

PALAEONTOLOGY OF
HARRAR PROVINCE, ETHIOPIA

PART 1. THE DUDLEY EXPEDITION

BARNUM BROWN

PART 2. ECHINOIDEA

ETHEL D. CURRIE

BULLETIN

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

VOLUME 82 : ARTICLE 1

NEW YORK : 1943

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ME 82 : ARTICLE 1
NEW YORK : 1943

BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY
Volume 82, article 1, pages 1-30, text figures 1-11,
plates 1-4, map 1

43-155760- Dec. 28

Issued December 30, 1943

PREFACE

THE EXTENSIVE COLLECTIONS of palaeontological, ethnological, and herpetological material from Harrar Province, Ethiopia, and the adjacent area, near Hargeisa, British Somaliland, made by the Dudley Expedition of the Anglo-American Oil Company were presented to the American Museum of Natural History through the generosity of the directors of that company.

The palaeontological material contains representative collections from the Upper Jurassic and Cretaceous (Albian) of Harrar Province and from the Eocene deposits near Hargeisa. The study of this material has been entrusted to specialists who have generously volunteered to report on the material within the field of their specializations. The following divisions of the collection have been made:

Foraminifera: Dr. Brooks F. Ellis, the American Museum of Natural History;

The American Museum of Natural History
July, 1943

Corals: Dr. John W. Wells, Ohio State University, Columbus, Ohio;

Echinoids: Dr. Ethel D. Currie, Hunterian Museum, University of Glasgow, Scotland;

Brachiopods: Dr. G. Arthur Cooper, United States National Museum, Washington, D. C.;

Cephalopods: Dr. Gayle Scott, Texas Christian University, Dallas, Texas;

Gastropods and Pelecypods: Dr. H. E. Vokes, the American Museum of Natural History.

In addition to these reports, which will be published as received, it is planned to include an introductory description of the Dudley Expedition and an outline of the geology of the Harrar Plateau by Dr. Barnum Brown, geologist-in-charge of the expedition, and a final geologic and palaeontologic summary by Dr. Barnum Brown and the writer.

H. E. VOKES

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PART 1. THE DUDLEY EXPEDITION

THE DUDLEY EXPEDITION of the Anglo-American Oil Company was organized early in 1920 to investigate the potential petroleum and other mineral and natural resources of a concession embracing one-half of Harrar Province, Ethiopia, which had been secured through the Regent Ras Taffari, now Emperor Haile Selassie. The members of the expedition included Mr. Shephard, Major Simon Rooney, Captain Moon, Mr. George Powell, and the writer.

Leaving London, England, on May 29, 1920, we reached Addis Abbaba about the first

of July, but it was not until September 27 that we were able to leave Dirre Daua to begin the actual field work. The intervening three months were spent in the complicated negotiations necessary to confirm our concession and to placate all the officialdom, major and minor, before undertaking any work in a country of this kind. Field work by mule and camel caravan continued until January 19, 1921. The caravan routes, camping places, and principal fossil localities are indicated on the map in this article.

THE HARRAR PLATEAU

The Harrar Plateau is a great tableland bounded on the north by the Tscherscher Mountains and their eastward extension of exposed granitic and other igneous intrusions. To the south it slopes off into the little-explored desert of the Ogaden country. The western margin seems to be a great fault scarp forming part of the great African Rift Zone, this margin of the plateau rising almost 4000 feet above the plain on which Dirre Daua is situated. The elevation at "North Dirre Daua" (camp station 39) was 3600 feet, while at Haramaya (camp station 1), at the western edge of the plateau, it was 6675 feet in the pass leading onto the plateau itself.

The surface of the plateau is, in general, fairly level, being formed on the flat lying, or but gently dipping, Jurassic limestones. To the northward, paralleling our route westward from Harrar, the southern foothills of the Tscherscher Mountains encroach on the surface of the plateau. These foothills are mostly remnants formed of basaltic lavas, representing several distinct superposed flows. From these mountains flow tributaries of the Webbi Shebeli River. These cross the plateau, flowing almost directly from the north toward the south, trenching the plateau every few miles with canyons up to 1000 feet deep cut into the limestones. Excellent exposures of all the formations are, therefore, readily accessible.

CRYSTALLINE BASEMENT

The oldest rocks exposed in the region are metamorphic and igneous crystallines. These

include large areas of biotite gneiss which have been highly intruded by a dense network of aplitic, pegmatitic, and quartz veins. As a result typical injection gneisses are commonly present. In addition, there are considerable areas of red granitic, batholithic (?) intrusions. These older rocks are extensively exposed in the lower parts of the fault scarp forming the western margin of the plateau as well as in some of the deeper river canyons, as in that of the Gobelli River near Jimabiro (camp station 4), where the river has cut its canyon 1000 feet below the base of the sedimentaries. In this region some serpentines also occur in the lower series.

There are also a number of places, including Mt. Harrhe (camp station 35) and particularly in the chain of hills west of Jig Jiga, where these crystallines and associated ancient eruptive rocks outcrop as erosion remnants, around which the Jurassic limestones are present with only a slight initial dip observable, indicating that these areas of ancient rock were present as elevations on the Jurassic sea floor.

The row of hills west of Jig Jiga, mentioned above, is said to extend northwest-southeast without interruption for a distance equal to seven days' travel into the Ogaden country, as far as Lagahabour. They evidently are developed along a very old tectonic or structural line.

It seems most probable that these are the rocks described from British Somaliland by Macfadyen (1933, pp. 33-35) under the titles "The Inda Ad Series" and "The Igne-

ous and Metamorphic Series." The Inda Ad Series there consists of a "succession of slates, grayish and greenish quartzites, slaty sandstones and beds of limestone." These beds are cut by quartz veins and intruded by granites, a condition which also is characteristic of the basement rocks in the Harrar region.

The Igneous and Metamorphic Series in Somaliland consists of "foliated crystalline rocks, gneisses, chlorite-, mica-, garnet- and hornblende-schists, etc. These are associated with, or intruded by unfoliated plutonic rocks, syenites, granites, pegmatites, gabbros and diorites, with a few hypabyssal intrusives."

The crystalline rocks in the Harrar region were not studied in sufficient detail to permit any suggestion as to the probable correlation of that series with either, or with both, of the series developed in British Somaliland. A comparison of the geologic map accompanying Macfadyen's report with the route map included here shows that the outcrops of these series in British Somaliland are adjacent to Mt. Harrhe (camp station 35) where crystalline basement rocks similar to those exposed in the hills west of Jig Jiga and in the Harrar area are exposed.

In the British Somaliland report these rocks are referred to the Archaean. However, since these rocks are unconformably overlain by sandstones of Triassic or Lower Jurassic age, there is no evidence at present available which would seem to justify any such definite age assignment.

THE ADIGRAT SANDSTONE

In 1869 Blanford (p. 402) proposed the term Adigrat Sandstone for a series of massive sandstones, white, brown, lilac, or red in color, with a zone of blue or lilac shales toward the base. These were unfossiliferous and up to 1000 feet or more in thickness as exposed in the area in northern Ethiopia where Blanford was working. They underlay the fossiliferous Antalo limestone of Jurassic age and rested upon a series of ancient metamorphics.

Within the Harrar region there are a series of sandstones and quartzites, passing upwards in at least one place into red slaty phyllites, which appear to have been trans-

gressively deposited across the crystalline series from the south. They appear to be almost wholly composed of detritus from the crystallines, and large rounded boulders of the underlying rocks are not uncommon, particularly in the basal conglomerate. The sands are generally highly arkosic, often conglomeratic, and are varicolored, though predominantly reddish. The lower beds are extensively cross-bedded with inter-bedded, markedly lenticular conglomerates. Lenses of sandy shale or "siltstones" are also commonly present. These lower beds have the appearance of being of continental flood plain or deltaic deposition.

The upper strata of this series are more evenly bedded and are much less variable in composition, being essentially composed of hard sandstones and quartzites. The fact that they appear to pass gradationally into the overlying limestones suggests that they may be of marine origin. They are almost entirely unfossiliferous, but von zur Muehlen (1931, p. 630) and Gortani and Bianchi (1937, p. 503; 1938, p. 238) report a "bone bed" containing abundant scales, teeth, and bones of *Lepidotus* in the vicinity of Harrar near the base of Mt. Achim. Von zur Muehlen considers that this evidence suggests a Triassic or Lower Jurassic (Liassic) age for the series, while the latter authors believe that this same evidence indicates an Upper Liassic or Lower Oolitic age for these beds, and consider the entire series to be of Jurassic age.

Since the primary purpose of the Dudley Expedition was the search for possible petroleum resources, this formation was not studied in any detail. Such investigations as were made, however, suggest the probable correlation of these beds with those of the typical locality of the Adigrat sandstone, although in the present area they thin markedly toward the north. At Grau (camp station 6) they are 575 feet thick, at Hamaressa (camp station 14), 250 feet thick, while they are entirely absent in the pass of Au Nugua near Komboltcha (camp station 27). At this latter locality the limestones rest directly upon the granite with a peculiar basal limestone conglomerate containing large boulders of the crystallines.

This thinning to the north, together with the fact that these beds seem to be grada-

tional into the overlying formations, suggests that the sea transgressed across the area from the south, and probably up an initial bed-rock slope. In view of the fact that the rocks of the crystalline basement complex are known to have stood high in the hills west of Jig Jiga and at Mt. Harrhe, it seems quite possible that there was a similar topographic high in the region of the present Tscherscher Mountains, and that the observed thinning of the formation was essentially a purely local phenomenon in this area, and that the sea swept around the region, being continuous to the north into the region studied by Blandford.

Farther south in Italian Somaliland the "Serie di Lugh," which occupies a similar stratigraphic position, has yielded a *Natica* sp. indet., and *Mytilus* cf. *pilonoti* Quenstedt, together with fish remains. These beds are considered by Stefanini (1932, pp. 17-23) as probably representing the whole series "Retico-Lias-Oolitico Inferiore." In British Somaliland (Macfadyen, 1933, pp. 31-33) the Adigrat Sandstone is represented by a coarse, yellow, current-bedded sandstone at the base overlain by a series of limestones, shales, and sandstones, containing a few fossil lamelli-branches, with generally an upper sandstone which, as in the Harrar region, seems to pass up conformably into the fossiliferous limestones of the Upper Jurassic. It is reported that at Bihendula there is a sill of igneous rock about 40 feet thick intruded into the formation, while in the Bur Ad Range to the west the lower shales immediately above the basal sandstones are intruded and dislocated by a basaltic doleritic dike. No such igneous rocks were observed in the Harrar section.

