seven miles from the sea, at an altitude of 100 feet on Uloa hill, and dips seaward. The outcrop forms part of the coastal plain of Zululand that almost everywhere is covered by sand of presumed Pleistocene and Recent age.

The plain begins in the west, at a line of basaltic (Stormberg) hills. Probably during the Cretaceous, the basalt was faulted against Older Granite where the Umsunduzi River falls into Lake Eteza, but, as shown along the western side of the lake, the two formations were then bevelled by erosion so that the shore-line deposits of the Senonian (late Cretaceous) lie smoothly across them both. From this line eastward, most of the breadth of the coastal plain is underlain by marine sediments of latest-Cretaceous age. Only rarely are these formations visible beneath the mantle of Quaternary sands. So much is ancient history. The Pleistocene and Recent events may now be reviewed.

The later history of the region is comparable in every respect with that general along the Natal-Zululand coast. After the coastal plain had been bevelled in late-Tertiary time, and the land stood perhaps 150 feet higher with respect to sea-level, the lower Umfolozi River and its tributaries excavated broad, open valleys exceeding a mile in width. A regional subsidence (or rise of sea-level) then inundated the lower Umfolozi as part of the Lake St. Lucia system. Into this southern extension of St. Lucia the Umfolozi poured great

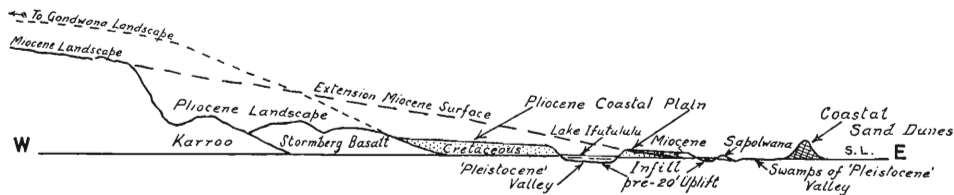


FIG. 2.

Presumed relationships of erosional land surfaces and marine fossiliferous deposits north of the Umfolozi River, Zululand.

quantities of alluvium which filled in the drowned valley-head as far east as Sapolwana. The drowned valley of a tributary stream was shut in on the north as Lake Ifutululu.

A 20 feet regional uplift then drained the deltaic flats, now used as sugar plantations, and the Umfolozi River continued to fill in the head of the remaining St. Lucia lake, making thereby the extensive swamps that now extend continuously from Sapolwana to the Estuary. At present the authorities are fighting a difficult battle to prevent the river from filling in yet more of St. Lucia.

Between the two series of events which we have narrated, *i.e.* between the accumulation of late-Cretaceous sediments and the Quaternary valley excavation and infilling of the lower Umfolozi Valley, was a long interval of Tertiary time of which scarcely any record has been available. One chapter of the Tertiary history is now before us. The Uloa deposit demonstrates that the early Miocene sea reached over quite half the width occupied by the present coastal plain. How far inland it extended we do not know, for the Miocene beds, after accumulation, were tilted from west to east and there further westward or inland, extension was removed by erosional processes that in Miocene and Pliocene times carved the coastal plain into its Pliocene form. In the Alexandria district, Cape Province, as Haughton (1925) has shown, the Tertiary beds can be traced far inland to high levels (in places exceeding 1,000 feet). There is no such continuity near

Mtubatuba, but instead the surface beneath the Miocene formations may be correlated with the "African" landsurface of the coastal hinterland, deemed to be of Cretaceous to Miocene age (King, 1951, p. 299). This landsurface stands at about 1,500 feet at its eastern edge through most of the coastal hinterland, standing usually at the crest of steep scarps overlooking a later, Miocene erosional landscape to the east. The relations between the various surfaces are suggested in Fig. 2.

The slope induced by the Miocene deformation for the Mtubatuba-Empangeni region is south-eastwards, instead of due east as in Northern Zululand and in Natal. This is in full accord with the deviation of the coast line which takes place from Cape St. Lucia to the mouth of the Umlalazi River. The deviation may be due either to a steepening of the eastward tilt in the Natal sector (see for a similar case on this coast King (1940) ) or to a shift of the axis of tilt farther to the west in Natal (compare with conditions south of Waterfall Bluff in Pondoland where the displacements are effected, however, abruptly at faults). Of these two possibilities, the former seems the more probable.

The physiographic history involving a Miocene erosional surface, which bears in its coastal portion fossiliferous marine deposits, and which rises steeply in a score or so miles to a hinterland plateau at 1,500-2,000 feet seems to be general for the seaboard of the Union, Mozambique and East Africa (*e.g.* at Lindi in Tanganyika and Fundi Isa in Kenya), and to be demonstrated also inversely along the west coast in South-West Africa and in Angola (King, 1949, pp. 450-1). In all instances the deposits are conceivably of earliest Miocene age, so that the submergences and later outward tiltings seem to have been essentially synchronous over a vast area. Even in land masses isolated from Africa such as Madagascar (the Miocene fauna of which is strangely distinctive) the same synchronicity of disturbance seems to have existed.

## V. SYSTEMATIC PALAEONTOLOGY.

Systematic studies have been hampered by lack of comparative material, recent and fossil, though the collections of modern species in the Natal and Durban Museums have proved helpful. Grateful acknowledgment is made to the authorities of both these institutions.

### A. FORAMINIFERA.

Reserved for specialist study.

### B. COELENTERATA.

#### CLASS ANTHOZOA.

**Ceratotrochus alcockianus.** Noetling (figured Noetling, 1901, Plate I).

The record is based upon a single calyx observed in the field, but in too tender a state for removal; and an internal cast.

**Flabellum distinctum.** Milne-Edwards (figured Noetling, 1901, Plate I).

Many specimens, nearly all internal casts, agreeing well with records from the Miocene of Burma (Noetling 1901); Tenison-Woods' species from New Zealand and Australia *F. radians* seems also fairly close, except that the angle of the fan is less, and the septa consequently fewer.



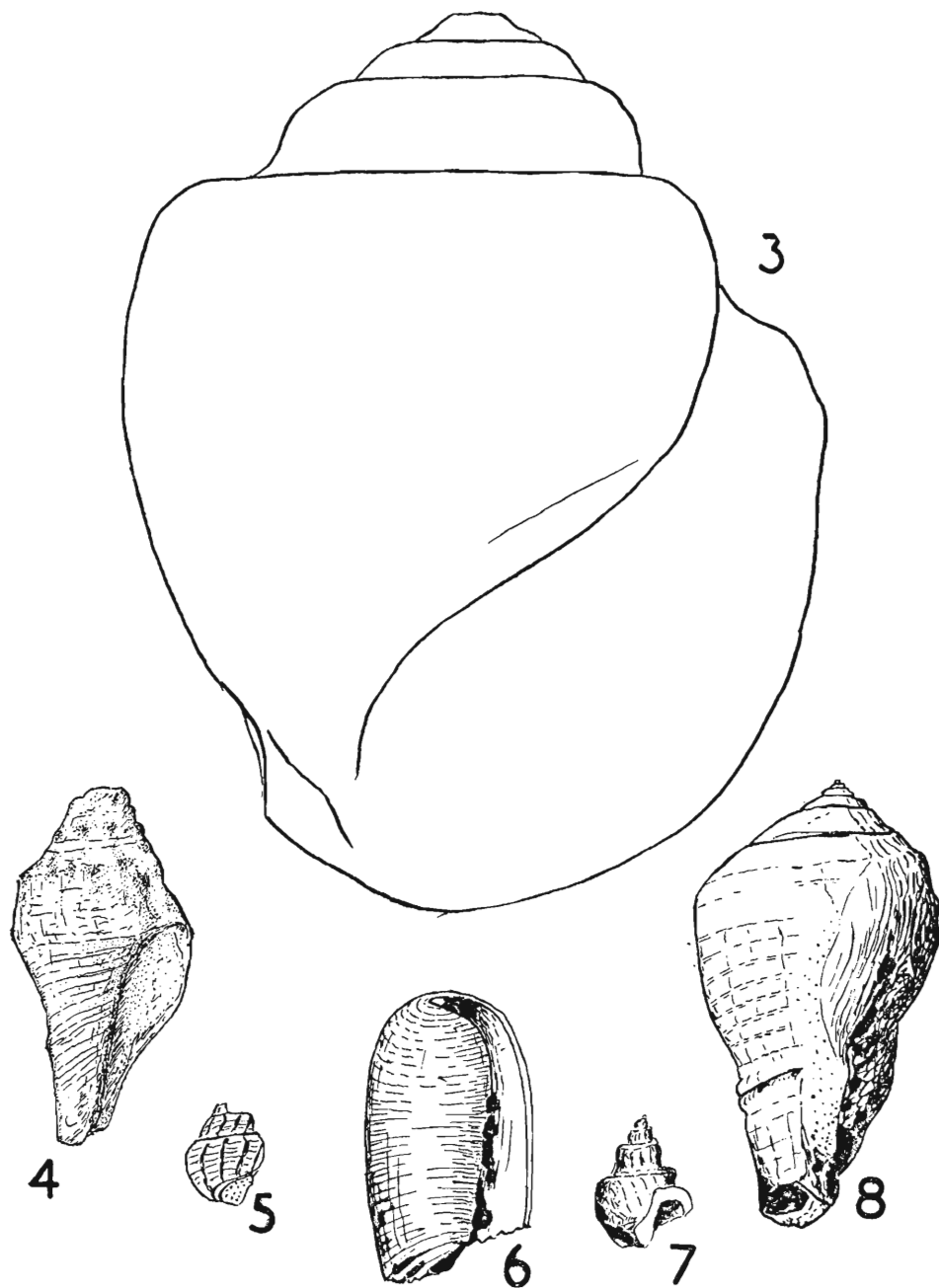


FIG. 3. *Tonna nkulunkulu*, n.sp. Holotype.  
 FIG. 4. *Turbinella premekranica*. Vredenburg.  
 FIG. 5. *Crassisipira coxana*, n.sp. Holotype.  
 FIG. 6. *Kaitoa islandica*. Marwick.  
 FIG. 7. *Cancellaria govenderi*, n.sp. Holotype.  
 FIG. 8. *Galeodes kehla*, n.sp. Paratype.

