THE MIOCENE OF BURMA

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I.

HISTORICAL SUMMARY.

Since the days of Marco Polo, but particularly since the end of the last century, Burma always had a great attraction for European travellers, but though almost every one of them has told his experiences in a more or less graphic manner, the geology of the country remained, except for a few casual observations, almost unkown. This is the more remarkable, because Burma has always had a great great reputation for its mineral wealth, and to gather information about it was the ultimate object of many a journey into unkown Burma. Some of the earlier books are most glowing in their accounts of the mineral wealth, but recent researches have proved how exaggerated these reports were, and have further proved of how unreliable a nature all geological observations are, which have not been made by a trained geologist.

Many are the notes on the Geology of Burma, but until the country was occupied by the British Government, only two trained geologists have written on the subject. Mr. Crawfurd who travelled in Burma in 1826 [1]) apparently brought back a good collection of specimens, among which there were numerous fossil bones from the Irrawaddi series near Yenangyoung. This collection

[1]) Journal of an Embassy from the Governor-General of India to the Court of Ava in 1827. 4° London 1829.

was examined by Dr. Buckland who was able to distinguish eight different formations. Considering the primitive state of the geological science at that period, it is astonishing how accurately the geological outlines of Burma are as given by Dr. Buckland. If he had not been led to believe that the fossil bones were found in the diluvial beds, he would have already fixed the two great groups into which the Tertiaries of Burma can be divided.

About a quarter of a century later, Burma was visited by the late Dr. Oldham, who laid down his views in his notes on the Geological features of the banks of the Irrawaddi in Yule's famous book on Burma [1]). Dr. Oldham's examination was necessarily a rather limited one, because the Burmese Government would not allow him to go beyond a very short distance from the banks of the Irrawaddi. Notwithstanding this disadvantage Dr. Oldham's notes are full of valuable observations, but it is obvious that he could not enter into details.

It was not until some time after the annexation of lower Burma and after the country had been visited by Messrs. Blanford, Fedden and Theobald, that an accurate knowledge of at least the southern part of Burma was obtained. As the Tertiary formation almost entirely composes the old province of lower or British Burma, the first subdivision which was established by Mr. Theobald in his memoir on the Geology of Pegu [2]) refers only to this particular part of country. He proposed the following subdivision in descending order:

2.	Younger Tertiary formation.	*Fossil Wood group.*
		Pegu group.
1.	Older Tertiary formation.	*Nummulitic group.*

Mr. Theobald considers that the *Nummulitic* group represents the Eocene, the *Pegu*-group the Miocene and the *Fossil Wood*-group the Pliocene. In the above subdivision the division of the Burma Tertiaries in three groups is already markedly expressed, but Mr. Theobald, who considers all the strata above the Nummulitic rocks as Younger Tertiary, thus includes marine and fluviatile beds in one subdivision. It is of course perfectly correct that both the *Pegu*-group and the *Fossil Wood*-group represent the Younger

[1]) Yule, Narrative of the mission sent by the Governor-General of India to the Court of Ava in 1855 with notices of the country, government and people. 4° London 1858. Appendix A. pag. 307 and pag. 19—22.

[2]) Geology of Pegu, Mem. Geolog. Survey of India 1873 vol. X.

Tertiaries but the principle of subdivision which I adopted, based on the great faunistic differences existing between the *Fossil Wood*-group on one, and the *Pegu*- and *Nummulitic*-groups on the other hand, answers much better to a natural subdivision than Mr. Theobald's. It is further almost certain that not the entire Tertiary formation is included in the above delimitation. If not the whole, at least the upper part of the „*Axial group*", which Mr. Theobald on the evidence of a misinterpreted fossil considered to be of Triassic age, belongs to the Lower Eocene. This question is not quite settled yet, we know for certain that the „*Axial group*" is not Triassic, but whether it belongs to the Tertiary formation throughout, or whether, as I believe its lower part belongs to the Cretaceous formation, must be left to future researches for decission. There is also some uncertainty with regard to Mr. Theobald's „Negrais" rocks, which are probably only metamorphized Eocene beds, but not having seen them, I cannot offer any definite opinion on this subject.

Mr. Theobold has divided both the *Pegu* and the *Fossil wood group*, the first into two, the second into three subdivisions, but being based almost solely on lithological characters, both can hardly claim more than a local importance.

After Mr. Theobald's memoir had been published, further geological researches in Burma came to a standstill, until they were again resumed after the annexation of upper Burma. The late Mr. Jones was the first geologist, who explored parts of Burma, hitherto unknown, but though writing an elaborate paper on the occurence of coal in the Yamethin district, he was by his untimely death prevented, to summarize his views on the Tertiary formation.

I was deputed to Burma early in 1888 where I was engaged in geological researches up to the beginning of 1895 and I published my views in various papers, the titles of which will be found among the litterary references at the end. Though almost in every one of them reference is made to the Tertiary formation, I embodied my views on its development and subdision in a special paper [1]). Further details, particularly about the development of the Tertiary formation in the petroliferous regions of Yenangyoung, Yenangyat and Minbu will be found in my memoir on the occurence of petroleum in Burma [2]), and quite lately a paper by

[1]) The Development and Subdivision of the Tertiary System in Burma. Record. Geolog. Survey of India 1895 vol. XXVII pag. 59 f. f.

[2]) The occurence of Petroleum in Burma and its technical exploitation. Mem. Geolog. Survey of India 1898 vol. XXVII. pag. 47 f. f.

the late Mr. Grimes on the Geology of parts of Myingyan, Magwe and Pakokku Districts, which contains some important details on the development of the *Promeian* and *Yenangyoungian* has been published [1]).

On the following pages I have attempted to summarize all the observations contained in the above mentioned papers, and so far I have no reason to change the principles which guided me in my first subdivision of the Burma Tertiaries. My views are now better supported by palaeontological evidence as before, because I have since examined and described Mr. Theobalds collections from lower Burma, Mr. Grimes collections from Yenangyat and Singu in connection with my own collections from Yenangyat, Singu and Minbu. These collections comprise chiefly Miocene fossils and thus the *Pegu*-Division of the Burma Tertiaries is much better known at present, than any of its other parts. But though our knowledge has been considerably advanced since my first paper on the subdivision of the Tertiary formation has been published, I opine that still a tremendous work lies in front of us, till we arrive at anything like a satisfactory view of the development of the Tertiary formation in Burma, in as much as the whole of the Eocene and Pliocene is all, but unworked ground.

II.

THE DEVELOPMENT AND SUBDIVISION OF THE TERTIARY FORMATION IN BURMA.

Before proceeding to the discussion of the Miocene formation as represented in Burma, it will be useful to give here the main features of the subdivision of the whole of the Tertiaries as set forth by me, not only because it will save a constant reference to my first paper, in which I laid down my views on this subject, but also because the principles which have guided me will be better understood.

Wherever in Burma a complete series of the Tertiary formation is developed and well exposed, *two* groups can be recognized and

[1]) Geology of parts of the Myingyan, Magwe and Pakokku districts Burma. Mem. Geolog. Survey of India 1898 vol. XXVIII pag. 30 f. f.

distinguished with the greatest ease. Both differ widely in their faunistic character and in a broad sense also, in their lithological features, rendering it almost certain that they are of a different origin.

2. The *Upper* group contains chiefly remains of *terrestric* animals mixed with species leading a *fluviatile* life; but the former are considerably in the majority. Lithologically arenaceous beds of yellow colour prevail; more subordinate are olive coloured argillaceous beds, in addition to which ferruginous conglomerates of a dull-red colour are not unfrequent. This series must be considered as of decidedly fluviatile origin.

1. The *Lower* group is characterised by a *marine* fauna of distinctly littoral facies, a character which locally undergoes a change indicating estuarine origin. Lithologically bluish or grey tinges prevail, and the strata are decidedly of marine origin, notwithstanding the estuarine element towards the top. The above features ares summarized in the following table:

	Character of Fauna.	Colour of Sediments.	Origin of Sediments.
Upper group.	Terrestric & fluviatile.	Yellow, Olive, Red.	Fluviatile.
Lower group.	Marine & Estuarine.	Bluish & Grey.	Marine.

Notwithstanding these enormous differences in the total character of both groups, the upper seems to rest conformably on the lower one. This is certainly the case in the neighbourhood of Yenangyoung or Singu, unless the ferruginous conglomerate which forms its basis, is regarded as a sign of unconformity. The late Mr. Grimes [1]) claims however to have discovered an unconformity between the two groups North of Yenangyat. Though only deduced from the varying thickness of the uppermost beds of the lower group, as the bedding is perfectly conformable throughout the whole series, my own observations with regard to the occurence of certain fossiliferous horizons in the same level led me almost to the same conclusion, though I have previously refrained from expressing a definite opinion, because in a matter of such importance a few isolated observations cannot be considered as descisive. We

[1]) Mem. Geolog. Survey of India 1898 vol. XXVIII pag. 43.

may now take it is granted that notwithstanding the apparent conformity of beds, a considerable denudation of the lower Group took locally place, before the upper Group became deposited. Though locally extensive, as for instance near Yenangyat, at other places like Yenangyoung, the amount of denudation can only have been small. The fact, that locally the denudation was only small, seems to be of importance, in as much as it proves that the deposit of beds does not appear to have been interrupted for a long time.

The following names are suggested for these two groups viz.

2. *Irrawaddi-Series* for the upper group, because it is chiefly developed in the broad depression between the Arrakan Yoma in the West and the Shan hills in the East, intersected by the river Irrawaddi.
1. *Arrakan-Series* for the lower group because it is chiefly developed in the Arrakan Yoma and its outskirts.

1. THE ARRAKAN SERIES.

According to my own observations combined with those of Mr. Theobald the *Arrakan*-Series may conveniently be divided into three subdivisions which are in descending order:

C. The *Pegu-Division.*
B. The *Bassein-Division.*
A. The *Chin-Division.*

This subdivision is solely based on the presence or absence of the genus *Nummulites*, which occurs in abundance in the middle subdivision, but is entirely absent in the upper and lower one. Palaeontological reasons have therefore been exclusively used in subdividing the *Arrakan*-Series but I am unable to say, whether this view is also supported by stratigraphical evidence, as I neither observed the contact between the *Chin*- and *Bassein*- nor between the *Bassein*- and *Pegu*-divisions.

At present the three divisions are very unequally known and I can give nothing but the barest outlines of the *Chin*- and *Bassein*-divisions chiefly based on Mr. Theobalds observations. The *Pegu*-division is on the other hand much better known, because rich collections of fossils have been examined, and the sequence of fossiliferous horizons carefully noted.

A. The *Chin-Division.*

The name of *Chin*-division is suggested for this series of strata, because it chiefly occurs in the centre of the Arrakan Yoma, inhabited by the wild Chins.

Dark, flysh-like shales and hard unfossiliferous (?) limestones are the prevailing rocks, and it appears that the former chiefly occupy the lower part of the group and are followed by the limestones.

No definite data are available with regard to the thickness of this division; as far as it is known the central part of the Arrakan Yoma is chiefly built up by it, forming numerous parallel ridges rising up to over 7000 feet. We may however assume that the thickness is not less than 10,000 feet.

No fossils have so far been found, and it seems certain that the shales are destitute of any organisms, except fucoied-like impressions.

In its present delimitation the *Chin*-division includes all the beds below those, containing *Nummulites*, and though its upper boundary is thus well determined, its lower one is perfectly indefinite for the present, as we know nothing about the beds on which it rests. It is quite probable that the *Chin*-division, if not wholly cretaceous, includes beds of upper Cretaceous age, but we are unable to say for the present, where the boundary is to be drawn, in as much as the possibility of a gradual passage from Cretaceous to Tertiary beds, as observed in Baluchistan, cannot be denied.

B. The *Bassein-Division.*

Though scanty, our knowledge with regard to this division rests on a firmer ground, because there is some palaeontological evidence from which definite conclusions with regard to its age may be drawn.

The *Bassein*-division skirts the Arrakan Yoma on probably either side; it certainly forms a long band stretching along its eastern side and the same may be said with regard to its western side, though we know very little of these parts. It also skirts the Pegu Yoma and may probably be found in its central part.

According to Mr. Theobald the lower part of this division consists of shales and sandstones, occasionally fossiliferous, which are capped by a bed of highly fossiliferous, nummulitic limestone of only 10 feet in thickness. This may be so in the southern part of the Arrakan Yoma, but it is quite certain that the calcareous beds increase in thickness in northern direction.

The total thickness of this group is assumed by Mr. Theobald to be 1,223 feet, but to judge from the table given on page 100 of his memoir, he included at least 227 fect, but probably 500 feet, which should belong to the *Chin*-division.

The fauna appears to be rich, but having examined Messrs Theobald and Fedden's collections, only a few specimens could be found, and it seems probable that not much time was devoted towards collecting. So far we know, that there are several species of the genus *Nummulites* and in a bed which most probably belongs to the upper part, the well known *Velates schmiedeliana* Chemn. sp. hat been found [1]), but for the present no further attempt has been made to determine the specimens, particularly as it seemed advisable to wait till further researches had yielded a better collection, the horizons of which were known.

C. The *Pegu-Division.*

The name of *Pegu*-group was proposed by Mr. Theobald „for a very important series of beds intervening between the Eocene or Nummulitic Division on the one hand and the fossil wood group on the other." This definition of the *Pegu*-group would be very clear and concise had Mr. Theobald more accurately defined the lower boundary of his fossil wood group. As it is, this boundary is very uncertain, and I propose to restrict the name of *Pegu Division* to that series of beds, which rest upon the nummuliferous strata, but are below those, containing a terrestric and fluviatile fauna; they are characterized by a marine fauna which differs from the older one by the total absence of the genus *Nummulites.*

In the above definition· the *Pegu*-division constitutes a well circumscribed series of beds which represent the upper part of the *Arrakan*-series and which can be characterized as follows:

Fauna marine, bearing a littoral facies; probably of estuarine character in the lower, of marine and estuarine character in the upper part. Glauconitic sandstones of dark green or grey, pepper and salt colour prevail, while argillaceous beds of bluish colour are more subordinate.

If the above stratigraphical, faunistic and lithological features are kept in mind, the *Pegu*-division is well recognisable all over Burma, though its local development varies considerably, as can only be expected from a series which represents such an eminent littoral facies.

The *Pegu*-division can be divided into two parts which are readily distinguished, when the whole series is exposed: these are in descending order:

b. The upper part or *Yenangyoungian.*

a. The lower part or *Promeian.*

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[1]) Record. Geolog. Survey of India 1894. vol. XXVII pag. 103.

The *Promeian* appears to be chiefly of an estuarine character both, in upper and lower Burma.

In lower Burma it seems to be represented by the unfossiliferous series containing coal seams and locally Petroleum, occuring below the zone of *Cytherea erycina;* in upper Burma it is represented by the petroliferous beds of Yenangyoung, and the carboniferous series of the Chindwin district.

The *Yenangyoungian* exhibits a rapidly changing facies of marine and brackish beds, as will be seen from the detailed description.

The difficulties which under these circumstances have to be met with regard not only to a general subdivision, but also to the correlation of local developments can be readily understood, and the various horizons which I discerned, may be only of purely local character. If it be however remembered that this is the first attempt to sift a large amount of material, gathered during the last thirty years, and if further the tremendous climatic difficulties under which the observations had to be made, difficulties only those who ever penetrated the jungles of Burma can realize, are taken in consideration, a certain allowance will be made for future changes.

a. The *Promeian*.

1. *Thickness*. Mr. Theobald describes on pag. 83 & 84 of his memoir a section in which unquestionably the lower portion measuring 1418 feet in thickness, represents the *Promeian,* to this we have to add the thickness of the Sitsyahn shales with 800 feet bringing the total thickness up to 2200 feet. At Yenangyoung the drill has gone through rocks belonging to this stage upwards of 1000 feet from their upper boundary, without striking the base. At Yenangyat 1100 feet have been drilled through with the same result. On the right bank of the Chindwin river I measured a fine section along the Yu river of 3100 feet, without having observed the base; but as numerous pebbles containing Eocene fossils were found in the streams intersecting the lower parts of the section, the lower boundary cannot be much further down. If we therefore assume 3000 feet to be the thickness of the *Promeian* we are rather under than above the mark.

2. *Lithological characters*. The chief constituents are sandstones and clays; the latter are however subordinate to the former; accessory are coal seams, ironstone, petroleum and the fossil resin Burmite. The sandstone is of very uniform character, it is finely grained, contains plenty of Glauconite and assumes generally a greyish colour, which may best be styled „pepper and salt'' colour.

Frequently, when there is a large admixture of glauconite grains it exhibits a dark green or bluish-green colour. Its hardness varies considerably; sometimes it is soft and friable, sometimes siliceous and splintery. A curious instance of its weathering may often be noticed along the banks of the Irrawaddi or the Chindwin; the sandstone desintegrates into rather regular lumps which retain their original position for a long time, thus imitating a street pavement.

The clay is still more monotonous, being usually a tough clunch of bluish colour.

It would exceed the limits of this paper, were I to describe in extenso the occurence of coal, petroleum and Burmite, anybody interested in these subjects will find ample information in the papers cited in the litterary references.

3. *Palaeontological characters.* The *Promeian* has hitherto yielded not more than 13 species, occuring close towards its top at Yenangyoung, otherwise it appears to be unfossiliferous. The fauna exhibits a curious mixture of marine and terrestric animals, which will be discussed in a subsequent chapter.

4. *Subdivision.* It is obvious that under these circumstances a subdivision is almost an impossibility, and this will remain so until some more fossiliferous horizons are discovered. At Yenangyoung and Yenangyat the *Promeian* is chiefly known from bore holes and the evidence relating to a general subdivision is very unsatisfactory. We know that there exist a series of alternating arenaceous and argillaceous beds of bluish colour, the former charged with petroleum, but in want of any palaeontological evidence no subdivision was even attempted; in fact the lithological change seems so rapid and unexpected that I experienced the greatest difficulty in correlating the sections of the different bore holes. The zone of *Anoplotherium birmanicum* which occurs close to the top, is so far the only fossiliferous horizon which could be distinguished, and even this is apparently of very local occurence only.

b. The *Yenangyoungian.*

1. *Thickness.* There are some good and reliable observations with regard to the thickness of this group; at Yenangyat I measured a thickness of 1200 feet; at Singu I found it only 700 feet, but the late Mr. Grinus measured 2450 feet, about three miles south of Singu. At Yenangyoung I found the thickness to be 1100 feet. As these data are founded on reliable measurements, it is almost certain that the thickness of the *Yenangyoungian* undergoes considerable changes within a distance of about 50 miles, but whether these differences are due to denudation of its upper part, or to the

uneveness of the surface of the *Promeian*, I am unable to say. It seems certain, that part of it is due to the first cause, but the second one may also answer for it.

The data regarding lower Burma are much less reliable, it is certain that the topmost 514 feet of Mr. Theobald's section belong to the *Yenangyoungian* but to this we have to add a) the thickness of the beds below the Kama clay b) the thickness of the Kama clay, c) all that „very thick" series of beds between the Kama clay and the Fossil wood group. It is extremely difficult to form an estimate, but if we assume a & b to be 500 feet and c to be 1000 feet, we obtain a total thickness of about 2000 feet, an estimate which is probably rather under, than above the mark.

2. *Lithological characters.* The strata developed, show the same composition as those of the *Promeian* viz. sandstones and clays, but there is a distinct change of colour, at least in such places where the estuarine facies is developed. In the latter case olive tinges prevail, while in the marine facies dark green or dark blue colours will be observed. A remarkable feature is the occurence of gypsum which is often found in large crystals. So far this mineral has not been observed in the *Promeian*, neither has it been found in the marine facies of the *Yenangyoungian*. Its presence is therefore almost sure to denote the estuarine facies of the *Yenangyoungian*.

3. *Palaeontological characters.* The *Yenangyoungian* has almost exclusively yielded the well preserved fossils described in my memoir, of which there are 203 species known for the present and as these will be discussed in subsequent chapters it is needless to dwell here on this subject.

4. *Facial development.* In upper Burma the *Yenangyoungian* is developed in two distinct facies viz. a marine and an estuarine one, an observation about which there can be not the slightest doubt, as owing to good exposures and correct maps, it could be proved to a certainty that a marine fauna occurs at Singu and Yenangyat in the same level, as in which at Yenangyoung an estuarine fauna occurs. In fact if more time could be spent, the gradual passage from estuarine to marine beds could be easily traced.

The *marine* facies which contains a rich fauna in upper Burma is chiefly exposed in the Yenangyat Anticlinal between Singu and Yenangyat, it occurs also near Minbu. Dark green, very hard glauconitic sandstones are prevailing, more subordinate are layers of dark olive colour.

The *estuarine* facies is almost unfossiliferous, except for three species of the genus *Cyrena* which occur locally towards its top.

It is generally composed of olive coloured clays, containing gypsum; layers of hard concretionary sandstone are frequently intercalated. This facies is particularly well developed near Yenangyoung where it attains a thickness of 1100 feet; at Minbu, Singu and Yenangyat it is considerably reduced, its place being almost occupied by the marine facies. With regard to lower Burma it is at present impossible to say, whether both the marine and estuarine facies are developed. The marine facies is unquestionably well represented, as is proved by the fine collection of fossils, but there is no evidence to say whether estuarine beds occur or not.

5. *Subdivision.* There is great difficulty with regard to the subdivision of the estuarine facies, and no attempt has been made to subdivide the monotonous series of unfossiliferous beds. Only at the top of the series a few species of *Cyrena* appear, which though occuring only locally, form the characteristic horizon of *Cyrena (Batissa) crawfurdi* Noetl. near Yenangyoung. On the other hand we are much better off with regard to the marine facies of which the vertical sequence of several horizons has been ascertained by actual observation. In descending order the following horizons could be distinguished:

Marine Facies.	Estuarine Facies
6. Zone of *Cardita tjidamarensis* K. Mart.	1. Zone of *Cyrena (Batissa) crawfurdi* Noetl.
5. Zone of *Mytilus nicobaricus* Chemn.	
4. Zone of *Meiocardia metavulgaris* spec. nov.	
3. Zone of *Dione dubiosa* Noetl.	
2. Zone of *Cancellaria martiniana* spec. nov.	
1. Zone of *Paracyathus caeruleus* Dunc.	

It must be mentioned that it is not quite certain whether the zone of *Cyrena crawfurdi* is really correlated to the zone of *Cardita tjidamarensis*, in fact there seems reason to believe that it is probably equivalent to the zone of *Mytilus nicobaricus.*

In Lower Burma the following horizons could be distinguished.

Marine Facies.	
7. Zone of *Turritella acuticarinata Dunk.*	
6. Zone of *Ostrea peguensis* spec. nov.	(?) Zone of *Ostrea promensis* spec. nov. (?)
5. Zone of *Arca theobaldi* spec. nov.	
4. Zone of *Parallelipipedum prototortuosum* spec. nov.	
3. Zone of *Pholas orientalis* Gmel.	

2. Zone of *Aricia humerosa* Sow. spec.
1. Zone of *Cytherea erycina* Linné.

2. THE IRRAWADDI SERIES.

The *Irrawaddi*-series comprises all that enormous thickness of strata, which rest on the marine and estuarine beds, and which are unconformably overlaid by silts and gravels of diluvial age. Palaeontologically this series is characterized by a terrestric and fluviatile fauna, in addition to which, it contains large quantities of silicified wood. So far no well defined subdivisions could be distinguished, because the lithological character is very monotonous and though fossils have been found, they seem to occur only locally, thus rendering the tracing of a given horizon over a larger distance an impossibility.

A. *Thickness.* The *Irrawaddi*-series, as above circumscribed exhibits a measured thickness of 4620 feet in the neighbourhood of Yenangyoung, but this appears to be only a small part of its total thickness. The fine cross-cut of the Irrawaddi, between Singu and Salemyo, affords an almost complete section of the *Irrawaddi*-series from its base, to probably within a short distance of its uppermost beds, and the thickness calculated would not be less than 20,000 feet. This probably represents the maximum thickness and it appears that in lower Burma it is of much smaller thickness.

B. *Lithological Character.* The rocks which compose this series, form by their light tinges a most marked contrast to the dark coloured beds of the *Arrakan*-series. Light yellow is the prevailing colour, but dull red, brown and olive tinges are by no means rare, though they take only a subordinate rank. The predominant rock is a very soft sandstone which might perhaps better be termed „sand-rock" of light yellow colour. It is deposited in thick beds, which frequently contain nodular, or kidney-shaped concretions of very hard siliceous sandstone. These concretions, sometimes of considerable size, are arranged in strings parallel to the bedding and stick out of the surrounding softer material, forming a very characteristic feature of the landscape. Alternating with the sandstone are beds of light, olive-coloured clay which however never obtain the thickness of the arenaceous beds. Still more subordinate are bands of ferruginous conglomerate; in these beds foreign matter is sometimes so rare that they form regular layers of cellular iron ore which has in former times been used for iron-smelting purposes. Their thickness changes from a few inches upwards to 15 feet, but except the basal conglomerate, they form most irregular, lenticular masses of often not more than a few feet in length.

C. *Palaeontological characters.* The *Irrawaddi*-series contains numerous remains of terrestric and fluviatile animals, but so far I have not been able to discover, whether they are generally distributed throughout the series, or whether they are confined to certain localities only. It is however a fact that they occur in the conglomeratic beds in preference to all others, but even here the distribution is very erratic. The number of species so far discovered amounts to about 30, but except a preliminary determination, they were not further examined.

In addition to the animalic remains numerous fragments of silicified wood, often of considerable size, occur throughout the series; no examination of these fossil remains has hitherto been undertaken, but it appears that monocotyledonous species preponderate.

D. *Subdivision.* There have been several attempts of subdividing this enormous series, but whether they can claim more than local importance remains to be seen. In lower Burma Mr. Theobald [1]) distinguishes the following three groups, of which it is quite certain that they can be distinguished only in the neighbourhood of Prome and Thayetmyo, these are in descending order:

c. Fossil wood sands.
b. Fine silty clay.
a. Mogoung sands.

The late Mr. Grimes [2]) based his subdivision also on lithological differences only, and he distinguishes in descending order:

d. Sandstone with ferruginous conglomerate and much fossil wood.
c. Sandstone with numerous small root-like concretions and little fossil wood.
b. Sandstone with large rounded concretions and much fossil wood.
a. Sandstone with numerous bands of ferruginous conglomerate containing vertebrate remains.

As I thoroughly know the country around Yenangyoung, for

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1) Mem. Geolog. Survey of India 1873. vol. X. pag. 62.
2) Mem. Geolog. Survey of India 1898. vol. XXVIII. pag. 62.

which this subdivision has been established, I can confidently say, that the principles on which it has been based are of no value whatsoever. The fossil wood occurs in a most erratic manner, and to use the frequency of its occurence as the basis for a subdivision is perfectly erroneus. The above subdivision holds good on paper only, and if it were put to a practical test it would soon fail except for the country around Yenangyoung. To subdivide such a monotonous series of arenaceous beds as the *Irrawaddi*-series, on lithological differences only, seems perfectly impracticable, because the lithological character changes so frequently. The basal conglomerate seems to be the only instance of a single bed of the *Irrawaddi*-series being continued over a larger distance, but even this appears to split up north of Yenangyat and Mr. Grimes felt inclined to include in this zone the next 150 to 200 feet of sandstone, containing bands of conglomerate, a view which I by no means approve of. I still maintain that a subdivision based on palaeontological evidence, however incomplete it may be, deserves preference to any other, based on lithological differences only, and I see therefore no reason why I should alter the preliminary subdivision as suggested by me unless better palaeontological evidence should be forthcoming. In descending order I divide the *Irrawaddi*-series into the following subdivisions.

b. *Upper Irrawaddi-Series:*
Yellow soft and friable sandstones, alternating with beds of brown clay. No fossil bones; Fossil wood not verycommon.

a. *Lower Irrawaddi-Series:*

1. Zone of *Hippotherium antelopinum* & *Acerotherium perimense*. A ferruginous conglomerate forming the base of the series and containg numerous fossil bones, the most frequent of which are the above two species, which have hitherto not been found in higher strata.
2. Zone of *Mastodon latidens* & *Hippopotamus irravadicus*. Yellow soft and friable sandstones, alternating with conglomeratic beds, containing numerous fossil bones, among which the above two species are the most frequent; fossil wood very common.

I admit that this subdivision is only a preliminary one, in as much as the three groups are of very unequal value. In fact, it is difficult to say, chiefly on account of the erratic occurence of the fossil bones at what level the *Lower Irrawaddi*-series ends and where the *Upper Irrawaddi*-series commences, but until more time can be spent in the examination of this series the question must remain an open one.

In the following tabular view I arranged the subdivision of the Tertiary formation, and the principles which guided me in such a way that the system adopted may be seen at a glance.

Character of Fauna.		Character of Sediments.		Name of Series.	Name of Division.	Name of Subdivision.	Thickness.	European Equivalents.
Terrestric & Fluviatile.		Yellow Sandstone.		Irrawaddi-Series.	Upper Irrawaddi Series.	Unfossiliferous. (?)	20,000 feet.	Pliocene.
					Lower Irrawaddi Series.	Zone of *Mastodon latidens* & *Hippopotamus irravadicus*.		
						Zone of *Hippotherium antelopinum* & *Acerotherium perimense*.		
Marine.	No *Nummulites*.	Marine Facies.	Brackish Facies.	Arrakan-Series.	Pegu-Division.	Yenangyoungian.	2450 } 5500 feet.	Miocene.
		Bluish green glauconitic sandstone	Olive-coloured clays with Gypsum.					
		Bluish green, Bluish grey glauconitic, & pepper & salt coloured Sandstones.				Promeian.	3100	
	Nummulites.	Limestone & Shales.			Bassein Division.	Not subdivided.	1200 feet.	Eocene.
	No *Nummulites*.	Limestone Shales.			Chin-Division.	Not subdivided.	More than 10,000 feet.	Eocene (?) Cretaceous (?)