UPPER JURASSIC LIMESTONES

The limestones which rest upon and apparently grade down into the sandstone series form the surface of the Harrar Plateau. In general they have been somewhat eroded, so that the plateau surface lies within the series, and the complete section is exposed only in certain of the mountain areas and in some of the foothills of the Tscherscher Range. It is quite variable in nature and in thickness, though in general it consists of the following sequence: (a) a highly arenaceous, generally thin, basal limestone

gradually passing up into (b) a thick, often massive, bedded, crystalline limestone. This commonly forms rather prominent cliffs along the canyons cut by the tributaries of the Webbi Shebeli, and was referred to in the field as the "canyon limestone." Fossils are rare and when present are poorly preserved, except in certain localities where there are lenses containing abundant, small, *Corbis*-like pelecypods. The thickness of this zone varies somewhat from place to place. In general the transitional nature of the contact between zones (a) and (b) was such as to make it difficult to separate them for exact measurement. At Grau (camp station 6) in the Garamoulata mountainous area these two zones had a combined thickness of 1100 feet, while at Dogou (camp station 5) nearby they were 975 feet thick.

(c) Above this "canyon limestone" there is a relatively thin zone, 50 feet thick at Grau, characterized by an abundance of ammonites, which are often well preserved. This zone was also found at Dogou, Dirre Daua, and Gildessa and is believed to be equivalent to that at Bihendula and Daghani, British Somaliland, from whence were obtained the ammonites described by Spath (1935). In addition, the fauna of this zone includes abundant pelecypods and brachiopods, together with some corals and echinoids.

(d) Above is a zone of alternating limestones and clays; the limestones often contain abundant chert in nodules, and the fossils may be silicified. The thickness of this section is commonly reduced by erosion. At Grau, where it seems to be complete, it is 250 feet thick. At Dogou the following sequence was measured within this zone:

Thin white limestone (top of section)	1 foot
Alternating whitish yellow limestone and clay with " <i>Lucina</i> ," <i>Gryphaea</i> , <i>Ostrea</i> , and <i>Terebratulids</i>	185 feet
Thick yellowish limestone, unfossiliferous	15 feet
Shaly limestone with " <i>Lucina</i> " and echinoderms	5 feet
Clay alternating with thin limestone	20 feet
Red hematitic clay with " <i>Lucina</i> " and <i>Gryphaea</i>	1 foot
Alternating clay and thin limestone	30 feet
Total	257 feet

Fossils from this series, presumably mainly from our zones (c) and (d), have been described by Dacqué (1905) and Cottreau (1925). The Oxfordian and Kimmeridgian age of these strata seems to be certain. In addition, von Huene (1938) has recently described a new species of Plesiosaur, *Simolesites nowackianus*, reported as having been found 5 meters above the base of this series, probably within our zone (a), near Feyambiro. This form is believed by von Huene to be of lower Malm age and, therefore, this entire limestone series is of Upper Jurassic age.

There is no evidence in this section of the thick shales that are to be found in British Somaliland (Macfadyen, 1933, pp. 27-31), and until the fossils of the present collection are studied it is impossible to indicate the probable correlations between the present section and the formations described by Macfadyen.

CRETACEOUS DEPOSITS

Throughout most of the area the Jurassic limestones are the highest Mesozoic deposits preserved. In the Garamoulata region, however, there is a series of sandstones and sandy limestones, the latter containing an upper Aptian or Albian fauna. At the base of this section, and resting conformably on the Upper Jurassic limestones, are 345 feet of cross-bedded, loosely consolidated sandstones. These are somewhat variegated in color but are chiefly of a white to whitish buff phase. They are unfossiliferous and their geologic position is uncertain, but they are here referred to the Cretaceous simply as a matter of convenience, and also because of the sandy nature of the overlying fossiliferous limestones.

These limestones are white, compact, and highly fossiliferous. At Grau they form a rather prominent cliff and are about 95 feet thick. They break off in great blocks, some of which are as much as 30 feet long and 20 feet thick. The upper part of this series is composed of an almost solid mass of shells in which those of species of *Ostrea* predominate. In addition, however, *Turritella*, *Glaucomya*, *Nerinea*, *Natica*, serpulids, many pelecypods, and a number of echinoids are also present. The middle part of this limestone contains highly crystalline layers which break in abrupt faces and contain abundant *Nerinea*. Toward the base of the zone the strata are somewhat softer and are characterized by two species of *Cardium* (*sensu lato*). A few terebratulid brachiopods and echinoids were also collected here.

Orbitolina lenticularis (Blumenbach) is not rare in this limestone and *O. discoidea* (Gras) is also present.

NUBIAN SANDSTONE (?)

Unconformably above this limestone at Grau was measured a section 375 feet thick, of unfossiliferous sediments whose age is entirely uncertain. They may be of Upper Cretaceous or early Tertiary deposition. The formation consists of an upper zone 10 feet thick, composed of whitish chalk which seems to grade down into a thick series of sands and coarse gravels, all carrying a considerable amount of iron. This zone forms cliffs which on their weathered surface have a bright red color.

Below the cliffs are slopes formed of coarse sand and abundant siliceous pebbles which attain a size as large as pigeons' eggs. Cut faces show that these beds are loosely consolidated and strongly cross-bedded. No

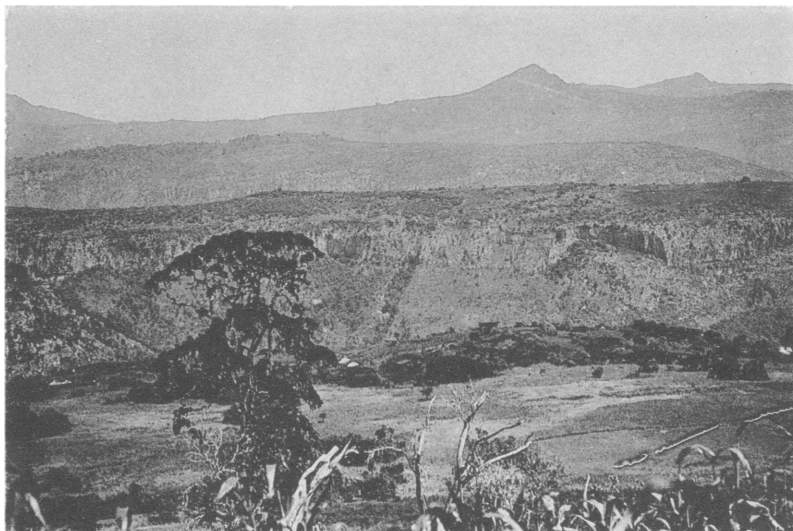
PLATE 1

FIG. 1. The Jurassic limestones of the Harrar Plateau are deeply trenched, particularly near the southern margins of the Tscherscher Range, by tributaries of the Webbi Shebeli River.

FIG. 2. A typical exposure of Upper Jurassic

limestones, zone (d), in one of the tributaries of the Webbi Shebeli.

FIG. 3. Typical scene at the foot of the Garamoulata Mountains. The hill at the left is composed of the Upper Jurassic limestones; that in the rear is capped by basaltic flows.



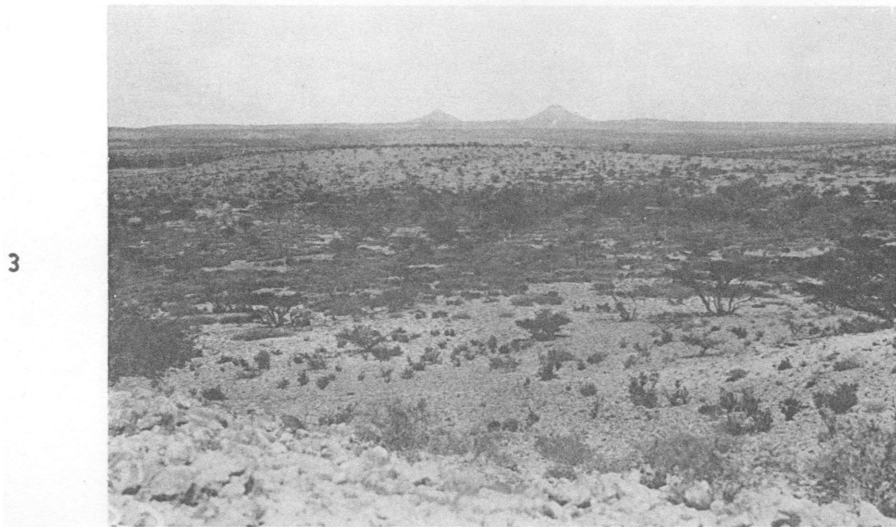
1



2



3



siliceous strata, which might serve as a source for these pebbles, were observed to the east of this area and they must have come from the south or the west.

A somewhat similar series of sandstones and quartzites was observed north of Dirre Daua, but here also there is no certain evidence as to their age.

In British Somaliland the Cretaceous section in the western part of the Protectorate consists entirely of sandstones that are considered as being equivalent to the Nubian sandstone. To the east it is gradually replaced by marine limestones, which must, however, have been from an entirely different marine basin than that represented at Grau. The general description of the Nubian sandstones as developed in the western part of the region agrees fairly well with that of the sandstones at the top of the section at Grau, and it may be that the strata found at the latter locality represent a small part of the rather heterogeneous assemblage of Cretaceous continental sandstones referred to under the term "Nubian Sandstone." It is equally possible, however, that they are a sequence deposited during some part of the Tertiary period.

TERTIARY AND QUATERNARY DEPOSITS

The crests of the Garamoulata, Jebel Kondoura, Kondudo Hill, and most of the other "foothills" of the Tscherscher Range are composed of great thicknesses of successive

flows of basaltic lavas. The thickness of this series was not measured, but it must be in the neighborhood of 3000 feet. Near the base, in the Garamoulata region at least, the individual flows show interbedded thin to moderately thick strata of calcareous sandstone similar to that noted at the top of the Albian deposits at Grau. This association, however, as noted above, furnished no evidence as to the age of either the lower sediments or the basalts. They are generally said to be of Tertiary age (see Lebling and Nowack, 1939, p. 3), but this assignment is based on superposition only.

The basalt itself is generally poor in olivine and has been described by Gortani and Bianchi (1937, pp. 506-511) as an "andesitic basalt." In some porphyritic samples, however, minute phenocrysts of augite and olivine have been observed. Flow structures are frequently present on a rather large scale, and pillow structures are not uncommon in the lower flows.

In the area about Jig Jiga, west of the row of hills formed of ancient crystallines described above, the surface of the plateau is covered by Quaternary deposits composed mainly of sandstones and gravels, many of which are cemented with calcareous material deposited during the evaporation of small transient lakes. The surface of the plateau developed on these Quaternary sediments is a level to slightly rolling plain covered by a dense growth of grass. The whole is very reminiscent of the plains of eastern Montana.

THE DIRRE DAUA REGION

Dirre Daua lies to the west of the great fault scarp which marks the western limit of the Harrar Plateau. The city itself lies in an amphitheater-like basin. Along its western margin near the scarp there are numerous

low hills formed of large, broken, down-faulted blocks of Upper Jurassic limestone. They are tipped in various directions, though mostly north and northwestward at angles from 10 to 45 degrees.