## C. ECHINODERMATA.

## CLASS ECHINOIDEA.

**Cidaroid spines.**

Characteristic heavy spines, nearly an inch in length, indicate the existence of cidaroid species in the fauna, but no tests were recovered.

**Temnopleurus cf. toreumaticus.** Leske (figured Stockley 1927, Plate XX).

A single, small and imperfect test, but showing the characteristic deep pitting of the plate sutures in both ambulacral and interambulacral areas. Test globose, 10 mm. in diameter; ambulacrals about four-fifths the width of the interambulacrals, and seemingly with triad plates. Tubercles and granules cover most of the surface and are joined by well-marked parallel ridges girdling the corona. Shorter vertical ridges also link the primary tubercles.

The specimen is typical of this widely distributed Indo-Pacific genus, and may be compared with *T. toreumaticus* (Leske) from the lower Miocene of India and East Africa.

**Clypeaster martini.** Desmoulins (Plate X, Fig. 3).

A specimen of this flat urchin comparing with *C. martini* mut. *rolfsi* Fuchs, as illustrated in Stockley's memoir on East African echinoids.

**Clypeaster cf. profundus.** d'Archiac and Haime (figured Stockley 1927, Plate XX).

The Zululand specimens do not agree well with *C. profundus*, so the following diagnosis is given. Test sub-conical, approximately circular or with tendency to a pentagonal outline. Diameter 50-60 mm. Adoral surface concave, leading to the peristome which is thus raised, and served by five radiating, unbranched feeding grooves. No lunules. Five equally-spaced gonopores at the flattened crest of the subcone. Ambulacra with well-developed petals, the ends only partly closed. Pores regular, in simple pairs. Interambulacrals continuous. Both interambulacrals and ambulacrals covered with simple bosses for the articulation of fine spines; each boss surrounded by a small, circular fossa. Periproct inframarginal, about one-fifth of the distance from the margin to the peristome. Peristome, central, sub-circular, small or moderate in size. Test strengthened internally by five pairs of vertical plates radiating from the edges of the peristome.

As the diagnosis shows, the external appearance of the test is rather like *Protoscutella*, especially the North American branch of the family, *Periarchus*.

**Laganum depressum.** Agassiz (figured Stockley 1927, Plate XXI).

Three specimens of this small cake urchin are identified with specimens from the Pliocene of Zanzibar, thus extending its range down into the Miocene. The tests are very thin and flat, 20-30 mm. in diameter, with a central elevation carrying the apical area which is slightly eccentric. Ambulacra are petaloid and closed. The periproct is about one-third of the radius from the margin.

**Echinolampas jacquemonti.** d'Archiac and Haime (Plate IX, Figs. 1 and 2).

The species is a typical large, elevated Miocene form of the genus, and resembles Mediterranean forms as well as Indian. There is considerable variation in tests from India, which I have used to cover deviations in the Zululand species, but a separate name may have to be found for the austral forms which are larger (80 mm. diameter), higher in proportion, and show other minor differences.

**Echinolampas spheroidalis.** d'Archiac and Haime (Plate X, Fig. 6).

Two specimens, differing from the type in that the apex is much lower, and the petals longer and narrower, so that the reference to this species is best regarded as provisional. Stockley has recorded the species from Pemba.

#### D. POLYZOA.

##### CLASS CHEILOSTOMATA.

**Retepora cellulosa.** Linné (Zittel, Fig. 523).

The comparison with Linné's species is very close. Dighton Thomas has recorded similar materials from the Miocene of Fundi Isa, Kenya.

#### E. BRACHIOPODA.

##### CLASS TELOTREMATA.

**Terebratulina** sp. indet.

A few adult ventral valves and closed juvenile specimens.

#### F. MOLLUSCA.

##### CLASS PELECYPODA.

**Nucula dowlingi** n.sp. (Plate X, Fig. 7).

Shell obliquely oval, inflated, rather ventricose below the beaks, equivalve, inequilateral. Diameter 20 mm. Umbones prominent, opisthogyal. Anterior edge straight, posterior smoothly rounded. Sculpture of regular, radial riblets (about 35 in number) with equally broad interspaces. Growth lines and concentric ornament inconspicuous. Ligament pit apparently small, anterior teeth strong, probably eight in number. Posterior teeth hidden in specimens available.

The genus is widespread in Tertiary beds, and there are a number of species with which the Zululand shells compare superficially. The small number and strength of the teeth seem, however, to be characteristic, as also is the strong radial sculpture and apparent absence of concentric striae.

This, the first new species from Uloa, is named for Mr. Justin Dowling who originally brought specimens from Uloa to the Durban Museum.

**Nucula** spp.

Internal casts and fragments occur of two small species distinct from *N. dowlingi* but too imperfect for description.

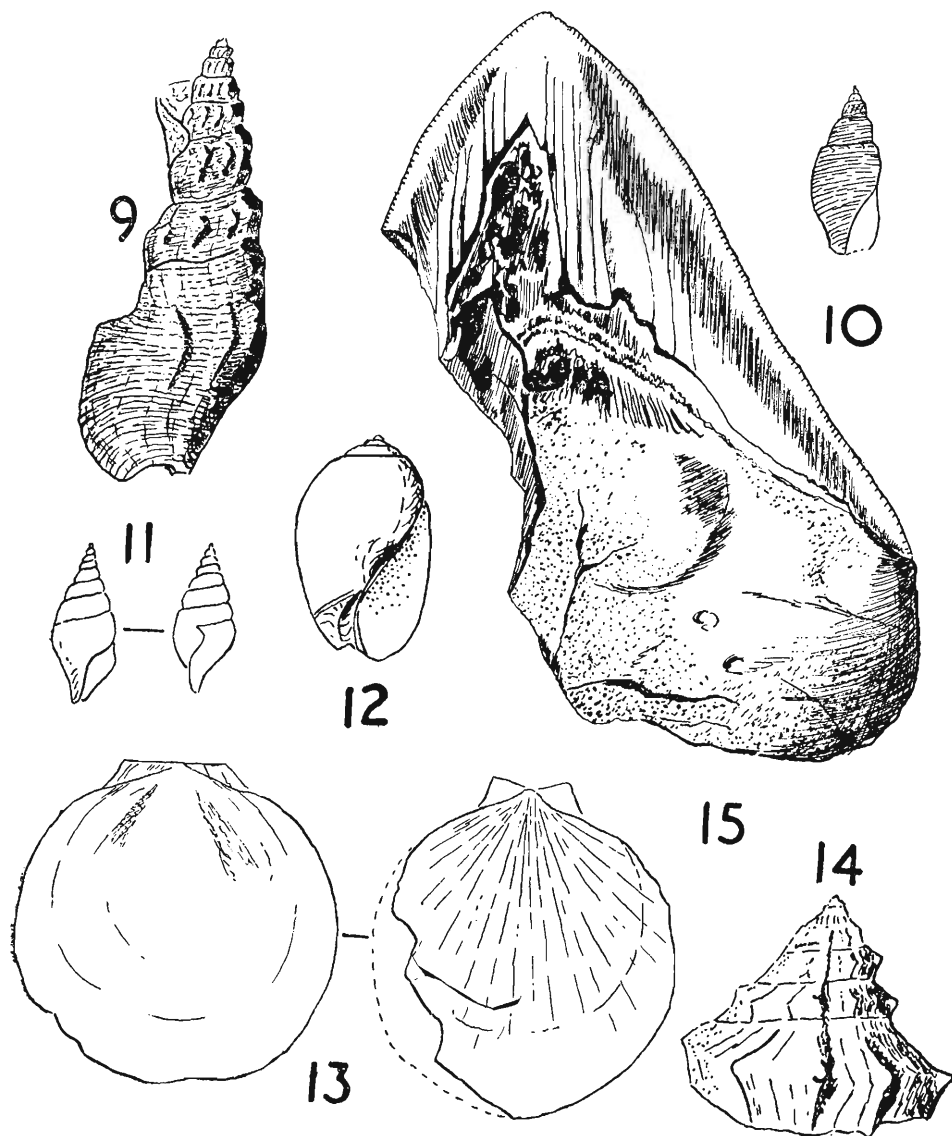


FIG. 9.

*Strombus altispirus*, n.sp. Holotype.

FIG. 10.

"Drillia" *curiosa*, n.sp. Holotype.

FIG. 11.

"Clionella" *inornata*, n.sp. Holotype.

FIG. 12.

*Olivella (Callianax) martiniopsis*, n.sp. Paratype.

FIG. 13.

*Amussium umfolozianum*, n.sp. Syntypes. Left and right valves.

FIG. 14.

*Ranella elegans*. Beck.

FIG. 15.

*Carcharodon megalodon* (height 3 inches).

**Cucullaea concamera.** Bruguiere.

Stout shells, trapezoidal in outline, rounded anteriorly and truncate posteriorly, mostly about 40 mm. in length, though with large individuals attaining 60 mm. Hinge area and teeth typical of the group. Umbones prominent. Ornament of finely incised radial and concentric lines, making a smooth, regular and delicate rectangular pattern. The species is widespread living in Indo-Pacific waters and is known fossil back to the late Miocene in Sumatra and Pliocene in East Africa.

The genus is apparently absent from the modern South African fauna.

**Scapharca inaequilateralis.** Guppy (figured de Oliveira and Leonardos, 1943, Plate XXX, III) (Plate X, Fig. 4).

The shells do not agree in shape with any of the numerous species of *Scapharca* described from the Indonesian-African region except the extremely variable *S. burnesi*. Noetling (1901, p. 131) gives a table of measurements on which our specimens approach *S. burnesi* var. *media*. On the other hand the resemblance to *S. inaequilateralis*, a Brazilian Miocene species figured by de Oliveira and Leonardos, is so close as to amount almost to identity.

*Scapharca* is rare before the Miocene, but abundant thereafter.