III.

CORRELATION OF THE BURMA TERTIARY FORMATION WITH THE EUROPEAN TERTIARIES.

It will be seen from the foregoing pages that in Burma the Tertiary formation exhibits a development which is widely different from what that formation shows in Europe. If Tertiary Geology had first been started in India, we would have arrived at totally different views regarding this formation and the name of „Dyas" on account of its pronounced bi-division would have probably been chosen. It is obvious that under these circumstances any correlation with the European Tertiaries can only be carried out in the broadest sense possible, every attempt to go into details, or to recognize smaller European divisions as for instance the Oligocene, in the Burma facies of the Tertiaries must result in a failure. The development of the Tertiary series in Burma is so totally different from that of Europe, faunistically as well as stratigraphically that we have almost nothing to guide us in its interpretation and we are obliged to refrain from any correlation to the now recognized subdivision of the Tertiary formation in Europe except on the broadest, lines. To arrive at an idea of the relative age of the various subdivisions of the Burma Tertiaries we have three distinct faunas succeeding in vertical direction; in descending order these are:

3. The *terrestric* and *fluviatile* fauna of the *Irrawaddi*-series.
2. The *marine* fauna of the *Pegu*-division.
1. The *marine* fauna of the *Bassein*-division.

Though the most important conclusions could be deduced from the study of these faunas, we meet almost at once with a great difficulty: the continuity of the marine fauna is interrupted. It is almost certain that the fauna of the *Irrawaddi*-series did not immediately succeed that of the *Pegu*-division, though the strata of the former rest apparently conformable on the latter.

Now it is certain that any deductions drawn from the vertical distribution of vertebrate remains, can never be compared with similar deductions derived from the study of the invertebrates. Whatever results we can deduce from the study of the vertebrates, it will be always difficult to bring them in harmony with those derived from the study of the invertebrates. This view holds good even, when the fauna of the *Irrawaddi*-series will be better known than at present. A preliminary examination of the numerous vertebrate remains I collected has proved, that the fauna of the *Irrawaddi*-series is certainly identical with that of the Siwaliks in India. It would be out of place to roll up here the question of the age of the Siwaliks, but I fully concur with Mr. Oldham who thinks that the balance of evidence is more in favour of the Pliocene than the Miocene age. If it were possible to settle this question we would at once know that the *Pegu* division must be either Prae-pliocene of Prae-miocene. If we accept the view that the *Irrawaddi*-series represents the Pliocene period, the *Pegu*-division must, notwithstanding the unconformity necessarily represent the Miocene unless an earlier age would be proved by its fauna.

Unfortunately the fauna of the *Pegu*-division affords not the slightest indications by which it may be compared to any fauna of the subdivisions of the Tertiary period in Europe, because it has not a single species in common with them. On the other hand it bears the closest relationship to the fauna inhabiting the Indian Ocean, and under these circumstances any attempt to correlate it faunistically with any subdivision of the European Tertiaries must remain futile.

If we now turn to the fauna of the *Bassein*-division, we have some better evidence, though the fauna is comparatively unknown; it chiefly consists of *Nummulites* and a few other fossils among which *Velates schmiedeliana* Chemn. spec. has been recognized. Poor as these facts may be, they enable us to form a definite view with regard to the position the *Bassein*-division holds in the sequence of the Tertiary epoch. The genus *Nummulites* is a typical eocene fossil, at least there is no evidence that true *Nummulites* occur in abundance anywhere else, but in the Eocene formation. We are therefore fully justified in assuming that the *Bassein* division corresponds to the Eocene period of Europe, and if we further take the limited vertical distribution of *Velates schmiedeliana* Chemn. spec. into consideration, we may assume that the *Bassein* division is correlative to the Upper Eocene and most probably represents the *Khirtharian* of Western India and Baluchistan.

We have now gained a firmer basis than before, starting from which we can arrive at some more definite views with regard to the age of the superimposed beds. The whole series resting on the *Bassein*-division must necessarily represent the Younger Tertiaries, that is to say upwards of the *Bartonian* of the European geologists. Now as the fauna of the *Irrawaddi*-series renders it almost certain that it should be correlated to the Pliocene of Europe, the *Pegu*-division must necessarily represent the *Miocene* period. It may at once be argued that this view is by no means certain, because it may also represent the *Oligocene* period. I admit that such a view may be held, but if we remember for what series of strata the Oligocene had originally been established, it would seem almost absurd, to recognize this particular division of the European Tertiaries which so emminently bears the sign of a European continental facies, in Burma. I am fully in concordance with Professor Martin that no evidence warrants the adoption of this term for any part of the Indian Tertiary formation whether it be in Baluchistan, Western India, Burma, Sumatra, Java or Borneo. We have, as I repeatedly pointed out a few meagre facts to correlate certain beds with the Eocene period of Europe, but palaeontological evidence holds no longer any good with regard to the marine beds resting on those which we consider as Eocene. The only fact we know is, that they must be younger than Eocene and the natural conclusion is that we consider them as the representatives of the Miocene period.

IV. THE MIOCENE OF BURMA.

1. DEVELOPMENT AND SUBDIVISION.

A. *Lower Burma: Prome and Thayetmyo.*

a. *General Remarks.*

Messrs. Theobald' and Fedden's collections have been chiefly made in this part of Burma, but having had no opportunity myself of examining the Tertiary beds of lower Burma, except by such observations as could be made by rapidly passing through the country I have solely to depend with regard to the stratigraphical features on Mr. Theobalds memoir.

Mr. Theobald divided his *Pegu* group, which as pointed out above corresponds to my *Pegu*-division in two subdivisions viz.:

2. *Prome-beds.*

1. *Sitsyahn-shales.*

According to Mr. Theobald the Sitsyahn-shales are unfossiliferous;

the fossils collected by him come therefore all from the *Prome*-beds, and if I am correct in my interpretation they must all come from the upper part of the *Prome*-beds that is to say from Mr. Theobalds group B, the lower group A, being unfossiliferous. After carefully sorting his collections and rejecting all doubtful specimens, six horizons, well characterized by different lithological and palaeontological features could be distinguished, but as no information as to the relative vertical position of these beds had been left, I was absolutely in the dark with regard to their sequence. The section given on pag. 83 & 84 of Mr. Theobald's memoir, as well as a few stray remarks scattered here and there helped materially in solving this mystery and though I am still not quite certain as to the position of some of them, the position of the most important zones has been fairly well fixed.

On pag. 84 Mr. Theobald states that the upper of the two groups into which he has divided the *Prome* beds begins with „compact marly sandstone softer at the base" which contains „*Cardita*" and „*Cytherea*". There can be no doubt that this bed represents the horizon frequently alluded to by Mr. Theobald as *Cytherea promensis*-bed, because one of the chief characteristics of this horizon is the large number of two species, *Cytherea erycina* Fav. and *Cytherea protovariegata* spec. nov. As I have proved that *Cytherea promensis* Theob. is identical with the living *Cytherea erycina* Fav., the horizon which I called zone of *Cytherea erycina* must be represented by this bed which would therefore occur 1418 feet, plus 800 feet, the thickness of the Sitsyahn shales, that is to say 2200 above the base of the *Pegu*-division.

I have not been able to identify any of the other two fossiliferous horizons mentioned in the section composing Mr. Theobalds group B, but the position of two other horizons most important on account of the rich and well preserved fauna they contain, has again been fairly well fixed. Mr. Theobald writes on pag. 85:

„The channel of the Irrawaddi here intervenes, causing a break between the section above given and its continuation on the opposite bank"..... The most importand beds in the section, however, which I think must intervene at the place, are some very fossiliferous blue shales which..... I have termed Kama clay".

This is a very precise and clear statement and we must therefore conclude that the fauna of the Kama clay is younger than that of the zone of *Cytherea erycina* and occurs perhaps 1000 feet above it.

When examining the collections labelled Kama, it became evident that there were two, lithologically and as it afterwards proved also palaeontologically different horizons. One of the beds is a soft, *yellow*, hardly argillaceous sandstone, in which the shells are simply bleached, the other is a *bluish-green* somewhat argillaceous sand in which the fossils have a slightly reddish tinge. After a little practice it is impossible to mistake the fossils even if they should have become mixed up.

If we assume that the bluish sand represents the Kama clay properly speaking, the position of the yellow sand is doubtful so far, as it cannot be stated whether it occurs above or below the former one. Certain palaeontological reasons of which I shall speak more later on (pag. 28) have however led me to believe that the yellow sand is older than the bluish one. I termed the former the zone of *Parallelipipedum prototortuosum* and the latter, the Kama shales s. s. zone of *Arca theobaldi* and these horizons would occur about 3300 feet above the base of the *Pegu*-division.

There are however three or perhaps four more fossiliferous horizons which I termed zone of *Ostrea promensis*, zone of *Ostrea peguensis*, zone of *Pholas orientalis*, zone of *Aricia humerosa*, the position of which is very uncertain and can only be guessed. The first two zone that of *Ostrea promensis* and *Ostrea peguensis* represent Ostrea-beds which are probably exclusively built up by the shells of either, both, or only one species, but as neither has been found in any other horizon, we are perfectly in the dark as to their position, and they may occur anywhere between the zone of *Cytherea erycina* and *Turitella acuticarinata* though it is probable that they occur above the zone of *Arca theobaldi*. There are a few, though faint indications with regard to the position of the remaining horizons; both are represented by a dark green, very glauconitic sandstone and a considerable number of species occuring in both are common to the zone of *Cytherea ery.ina* and the zones of *Parallelpipedum prototortuosum* and *Arca theobaldi*. I assume both horizons to hold an intermediate position between that of *Cytherea erycina* and the two other ones. This view is further strengthened by Mr. Theobald's section, according to which no fossiliferous horizons occur below the bed containing *Cytherca* and *Cardita*, but no definite position can be assigned to them and I must leave it an open question in which part of the 514 feet above the zone of *Cytherea erycina* they occur.

„Above the Kama shales occurs a very thick series of sandstones and shales, which do not present any bed sufficiently well marked, either by mineral character or fossil contents, to serve as a servicable horizon for the division of the group" (Theobald l. c. pag. 86)..... „There are some slight means however, of judging the position of some of the highest beds of the present group, as, for instance the occurence of a species of *Turritella* hardly distinguishable from one now living on the coast, which seems, where it occurs plentifully, to mark a high position in this group". (Theobald l. c. pag. 87). From these remarks we may suppose, that the most important fossiliferous horizons near Thayetmyo and Prome are restricted to the middle part of Theobalds *Pegu*-group, as represented by group B of his *Prome*-beds and that above the zone of *Arca theobaldi* only a few fossiliferous horizons occur among which are perhaps the *Ostrea*-beds, and one containing numerous specimens of a *Turritella*.

b. *Detailed Description.*

1. *Sitsyahn shales.*

„The base of the Pegu group would appear to consist of a „thick deposit of shales, with a little sandstone very subordinately „developed...... The Sitsyahn shale is a blue, somewhat clunchy „clay, with very little appearence of bedding save towards its „upper portion where sandstone courses begin to come in...... „It is as far as I know entirely unfossiliferous and along the long „expanse of this shale below Sitsyahn, I failed to detect the sligh- „test trace of any organism whatsoever..... No estimate can be „formed of the entire thickness, of this lower division of the group, „but I think that close on 400 feet are here (viz. near Sitsyahn) „seen and probably twice that amount would not be an overesti- „mate for the entire thickness of this division". (Theobald l. c. pag. 81 & 82).

2. *Prome*-sandstone.

Above the *Sitsyahn* shales follows a series of chiefly arenaceous beds with subordinate layers of clay; according to Theobald the sandstones are of grey colour, but no mention is made of any fossiliferous horizon in his section on pag. 83 and the inference, that the group is unfossiliferous would therefore be fully justified. If this be the case and we have at present no further proofs contradicting this view it is perhaps probable that the lower part of the Miocene near Prome and Thayetmyo is unfossiliferous, and equivalent to the unfossiliferous series containing the petroleum in upper Burma. The development of the Miocene in lower and upper

Burma would therefore be exactly alike, but further proofs to support this view are required.

3. Zone of *Cytherea erycina* Favanne.

The lowest known fossiliferous horizon is a bed of compact marly sandstone of 5 feet in thickness, forming the base of Mr. Theobald's group B; the sandstone is rather hard and almost entirely built up of shells of *Cytherea erycina* Fav. and *Cardita protovariegata* spec. nov., both species having almost always the two valves united. Other species are much less common, except perhaps *Ceratotrochus alcockianus* spec. nov. The following is the list of fossils described from this bed.

1. *Ceratotrochus alcockianus* spec. nov.
2. *Flabellum distinctum* Milne Edwards.
3. *Pecten kokenianus* spec. nov.
4. *Cardita protovariegata* spec. nov.
5. *Cytherea erycina* Favanne.
6. *Dione protolilacina* spec. nov.
7. 〃 *protophilippinarum* spec. nov.
8. *Dosinia protojuvenilis* spec. nov.
9. *Tellina grimesi* spec. nov.
10. *Trochus spec.*
11. *Vermetus javanus* K. Martin.
12. *Natica callosa* Sowerby.
13. 〃 *obscura* Sowerby.
14. *Sigaretus neritoideus* Linnè.
15. *Ranella elegans* Beck.
16. *Eburna protozeylanica* spec. nov.
17. *Pyrula pugilina* Born spec.
18. *Ancillaria cf. vernedei* Sowerby.
19. *Subula* spec.
20. *Conus avaënsis* spec. nov.
21. *Balanus tintinnabulum* Linnè.

4. Above the last named zone follows a series of beds, measuring 514 feet in thickness, which contain several fossiliferous horizons. As the *Sitsyahn* shales and the *Prome* sandstone are apparently unfossiliferous I do not think that I am wrong if I attribute the following two zones a place in this series though it must be left an open question which of the two is the older.

4. a. Zone of *Aricia humerosa* Sowerby spec.

Lithologically this zone is characterised by a bright green fairly hard sandstone; the fossils are generally well preserved but exhibit a peculiar ockry tinge.

The following is the list of fossils described from this bed.

1. *Flabellum distinctum* Milne Edwards.
2. *Spondylus* spec.
3. *Lima griesbachiana* spec. nov.
4. *Peeten kokenianus* spec. nov.
5. *Cardita viquesneli* d'Arch. & Haime.
6. 〃 *planicosta* spec. nov.
7. *Crassatella rostrata* Lamarck.
8. *Cardium protosubrugosum* spec. nov.
9. 〃 *minbuense* spec. nov.
10. *Dione amygdaloides* spec. nov.
11. 〃 *protophilippinarum* spec. nov.
12. *Dosinia protojuvenilis* spec. nov.
13. *Tellina grimesi* spec. nov.
14. 〃 *foliacea* Reeve.
15. 〃 *hilli* Noetling.
16. *Solarium coniforme* spec. nov.
17. *Vermetus javanus* K. Martin.
18. *Xenophora birmanica* spec. nov.
19. *Calyptraea rugosa* Noetling.
20. *Natica callosa* Sowerby.
21. 〃 *obscura* Sowerby.
22. *Aricia humerosa* Sowerby. spec.

23. *Ranella elegans* Beck.
24. *Fusus verbeeki* K. Martin.
25. *Oliva rufula* Duclos.
26. *Ancillaria cf. vernedei* Sowerby.
27. *Subula* spec.
28. *Conus literatus* Linné.
29. 〃 *avaënsis* spec. nov.
30. 〃 *yuleiauus* spec. nov.
31. *Balanus tintinnabulum* Linné.

4. b. Zone of *Pholas orientalis* Gmelin.

This zone is represented by a hard quartzitic sandstone of very dark green or brown colour, the shells are generally snowy white and shine out brilliantly against the surrounding matter; they are however generally not well preserved, and mostly strongly weathered, particularly the pelecypodan shells. The most common species is *Pholas orientalis* Gmel. while the other species are known only in a few specimens. The following is the list of fossils described from this bed:

1. *Flabellum distinctum* Milne Edwards.
2. *Pecten kokenianus* spec. nov.
3. *Pinna* spec.
4. *Arca oldhamiana* spec. nov.
5. 〃 *bataviana* K. Martin.
6. 〃 *peethensis* d'Arch & Haime.
7. *Cardita planicosta* spec. nov.
8. *Meicocardia protovulgaris* spec. nov.
9. *Petricola incerta* spec. nov.
10. *Venus protoflexuosa* spec. nov.
11. *Cytherea erycina* Favanne.
12. 〃 *yomaënsis* spec. nov.
13. *Dione protolilacina* spec. nov.
14. 〃 *amygdaloides* spec. nov.
15. *Dione protophilippinarum* spec. nov.
16. *Tellina grimesi* spec. nov.
17. 〃 *foliacea* Reeve.
18. 〃 *hilli* Noetling.
19. *Solen* spec.
20. *Mactra protoreeresii* spec. nov.
21. *Corbula socialis* K. Martin.
22. *Pholas orientalis* Gmelin.
23. 〃 *blanfordianus* spec. nov.
24. *Solarium nitens* spec. nov.
25. *Calyptraea rugosa* Noetling.
26. *Natica obscura* Sowerby.
27. *Ancillaria cf. vernedei* Sowerby.
28. *Conus avaënsis* spec. nov.

5. If I interpret Mr. Theobalds view correctly he thinks, that above the section described on pag. 83 & 84 of his memoir and below the Kama clay there follows a series of beds which are hidden by the Irrawaddi, in other words, the Kama clay does not follow immediately on the top of the last bed mentioned in his section. The thickness of these beds supposed to be 500 feet [1]) will be rather below than above the mark.

6. Zone of *Parallelipipedum prototortuosum* spec. nov.

This zone is represented by a very soft, finely grained sandrock of yellow colour, which when soaked with water easily crumbles away. Nothing definite is known about the thickness or exact position of this zone though palaeontologically it represents one of the most important horizons of the whole series.

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[1]) The breadth of the Irrawaddi between Prome and the opposite bank is almost a mile.

The fossils are beautifully preserved but what is remarkable, with a few exceptions the Pelecypoda are much better preserved than the Gastropoda. The shells almost resemble living ones picked up on the sea shore only that they lost their colour. The most characteristic species ist *Parallelipipedum prototortuosum* spec. nov. a species which has not been found in any other bed. The following is the list of fossils described from this bed and though it contains the largest number of species, I have not the slightest doubt, that it is not exhaustive and future researches will probably considerably swell the number.

1. *Ceratotrochus alcockianus* spec. nov.
2. *Flabellum distinctum* Milne Edwards.
3. *Paracyathus caeruleus* Duncan.
4. *Cidaris* spec.
5. *Ostrea papyracea* spec. nov.
6. *Pecten kokenianus* spec. nov.
7. *Vulsella linguatigris* spec. nov.
8. *Arca burnesi* d'Arch. & Haime.
9. 〃 *yawensis* spec. nov.
10. 〃 *peethensis* d'Arch. & Haime.
11. *Parallelipipedum prototortuosum* spec. nov.
12. *Nucula phayreiana* spec. nov.
13. *Leda avaënsis* spec. nov.
14. *Cardita protovariegata* spec. nov.
15. 〃 *viquesneli* d'Arch. & Haime.
16. *Lucina neasquamosa* spec. nov.
17. 〃 *pagana* spec. nov.
18. *Cardium protosubrugosum* spec. nov.
19. 〃 *minbuënse* spec. nov.
20. *Meiocardia protovulgaris* spec. nov.
21. *Cytherea erycina* Favanne.
22. *Dione protolilacina* spec. nov.
23. 〃 *arrakanensis* spec. nov.
24. 〃 *amygdaloides* spec. nov.
25. 〃 *protophilippinarum* spec. nov.
26. *Dosinia protojuvenilis* spec. nov.
27. *Tellina grimesi* spec. nov.
28. 〃 *protostriatula* spec. nov.
29. 〃 *protocandida* spec. nov.
30. 〃 *indifferens* spec. nov.
31. 〃 *foliacea* Reeve.
32. 〃 *hilli* Noetling.
33. *Tellina pseudohilli* spec. nov.
34. *Gari natensis* spec. nov.
35. 〃 *protokingi* spec. nov.
36. *Hiatula textilis* spec. nov.
37. *Mactra protoreevesii* spec. nov.
38. *Corbula socialis* K. Martin.
39. *Dentalium junghuhni* K. Martin.
40. *Solarium maximum* Philippi.
41. *Scalaria birmanica* Noetling.
42. *Turritella simplex* Jenkins.
43. 〃 *acuticarinata* Dunker.
44. 〃 *leiopleurata* spec nov.
45. 〃 *lydekkeri* spec. nov.
46. 〃 spec.
47. *Vermetus javanus* K. Martin.
48. *Natica callosa* Sowerby.
49. 〃 *obscura* Sowerby.
50. 〃 *gracilior* spec. nov.
51. *Sigaretus neritoideus* Linné.
52. *Ficula* spec.
53. *Ranella prototubercularis* spec. nov.
54. 〃 *elegans* Beck.
55. *Oliva rufula* Duclos.
56. *Conus avaënsis* spec. nov.
57. 〃 *yuleianus* spec. nov.
58. 〃 *hanza* spec. nov.
59. 〃 *protofurvus* spec. nov.
60. *Clavatula munga* spec. nov.
61. *Ringicula turrita* K. Martin.
62. *Balanus tintinnabulum* Linnè.
63. *Callianassa birmanica* spec. nov.

7. Zone of *Arca theobaldi* spec. nov.

For reasons above stated I think that this zone represents the true Kama clay of Mr. Theobald; the matrix in which the shells are contained is a bluish green, arenaceous clay, which readily crumbles away in water. The shells are quite as well preserved as in the zone of *Parallelipipedum prototortuosum* though perhaps they do not quite show the same clearness of detail; a reddish tinge is peculiar to all shells and the Gastropoda are better preserved than in the former zone. The most common species is *Arca theobaldi* spec. nov. and it is chiefly on account of this species that I attributed a position above the zone of *Parallelipipedum prototortuosum* to this horizon. *Arca theobaldi* spec. nov. is so closely related to *Arca burnesi* d'Arch. & Haime, one of the most common species of the former zone that at the first glance it might be mistaken for this species; on closer examination it will however be found, that while in *Arca burnesi* d'Arch. & Haime only the left valve exhibits a certain ornamentation, the same ornamentation occurs on both valves in *Arca theobaldi* spec. nov. Assuming that the more differentiated species holds a higher position in the sequence, I placed the zone of *Parallelipipedum prototortuosum* below that of *Arca theobaldi*. The following is the list of species described from this bed:

1. *Paracyathus caeruleus* Duncan.
2. *Cidaris spec.* 1.
3. 〃 *spec.* 2.
4. *Ostrea papyracea* spec. nov.
5. *Pecten kokenianus* spec. nov.
6. *Arca theobaldi* spec. nov.
7. 〃 *metabistrigata* spec. nov.
8. 〃 *myoënsis* spec. nov.
9. 〃 *nannodes* K. Martin.
10. 〃 *bataviana* K. Martin.
11. *Nucula alcocki* Noetling.
12. *Leda virgo* K. Martin.
13. *Dione protolilacina* spec. nov.
14. 〃 *amygdaloides* spec. nov.
15. 〃 *protophilippinarum* spec. nov.
16. *Tellina grimesi* spec. nov.
17. 〃 *protostriatula* spec. nov.
18. 〃 *foliacea* Reeve.
19. 〃 *hilli* Noetling.
20. *Gari protokingi* spec. nov.
21. *Corbula socialis* K. Martin.
22. 〃 *prototruncata* spec. nov.
23. *Dentalium boettgeri* spec. nov.
24. *Calliostoma koenenianum* spec. nov.
25. *Basilissa lorioliana* spec. nov.
26. *Turcica protomonilifera* spec. nov.
27. *Solarium maximum* Philippi.
28. *Torinia protodorsuosa* spec. nov.
29. *Turritella simplex* Jenkins.
30. *Turritella acuticarinata* Dunker.
31. *Calyptraea rugosa* Noetling.
32. *Natica callosa* Sowerby.
33. 〃 *obscura* Sowerby.
34. 〃 *spec.*
35. *Fossarus krausei* spec. nov.
36. *Rimella scripta* Sowerby spec.
37. *Galeodea monilifera* spec. nov.
38. *Triton pardalis* Noetling.
39. 〃 *neacolubrinus* spec. nov.
40. *Persona gautama* spec. nov.
41. *Ranella prototubercularis* spec. nov.
42. *Eburna protozeylanica* spec. nov.
43. *Marginella scripta* Reeve.
44. *Oliva rufula* Duclos,
45. *Cancellaria neavolutella* spec. nov.
46. 〃 *inornata* spec. nov.
47. *Strioterebrum protomyuros* spec. nov.
48. 〃 *unicinctum* spec. nov.
49. 〃 *bicinctum* K. Martin.
50. *Terebrum protoduplicatum* spec. nov.
51. *Pleurotoma karenaica* spec. nov.
52. *Surcula feddeni* Noetling.
53. *Drillia protointerrupta* spec. nov.
54. 〃 *promensis* spec. nov.
55. 〃 *protocincta* spec. nov.
56. *Conus avaënsis* spec. nov.
57. *Balanus tintinnabulum* Linnè.
58. *Callianassa birmanica* spec. nov.

8. *Thayetmyo*-Sandstone.

The zone of *Arca theobaldi* closes the fossiliferous series in lower Burma; at least according to Mr. Theobald no more fossiliferous beds occur above the Kama clay except at the end of the series [1]). Mr. Theobald only states that this series is composed of sandstones and shales but gives no particulars as to colour or thickness. I presume that yellow tinges prevail because to judge from Mr. Theobald's section on pag. 84 it is unquestionable that yellow colours preponderate in his B group, and because in upper Burma this colour supersedes the grey or bluish tinge of the lower beds. It is difficult to form an opinion regarding the thickness, but I suppose if we estimate Mr. Theobald's very thick series to about 1000 feet, we will be rather below than above the mark. As already stated I believe that the zone of *Ostrea promensis* and *Ostrea peguensis* if both really occur in different horizons and not together in one bed, are found in this series.

9. Zone of *Turritella acuticarinata*. Dunker.

Mr. Theobald's collection does not contain any species from this bed and it is only on the strength of his remark of „the occurence of a species of *Turritella* hardly distinguishable from one now living on the coast" that I call this zone by the name of *Turritella acuticarinata*. Dunk. because it is only either this or *Turritella simplex* Jenk. which could come in consideration both of which are certainly very close relatives of the living *Turritella duplicata* Lin. This zone closes the *Pegu*-division and immediately above it follows the *Irrawaddi*-series. The section in lower Burma, would therefore be in descending order:

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[1]) I may mention here that the strata from which Mr. Theobald obtained a *Pseudodiadema* and other Echinoidea are most probably Eocene, unless they represent the supposed coralline facies, and his so-called *Ngathamu*-beds are of Alluvial age.

Pliocene.			Irrawaddi Series.	Thickness unknown.
Upper Miocene.	Pegu Division.	Yenangyoungian.	9. Zone of *Turritella acuticarinata* Dunk.	10 feet.
			8. *Thayetmyo*-Sandstone.............	1000 "
			(?) 8. b. Zone of *Ostrea peguensis* spec. nov.	
			(?) 8. a. Zone of *Ostrea promensis* spec. nov.	
			7. Zone of *Arca theobaldi* spec. nov. } 6. Zone of *Parallelipipedum prototortuosum* spec. nov.............. }	20 "
			5. Sandstones and Shales not seen....	500 "
			4. A series of sandstones and shales containing probably several fossiliferous horizons.................	514 "
			4. b. Zone of *Pholas orientalis* Gmel.	
			4. a. Zone of *Aricia humerosa* Sow. spec.	
			3. Zone of *Cytherea erycina* Fav......	5 "
Lower Miocene.		Promeian.	2. *Prome*-Sandstone.................	1418 feet.
			1. *Sitsyahn*-shales..................	800 "

B. *Upper Burma.*

a. *Minbu.*

Though of course Tertiary beds are exposed every where north of Thayetmyo between this place and Minbu, no examination has been carried out in this part of the country. The southernmost locality where Tertiary beds have been studied in upper Burma is the small village of Minbu Lat. 20° 10′ N. Long, 94° 56′ E on the right bank of the Irrawaddi, 423 miles by river from Rangoon.

Any section near Minbu, taken from the river bank in western direction proves that the strata form an unsymmetrical anticlinal arch, the sides of which are formed by the *Irrawaddi*-series while in the centre the *Pegu*-division is exposed. Near the river the beds dip vertically and are even reversed at some places; this vertical dip continues for a distance of about 1000 feet from the river bank, but then the angle lessens and within a distance of 600 feet, in horizontal direction, from the last vertically dipping bed, the strata dip at an angle of 15° towards East; the angle becomes smaller and smaller, till it is perfectly horizontal in the low ridge forming the northern end of the valley in which the mud volcanoes are situated. The dip assumes now rather quickly a western direction and an angle of 12° to 15° is observed which apparently remains unchanged, as far as I have followed the strata in western direction.