PLATE 2

FIG. 1. Looking westward across the Jig Jiga Plain to the row of hills formed of ancient crystalline rocks that mark the western boundary of the plain. Jig Jiga in the middle distance.

FIG. 2. Cretaceous exposures in the cliff immediately below the Coptic Christian church at

Grau. The upper zone is of Nubian (?) sandstone; the lower strata are of Aptian age.

FIG. 3. The buttes of Naso Hablod, northeast of Hargeisa, British Somaliland. They are formed of Lower Eocene Auradu limestone; the plain and their lower slopes are composed of Nubian sandstone.

These limestone blocks "swim" in a great "sea" of lava flows that seem to have come from the Burhad craters, located six hours' journey to the northwest. The lavas floor the northern part of the Dirre Daua basin and also serve to form its northern boundary. The flows are horizontal in position and were certainly extruded subsequent to the folding and faulting of the sedimentary series.

The Upper Jurassic limestones are also well exposed in a cliff about 10 kilometers northwest of Dirre Daua (north Dirre Daua, camp station 39). Fossils found here indicate the correlation of the exposed section with the fossiliferous strata of our zones (c) and (d) of the Upper Jurassic on the Harrar Plateau.

Disconformably overlying this limestone is a series of sandstones at least 600 feet thick. They are, in general, quartzitic in character and seem to lack the calcareous facies present

in the upper sandstones of uncertain age observed on the Harrar Plateau at Grau in the Garamoulata area. These sandstones may be the equivalent of these upper beds, or they may also include strata contemporaneous with the known Cretaceous sediments in the latter area. No fossils were found in them.

Reconnaissance surveys showed that no sedimentary rocks are exposed for some distance north of this area, the entire area surrounding the Burhad craters forming a large lava field. Six miles north of these craters, however, some prominent peaks, the Gambutta Wallali, were found to be composed of the same type of quartzitic sandstones found at north Dirre Daua. They are entirely surrounded by the lavas, and no exposures of limestone were found.

THE HARGEISA, BRITISH SOMALILAND, REGION

Hargeisa is the principal town in the area of British Somaliland adjoining the part of Harrar Province investigated by the Dudley Expedition. During the course of the studies a camel caravan trip was made from Harrar via Jig Jiga to Hargeisa and return, and the region between Hargeisa and Berbera, the seaport capital of the colony, was investigated later by car.

At the time of our visit Hargeisa was a village with a shifting population, usually of 2000 to 3000 people, and a military post of 100 police, mostly of the famed camel corps. It is located at the site of permanent water holes in the bed of the Erer River, and consisted at that time of two or three groups of grass mat huts and a few sun-dried brick houses for the Arab merchants.

The fossiliferous strata in the vicinity are of Eocene age. They are well exposed at Naso Hablod, two prominent limestone buttes six miles northeast of Hargeisa. Rocks of this age were first observed at Laliskwe, north of Dabolak (camp station 32). From this point they thicken to the east, being 350 feet thick at Naso Hablod and at least 600 feet thick 20 miles farther down the Erer River. At Naso Hablod the strata have a uniform south-southwestward dip at a low angle, generally about 3 degrees. They rest upon a

series of quartzites which are referred to the Nubian sandstone by Macfadyen (1933, map).

The Eocene beds consist of a somewhat arenaceous limestone, massive and thick-bedded, and in places very hard. Some pure, foraminiferal limestones occur toward the middle and in the lower part of the section. The upper 80 to 100 feet are composed of harder strata that weather into rather vertical cliff faces, which mark the margins of the Erer River Valley and also form some rather prominent hills to the north, as well as serving as a cap-rock on the buttes at Naso Hablod. Chert is abundant throughout the section but is most pronounced in the upper, cliff forming beds. The iron content is also high and is usually found in the poorly preserved fossils, as well as around clear chert concretions. Some specimens show well-developed limonitic pseudomorphs after pyrite.

A peculiar feature of these upper strata in this region is the presence of quantities of salts concentrated in softer places in the strata. These salts seem to effervesce when moistened and are leached out by the rain. Their removal loosens the sediments so that they are easily blown away by the winds or are removed during the rains. As a result the upper portion of the cliffs are extensively

"pocketed" by numerous small caves whose roofs all have a lattice-like appearance.

During the course of the automobile reconnaissance from Hargeisa to Berbera, exposures were poor between Hargeisa and Oadweina, 85 miles distant by road. Between here and Burao, over a distance of 35 miles, there were a few escarpments of Eocene rocks similar to those of the upper part of the section at Hargeisa. The next adequate exposures encountered were near the Goldahamid Camel Corps Headquarters at Upper Sheik, 40 miles by road from Burao.

Here there are bold cliffs facing toward the distant coast. At first glance they appear to be composed entirely of thick conglomerates, but investigation shows them to be of limestone which contains great numbers of concretionary structures. On weathering these tend to cover the surface, giving a striking conglomeratic aspect to the outcrop. These

beds also contain a large amount of iron, and weather to a deep rusty red color, though on fresh surface the limestone has a gray to buff tint. Fossils, including corals, mollusca, and echinoids, were found here which seem to be conspecific with those found at Naso Hablod near Hargeisa.

These Eocene deposits are correlated by Macfadyen (1933, pp. 22-24) with those from somewhat near the coast which were called the Auradu Limestone by Gregory (1900), who first considered that the poorly preserved fossils indicated a Cretaceous age for this formation. Later (1925) he referred it to the Middle Eocene. Macfadyen (1933, p. 22) refers these beds to the Lower Eocene on the basis of their stratigraphic position and "of the body of fossil evidence now available." This latter evidence is not discussed and cannot be evaluated here.

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PART 2. ECHINOIDEA

THE COLLECTION to be discussed in the following pages included Jurassic and Cretaceous echinoids from Ethiopia and Eocene echinoids from British Somaliland. The collection is in the American Museum of Natural History and was entrusted to me for

examination by Dr. H. E. Vokes of that Museum. I am indebted to Dr. Vokes for the opportunity of studying this interesting material and also to my chief, Prof. A. E. Truman, for reading the typescript and for many helpful suggestions.

JURASSIC ECHINOIDEA FROM ETHIOPIA

The Jurassic material is not well preserved. Most of the specimens are crushed to some extent and are covered with a tough limestone matrix very difficult to remove. The following species have been identified:

- Acrosalenia* cf. *smelliei* Currie
- Acrosalenia* sp.
- Acrosalenia* (*Metacrosalenia*) *pseudocidaroides* Currie
- A.* (*M.*) *pseudocidaroides* var. *quadrimiliaris* Currie
- Acrosalenia* (*Metacrosalenia*) sp.
- Recrosalenia somaliensis* Currie
- Pseudocidaris* sp.
- Pseudocidaris* sp. (spines only)
- ? *Psephochinus* sp.
- Holactypus* sp. indet.
- Mepygurus* cf. *smelliei* (Currie)
- Mepygurus* sp.

The identifiable species, unfortunately few in number, are already known from the Bihen Limestone of British Somaliland. They were represented among the echinoids in the collection of fossils from British Somaliland made by Dr. W. R. Smellie and Mr. B. K. N. Wyllie on behalf of the Anglo-Persian Oil Company. The echinoids in this collection (described, Currie, 1925) appeared to be either Bathonian or Callovian in age, and general evidence led the late J. W. Gregory (1925, pp. 2, 3) to conclude that the "Echinoid Limestone," as the lowest beds of the Bihen Limestone were then called, is probably Bathonian. The collection of echinoids from British Somaliland made by Mr. R. A. Farquharson, Government Geologist, in 1923-1924 (described, Currie, 1927) tended, if anything, to confirm the Bathonian age of the echinoid fauna of the Bihen Limestone. The Jurassic echinoids from British Somaliland in the collections of Mr. C. Barrington

Brown and the Somaliland Petroleum Company (now in the Sedgwick Museum, Cambridge) led the writer (Currie, 1935) to no change of view on this matter, but the evidence of the echinoids is not inconsistent with the conclusion of Muir-Wood (1935, pp. 66-67, and see Cox, 1935, p. 150) based on the brachiopods from the same and intermediate horizons, that the Bihen Limestone is Callovian rather than Bathonian. It may be assumed that the Jurassic echinoids from Ethiopia in the present collection are from a formation contemporaneous with the Bihen Limestone of British Somaliland (? the Antalo Limestone) and probably of Callovian age. There is nothing to indicate that the material is not all from one horizon.

Two species of echinoid, *Hemicidaris abyssinica* sp. nov. and *Cidaris* ? (a fragment), were described by Blanford (1870, pp. 179, 199, pl. 8, fig. 1) from the Antalo Limestone of Ethiopia which has been generally assigned to the Bathonian or Callovian. Neither *H. abyssinica* nor any remains of *Cidaris* occur in the present collection. Cottreau (1925, p. 580) recorded *H. abyssinica* Blanford and *Pygurus* sp. from Harrar, Ethiopia. It is now apparent that *H. abyssinica* is from the upper of the two Jurassic marine horizons, Sequanian-Kimmeridgian and Bathonian according to Cottreau, recognized in Ethiopia.

A striking feature of the echinoids under consideration is the preponderance of specimens of *Metacrosalenia*. Out of 36 identifiable specimens, 19 belong to that subgenus. In the collections from Somaliland referred to above, certain species of irregular echinoid are most numerous in individuals (e.g., *Bothriopneustes somaliensis* and *Mepygurus smelliei*).

DESCRIPTION OF THE MATERIAL

GENUS ACROSALENIA AGASSIZ, 1840

Acrosalenia cf. *smelliei* Currie

MATERIAL: Two crushed and incomplete specimens about 17 or 18 mm. in diameter probably belong to *Acrosalenia smelliei* Currie (1925, p. 53, pl. 8, fig. 5). As far as one can judge, they differ from the holotype only in their smaller size. Apical systems not preserved.

LOCALITY: Modjo River.

Acrosalenia sp.

MATERIAL: One specimen about 26 mm. in diameter and 11.5 mm. in height. The exposed parts of its surface are abraded, and the apical disk is missing.

LOCALITY: Modjo River.

REMARKS: This specimen shows considerable resemblance to *A. smelliei*, but it is more depressed, its ambulacral tubercles do not appear to be of alternating sizes, and the main interambulacral tubercles are slightly more distant from the inter-radial suture.

The tuberculation is not unlike that of *Acrosalenia gananensis* Stefanini (1931, p. 97, pl. 4, fig. 3), but the form of the test is much more depressed.