**Scapharca prae-natalensis** n.sp. (Plate X, Fig. 5).

A large, robust shell, sometimes exceeding 60 mm. both in length and breadth, which are nearly equal. Equivalve, moderately inequilateral, rounded anteriorly, angulate and truncate posteriorly. Umbones prominent and incurved, hinge area large, chevroned, hinge-line straight with numerous small taxodont teeth, the last three or four at each end increasing considerably in size. Ornamentation of about 40 strong, square, radial ribs increasing steadily to the ventral margin, and separated by equal, sharp, rectilinear depressions. On very large specimens the ribs, but not the depressions, are divided by fine, secondary raised lines which remain weak. Erosion of the shell reveals growth-lines crossing the ridges.

The shell resembles the handsome *S. natalensis* of the modern coast, but differs in the angularity and truncation of the posterior and in the greater number of radial ribs. The teeth are similar in both species. In the modern fauna *Arca* (*Scapharca*) *antiquata* also approaches this species, but the shell is smaller, less equilateral and less angular than the fossil.

**Glycymeris austroafricana** n. sp. (figured Bullen Newton 1913, Plate XIX).

Many specimens, mostly casts, agree with the type descriptions of *G. africana* (Cox, 1939) and with Bullen Newton's account (under the name of *G. pilosa* Linné) of specimens from Redhouse in the Cape. Variation within the species is similar to that ascribed to it by Bullen Newton. Cox's name *G. africana* was preoccupied by *G. africana* Griesbach (*Q.J.G.S.*, 1870), so I have re-named it as above.

**Ostrea cf. hyotis.** Linné (figured Cox 1927, Plate III).

Allowance being made for the notorious individual variation among oysters, the species is generally considered to range from Miocene to Recent. Only one good specimen is available from Zululand ; occurs in the Miocene of Pemba.

**Ostrea hyotiformis.** Philippi (figured Cox 1927, Plate XIV).

Two valves, a right and a left showing the typical saddle shape. The East African forms are Pliocene, but similar forms are known from the Miocene of Persia and Indonesia. Cox gives an extended discussion of the species (1927, p. 69).

**Ostrea angulata.** J. de C. Sowerby (figured Vredenburg 1925, Plate XXIVb).

Shell, small, with numerous strong radial ribs giving a corresponding number of zig-zag crenulations at the margin.

**Crassostrea prismatica.** Gray (Plate XI, Fig. 14).

Three specimens in which the lower valve is built up to a thickness of 25 mm. or more. Lamellar structure giving a prismatic effect. Upper valve less than 25 mm. in diameter.

**Sectipecten vasseli.** Fuchs (figured Cox 1927, Plate XV).

The Zululand shells are of moderate size (60 mm.), thick and strong except near the margins.

The species has occasioned much discussion as to its age, having been recorded from beds ranging from lower Miocene to Pleistocene. Cox (1927, p. 74) has noted that in examples from the Pliocene and Pleistocene "the costae bifurcate near the umbo and remain grouped in pairs, each member of which may, however, again bifurcate at a considerable distance from the umbo. In the Miocene ancestral form the costae bifurcate a second time quite near the umbo, the resulting costae remaining conspicuously grouped in bundles of four." The Zululand shells are of the Miocene type.

On account of its well-defined ornamentation, I have preferred to remove the species from *Pecten*, under which it was listed by Cox, to *Sectipecten*, a genus known originally from the south-west Pacific (Marwick, 1928).

**Aequipecten uloa** n. sp. (Plate XI, Figs. 9, 11, 12).

Shell orbicular, of moderate size (diameter 45-50 mm.), subequilateral, valves equal, inflated. Ears large, subequal, with a distinct byssal notch. Auricular crura ending in tubercles. Sculpture of about ten strong radiating ribs, rather broader than the interspaces. Both ribs and interspaces sometimes divided by one, two or three radiating grooves or incisions. Radiating sculpture frequently crossed by fine concentric lirae. All external ornamentation decreasing towards the margin, and replaced by secondary, internal riblets making interlocking ventral margins to the valves. Teeth in the right valve stronger than those in the left, as illustrated.

The hundred-odd specimens for examination show considerable differences in ornamentation. In some, ribs and interspaces remain undivided; in some, the concentric lirae are scarcely, if at all, developed. Evidently the species was undergoing variation, perhaps accompanied by hybridization. Its vigour is attested by the vast numbers of this species present, outnumbering all the other molluscan species taken together. The hordes of specimens recall Cox's comment (1927) that in the Pliocene of Zanzibar *Chlamys* (*Aequipecten*) *werthi* "occurs in great profusion at every horizon of the lower series of beds." The two species, indeed, closely resemble each other in size and form, but the ribs of *A. uloa* fade away towards the circumference of the shell, their strengthening function being taken over by marginal internal ribs. Though *A. werthi* also possesses these internal ribs, the external sculpture does not disappear over the outer one-third of the radius.

On the other hand, an interesting resemblance exists between *Aequipecten uloa* and *Pecten* (*Amussiopecten*) *gregoryi* Cox. Externally the shells bear similar ornament, and are distinguished only by the smaller size of *A. uloa* and its more marked byssal notch. *P. gregoryi* was referred by Cox to *Amussiopecten* because the internal paired ribs continue right across the interior of the shell. In *A. uloa* these are seldom more than sub-marginal, though in occasional specimens they continue for nearly half the radius of the shell.

The Zululand species serves as the index fossil for the Uloa horizon.

***Chlamys senatoria*.** Gmelin (figured Cox 1927, Plates VII and XV).

The occurrence of this widespread species, ranging through Europe, Africa and Asia, has been discussed for East Africa by Cox (1927, p. 45). It appears in both the lower Miocene of Pemba and the Pliocene of Zanzibar and of Kenya. Apart from a more southerly range, the Zululand shells add little to his discussion. Noetling (1901, p. 115) has described from the Miocene of Burma *Chlamys protosenatorius* as a distinct species, but this is now merged with Gmelin's living species.

***Chlamys puzio*.** Linné (figured Cox 1927, Plate VII).

Found fossil from Miocene to Recent, this is the common *C. tinctus* of the South African coast to which Cox has re-applied the name *C. puzio* of Linné.

***Chlamys* sp.**

A pair of valves with five major and 25-30 minor riblets, bearing strong transverse scales, especially upon the major ribs.

***Amussium umfaloizianum* n.sp.** (Fig. 13).

Shell about 60 mm. in diameter, equilateral, equivalve. Ears sub-equal, slightly channelled at the base, ears of the left valve smaller than those of the right, not ascending, ears of the right valve ascending distally. No byssal notch. Both valves flat, smooth and shining, with traces of very fine concentric growth-lines. Left valve flatter than the right, with two depressions, broadening from the umbo towards the anterior and posterior margins respectively. Right valve with numerous fine internal ribs, equally spaced, sometimes showing exteriorly through the shell. Hinge normal for the group.

The shells are close to *A. pleuronectes* Linné, a modern Indo-Pacific species that is also recorded fossil from the Miocene of the Philippines, and from the Pliocene of Java and of Zanzibar.

By evolutionary convergence, with loss of external ribbing, the species resembles very closely *Lentipecten hochstetteri* a common Oligo-Miocene species from New Zealand. But the two are generically distinct, for the antipodean shells lack the fine, internal ribs typical of *Amussium*. Smooth Pectenidae of moderate size seem to have arisen widely in the Miocene; another example is *Amussium mortoni* from Maryland, U.S.A.

### **Spondylus** sp.

Two specimens of Spondylidae too imperfect for specific description.

### **Lima lima.** Linné (figured Cox 1927, Plate XVI).

Two very typical specimens. In the Miocene it is apparently a characteristic form; Cox records it also from Pemba.

### **Placuna anomala** n.sp. (Plate XI, Fig. 15).

Shell irregular, of medium size (20-30 mm.), inequivalve, the right valve much more inflated than the left. Edentulous, but with a prominent resilium in the right valve that is extremely variable in shape in different specimens but rarely shows the typical strongly bent form of the resilium in *Indoplacuna*. Right valve with a prominent umbo, directed forward; left valve much flatter, and with less prominent umbo. Ornamentation weak on both valves; or irregular broad ridges over the first half of the shell, becoming lamellar sometimes towards the periphery. Fine radial riblets visible towards the margin.

The species does not appear to be related to forms recorded from the Miocene of India or the Middle East, and hence is designated as distinct. The genus is absent from the modern South African fauna.

### **Modiolus** cf. *capensis*. Krauss (Plate XI, Fig. 10).

A small species scarcely distinguishable from the modern *M. capensis* of our coasts.

### **Modiolaria excavata** n.sp. (Plate XI, Fig. 13).

Shell broadly oblong in outline, wider at the posterior end, smoothly rounded anteriorly. Inflated, with a broad and shallow sulcus extending from the umbo to the mid-point of the ventral margin. Umbo broad and prominent; hinge-line nearly straight, edentulous, so far as can be determined. The surface is covered with fine, radiating, flattened riblets, with interspaces half the width, but as many of the riblets bear a fine median division both riblets and interspaces tend to equalize over parts of the shell. Concentric ornament is of finely incised growth-lines about twice as far apart as the radial ornament. Radial and concentric lineaments confer a rectangular pattern on the surface as a whole.



Length of incomplete holotype, 27 mm., height 20 mm.

The most similar of recent forms is *M. albanyana* Turton from Port Alfred.

**Crassatellites cf. sulcatus.** Solander (figured Cox 1930, Plate XIII).

Two specimens that are only doubtfully identified with Solander's species. A similar form is recorded by Cox from the Miocene of East Africa.

**Lucina neasquamata.** Noetling (figured Noetling 1901, Plate X).

A single specimen from Uloa presents the form and ornamentation of Noetling's species, which, though described from Burma, does not seem to have been recorded elsewhere from India or East Africa since its designation in 1901.

**Loripes clausa.** Philippi (figured Cox 1927, Plate XIX).

The specimens from Uloa show no significant differences from the modern shells of the Natal and East African coasts.

**Cardium papyraceum.** Chemnitz.

Comparison with modern shells from Natal is close.

**Trachycardium cf. sindense.** Vredenburg (figured Vredenburg 1925, Plate XXVII).

The identification with Vredenburg's species is doubtful owing to the poor state of preservation of Zululand specimens. The proportions of the fossils resemble also *T. rubicundum* Reeve and may perhaps be related to this living species.