The strata exposed in this anticlinal consist of layers of hard sandstone near the river bank, separated by beds of brown clay; the hard beds disappear and are gradually replaced by olive coloured clays containing gypsum, and occasional layers of flaggy hard sandstone. In the centre of the Anticlinal the clay assumes a more bluish colour, the intercalated beds of sandstone being brown; this last named series is exposed for about 150 feet in thickness and contains the fauna mentioned below. There are apparently several fossiliferous beds, but the fauna here described comes from a bed of light coloured calcareous sandstone close to the surface, which I termed zone of *Cancellaria martiniana*. The following fossils have been described from this bed:

1. *Paracyathus caeruleus* Duncan.
2. *Pecten irravadicus* spec. nov.
3. *Pinna spec.*
4. *Arca bistrigata* Reeve.
5. *Nucula alcocki* Noetling.
6. *Dione dubiosa* Noetling.
7. 〃 *protophilippinarum* spec. nov.
8. *Tellina hilli* Noetling.
9. *Gari kingi* Noetling.
10. *Corbula prototruncata* spec. nov.
11. *Calliostoma blanfordi* Noetling.
12. *Solarium maximum* Philippi.
13. *Torinia protodorsuosa* spec. nov.
14. 〃 *buddha* Noetling.
15. *Discohelix minuta* Noetlfng.
16. *Scalaria spathica* spec. nov.
17. 〃 *birmanica* Noetling.
18. 〃 *irregularis* Noetling.
19. *Turritella affiniformis* spec. nov.
20. *Calyptraea rugosa* Noetling.
21. *Natica callosa* Sowerby.
22. 〃 *obscura* Sowerby.
23. *Cypraea granti* d'Arch. & Haime.
24. *Cassis d'archiaci* Noetling.
25. *Semicassis protojaponica* spec. nov.
26. *Oniscidia minbuensis* Noetling.
27. *Ficula theobaldi* Noetling.
28. *Triton pardalis* Noetling.
29. *Ranella prototubercularis* spec. nov.
30. *Fusus seminudus* spec. nov.
31. *Fasciolaria nodulosa* Sowerby.
32. *Murex arrakanensis* Noetling.
33. *Volvaria birmanica* Noetling
34. *Voluta ringens* spec. nov.
35. 〃 *dentata* Sowerby.
36. *Oliva rufula* Duclos.
37. *Cancellaria davidsoni* d'Arch & Haime.
38. 〃 *martiniana* spec. nov.
39. *Terebrum smithi* K. Martin.
40. *Subula spec.*
41. *Surcula feddeni* Noetling.
42. *Genota irravadica* Noetling.
43. *Clavatula protonodifera* spec. nov.
44. *Drillia protointerrupta* spec. nov.
45. *Conus malaccanus* Hwas.
46. *Balanus tintinnabulum* Linnè.
47. *Callianassa birmanica* spec. nov.
48. *Cancer spec.*
49. *Myliobates spec.*
50. *Carcharias gangeticus* Müller & Henle.
51. *Galeocerdo spec.*
52. *Oxyrhina spalanzanii* Bonaparte.

The delimitation of the groups composing this section is not very easy; it seems unquestionable, that no strata belonging to the *Promeian* come to the surface, though the existence of this group in greater depth in unquestionably proved by the mud ejected by the mud volcanoes, the appearence of which is exactly like that from the drilled bore holes of Yenangyoung.

The occurence of fragments of fossil bones among which *Trionyx spec.* was recognized in some of the conglomeratic beds near the river bank proves that the strata here exposed belong to the *Irrawaddi*-series, though there appears to be a gradual passage to the upper beds of the *Yenangyoungian*. The section near Minbu would be therefore in descending order:

				Thickness.
Pliocene.	Irrawaddi Series.			Unknown.
Upper Miocene.	Pegu Division.	Yenangyoungian.	5. *Minbu*-shales, olive coloured unfossiliferous clay, with layers of hard concretionary sandstone...........	1300 feet.
			4. Bluish clay, unfossiliferous........	500 "
			3. Zone of *Cancellaria martiniana* spec. nov..........................	5 "
			2. Bluish clay with layers of fossiliferous sandstone..................	150 "
Lower Miocene.		Promeian.	1. Petroliferous sandstones and clays, not exposed.	Unknown.

b. *Yenangyoung*.

The important village of Yenangyoung, Lat. 20° 29′ N. Long. 94° 56′ E. is situated on the left bank of the Irrawaddi 458 miles from Rangoon. The strata form a very flat, symmetrical arch, the top of which has been greatly planed down by subsequent denudation. As almost all the chief valleys cut the anticlinal arch at right angles, very good sections can be seen, but it is only for the comparatively small horizontal distance of 5100 feet, measured along the line of greatest exposure, that beds older than the *Irrawaddi*-series are exposed in the centre of the anticline.

Marching from the river in eastern direction, strata belonging to the *Irrawaddi*-series will be observed dipping at 37° to 38° in southwestern direction; the lower boundary of the *Irrawaddi*-series being well defined, their thickness was found to be 4620 feet. Below the basal bed of the *Irrawaddi*-series, the zone of *Hippotherium antelopinum* and *Acerotherium perimense*, follows a series of soft, olive-coloured clays, alternating with thin beds of sandstone. In the top layer, immediately underneath the basal conglomerate I discovered on the eastern side of the anticlinal arch near Minlindoung two patches full of shells of *Cyrena (Batissa) crawfurdi* Noetl. and *Cyrena (Batissa) petrolei* Noetl. but nowhere else have these species been found again. I therefore termed the top-layer of the *Yenangyoungian* zone of *Cyrena crawfurdi*, though it must be understood that it is unfossiliferous for the greatest part. The following fossils have been described from this bed:

1. *Cyrena (Batissa) crawfurdi* Noetling.
2. " " *petrolei* Noetling.
3. " " *kodoungensis* spec. nov.

Except for this local occurence the *Yenangyoungian* is absolutely unfossiliferous and even the most careful examination failed to discover any fossils, on the other hand the strata are full of gypsum. In the very centre of the anticline, and exposed for about 1320 feet in horizontal distance, forming a very flat arch, the top beds of the *Promeian*, characterized by bluish grey sandstones and blue clays, rise to the surface. The sequence of the *Promeian* has been demonstrated by the native pit-wells as well as by sections from bore holes, and so far we can say that it is composed of a series of bluish grey sandstones, often charged with either water or petroleum, separated by clunchy clays of bluish colour.

The thickness of the *Promeian* is not fully known yet; in the centre of the Anticlinal, where the beds are almost flat the drill went through upwards of 1100 feet without touching its base. The strata are generally unfossiliferous, only in the upper part, about 150 feet from the top a fossiliferous layer of small extension, containing a curiously mixed fauna of truly marine species and terrestric animals, has been found. The following species have been described from this bed, which I call zone of *Anoplotherium birmanicum*:

1. *Paracyathus caeruleus* Duncan.
2. *Pecten kokenianus* spec. nov.
3. *Lithodomus* spec.
4. *Arca bistrigata* Dunker.
5. *Dione protophilippinarum* spec. nov.
6. *Cardium cf. minbuense* spec. nov.
7. *Myliobates* spec.
8. *Carcharias gangeticus* Müller & Henle.
9. *Siluroid. gen.*
10. *Python cf. molurus* Linné.
11. *Crocodilus palustris* Less.
12. *Gharialis gangeticus* Gmelin.
13. *Anoplotherium birmanicum* spec. nov.

This list does not include all the species found, there are two more species of corals, a few more gastropoda and several species of vertebrata, but the specimens are too ill preserved to allow for even the determination of the genus. The bed contained a considerable quantity of iron pyrites, the desintegration of which destroyed the molluscan shells, while the vertebrata are generally very badly rolled.

The section in the Yenangyoung Anticline is there fore as follows:

Pliocene.	Irrawaddi-Series.			Thickness. 4620 feet.
Upper Miocene.	Pegu-Division.	Yenangyoungian.	8. Zone of *Cyrena crawfurdi*.........	20 feet.
			7. Unfossiliferous olive coloured clays containing gypsum..............	1080 "
Lower Miocene.		Promeian.	6. Unfossiliferous bluish clays and sandstones incl. 1st oilsand...........	150 "
			5. Zone of *Anoplotherium birmanicum*..	0 " 4"
			4. Unfossiliferous, bluish clays and sandstones incl. 2nd oilsand..........	50 "
			3. Bluish clay.....................	20 "
			2. Unfossiliferous sand (4nd oilsand)..	30 "
			1. A series of alternating sandstones and clays of bluish colour, containing several petroliferous beds......	850 "

c. *Singu.*

The little village of Singu, 518 miles north of Rangoon, is situated on the left bank of the Irrawaddi, Lat. 21° 5′ North and Long. 94° 51′ E., near the eastern end of the cross channel, which the Irrawaddi has dug through the *Pegu* and *Irrawaddi*-series exposing one of the finest sections through the Upper Tertiary beds that can be seen in Burma.

The stratá form an unsymmetrical anticlinal arch, the eastern side of which is the shorter; in the centre the *Yenangyoungian* is exposed and the western side is mostly composed of the *Irrawaddi*-series extending in western direction as far as Silemyo and exhibiting a thickness of not less than 20,000 feet.

The late Mr. Grimes has measured a good section about three miles south of Singu, and I shall combine here his, with my own observations. Marching from Singu in western direction the beds of the *Irrawaddi*-series will first be met with along the bank of a little stream, dipping at a very high angle in eastern direction; the dip lessens and gradually conglomeratic beds containing fragments of fossil bones are met with, which indicate the base of the *Irrawaddi*-series. Immediately below and apparently conformably follows the *Yenangyoungian*, characterised by a series of olive coloured clays with intercalated strings of harder sandstone. According to the late Mr. Grimes these beds for which the name Singu-shales would be appropriate, are unfossiliferous up to a thickness of 1450 feet from the top.

The highest fossiliferous bed met with, is a band of calcareous sandstone of brown colour, containing a few ill preserved specimens of *Cardita tjidamarensis* K. Martin.

Below this bed follow some more unfossiliferous beds of greenish colour measuring about 100 feet in thickness, after which one of the most important beds is met with. This is a very hard glauconitic sandstone of bluish green or dark green colour, containing a rich fauna; the shells are generally well preserved and shine out beautifully in their white lustre from the surrounding bluish green matrix. From the frequency of *Mytilus nicobaricus* Chemn. I termed it zone of *Mytilus nicobaricus*, and the species described from this horizon are given in the following list:

1. *Paracyathus caeruleus* Duncan.
2. *Lima protosquamosa* spec. nov.
3. *Pecten irravadicus* spec. nov.
4. *Vulsella lingualigris* spec. nov.
5. *Mytilus nicobaricus* Chemnitz.
6. *Modiola buddhaica* spec. nov.
7. " *pseudobuddhaica* spec. nov.
8. *Arca bistrigata* Reeve.
9. *Cardita viquesneli* d'Arch. & Haime.
10. " *planicosta* spec. nov.
11. " *cf. mutabilis* d'Arch. & Haime.
12. *Crassatella dieneri* spec. nov.
13 *Cardium minbuense* spec. nov.
14. *Meiocardia metavulgaris* spec. nov.
15. *Dione protolilacina* spec. nov.
16. " *amygdaloides* spec. nov.
17. " *protophilippinarum* spec. nov.
18. *Tellina grimesi* spec. nov.
19. *Gari deuterokingi* spec. nov.
20. *Corbula rugosa* Sowerby.
21. *Dentalium junghuhni* K. Martin.
22. *Calliostoma blanfordi* Noetling.
23. *Basalissa lorioliana* spec. nov.
24. *Solarium maximum* Phillipi.
25. *Turritella simplex* Jenkins.
26. *Siliquaria spec* 2.
27. *Calyptraea rugosa* Noetling.
28 *Natica obscura* Sowerby.
29. *Sigaretus neritoideus* Linne.
30. *Cypraea granti* d'Arch. & Haime.
31. *Galeodea monilifera* spec. nov.
32. *Ficula theobaldi* Noetling.
33 *Pyrula bucephala* Lamarck.
34. " *pseudobucephala* spec. nov.
35. *Oliva rufula* Duclos.
36. *Genota irravadica* Noetling.
37. *Clavatula fulminata* Kiener.
38. " *protonodifera* spec. nov.
39. *Conus avaënsis* spec. nov.
40. *Callianassa birmanica* spec. nov.
41. *Oxyrhina spalanzanii* Bonaparte.
42. *Carcharias gangeticus* Müller & Henle.

Then follows a series of unfossiliferous beds of olive green colour measuring about 300 feet, and then an other fossiliferous layer, which I termed zone of *Meiocardia metavulgaris* is met with [1]). This zone is represented by a soft argillaceous sandstone of brown colour containing however a number of grains of glauconite. The lithological appearence leads to the belief that volcanic ash has greatly contributed towards its composition. Another curious feature are numerous lumps of hardened clay which prove unquestionably that previous to their imbedding they were perfectly riddled by the holes of *Lithodomus* spec. which became subsequently filled up with the surrounding matrix. Fossils are numerous, but there is no great variety and the preservation is not always the best, particularly that of the Gastropoda, the shell of which has been almost always destroyed. The following is the list of fossils described from this horizon:

1. *Paracyathus caeruleus* Duncan.
2. *Pecten irravadicus* spec. nov.
3. *Avicula suessiana* spec. nov.
4. *Vulsella linguatigris* spec. nov.
5. *Modiola buddhaica* spec. nov.
6. *Lithodomus spec.*
7. *Arca bistrigata* Reeve.
8. *Nucula alcocki* Noetling.
9. *Leda birmanica* spec. nov.
10. *Cardita scabrosa* spec. nov.
11. " *tjidamarensis* K. Martin.
12. " *viquesneli* d'Arch. & Haime.
13. " *cf. mutabilis* d'Arch. & Haime.
14. *Crassatella dieneri* spec. nov.
15. *Meiocardia metavulgaris* spec. nov.
16. *Dione protolilacina* spec. nov.
17. *Dione protophilippinarum* spec. nov.
18. *Tellina grimesi* spec. nov.
19. *Gari kingi* Noetling.
20. *Corbula rugosa* Sowerby.
21. *Calliostoma blanfordi* Noetling.
22. *Turcica protomonilifera* spec. nov.
23. *Basalissa lorioliana* spec. nov.
24. *Solarium maximum* Philippi.
25. *Cypraea granti* d'Arch. & Haime.
26. *Galeodea monilifera* spec. nov.
27. *Ficula theobaldi* Noetling.
28. *Conus avaënsis* spec. nov.
29. *Balanus tintinnabulum* Linné.
30. *Callianassa birmanica* spec. nov.
31. *Oxyrhina spalanzanii* Bonaparte.
32. *Carcharias gangeticus* Müller & Henle.

Then follows another 300 feet of unfossiliferous beds, below which there are several thin layers of hard sandstone, the surface of which is covered with numerous fossils; most of them are however in a very fragmentary state of preservation and only a few species could be specifically determined. The following is the list of fossils described from this bed, termed zone of *Dione dubiosa*:

1. *Lucina d'archiaciana* spec. nov.
2. *Dione dubiosa* Noetling.
3. *Corbula prototruncata* spec. nov.
4. *Scalaria leptopleurata* spec. nov.

Then follows another series of unfossiliferous beds measuring about 300 feet below which must come the *Promeian*, though this group is apparently nowhere exposed on the surface; the section in descending order is therefore:

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[1]) This bed is identical with the *Cypricardia*-bed of my former paper (Develop. & Subdiv of Tert. pag. 74). At the time the true generic position of *Meiocardia metavulgaris* was not known to me and misled by the shape I believed it to be a *Cypricardia*.

Pliocene.	Irrawaddi Series.			Thickness. 20,000 feet.
Upper Miocene.	Pegu Division.	Yenangyoungian.	10. *Singu* shales, unfossiliferous........	1450 feet.
			9. Zone of *Cardita tjidamarensis*......	0 〃 6″
			8. Unfossiliferous sandstone & Clay...	100 〃
			7. Zone of *Mytilus nicobaricus*.......	0 〃 6″
			6. Unfossiliferous sandstone & Clay...	300 〃
			5. Zone of *Meiocardia metavulgaris*....	1 〃
			4. Unfossiliferous sandstone & Clay...	300 〃
			3. Zone of *Dione dubiosa*............	0 〃 6″
			2. Unfossiliferous sandstone & Clay...	300 〃
Lower Miocene.		Promeian.	1. Petroliferous Sandstones and Clay, not exposed.	Unknown.

d. *Yenangyat.*

The little village of Yenangyat, Lat. 26° 6′ North, Lat. 94° 51′ East, is situated on the right bank of the Irrawaddi about 540 miles from Rangoon, at the eastern foot of the Tangyi hill range. This range is formed by an unsymmetrical Anticlinal, dipping almost vertically on its eastern, and very gently on its western side. Wherever the valleys have cut in deeply enough, the *Yenangyoungian* can be seen in the centre, while the sides are formed by the *Irrawaddi*-series.

Marching from the river bank along the Yananchoung-ravine in western direction for about 500 or 600 feet horizontally the *Irrawaddi*-series can be seen, dipping at about 70° to 80° in eastern direction. The dip slowly decreases to about 45° at a distance of 1200 feet from the river, and then suddenly changes to 7° West. Below the *Irrawaddi*-series follow olive coloured clays with interstratified beds of sandstone, sometimes very hard, sometimes rather soft. The thickness of this series seem to vary greatly owing to the extensive denudation which it underwent, previous to the deposit of the *Irrawaddi*-series. In the Yananchoung ravine I observed a thickness of about 500 feet, but the late Mr. Grimes thinks that at some localities in the Tangyi-range it is rather more. The correctness of this view must be proved by future researches. Fossils are scarce and scattered, generally ill-preserved, but apparently of marine character, no estuarine types occuring, though the upper unfossiliferous beds prove by the occurence of gypsum that they belong to the estuarine facies. A few fossils have been found about 350 feet above the base of the *Yenangyoungian* in a hard, thinly bedded sandstone, the surface of which is covered whith a perfect agglomerate of shell fragments. From the frequency of *Dione dubiosa* Noetl. this zone has received its name and the following species have been recognized:

1. *Lucina d'archiaciana* spec. nov.
2. *Dione dubiosa* Noetling.
3. *Corbula prototruncata* spec. nov.
4. *Scalaria leptopleurata* spec. nov.

The *Yenangyoungian* gradually passes into bluish coloured beds, and the zone of *Paracyathus caeruleus* Dunc., as I termed it after the most frequent species, apparently concludes this series.

The following species have been described from this horizon:

1. *Paracyathus caeruleus* Duncan.
2. *Eupsammia regalis* Alcock.
3. *Pecten irraradicus* spec. nov.
4. *Arca bistrigata* Reeve.
5. *Nucula alcocki* Noetling.
6. *Lucina pagana* spec. nov.
7. *Dione amygdaloides* spec. nov.
8. 〃 *protophilippinarum* spec. nov.
9. *Tellina hilli* Noetling.
10. *Gari kingi* Noetling.
11. *Solen* spec.
12. *Calliostoma blanfordi* Noetling
13. *Solarium maximum* Philippi.
14. *Torinia buddha* Noetling.
15. *Turritella affiniformis* spec. nov.
16. *Siliquaria* spec. 1.
17. *Calyptraea rugosa* Noetling.
18. *Natica callosa* Sowerby.
19. 〃 *obscura* Sowerby.
20. *Sigaretus neritoideus* Linnè.
21. *Cypraea granti* d'Arch & Haime.
22. *Trivia smithi* K. Martin.
23. *Ficula theobaldi* Noetling.
24. *Triton pardalis* Noetling.
25. 〃 *neastriatulus* spec. nov.
26. *Ranella prototubercularis* spec. nov.
27. *Fusus seminudus* spec. nov.
28. *Fasciolaria nodulosa* Sowerby.
29. *Murex* (?) *tchihatcheffi* d'Arch. & Haime.
30. *Voluta dentata* Sowerby.
31. *Oliva rufula* Duclos.
32. *Cancellaria pseudocancellata* spec. nov.
33. 〃 *davidsoni* d'Arch. & Haime.
34. 〃 *martiniana* spec. nov.
35. *Terebrum* spec.
36. *Surcula feddeni* Noetling.
37. *Drillia yenanensis* Noetling.
38. *Conus malaccanus* Hwass.
39. 〃 *protofurvus* spec. nov.
40. 〃 *galensis* spec. nov.
41. *Balanus tintinnabulum* Linnè.
42. *Callianassa birmanica* spec. nov.
43. *Myliobates* spec.
44. *Oxyrhina spalanzanii* Bonaparte.
45. *Carcharius gangeticus* Müller & Henle.
46. *Otolithus spec.*

Below this bed follows the monotonous series of the *Promeian* composed of bluish sandstones and clays, the former charged with petroleum; this group is known to upwards a 1000 feet without finding the base. The following would therefore represent the section in the Yananchoung ravine, though it must be understood that it probably does not exhibit the full thickness of the *Yenangyoungian*.

Pliocene.			Irrawaddi Series.	Thickness not measured.
Upper Miocene.	Pegu Division.	Yenangyoungian.	5. Unfossiliferous clays of olive colour, alternating with sandstone	150 feet.
			4. Zone of *Dione dubiosa*............	10 〃
			3. Unfossiliferous clays with hard concretions and beds of sandstone	350 〃
			2. Zone of *Paracyathus caerulens*......	10 〃
Lower Miocene.		Promeian.	1. A series of unfossiliferous sandstones frequently petroliferous, alternating with beds of clay.........	1000 feet.

e. *Chindwin District.*

I visited the Chindwin district as far back as 1889 and since that time no further survey of this remote and jungly district has been made; I examined however two fairly good sections along the Nantahin ravine and the bed of the Yu-river. My visit was however a rather hurried one and I was not able to spend much time in searching for fossils. Whether the *Yenangyoungian* is therefore really destitute of fossils as it appeared to be, or whether future researches will reveal the existence of fossiliferous beds, remains to be seen. In descending order the section is as follows.

Pliocene.		Irrawaddi Series.	20,000 feet.
Upper Miocene.	Pegu-Division.	Yenangyoungian.	3000 feet.
Lower Miocene.		Promeian.	3800 feet.

The occurence of the *Yenangyoungian* is not beyond any doubt as the lithological characters of this series are rather those of the *Promeian* viz. pepper and salt coloured sandstone, alternating with beds of bluish clay. The probability that the *Yenangyoungian* has not been deposited at all in this part of the country is by no means small. If this view be correct and the whole series were to represent the *Promeian*, an unconformity would exist between the *Promeian* and *Yenangyoungian*. This view is to some extent corroborated by observations in the Yenangyoung oilfield, where a local overlap of the *Yenangyoungian* has been noticed. It requires however a good deal of further researches before this question can be finally decided.

f. *Correlation of the different sections.*

In the following table I tried to correlate the first five sections omitting that of the Chindwin district for not giving a sufficient amount of detail. Each section is drawn to scale of thickness in order to show the position, the fossiliferous horizons hold in the sequence of strata. In explanation a few words must however be said, otherwise an erroneous idea might be concieved. The table does not show the correlation of the different fossiliferous horizons, and does not pretend to do so. Each section, as already said, has been drawn to scale, that is to say the fossiliferous horizons are represented in their correct height above the base of the *Yenangyoungian*, except those of *Aricia humerosa* and *Pholas orientalis* the position of which in the sequence is not known (see above pag. 23) and their place is therefore a purely hypothetical one. The still more doubtful horizons of *Ostrea peguensis* and *Ostrea promensis* have been entirely omitted, though if my supposition is correct they ought to be shown in the Thayetmyo sandstone.

The sections have been placed next to each other, assuming at the same time that the boundary between the *Promeian* and *Yenangyoungian* represents a constant level. If this view is correct, the sections would prove better than the description, that the boundary between the *Yenangyoungian* and the *Irrawaddi*-series is a very irregular one, in other words that there exists an unconformity between the *Pegu*-division (Miocene) and the *Irrawaddi*-series (Pliocene). At places the denudation of the *Yenangyoungian* caused a considerable portion of its upper part to disappear, and though for instance the zone of *Cyrena crawfurdi* represents at present the top of the *Yenangyoungian*, it was originally much further down in the series and its high position is only an apparent one. I have dwelt on the unconformity between the two great divisions of the Tertiaries in Burma on pag. 7 & 8, and if my view be correct, the theory of an unconformity between the *Arrakan* and *Irrawaddi*-series is strongly supported by the sections.

On the other hand the regularity of the boundary between *Promeian* and *Yenangyoungian* is by no means an established fact, and I spoke above of the probability of an unconformity between the two parts of the *Pegu*-division. If such an unconformity exists and would not be a local one only, then the sections had of course to be arranged differently and the boundary between *Yenangyoungian* and *Irrawaddi*-series would not be such an extremely irregular one, as demonstrated by the sections. I wish however to say that so far the evidence is more in favour of an unconformity between *Arrakan* and *Irrawaddi*-series, than within the former itself, between *Yenangyoungian* and *Promeian*, though local overlaps unquestionably occur.

Thayetmyo, Prome.	Minbu.	Yenangyoung.	Singu.	Yenangyat.
Irrawaddi-Series.	*Irrawaddi*-Series.	*Irrawaddi*-Series.	*Irrawaddi*-Series.	*Irrawaddi*-Series.
Zone of *Turritella acuticarinata.* Thayetmyo-Sandstone. Zone of *Arca theobaldi.* Zone of *Parallelipip. prototortuosum.* Zone of *Pholas orientalis.* Zone of *Aricia humerosa.* Zone of *Cytherea erycina.*	Minbu-Shales. Zone of *Cancellaria martiniana.*	Zone of *Cyrena crawfurdi.* Twingon-Shales.	Singu-Shales. Zone of *Cardita tjidamarensis.* Zone of *Mytilus nicobaricus.* Zone of *Meiocardia metavulgaris.* Zone of *Dione dubiosa.*	Zone of *Dione dubiosa.* Zone of *Paracyathus caeruleus.*
Prome-Sandstone. (Petroliferous & Carboniferous).	Petroliferous Sandstone.	Petroliferous sandstone. Zone of *Anoplotherium birmanicum* spec. nov. Petroliferous Sandstone.	Petroliferous Sandstone.	Petroliferous Sandstone.
Sitsyahn-Shales.				

2. VERTICAL DISTRIBUTION OF THE FOSSILS.

A. *General Remarks.*

In the following table [1]) the vertical distribution of the fossils is given; for convenience sake the five horizons of lower Burma have been put together, while the remaining eight represent those of upper Burma. In the last column those fossils are enumerated the geological horizon of which is not known, but of which it is certain that they do not occur in any of the named horizons.

The sequence of the columns does therefore not exactly represent the natural sequence of the horizons, because without knowning more about the correlation in upper and lower Burma I think it better not to mix them up and to arrange a sequence which may after all be perfectly wrong. The sequence of the horizons in lower Burma is given as I believe it to be, in upper Burma the natural sequence is given, except that for reasons explained above, it is not quite certain whether the zone of *Cyrena crawfurdi* occupies really a position at the top of the *Yenangyoungian* or not.

B. *The Fauna of the Yenangyoungian.*

The contents of the above table can be condensed in the following way, the figure of first column giving the number in how many horizons a certain species occurs; in the other columns the classes showing number of species are given.

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[1]) See list of fossils pag. 44 ff.