SUBGENUS METACROSALENIA CURRIE, 1925

REMARKS: Mortensen (1935, p. 316) regards *Metacrosalenia* as a synonym of *Heterosalenia*. After careful consideration of the matter, I find I cannot agree with this point of view. In the four known accepted species of *Heterosalenia* (i.e., excluding *A. corallina* Dames; see Hawkins, 1923, p. 210), the apical system is rugose and the periproct, which has a beaded edge, is situated to the right of the anteroposterior axis. Although Mortensen does not regard the rugosity of the apical system and the beaded edge of the periproct as essential generic characters, he does so consider the position of the periproct to the right of the anteroposterior axis. But the merging of *Metacrosalenia* in *Heterosalenia* would involve the inclusion in *Heterosalenia* of forms which have the periproct in the line of the anteroposterior axis, or it would necessitate the rejection from *Metacrosalenia* (or *Heterosalenia*) of some of the forms which (on account of the close simi-

larity in all characters except the symmetry of the apical disk) the writer suggests in the following pages constitute a single species. Another character present in *Metacrosalenia* appears, however, to indicate the distinctness of the genera. In *Metacrosalenia*, all the plates, with the exception of the extreme adoral plates, are simple primaries and each simple primary bears a tubercle. In *Heterosalenia* and *Pseudosalenia*, as in some species of *Acrosalenia*, the plates are simple above the ambitus but are compound (in triads) below. If, as seems likely, the grouping of the primary plates of *Heterosalenia occidentalis* Hawkins (1923, p. 207), dyads alternating with simple primaries above and triads below, is characteristic of the genus *Heterosalenia*, there can be no question of merging *Metacrosalenia* in *Heterosalenia*.

Acrosalenia (*Metacrosalenia*) *pseudocidaroides* Currie

Text figure 1a

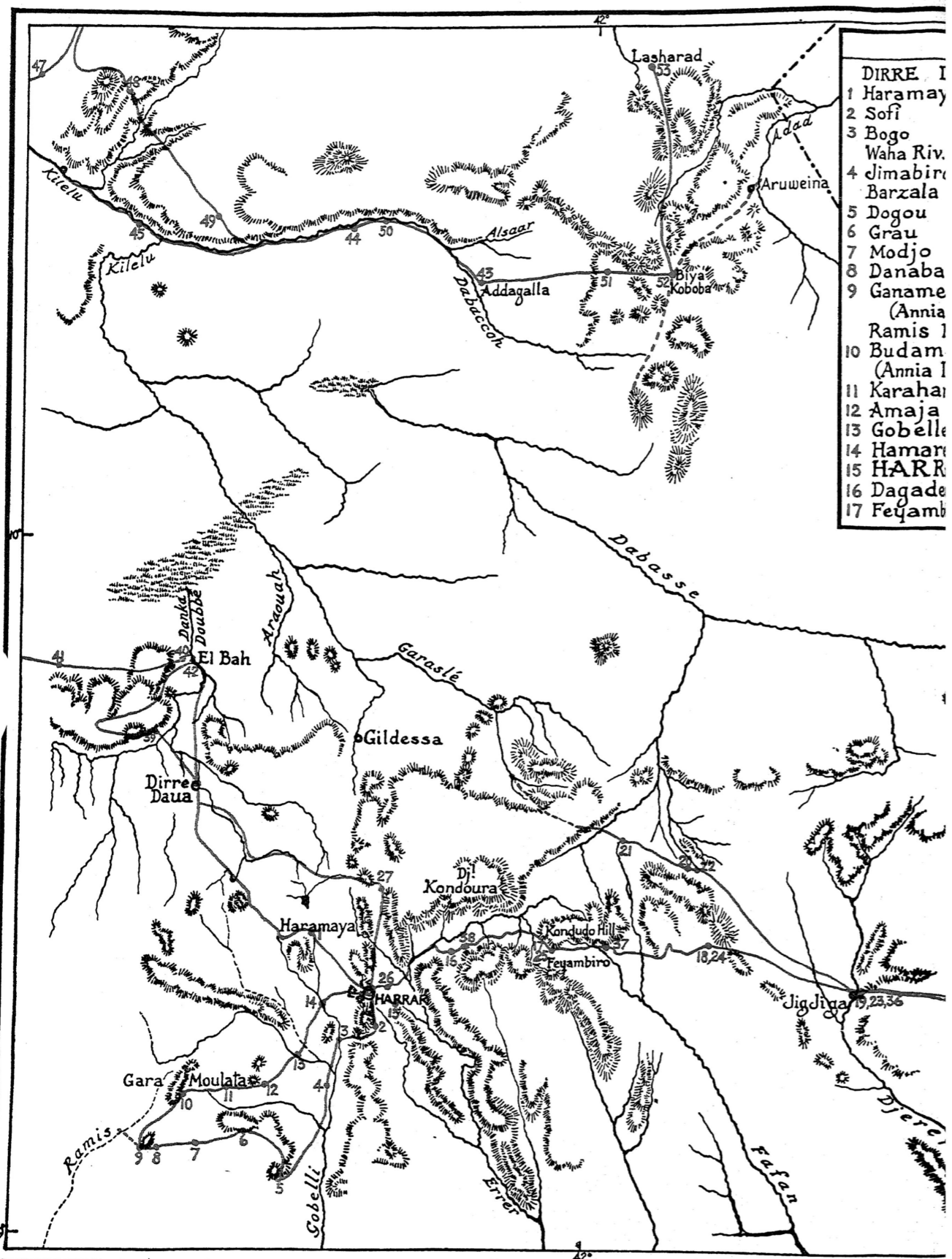
Acrosalenia (*Metacrosalenia*) *pseudocidaroides* CURRIE, 1925, p. 55, pl. 8, fig. 6a, b; 1927, p. 413.

MATERIAL: Seven specimens. Five other specimens probably belong to this species also; owing to their state of preservation there is just a shade of doubt as to whether they belong to this species or to the variety *quadrimiliaris*.

LOCALITIES: Feyambiro (Mt. Kondoura, 8600 feet); Jig Jiga (500 feet above granite); Kurtcha (500 feet above base).

REMARKS: In 1927, the writer (Currie, 1927, pp. 413-414) referred to weathered specimens of *Metacrosalenia* from Somaliland that probably represented "pentagonal" and "tumid" varieties of this species. The specimens in the present collection from Ethiopia are mostly crushed, but it is apparent that forms similar to the holotype and to the pentagonal and tumid varieties are represented. There is probably a gradation from the form of the holotype to a large pentagonal form, of which there are four or five examples. The largest of these has a diameter of about 33 mm. Only one incomplete specimen seems to represent the tumid variety.

In addition to variations in form and dimensions, variations in the ambulacra and in the apical disk have been noted. The char-



- DIRRE I**
- 1 Haramaya
 - 2 Sofi
 - 3 Bogo
 - 4 Jimabira
 - 5 Dogou
 - 6 Grau
 - 7 Modjo
 - 8 Danaba
 - 9 Ganame (Annia I)
 - 10 Budam (Annia I)
 - 11 Karahar
 - 12 Amaja
 - 13 Gobelle
 - 14 Hamari
 - 15 HARRAR
 - 16 Dagadera
 - 17 Feyambiro

- MP STATIONS**
- | | |
|----------------------|----------------------------|
| 18 Adow | 38 Dagadera |
| 19 Jig Jiga | 39 North Dirre Daua |
| 20 Gotchar (Girri) | 40 Near El Bah |
| 21 Darmi | 41 Metto |
| 22 Gotchar | 42 El Bah |
| 23 Jig Jiga | 43 Addagalla |
| 24 Adow | 44 Gorgour |
| 25 Feyambiro | 45 Gomish |
| 26 Erer River | 46 Near Gouhan |
| 27 Komboltcha | 47 Lava field |
| 28 Near Abou Foulan | 48 Lava field |
| 29 Near Gelmaharis | Takale (hot spring) |
| 30 Near Ejara | 49 Debu (Pleistocene Lake) |
| 31 HARGEISA | 50 Domboshe Bead |
| 32 Dabolak | 51 Addagalla |
| 33 Near Debiylouein | 52 Biya Kaboba |
| 34 Near Debilé | Mt. Aiya Makkeran |
| 35 Mt. Harrhe | 53 Lasharad |
| 36 Jig Jiga | |
| 37 Santhala | |
| Mt. Kondudo | |
| top of sedimentaries | |

ROUTE MAP
ANGLO-AMERICAN OIL COMPANY
 Exploration of Ethiopia
 Dudley Expedition,
 Harrar Province,
 1920-1921
 Barnum Brown, Geologist

Kil.
 5 10 15 20 25 30 35 40 45 50



Base Map from Harrar Sheet, CARTE de la CÔTE FR^{SE} des SOMALIS. Service Géographique des Colonies. 1909
 D.F. Levett Bradley. 1939

acteristic appearance of the ambulacra, as described by the writer (Currie, 1925, pp. 55-56), is always found at the ambitus but in one or two specimens (A.M.N.H. Nos. 25328 and 25329), there are, at the extreme adapical end of the ambulacra, four vertical series of small tubercles or miliaries as in the form described as *A. (M.) quadrimiliaris* (Currie, 1927, p. 414). The variation in the apical system lies in the position of ocular V and in the number of suranal plates. The peristome is to the right of the anteroposterior axis, and while ocular I is invariably insert, ocular V may be exsert or insert to some extent. It is never completely insert as is ocular I. As regards suranal plates, two, four, and six can be seen in certain specimens, and although the apical disks of these specimens are incomplete and do not show their complement of suranal plates, it is clear that the number is variable.

As stated elsewhere (Currie, 1927, p. 415), this species is closely similar to *A. (M.) quadrimiliaris*, and the "quadrimiliaris" condition referred to above at the apical ends of the ambulacra in certain specimens of *A. (M.) pseudocidaroides* renders the similarity even closer and leads one to regard "quadrimiliaris" as a variety of "pseudocidaroides." The ambulacra of *A. (M.) pseudocidaroides* are wider than those of the variety *quadrimiliaris*, and the miliaries (or granules) between the main marginal series of tubercles are small and number up to 5 or 6 at the ambitus.

In the variety *quadrimiliaris*, the four vertical series of tubercles or large miliaries at the apical end of the ambulacra give place gradually to an arrangement of main marginal tubercles with intermediate miliaries, but the miliaries are larger, less regular in size, and fewer in number than in *A. (M.) pseudocidaroides*.

It has been possible to clear the apical disks of a few of the specimens of *A. (M.) pseudocidaroides* and the variety *quadrimiliaris*, and as far as can be determined these show that the essential features of the apical disks of the holotypes are constant for each variety. As already stated, the periproct in *A. (M.) pseudocidaroides* lies to the right of the anteroposterior axis, and ocular V may be exsert or insert to some extent. In the

variety *quadrimiliaris*, on the other hand, the periproct is on the line of the anteroposterior axis, and ocular V like ocular I is completely insert.