**Antígona granosa.** Sowerby (figured Cox 1927, Plate III).

This well-known species, the type of which is from the lower Miocene beds of north-west India, is recorded also from the Miocene of Ceylon, Burma, Java, Iran (?), Armenia and Pemba.

**Macrocallista erycina.** Linné (figured Cox 1927, Plate IX).

The shell is somewhat longer, thinner and more angulate than Pliocene and Recent examples, and compares better with shells described under the same name from the Miocene of Burma by Noetling.

**Marcia (Levimarcia) paupercula.** Dillywn (figured Cox 1927, Plate VIII).

Cox (1927, p. 53) describes his specimens: ". . . surface smooth, polished, with growth stages rather accentuated in places." One of the Uloa specimens has strong, irregular concentric folds. The other is rubbed nearly smooth.

**Tapes sulcaria.** Lamarek.

Uloa specimens are typical of this modern Indian Ocean species, even showing traces of the zig-zag colour pattern. Some authors have preferred to place the species under *Paphia*.

***Tellina* (?) *regularis*. Smith.**

Several rubbed shells measuring up to 20 x 14 mm. In the absence of distinguishing details, these are classified with Smith's modern species, found living along the east coast of South Africa.

***Gari elongata* n. sp. (Plate X, Fig. 8).**

Shell twice as long as high, rounded in front, tapering and more acute behind. Margin behind the umbo long and straight. Posterior gape very small. Surface smooth, with numerous fine growth-lines. The ligament groove, hinge and internal details are all hidden on specimens available, but the proportions of the species are unmistakable. Length 70 mm.; 20 mm. before the umbo, 50 mm. behind.

***Teredo* (*Kuphus*) aff. *polythalamia*. Linné (figured Cox 1927, Plate VIII).**

A few broken tubes, agreeing with Cox's identification for specimens from the island of Pemba (lower Miocene).

***Corbula socialis*. Martin (figured Cox 1927, Plate IX).**

A single valve, similar to specimens from Pemba.

***Solen capensis*. Fisher.**

Shell fragments provisionally classed with the living Cape species, which they resemble closely.

## CLASS GASTROPODA.

***Cynisca formosa*. Turton (figured Turton 1932, Plate I).**

Two shells almost identical in size, shape and ornamentation with Turton's modern shell from Port Alfred.

***Architectonica* cf. *perspectiva*. Linné.**

This beautifully ornamented species appears to be related ancestrally to the modern *A. perspectiva* in much the same way that *A. affinis* Sowerby precedes the larger *A. maxima* Philippi from the Indian seas, *i.e.* the shell is smaller and corresponds with the whorls preceding the body whorl of the modern form, on which the ornamentation is somewhat less pronounced.

***Hipponyx* sp. (Plate XII, Fig. 24).**

Two thin, conical shells, with backwardly directed apex. As the interiors are not available for inspection the specimens may later have to be referred to *Cheilea*, an Indo-Pacific genus known from Miocene to Recent.

***Natica callosa*. Sowerby (figured Noetling 1901, Plate XIX).**

Specimens agree with those recorded from the Miocene of Burma by Noetling.

**Polinices mamilla.** Linné.

Linné's species, besides being modern in South Africa, is known fossil from the Miocene and Pliocene of the Philippines, Indonesia and elsewhere.

**Turritella** sp. aff. **carinifera.** Lamarck.

The Uloa shells are difficult to determine, but in height of spire, angulate whorl shape and central keel appear in the group of *T. carinifera*. The whorls of the modern species are, however, much more sharply angled than those of the fossils, which are specifically distinct, but too poor for description.

**Turritella** cf. **capensis.** Krauss.

Whorls gently rounded, with incised suture. Growth lines indicate that the labrum was swept back in the style of *Turritella sensu stricto*. More than one species of this type is present.

**Turritella angulata.** Sowerby.

Resembles *T. capensis* in whorl-shape, but bears a single median keel and three lesser cingulae on the lower part of the whorl.

**Vermetus** sp.

A number of coiled tubes referable to the genus, but specifically dubious.

**Strombus floridus.** Lamarck (Plate XII, Fig. 18).

A single specimen agreeing closely with modern shells in the Durban Museum. Resembles *Strombus* Sp. A. recorded by Cox from East Africa.

**Strombus altispirus** n.sp. (Plate XII, Fig. 32; Fig. 9).

Shell of medium size, with ten whorls; 55 mm. in height and proportionately slender. Early whorls markedly shouldered and angular, but from the sixth whorl onwards the shoulder drops progressively, and the body whorl, except for nodular ornament, is smooth in outline. Suture lightly incised, wavy due to axial ribs on previous whorls. On the early whorls ornamentation is strong, consisting of prominent axial or inclined ribs reaching almost from suture to suture and crossed by spiral lirae of lesser prominence. Stronger axial ribs indicate stages of growth. At the fifth whorl the shoulder begins to drop and the axial ribs appear only on and below the shoulder, except where they represent growth stages, and beyond the sixth whorl the ribs shorten from below also until they are merely a row of smooth nodules upon the shoulder-angle. Spiral ornament continues and increases slightly throughout; on the body whorl it is crossed by fine, incised lines parallel with the outer lip, and more widely spaced than the spirals.

The modern *S. columbus* and *S. pacificus* both have a high spire and characteristically nodular ornamentation, but neither is as high or slender as this fossil species.

**Seraphs naricum.** Vredenburg (figured Vredenburg 1925, Plate XIII).

A solitary specimen resembling very closely the type from Bagthoro Hill, Sind, which is of Oligocene age.

**Trivia cf. oryza.** Lamarek.

A very small and imperfect shell which is best referred to *T. oryza*, recorded from the Natal coast.

**Cypraea aff. citrina.** Linné.

The described species of *Cypraea* are legion, and as the Uloa cowries are all damaged, comparison with Linné's species, found living on the South African coast, can only be provisional.

**Cassis achatina.** Lamarek (Plate XII, Fig. 31).

Three specimens, all very typical, but small, measuring only 25-30 mm. in height.

**Cassis cf. mombasana.** Cox (figured Cox 1930, Plate XII).

Part of a spire, evidently from a juvenile shell, that exhibits the general features of Cox's species, which is from the Pliocene of East Africa.

**Cymatium sp.**

A single juvenile shell like the juveniles of *C. durbanense* Smith and *C. vespaceus* Krauss, but more slender and with the whorls less sharply angled and turretted.

**Tonna luteostoma.** Küster (figured Cox 1930, Plate XII).

The present record carries the species back to the beginning of the Miocene. It is known also from the Pliocene, Pleistocene and Recent.

**Tonna nkulunkulu** n.sp. (Fig. 3).

A gigantic species of which the unique specimen is unfortunately in a poor state of preservation. Shell inflated, 210 mm. in height and 160 mm. broad in the body whorls. Spire relatively small and low, about 40 mm. in height, or less than one-quarter the height of the body whorl, indistinctly stepped. Aperture semi-lunate, inner lip smooth. Anterior canal short. Portions of the original shell remaining are smooth and devoid of ornament.

Neither *T. luteostoma* nor *T. ampullacia* Philippi of our present coasts resembles this fossil giant, which, for all its imperfect preservation, appears to be royally distinct.

**Ficus cf. condita.** Brongniart.

Shell large, thin, inflated. Spire very low, Delicately reticulate sculpture typical of the genus. Only the modern species *F. ficus* Linné has as low a spire as the Zululand shells, but its ornamentation is coarser. *F. ficoides* Lamarek

has a higher spire. *F. paraense* (White) from the Miocene of Brazil is again similar but with coarser ornament, especially the spiral lirae. *F. mississippiensis* from the Oligocene of Ficksburg is smaller and has a higher spire. Even the identification with Brongniart's species is not exact, and these shells may later have to be transferred to *F. ficus*.

**Ranella elegans.** Beck (figured Noetling 1901, Plate XX, Fig. 14).

A single broken specimen showing the spire agrees tolerably well with examples from the Miocene of Burma and of north-west India.

**Coralliophila violacea.** Kiener.

A few specimens smaller than the living, widespread, Indo-Pacific species, but otherwise indistinguishable.

**Pyrene cf. pardalina.** Lamarck.

The species is known fossil from the Pliocene of the Molluccas, and Pleistocene and Recent along most coasts from East Africa to Indonesia and even New South Wales. This seems to be the first record of it from the lower Miocene.

**Nassarius kraussianus.** Dunker.

This very characteristic living species is represented by two almost identical fossils. The shells are globose, with faint axial ribs upon the earlier whorls, and faint spiral ornament upon the body whorl, except anteriorly where it is strong. Neither fossil shows any trace of the callus that so often and so abundantly encloses modern shells of this species.

**Nassarius delislei** n.sp. (Plate XII, Fig. 28).

The sub-globose shell bears regular, heavy ribs, about 35 upon the body whorl, and all inclined to the right. The ribs rise gently upon the forward aspect, steeply upon the backward (with respect to the coiling of the shell) so that a section through them is rather like the teeth of a saw. The only spiral ornament is upon the base, where it crosses the axial ribs in a regular pattern.

Relationships appear to be with *N. arcularia* Linné rather than with the commoner *Nassarius* species of our coasts. *N. olivaceus* Bruguiere seems to be the closest of existing South African species, but the fossil is a broader shell with more globose whorls, and lacks the spiral groove below the suture that appears on *N. olivaceus*.

This very handsome species is named for Mr. de Lisle, manager at Uloa Estates, in appreciation of his kindness and co-operation.

**Nassarius (Hima) tringa.** Sowerby (figured Cox 130, Plate XIII).

Cox (1930, p. 144) has recorded this species, originally described from New Caledonia, as present in the post-Pliocene deposits of East Africa. I have been unable to check the original description, but five specimens from Zululand agree so exactly with Cox's figure that, if his identification for the East African shells is correct, the species is now recorded from the Tertiary for the first time.

**Galeodes kehla** n.sp. (Plate XII, Fig. 20 ; Fig. 8).

Shell about 55 mm. in height, stoutly pyriform, with the spire about one-third the height of the aperture. Spire short and obtuse, almost straight in outline, the whorls being flat and increasing regularly. Surface smooth, but removal of the outer layer reveals a structure of fine spiral lines, closely spaced over most of the sub-surface of the shell. At regular intervals, groups of five or six lines are more deeply impressed and broader, giving the effect upon the body whorl of widely spaced striations.