	Anthozoa.	Echinoidea	Pelecypoda.	Gastropoda.	Crustacea.	Pisces.
13	—	—	—	—	—	—
12	—	—	—	—	—	—
11	—	—	—	—	—	—
10	—	—	1	—	—	—
9	—	—	—	—	—	—
8	—	—	—	1	1	—
7	1	—	1	1	—	—
6	—	—	4	4	1	—
5	—	—	1	—	—	—
4	1	—	4	5	—	1
3	—	—	8	9	—	1
2	1	1	19	19	—	1
1	1	1	38	57	—	2

Name of Species.	1. Zone of *Cytherea erycina* Prome.	2. Zone of *Aricia humerosa.* Thayet-myo.	3. Zone of *Pholas orientalis.* Thayet-myo.	4. Zone of *Paralleli-pipedum prototortuosum.* Kama.	5. Zone of *Arca theobaldi.* Kama.
ANTHOZOA.					
1. *Ceratotrochus alcockianus* spec. nov.	*	—	—	*	—
2. *Flabellum distinctum* Milne Edwards.	*	*	*	*	—
3. *Paracyathus caeruleus* Duncan.	—	—	—	*	*
4. *Eupsammia regalis* Alcock.	—	—	—	—	—
ECHINOIDEA.					
5. *Cidaris* spec. 1.	—	—	—	*	*
6. 〃 spec. 2.	—	—	—	—	*
7. *Clypeaster duncanianus* spec. nov.	—	—	—	—	—
PELECYPODA.					
8. *Ostrea peguensis* spec. nov.	—	—	—	—	—
9. 〃 *promensis* spec. nov.	—	—	—	—	—
10. 〃 〃 spec. nov. var.	—	—	—	—	—
11. 〃 *papyracea* spec. nov.	—	—	—	*	*
12. *Spondylus* spec.	—	*	—	—	—
13. *Lima griesbachiana* spec. nov.	—	*	—	—	—
14. 〃 *protoquamosa* spec. nov.	—	—	—	—	—
15. *Pecten protosenatorius* spec. nov.	—	—	—	—	—
16. 〃 *kokenianus* spec. nov.	*	*	*	*	*
17. 〃 *irravadicus* spec. nov.	—	—	—	—	—
18. *Avicula suessiana* spec. nov.	—	—	—	—	—
19. *Vulsella linguatigris* spec. nov.	—	—	—	*	—
20. *Mytilus nicobaricus* Chemnitz.	—	—	—	—	—
21. *Modiola buddhaica* spec. nov.	—	—	—	—	—
22. 〃 *pseudobuddhaica* spec. nov.	—	—	—	—	—
23. *Lithodomus* spec.	—	—	—	—	—
24. *Pinna* spec.	—	—	*	—	—
25. *Arca burnesi* d'Archiac & Haime.	—	—	—	*	—
26. 〃 *theobaldi* spec. nov.	—	—	—	—	*
27. 〃 *thayetensis* spec. nov.	—	—	—	—	—
28. 〃 *metabistrigata* spec. nov.	—	—	—	—	*
29. 〃 *bistrigata* Reeve.	—	—	—	—	—
30. 〃 *oldhamiana* spec. nov.	—	—	*	—	—
31. 〃 *yawensis* spec. nov.	—	—	—	*	—
32. 〃 *myoënsis* spec. nov.	—	—	—	—	*
33. 〃 *nannodes* K. Martin.	—	—	—	—	*
34. 〃 *bataviana* K. Martin.	—	—	*	—	*
35. 〃 *peethensis* d'Archiac & Haime.	—	—	*	*	—
36. *Parallelipipedum prototortuosum* spec. nov.	—	—	—	*	—

6. Zone of *Anoplotherium birmanicum.* Yenangyoung.	7. Zone of *Paracyathus caeruleus.* Yenangyat.	8. Zone of *Cancellaria martiniana.* Minbu.	9. Zone of *Dione dubiosa.* Yenangyat & Singu.	10. Zone of *Meiocardia metavulgaris.* Singu.	11. Zone of *Mytilus nicobaricus.* Singu.	12. Zone of *Cardita tjidamarensis.* Singu.	13. Zone of *Cyrena crawfurdi.* Yenangyoung.	14. Uncertain.
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Name of Species.	1. Zone of *Cytherea erycina*. Prome.	2. Zone of *Aricia humerosa*. Thayetmyo.	3. Zone of *Pholas orientalis*. Thayetmyo.	4. Zone of *Parallelipipedum prototortuosum*. Kama.	5. Zone of *Arca theobaldi*. Kama.
37. *Cucullaea protoconcamerata* spec. nov.	—	—	—	—	—
38. *Nucula alcocki* Noetling.	—	—	—	—	★
39. 〃 *phayreiana* spec. nov.	—	—	—	★	—
40. *Leda birmanica* spec. nov.	—	—	—	—	—
41. 〃 *virgo* K. Martin.	—	—	—	—	★
42. 〃 *avaënsis* spec. nov.	—	—	—	★	—
43. *Cardita scabrosa* spec. nov.	—	—	—	—	—
44. 〃 *protovariegata* spec. nov.	★	—	—	★	—
45. 〃 *tjidamarensis* K. Martin.	—	—	—	—	—
46. 〃 *viquesneli* d'Archiac & Haime.	—	★	—	★	—
47. 〃 *planicosta* spec. nov.	—	★	★	—	—
48. 〃 *cf. mutabilis* d'Archiac & Haime.	—		—	—	—
49. *Crassatella dieneri* spec. nov.	—	—	—	—	—
50. 〃 *rostrata* Lamarck.	—	★	—	—	—
51. *Lucina neasquamosa* spec. nov.	—	—	—	★	—
52. 〃 *pagana* spec. nov.	—	—	—	★	—
53. 〃 *d'archiaciana* spec nov.	—	—	—	—	—
54. *Cardium protosubrugosum* spec. nov.	—	★	—	★	—
55. 〃 *minbuense* spec. nov.	—	★	—	★	—
56. *Cyrena kodoungensis* spec. nov.	—	—	—	—	—
57. 〃 *crawfurdi* Noetling.	—	—	—	—	—
58. 〃 *petrolei* Noetling.	—	—	—	—	—
59. *Meiocardia protovulgaris* spec. nov.	—	—	★	★	—
60. 〃 *metavulgaris* spec. nov.	—	—	—	—	—
61. *Petricola incerta* spec. nov.	—	—	★	—	—
62. *Venus protoflexuosa* spec. nov.	—	—	★	—	—
63. 〃 *granosa* Sowerby.	—	—	—	—	—
64. *Cytherea erycina* Favanne.	★	—	★	★	—
65. 〃 *yomaënsis* spec. nov.	—	—	★	—	—
66. *Dione protolilacina* spec. nov.	★	—	★	★	★
67. 〃 *arrakanensis* spec. nov.	—	—	—	★	—
68. 〃 *amygdaloides* spec. nov.	—	★	★	★	★
69. 〃 *dubiosa* Noetling.	—	—	—	—	—
70. 〃 *protophilippinarum* spec. nov.	★	★	★	★	★
71. *Tapes protolirata* spec. nov.	—	—	—	—	—
72. *Dosinia protojuvenilis* spec. nov.	★	★	—	★	—
73. *Tellina grimesi* spec. nov.	★	★	★	★	★
74. 〃 *protostriatula* spec. nov.	—	—	—	★	★
75. 〃 *protocandida* spec. nov.	—	—	—	★	—
76. 〃 *indifferens* spec. nov.	—	—	—	★	—

6. Zone of *Anoplotherium birmanicum.* Yenangyoung.	7. Zone of *Paracyathus. caeruleus.* Yenangyat.	8. Zone of *Cancellaria martiniana.* Minbu.	9. Zone of *Dione dubiosa.* Yenangyat & Singu.	10. Zone of *Meiocardia metavulgaris,* Singu.	11. Zone of *Mytilus nicobaricus.* Singu.	12. Zone of *Cardita tjidamarensis.* Singu.	13. Zone of *Cyrena crawfurdi.* Yenangyoung.	14. Uncertain.
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Name of Species.	1. Zone of *Cytherea erycina.* Prome.	2. Zone of *Aricia humerosa.* Thayet-myo.	3. Zone of *Pholas orientalis.* Thayet-myo.	4. Zone of *Parallelipipedum prototortuosum.* Kama.	5. Zone of *Arca theobaldi.* Kama.
77. *Tellina foliacea* Reeve.	—	*	*	*	*
78. 〃 *hilli* Noetling.	—	*	*	*	*
79. 〃 *pseudohilli* spec. nov.	—	—	—	*	—
80. *Gari natensis* spec. nov.	—	—	—	*	—
81. 〃 *protokingi* spec. nov.	—	—	—	*	*
82. 〃 *kingi* Noetling.	—	—	—	—	—
83. 〃 *deuterokingi* spec. nov.	—	—	—	—	—
84. *Hiatula textilis* spec. nov.	—	—	—	*	—
85. *Solecurtus exsulcatus* spec. nov.	—	—	—	—	—
86. *Solen* spec.	—	—	*	—	—
87. *Mactra protoreevesii* spec. nov.	—	—	*	*	—
88. *Corbula socialis* K. Martin.	—	—	*	*	*
89. 〃 *rugosa* Sowerby.	—	—	—	—	—
90. 〃 *prototruncata* spec. nov.	—	—	—	—	*
91. *Pholas orientalis* Gmelin.	—	—	*	—	—
92. 〃 *blanfordianus* spec. nov.	—	—	*	—	—
GASTROPODA.					
93. *Dentalium junghuhni* K. Martin.	—	—	—	*	—
94. 〃 *boettgeri* spec. nov.	—	—	—	—	*
95. *Calliostoma blanfordi* Noetling.	—	—	—	—	—
96. 〃 *koenenianum* spec. nov.	—	—	—	—	*
97. *Basilissa lorioliana* spec. nov.	—	—	—	—	*
98. *Turcica protomonilifera* spec. nov.	—	—	—	—	*
99. *Trochus* spec.	*	—	—	—	—
100. *Solarium nitens* spec. nov.	—	—	*	—	—
101. 〃 *maximum* Philippi.	—	—	—	*	*
102. 〃 *coniforme* spec. nov.	—	*	—	—	—
103. *Torinia protodorsuosa* spec. nov.	—	—	—	—	*
104. 〃 *buddha* Noetling.	—	—	—	—	—
105. *Discohelix minuta* Noetling.	—	—	—	—	—
106. *Scalaria spathica* spec. nov.	—	—	—	—	—
107. 〃 *leptopleurata* spec. nov.	—	—	—	—	—
108. 〃 *birmanica* Noetling.	—	—	—	*	—
109. 〃 *irregularis* Noetling.	—	—	—	—	—
110. *Turritella simplex* Jenkins.	—	—	—	*	*
111. 〃 *acuticarinata* Dunker.	—	—	—	*	*
112. 〃 *affiniformis* spec. nov.	—	—	—	—	—
113. 〃 *leiopleurata* spec. nov.	—	—	—	*	—
114. 〃 *lydekkeri* spec. nov.	—	—	—	*	—

6. Zone of *Anoplotherium birmanicum.* Yenangyoung.	7. Zone of *Paracyathus caeruleus.* Yenangyat.	8. Zone of *Cancellaria martiniana.* Minbu.	9. Zone of *Dione dubiosa.* Yenangyat & Singu.	10. Zone of *Meiocardia metavulgaris.* Singu.	11. Zone of *Mytilus nicobaricus.* Singu.	12. Zone of *Cardita tjidamarensis.* Singu.	13. Zone of *Cyrena crawfurdi.* Yenangyoung.	14. Uncertain.
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Name of Species.	1. Zone of *Cytherea erycina.* Prome	2. Zone of *Aricia humerosa.* Thayet-myo.	3. Zone of *Pholas orientalis.* Thayet-myo.	4. Zone of *Parallelipipedum prototortuosum.* Kama.	5. Zone of *Arca theobaldi.* Kama.
115. *Turritella angulata* Sowerby.	—	—	—	—	—
116. 〃 spec.	—	—	—	★	—
117. *Vermetus javanus* K. Martin.	★	★	—	★	—
118. *Siliquaria* spec. 1.	—	—	—	—	—
119. 〃 spec. 2.	—	—	—	—	—
120. *Xenophora birmanica* spec. nov.	—	★	—	—	—
121. *Calyptraea rugosa* Noetling.	—	★	★	—	★
122. *Natica callosa* Sowerby.	★	★	—	★	★
123. 〃 *obscura* Sowerby.	★	★	★	★	★
124. 〃 *gracilior* spec. nov.	—	—	—	★	—
125. 〃 spec.	—	—	—	—	★
126. *Sigaretus neritoideus* Linné.	★	—	—	★	—
127. *Fossarus krausei* spec. nov.	—	—	—	—	★
128. *Rimella scripta* Sowerby spec.	—	—	—	—	★
129. *Cypraea granti* d'Arch. & Haime.	—	—	—	—	—
130. *Aricia humerosa* Sowerby spec.	—	★	—	—	—
131. *Trivia smithi* K. Martin.	—	—	—	—	—
132. *Cassis d'archiaciana* Noetling.	—	—	—	—	—
133. *Semicassis protojaponica* spec. nov.	—	—	—	—	—
134. *Galeodea monilifera* spec. nov.	—	—	—	—	★
135. *Oniscidia minbuensis* Noetling.	—	—	—	—	—
136. *Ficula theobaldi* Noetling.	—	—	—	—	—
137. 〃 spec.	—	—	—	★	—
138. *Triton neastriatulus* spec. nov.	—	—	—	—	—
139. 〃 *pardalis* Noetling.	—	—	—	—	★
140. 〃 *neacolubrinus* spec. nov.	—	—	—	—	★
141. *Persona gautama* spec. nov.	—	—	—	—	★
142. *Ranella prototubercularis* spec. nov.	—	—	—	★	★
143. 〃 *elegans* Beek.	★	★	—	★	—
144. *Eburna protozeylanica* spec. nov.	★	—	—	—	★
145. *Fusus seminudus* spec. nov.	—	—	—	—	—
146. 〃 *verbeeki* K. Martin.	—	★	—	—	—
147. *Fasciolaria nodulosa* Sowerby.	—	—	—	—	—
148. *Pyrula pugilina* Born spec.	★	—	—	—	—
149. 〃 *bucephala* Lamarck.	—	—	—	—	—
150. 〃 *pseudobucephala* spec. nov.	—	—	—	—	—
151. *Murex arrakanensis* Noetling.	—	—	—	—	—
152. 〃 (?) *tchihatcheffi* d'Arch. & Haime.	—	—	—	—	—
153. *Marginella scripta* Reeve.	—	—	—	—	★
154. *Volvaria birmanica* Noetling.	—	—	—	—	—

6. Zone of *Anoplotherium birmanicum*. Yenangyoung.	7. Zone of *Paracyathus caeruleus*. Yenangyat.	8. Zone of *Cancellaria martiniana*. Minbu.	9. Zone of *Dione dubiosa*. Yenangyat & Singu.	10. Zone of *Meiocardia metavulgaris*. Singu.	11. Zone of *Mytilus nicobaricus*. Singu.	12. Zone of *Cardita tjidamarensis*. Singu.	13. Zone of *Cyrena crawfurdi*. Yenangyoung.	14. Uncertain.
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Name of Species.	1. Zone of *Cytherea erycina.* Prome.	2. Zone of *Aricia humerosa.* Thayetmyo.	3. Zone of *Pholas orientalis.* Thayetmyo.	4. Zone of *Parallelipipedum prototortuosum.* Kama.	5. Zone of *Arca theobaldi.* Kama.
155. *Voluta ringens* spec. nov.	—	—	—	—	—
156. 〃 *dentata* Sowerby.	—	—	—	—	—
157. *Oliva rufula* Duclos.	—	*	—	*	*
158. *Ancillaria cf. vernedei* Sowerby.	*	*	*	—	—
159. *Cancellaria neavolutella* spec. nov.	—	—	—	—	*
160. 〃 *inornata* spec. nov.	—	—	—	—	*
161. 〃 *pseudocancellata* spec. nov.	—	—	—	—	—
162. 〃 *davidsoni* d'Arch. & Haime	—	—	—	—	—
163. 〃 *martiniana* spec. nov.	—	—	—	—	—
164. *Strioterebrum protomyuros* spec. nov.	—	—	—	—	*
165. 〃 *unicinctum* spec. nov.	—	—	—	—	*
166. 〃 *bicinctum* K. Martin.	—	—	—	—	*
167. *Terebrum protoduplicatum* spec. nov.	—	—	—	—	*
168. 〃 *smithii* K. Martin.	—	—	—	—	—
169. 〃 spec.	—	—	—	—	—
170. *Subula* spec.	*	*	—	—	—
171. *Pleurotoma karenaica* spec. nov.	—	—	—	—	*
172. *Surcula feddeni* Noetling.	—	—	—	—	*
173. *Genota irravadica* Noetling.	—	—	—	—	—
174. *Clavatula munga* spec. nov.	—	—	—	*	—
175. 〃 *fulminata* Kiener.	—	—	—	—	—
176. 〃 *protonodifera* spec. nov.	—	—	—	—	—
177. *Drillia yenanensis* Noetling.	—	—	—	—	—
178. 〃 *protointerrupta* spec. nov.	—	—	—	—	*
179. 〃 *promensis* spec. nov.	—	—	—	—	*
180. 〃 *protocincta* spec. nov.	—	—	—	—	*
181. *Conus literatus* Linné.	—	*	—	—	—
182. 〃 *malaccanus* Hwas.	—	—	—	—	—
183. 〃 *avaënsis* spec. nov.	*	*	*	*	*
184. 〃 *yuleianus* spec. nov.	—	*	—	*	—
185. 〃 *hanza* spec. nov.	—	—	—	*	—
186. 〃 *protofurvus* spec. nov.	—	—	—	*	—
187. 〃 *galensis* spec. nov.	—	—	—	—	—
188. *Ringicula turrita* K. Martin.	—	—	—	*	—
CRUSTACEA.					
189. *Balanus tintinnabalum* Lin.	*	*	—	*	*
190. *Callianassa birmanica* spec. nov.	—	—	—	*	*
191. *Calappa protopustulosa* spec. nov.	—	—	—	—	—
192. *Ebalia sixtuberculata* spec. nov.	—	—	—	—	—

6. Zone of *Anoplotherium birmanicum.* Yenangyoung.	7. Zone of *Paracyathus caeruleus.* Yenangyat.	8. Zone of *Cancellaria martiniana.* Minbu.	9. Zone of *Dione dubiosa.* Yenangyat & Singu.	10. Zone of *Meiocardia metavulgaris.* Singu.	11. Zone of *Mytilus nicobaricus.* Singu.	12. Zone of *Cardita tjidamarensis.* Singu.	13. Zone of *Cyrena crawfurdi.* Yenangyoung.	14. Uncertain.
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Name of Species.	1. Zone of *Cytherea erycina*. Prome.	2. Zone of *Aricia humerosa*. Thayet-myo.	3. Zone of *Pholas orientalis*. Thayet-myo.	4. Zone of *Parallelipipedum prototortuosum*. Kama.	5. Zone of *Arca theobaldi*. Kama.
193. *Neptunus* spec.	—	—	—	—	—
194. *Cancer* spec.	—	—	—	—	—
PISCES.					
195. *Oxyrhina pagoda* spec. nov.	—	—	—	—	—
196. 〃 *spallanzanii* Bon.	—	—	—	—	—
197. *Alopias vulpes* Gmel.	—	—	—	—	—
198. *Carcharodon megalodon* Agass.	—	—	—	—	—
199. *Hemipristis serra* Agass.	—	—	—	—	—
200. *Galeocerdo* spec.	—	—	—	—	—
201. *Carcharias gangeticus* M. & H.	—	—	—	—	—
202. *Myliobates* spec.	—	—	—	—	—
203. *Otolithus* spec.	—	—	—	—	—
204. *Siluroid* gen.	—	—	—	—	—
REPTILIA.					
205. *Python cf. molurus* Linne.	—	—	—	—	—
206. *Crocodilus palustris* Less.	—	—	—	—	—
207. *Gharialis gangeticus* Gmel.	—	—	—	—	—
MAMMALIA.					
208. *Anoplotherium birmanicum* spec. nov.	—	—	—	—	—

6. Zone of *Anoplotherium birmanicum.* Yenangyoung.	7. Zone of *Paracyathus caeruleus.* Yenangyat.	8. Zone of *Cancellaria martiniana.* Minbu.	9. Zone of *Dione dubiosa.* Yenangyat & Singu.	10. Zone of *Meiocardia metavulgaris.* Singu.	11. Zone of *Mytilus nicobaricus.* Singu.	12. Zone of *Cardita tjidamarensis.* Singu.	13. Zone of *Cyrena crawfurdi.* Yenangyoung.	14. Uncertain.
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This table shows at once what a small number of species possess a large vertical range, while the majority are known to occur in one or two horizons only. The small number of species other than Pelecypoda and Gastropoda renders them of very inferior importance and if they are disregarded in the following discussion, such an omission will not materially affect the result.

The vertical distribution of the Pelecypoda and Gastropoda will be better understood if instead of the actual number, we represent it in percents of the total. These figures are computed in the following table:

	Pelecypoda.	Gastropoda.	Pelecypoda + Gastropoda.
13	—	—	—
12	—	—	—
11	—	—	—
10	1.30 %	—	0.58 %
9	—	—	—
8	—	1.04 %	0.58 %
7	1.31 %	1.04 %	1.16 %
6	5.24 %	4.16 %	4.64 %
5	1.31 %	—	0.58 %
4	5.24 %	5.20 %	5.22 %
3	10.48 %	9.36 %	9.86 %
2	24.89 %	19.76 %	22.04 %
1	49.78 %	59.28 %	55.10 %

These figures prove as distinctly as possible that the vertical range of the majority of species is a very short one; over one half of the number of mollusca occur in one horizon only; 22.04 % that is two say less than one quarter, occur in two horizons, and from there the percentage rapidly decreases; 15.08 % occur in three and four horizons, and only 7.54 % are known to occur in five und more horizons. Those which might perhaps be considered as the guide fossils for the *Yenangyoungian* are the following:

1. *Dione protophilippinarum* spec. nov.	occurs	in	10	different	horizons.
2. *Natica obscura* Sow.	〃	〃	8	〃	〃
4. *Conus avaënsis* spec. nov.	〃	〃	7	〃	〃
3. *Tellina grimesi* spec. nov.	〃	〃	7	〃	〃
5. *Pecten kokenianus* spec. nov.	〃	〃	6	〃	〃
6. *Dione protolilacina* spec. nov.	〃	〃	6	〃	〃
7. *Dione amygdaloides* spec. nov.	〃	〃	6	〃	〃

8.	*Tellina hilli* Noetl.	occurs	in	6	different	horizons.
9.	*Solarium maximum* Phil.	"	"	6	"	"
10.	*Calyptraea rugosa* Noetl.	"	"	6	"	"
11.	*Oliva rufula* Duclos	"	"	6	"	"
12.	*Natica callosa* Sow.	"	"	6	"	"
13.	*Arca bistrigata* Dunker	"	"	5	"	"

To this list we may add the following species:

14.	*Paracyathus caeruleus* Dunc.	occurs	in	7	different	horizons.
15.	*Balanus tintinnabulum* Lin.	"	"	8	"	"
16.	*Callianassa birmanica* spec. nov.	"	"	6	"	"

bringing the total number of species which have been found in more than four horizons up to 16. This is a very insignificant number which amounts to not more than 8.2 °/₀ of the total described from the *Yenangyoungian*. If we examine the value of the different species we see that out of the whole number only five, viz.

Paracyathus caeruleus Dunc.
Tellina grimesi spec. nov.
Tellina hilli Noetl.
Solarium maximum Phil.
Callianassa birmanica spec. nov.

are such species which can always be unmistakeably recognized; the remaining eight exhibit more or less indifferent features, that is to say unless very well preserved, a small change which would constitute a different species, is not noticed.

The great faunistic difference between two horizons, which are not far distant from each other in the vertical sequence is exceedingly well illustrated by the two following instances.

I have dwelt on pag. 22 & 23 on the stratigraphical position of the zones of *Parallelipipedum prototortuosum* spec. nov. and *Arca theobaldi* spec. nov. the following table shows the vertical distribution of the fossi's in these two horizons.

	Common to both.	Only occuring in the zone of *Parallelipipedum prototortuosum.*	Only occuring in the zone of *Arca theobaldi.*
Anthozoa....	1	2	nil.
Echinoidea ..	1	1	nil.
Pelecypoda ..	11	23	8
Gastropoda ..	8	15	26
Crustacea....	2	nil.	nil.

It will be seen that out of a total of 98 speeies only 23 (= 23.46 °/₀) occur in both horizons, the majority of these species being Pelecypoda, and if we examine them we see that 7 belong to the above mentioned group which occur in more than four horizons. On the other hand the zone of *Parallelipipedum prototortuosum* spec. nov. contains 41 species (= 41.82 °/₀) which do not occur in the zone of *Arca theobaldi* spec. nov. the majority of this group being again Pelecypoda, while the zone of *Arca theobaldi* spec. nov. contains 34 (= 34.68 °/₀) species the majority of which are Gastropoda which do not occur in the zone of *Parallelipipedum prototortuosum* spec. nov.

Not less instructive is the comparison of the zones of *Meiocardia metavulgaris* spec. nov. and *Mytilus nicobaricus* Reeve, which as we have seen on pag. 35 are separated by 300 feet of intermediate beds. The vertical distribution of their fauna is shown in the following list.

	Common to both horizons.	Only occuring in the zone of *Meiocardia metavulgaris*.	Only occuring in the zone of *Mytilus nicobaricus*.
Anthozoa....	1	—	—
Echinoidea ..	—	—	—
Pelecypoda ..	12	7	7
Gastropoda ..	7	1	12
Crustacea ...	1	—	—
Pisces	1	—	1

Out of a total of 50, 22 (= 44 °/₀) species are common to both horizons the majority of which are again Pelecypoda and again mostly the same species which occur in more than four horizons. The zone of *Meiocardia metavulgaris* spec. nov. contains 8 (= 16 °/₀) species which do not occur in the zone of *Mytilus nicobaricus* Reeve while this zone is characterised by 20 (= 40 °/₀) not found in the lower bed.

In the following table these figures are arranged a little more distinctly; there are:

	Common to both horizons.	Characteristic for each horizon.
Zone of *Parallelipipedum prototortuosum.*	33.46 %	41.82 %
Zone of *Arca theobaldi.*		34.68 %
Zone of *Meiocardia metavulgaris.*	44.00 %	16.00 %
Zone of *Mytilus nicobaricus.*		40.00 %

If it is permitted to take the average of there figures we may say that out of a given number of species occurring in two different horizons of the *Yenangyoungian* 33.73 % will be common to both, while each horizon contains 33.12 % which are characteristic of it. It must however be understood that the chronological difference must not be too great; it will be seen at once if we compare the zones of *Mytilus nicobaricus* and *Parallelipipedum prototortuosum* which have only 12 species or 12.61 % in common.

The result of this discussion is, that under favourable circumstances, when there is no great vertical difference between two horizons the proportion of species common to both may be about 33.73 %, but when there is a great vertical distance, perhaps also a wide horizontal one, the proportion may be 12.61 % at the outside and can even sink below this figure, while the species characteristic for each horizon can be 34.18 % in the average but may rise as high as 74.78 %. Each horizon appears therefore to contain a small number of species which it shares with the neighbouring beds, a still smaller number having a wider range, while the largest number of species is represented by such which are characteristic for it. *It is obvious that under these circumstances the fossils are of very small correlative value* and if we would attempt to correlate the different horizons here distinguished by means of their fauna, not even a fairly accurate result would be obtained.

The limited horizontal distribution may also to some extent be responsible for the small number of species two horizons which occur in the same position in the sequence, but at different localities, have in common.

We can therefore conclude that in the *Yenangyoungian* a series of rapidly changing faunas of very limited horizontal range is preserved. Only a very few species which at the same time had a wider horizontal distribution persisted, but it also appears that a few species may be common to two horizons holding a different position in the sequence without being found in the intermediate beds. Under favourable circumstances a fauna thrived at one locality over a short horizontal distance; for reasons irrelevantly which, the majority of the species died out and in the next higher bed we find at the same locality a perfectly different fauna containing only a few species of the earlier one. Such changes can only be explained by the supposition that the younger fauna immigrated from somewhere else to the place of the older one, only to be replaced in its own turn by an other fauna. This unsettled state of the fauna of the *Yenangyoungian* will be further confirmed by certain pecularities of the Pelecypoda (pag. 78).

C. *The Fauna of the Promeian.*

A few words are sufficient to deal with the fauna of the zone of *Anoplotherium birmanicum* spec. nov. The invertebrates are all such species which it shares in common with the zones of *Paracyathus caeruleus* Dun. and *Cancellaria martiniana* spec. nov., thus proving unmistakeably the faunistic relationship with the *Yenangyoungian*. In fact the few species that have been recognized are chiefly such that occur in more than four horizons.

On the other hand the vertebrata, with the exception of the fishes, have not been found in any higher bed yet. Whether they occur in older horizons of the *Promeian* I am unable to say, but if it were permitted to form a conclusion from the absolutely unfossiliferous samples of the bore-holes, the answer would be negative. It is however certain that the horizontal range of the zone of *Anoplotherium birmanicum* spec. nov. is a very limited one, no trace of it having been found in any of the neighbouring pit-wells, and the abscence of fossiliferous beds in the drilled bore holes might after all be only an apparent one. Whether therefore other fossiliferous horizons will in future be discovered in the *Promeian* or not, cannot be stated with certainty, but the probability is in favour of such a view, particularly when the strata of the *Prome*-sandstone will be carefully searched. The little we know however about the fauna of the *Promeian* proves that it exhibits the same features as that of the *Yenangyoungian* viz. a limited vertical and horizontal range.

3. COMPOSITION OF THE FAUNA.

A. *General Remarks.*

After the determination of the species had progressed for a certain time, I soon noticed that the fauna was composed of very different elements, a view which might have been anticipated considering its geological and geographical position. A priorî we might have expected species related to such of the Eocene of India-Burma, and others more or less related to those inhabiting the Indian ocean; we might have further expected species identical with the Tertiary beds of Western India, others identical with those of Java-Sumatra, and to judge from the results Professor Martin arrived at from the study of the Tertiary fossils of Java, it would have been very strange, if a relationship with the Miocene of Europe existed.

However, in order not to prejudice my mind by autosuggestion I carefully refrained from taking notice of any such observation, that might agree with these views, while the determination was progressing, trying to take as impartial an opinion of each species as possible, and I think I have in this way avoided the danger of determining the species under the impression of a previously fixed idea. After the determination had been completed the various notes were collected and they proved to be of unusual interest.

I have described 181 species of Pelecypoda and Gastropoda (= $88._8\ ^0/_0$) of total fauna of the *Yenangyoungian*, of which 14 only could not be determined specifically. These species are therefore omitted from the following discussion, and for obvious reasons the Anthozoa, Echinoidea and Vertebrata have also been disregarded. The remaining 167 species of Pelecypoda and Gastropoda can be divided into two classes viz:

a. Species representing types which do not exist among the fauna of the Indian ocean; this class would therefore represent the „extinct'' species with reference to the fauna of the Indian ocean, but for reasons presently seen I reject this term and propose the name of *Palaeogene* species for this group.

b. Species which are either identical with species inhabiting the Indian ocean, or which in some way or other could be referred to such species; the term *Neogene* species is suggested for this group.

a. *Palaeogene Species.*

I very soon discovered that the palaeogene species do by no means represent a harmonious group, but are made up of various, rather heterogenous elements, and four distinct classes could be discerned.

Of a large number of species no relatives, either fossil or living, could be traced and it is very probable that this group represents the *indigenous* element, that is to say species which are either direct descendants of species occuring in the Eocene of India-Burma, or have their nearest relatives in the same formation. How far this view is correct can only be ascertained after the Eocene fauna of India-Burma is fully known.