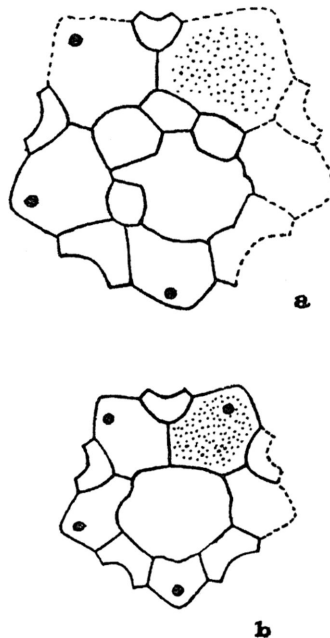


FIG. 1. a, *Acrosalenia (Metacrosalenia) pseudocidaroides* Currie. Apical disk of A.M.N.H. No. 25328; magnified. b, *A. (M.) p. var. quadrimiliaris* Currie. Apical disk of A.M.N.H. No. 25330; magnified.

Acrosalenia (Metacrosalenia) pseudocidaroides
var. *quadrimiliaris* Currie

Text figure 1b

Acrosalenia (Metacrosalenia) quadrimiliaris
CURRIE, 1927, p. 414.

MATERIAL: Four specimens. Two other specimens (from Kurtcha) are probably the same.

LOCALITIES: Feyambiro (Mt. Kondoura, 8600 feet); Harrar (450 feet from top of hill); Gotchar (500 feet above base).

Acrosalenia (Metacrosalenia) sp.

MATERIAL: One small specimen (A.M.N.H. No. 25331) about 15 mm. in diameter.

LOCALITY: Feyambiro (Mt. Kondoura, 8600 feet).

REMARKS: The ambulacra are not clear, but one area appears to show two vertical series of tubercles near the apex and four

series about the ambitus. The apical system is of the type described for *A. (M.) pseudocidaroides*. This specimen may represent a new species of *Metacrosalenia*, or it may possibly be another variety of *A. (M.) pseudocidaroides*.

GENUS RECROSALENIA CURRIE, 1925

Recrosalenia somaliensis Currie

Recrosalenia somaliensis CURRIE, 1925, p. 48, pl. 8, fig. 1a-e; 1927, p. 415; 1935, p. 42.

MATERIAL: One incomplete test.

LOCALITY: Kurtcha (500 feet above the base).

GENUS PSEUDOCIDARIS ÉTALLON, 1859

Pseudocidaris sp.

Plate 4, figure 10

MATERIAL: One specimen (A.M.N.H. No. 25332).

DIMENSIONS: Diameter, about 16 mm.; height, 9.7 mm.; h/d, 0.60.

LOCALITY: Dogou.

DESCRIPTION OF SPECIMEN: Attempts to clear this specimen of matrix have succeeded in exposing only the apical system and small patches on other parts of the test. The apical disk is characterized by depressions in the centers of the genital plates and by radial striations on both genital and ocular plates. The genital pores are probably in the outer edge of the depressions. The sutures appear to be grooved or very wide, but this may have been brought about during the clearing of the test. The ambulacra, adapically at least, have marginal series of close-set tubercles with space between for only one irregular series of secondary tubercles. Large tubercles occur near the peristome. The interambulacral tubercles become very large suddenly near the apex as, for example, in *P. lusitanica*.

Pseudocidaris peroni Cotteau from the French Bathonian (Cotteau, 1880-1885, p. 14, pl. 263) has depressions in the genital plates, and the plates of the disk appear to be radially striated, but the genital pores are situated at the angular margins of the plates.

Pseudocidaris sp.

Plate 4, figure 9

MATERIAL: Four small spines, none longer than 2 cm. The example figured (A.M.N.H. No. 25333) is 18 mm. in length.

LOCALITIES: Budame and Dogou.

REMARKS: These spines are of the type usually associated with *Pseudocidaris*. They are comparable with spines of such species as *P. mammosa* (Agassiz) from the Corallian of France, Switzerland, and Algeria, with *P. thurmanni* (Agassiz) from the Kimmeridgian of France and Switzerland, and with *P. lusitanica* De Loriol (1890, p. 61, p. 11, figs. 7-12) from the Lusitanian of Portugal and Egypt.

GENUS PSEPHECHINUS POMEL, 1833

? *Psephechinus* sp.

MATERIAL: One crushed and poorly preserved specimen (A.M.N.H. No. 25334).

LOCALITY: Ganame.

REMARKS: This specimen, which measures about 32 mm. in diameter, is probably a *Psephechinus*. It is not clear whether there is a primary tubercle on every ambulacral plate or on every second, but the tubercles appear to be fairly uniform in size and hence *Psephechinus* is more probable than *Stomechinus*.

In this specimen, a number of interambulacral plates in the region of the ambitus appear to bear two horizontal rows of tubercles, about eight in each row. This shows a superficial resemblance to *Polycyphus normannus* Desor in which, however, each interambulacral plate at the ambitus bears a single horizontal row of eight tubercles.

The specimen under discussion is distinct from the specimens from Somaliland described by the writer as *Polycyphus* cf. *normannus* (Currie, 1925, p. 62, pl. 9, fig. 6) in which each interambulacral plate bears a single row of larger tubercles in more irregular rows. Incidentally these specimens from Somaliland have proved on further investigation, as suggested by Mortensen (1935, p. 502), to be really *Psephechinus* (*P.* sp. aff. *distinctus* Agassiz).

GENUS HOLECTYPUS DESOR, 1842

Holectypus sp. indet.

MATERIAL: One specimen (A.M.N.H. No. 25335) which is crushed and largely covered in matrix. Neither peristome nor periproct visible.

LOCALITY: Gotchar.

REMARKS: The tuberculation is of the same type as in the specimen from Somaliland de-

scribed as *Holectypus* n. sp. Currie (1927, p. 423). It may be the same form.

GENUS MEPTYGURUS POMEL, 1883

Meptygurus cf. *smelliei* (Currie)

Pygurus smelliei CURRIE, 1925, p. 67, pl. 10, fig. 5a-c; 1927, p. 424; 1935, p. 46.

MATERIAL: One crushed and poorly preserved specimen.

LOCALITY: Ganame.

REMARKS: The specimen is probably *M. smelliei*, but its state of preservation precludes absolute certainty.

Meptygurus sp.

MATERIAL: One specimen showing only part of the apical surface.

LOCALITY: Ganame.

CRETACEOUS ECHINOIDEA FROM ETHIOPIA

The Cretaceous echinoids from Ethiopia in the collection of the American Museum of Natural History are mainly from one locality, Grau in Harrar Province. They comprise the following species:

Salenia fraasi Cotteau

Goniopygus cf. *noguesi* Cotteau

Tetragramma sp.

Magnosia cf. *camarensis* De Loriol

Stomechinus sp. aff. *theveneti* (Gras)

Conulus grauensis, new species

Heteraster intermedius (Fourtau)

Salenia fraasi and *Heteraster intermedius* are known from the Aptian of Syria. As *H. intermedius* was found near the base of the white Cretaceous limestone at Grau and specimens of *S. fraasi* were found in the Ostrea zone at the top, it may be assumed that the whole thickness of limestone (95 feet) is of the same age. The less decisive evidence of the other species is consistent with their being of Aptian age. *C. grauensis* is very like *C. incertus* from the Aptian of Egypt. *G. noguesi* is from the Upper Neocomian and *S. theveneti* from the Upper Neocomian or Aptian of France. *Magnosia camarensis* is from the Hauteruvian of Portugal. *Tetragramma* sp. might be Aptian to Cenomanian.

DESCRIPTION OF THE MATERIAL

GENUS SALENIA GRAY, 1835

Salenia fraasi Cotteau

Plate 4, figures 7, 8; text figure 2

Salenia fraasi COTTEAU, 1885, p. 59, pl. 8, figs. 1-5.

MATERIAL: Fifteen specimens.

LOCALITY: Grau.

HORIZON: White limestone (Ostrea zone).

DIMENSIONS:

A.M.N.H. No.	DIAMETER	HEIGHT	$\frac{h}{d}$
	13.0 mm.	7.4 mm.	.57
	16.1	9.7	.60
25336	17.6	10.0	.56
25337	19.1	11.5	.60
	23.0	?16.0	? .69

REMARKS: The specimens from Ethiopia differ from *S. fraasi* from Liban (Syria) only in their larger size. Those from Liban appear to be about 10 mm. in diameter with a height of 0.6. In most of the specimens from Ethiopia, the proportion of height to diameter is 0.56:0.60, but in the two largest specimens (diameters about 23 mm.) the proportion is probably as much as 0.69.

S. fraasi was originally described by Cotteau as from the Cenomanian of Liban. Ac-

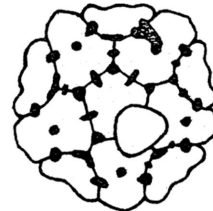


FIG. 2. *Salenia fraasi* Cotteau. Apical disk of A.M.N.H. No. 25336; magnified.

cording to Fourtau who re-examined all the available specimens of the species (Fourtau, 1913, p. 44) *S. fraasi* is Aptian in age and should not be confused with *S. keatingei* Fourtau (1919, p. 38, pl. 1, fig. 3) from the Bagh Beds of India and *S. egyptiaca* Fourtau (1914, p. 10, pl. 2, fig. 1) from the Santonian of Egypt.

The most striking feature of *S. fraasi* is its very narrow ambulacra. In the specimens

from Ethiopia, the proportion of the width of the ambulacra to that of the interambulacra is 1:4.25, and the ambulacral tubercles are close set and separated only by minute granules. These points show definitely that the Ethiopian *Salenia* is related to *S. fraasi* rather than to *S. egyptiaca* or *S. keatingei*.

The specimens from Ethiopia show some slight variations in the apical system, although the general plan is always that of *S. fraasi*. There are usually three pits on each suture line, but in some cases there are five. Pits at a junction of suture lines are usually slightly elongated along a suture, whereas pits on a suture line are usually slightly elongated in a direction at right angles to the suture.

These specimens differ from *Salenia somaliensis* Hawkins (1935, p. 48, pl. 6, fig. 9) from the ? Upper Senonian of Somaliland in their apical system having pits at the angles where sutures meet.

GENUS GONIOPYGUS AGASSIZ, 1838

Goniopygus cf. *noguesi* Cotteau

Plate 4, figures 1, 2; text figure 3

Goniopygus noguesi COTTEAU, 1863 (1862-1867), p. 725, pl. 1177, figs. 1-12.

MATERIAL: One specimen (A.M.N.H. No. 25338).

LOCALITY: Grau.

HORIZON. Top of white limestone.

DIMENSIONS: Diameter, 14.2 mm.; height, 7.0 mm.; h/d, 0.49.

REMARKS: This specimen shows striking agreement with *G. noguesi* from the Upper Neocomian of France. Its dimensions are slightly greater, but its shape and proportions are the same as those of *G. noguesi*. The interambulacrum of *G. noguesi* figured by Cotteau (*op. cit.*, pl. 1177, fig. 5) could be taken for an illustration of the specimen from Ethiopia except for one small detail, namely, that it shows the scrobicular tubercles slightly more numerous than they are in the specimen under discussion.