The species differs from *G. paradisicus* Bolten, which occurs in the Pliocene, Pleistocene and Recent of East Africa, Red Sea and Mekran, in that the whorls at the shoulder are not concave and the spire does not, in consequence, present a stepped appearance. The sub-surface ornament is also different. *G. paradisicus* is found living on the Natal coast.

**Streptosiphon pyriformis.** Kaiser (figured Kaiser 1926, Plate XXXIV).

Several specimens, indistinguishable from the type, which was found at Bogenfels, South-West Africa. This is one of the few strangers in a fauna almost wholly Indo-Pacific. Yet *Streptosiphon*, except for the absence of small tubercles on the shoulder, is very similar to a shell from the Miocene of Burma that Noetling called *Galeodea monilifera*.

**Fusus prolongata.** Turton (figured Turton 1932, Plate XI).

A tiny shell, smooth and shining, from washings. Identical in all respects with Turton's figure and description except that the cingulum about the suture is less marked. Turton's reference of the species to *Fusus* may perhaps be queried.

**Fusus** sp.

Fragments of a large species, axially ribbed and spirally strongly lirate. Shoulder ascending and embracing the previous whorl.

**Latirus pseudolynchoides.** Vredenburg (figured Vredenburg 1924, Plate I).

Shell immature, and smaller than that figured by Vredenburg. The type is from Burma, and the original *L. lynchoides* Bellardi, a larger shell with more ribs, is from the Miocene of Europe.

**Latirus indicus.** Vredenburg (figured Vredenburg 1924, Plate I).

The fossils compare closely with Vredenburg's figure.

**Turbinella premekranica.** Vredenburg (figured Vredenburg 1925, Plate XI, Fig. 4).

One youthful specimen showing the typical features of the original from the Miocene of north-west India.

**Fasciolaria** sp.

Fragmentary specimens only.

**Mitra textura.** Lamarck (Plate XII, Fig. 25).

Indistinguishable from many of the modern shells except by a slightly longer aperture, and fossilized condition.

**Voluta ponderosa.** Turton (figured Bullen Newton 1913, Plate XXIV).

Bullen Newton (1913, p. 343) identified with the modern species *V. africana* "an old and somewhat worn example" from Redhouse in the Eastern Province. He regarded the specimen as gerontic. A cast of a similar shell from Uloa, however, shows just the same characters as those of Bullen Newton's specimen. The shell is broader and heavier than *V. africana*, and the ornamentation, as in his figure, is virtually reduced from costae to isolated, heavy nodules.

Closest is Turton's *V. africana* var. *ponderosa*, which is shorter, heavier and more nodulose than *V. africana* s.s. The two are sufficiently distinct to mark separate species, a conclusion fortified by the persistence of *V. ponderosa* from the Miocene, both in the Cape and in Zululand. Bullen Newton's specimen is therefore cited as type of the full species, *Voluta ponderosa*. Height 60 mm., diameter 38 mm.

**Harpa (Eocithara) narica.** Vredenburg (figured Vredenburg 1925, Plate II).

In size, proportions and general ornamentation the shell closely resembles the type from the upper Oligocene of India. It differs in a greater refinement of the widely spaced vertical costae, which are also more strongly bent anteriorly, and in a less channelled shoulder. Spiral ornament is absent. The species is quite distinct from *H. conoidalis*, which is the nearest species in the living South African fauna.

**Oliva australis.** Duclos (figured Vredenburg 1925, Plate VI) (Plate XII, Fig. 19).

Specimens do not compare with modern South African species.

**Olivella (Callianax) martiniopsis** n.sp. (Plate XII, Fig. 26 ; Fig. 12).

Shell small, broadly ovoid, with the spire two-fifths of the height. Protoconch helicoidal, set at an angle with the early whorls. Spire whorls  $3\frac{1}{2}$ , increasing very rapidly, separated by a channelled suture. The barrel-shaped body whorl occupies nine-tenths of the total height, and measures in width more than half the height, it curves evenly from the suture to the anterior canal and about the outer lip. The terminal truncation is broad and deeply notched, the former positions of the notch leaving a raised, steeply inclined ridge across the lower part of the body whorl. Aperture broad, outer lip smooth ; inner lip with a light ridge of callus below the curve of the body whorl. Height 14 mm., breadth 9 mm.

The record, based on several specimens, is an isolated one for this part of the Indian Ocean during the Miocene, though several species are known in Australia at that time.

This unusual species is named in honour of Dr. A. Martin, who first drew my attention to the fossils from Uloa.

**Ancilla glandiformis.** Lamarck (Zittel, Fig. 1041).

A single specimen of this Mediterranean form. The shells from Redhouse described by Bullen Newton (1913, p. 348) as *Baryspira* sp. are the same. Bullen Newton noted, indeed, their close resemblance to Lamarck's species.

**Ancilla glabrata.** Linné (Plate XII, Fig. 27).

The species is well known in the modern Southern African fauna, and now seems to have been long established here.

**Ancilla ntombazana** n.sp. (Plate XII, Fig. 22).

A very large species; height 60 mm., diameter 27 mm.; the largest specimens exceed 30 mm. in diameter. Shell smoothly outlined from the spire to the anterior end; sutures not impressed. Whorls four or five, almost devoid of ornament except for a single fine, spiral line, one-quarter the width of the shell from the suture. On the lower part of the body whorl appear a broad spiral depression and a narrower, lower, spiral groove. Columella twisted outwards. Inner lip calloused above, smooth against the columella. Anterior notch moderate. Outer lip rather straight, truncate below. Aperture half the height of the shell; width of aperture two-fifths of its height.

The largest modern species of our coast, *A. optima* Sowerby, is easily matched by the fossil forms which are, moreover, heavier in build and often smoother in outline. The differences, as often between species of the genus *Ancilla*, are not great, but are consistent and sufficient for recognition of either species. *A. ntombazana* may well be ancestral to *A. optima*.

*Ancilla* (Latin)=a handmaiden.

*Ntombazana* (Zulu)=a maiden.

**Baryspira impi** n.sp. (Plate XII, Fig. 29).

Spire short and broad, conical, sometimes heavily calloused. The spire passes at an angulate shoulder into a broad, rectilinear body whorl tapering rapidly to an apparently blunt anterior end. Ornamentation of the body whorl typical of the group, spire smooth. Aperture incomplete, but inner lip heavily calloused. Height 40 mm., diameter 28 mm.

The short, blunt spire on some of these specimens is very reminiscent of the species of *Baryspira* in the Tertiary of the New Zealand region, e.g. *B. waikakaensis* and *B. spinigera*, but they do not seem to have relatives in the



other Tertiary deposits of East and South Africa so far studied. The record of *Baryspira* by Bullen Newton, as noted previously, refers to *Ancilla glandiformis*, not to *Baryspira* in the sense here used, wherein the short, rectilinear, obtuse spire (shorter than broad) is regarded as diagnostic of the genus.

***Baryspira shaka* n.sp.** (Plate XII, Fig. 30).

Shell small and ovoid (height 21 mm., diameter 17 mm.). Heavily calloused so that most details are obscured. Spire very low, conical, body whorl rectilinear, tapering rapidly towards the anterior end. Columella curved to the right anteriorly. Aperture sub-lunate, smoothed posteriorly by callus.

This unmistakable form is also reminiscent of New Zealand types, and appears exotic in the South African province where the genus has been unrepresented hitherto.

***Cancellaria govenderi* n.sp.** (Fig. 7).

A small, and probably juvenile shell, like *C. foveolata*, a modern species of Natal and Mozambique, but differing in that the shoulder slopes slightly outwards instead of inwards. The axial ribs also incline downward and forward, instead of downward and backward, they are also much weaker and fail to make spines upon the shoulder as upon *C. foveolata*. On the modern species the ribs continue equally strong to the end of the body whorl, but on the fossil are almost obsolete even upon the body whorl of the juvenile *Uloa* specimen. Spiral ornament conversely strengthens and is at a maximum on the body whorl, and especially upon the base of the fossil. Umbilicus smaller, inner lip expanded. Height 8 mm.

Named in appreciation of Mr. C. N. Govender, laboratory assistant in the Geology Department, to whose keen eyesight the collection from *Uloa* owes several small specimens.

**"*Drillia*" *curiosa* n.sp.** (Fig. 10)

Shell small, a little more than 10 mm. in height and slender in proportion, narrowly conic. Whorls smoothly rounded to the shoulder angle, lightly convex above. Early whorls missing on type. Sculpture on the first visible whorl (probably the third whorl) of sixteen axial riblets crossed by 7 or 8 weaker, more closely spaced spiral threads. The threads are of unequal strength, four being more prominent than the others. The shoulder is crossed by sulcate growth-lines and is smooth except for a narrow, raised, gently beaded cingulum following the suture. On the succeeding whorl the axial ribs are much weaker, and fade altogether upon the penultimate whorl, leaving only the spiral threads as ornament. These cover the whole of the body whorl, where they are crossed only by weak growth-lines.

In general appearance the shell is very like *D. prolongata* Turton in the modern fauna, but the presence of marked axial sculpture upon the early whorls of *D. curiosa* shows that they are not closely related. The reference of these shells with spiral sculpture to the genus *Drillia*, which has marked axial sculpture throughout, can only be provisional. Precise generic location must await revision of the South African *Turridae* as a whole.

**Crassispira (Inquisitor) coxana** n.sp. (Fig. 5).

Shell very small and slender, aperture about one-third the height of the shell. Whorls slightly convex, angulate above and below, ornamented with strong, oblique axial ribs, eleven per whorl and continuing nearly in line from each whorl to the next. Between pairs of ribs are eight or less fine lirae; the whole axial sculpture being crossed by about nine widely spaced thin spiral threads. Aperture about one-third the height of the shell, strongly channelled below with the canal reflexed, scarcely sulcate above, outer lip unknown.