A second though smaller group, being about one third of the number of the former, exhibited the closest relationship with species occuring in the Eocene of Paris. I term this group *Gallic* types.

The third group which is about half the number of the first is closely related to species which according to our present knowledge do not inhabit the Indian ocean, but live in China, Japan, the Philippine Istands and Australia. The term *Pacific* types is used for this group.

The fourth and smallest group represents species the relatives of which live neither in the Indian ocean nor in the pacific province, but appear to be limited to the Mediterranean, and *Mediterranean* types would be an appropriate term for this group.

The fifth group containing a single species only which could not be classified, is of course only a makeshift, which would disappear if the characters of this species were better known.

b. *Neogene Species.*

Three groups could be distinguished in this class, though they are not as sharply defined as those of the Palaeogene species. In several instances it was somewhat doubtful to which class a certain species should be assigned, and much is left to personal opinion and palaeontological tact, when such doubtful cases have to be decided.

The first group represents those species which are *identical* with species inhabiting the Indian ocean, their number is about one third of that of the indigenous types.

The second group includes those which for reasons presently explained, could not be considered as exactly identical with species inhabiting the Indian ocean; these are the *subidentical* species, their number being about the same as that of the identical species.

The third and smallest group represents those species which unquestionably represent a permanent juvenile stage of species inhabiting the Indian ocean; they may be called *evolutionary* species.

The fourth group includes all those which for some reason or other could not be included in one of the former groups; it is like the last group of the palaeogene species only a makeshift which would disappear were the species better known.

If we assume the number of indigenous types to be 100 the proportion by which the other groups contribute towards the composition of the fauna would be as follows:

1.	Indigenous types........	100
2.	Gallic types............	37
3.	Pacific types...........	50
4.	Mediterranean types......	3
5.	Identical species.........	30
6.	Subidentical species......	30
7.	Evolutionary species......	13

On the following pages I intend to discuss these seven groups firstly from a purely palaeontological, and secondly from the geological point of view. No mention will therefore be made of the geological distribution in the first part and the fauna will be considered as a whole; in the second part the geological occurence is also considered.

B. *Palaeontological Considerations.*

a. *Palaeogene Species.*

1. *Indigenous types.* The following is the list of species of which no relatives, either living or fossil, could be traced, and which for this reason are assumed to be species which have the closest relationship with species occuring in the Eocene of India and Burma. This view is corroborated by an other observation; a glance through the list will show that only 7 out of the total of 62 species occur in Java, the remainder has so far not been observed outside India or Burma. Pelecypoda and Gastropoda contribute in unequal shares to make up the total, though the latter are with 37 species not much in excess of the former with 25 species, at least as regards absolute numbers, yet if computed in percents we see that the Gastropoda form exactly 60 °/₀ and the Pelecypoda only 40 °/₀. We shall see later on that this disproportion between the two classes occurs more frequently and a theory to explain it will be given.

1. *Ostrea peguensis* spec. nov.
2. *Lima griesbachiana* spec. nov.
3. *Vulsella linguatigris* spec. nov.
4. *Modiola buddhaica* spec. nov.
5. 〃 *pseudobuddhaica* spec. nov.
6. *Arca oldhamiana* spec. nov.
7. 〃 *yawensis* spec. nov.
8. 〃 *myöënsis* spec. nov.
9. 〃 *nannodes* K. Martin.
10. 〃 *peethensis* d'Arch. & Haime.
11. *Nucula phayreiana* spec. nov.
12. *Leda birmanica* spec. nov.
13. 〃 *virgo* K. Martin.
14. 〃 *avaënsis* spec. nov.
15. *Cardita viquesneli* d'Arch. & Haime.
16. *Cardita planicosta* spec. nov.
17. *Lucina d'archiaciana* spec. nov.
18. *Cardium minbuense* spec. nov.
19. *Petricola incerta* spec. nov.
20. *Cytherea yomaënsis* spec. nov.
21. *Dione arrakanensis* spec. nov.
22. *Dione amygdaloides* spec. nov.
23. 〃 *dubiosa* Noetl.
24. *Hiatula textilis* spec. nov.
25. *Corbula rugosa* Sow.
26. *Dentalium boettgeri* spec. nov.
27. *Calliostoma blanfordi* Noetling.
28. *Calliostoma koenenianum* spec. nov.
29. *Basilissa lorioliana* spec. nov.
30. *Solarium coniforme* spec. nov.
31. *Torinia buddha* Noetl.
32. *Scalaria leptopleurata* spec. nov.
33. 〃 *irregularis* Noetl,
34. *Turritella simplex* Ienk.
35. 〃 *affiniformis* spec. nov.
36. *Cypraea granti* Sow.
37. *Aricia humerosa* Sow. spec.
38. *Trivia smithi* K. Martin.
39. *Cassis d'archiaciana* Noetl.
40. *Galeodea monilifera* spec. nov.
41. *Oniscidia minbuensis* Noetl.
42. *Ficula theobaldi* Noetl.
43. *Triton pardalis* Noetl.
44. *Persona gautama* spec. nov.
45. *Fusus verbeeki* K. Martin.
46. *Murex arrakanensis* d'Arch. & Haime.
47. *Murex* (?) *tchichatcheffi* d'Arch. & Haime.
48. *Voluta ringens* spec. nov.
49. *Cancellaria inornata* spec. nov.
50. *Cancellaria martiniana* spec. nov.
51. *Terebrum unicinctum* spec. nov.
52. *Terebrum bicinctum* spec. nov.
53. *Terebrum smithi* K. Martin.
54. *Pleurotoma karenaica* spec. nov.
55. *Surcula feddini* Noetl.
56. *Genota irravaddica* Noetl.
57. *Clavatula munga* spec. nov.
58. *Drillia yenanensis* Noetl.
59. 〃 *promensis* spec. nov.
60. *Conus yuleianus* spec. nov.
61. 〃 *galensis* spec. nov.
62. *Ringicula turrita* K. Martin.

There is nothing more to be said about this group except that it will be of great importance when the fauna of the lower Tertiaries of India will be examined.

2. *Gallic types.* This group contains the following 23 species, all of which bear a very strong resemblance to species occuring in the Eocene of Paris without being however directly identical with any of them. The grade of relationship could not be ascertained because for such a purpose a large collection of fossils from the Eocene of Paris would be required. It is however certain that it varies a good deal; in some instances like *Triton neastriatulus*

spec. nov. it is difficult to discover any difference at all while in others the difference is more marked. Of a few species it could not be decided to which species it is nearest related to, in such a case the two species have been mentioned. The following is the list of Gallic types and their nearest relatives.

Name of species.	Name of nearest relative.	Reference.
1. *Ostrea promensis* spec. nov.	*Ostrea multicostata* Desh. *Ostrea flabellula* Lmk.	Desh. Coq. Pl. LVII fig. 3, 4, 5, 6. Desh. Coq. Pl. LXIII fig. 5, 6, 7.
2. 〃 *papyracea* spec. nov.	*Ostrea simplex* Desh.	Desh. Coq. Pl. LVII fig. 7; pl. LIX fig. 11, 12; pl. LX fig. 3, 4.
3. *Pecten kokenianus* spec. nov.	*Pecten reconditus* Sol.	Wood, Eoc. Moll. pl. IX fig. 3, a-d.
4. 〃 *irravadicus* spec. nov.	*Pecten lucidus* Phil.	Desh. Anim. pl. LXXIX fig. 15, 16.
5. *Lucina pagana* spec. nov.	*Lucina squamula* Desh.	Desh. Coq. pl XVII fig. 17, 18.
6. 〃 *neasquamosa* spec. nov.	*Lucina squamosa* Lmk.	Desh. Coq. pl. XVII fig. 12, 13, 14.
7. *Tellina grimesi* spec. nov.	*Tellina sinuata* Lmk.	Desh. Coq. pl. XI fig, 15, 16.
8. *Solarium nitens* spec. nov.	*Solarium picteti* Desh. *Solarium bistriatum* Desh.	Desh. Anim. pl. XL fig. 32, 33, 34. Desh. Coq. pl. XXV fig. 19, 20.
9. *Scalaria spathica* spec. nov.	*Scalaria multilamella* Desh.	Desh. Coq. pl. XXII fig. 15, 16.
10. *Turritella acuticarinata* Dnk.	*Turritella fasciata* Lmk.	Desh. Coq. pl. XXXIX fig. 1—20; pl. XXXVIII fig. 13, 14, 17, 18.
11. *Turritella leiopleurata* spec. nov.	〃 *dixoni* Desh.	Desh. Anim. pl. XIV fig. 12, 13.
12. *Turritella lydekkeri* spec. nov.	〃 *sulcifera* Desh.	Desh. Coq. pl. XXXV fig. 5, 6. pl. XXXVI fig. 3, 4. pl. XXXVII fig. 19, 20.
13. *Turritella angulata* Sow.	〃 *carinifera* Desh.	Desh. Coq. pl. XXXVI fig. 1, 2.
14. *Vermetus javanus* K. Martin.	*Siliquaria multistriata* Deft.	Desh. Anim. pl. X fig. 1, 2.
15. *Fossarus krausei* spec. nov.	*Nerita pentastoma* Desh.	Desh. Coq. pl. XIX fig. 13, 14. Desh. Anim. pl. LXVI fig. 7, 8, 9.
16. *Triton neastriatulus* spec. nov.	*Triton striatulus* Lmk sp.	Desh. Coq. pl. LXXX fig. 13, 14, 15.
17. *Triton neacolubrinus* spec. nov.	〃 *colubrinus* Lmk.	Desh. Coq. pl. LXXX fig. 22, 23, 24.
18. *Fusus seminudus* spec. nov.	*Fusus conjunctus* Desh.	Desh. Coq. pl. LXX fig. 16, 17.
19. *Volvaria birmanica* Noetl.	*Volvaria acutiuscula* Sow.	Desh. Coq. pl. XCV fig. 7, 8, 9.
20. *Voluta dentata* Scw.	*Voluta mutata* Desh.	Desh. Coq. pl. XCII fig. 1, 2.
21. *Cancellaria neavolutella* spec. nov.	*Cancellaria volutella* Lmk.	Desh. Coq. pl. LXXIX fig. 19, 20, 21.
22. *Cancellaria davidsoni* d'Arch. & Haime.	〃 *evulsa* Sol.	Desh. Coq. pl. LXXIX fig. 27, 28.
23. *Conus avaënsis* spec. nov.	*Conus diversiformis* Desh.	Desh. Coq. pl. XCVIII fig. 9, 10, 11, 12.

The most remarkable feature of this fauna is the preponderance of the Gastropoda which come to more than double the number of the Pelecypoda, a fact which is the more curious, because if the total of the Palaeogene species is considered Pelecypoda and Gastropoda contribute almost the same share. The occurence of the „Gallic types" in the fauna of the *Yenangyoungian* is of the greatest interest and the question how we are to account for this remarkable feature is not easy to answer. Two theories only are possible.

We may assume that the Eocene fauna had a very large geographical range, that is to say, the same fauna occured simultaneously in the Eocene of France and India. This theory finds a strong support in some facts we know about the Eocene fauna of India, however few they may be. I myself described the remarkable occurence of *Velates schmiedeliana* Chemn. spec. from Burma and I dwelt on its wide geographical distribution, over an enormous area ranging, roughly speaking from Long 0° E. to Long 94° E. [1]) Messrs. d'Archiac and Haime mention quite a number of species of *Nummulites* as identical with those from France. On the other hand Messrs Duncan and Sladen have arrived at the conclusion that the Anthozoa and Echinoidea of the *Ranikotian* and *Khirtharian* are distinctly different from those of the Eocene of Europe. These views being in direct opposition, it would be useless to speculate any more as to the character of the Indian Eocene fauna; this question will only be solved by its actual examination, and the results are sure to be more reliable than those arrived at, by any kind of argumentation. I may however say, that it would appear very strange if an identical fauna existed in France and India during the Eocene period, at a time, when most probably already well defined geographical provinces existed.

The second theory is based on the migration of species; we may suppose that the fauna which lived during the Eocene period in France gradually migrated in eastern direction, and that during this migration, which took place in horizontal as well as in vertical direction, that is to say, from West towards East, and from the Eocene to the Miocene, the species underwent certain changes and they eventually assumed the shape in which they occur in the Miocene of Burma. Though distinctly different from their

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[1]) Record. Geolog. Survey of India 1894; vol. XXVII pt. 3 pag. 106.

Eocene ancestors they still preserve sufficiently of their features to give them the hall mark of their European Eocene home.

This theory is in direct opposition to that of Semper [1]) who holds that during the Eocene period an oceanic current run from India to Europe, and I think he supposes that a migration of species took place in the direction of this current, that is to say just the opposite way, as I assume. I do not wish to enter here into a discussion of Dr. Sempers theory, but I think that the data available with regard to the fauna of the Indian Eocene, on which I think Dr. Sempers theory is chiefly based, are not reliable enough to built on such a far reaching theory. It fully corroborates however Jenkins [2]) view, who I believe was the first, who promulgated the theory of an eastern migration of European species in order to explain the relationship of the Fauna of the Indian ocean with the Miocene of Europe. The only difference is the proof that this migration began earlier than assumed by Jenkins. My theory, on the other hand, assuming a migration in Eastern direction is supported by some exceedingly good facts. We shall presently see that a strong relationship exists between the fauna of the *Yenangyoungian* and that of China, Japan and the Philippines, but more important is the observation with regard to the relationship of two species viz. *Lucina pagana* spec. nov. and *Lucina neasquamosa* spec. nov.

Lucina pagana represents unquestionably the nealogic stage of *Lucina philippinarum* Reeve; a species which apparently does not occur in the Indian ocean, but only eastwards of Singapore as far as the Philippines. On the other hand, *Lucina pagana* bears the closest relationship to *Lucina squamula* Desh. from the Eocene of Paris.

Perhaps still better proved is the relationship between *Lucina squamosa* Lmk. *Lucina neasquamosa* spec. nov. and *Lucina venusta* Reeve. *Lucina neasquamosa* spec. nov. is so similar to *Lucina squamosa* Lmk. from the Eocene of Paris that it is almost difficult to discover any differences; on the other hand is this species so similar to *Lucina venusta* Reeve, from the Philippines, that the relationship of these two species is out of question.

Both species indicate therefore a migration from West to East which has been going on since the Eocene to the recent period and the follow diagram will illustrate this view.

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[1]) Zeitschr. d. Deutsch. Geolog. Gesell. 1896; vol. XLVIII pag. 310.

[2]) Quarterly Journ. Geolog. Soc. of London 1864 vol. XX pag. 62.

	France.	Burma.	Philippines.	France.	Burma.	Philippines.
Recent...	—	—	*Lucina philippinarum.*	—	—	*Lucina venusta.*
Miocene..	—	*Lucina pagana.*	—	—	*Lucina neasquamosa.*	—
Eocene...	*Lucina squamula.*	—	—	*Lucina squamosa.*	—	—

A further proof for this theory is given by the genus *Basilissa;* this genus which has hitherto only been known from the recent fauna of Japan and the Eocene of Paris is unmistakeably represented by *Basilissa lorioliana* spec. nov. in Burma.

If a certain genus X which has hitherto been known to occur in two countries A and C only, in two vertically succeeding beds A′ and C′ is suddenly found in an other country B half way between A and C in a bed B′ which holds an intermediate position between A′ and C′, the notion that this genus X migrated, from A to C′, ascending at the same time in vertical direction from A′ to C′ is well founded.

The facts here recorded are fully in harmony with the known similarity between the Eocene of France and the recent fauna of Japan. In fact according to this view, one ought to have expected the occurence of species related to such from the Eocene of Paris and others related to such from the China-Japanese seas in the Miocene of Burma.

It is perhaps this observation, though not the recognition of the Gallic element in the Miocene fauna of Java and Sumatra which let Boettger to assume the views expressed in his memoir [1]). It would certainly be exceedingly interesting if the Miocene fauna of Java and Sumatra would be examined in order to ascertain, whether the Gallic element exists as I believe, or whether no such relationship can be traced.

3. *Pacific types.* The species included in this group amounting to 31 in all [2]) are characterised by a great relationship to species inhabiting the western part of the Pacific ocean from Japan to Australia, but which apparently do not occur among the fauna of

[1]) Boettger, Tertiärformation von Sumatra. Palaeontographica Suppl. 1880.

[2]) The true absolute figure would only be 29 because *Lucina pagana* spec. nov. and *Lucina neasquamosa* spec. nov. which have already been counted among the Gallic types appear again in this group.

the Indian ocean, and though „recent" species to some degree, are „extinct" with reference to the fauna of the Indian ocean. The degree of relationship varies a good deal, some species are only distinguished by a smaller shell and a more delicate ornamentation from their living relatives, others represent unquestionably permanent juvenile stages, while others are most probably the direct ancestors from which certain species living now in the above region have evolved. These species are:

Name of species.	Name of nearest relative.	Reference.
1. *Avicula suessiana* spec. nov.	*Avicula electrina* Reeve. Moluccas.	Reeve. Mon. of *Avicula* pl. XVI fig. 6?.
2. *Arca thayetensis* spec. nov.	*Arca gubernaculum* Reeve. Philippines.	Reeve. Mon. of *Arca* pl. X fig. 58.
	Arca japonica Reeve. Japan.	Reeve. Mon. of *Arca* pl. V fig. 32.
3. 〃 *bataviana* K. Martin.	*Arca symmetrica* Reeve. Philippines.	Reeve. Mon. of *Arca* pl. XVII fig. 117.
	Arca sculptilis Reeve. Philippines.	Reeve. Mon. of *Arca* pl. XVII fig. 118.
4. *Parallelipipedum prototortuosum* spec. nov.	*Parallelipipedum tortuosum* Lin. spec. China.	Reeve. Mon. of *Arca* pl. XIII fig. 86.
5. *Cardita scabrosa* spec. nov.	*Cardita crassicosta* Lmk. Philippines.	Reeve. Mon. of *Cardita* pl. II fig. 7.
6. 〃 *tjidamarensis* K. Martin.	*Cardita pica* Reeve. Philippines.	Reeve. Mon. of *Cardita* pl. II fig. 8.
7. *Crassatella dieneri* spec. nov.	*Crassatella jubar* Reeve. Philippines.	Reeve. Mon. of *Crassatella* pl. II fig. 11.
8. *Lucina neasquamosa* spec. nov.	*Lucina venusta* Phil. Philippines.	Reeve. Mon. of *Lucina* pl. III fig. 15.
9. 〃 *pagana* spec. nov.	*Lucina philippinarum* Hanl. Philippines.	Reeve. Mon. of *Lucina* pl. N fig. 18.
10. *Cyrena crawfurdi* Noetl. 11. 〃 *petrolei* Noetl.	*Cyrena sumatrensis* Sow. Sumatra.	Reeve. Mon. of *Cyrena* pl. XIII fig. 62.
12. *Meiocardia protovulgaris* spec. nov. 13. *Meiocardia metavulgaris* spec. nov.	*Meiocardia vulgaris* Reeve. spec. China.	Reeve. Mon. of *Isocardia* pl. I fig. 2.
14. *Venus protoflexuosa* spec. nov.	*Venus flexuosa* Lin. China.	Reeve. Mon. of *Venus* pl. XXI fig. 99.
15. *Dione protolilacina* spec. nov.	*Dione lilacina* Lmk. Australia.	Reeve. Mon. of *Dione* pl. I fig. 5.
16. *Dosinia protojuvenilis* spec. nov.	*Dosinia juvenilis* Gmel. Philippines.	Reeve. Mon. of *Artemis* pl. I fig. 5.
17. *Tellina protostriatula* spec. nov.	*Tellina striatula* Lmk. Philippines.	Reeve. Mon. of *Tellina* pl. VIII fig. 34.
18. 〃 *protocandida* spec. nov.	*Tellina candida* Lmk. China.	Reeve. Mon. of *Tellina* pl. V fig. 21.
19. 〃 *indifferens* spec. nov.	*Tellina triangularis* Chemn. China.	Reeve. Mon. of *Tellina* pl. XXV fig. 136.
20. 〃 *hilli* Noetl.	*Tellina rostrata* Lin. Philippines.	Reeve. Mon. of *Tellina* pl. XVII fig. 83.
21. 〃 *pseudohilli* spec. nov.	*Tellina rastellum* Han. Philippines.	Reeve. Mon. of *Tellina* pl. XVII fig. 85.
	Tellina planispinosa Sow. Philippines.	Reeve. Mon. of *Tellina* pl. XXXV fig. 196.
22. *Gari natensis* spec. nov.	*Gari puella* Desh. Australia.	Reeve. Mon. of *Psammobia* pl. I fig. 2.
	Gari corrugata Desh. Philippines.	Reeve. Mon. of *Psammobia* pl. II fig. 9.
23. *Solecurtus exsulcatus* spec. nov.	*Solecurtus exaratus* Phil. China.	Reeve. Mon. of *Solecurtus* pl. 1 fig. 1.

Name of species.	Name of nearest relative.	Reference.
24. *Mactra protoreevesi* spec. nov.	*Mactra reevesi* Desh. Malacea.	Reeve. Mon. of *Mactra* pl. XVII fig. 92.
25. *Pholas blanfordianus* spec. nov.	*Pholas manillae* Sow. Philippines.	Reeve. Mon. of *Pholas* pl. VIII fig. 31.
26. *Turcica protomonilifera* spec. nov.	*Turcica monilifera* Adams. Australia.	H. & A. Adams Gen. of Moll. vol. I pl. 48 fig. 3.
27. *Scalaria birmanica* Noetl.	*Scalaria delicatula* Cross. Australia.	Reeve. Mon. of *Scalaria* pl. XV fig. 115.
28. *Calyptraea rugosa* Noetl.	*Calyptraea dormitoria* Reeve. Philippines.	Reeve. Mon. of *Calyptraea* pl. II fig. 5.
29. *Semicassis protojaponica* spec. nov.	*Cassis japonica* Reeve. Japan.	Reeve. Mon. of *Cassis* pl. IX fig. 23.
30. *Conus protofurvus* spec. nov.	*Conus furvus* Reeve. Philippines.	Reeve. Mon. of *Conus* pl. XIII & XL fig. 69.
31. " *hanza* spec. nov.	*Conus sinensis* Sow. China.	Reeve. Mon. of *Conus* pl. XV fig. 76.

The disproportion of Pelecypoda and Gastropoda is the striking feature of this list, the former greatly exceeding the latter; thus just the reverse takes place as we have noticed in the Gallic types. In that group the proportion of Pelecypoda to Gastropoda was $1 : 3._{14}$ in this group it is $4._{16} : 1$. This is the more remarkable because as already stated the proportion of Pelecypoda to Gastropoda is almost 1 : 1, among the total of the Palaeogene, as well as the Neogene species.

Two species are of particular interest among the pacific types because they represent unquestionably species from which new ones have evolved; these are *Parallelipipedum prototortuosum* spec. nov. and *Meiocardia protovulgaris* spec. nov.

The first named species represents that peculiar group of contorted *Arcae* for which the rather long name of *Parallelipipedum* has been chosen; no representatives of this group are known from Europe and it seems that this genus first appears in the Miocene of Western India and Burma; it was probably very short lived in Burma but in Western India it existed apparently longer, because it occurs in the Pleistocene deposits of the Mekran coast. It must have then died out, for it is certainly not represented among the fauna of the Indian ocean but eastwards of Singapore it is now represented by the only living species, *Parallelipipedum tortuosum* Reeve. which has unquestionably evolved from the Miocene *Parallelipipedum prototortuosum* spec. nov.

A similar and not less interesting instance is that of *Meiocardia protovulgaris* spec. nov. and its descendant *Meiocardia metavulgaris* spec. nov. The genus *Meiocardia* has been established for a few peculiarly shaped species which have formerly been classified among the genus *Isocardia;* the living representatives are at present restricted to the Chinese sea, but is is very probable, that it was largely distributed in earlier periods, because many of the so called *Cypricardiae* probably belong to the genus *Meiocardia.* In Burma the oldest species is *Meiocardia protovulgaris* spec. nov. occuring in the zones of *Pholas orientalis* and *Parallelipipedum prototortuosum* this species is triangular in shape, having a rather small index, and delicate concentric striae as ornamentation; in the younger zone of *Meiocardia metavulgaris* spec. nov. the shape has become more elongate, the index therefore larger and the surface is covered with coarse concentric wrinkles. The genus seems then to have died out in India, but in Java it is represented by the pleistocene *Meiocardia subcumingii* Woodward and at present it occurs only in three species which apparently little differ from each other, and of which *Meiocardia vulgaris* Reeve is unquestionably the direct descendant of *Meiocardia protovulgaris* spec. nov. through *Meiocardia metavulgaris* spec. nov., having the same elongate shape but strong concentric ribs, instead of coarse wrinkles.

These instances are sufficient to prove the connection between the Miocene fauna of Burma and that inhabiting the Western part of the Pacific, a fact which can only be explained by the theory of migration.

4. *Mediterranean types.* This group includes a very small number of species the nearest relatives of which inhabit at present the Mediterranean and which are unquestionably not represented among the present fauna of the Indian ocean. These species are.

Name of species.	Name of nearest living relative.	Remarks.
1. *Discohelix minuta* Noetl.	*Discohelix zanclea* Phil.	No recent specimen compared.
2. *Cancellaria pseudocancellata* spec. nov.	*Cancellaria cancellata* Lmk.	Specimen compared from the Indian museum.

Both species are represented by a single specimen only, no others having been found; they appear therefore to be rather rare.

The occurence of this element is perhaps as puzzling as that of the gallic types and if a rash conclusion were drawn from the occurence of this particular group, it would be entirely wrong. One might assume that this group occuring in the Miocene of Burma, but not in the fauna of the Indian ocean, migrated from

East to West thus indicating a direction of migration fully in opposition to the one above proved, but in harmony with Dr. Semper's theory.

An other explanation can however be given which is fully in harmony with the theory here promulgated, viz. a migration from West towards East. The nearest relatives of both species occur in the Miocene of Europe; whether an Eocene ancestor of *Cancellaria tubercularis* exists, or will be found, I am unable to say, but there are certainly Eocene predecessors of *Discohelix zanclea.* If we suppose that both types existed during the Eocene period in Europe and some of their representatives migrated with other species towards East, where they died out with the end of the Miocene period, while they persisted in Europe up to the recent time, we have a perfectly satisfactory explanation for the occurence of this remarkable element in the Miocene of Burma, without being in contradiction to the conclusions arrived at from the study of other groups. The number of the Mediterranean types is unfortunately very small, but it may not be too rash a conclusion if we assume that a larger number of this group occurs in the Miocene of Western India.

5. *Species not classified.* This group calls for no further remarks; it contains a single species only, *Ostrea promensis* spec. nov. var. which is too ill preserved to allow for classification. All that can be said about this species is that it bears not similarity or relationship to any species of Ostrea living in the Indian ocean and represents perhaps a Gallic type.

b. *Neogene Species.*

1. *Identical species.* This group includes only such species which after a careful examination could be pronounced to be identical with species inhabiting the Indian ocean. The list is rather a meagre one giving only 19 species, which show an almost equal proportion of Pelecypoda and Gastropoda, the latter being slightly in excess of the former.

Name of species.	Reference.	Recent specimen compared from.
1. *Mytilus nicobaricus* Chemn.	Reeve. Mon. of *Mytilus* pl. IX fig. 42.	No recent specimen compared.
2. *Arca bistrigata* Dunk.	—	Indian Museum.
3. *Crassatella rostrata* Lmk.	Reeve. Mon. of *Crassatella* pl. II fig. 10.	do.
4. *Venus granosa* Sow.	—	do.
5. *Cytherea erycina* Fav.	Reeve. Mon. of *Dione* pl. I fig. 3.	do.
6. *Tellina foliacea* Lin.	Reeve. Mon. of *Tellina* pl. III fig. 11.	do.
7. *Pholas orientalis* Gmel.	Reeve. Mon. of *Pholas* pl. II fig. 5.	do.
8. *Dentalium junghuhni* K. Martin.	*Dentalium magnificum* (Authors name not stated).	do.
9. *Solarium maximum* Phil.	Reeve. Mon. of *Solarium* pl. I fig. 4.	do.
10. *Sigaretus neritoideus* Linn.	Reeve. Mon. of *Sigaretus* pl. I fig. 5.	do.
11. *Rimella crispata* Sow.	Reeve. Mon. of *Rostellaria* pl. III fig. 8.	do.
12. *Ranella elegans* Beek.	Reeve. Mon. of *Ranella* pl. V. fig. 1.	do.
13. *Pyrula pugilina* Born. spec.	Reeve. Mon. of *Pyrula* pl. I fig. 1.	do.
14. 〃 *bucephala* Lmk. spec.	Reeve. Mon. of *Pyrula* pl. VII fig. 24.	No recent specimen compared.
15. *Marginella scripta* Hinds.	Reeve. Mon. of *Marginella* pl. XIV fig. 58.	Indian Museum.
16. *Oliva rufula* Ducl.	Reeve. Mon. of *Oliva* pl. XX fig. 50.	do.
17. *Clavatula fulminata* Kien.	Reeve. Mon. of *Pleurotoma* pl. V fig. 37.	do.
18. *Conus literatus* Linn.	Reeve. Mon. of *Conus* pl. XXXIII fig. 183.	do.
19. 〃 *malaccanus* Hwass.	Reeve Mon. of *Conus* pl. X fig. 49.	do.

2. *Subidentical species.* This group contains roughly speaking all those which are neither exactly identical, nor represent an evolutionary stage of recent species, but which are so similar to species inhabiting the Indian ocean, that there can be no doubt as to their representing their Miocene ancestors.