The apical disk of this specimen from Ethiopia shows a peculiar feature, a small extra plate between genital 3 and ocular IV. This is obviously a monstrosity. The general character of the system is the same as that of *G. noguesi*. The periproct is not perfectly clear, but there are indications that it was

most probably four-sided with four tubercles as in *G. noguesi*.

Closely related species are *G. menardi* Agassiz from the French Cenomanian and *G. brossardi* Coquand from the Cenomanian of North Africa. *G. brossardi* is regarded by some (e.g., Fourtau, 1914, p. 40) as a variety

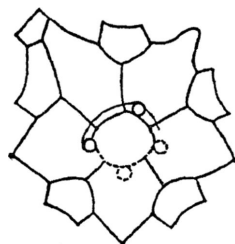


FIG. 3. *Goniopygus* cf. *noguesi* Cotteau. Apical disk of A.M.N.H. No. 25338; magnified.

of *G. menardi*. It is possible that *G. noguesi* may be an early mutation of *G. menardi*. The specimen under discussion differs from *G. menardi* and *G. brossardi* in its smaller size and more depressed form and in its periproct tending to a four-sided rather than a triangular outline.

GENUS TETRAGRAMMA AGASSIZ, 1838

Tetragramma sp.

MATERIAL: Four fragments of tests.

LOCALITY: Grau.

HORIZON: White limestone (Ostrea zone).

REMARKS: These specimens are too incomplete for accurate determination. They recall at once the well-known *T. variolare* which is known from the Cenomanian of Europe and Egypt (Fourtau, 1914, p. 15) and the Albian of Algeria (Cotteau, Péron, and Gauthier, 1876, p. 89). The specimens could equally well be compared with *T. dubia* (Gras) from the Aptian of Europe and Egypt (Lambert, 1932, p. 186), and with *Diplopodia Barthouxi* Fourtau (1921, p. 20) from the Egyptian, Aptian, which according to Lambert (1932, p. 186) is the same as *T. dubia*. *T. malbosi* (Cotteau) from the Upper Neocomian of Europe, the Urgo-Aptian of Algeria (Cotteau, Péron, and Gauthier, 1876, p. 38) and the Aptian and Albian of Egypt (Fourtau, 1921, p. 25) is also a related species, but the specimens are usually larger than those represented by the fragments under discussion.

GENUS *MAGNOSIA* MICHELIN, 1853*Magnosia* cf. *camarensis* De Loriol

Plate 4, figures 3, 4

Magnosia camarensis DE LORIO, 1887, p. 59, pl. 10, fig. 1.

MATERIAL: One specimen (A.M.N.H. No. 25339). Most of the lower surface is obscured by matrix.

LOCALITY: Grau.

HORIZON: White limestone (Ostrea zone).

DIMENSIONS: Diameter, 14 mm.; height, 8.8 mm.; h/d, 0.62.

REMARKS: This specimen differs from *M. camarensis* from the Hauteruvian of Portugal only in its smaller size, slightly greater height, and subconical upper surface.

M. pulchella Gras (1852, pp. 36, 51, pl. 1, figs. 10-12; Cotteau, 1862-1867, p. 806, pl. 195, figs. 17-27) from the Aptian of France is a comparable form. In the specimen from Ethiopia, the interambulacral tubercles decrease in size towards the ambitus where they are very small. They are replaced abruptly by larger tubercles on the oral surface. In *M. pulchella*, the change in size of the tubercles at the ambitus is less abrupt and less striking. At the ambitus, in the present specimen as in *M. camarensis*, the rows of interambulacral tubercles are arched, whereas in *M. pulchella* the rows are more nearly straight.

GENUS *STOMECHINUS* DESOR, 1857*Stomechinus* sp. aff. *theveneti* (Gras)

MATERIAL: One specimen (A.M.N.H. No. 25340) crushed to a semblance of strong bilateral symmetry.

LOCALITY: Kurtcha.

REMARKS: This interesting specimen is unfortunately too poorly preserved to enable one to describe it in detail. Its resemblance to *S. theveneti* (Gras, 1848, p. 4, pl. 1, figs. 2-4;

Cotteau, 1862-1867, p. 843, pl. 1203) from the Upper Neocomian or Aptian of France lies in the nature of the tuberculation, i.e., in the small "sub-scribulate" tubercles of the interambulacra, in the granules covering the plates, and in the bare areas along the inter-radial sutures. The following points of difference have been noted:

1. The granulation of the specimen under discussion is a little coarser and less regular than that of *S. theveneti*.

2. In the interambulacra, as in *S. theveneti*, there is a single series of secondary tubercles on the adambulacral side of the main series. Unlike *S. theveneti*, this specimen has in addition, adorally at least, a secondary tubercle on the inter-radial side of the main tubercle.

3. In the ambulacra, this specimen differs from *S. theveneti* in the presence of comparatively large tubercles in the pore fields. They form a vertical series, each one set inside an arc of three pore pairs and alongside a tubercle of the main series which extends along the margin of the pore field. Adapically and adorally, the tubercles in the pore fields are small compared with the main ambulacral tubercles, but between these areas the tubercles in the pore fields are almost as large as the ambulacral tubercles. This may give a first impression that there are two vertical series of tubercles along the margins of the pore fields.

In the ambulacra, on the oral surface near the ambitus, there appear to be one or two large tubercles between the main series. Their arrangement is not clear, but it appears to be quite irregular.

Cotteau's figure 4 of an ambulacrum of *S. theveneti* seems to indicate that the species is a *Stomechinus*. His figure 6, however, showing primary tubercles on each ambulacral plate, suggests that it is a *Psephechinus*. Ac-

PLATE 3

Conulus grauensis, new species. Aptian. Grau. Natural size.

1. Apical aspect of syntype, A.M.N.H. No. 25341 (var. A).

2. Apical aspect of syntype, A.M.N.H. No. 25343 (var. B).

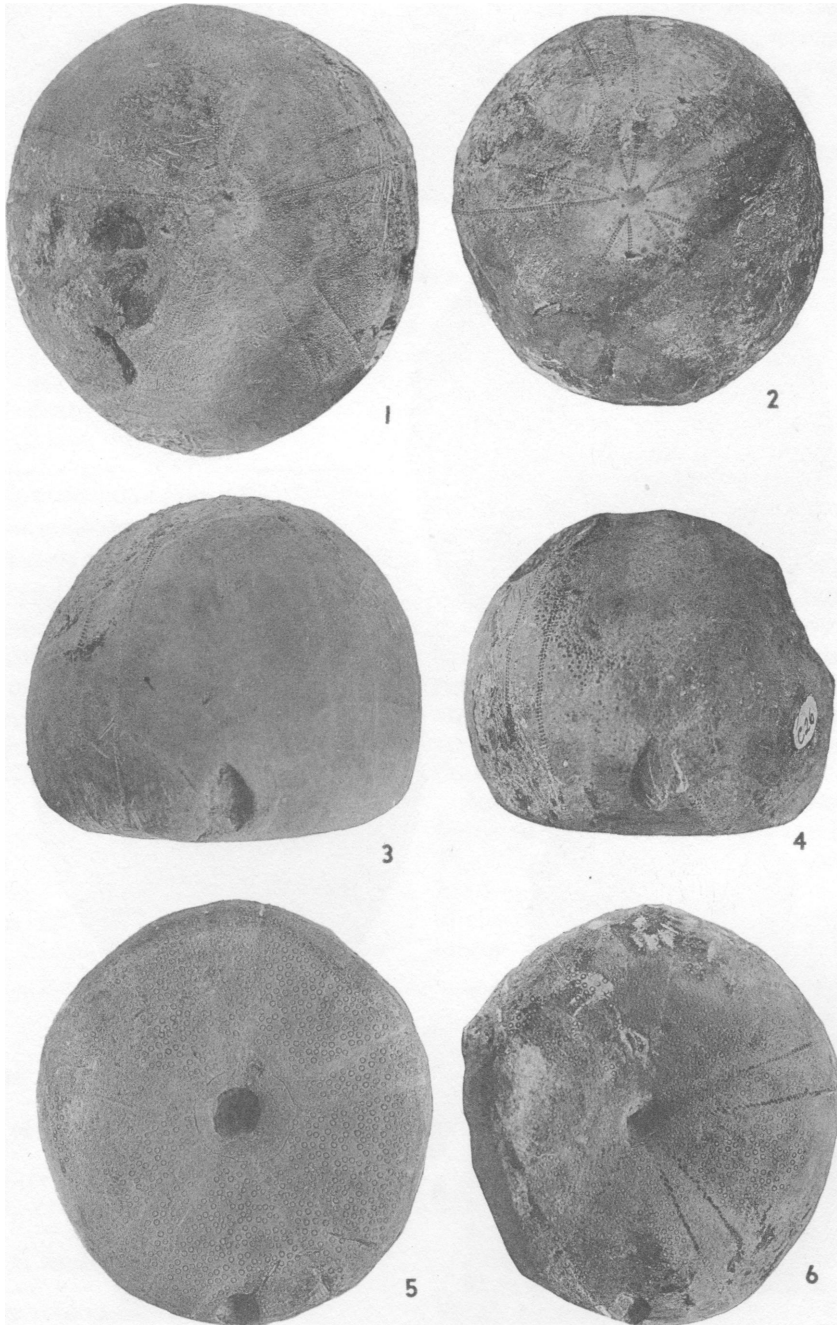
3. Posterior view of syntype, A.M.N.H. No.