The proportions and appearance of the shell resemble *C. hamus* Cox, from the Miocene of Pemba, but the ribs are not hooked at the posterior end, as is characteristic and led to the naming of Cox's species. The new species is named in honour of Mr. L. R. Cox, whose published works upon the fossil mollusca of East Africa have been of the greatest assistance in study of the Zululand material.

**Clionella bipartita.** Smith (figured Turton 1932, Plate III).

A large specimen agreeing closely with that figured by Turton.

**Clionella inornata** n.sp. (Fig. 11).

Shell small (10 mm. in height), fusiform, with the aperture two-fifths the height of the shell. Spire smooth in outline, except for the slightly impressed suture. Whorls rectilinear, tapering regularly, body whorl contracting smoothly below to a long anterior canal. Outer lip strongly curved below a deep posterior notch situated immediately below the suture. Sculpture of faint spiral lines on all whorls, strengthening on the base and canal, otherwise smooth.

The relationships of the shell are obscure. It is indubitably a Turrid as demonstrated by the strong posterior notch, and the position of the notch immediately below the suture suggests, with its smooth outline and the moderately long anterior canal, the genus *Surcula*. But the typical smooth species of *Surcula* are much larger shells, and the posterior notch is situated always on a sub-sutural concavity that does not exist in this species, the whorls being absolutely right-sided. The straightness of outline suggests affinity with *Clionella*, of which *C. striolata* Turton is perhaps the closest in appearance to the fossil.

**Conus (Lithoconus) litteratus.** Linné (figured Cox 1927, Plate XVII).

There is considerable variation in height of spire, hollowing of the upper surface of the whorls and shape among the fossils, but most of the differences can be matched in modern shells. The record now carries this living species back to the Miocene.

**Conus (Chelyconus) haughtoni** n.sp. (Plate XII, Fig. 17).

Shell about 35 mm. in height, with spire low or of medium height. Body whorl not inflated, contracting regularly to the anterior end, outline smooth. Shoulder broadly rounded, whorls convex, distinct. Sculpture on the anterior half of the body whorl, of well-spaced grooves, alternately broad and narrow, otherwise smooth. Anterior end truncate, sinus very weak. Posterior sinus also weak or absent. Columella with a very slight twist, low down. Juvenile specimens have a proportionately higher spire and an ornamentation of spiral grooves, one-third as wide as the flat intervening, spiral ridges extending from the anterior end to just beneath the rounded shoulder. Juveniles are also proportionately more slender than adult shells.

The nearest relative is probably *C. avaensis* Noetling, from Burma.

The species is named for Dr. S. H. Haughton, in recognition of his many years of palaeontological research in South Africa, and especially of his studies upon the Tertiary marine palaeontology of the Cape Province and South-West Africa. After *Aequipecten uloa*, *C. haughtoni* and *C. proliferatus* are the most abundant species at the Uloa locality.

**Conus (Chelyconus) proliferatus** n.sp. (Plate XII, Figs. 21, 23).

Adult shell 40-50 mm. in height, typically coniform, with a low, smooth spire (slightly stepped on immature specimens). Whorls flat or hollowed, suture channelled. Shoulder angle sharp. Very weak spiral ornamentation on the lower part of the shell. Aperture long and narrow, outer lip sharp; neither anterior nor posterior sinuses marked. Columella smooth.

This species may be distinguished from *C. haughtoni* by its somewhat larger size, less ovate form, flatter spire and the sharp shoulder angle. But hybridization between the two species cannot be excluded. *C. malaccaensis* Hwass from Burma appears to be the closest relative, though the species resembles superficially also the well-known *C. ponderosus* Brocchi from the Transylvanian Miocene.

**Ringicula turrita.** Martin (figured Noetling 1901, Plate XXIII).

This is an interesting record of a tiny shell that compares well with Martin's type from the Tertiary of Java, and Noetling's record of a single specimen from the Miocene of Burma. The shell is well preserved except for the outer lip and

easy to identify. The query as to how so small a species could be distributed so widely is emphasized by the allied *R. australis* Hind, which is an Australian shell reported from Port Elizabeth.

**Kaitoa islandica.** Marwick (figured Marwick 1931, Plate XVII, Fig. 6).

The solitary specimen has the lower part of the aperture damaged, which makes identification a little difficult, but I have compared it meticulously with the figures and description given by Marwick of this curious and rare little shell from the Miocene of New Zealand, and am satisfied of the identity. The record recalls the similarity of our *Baryspiras* with those from the New Zealand Miocene.

The size of the *Uloa* specimen (restored) is 10 mm. x 5 mm., that of the New Zealand shell is 10.1 mm. x 3.8 mm.

I am pleased indeed to identify among molluscan species from *Uloa*, one of the rare and curious species described by my old friend, and mentor in palaeontology, Dr. J. Marwick.

## G. ARTHROPODA.

### CLASS CIRRIPIEDIA.

**Balanus** sp. cf. **amphitrite.** Darwin.

In the absence of sufficient comparative material there is doubt as to which subspecies of *B. amphitrite* the specimens refer. *B. tintinnabulum* Linné, recorded by Noetling from the Burmese Miocene, does not appear at *Uloa*.

### CLASS CRUSTACEA.

A Neptunid crab carapace has been reserved for specialist study.

## H. VERTEBRATA.

### CLASS PISCES.

**Carcharodon megalodon** (Fig. 15).

Many teeth and much bone of this species have come from a single part of the north side of the cutting, but there seems no reason to believe that more than a single shark was stranded and died there. Certain of the teeth are huge, measuring 120 mm. from tip to base. Their worn condition indicates that the specimen was aged.

TABLE 1.  
DISTRIBUTION OF SPECIES RECORDED FROM ULOA.

× = recorded.      a = allied species.

	Mocambique Miocene	East African Miocene.	East African Pliocene.	Mediterranean Miocene.	N.W. India Oligo-Miocene.	Burma Miocene.	Cape Province Mio-Pliocene.	South Africa Recent.
<i>Ceratotrochus alcockianus</i> ..						×		
<i>Flabellum distinctum</i> ..						×		
<i>Cidaroid spines</i> .. ..		×	×	×	×	×		
<i>Temnopleurus toreumaticus</i> ..		×			×			
<i>Clypeaster martini</i> .. ..		×		×				
<i>Clypeaster profundus</i> ..		×						
<i>Laganum depressum</i> ..		×	×					
<i>Echinolampas jacquemonti</i> ..		a		a	×			
<i>Echinolampas spheroidalis</i> ..		×			×			
<i>Retepora cellulosa</i> .. ..		×				×		
<i>Terebratulina</i> sp. .. ..								
<i>Nucula doulingi</i> .. ..		a			a			a
<i>Nucula</i> sp. .. ..								
<i>Cucullaea concamerata</i> ..			×		×	×		
<i>Scapharca inaequilateralis</i> ..						a		
<i>Scapharca praeatalensis</i> ..								a
<i>Glycymeris austroafricana</i> ..			×				×	×
<i>Ostrea angulata</i> .. ..		a			×	a		
<i>Ostrea hyotis</i> .. ..					×	a		
<i>Ostrea hyotiformis</i> .. ..			×					
<i>Crassostrea prismatica</i> ..							×	
<i>Sectipecten vasseli</i> .. ..	×	×	×		×			
<i>Aequipecten uloa</i> .. ..		a	a					
<i>Chlamys senatoria</i> .. ..	×	×	×	×	×	×		
<i>Chlamys puzio</i> .. ..		×		×				×
<i>Chlamys</i> sp. .. ..								

TABLE 1 (*continued*).

## DISTRIBUTION OF SPECIES RECORDED FROM ULOA.

× = recorded.      a = allied species.

	Mocambique Miocene	East African Miocene.	East African Pliocene.	Mediterranean Miocene.	N.W. India Oligo-Miocene.	Burma Miocene.	Cape Province Mio-Pliocene.	South Africa Recent.
<i>Amussium umfolozianum</i> ..			a	a				
<i>Spondylus</i> sp. .. ..								
<i>Lima lima</i> .. ..		×		×				
<i>Placuna anomala</i> .. ..								
<i>Modiolus</i> cf. <i>capensis</i> ..								×
<i>Modiolaria excavata</i> ..								a
<i>Crassatellites</i> cf. <i>sulcatus</i> ..		×						
<i>Lucina neasquamata</i> ..						×		
<i>Loripes clausa</i> .. ..			×					×
<i>Cardium papyraceum</i> ..								×
<i>Trachycardium</i> cf. <i>sindense</i> ..					×			
<i>Antigona granosa</i> .. ..	.	×			×	×		
<i>Macrocallista erycina</i> ..			×			×		
<i>Marcia</i> ( <i>Levimarcia</i> ) <i>paupercula</i> .. ..		×						
<i>Tapes sulcaria</i> .. ..								×
<i>Tellina</i> ? <i>regularis</i> .. ..								a
<i>Gari elongata</i> .. ..								a
<i>Teredo</i> ( <i>Kuphus</i> ) aff. <i>polythalamia</i> .. ..		×		×	×			a
<i>Corbula socialis</i> .. ..		×						
<i>Solen capensis</i> .. ..								×
<i>Cynisca formosa</i> .. ..								×
<i>Architectonica</i> cf. <i>perspectiva</i>					×			×
<i>Hipponyx</i> sp. .. ..								a
<i>Natica callosa</i> .. ..						×		
<i>Polinices</i> cf. <i>mamilla</i> ..		×						×

TABLE 1 (continued).

DISTRIBUTION OF SPECIES RECORDED FROM ULOA.

× = recorded.      a = allied species.