The relationship in which these species stand to their living descendants is rather a peculiar one, the recent species cannot be called a variety of the fossil one, nor is it a new species which has evolved from the former one. As for a variety the features are too different and as for a new species they are too similar. The difference may best be characterised as follows: In the Miocene we have a small shell with a delicate ornamentation, in the recent fauna we have exactly the same characters but the whole is transformed into the coarse so to speak, the shell has become larger and the ornamentation stronger. The term „mutatio" might perhaps be applied to this group.

In other instances like that of *Gari protokingi* spec. nov. —

Gari kingi Noetl. — *Gari deuterokingi* spec. nov. — *Gari caerulescens* Reeve which represent a perfect line of evolution from the zone of *Parallelipipedum prototortuosum* spec. nov. to the present time it is certain that by a gradual change a new species has evolved from an older one. There is no doubt as to the difference of *Gari protokingi* spec. nov. and *Gari caerulescens* Reeve. yet both species are intimately connected by the intermediate species of *Gari kingi* Noetl. and *Gari deuterokingi* spec. nov.

It is unfortunate that no definite rules can be given as to the delimitation of both subgroups, because too much must be left to personal opinion. Two authors might perfectly disagree as to what is considered a new species or a mutatio only, or even whether two species are identical or not. The line here taken expresses of course my personal opinion and others may differ from it, yet I think that the mutatios greatly exceed the new species among this group.

Pelecypoda and Gastropoda contribute almost evenly towards its composition, there being 10 of the former and nine of the latter. The following is the list of subidentical species.

Name of species. [1]	Name of nearest recent relative.	Reference.
1. *Lima protosquamosa* spec. nov.	*Lima squamosa* Lamk.	Reeve. Mon. of *Lima* pl. II fig. 10.
2. *Cucullaea protoconcamerata* spec. nov.	*Cucullaea concamerata* Lmk.	Reeve. Mon. of *Cucullaea* pl. I fig. 1.
3. *Nucula alcocki* Noetl.	*Nucula cumingi* Hinds.	Reeve Mon. of *Nucula* pl. I fig. 5.
4. *Cardita protovariegata* spec. nov.	*Cardita variegata* Beug.	Reeve. Mon. of *Cardita* pl. I fig. 3.
5. *Dione protophilippinarum* spec. nov.	*Dione philippinarum* Han.	Reeve. Mon. of *Cytherea* pl. X fig. 47.
6. *Tapes protolirata* spec. nov.	*Tapes lirata* Phil. spec.	Reeve. Mon. of *Tapes* pl. V fig. 20.
7. *Gari protokingi* spec. nov.		
8. 〃 *kingi* Noetl.	*Gari caerulescens* Lmk.	Reeve. Mon. of *Psammobia* pl. VIII fig. 60.
9. 〃 *deuterokingi* spec. nov.		
10. *Corbula socialis* K. Martin.	*Corbula crassa* Hinds.	Reeve. Mon. of *Corbula* pl. I fig. 8.
11. *Torinia protodorsuosa* spec. nov.	*Solarium dorsuosum* Sow.	—
12. *Natica obscura* Sow.	*Natica lineata* Lmk.	Reeve. Mon. of *Natica* pl. VII fig. 24.
13. *Eburna protozeylanica* spec. nov.	*Eburna zeylanica* Lmk.	Reeve. Mon. of *Eburna* pl. I fig. 8.
14. *Fasciolaria nodulosa* Sow.	*Fasciolaria filamentosa* Martini.	Reeve. Mon. of *Fasciolaria* pl. II fig. 4.
15. *Pyrula pseudobucephala* spec. nov.	*Pyrula bucephala* Lmk.	Reeve. Mon. of *Pyrula* pl. VII fig. 24.
16. *Strioterebrum protomyuros* spec. nov.	*Terebra myuros* Lmk.	Reeve. Mon. of *Terebra* pl. VIII fig. 31.
17. *Terebrum protoduplicatum* spec. nov.	*Terebra duplicata* Lin. spec.	Reeve. Mon. of *Terebra* pl. I fig. 3.
18. *Drillia protointerrupta* spec. nov.	*Drillia interrupta* Lmk.	Reeve. Mon. of *Pleurotoma* pl. VII fig. 51.
19. *Drillia protocincta* spec. nov.	*Drillia cincta* Lmk.	Reeve. Mon. of *Pleurotoma* pl. XII fig. 99.

[1]) All these species have been compared with specimens from the Indian Museum.

3. *Evolutionary species.* This small but interesting group includes such species which were recognized with certainty to represent permanent juvenile stages of recent species. So far it seems that they all exhibit about the same stage of evolution, not that one species represents a more advanced stage than the other; this question is however not finally settled yet. The total number of species belonging to this group, is small, there being not more than eight; the following is the list:

Name of species. [1])	Name of nearest recent relative.	Reference.
1. *Pecten protosenatorius* spec. nov.	*Pecten senatorius* Gmel.	Reeve. Mon. of *Pecten* pl. XXXIV fig. 159.
2. *Arca burnesi* d'Arch. & Haime.	*Arca granosa* Lin.	Reeve. Mon. of *Arca* pl. III fig. 15.
3. 〃 *theobaldi* spec. nov.		
4. 〃 *metabistrigata* spec. nov.	*Arca bistrigata* Dunk.	—
5. *Cardium protosubrugosum* spec. nov.	*Cardium subrugosum* Sow.	Reeve. Mon. of *Cardium* pl. XI fig. 55.
6. *Corbula prototruncata* spec. nov.	*Corbula truncata* Sow.	—
7. *Ranella prototubercularis* spec nov.	*Ranella tubercularis* Lmk.	—
8. *Clavatula protonodifera* spec. nov.	*Pleurotoma nodifera* Lmk.	Reeve. Mon. of *Pleurotoma* pl. IV fig. 28.

Meagre as this list is it seems certain that the number of Pelecypoda is far greater than that of the Gastropoda, the proportion being 75 : 25. If we recollect that a similar proportion existed between the Pelecypoda and Gastropoda of the Pacific species where the ratio was 75 : 18 it is perhaps not too rash to suppose that the Pelecypoda of the Miocene formation were probably in a stage of transformation while the Gastropoda represented a more stabile element.

4. *Species not classified* this group is represented by a very small number of species only viz.

1. *Cyrena kodoungensis* spec. nov.
2. *Xenophora birmanica* spec. nov.
3. *Natica callosa* Sow.
4. 〃 *gracilior* spec. nov.

These species have probably living relatives among the fauna of the Indian ocean but owing to the indifference of their features caused by the state of preservation they could not be brought in relation with any given species, but appeared to be related to

[1]) All these species have been compared with specimens from the Indian Museum.

quite a number. Better preserved specimens will perhaps in future allow for their classification.

c. *Summary of Palaeontological considerations.*

The following table will give in a convenient arrangement the chief results of the above considerations, at least as far as they can be expressed by figures; the left hand part contains the absolute number of species contained in each group, the first column gives the total of Pelecypoda and Gastropoda while in the second and third, each class is given separately. In adding up the figures it will be seen that in the first and second column the total number of 169 and 82 exceeds that of the actual number 167 and 80 by two. This is accounted for by the two species *Lucina neasquamosa* spec. nov. and *Lucina pagana* spec. nov. being mentioned twice, once among the gallic and the second time among the pacific types.

The right hand part of contains the percentage each of the six groups contributes towards the composition of the fauna. In the first column the total of Pelecypoda and Gastropoda is given, in the second and third each class sparately.

		Absolute Number.			In percents.		
		Total.	Pelecypoda.	Gastropoda.	Total.	Pelecypoda.	Gastropoda.
Palaeogene Species.	Species of which no relatives, either living or fossil could be traced. (*Indigenous types*).	62	25	37	36.2 %	31.25 %	42.35 %
	Species of which the nearest relatives occur in the Eocene of Paris. (*Gallic types*).	23	7	16	13.8 %	8.75 %	18.40 %
	Species of which the nearest relatives live at present in China, Japan, Philippines, Australia. (*Pacific types*).	31	25	6	18.6 %	31.25 %	6.90 %
	Species of which the nearest relatives live at present in the Mediterranean. (*Mediterranean types*).	2	—	2	1.2 %	—	2.30 %
	Species which could not be classified.	1	1	--	0.6 %	1.25 %	—
Neogene Species.	Species which are *identical* with species living in the Indian ocean.	19	7	12	11.4 %	8.75 %	13.80 %
	Species which are *subidentical* with species living in the Indian ocean.	19	10	9	11.4 %	12.50 %	10.35 %
	Species representing a permanent *evolutionary* stage of species living in the Indian ocean.	8	6	2	4.8 %	7.50 %	2.30 %
	Species which could not be classified.	4	1	3	2.4 %	1.25 %	3.45 %

Though these figures are in themselves instructive enough their value will be better realized from the following diagram, in which the percents have been entered from the bottom to the top, while the groups are given from left to right. The first curve represents that of the total of Pelecypoda and Gastropoda, the second and third one, that of the Pelecypoda and Gastropoda separately.

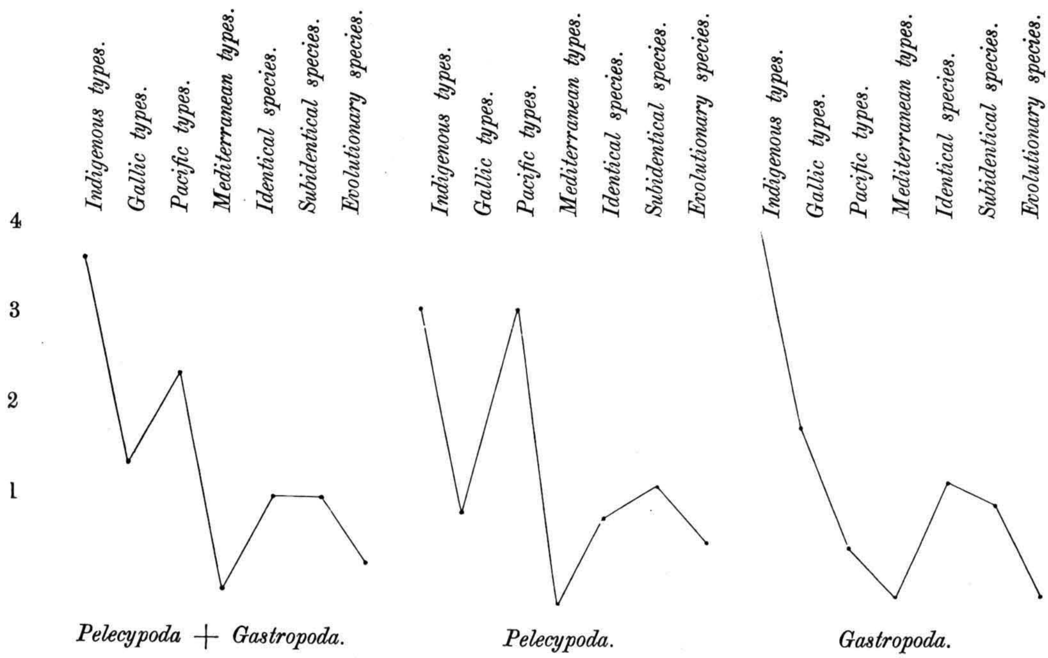

Fig. 1.

The curve of composition, as it may be called, is very instructive; we see at the first glance the great difference that exists in the composition of the Gastropoda and Pelecypoda by the different shape of the curve, we also notice that this difference is solely caused by the composition of the Palaeogene species, represented by the left part of the curve, while the right part, which represents the Neogene species is very similar in both classes, thus indicating a very similar composition of the Neogene class of the Pelecypoda and Gastropoda.

If we compare the curves of the Pelecypoda and Gastropoda with that expressed by the total of both classes, the striking similarity between this curve and that of the Pelecypoda is evident. The Pelecypoda have therefore impressed their stamp on the curve notwithstanding that both classes are represented by almost equal numbers (80 and 87) the Gastropoda being even slightly in excess.

We have now to inquire what reason caused this difference? As already stated the composition of the Palaeogene species accounts for it, and the reason is clearly visible; it is the small number of Gallic, and the large number of pacific types, which causes the bulging out of the curve. The Pelecypoda having thus influenced the curve of composition we must endeavour to ascertain the nature of this influence, which I think can be found in the rapidly changing character of the Pelecypoda while the Gastropoda represent a more stabile element, which is subject to a much smaller degree of alteration.

This view is fully supported by figures; out of a total of 80 species of Pelecypoda not more that 7 (= 8.75 °/₀) or if we add to this the number of mutatios with 7, 14 species (= 17.50 °/₀) can be considered as identical with species inhabiting the Indian ocean. In a strange contrast stands the large figure of those which are not absolutely identical with recent species; this group is composed of the palaeogene, the evolutionary and the small number of subidentical species represented by *Gari protokingi*, *Gari kingi* and *Gari deuterokingi* aggregating to 66 species (= 82.50 °/₀).

If we examine the Gastropoda we see that 21 species (= 24.15 °/₀) of the total are identical with living species while the remainder of 63 (= 72.25 °/₀) is represented by the non-identical species.

These figures may perhaps not be very convincing, as they do not reveal the true facts, which are better shown if we take the pacific and evolutionary species together, as the former can certainly be considered as a modification of the latter, in being represented by recent species, though occuring outside the Indian ocean and then compare Pelecypoda and Gastropoda. The number of Pelecypoda is 31 (= 38.75 °/₀), while the same group is only represented by 8 Gastropoda (= 9.20 °/₀). If we compare with these figures the number of species identical with living ones viz 14 species (= 17.5 °/₀) of Pelecypoda and 21 species (= 24.15 °/₀) of Gastropoda the contrast becomes evident. We may therefore assume, that while the Gastropoda remained fairly stabile, the Pelecypoda were subject to great changes; a large number died out, a good number migrated into foreign seas, being differently affected and modified during this process; a small number gradually evolved new characters, a still smaller number producing new species, while only a few did not change and persisted in an unaltered state, from the Miocene to recent times.

In the next table I have still more summarized the results by adding together the different groups composing the palaeogene and neogene species. This table would therefore represent those species which would formerly have been summarily called „extinct" and „recent" species, and the figures would have to be used when determining the age of the *Yenangyoungian* by means of Lyell's rule.

The left hand part of the table contains the actual number of species, the right hand part the percents, Pelecypoda and Gastropodo being again taken in total and separately.

	Absolute number.			In percents.		
	Total.	Pelecypoda.	Gastropoda.	Total.	Pelecypoda.	Gastropoda.
Palaeogene Species...	117	56	61	70.4 °/₀	70.0 °/₀	70.0 °/₀
Neogene Species.....	50	24	26	30.0 °/₀	30.0 °/₀	30.0 °/₀
	167	80	87	100.4 °/₀	100.0 °/₀	100.0 °/₀

These figures give the very interesting result, that whatever their composition may be the total of the Palaeogene and Neogene species is represented in both, the Pelecypoda and Gastropoda, by the same proportion viz. 70 : 30. This harmony of figures seems to prove that whatever cause may have influenced certain groups of either Pelecypoda or Gastropoda, both classes taken as a whole stand in the same relation to the present fauna of the Indian ocean, by containing 30 °/₀ of species which are more or less the same as species inhabiting this region nowadays.

C. *Vertical distribution of the different groups of Palaeogene and Neogene species.*

In the following tables the vertical distribution of the different groups of fossils has been given and the results of this investigation are again condensed in the last three tables, the first of which gives the absolute number of species, the second the percents and the third the number and percents of palaeogene and neogene species; all these tables give the total of Pelecypoda and Gastropoda, because a division into both classes does not appear to give any new results.

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parall. prototortuosnm.*	Zone of *Arca theobaldi.*	Zone of *Anoploth. birmanicum.*	Zone of *Parac. caeruleus.*	Zone of *Canc. martinima.*	Zone of *Dione dubiosa.*	Zone of *Meio. metavulgaris.*	Zone of *Mytil. nicobaricus.*	Zone of *Card. tjidamarensis.*	Zone of *Cyrena crawfurdi.*	*Uncertain.*
1. INDIGENOUS SPECIES.														
1. *Ostrea peguensis* spec. nov.	—	—	—	—	—	—	—	—	—	—	—	—	—	★
2. *Lima griesbachiana* spec. nov.	—	★	—	—	—	—	—	—	—	—	—	—	—	—
3. *Vulsella linguatigris* spec. nov.	—	—	—	★	—	—	—	—	—	★	★	—	—	—
4. *Modiola buddhaica* spec. nov.	—	—	—	—	—	—	—	—	—	★	★	—	—	—
5. 〃 *pseudobuddhaica* spec. nov.	—	—	—	—	—	—	—	—	—	—	★	—	—	—
6. *Arca oldhamiana* spec. nov.	—	—	★	—	—	—	—	—	—	—	—	—	—	—
7. 〃 *yawensis* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
8. 〃 *myoënsis* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
9. 〃 *nannodes* K. Martin.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
10. 〃 *peethensis* d'Arch. & Haime.	—	—	★	★	—	—	—	—	—	—	—	—	—	—
11. *Nucula phayreiana* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
12. *Leda birmanica* spec. nov.	—	—	—	—	—	—	—	—	—	★	—	—	—	—
13. 〃 *virgo* K. Martin.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
14. 〃 *avaënsis* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
15. *Cardita viquesneli* d'Arch. & Haime.	—	★	—	★	—	—	—	—	—	★	★	—	—	—
16. 〃 *planicosta* spec. nov.	—	★	★	—	—	—	—	—	—	—	★	—	—	—
17. *Lucina d'archiaciana* spec. nov.	—	—	—	—	—	—	—	—	★	—	—	—	—	—
18. *Cardium minbuense* spec. nov.	—	★	—	★	—	—	—	—	—	—	★	—	—	—
19. *Petricola incerta* spec. nov.	—	—	★	—	—	—	—	—	—	—	—	—	—	—
20. *Cytherea yomaënsis* spec. nov.	—	—	★	—	—	—	—	—	—	—	—	—	—	—
21. *Dione arrakanensis* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
22. 〃 *amygdaloides* spec. nov.	—	★	★	★	★	—	★	—	—	—	★	—	—	—
23. 〃 *dubiosa* spec. nov.	—	—	—	—	—	—	—	★	★	—	—	—	—	—
24. *Hiatula textilis* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
25. *Corbula rugosa* Sow.	—	—	—	—	—	—	—	—	—	★	★	—	—	—
26. *Dentalium boettgeri* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
27. *Calliostoma blanfordi* Noetling.	—	—	—	—	—	—	★	★	—	★	★	—	—	—
28. 〃 *koenenianum* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
29. *Basilissa lorioliana* spec. nov.	—	—	—	—	★	—	—	—	—	★	★	—	—	—
30. *Solarium coniforme* spec. nov.	—	★	—	—	—	—	—	—	—	—	—	—	—	—
31. *Torinia buddha* Noetling.	—	—	—	—	—	—	★	★	—	—	—	—	—	—
32. *Scalaria leptopleurata* spec. nov.	—	—	—	—	—	—	—	—	★	—	—	—	—	—
33. 〃 *irregularis* Noetl.	—	—	—	—	—	—	—	★	—	—	—	—	—	—
34. *Turritella simplex* Ienkins.	—	—	—	★	★	—	—	—	—	—	★	—	—	—
35. 〃 *affiniformis* spec. nov.	—	—	—	—	—	—	—	★	★	—	—	—	—	—
36. *Cypraea granti* Sow.	—	—	—	—	—	—	★	★	—	★	★	—	—	—

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parall. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoploth. birmanicum.*	Zone of *Parac. caeruleus.*	Zone of *Canc. martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meio. metavulgaris.*	Zone of *Mytil. nicobaricus.*	Zone of *Card. tjidamarensis.*	Zone of *Cyrena crawfurdi.*	*Uncertain.*
37. *Aricia humerosa* Sow. spec.	—	★	—	—	—	—	—	—	—	—	—	—	—	—
38. *Trivia smithi* K. Martin.	—	—	—	—	—	—	★	—	—	—	—	—	—	—
39. *Cassis d'archiaci* Noetl.	—	—	—	—	—	—	—	★	—	—	—	—	—	—
40. *Galeodea monilifera* spec. nov.	—	—	—	—	★	—	—	—	—	★	★	—	—	—
41. *Oniscidia minbuensis* Noetl.	—	—	—	—	—	—	—	★	—	—	—	—	—	—
42. *Ficula theobaldi* Noetl.	—	—	—	—	—	—	★	★	—	★	★	—	—	—
43. *Triton pardalis* Noetl.	—	—	—	—	★	—	★	★	—	—	—	—	—	—
44. *Persona gautama* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
45. *Fusus verbecki* K. Martin.	—	★	—	—	—	—	—	—	—	—	—	—	—	—
46. *Murex arrakanensis* spec. nov.	—	—	—	—	—	—	—	★	—	—	—	—	—	—
47. *Murex* (?) *tchihatcheffi* d'Arch. & Haime.	—	—	—	—	—	—	★	—	—	—	—	—	—	—
48. *Voluta ringens* spec. nov.	—	—	—	—	—	—	—	★	—	—	—	—	—	—
49. *Cancellaria inornata* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
50. 〃 *martiniana* spec. nov.	—	—	—	—	—	—	★	★	—	—	—	—	—	—
51. *Terebrum unicinctum* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
52. 〃 *bicinctum* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
53. 〃 *smithi* K. Martin.	—	—	—	—	—	—	—	★	—	—	—	—	—	—
54. *Pleurotoma karenaica* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
55. *Surcula feddeni* Noetl.	—	—	—	—	★	—	★	★	—	—	—	—	—	—
56. *Genota irravadica* Noetl.	—	—	—	—	—	—	—	★	—	—	★	—	—	—
57. *Clavatula munga* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
58. *Drillia yenanensis* Noetl.	—	—	—	—	—	—	★	—	—	—	—	—	—	—
59. 〃 *promensis* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
60. *Conus yuleianus* spec. nov.	—	★	—	★	—	—	—	—	—	—	—	—	—	—
61. 〃 *galensis* spec. nov.	—	—	—	—	—	—	★	—	—	—	—	—	—	—
62. *Ringicula turrita* K. Martin.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
2. GALLIC TYPES.														
1. *Ostrea promensis* spec. nov.	—	—	—	—	—	—	—	—	—	—	—	—	—	★
2. 〃 *papyracea* spec. nov.	—	—	—	★	★	—	—	—	—	—	—	—	—	—
3. *Pecten kokenianus* spec. nov.	★	★	★	★	★	★	—	—	—	—	—	—	—	—
4. 〃 *irravadicus* spec. nov.	—	—	—	—	—	—	★	★	—	★	★	—	—	—
5. *Lucina pagana* spec. nov.	—	—	—	★	—	—	★	—	—	—	—	—	—	—
6. 〃 *neasquamosa* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
7. *Tellina grimesi* spec. nov.	★	★	★	★	★	—	—	—	—	★	★	—	—	—
8. *Solarium nitens* spec. nov.	—	—	★	—	—	—	—	—	—	—	—	—	—	—
9. *Scalaria spathica* spec. nov.	—	—	—	—	—	—	—	★	—	—	—	—	—	—

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parall. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoploth. birmanicum.*	Zone of *Parac. caeruleus.*	Zone of *Canc. martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meio. metavulgaris.*	Zone of *Mytil. nicobaricus.*	Zone of *Card. tjidamarensis.*	Zone of *Cyrena crawfurdi.*	*Uncertain.*
10. *Turritella acuticarinata* Dunk.	—	—	—	★	★	—	—	—	—	—	—	—	—	—
11. 〃 *leiopleurata* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
12. 〃 *lydekkeri* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
13. 〃 *angulata* Sow.	—	—	—	—	—	—	—	—	—	—	—	—	—	★
14. *Vermetus javanus* K. Martin.	★	★	—	★	—	—	—	—	—	—	—	—	—	—
15. *Fossarus krausei* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
16. *Triton neastriatulus* spec. nov.	—	—	—	—	—	—	★	—	—	—	—	—	—	—
17. 〃 *neacolubrinus* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
18. *Fusus seminudus* spec. nov.	—	—	—	—	—	—	★	★	—	—	—	—	—	—
19. *Volvaria birmanica* Noetl.	—	—	—	—	—	—	—	★	—	—	—	—	—	-
20. *Voluta dentata* Sow.	—	—	—	—	—	—	★	★	—	—	—	—	—	—
21. *Cancellaria neavolutella* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
22. 〃 *davidsoni* d'Arch.	—	—	—	—	—	—	★	★	—	—	—	—	—	—
23. *Conus avaënsis* spec. nov.	★	★	★	★	★	—	—	—	—	★	★	—	—	—
3. Pacific types.														
1. *Avicula suessiana* spec. nov.	—	—	—	—	—	—	—	—	—	★	—	—	—	—
2. *Arca thayetensis* spec. nov.	—	—	—	—	—	—	—	—	—	—	—	—	—	★
3. 〃 *bataviana* K. Martin.	—	—	★	—	★	—	—	—	—	—	—	—	—	—
4. *Parallelipipedum prototortuosum* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
5. *Cardita scabrosa* spec. nov.	—	—	—	—	—	—	—	—	—	★	—	—	—	—
6. 〃 *tjidamarensis* K. Martin.	—	—	—	—	—	—	—	—	—	★	—	★	—	—
7. *Crassatella dieneri* spec. nov.	—	—	—	—	—	—	—	—	—	★	★	—	—	—
8. *Lucina neasquamosa* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
9. 〃 *pagana* spec. nov.	—	—	—	★	—	—	★	—	—	—	—	—	—	—
10. *Cyrena crawfurdi* Noetl.	—	—	—	—	—	—	—	—	—	—	—	—	★	—
11. 〃 *petrolei* Noetl.	—	—	—	—	—	—	—	—	—	—	—	—	★	—
12. *Meiocardia protovulgaris* spec. nov.	—	—	★	★	—	—	—	—	—	—	—	—	—	—
13. 〃 *metavulgaris* spec. nov.	—	—	—	—	—	—	—	—	—	★	★	—	—	—
14. *Venus protoflexuosa* spec. nov.	—	—	★	—	—	—	—	—	—	—	—	—	—	—
15. *Dione protolilacina* spec. nov.	★	—	★	★	★	—	—	—	—	★	★	—	—	—
16. *Dosinia protojuvenilis* spec. nov.	★	★	—	★	—	—	—	—	—	—	—	—	—	—
17. *Tellina protostriatula* spec. nov.	—	—	—	★	★	—	—	—	—	—	—	—	—	—
18. 〃 *protocandida* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
19. 〃 *indifferens* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
20. 〃 *hilli* Noetl.	—	★	★	★	★	—	★	★	—	—	—	—	—	—
21. 〃 *pseudohilli* spec. nov.	—	—	—	—	—	—	—	—	—	—	—	—	—	—

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parall. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoploth. birmanicum.*	Zone of *Parac. caeruleus.*	Zone of *Canc. martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meio. metavulgaris.*	Zone of *Mytil. nicobaricus.*	Zone of *Card. tjidamarensis.*	Zone of *Cyrena crawfurdi*	*Uncertain.*
22. *Gari natensis* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
23. *Solecurtus exsulcatus* spec. nov.	—	—	—	—	—	—	—	—	—	—	—	—	—	★
24. *Mactra protoreevesii* spec. nov.	—	—	★	★	—	—	—	—	—	—	—	—	—	—
25. *Pholas blanfordianus* spec. nov.	—	—	★	—	—	—	—	—	—	—	—	—	—	—
26. *Turcica protomonilifera* spec. nov.	—	—	—	—	★	—	—	—	—	★	—	—	—	—
27. *Scalaria birmanica* spec. nov.	—	—	—	★	—	—	—	★	—	—	—	—	—	—
28. *Calyptraea rugosa* Noetl.	—	★	★	—	★	—	★	★	—	—	★	—	—	—
29. *Semicassis protojaponica* spec. nov.	—	—	—	—	—	—	—	★	—	—	—	—	—	—
30. *Conus protofurvus* spec. nov.	—	—	—	★	—	—	★	—	—	—	—	—	—	—
31. 〃 *hanza* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
4. MEDITERRANEAN TYPES.														
1. *Discohelix minuta* Noetl.	—	—	—	—	—	—	—	★	—	—	—	—	—	—
2. *Cancellaria pseudocancellata* spec. nov.	—	—	—	—	—	—	★	—	—	—	—	—	—	—
5. SPECIES NOT CLASSIFIED.														
1. *Ostrea promensis* spec. nov. var.	—	—	—	—	—	—	—	—	—	—	—	—	—	★
6. IDENTICAL SPECIES.														
1. *Mytilus nicobaricus* Chemn.	—	—	—	—	—	—	—	—	—	—	★	—	—	—
2. *Arca bistrigata* Dunk.	—	—	—	—	—	★	★	★	—	★	★	—	—	—
3. *Crassatella rostrata* Lmk.	—	★	—	—	—	—	—	—	—	—	—	—	—	—
4. *Venus granosa* Sow.	—	—	—	—	—	—	—	—	—	—	—	—	—	★
5. *Cytherea erycina* Fav.	★	—	★	★	—	—	—	—	—	—	—	—	—	—
6. *Tellina foliacea* Reeve.	—	★	★	★	★	—	—	—	—	—	—	—	—	—
7. *Pholas orientalis* Gmel.	—	—	★	—	—	—	—	—	—	—	—	—	—	—
8. *Dentalium junghuhni* K. Martin.	—	—	—	★	—	—	—	—	—	—	★	—	—	—
9. *Solarium maximum* Phil.	—	—	—	★	★	—	★	★	—	★	★	—	—	—
10. *Sigaretus neritoideus* Linn.	★	—	—	★	—	—	★	—	—	—	★	—	—	—
11. *Rimella crispata* Sow. spec.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
12. *Ranella elegans* Beck.	★	★	—	★	—	—	—	—	—	—	—	—	—	—
13. *Pyrula pugilina* Born. spec.	★	—	—	—	—	—	—	—	—	—	—	—	—	—
14. 〃 *bucephala* Link. spec.	—	—	—	—	—	—	—	—	—	—	★	—	—	—
15. *Marginella scripta* Reeve.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
16. *Oliva rufula* Ducl.	—	★	—	★	★	—	★	★	—	—	★	—	—	—
17. *Clavatula fulminata* Kien.	—	—	—	—	—	—	—	—	—	—	★	—	—	—
18. *Conus literatus* Lin.	—	★	—	—	—	—	—	—	—	—	—	—	—	—
19. 〃 *malaccanus* Hwass.	—	—	—	—	—	—	★	★	—	—	—	—	—	—