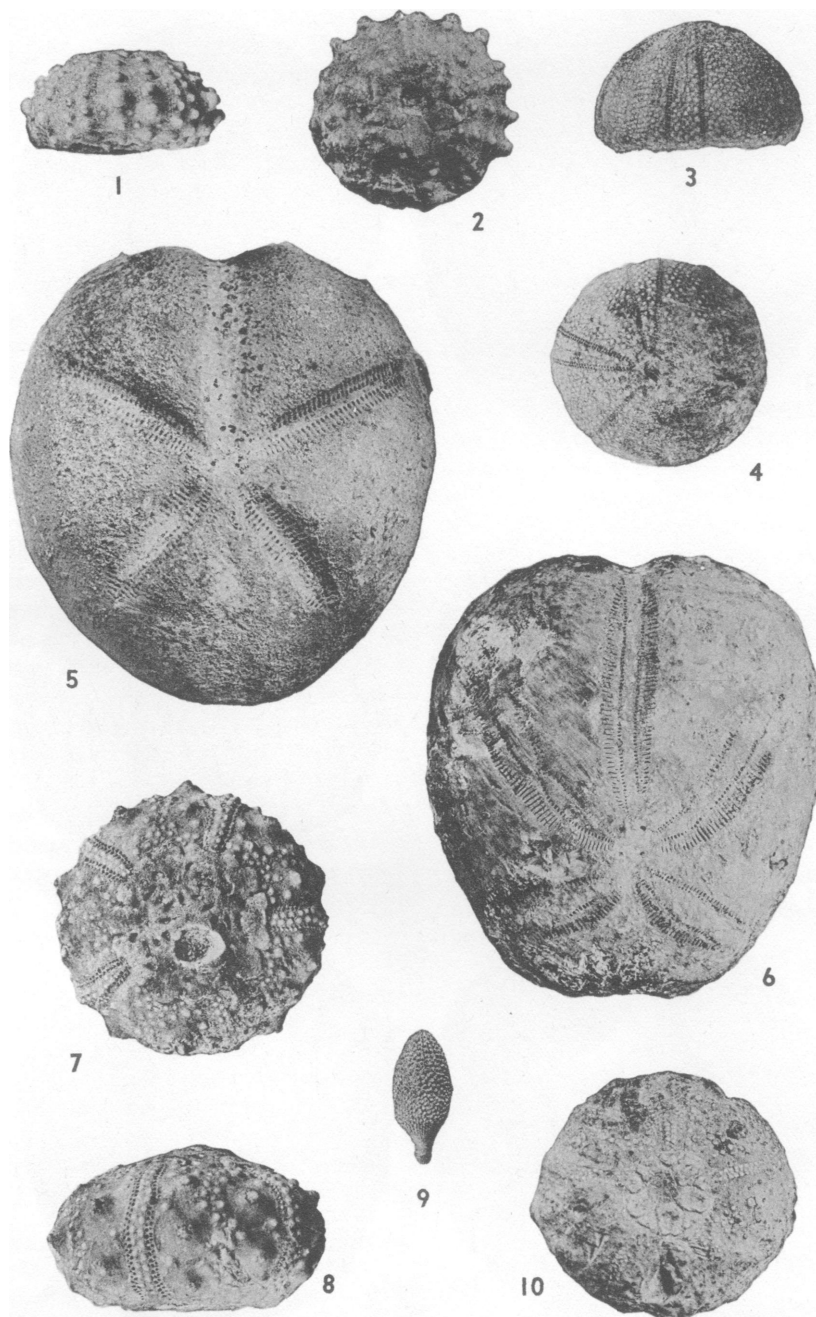
25342 (var. A).

4. Posterior view of syntype, A.M.N.H. No. 25343 (var. B).

5. Oral aspect of syntype, A.M.N.H. No. 25342 (var. A), peristome incomplete.

6. Oral aspect of syntype, A.M.N.H. No. 25344 (Var. B).





cording to Lambert and Thiéry (1910, p. 238) *S. theveneti* is a *Stomechinus*.

It is not certain that the specimen from Ethiopia under discussion is a *Stomechinus*. It appears to have a tubercle on each ambulacral plate, but the state of the test makes it impossible to decide definitely whether the tubercles are all primaries or of alternating size as in *S. theveneti*. The specimen is referred to *Stomechinus* on account of its resemblance to *S. theveneti*.

three specimens are too incomplete to be assigned to a particular variety. A larger series of specimens would probably show complete and gradual transition between the two varieties A and B, for transition between the variants is suggested by the specimens available in slight differences among those assigned to each variety.

LOCALITY: Grau.

HORIZON: Top of white limestone (Ostrea zone).

DIMENSIONS:

	A.M.N.H. No.	LENGTH	BREADTH	HEIGHT	$\frac{b}{l}$	$\frac{h}{l}$
Var. A	25341	59.2 mm.	54.8 mm.	47.0 + mm.	.92	.79
	25342	55.2	51.3	42.0	.93	.76
Var. B	25343	53.4	50.7	44.0	.95	.82
	25346	53.5	50.8	43.5 +	.95	.81
	25344	55.7	50.7 +	42.8 +	.91	.77

GENUS *CONULUS* LESKE, 1778

Conulus grauensis, new species

Plate 3, figures 1-6; text figures 4-7

MATERIAL: Ten specimens.

The specimens of this species show variation in the form of the test. Four specimens (A.M.N.H. Nos. 25341, 25342, 25343, 25344) have been selected as syntypes. These comprise two examples (to show apical and oral surfaces) of two distinct varieties described as A (A.M.N.H. Nos. 25341, 25342) and B (A.M.N.H. Nos. 25343, 25344). The collection includes three examples of var. A (A.M.N.H. Nos. 25341, 25342, 25345) and four examples of var. B (A.M.N.H. Nos. 25343, 25344, 25346, 25347). The remaining

DESCRIPTION OF SPECIES: Test large, high, and domed or tending to subconical (as in A.M.N.H. No. 25341). Ambital outline pentagonal with rounded angles. Lower surface flat in all specimens, but in var. B the base is smaller than in var. A and it merges into the sides of the test in a wide rounded curve. In type A, the base is larger, and it meets the sides of the test at a sharper angle. The ambitus of var. B is thus higher than that of var. A.

Apical system excentric towards the anterior (0.44 of length from anterior margin). The details of the disk are not perfectly clear. Madreporite large, occupying a large part of the disk. Genital 3 small; genitals 1 and 4 larger and in contact as can be seen in

PLATE 4

Goniopygus cf. *noguesi* Cotteau. Aptian. Grau. $\times 2$.

1. Side view of figured specimen, A.M.N.H. No. 25338.

2. Apical aspect of same.

Magnosia cf. *camarensis* De Loriol. Aptian. Grau. $\times 2$.

3. Side view of figured specimen, A.M.N.H. No. 25339.

4. Apical aspect of same.

Pericosmus gregoryi Currie. Lower Eocene. Goldhamid, British Somaliland.

5. Apical aspect of hypotype, A.M.N.H. No. 25350. Natural size.

Heteraster intermedius (Fourtau). Aptian. Grau.

6. Apical aspect of hypotype, A.M.N.H. No. 25349. Natural size.

Salenia fraasi Cotteau. Aptian. Grau. $\times 2$.

7. Apical aspect of hypotype, A.M.N.H. No. 25337.

8. Side view of same.

Pseudocidaris sp. (Agassiz). Callovian. Budame.

9. A spine, figured specimen, A.M.N.H. No. 25333. Natural size.

Pseudocidaris sp. Callovian. Dogou.

10. Apical aspect of figured specimen, A.M.N.H. No. 25332. $\times 2$.

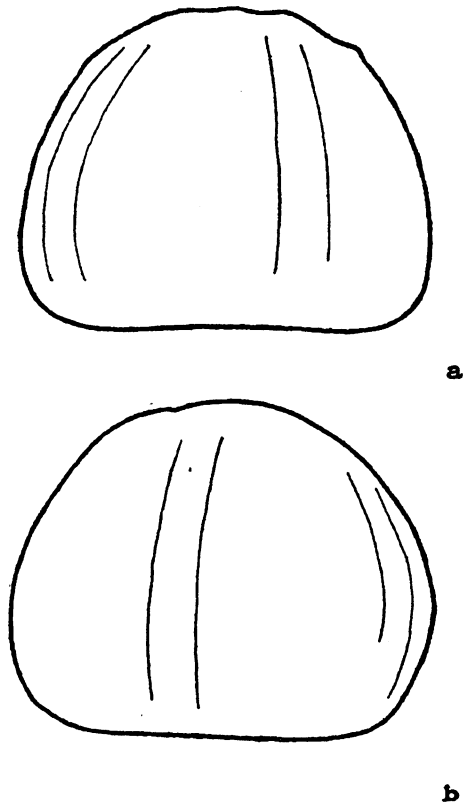


FIG. 4. *Conulus grauensis*, new species. a, Side view of A.M.N.H. No. 25342 (var. A); natural size. b, Side view of A.M.N.H. No. 25344 (var. B); natural size.

A.M.N.H. No. 25341. Genital pores large. Oculars I and V not clear in any of the specimens.

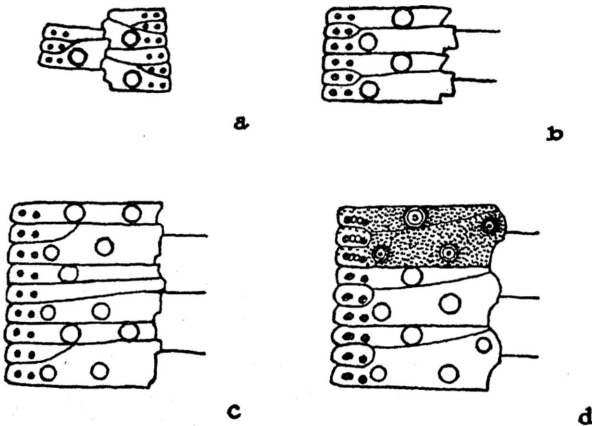


FIG. 5. *Conulus grauensis*, new species. Reconstruction of apical disk based on A.M.N.H. Nos. 25341 and 25343.

Ambulacra about one-fourth of the width of the interambulacra at the ambitus. Pore fields narrow, in slight linear depressions. The depressions are more marked in var. A than in var. B, especially on the oral surface. Pore pairs appear to have a large interporal granule, but in well-preserved areas, this is seen to consist of a pair of smaller interporal granules. Pore pairs directly superposed on the upper surface; slightly irregular (that is, out of strict alignment) on the outer half of the oral surface and definitely in slightly oblique sets of triplets on the inner half, becoming more crowded and oblique towards the peristome.

Peristome elliptical, set slightly obliquely. Level with the test or slightly depressed in var. B but in a slightly more marked depression in var. A. The ambulacra in the peristomial depression are slightly depressed.

The posterior interambulacrum has a slight median keel which is more marked in var. A than in var. B. Periproct large, oval, acuminate at its upper end. Its apex is on the line of the ambitus in var. A and just below that line in var. B. From there the periproct

FIG. 6. *Conulus grauensis*, new species. a, Adapical part of an ambulacrum, A.M.N.H. No. 25345; magnified. b, Part of an ambulacrum at the ambitus, same specimen. c, Part of an ambulacrum of another specimen between apex and ambitus, A.M.N.H. No. 25348. d, Part of an ambulacrum of another specimen at the ambitus, syntype, A.M.N.H. No. 25342.

extends downwards and inwards to the base level of the test in var. A and almost to the base level in var. B. The periproct is not visible from above.

Tubercles small on the apical surface, larger and more crowded on the oral surface, separated by a fine granulation all over the test.

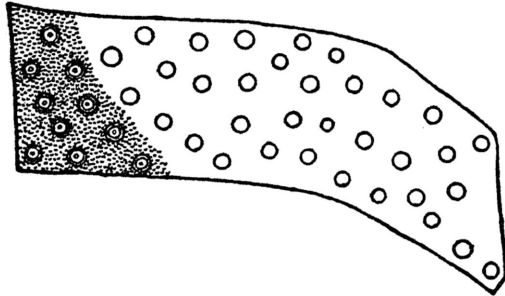


FIG. 7. *Conulus grauensis*, new species. An interambulacral plate at the ambitus, syntype, A.M.N.H. No. 25342; magnified.

The essential differences between the variants represented in the collection may be summarized as follows:

VAR. A	VAR. B
Wide base with somewhat angular margin—low ambitus.	Narrow base with rounded margin—ambitus not so low as in A.
Peristome in slight depression.	Peristome level with base or only slightly depressed.