	Mocambique Miocene	East African Miocene.	East African Pliocene.	Mediterranean Miocene.	N.W. India Oligo-Miocene.	Burma Miocene.	Cape Province Mio-Pliocene.	South Africa Recent.
<i>Turritella</i> aff. <i>carinifera</i> ..								a
<i>Turritella</i> cf. <i>capensis</i> ..								a
<i>Turritella</i> <i>angulata</i> .. ..						×		
<i>Vermetus</i> sp. .. ..		a						
<i>Strombus</i> <i>floridus</i> .. ..		×						×
<i>Strombus</i> <i>altispirus</i> ..								
<i>Seraphs</i> cf. <i>naricum</i> ..					×			
<i>Trivia</i> cf. <i>oryza</i> .. ..								a
<i>Cypraea</i> aff. <i>citrina</i> ..								a
<i>Cassis</i> <i>achatina</i> .. ..								×
<i>Cassis</i> cf. <i>mombasana</i> ..			×					a
<i>Cymatium</i> sp. .. ..								a
<i>Tonna</i> <i>luteostoma</i> ..			×					×
<i>Tonna</i> <i>nkulunkulu</i> .. ..								
<i>Ficus</i> cf. <i>condita</i> .. ..	×	a		×				a
<i>Ranella</i> <i>elegans</i> .. ..					×	×		
<i>Calliophora</i> <i>violacea</i> ..			×					
<i>Pyrene</i> ? <i>pardalina</i> ..			×					
<i>Nassarius</i> <i>krussianus</i> ..								×
<i>Nassarius</i> <i>delislei</i> .. ..								a
<i>Nassarius</i> ( <i>Hima</i> ) <i>tringa</i> ..								
<i>Galeodes</i> <i>kehla</i> .. ..			a					
<i>Streptosiphon</i> <i>pyriformis</i> ..							×	
<i>Fusus</i> <i>prolongata</i> .. ..								×
<i>Fusus</i> sp. .. ..								
<i>Latirus</i> <i>pseudolynchoides</i> ..				a		×		

TABLE 1 (continued).

DISTRIBUTION OF SPECIES RECORDED FROM ULOA.

× = recorded.      a = allied species.

	Mozambique Miocene	East African Miocene.	East African Pliocene.	Mediterranean Miocene.	N.W. India Oligo-Miocene.	Burma Miocene.	Cape Province Mio-Pliocene.	South Africa Recent.
<i>Latirus indicus</i> .. ..					×	×		
<i>Turbinella premekranica</i> ..					×			
<i>Fasciolaria</i> sp. .. ..								a
<i>Mitra textura</i> .. ..								×
<i>Voluta ponderosa</i> .. ..							×	×
<i>Harpa</i> cf. <i>narica</i> .. ..				a	×			
<i>Oliva australis</i> .. ..					×	×		
<i>Olivella</i> ( <i>Callianax</i> ) <i>martin-</i> <i>iopsis</i> .. ..					a			
<i>Ancilla glandiformis</i> ..				×			×	
<i>Ancilla glabrata</i> .. ..								×
<i>Ancilla ntombazana</i> ..								a
<i>Baryspira impi</i> .. ..								
<i>Baryspira shaka</i> .. ..								
<i>Cancellaria govenderi</i> ..								a
" <i>Drillia</i> " <i>curiosa</i> ..								
<i>Crassispira coxana</i> .. ..		a						
<i>Clionella bipartita</i> .. ..								×
<i>Clionella inornata</i> ..								
<i>Conus</i> ( <i>Lithoconus</i> ) <i>litteratus</i>			a					×
<i>Conus</i> ( <i>Chelyconus</i> ) <i>haughtoni</i>				a		a		
<i>Conus</i> ( <i>Chelyconus</i> ) <i>proli-</i> <i>feratus</i> .. ..				a		a		
<i>Ringicula turrita</i> .. ..						×		
<i>Kailoa islandica</i> .. ..								
<i>Balanus</i> aff. <i>amphitrite</i> ..						a		a
<i>Carcharodon megalodon</i> ..	a		a		a			



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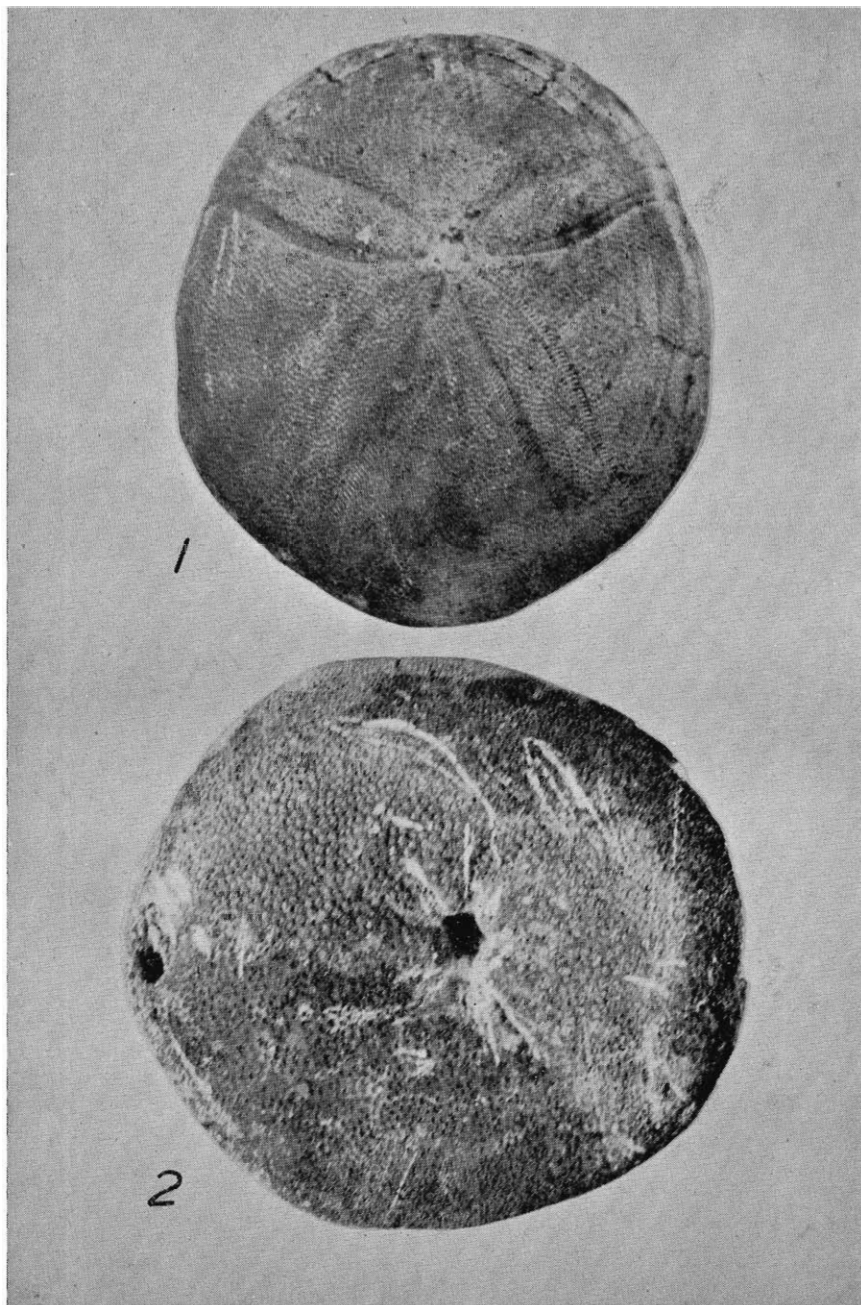
FIG. 1.

Fossil locality at Uloa, Zululand, showing the railway cutting and bridge.



FIG. 2.

Shelly sandstone exposed in the railway cutting at Uloa, showing swarming of the species *Aequipecten uloa*, n. sp.



FIGS. 1 and 2.  
*Echinolampas jacquemonti*. d'Archiac and Haime.