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Phos orientalis.*	Zone of *Parall. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoploth. birmanicum.*	Zone of *Parac. caeruleus.*	Zone of *Canc. martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meio. metavulgaris.*	Zone of *Mytil. nicobaricus.*	Zone of *Card. tjidamarensis.*	Zone of *Cyrena crawfurdi.*	*Uncertain.*
7. SUBIDENTICAL SPECIES.														
1. *Lima protosquamosa* spec. nov.	—	—	—	—	—	—	—	—	—	—	★	—	—	—
2. *Cucullaea protoconcamerata* spec. nov.	—	—	—	—	—	—	—	—	—	—	—	—	—	★
3. *Nucula alcocki* Noetl.	—	—	—	—	★	—	★	★	—	★	—	—	—	—
4. *Cardita protovariegata* spec. nov.	★	—	—	★	—	—	—	—	—	—	—	—	—	—
5. *Dione protophilippinarum* spec. nov.	★	★	★	★	★	★	★	★	—	★	★	—	—	—
6. *Tapes protolilacina* spec. nov.	—	—	—	—	—	—	—	—	—	—	—	—	—	★
7. *Gari protokingi* spec. nov.	—	—	—	★	★	—	—	—	—	—	—	—	—	—
8. 〃 *kingi* Noetl.	—	—	—	—	—	—	★	★	—	★	—	—	—	—
9. 〃 *deuterokingi* spec. nov.	—	—	—	—	—	—	—	—	—	—	★	—	—	—
10. *Corbula socialis* K. Martin.	—	—	★	★	★	—	—	—	—	—	—	—	—	—
11. *Solarium protodorsuosum* spec. nov.	—	—	—	—	★	—	—	★	—	—	—	—	—	—
12. *Natica obscura* Sow.	★	★	★	★	★	—	★	★	—	—	★	—	—	—
13. *Eburna protozeylanica* spec. nov.	★	—	—	—	★	—	—	—	—	—	—	—	—	—
14. *Fasciolaria nodulosa* Sow.	—	—	—	—	—	—	★	★	—	—	—	—	—	—
15. *Pyrula pseudobucephala* spec. nov.	—	—	—	—	—	—	—	—	—	—	★	—	—	—
16. *Strioterebrum protomyuros* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
17. *Terebrum protoduplicatum* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
18. *Drillia protointerrupta* spec. nov.	—	—	—	—	★	—	—	★	—	—	—	—	—	—
19. 〃 *protocincta* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
8. EVOLUTIONARY SPECIES.														
1. *Pecten protosenatorius* spec. nov.	—	—	—	—	—	—	—	—	—	—	—	—	—	★
2. *Arca burnesi* d'Arch. & Haime.	—	—	—	★	—	—	—	—	—	—	—	—	—	—
3. 〃 *theobaldi* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
4. 〃 *metabistrigata* spec. nov.	—	—	—	—	★	—	—	—	—	—	—	—	—	—
5. *Cardium protosubrugosum* spec. nov.	—	★	—	★	—	—	—	—	—	—	—	—	—	—
6. *Corbula prototruncata* spec. nov.	—	—	—	—	★	—	—	★	★	—	—	—	—	—
7. *Ranella prototubercularis* spec. nov.	—	—	—	★	★	—	★	★	—	—	—	—	—	—
8. *Clavatula protonodifera* spec. nov.	—	—	—	—	—	—	—	★	—	—	★	—	—	—
9. SPECIES NOT CLASSIFIED.														
1. *Cyrena kodoungensis* spec. nov.	—	—	—	—	—	—	—	—	—	—	—	—	★	—
2. *Xenophora birmanica* spec. nov.	—	★	—	—	—	—	—	—	—	—	—	—	—	—
3. *Natica callosa* Sow.	★	★	—	★	★	—	★	★	—	—	—	—	—	—
4. 〃 *gracilior* spec. nov.	—	—	—	★	—	—	—	—	—	—	—	—	—	—

		Zone of *Cytherea erycina* Fav.	Zone of *Aricia humerosa* Sow.	Zone of *Pholas orientalis* Gm.	Zone of *Parallelipip. prototortuosum* spec. nov.	Zone of *Arca theobaldi.* spec. nov.	Zone of *Paracyathus caeruleus* Dunc.	Zone of *Cancellaria martiniana* spec. nov.	Zone of *Meiocardia metavulgaris* spec. nov.	Zone of *Mytilus nicobaricus* Chemn.
Palaeogene Species.	Species of which no relatives either living or fossil could be traced (*Indigenous types*).	—	9	6	14	17	13	16	10	15
	Species of which the nearest relatives occur in the Eocene of Paris (*Gallic types*).	4	4	4	10	8	6	6	3	3
	Species of which the nearest relatives live at present in China, Japan, Philippines, Australia (*Pacific types*).	2	3	8	16	6	4	4	7	4
	Species of which the nearest relatives live at present in the Mediterranean (*Mediterranean types*).	—	—	—	—	—	1	1	—	—
Neogene Species.	Species which are *identical* with species living in the Indian ocean.	4	5	3	7	5	5	4	2	8
	Species which are *subidentical* with species living in the Indian ocean.	4	2	3	5	11	5	7	3	5
	Species representing a permanent *evolutionary* stage of species living in the Indian ocean.	—	1	—	3	4	1	3	—	5
	Species not classified.	1	2	—	2	1	1	1	—	—
	Total.	15	26	25	57	52	36	42	25	36

		Zone of *Cytherea erycina* Fav.	Zone of *Aricia humerosa* Sow.	Zone of *Pholas orientalis* Gm.	Zone of *Paralleli-pip. prototortu-osum* spec. nov.	Zone of *Arca theobaldi.* spec. nov.	Zone of *Paracy-athus caeruleus* Dunc.	Zone of *Cancella-ria martiniana* spec. nov.	Zone of *Meiocar-dia metavul-garis* spec. nov.	Zone of *Mytilus nicobari-cus* Chemn.
Palaeogene Species.	Species of which no relatives either living or fossil could be traced (*Indigenous types*).	—	34.56 %	24.96 %	24.50 %	31.96 %	36.40 %	38.08 %	40.00 %	42.00 %
	Species of which the nearest relatives occur in the Eocene of Paris (*Gallic types*).	26.66 %	15.36 %	16.64 %	17.50 %	17.04 %	16.80 %	14.28 %	12.00 %	8.40 %
	Species of which the nearest relatives live at present in China, Japan, Philippines, Australia, (*Pacific types*).	13.33 %	11.52 %	33.28 %.	28.00 %	11.28 %	11.20 %	9.52 %	28.00 %	11.20 %
	Species of which the nearest relatives live at present in the Mediterranean (*Mediterranean types*).	—	—	—	—	—	2.80 %	2.38 %	—	—
Neogene Species.	Species which are *identical* with species living in the Indian ocean.	26.66 %	19.20 %	12.48 %	12.25 %	9.40 %	14.00 %	9.52 %	8.00 %	22.40 %
	Species which are *subidentical* with species living in the Indian ocean.	26.66 %	7.68 %	12.48 %	8.75 %	20.68 %	14.00 %	16.66 %	12.00 %	14.00 %
	Species which represent a permanent *evolutionary* stage of species living in the Indian ocean.	—	3.84 %	—	5.25 %	7.25 %	2.80 %	7.14 %	—	2.8 %
	Species not classified.	6.66 %	7.68 %	—	3.50 %	1.88 %	2.80 %	2.38 %	—	—

In the summary tables the zones of *Anoplotherium birmanicum* spec. nov., *Dione dubiosa* Noetl., *Cardita tjidamarensis* Mart., *Cyrena crawfurdi* Noetl. and those species the horizon of which is unknown have been omitted for obvious reasons. In the four first named horizons the number of Pelecypoda and Gastropoda is too small to be of any practical value and those, of which the horizon is not known, can of course not come into consideration, though some of the most interesting species come under this group. For the same reason the group of species not classified has been omitted among the palaeogene species.

Though the first table pag. 85 gives the actual figures, the information they contain is not made so evident as in the following pag. 86, where the percents are given, and some very interesting results are obtained. The lowest fossiliferous horizon, that of *Cytherea eryina* Fav. appears to be very abnormal, if those fossils that have been examined by me really represent its fauna; their number being however very small, aggregating to 15 only, not including 3 species which have only generically been determined. It is therefore quite probable, that if more extensive collections will be made, that is to say if the fauna is more completely known, the figures will be different. It seems rather strange that the lowest fossiliferous horizon should not contain any indigenous species at all, a group which in all other horizons is represented by one quarter to one third of the total fauna. This fact alone is sufficient to make the figures appear rather doubtful and it is the more emphazised by the neogene being greatly in excess of the palaeogene species; the percentage is 59.98 °/₀ of the former and 39.99 °/₀ of the latter or 60 °/₀ and 40 °/₀ in round figures, while in all the other horizons the proportion is 40—30 °/₀ of neogene, and 60—70 °/₀ of palaeogene species. The figures may however not be quite so wrong, a view which finds some support in the composition of the fauna of the zone of *Meiocardia metavulgaris* spec. nov. Having collected the specimens myself I can confidently say, that I got as exhaustive a collection as could be made, yet the fauna of this horizon, which is one of the youngest known, contains the largest percentage of palaeogene species, the proportion of palaeogene to neogene species being 80 °/₀ to 20 °/₀. In this instance the small number of species cannot account for the anomaly because the zones of *Aricia humerosa* Sow. spec. and *Pholas orientalis* Gmel. from which the same number of species have been described as from the zone of *Meiocardia metavulgaris* spec. nov., show a perfectly different proportion of palaeogene and neogene species, which in both instances approaches very closely the average, though both have, as we see from the diagram a very different curve of variation.

The probability that independent of their vertical position certain horizons contain a peculiar fauna, the character of which is demonstrated by an anomalous composition cannot be denied, and has to some extent been forestalled by the remarkable short vertical range most of the species have. This feature requires however further examination. If we therefore exclude the zone of *Cytherea erycina* Fav. there remain eight fossiliferous horizons the analysis of whose fauna is of great interest.

The group of *Indigenous* types varies considerably, as it ranges from 24.50 °/₀ in the zone of *Parallelipipedum prototortuosum* spec. nov. to 42.0 °/₀ in the zone of *Mytilus nicobaricus* Chemn. yet it is quite certain that if the former is not one of the oldest horizons known, it is certainly much older than that of the latter. The zone of *Pholas orientalis* Gmel. which though its exact position is not known, is probably closely related to the zone of *Aricia humerosa* Sow. spec. exhibits almost the same percentage of indigenous types as that of *Parallelipipedum prototortuosum* spec. nov. while the zone of *Meiocardia metavulgaris* spec. nov. containing 40 °/₀ of indigenous types stands in a similar relation to that of *Mytilus nicobaricus* Chemn. The other horizons call for no special remark, the percentage being very close to the average.

The group of *Gallic* types shows in general a very small fluctuation, but exceeds in all cases the average, except in the zone of *Meiocardia metavulgaris* spec. nov. and *Mytilus nicobaricus* Chemn. where it falls, particularly in the last instance considerably below the average.

The horizons of upper and lower Burma if considered together show however a feature of peculiar interest, which makes it particularly regrettable that the sequence in lower Burma is not known with sufficient correctness. It appears that in upper Burma the percentage of Gallic types decreases from the older to the younger beds, as will be seen from the following figures.

In descending order:

Zone of *Mytilus nicobaricus* Chemn. . . . . 8.4 °/₀
Zone of *Meiocardia metavulgaris* spec. nov. . . 12.00 °/₀
Zone of *Cancellaria martiniana* spec. nov. . . . 14.28 °/₀
Zone of *Paracyathus caeruleus* Dunc. . . . . 16.80 °/₀

On the other hand if we examine the same figures in the sequence as adopted for lower and upper Burma it appears that the percentage increases from the older to the younger horizons. I am unable to account for this anomaly unless it be that the position attributed to the Kama-clay by Mr. Theobald (see pag. 22) is erroneous and that instead of being at the top of the section, it is really at the bottom. It is useless to speculate any further on this problem which will only be solved by actual observation.

The group of *Pacific* types shows apparently the greatest fluctuations and its range is larger than any of the groups here distinguished, as it rises as high up as 33.28 °/₀ in the zone of *Pholas orientalis* Gm. while it sinks to 9.52 °/₀ in the zone of *Cancellaria martiniana* spec. nov. This state may be fairly anticipated from what has been said above about this group. It is chiefly composed of Pelecypoda (80 °/₀) and as this class is apparently in a very unstable state, it can be expected that in the different horizons it is represented by a varying number of species.

The small group of *Mediterranean* types which occurs only in two horizons calls for no further remark.

If we now summarize these results which has been done in the table pag. 91 we see that notwithstanding the considerable differences exhibited by the different groups in the above nine horizons, the total of the Palaeogene species exhibits a comparatively small range of variation in five horizons, where it fluctuates between 64.26 °/₀ and 74.88 °/₀; the zones of *Aricia humerosa* Sow. and *Mytilus nicobaricus* Chemn. have rather a low percentage with 61.44 °/₀ and 61.6 °/₀ respectively, while the zone of *Meiocardia metavulgaris* spec. nov. has an abnormally high percentage with 80 °/₀.

If we now turn to the *Neogene* species we see that the first group, the *Identical* species shows great fluctuations; in the zone of *Mytilus nicobaricus* Chemn. it is highest with 24.4 °/₀ and in the zone of *Meiocardia metavulgaris* spec. nov. which is only 300 feet lower it reaches with 8.0 °/₀ its minimum, but rises again in the still older zone of *Paracyathus caeruleus* Dun. to 14.0 °/₀.

The group of *Subidentical* species is subject to the same fluctuations, but it appears that a sort of compensating influence makes itself evident in such a way that in whatever horizon the number of identical species is small, the number of subidentical species is high and vice versa. The sum of both groups is therefore almost the same in each horizon, or at least subject to a much smaller range of fluctuation than noticed in any of the other groups as will be seen from the following figures:

Zone of *Aricia humerosa* Sow. . . . . 26.88 %
Zone of *Pholas orientalis* Gmel. . . . . 24.96 %
Zone of *Parallelipipedum prototortuosum* spec. nov . 21.90 %
Zone of *Arca theobaldi* spec. nov . . . . 30.08 %
Zone of *Paracyathus caeruleus* Dunc. . . . . 28.00 %
Zone of *Cancellaria martiniana* spec. nov . . . . 26.18 %
Zone of *Meiocardia metavulgaris* spec. nov . . . . 20.00 %
Zone of *Mytilus nicobaricus* Chemn. . . . . 26.40 %

We see, that only the two zones of *Meiocardia metavulgaris* spec. nov. and *Arca theobaldi* spec. nov. exhibit a larger deviation, the former being in defect the other in excess, yet the zone of *Meiocardia metavulgaris* is unquestionably much younger than that of *Arca theobaldi* spec. nov.

The last group of *Evolutionary* species calls for no special remarks except that the frequency of species belonging to this group appears to be independent of the geological horizon.

The group of species not classified can of course not be discussed, because if better preserved, the species it contains would come under any of the other three groups.

If we enter the figures contained in table pag. 86 in a diagram, arranged in the same way as that on pag. 77 some more interesting facts are exhibited which are not so obviously shown by the mere figures.

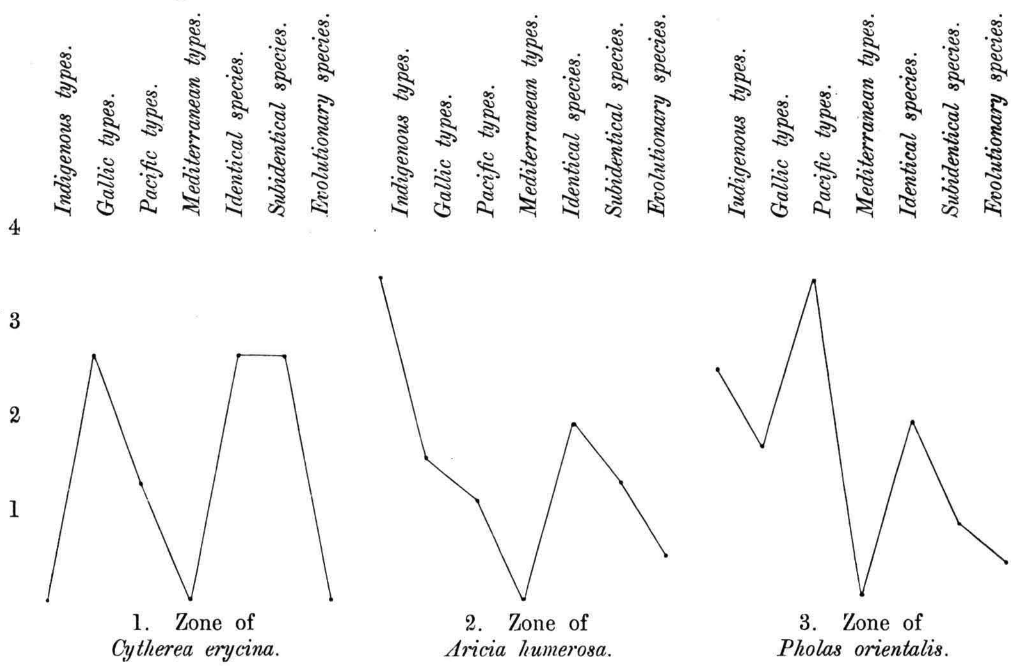

Fig. 2.

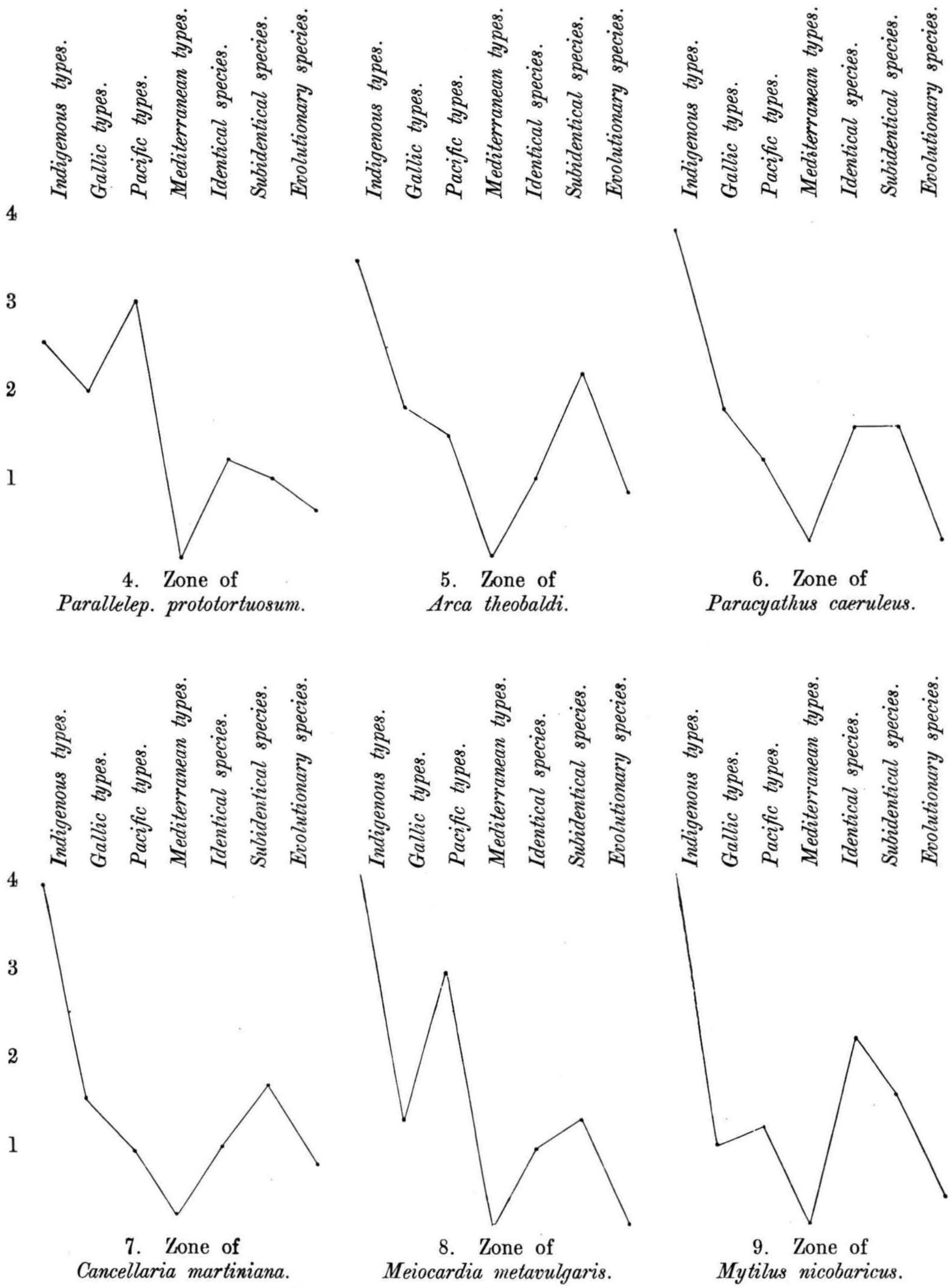

Fig. 2.

If we again omit the diagram of the zone of *Cytherea erycina* Fav. as likely being erroneous, it will at once be seen that the remaining eight can be arranged into two distinct groups, viz.

those having a strongly marked bulging out of the right hand part of the curve and those in which that part is almost flat.

To the first group belong:

1. The zone of *Pholas orientalis* Gmel.
2. The zone of *Parallelipipedum prototortuosum* spec. nov.
3. The zone of *Meiocardia metavulgaris* spec. nov.
4. The zone of *Mytilus nicobaricus* Chemn.

To the second group belong:

1. The zone of *Aricia humerosa* Sow. spec.
2. The zone of *Arca theobaldi* spec. nov.
3. The zone of *Paracyathus caeruleus* Dunc.
4. The zone of *Cancellaria martiniana* spec. nov.

Now if we compare these diagrams with those on pag. 77 we see that the first group is similar to the curve of composition shown by the Pelecypoda and the second one to that of the Gastropoda. We may therefore conclude that in the first diagrams a large number of pacific types of Pelecypoda occur, which are absent in the second group of diagrams. It is unnecessary to prove this by figures as a reference to the lists No. 1 to 8 will show the correctness of this statement.

The most important fact is however the proof that the *composition of the fauna is entirely independent on its geological position;* there can be no more different curves of composition than those of the zone of *Parallelipipedum prototortuosum* spec. nov. and *Arca theobaldi* spec. nov. and yet it is very probable that both horizons are separated only by a small thickness of beds. The same applies to the zones of *Meiocardia metavulgaris* spec. nov. and *Mytilus nicobaricus* Chemn.

In conclusion I have in the following table given the total percentage of the palaeogene and neogene species.

	Zone of *Cytherea erycina* Fav.	Zone of *Aricia humerosa* Sow. spec.	Zone of *Pholas orientalis* Gmel.	Zone of *Parallelipip. prototortuosum* spec. nov.	Zone of *Arca theobaldi.* spec. nov.	Zone of *Paracyathus caeruleus* Dunc.	Zone of *Cancellaria martiniana* spec. nov.	Zone of *Meiocardia metavulgaris* spec. nov.	Zone of *Mytilus nicobaricus* Chemn.
Palaeogene species.	39.99 %	61.44 %	74.88 %	70.00 %	60.28 %	67.20 %	64.26 %	80.00 %	61.60 %
Neogene species.	59.98 %	38.42 %	24.96 %	29.75 %	39.48 %	33.60 %	35.70 %	20.00 %	39.20 %

It will be seen that in every instance the percentage of Palaeogene species is considerably in excess of that of the Neogene species [1]), by being generally about double the number of the neogene ones, but in a few instances even four times their number. It is evident that the proportion of Palaeogene and Neogene species varies a good deal in the different horizons, the zone of *Parallelipipedum prototortuosum* only exhibiting the average figures. We may further conclude that the proportion of „extinct" to „recent" species, to use this term, is rather an uncertain factor, when solely used for the determination of age. According to this principle the zone of *Meiocardia metavulgaris* spec. nov. containing the smallest number of „recent" species ought to be the oldest and the zone of *Arca theobaldi* spec. nov. containing the largest number of „recent" species ought to be the youngest, yet if one fact seems certain it is that the zone of *Arca theobaldi* spec. nov. is much older than that of *Meiocardia metavulgaris* spec. nov. We arrive therefore at the important result that *unless supported by stratigraphical observations the Lyell-Deshayes rule for ascertaining the age of Tertiary beds is of problematic value.*

Even if we were to add the number of *Pacific* types to that of the Neogene species, in order to bring the figures more in harmony with those of Deshayes, their value would be a very uncertain one as seen from the following table:

	Percentage of Neogene species + Pacific types.
1. Zone of *Aricia humerosa* Sow. spec.	49.94 %
2. Zone of *Pholas orientalis* Gmel.	58.24 %
3. Zone of *Parallelipipedum prototortuosum* spec. nov.	57.75 %
4. Zone of *Arca theobaldi* spec. nov.	50.76 %
5. Zone of *Paracyathus caeruleus* Dunc.	54.80 %
6. Zone of *Cancellaria martiniana* spec. nov.	45.22 %
7. Zone of *Meiocardia metavulgaris* spec. nov.	48.00 %
8. Zone of *Mytilus nicobaricus* Chemn.	49.40 %

The older beds would therefore contain a larger percentage of „recent" than the geologically younger ones and if any conclusions were drawn from the fauna of a single horizon, for instance that of *Parallelipipedum prototortuosum* spec. nov. such conclusion would certainly be erroneous.

We may summarize the above facts in the following way: The Lyell-Deshayes rule for the determination of the age of Tertiary beds holds good only, when an average figure for a larger series has been obtained, provided it is supported by stratigraphical observations.

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[1]) The zone of *Cytherea erycina* Fav. being omitted.

4. BIOLOGICAL AND BATHYMETRIC CHARACTER OF THE FAUNA OF THE YENANGYOUNGIAN AND PROMEIAN.

A. *Comparison with the Fauna of the Miocene of Java and the Gajian of Western India.*

I described and determined 208 species which represent the following classes.

	Number of species.	Percents of total Fauna.
Anthozoa.	4	1.92 %
Echinoidea.	3	1.44 %
Pelecypoda.	85	40.80 %
Gastropoda.	96	46.08 %
Crustacea.	6	2.68 %
Pisces.	10	4.80 %
Reptilia.	3	1.44 %
Mammalia.	1	0.48 %

The Vertebrata, exclusive of 4 species of Squalidae, have so far only been found in the *Promeian,* while the remainder of the fauna occurs in the *Yenangyoungian,* and it is chiefly this fauna on which we can base any conclusions having a certain amount of probability, and unless stated otherwise, the following remarks refer to the fauna of the *Yenangyoungian* only. From the above figures it can be seen, that the Pelecypoda and Gastropoda occur in such numbers that the other classes almost completely disappear; the character of the fauna is therefore chiefly moulded by the Pelecypoda and Gastropoda.

The small number of Anthozoa and Echinoidea is very remarkable; according to Duncan and Sladen [1]) the *Gajian* of Sind has yielded:

Anthozoa 41 species.
Echinoidea 27 species.

The Miocene of Java has yielded according to Martin [2]).

Anthozoa 36 species = 11.73 % of the fauna.
Echinoidea 19 „ = 6.19 % „ „

[1]) Duncan & Sladen Tertiary & Cretaceous Fauna of Western India. Palacontologia. Indica Ser. VII & XVI. 1880/86.

[2]) Tertiärschichten auf Java. General part 28.

Unfortunately the Fauna of the *Gajian* is so little known yet that the number of Anthozoa and Echinoidea cannot be expressed in percents in order to allow for a better comparison with the figures obtained for the fauna of the *Yenangyoungian*, and the Miocene of Java, yet I can confidently say that the percentage of the total fauna will not be expressed by such a low figure as obtained for the *Yenangyoungian*, though it may perhaps be higher than that of Java.

There are only two ways of accounting for this scarcity of Anthozoa and Echinoidea in the *Yenangyoungian*. Either the horizon in which these classes occur more plentiful has not been discovered yet, or if not restricted to a certain horizon the *Yenangyoungian* is developed in a different facies which was not favourable to the existence of such a large number of Anthozoa and Echinoidea as occuring in Java and Western India.

We shall presently see (pag. 59) that there are several circumstances in favour of the first view. Professor Martin enumerates a number of species, among which there are several Anthozoa and Echinoidea from the Miocene of Java as common to the *Gajian* in Western India. *None* of these species have been found in Burma and the propability that they represent a horizon which if present has not been found yet is by no means small.