REMARKS: This species shows considerable resemblance to *C. incertus* Fourtau (1921, p. 51, pl. 8, figs. 2 and 3) from the Aptian of Egypt, a species that is described as variable. The var. A shows close agreement with the figures of *C. incertus*, but *C. incertus* does not appear to include in the variants such a form as var. B. The following points of difference between *C. grauensis* and *C. incertus* have been noted:

1. The apical disk of *C. grauensis* appears to have the same general plan as that of *C. incertus*, but the madreporite is larger in *C. grauensis*, and the genital pores also are larger.

2. In *C. incertus* the pore pairs do not form oblique triplets at the peristome as in *C. grauensis*.

3. In *C. incertus* the interporal granules

are single; in *C. grauensis* there is a pair of granules between the pores of a pair, although this is apparent only in well-preserved specimens.

I have not had an opportunity of examining actual specimens of *C. incertus* and am unable to judge whether the tuberculation of *C. grauensis* is similar to that of *C. incertus* or not.

According to Lambert and Thiéry (1925, p. 576), *C. incertus* is a variety of *C. castaneus*, and Lambert (1932, p. 187) has suggested that *C. incertus* is a synonym of *C. tumidus* Gauthier (Cotteau, Péron, and Gauthier, 1876, p. 82, pl. 7, fig. 5) from the Albian of Algeria. Such a relationship would not be surprising considering the great variation in the shape of the test within a species. Range of variation is well illustrated by Cotteau (1881, pp. 135–143, pl. 1) in his study of an assemblage of specimens of *Conulus* from the Turonian of Dracy. It is clear that investigation of numbers of individuals from various horizons would revolutionize the naming of species of *Conulus* and lead to a better understanding of the genus.

While *C. grauensis* resembles closely the form described as *C. incertus*, it shows less resemblance to *C. castaneus* and *C. tumidus*. In these forms the test is more depressed, the periproct is set very low, and the peristome does not appear to be set slightly obliquely as in *C. grauensis*. *C. grauensis* differs further in its paired interporal granules.

GENUS HETERASTER D'ORBIGNY, 1853

Heteraster intermedius (Fourtau)

Plate 4, figure 6; text figures 8, 9

Enallaster intermedius FOURTAU, 1912, p. 52, pl. 13, fig. 4.

MATERIAL: One specimen and a fragment.

LOCALITY: Grau.

HORIZON: Base of white limestone (50 feet below *Ostrea* zone).

DIMENSIONS: A.M.N.H. No. 25349, length, 61.2 mm.; breadth, 52.9 mm.; height, 32.6 mm.; b/l, 0.86; h/l, 0.53.

Apical disk excentric towards the posterior, 36/100 of length from posterior margin.

REMARKS: This specimen (A.M.N.H. No. 25349) differs from the figured specimen of *H. intermedius* from the Aptian of Syria in

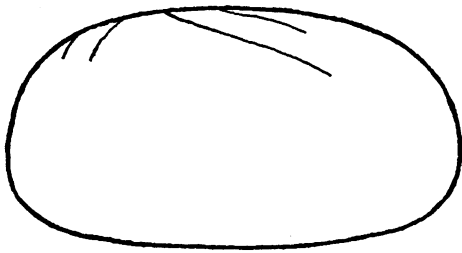


FIG. 8. *Heteraster intermedius* (Fourtau). Side view of A.M.N.H. No. 25349; natural size.

its larger size, its flatter upper surface, and its slightly greater irregularity in the disposition of the pores of ambulacrum III.

H. oblongus (Brongniart) from the Aptian of Europe and the Urgo-Aptian of Algeria (Cotteau, Péron, and Gauthier, 1876, p. 20) is closely similar to *H. intermedius*. Lambert and Thiéry (1925, p. 438) regard *H. intermedius* as a variety of *H. oblongus*. The specimen from Ethiopia under discussion differs

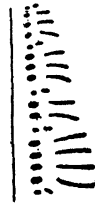


FIG. 9. *Heteraster intermedius* (Fourtau). Part of ambulacrum III of A.M.N.H. No. 25349; magnified.

from *H. oblongus* in its larger size, its flat upper surface, and its relatively narrower interporiferous areas.

In ambulacrum IV of this specimen, the pore fields deviate from their normal course. They converge and meet at a point about two-fifths of the length of the petal from the apex. This is no doubt a monstrosity similar to that figured by De Loriol in a specimen of *H. lepidus* from Portugal (De Loriol, 1888, pl. 15, fig. 5).

EOCENE ECHINOIDEA FROM BRITISH SOMALILAND

The Eocene Echinoidea from Somaliland in the collection of the American Museum of Natural History comprise the following species:

- Pericosmus gregoryi* Currie
- Linthia hargeisensis*, new species
- Catopygus* ? sp.
- Pliolampas* ? sp.
- Pyrina* ? sp.

P. gregoryi and *L. hargeisensis* are both known from the Auradu Limestone (=Auradli) of British Somaliland (Currie, 1927, pp. 412, 430, 437). Their state of preservation and that of the other specimens indicate that they are all probably from this massive cherty limestone.

The Eocene age of the Auradu Limestone was first recognized by R. B. Newton (1905, pp. 155-157). It was regarded as Middle Eocene by J. W. Gregory (1925, pp. 2, 5) and was thought to overlies the Allahkajid Limestone, although according to the field observations of Wyllie and Smellie (Wyllie, 1925, pp. 9-10) the Allahkajid Limestone overlies the massive cherty limestone. R. A. Farquharson (1924, p. 14) supported Wyllie and Smellie in describing the Eocene lime-

stone series as consisting of a lower massive limestone and an upper chalky white limestone. The writer (Currie, 1927, p. 412) examined the echinoids collected by Farquharson from the lower limestone (Auradu) and came to the conclusion that they were probably of Lower Eocene age. The Lower Eocene age of the Auradu Limestone and its place in the sequence were confirmed by the results of the Somaliland Petroleum Company Expedition under W. A. Macfadyen (Macfadyen, 1933, p. 22).

DESCRIPTION OF THE MATERIAL

GENUS *PERICOSMUS* AGASSIZ, 1847

Pericosmus gregoryi Currie

Plate 4, figure 5; text figure 10

Pericosmus gregoryi CURRIE, 1927, p. 480.

MATERIAL: One specimen (A.M.N.H. No. 25350) and possibly another specimen which is largely covered with matrix.

DIMENSIONS: A.M.N.H. No. 25350, length, 61.2 mm.; breadth, 54.7 mm.; height, approximately 37 mm. (base is crushed in).

LOCALITY: Camel Corps Camp, Gold-hamid.

REMARKS: I have not had an opportunity

of comparing this specimen with the holotype (B.M.E. 18080), but from my memory of that specimen I believe they are the same. The dimensions are not in close agreement, but some variation of dimensions within

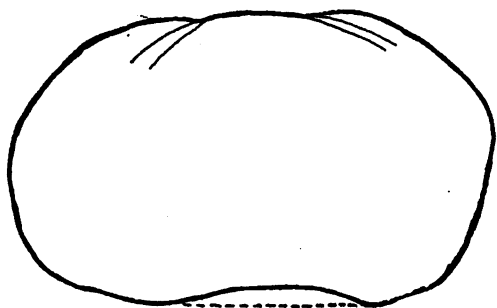


FIG. 10. *Pericosmus gregoryi* Currie. Side view of A.M.N.H. No. 25350; natural size.

a species is not unusual. The marginal fasciole, indicated in the holotype by three small portions, is apparent in this specimen, faint but continuous from ambulacrum I to ambulacrum III. As in the holotype, it is at a low level below petal I. A very indistinct small fragment of a peripetalous fasciole is apparent in interambulacrum 5 of this specimen and tends to confirm the identification of the genus as *Pericosmus*. Most species of *Pericosmus* appear to have three genital pores, whereas *P. gregoryi* has only two.

GENUS LINTHIA MÉRIAN, 1853

Linthia hargeisensis, new species

Hemias sp. indet. CURRIE, 1925, p. 74, pl. 9, figs. 7a, b.

Linthia ? n. sp. CURRIE, 1927, p. 437.

MATERIAL: Three incomplete and crushed specimens.

LOCALITY: Naso Hablod, Hargeisa.

REMARKS: The holotype of this species, here selected, is the specimen originally described and figured by the writer as *Hemias-*

ter sp. indet. (Currie, 1925, *loc. cit.*). This specimen, which is merely an iron-stained cast, is the only complete specimen known. It is usually inadvisable to make such a specimen the holotype of a new species, but it seems worth while in this particular case. The general shape and character of the test are so distinctive that later found specimens are easily recognized.

GENUS CATOPYGUS AGASSIZ, 1836

Catopygus ? sp.

Text figure 11

MATERIAL: One specimen (A.M.N.H. No. 25351).

DIMENSIONS: Length, 21.3 mm.; breadth, 17.8 mm.; height, 14 mm.

LOCALITY: Hargeisa.

REMARKS: This specimen is not sufficiently well preserved for identification. The nature of the ambulacra is not apparent, but the shape of the test, the shape and position of the periproct, and the elongate peristome surrounded by a floscelle suggest that it is probably a *Catopygus*.

Catopygus is usually Cretaceous, but Lambert and Thiéry (1921, p. 353; 1925, p. 587) record a Miocene species and a doubtful Eocene species.

GENUS PLIOLAMPAS POMEL, 1888

Pliolampas ? sp.

MATERIAL: One specimen which is incomplete, silicified, and iron-stained.

DIMENSIONS: Length, 26 mm.; breadth, 22 mm.; height, approximately 13 mm.

LOCALITY: Camel Corps Camp, Goldhamid.

REMARKS: The shape of the test, the shape and position of the periproct, and the nature of the peristome favor the view that this specimen may be a *Pliolampas*. The peristome is much elongated in the direction of

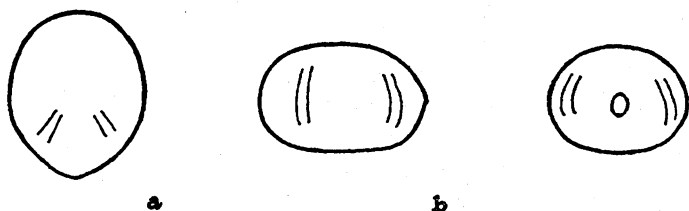


FIG. 11. *Catopygus* ? sp., A.M.N.H. No. 25351; natural size. a, Apical view; b, side view; c, posterior view.

the anteroposterior axis and is surrounded by a floscelle.

GENUS *PYRINA* DESMOULINS, 1835

Pyrina ? sp.

MATERIAL: Two incomplete, silicified, iron-stained specimens.

LOCALITY: Camel Corps Camp, Gold-hamid.

REMARKS: These specimens are too imperfect for identification, but it is interesting to speculate on the possible genera to which they may belong. *Pyrina* seems most probable.

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