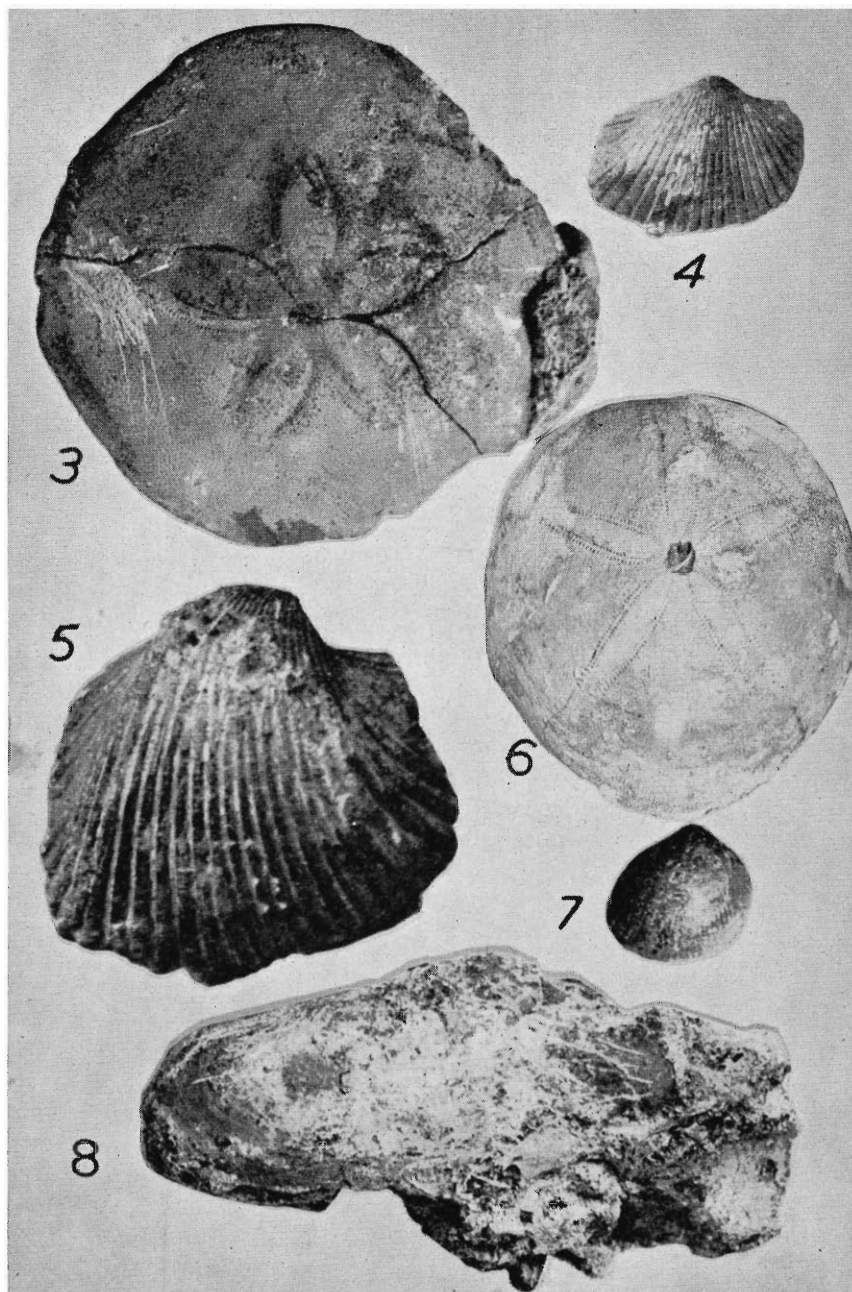


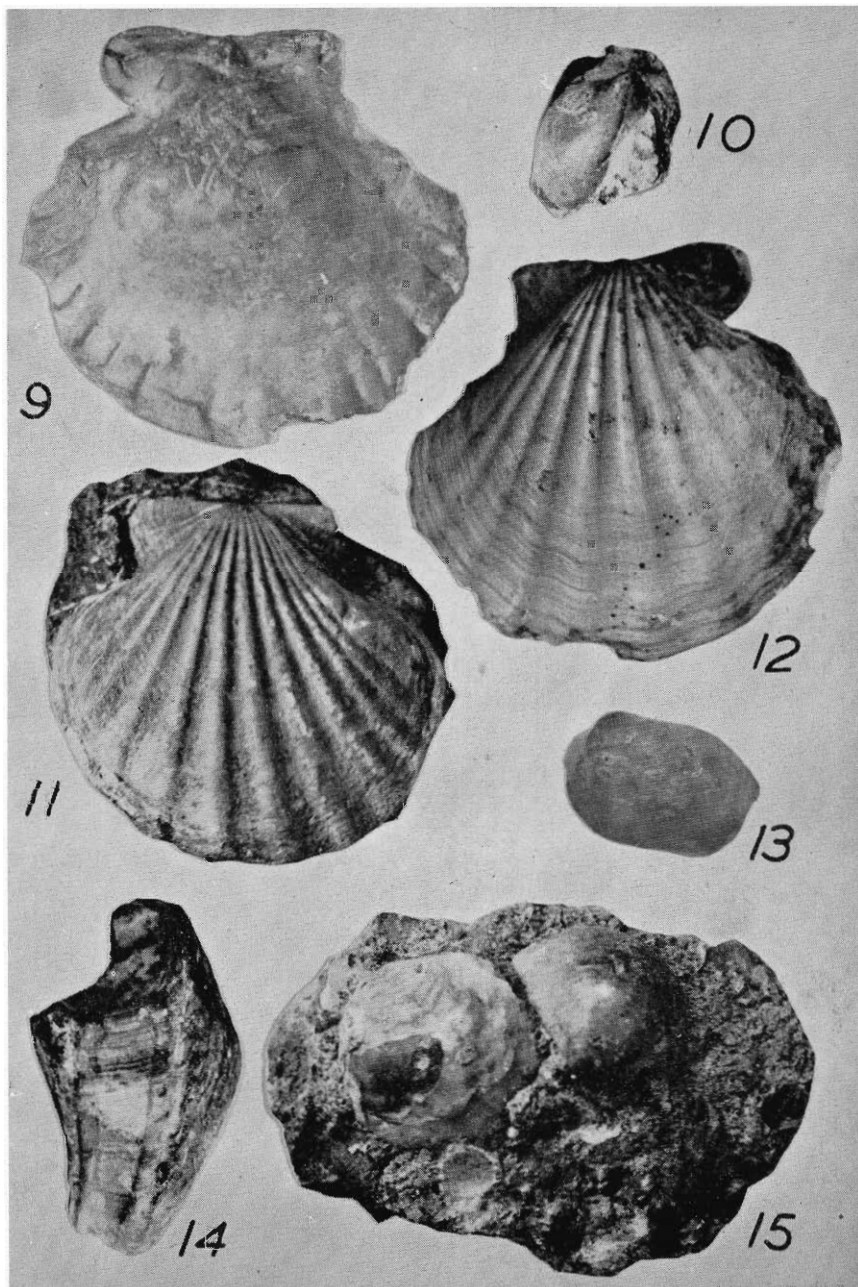
FIG. 3. *Clypeaster martini*. Desmoulins. FIG. 4. *Scapharca inaequilateralis*. Guppy.

FIG. 5. *Scapharca prae-natalensis*, n.sp. Holotype.

FIG. 6. *Echinolampas spheroidalis*. d'Archiac and Haime.

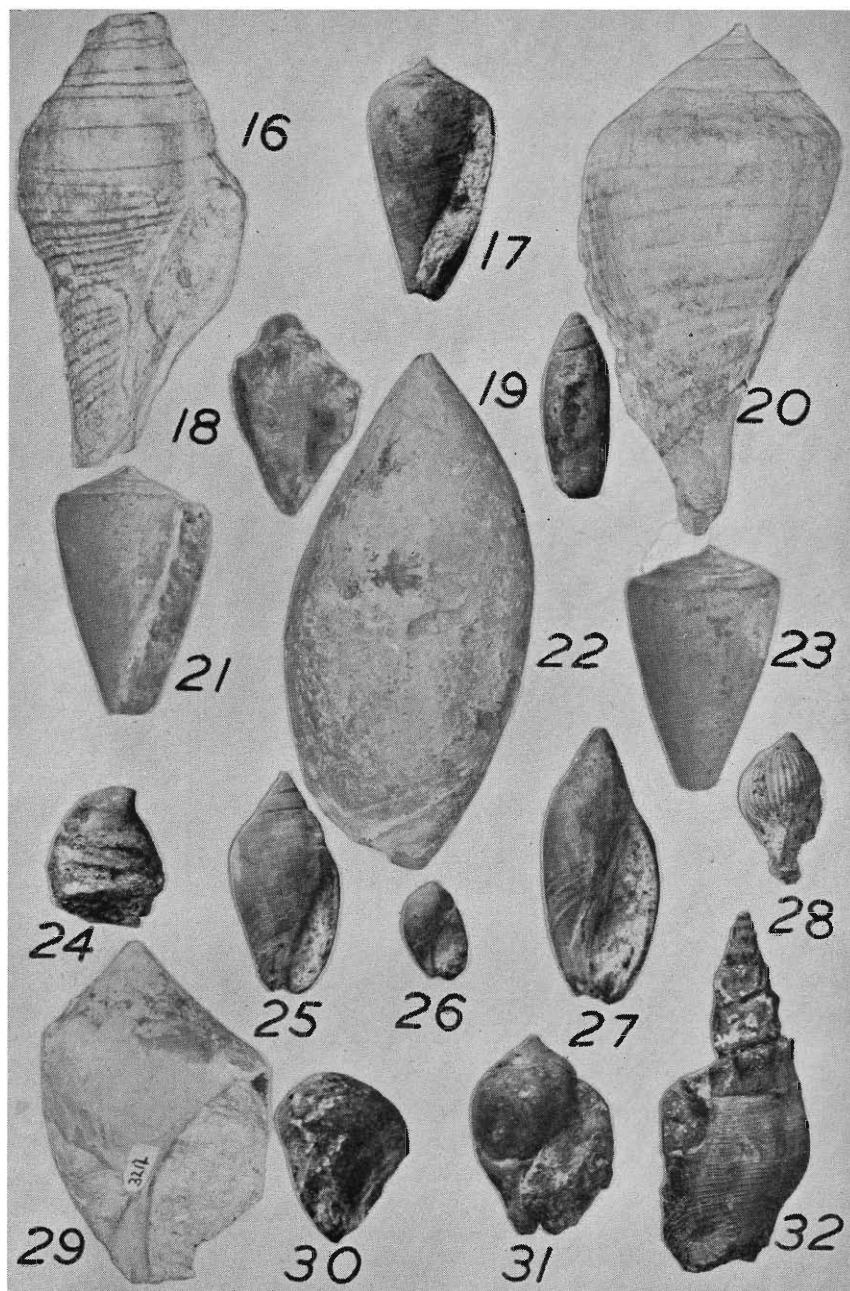
FIG. 7. *Nucula dowlingi*, n.sp. Holotype. FIG. 8. *Gari elongata*, n.sp. Holotype.

All figures nearly natural size.

FIG. 9. *Aequipecten uloa*, n.sp. Holotype.FIG. 10. *Modiolus* cf. *capensis*. Krauss.FIG. 11. *Aequipecten uloa*, n.sp. Paratype.FIG. 12. *Aequipecten uloa*, n.sp. Holotype.FIG. 13. *Modiolaria excavata*, n.sp. Holotype.FIG. 14. *Crassostrea prismatica*. Gray.FIG. 15. *Placuna anomala*, n.sp. Holotype. Right and left valves.

All figures nearly natural size.





- FIG. 16. *Turbinella premekranica*. Vredenburg.  
 FIG. 17. *Conus haughtoni*, n.sp. Holotype. FIG. 18. *Strombus floridus*. Lamarck.  
 FIG. 19. *Oliva australis*. Duclos. FIG. 20. *Galeodes kehla*, n.sp. Holotype.  
 FIG. 21. *Conus proliferatus*, n.sp. Holotype.  
 FIG. 22. *Ancilla ntombazana*, n.sp. Holotype.  
 FIG. 23. *Conus proliferatus*, n.sp. Holotype. FIG. 24. *Hipponyx*, sp.  
 FIG. 25. *Mitra textura*. Lamarck.  
 FIG. 26. *Olivella (Callianax) martiniopsis*, n.sp. Holotype.  
 FIG. 27. *Ancilla glabrata*. Linne. FIG. 28. *Nassarius delislei*, n.sp. Holotype.  
 FIG. 29. *Baryspira impi*, n.sp. Holotype. FIG. 30. *Baryspira shaka*, n.sp. Holotype.  
 FIG. 31. *Cassia achatina*. Lamarck. FIG. 32. *Strombus altispirus*, n.sp. Holotype.
- All figures nearly natural size.