On the other hand the theory of a different facial development cannot be put aside without further consideration. We shall presently see that the character of the fauna of the *Yenangyoungian* is distinctly littoral, no coral reefs having been discovered yet. On the other hand it seems almost certain that the majority of the Anthozoa and Echinoidea from Western India came from coral reefs while the same probably applies also to Java (vide Korallenkalke Martin, Tertiär. auf Java. General part. pag. 4).

But we may perhaps combine both views and suppose that the equivalent of the lower part of the *Pegu*-division, which is represented by the unfossiliferous *Promeian*, contains in Java and Western India coral reefs. This theory is however by no means supported by palaeontological evidence, because some of the species which Prof. Martin mentions, in addition to the Anthozoa and Echinoidea, occur in Baluchistan according to my own observations high up in the series of the *Gajian*. We shall see further on that another observation, Mr. Theobald's find of a *Pseudodiadema* spec. in the upper part of the Pegu group, renders the theory that the *Promeian* is the estuarine facies of the marine Korallenkalke of Java and the Lower *Gajian* of Western India very improbable.

This is, however another point on which it is useless to speculate any further, as it can only be solved by future researches in the field, the direction which these researches will have to take being clearly indicated by the above arguments.

The following table gives a comparison of the fauna of the *Pegu* Division, the Fauna of the *Yenangyoungian* and the Miocene of Java in percents of the total number.

	Pegu-Division. (Promeian + Yenangyoungian).	Yenangyoungian.	Miocene of Java.
Foraminifera.	nil.	nil.	1.95 °/₀
Anthozoa.	1.92 °/₀	2.02 °/₀	11.73 °/₀
Echinoidea.	1.44 °/₀	1.51 °/₀	6.19 °/₀
Brachiopoda.	nil.	nil.	0.32 °/₀
Pelecypoda.	40.80 °/₀	42.92 °/₀	24.12 °/₀
Gastropoda.	46.08 °/₀	48.48 °/₀	52.16 °/₀
Cephalopoda.	nil.	nil.	0.32 °/₀
Crustacea.	2.68 °/₀	3.03 °/₀	2.93 °/₀
Pisces.	4.80 °/₀	2.02 °/₀	nil.
Reptilia.	1.44 °/₀	nil.	nil.
Mammalia.	0.48 °/₀	nil.	nil.

It will be seen that, though differing somewhat in detail, the Miocene of Java shows the greatest similarity with the fauna of the *Yenangyoungian*, by the preponderance of the Pelecypoda and Gastropoda. In the *Yenangyoungian* the percentage of Mollusca is 91.4 °/₀, while in Java it is some what smaller 76.18 °/₀ only.

The differenes chiefly consist in the greater percentage of Anthozoa, Echinoidea, the presence of Brachiopoda and Cephalopoda all of which speak in favour of a coral-reef facies, while in the Miocene of Burma the occurence of Mammalia indicates perhaps an estuarine horizon. A similar horizon has however been subsequently discovered in Java [1]).

B. *The bathymetric character of the Fauna of the Yenangyoungian.*

The vertical distribution in connection with the character of the fauna proves that two different facies are represented in the *Yenangyoungian* viz.

[1]) Martin Tiefbohrungen auf Java pag. 324.

a. a purely marine facies
b. an estuarine facies

and if any conclusions are to be drawn with regard to the bathymetric conditions under which the *Yenangyoungian* has been deposited, these two facies have to be considered separately.

a. *The marine Facies.*

It appears that the marine facies was formed under two different conditions viz. in shallow water, characterized by the *Ostrea*-beds and in slightly deeper water, which however deed not exceed the depth of 25 meter. There may also be a third, the coralline facies, but its existence is purely conjectural for the present, and we can only deal with the first two.

1. *The shallow-water facies.* Unfortunately no actual observations are available with regard to the occurrence of this facies, we even do not know the position it holds in the sequence of the series. In lower Burma it is apparently represented by *Ostrea*-beds, chiefly composed of *Ostrea peguensis* spec. nov. and *Ostrea promensis* spec. nov. Most probably these *Ostrea*-beds contained no other species, except perhaps the large *Pecten protosenatorius* spec. nov. As already said, nothing is known about their vertical position, we even do not know whether the two species characterize different horizons or not, but it seems very probable to me that they occur above the zone of *Arca theobaldi* spec. nov., indicating the change which is gradually preparing towards the top of the *Yenangyoungian*. The occurence of this facies in upper Burma has not been proved yet, it is certainly absent in all the sections I examined.

2. *The littoral facies.* Strata belonging to this facies appear to constitute the larger portion of the *Yenangyoungian* in lower, as well as in upper Burma, and it is chiefly this facies which contains the rich fossiliferous horizons.

The fauna exhibits however a peculiarity; with the exception of *Pyrula pugilina*, *Pyrula bucephala* and *Pyrula pseudobucephala* spec. nov. all species examined are of small size, showing a delicate ornamentation. Strong, robust species are entirely absent. A further characteristic feature is the frequency of single corals like *Ceratotrochus alcockianus* spec. nov. *Paracyathus caeruleus* Dunk. or of genera like *Nucula*, *Leda*, *Dentalium* and *Basilissa*, which generally inhabit deep water. On the other hand this element of the deeper regions is fully counteracted by genera which habitually frequent the shallow water.

If we go through the lists of fossils as given on pag 44 we see that whatever species occur, there are always some genera which do not go beyond a depth of 25 meter and we must therefore assume, that none of the beds was deposited in a greater depth.

The following table pag. 99 shows the character of the fauna of each horizon; in the left hand part the actual numbers of species are given, in the right hand part the percents by which each class is represented in the total of the fauna.

These figures prove that though varying considerably in detail, the general character of the fauna as represented by the different fossiliferous horizons [1]) is very much the same. In all horizons the Pelecypoda and Gastropoda are greatly in excess of the other classes. It may happen that in some instances the Pelecypoda are greatly in the majority (zone of *Parallelipipedum prototortuosum* spec. nov.) while in others the reverse takes place (zone of *Arca theobaldi* spec. nov.) but if the two classes are added up the total is much the same in each horizon.

We can therefore conclude that all the fossiliferous horizons from the deepest up to the highest, were deposited under much the same conditions in water which not exceeded 25 meter in depth, on a sandy shore. Now as we know, that at least during the lower half of a series measuring about 2500 feet in thickness, fossiliferous horizons of the same character are distributed from the bottom to the top, we must conclude that the *Yenangyoungian* represented a period of, perhaps, rapid subsidence. This theory fully accounts for the quick change, indicated by the differently composed faunas of the succeeding horizons.

b. *The estuarine Facies.*

As far as I know this facies is only developed in upper Burma, and unknown in lower Burma which of course, does not prove its nonexistence in that part of the country. The estuarine facies is characterized by unfossiliferous beds containing gypsum. Only here and there *Cyrena*-marls occur, in which *Cyrena petrolei* Noetl. and *Cyrena crawfurdi* Noetl. are found in patches. The zone of *Cardita tjidamarensis* Mart. from Singu represents probably this facies too,

[1]) Of course horizons like that of *Dione dubiosa* Noetl. containing only a few species cannot be compared with those containing a larger number, or a totally wrong conclusion would be arrived at.

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelip. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Cancellar. martiniana.*	Zone of *Paracyathus caeruleus.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*
Anthozoa.	2	1	1	3	1	1	2	—	1	1	—	—
Echinoidea.	—	—	—	1	2	—	—	—	—	—	—	—
Pelecypoda.	7	14	22	34	19	9	9	3	19	19	1	3
Gastropoda.	11	15	5	23	34	35	29	1	8	19	—	—
Crustacea.	1	1	—	2	2	3	2	—	2	1	—	—
Pisces.	—	—	—	—	—	4	4	—	2	2	—	—
Reptilia.	—	—	—	—	—	—	—	—	—	—	—	—
Mammalia.	—	—	—	—	—	—	—	—	—	—	—	—

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelip. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Cancellar. martiniana.*	Zone of *Paracyathus caeruleus.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*
Anthozoa.	9.52	3.22	3.56	4.74	1.72	1.92	4.34	— [1]	3.12	2.38	— [1]	— [1]
Echinoidea.	—	—	—	1.58	3.44	—	—	—	—	—	—	—
Pelecypoda.	33.32	45.08	78.32	53.78	32.68	17.30	19.53	—	58.28	45.22	—	—
Gastropoda.	52.36	48.30	17.80	36.34	58.48	67.30	62.93	—	24.96	45.22	—	—
Crustacea.	4.76	3.22	—	3.16	3.44	5.76	4.34	—	6.24	2.38	—	—
Pisces.	—	—	—	—	—	7.69	8.68	—	6.24	4.76	—	—
Reptilia.	—	—	—	—	—	—	—	—	—	—	—	—
Mammalia.	—	—	—	—	—	—	—	—	—	—	—	—

[1] On account of the small number of species no °/₀ are given.

though this is not quite certain. The estuarine facies must have been formed under similar conditions as prevail at present in the large estuarines of the Ganges-Brahmaputra or Irrawaddi.

C. *The bathymetric character of the Fauna of the Promeian.*

Only one fossiliferous horizon has so far been discovered in the *Promeian*, the zone of *Anoplotherium birmanicum* spec. nov., which has been found 150 feet from the top of the *Promeian* in the Yenangyoung oilfield. The composition of its fauna is very peculiar, and completely differs from any of the faunas known from the *Yenangyoungian*, as can be seen from the following figures.

	Actual number	in percents.
Anthozoa.	1	7.7 °/o
Echinoidea.	—	—
Pelecypoda.	5	38.5 °/o
Gastropoda.	—	—
Crustacea.	—	—
Pisces.	3	23.1 °/o
Reptilia.	3	23.1 °/o
Mammalia.	1	7.7 °/o

Taking it as a whole we have a mixture of purely marine organisms with terrestric animals represented by the mammalia. The marine species are exactly the same as those occuring in the younger zones, thus proving their close palaeontological connection, but the Mammalia and Reptilia represent an absolutely foreign element. Most of the species are represented by fragments of bones only, most of them rolled and worn, but others are exceedingly well preserved, hardly showing any signs of wear and tear. Now how are we to account for this terrestric element among a fauna which could not have possibly existed in any but purely marine water?

The easiest explanation is of course to attribute an estuarine origin to the beds in which this zone occurs, assuming that the fragments of terrestric animals were carried out to sea by rivers. The character of the invertebrata is however decidedly against such a theory. Corals cannot exist anywhere in brackish water.

Now Fuchs [1]) has shown, that far from the coast at great depths

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[1]) Neues Jahrb. f. Min. Geol. and Petref. 1883 Beilage Band II pag. 498—99.

terrestric plants and fragments of terrestric animals have been found by the Challenger expedition and others. Terrestric remains can therefore occur in purely marine sediments not only in such of estuarine or fluviatile origin.

We must therefore claim a marine origin for the zone of *Anoplotherium birmanicum* spec. nov., and probably one of deep water into which the terrestric remains were accidentally dropped.

Whether a similarly composed fauna occurs in the lower beds of the *Promeian* remains to be seen, the sections from the bore holes in Upper Burma having so far proved unfossiliferous and no observations regarding fossiliferous beds from the series below Mr. Theobald's *Cytherea promensis* bed (= zone of *Cytherea erycina* Fav.) are known from lower Burma. The probability is however in favour of a terrestric fauna, if any fossiliferous horizons will ever be discovered. One fact remains however certain, the transport of terrestric remains ceased with the termination of the *Promeian*. To sum up; I think that the zone of *Anoplotherium birmanicum* spec. nov. which concludes the *Promeian* foreshadows by its marine organisms the conditions, we meet in the *Yenangyoungian*, yet at the same time indicates the conditions which prevailed during the formation of the *Promeian*. So far we know very little about the latter conditions, but the occurrence of coal seams and petroliferous beds shows that the *Promeian* was probably formed in an extensive Estuarine into which rivers brought a great quantity of vegetabilic and animal remains.

5. COMPARISON OF THE FAUNA OF THE PEGU DIVISION WITH THE FAUNA OF THE MIOCENE IN EUROPE, THE GAJIAN OF WESTERN INDIA, THE MIOCENE OF JAVA, AND THE FAUNA OF THE INDIAN OCEAN.

A. *The Fauna of the Yenangyoungian.*

a. *Comparison with the Miocene Fauna of Europe and the fauna of the Indian Ocean.*

The determination of the fauna soon proved that there was not a single species in common with the Miocene formation of Europe. There exists a certain relationship with the fauna of the European Eocene, which has already been discussed, (see pag. 64) but though such a relation is undeniably existing no species are are actually in common. We may therefore conclude that during the Miocene period the Indian province of the ocean was already well separated from that of Europe.

A similar conclusion has already been arrived at with regard to the fauna of the Miocene from Java by Professor Martin, who proved that it shares not a single species with the Miocene of Europe [1]).

On the other hand the fauna of the *Yenangyoungian* bears a close relationship to the present fauna of the Indian ocean; 30 °/₀ of the species described are either identical, or so closely related with species inhabiting the Indian ocean, that they might be considered as identical. In several instances, aggregating to 15.12 °/₀ of the total number of Mollusca, the Miocene species could be proved to be the direct ancestors of species inhabiting the Indian ocean. If we therefore assume that a part of the fauna of the Indian ocean has directly descended from the Miocene fauna of India and Burma, this theory is well supported by facts.

Professor Martin has come to the same conclusion with regard to the fauna of the Miocene of Java. He writes as follows: [2]) „so dass der Character der miocänen Fauna Javas nicht nur mit dem der indopacifischen übereinstimmt, sondern speciell die nächste Verwandtschaft zur Fauna desjenigen Meeres zeigt, welches noch heute die Küste Javas umspült". Now it will be admitted that if two different authors, at different times and by different ways, arrive at the same result with regard to the fauna of a certain period, such result is very possibly correct. We may therefore say that at least a part of the present fauna of the Indian ocean bears an archaic character, and is directly derived from the Miocene fauna occuring in India-Burma, Sumatra and Java.

On the other hand, a theory which I think was first promulgated by Jenkins [3]) and which has since been accepted in all manuals, assumes that the fauna of the European Miocene is closely related to the fauna of the Indian ocean. In the light of the present researches it is not easy to reconcile this theory with my own, if we keep in mind that the *Yenangyoungian* has not a single species in common with the European Miocene. It might be argued that if the fauna of the European Miocene is closely related to that of the Indian ocean, we should necessarily expect European Miocene species among the fauna of the *Yenangyoungian* because this fauna bears unquestionably the strongest relationship to the fauna of the Indian ocean. No such species have however

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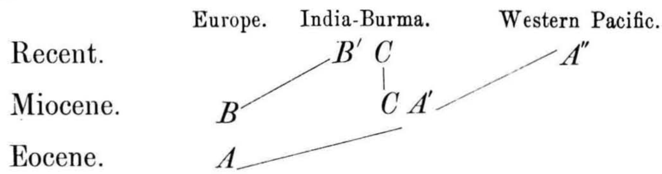
1) Tiefbohrungen auf Java pag. 355.
2) Tertiärschichten auf Java General. part. 39.
3) Quart. Journ. Geolog. Soc. of London 1864 vol. XX pag. 63.

been found, but how is then the relationship of the European Miocene fauna and that of the Indian ocean to be explained?

I think the following theory which accounts for such a relationship without interfering with the view that at least a part of the fauna of the Indian ocean is an indigenous one, will solve the difficulty. Several observations tend to prove that the present fauna of the Indian ocean contains a foreign element, which is apparently not represented in the fauna of the local Miocene. The examination of the Miocene species of the genus *Ostrea* has unquestionably proved that none of them has the slightest relationship with those, inhabiting the Indian ocean. In fact these species represent a different element which must necessarily have migrated to its present habitat from somewhere else; I think such instances will increase, once the Miocene fauna of India is better known.

We know, however, on the other hand that the fauna of the *Yenangyoungian* bears a remarkable relationship to the fauna of the Eocene of France, a relationship which can only be explained by a migration from West towards East, which probably begun with the Eocene time. I have further proved that there is a good deal of evidence to show that a further migration took place since the Miocene time from Burma towards the Pacific regions. Now if we assume with Jenkins that the migration continued during the Miocene time from Europe towards India, without any actual communication existing between the Miocene sea of Europe and that of India, the fauna of the European Miocene would stand in the same relation to the fauna of the Indian ocean, as the fauna of the Miocene of Burma stands to the recent fauna of China, Japan and the Philippines.

This view will perhaps be best illustrated by the following diagram.



Let *A* represent any number of species occuring in the Eocene of Europe; during their migration towards East this group became modified and is represented by the species *A′* in the Miocene of India-Burma, and by the still further modified species *A″* among the recent fauna of China, Japan and the Philippines. *B* represents any number of species from the European Miocene which during the migration towards East slowly changed, and are represented by B' in the present fauna of the Indian ocean; C represents the number of species the fauna of the Miocene has in common with the fauna of the Indian ocean, in other words the indigenous element, while B' represents the foreign element. The fauna of the Indian ocean is therefore represented by the symbol $B'\ C$ while that of the Miocene of India-Burma is represented by the symbol $A'\ C$ and though both faunas are intimately connected by the species in common C, each has its own characters in A' and B' of which B' cannot possibly occur in the fauna $A'\ C$, though it is by no means impossible that a modified A' may occur in the fauna $B'\ C$.

In other words, while it is impossible that the Miocene fauna of Europe is represented among the Miocene fauna of India-Burma, it is quite possible that it occurs in a modified way among the present fauna of the Indian ocean, which to an other part is the direct descendent of the local Miocene fauna.

It is only by this theory of migration from West to East which commenced probably with the Eocene and lasted throughout the Miocene that the relationship of the fauna of the Indian ocean, both with the Miocene of Europe and of India-Burma, without there being a single species in common, can be explained. This theory could easily be verified, if the fauna of the European Miocene will be examined in a similar way, as that of the Miocene of Burma.

b. *Comparison with the Fauna of the Gajian of Western India.*

The relationship of the fauna of the *Yenangyoungian* with that of the *Gajian* or the Miocene of Western India remains now to be examined. It must however be kept in mind that with regard to the fauna of the *Gajian* the results of such a comparison will be much less conclusive, than those with regard to the Miocene of Java, its fauna being very little known. If at present only a small number of species can be proved to be common to the *Yenangyoungian* and *Gajian*, this number will perhaps be increased after the fauna of the latter is better known.

The following table contains the species which have been found to be identical with such from the *Gajian*, showing at the same time their geological occurence in Burma.

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parall. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellar. martiniana.*	Zone of *Meiocard. metavulgaris.*	Zone of *Mytilus nicobaricus.*	*Uncertain.*
1. *Arca burnesi* d'Arch. & Haime.	—	—	—	★	—	—	—	—	—	—
2. 〃 *peethensis* d'Arch. & Haime.	—	—	★	★	—	—	—	—	—	—
3. *Cardita viquesneli* d'Arch. & Haime.	—	★	—	★	—	—	—	—	—	—
4. 〃 *cf. mutabilis* d'Arch. & Haime.	—	—	—	—	—	—	—	★	★	—
5. *Venus granosa* Sow.	—	—	—	—	—	—	—	—	—	★
6. *Corbula rugosa* Sow.	—	—	—	—	—	—	—	★	★	—
7. *Solarium maximum* Phil.	—	—	—	★	★	★	★	★	★	—
8. *Natica callosa* Sow.	★	★	—	★	★	★	★	—	—	—
9. 〃 *obscura* Sow.	★	★	★	★	★	★	★	—	—	—
10. *Cypraea granti* d'Arch. & Haime.	—	—	—	—	—	★	★	★	★	—
11. *Aricia humerosa* Low. spec.	—	★	—	—	—	—	—	—	—	—
12. *Cassis d'archiaci* Noetl. = *Cassidaria carinata* d'Arch. & Haime.	—	—	—	—	—	—	★	—	—	—
13. *Ranella prototubercularis* spec. nov. = *Ranella viperina* d'Arch. & Haime.	—	—	—	★	★	★	★	—	—	—
14. *Fasciolaria nodulosa* Sow.	—	—	—	—	—	★	★	—	—	—
15. *Murex tchihatcheffi* d'Arch. & Haime.	—	—	—	—	—	★	—	—	—	—
16. *Voluta dentata* Sow.	—	—	—	—	—	★	★	—	—	—
17. *Cancellaria davidsoni* d'Arch. & Haime.	—	—	—	—	—	★	★	—	—	—
18. *Strioterebrum protonugaros* spec. nov. = *Terebra reticulata* Sow.	—	—	—	—	★	—	—	—	—	—
19. *Conus literatus* Lin. = *Conus brevis* Sow.	—	★	—	—	—	—	—	—	—	—
20. *Balanus tintinnabulum* Lin. = *Balanus sublaevis* Sow.	★	★	—	★	★	★	★	★	★	—

Considering the limited vertical range the fossils have in Burma, we may conclude from the above list that all the main fossiliferous horizons, as observed in Burma, are also represented in the *Gajian*, but until the vertical distribution of the fossiliferous horizons in this group is better known than at present, it would be too rash to form any conclusions.

A more remarkable feature still, is the composition of the above list; though all the groups distinguished on pag. 90 are represented, the Gastropoda are in a much larger number than the Pelecypoda, the proportion being 2.16 : 1 while in the fauna of the *Yenangyoungian* the same proportion is 1.13 : 1. If therefore the same proportion were to exist among the species the *Yenangyoungian* has in common with the *Gajian*, the number of Pelecypoda ought to be 11 instead of 6. This preponderance of Gastropoda is a fact which cannot be accounted for at present. After I had found it out I carefully revised my determinations in order to see, whether I was wrong or not, but I discovered no reason why I should alter my views. It remains to be seen, however, whether this remarkable feature really exists, or is only an apparent one, because Sowerby and Archiac described only a small number of Pelecypoda in proportion to the actual number occuring.

c. *Comparison with the Fauna of the Miocene of Java.*

The following list shows the species in common with the Miocene of Java. [1])

This list contains only 28 species, some of which appear rather doubtful, that is to say I am not certain as to their identity, yet it does not seem probable that this number will be greatly increased. The fauna of the Miocene of Java is now so well known by the researches of Professor Martin that unless other fossiliferous horizons are discovered in Burma, which contain a larger number of species in common with Java, the results arrived at, by my examination will be fairly reliable.

The majority of the above named species occurs in the zones of *Parallelipipedum prototortuosum* spec. nov. and *Arca theobaldi* spec. nov. but we see, that the other horizons are also well represented, and if we consider the limited vertical range of the species as observed in Burma, which did not allow even for a correlation of the different horizons in Burma itself, it is obvious that any attempt to trace in Java the horizons distinguished by me, would be more than hazardous. All we can say is, that taken as a whole the *Yenangyoungian* is correlated to the Miocene of Java, or at least part of it.

It seems that in the Miocene of Java certain beds are developed which either do not exist in Burma or have not been discovered yet. On pag. 26 general part. Tert. auf Java Prof. Martin mentions the following species as identical with the *Gajian*.

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[1]) See pag. 107.

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallel. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellar. martiniana.*	Zone of *Meioc. metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	*Uncertain.*
1. *Flabellum distinctum* Milne Edw.	★	★	★	★	—	—	—	—	—	—	—
2. *Arca nannodes* K. Martin.	—	—	—	—	★	—	—	—	—	—	—
3. 〃 *bataviana* K. Martin.	—	—	—	—	★	—	—	—	—	—	—
4. 〃 *thayetensis* spec. nov. = *Arca rustica* K. Mart. (?).	—	—	—	—	—	—	—	—	—	—	★
5. *Leda virgo* K. Martin.	—	—	—	—	★	—	—	—	—	—	—
6. *Cardita tjidamarensis* K. Martin.	—	—	—	—	—	—	—	★	—	★	—
7. *Dione protolilacina* spec. nov. = *Cytherea lilacina* K. Martin.	★	—	★	★	★	—	—	★	★	—	—
8. *Corbula socialis* K. Martin.	—	—	★	★	★	—	—	—	—	—	—
9. *Dentalium junghuhni* K. Martin.	—	—	—	★	—	—	—	—	★	—	—
10. *Solarium maximum* Phil. = *Solarium perspecticum* K. Martin.	—	—	—	★	★	★	★	★	★	—	—
11. *Scalaria birmanica* Noetl. = *Scalaria samarangana* K. Martin (?).	—	—	—	★	—	—	★	—	—	—	—
12. *Turritella simplex* Ienk.	—	—	—	★	★	—	—	—	★	—	—
13. 〃 *acuticarinata* Dunk.	—	—	—	★	★	—	—	—	—	—	—
14. *Vermetus javanus* K. Martin.	★	★	—	★	—	—	—	—	—	—	—
15. *Ranella prototubercularis* spec. nov. = *Ranella tubercularis* K. Martin.	—	—	—	★	★	★	★	—	—	—	—
16. 〃 *elegans* Beek.	★	★	—	★	—	—	—	—	—	—	—
17. *Trivia smithi* K. Martin.	—	—	—	—	—	★	—	—	—	—	—
18. *Fusus verbecki* K. Martin.	—	★	—	—	—	—	—	—	—	—	—
19. *Pyrula bucephala* Lam.	—	—	—	—	—	—	—	—	★	—	—
20. *Oliva rufula* Ducl.	—	★	—	★	★	★	★	—	—	—	—
21. *Ancillaria cf. vernedci* Sow.	★	★	★	—	—	—	—	—	—	—	—
22. *Strioterebrum bicinctum* K. Martin.	—	—	—	—	★	—	—	—	—	—	—
23. *Terebrum protoduplicatum* spec. nov. = *Terebra bandangensis* K. Martin (?).	—	—	—	—	★	—	—	—	—	—	—
24. *Terebrum smithi* K. Martin.	—	—	—	—	—	—	★	—	—	—	—
25. *Drillia protointerrupta* spec. nov. = *Pleurotoma interrupta* K. Martin.	—	—	—	—	★	—	★	—	—	—	—
26. *Ringicula turrita* K. Martin.	—	—	—	★	—	—	—	—	—	—	—
27. *Balanus tintinnabulum* Linn.	★	★	—	★	★	★	★	★	★	—	—

1. *Turritella angulata* Sow. (?)
2. *Bulla javana* K. Mart. (?)
3. *Septaria arenaria* Lam.
4. *Corbula trigonalis* Sow.
5. *Clementia papyracea* Gray.
6. *Cytherea ventricola* Mart. (?)
7. *Ostrea hyotis* Lin.
8. 〃 *lingua* Sow.
9. *Balanus tintinnabulum* Lin.
10. 〃 *amaryllis* Darw.
11. *Phyllacanthus baculosa* Ag. (?)
12. *Clypeaster humilis* Ag.
13. *Echinolampas oviformis* Ag.
14. *Breynia magna* Mart.
15. *Maritia planulata* Gray.

None of these species have been known from Burma except *Turritella angulata* Sow. and *Balanus tintinnabulum* Lin; the exact horizon of the former species is not known and the latter has apparently a wide vertical and horizontal range; *Phyllacanthus baculosa* Ag. may perhaps be identical with the species here described as *Cidaris spec.*, yet the identification of these species with those observed in Western India is not beyond any doubt, as expressed by the querry, except that of *Balanus tintinnabulum.*

It appears therefore that in the Miocene of Java a number of species occur, which though identical with species from Western India, have not been found in Burma. The great question now arises, do these species represent a certain horizon or not? At present this question cannot be answered decisively one way or other, yet there seems to be quite a distinct hint as to its solution, particularly if we further consider Martin's list of species from Western India, which according to this author, though not quite identical with Java fossils, are very closely related to them.

Among the second list *Vicarya verneuili* d'Arch. & Haime is mentioned; now this species occurs in Baluchistan together with *Turritella angulata* Sow. and *Ostrea lingua* Sow. very high up in the series, directly below the Siwaliks, though the thickness of beds in which these species occur, is considerable. It is unquestionable that this horizon is not represented among those I mentioned here, though it is probably represented in lower Burma by the occurence of *Turritella angulata* Sow. the exact stratigraphical position of which is unfortunately not known. The greatest probability is in favour of the view, that this horizon occurs above the zone of *Arca theobaldi* spec. nov. somewhere in the series called Thayetmyo sandstone. If this view be correct, a part of Martin's species would represent beds which could be correlated to the upper part of the *Yenangyoungian* from which no fossiliferous horizons are known yet, though they may be discovered in future.

Another feature of Martin's list is also remarkable; in his first list five species of Echinoidea are mentioned, that is to say the

Echinoidea make 33 °/₀ of the total number of fossils identical with such from the *Gajian*. Now in the total number of fossils described from the *Yenangyoungian* the Echinoidea from such an insignificant number that their absence forms one of the most conspicous features. Unfortunately nothing is known as to the vertical distribution of the Echinoidea of the *Gajian*, and I am therefore not in the position to say wether the occurence of the Echinoidea in the *Gajian* represents a facies not developed in Burma, or forms the characteristic features of a horizon which does not occur in Burma. These view holds also good with regard to Java, and the reason why a good number of species which the Miocene of Java has in common with the *Gajian*, do not occur in Burma, may either be the non-development of the same facies, or the non-occurence of the same horizon.

A hint to the solution of this problem is perhaps given by Mr. Theobald's find of Echinoidea, particularly *Pseudodiadema* spec. in beds which he declares to occur in the upper part of the *Pegu* group [1]). If these are the same specimens which are among Mr. Theobald's collection, they must have been labelled wrongly, because they were stated to come from Eocene beds. The specimens are however too ill preserved to allow for any definite view, yet the probability that this Echinoid-horizon represents the facies of which I have just been speaking is by no means small, and its occurence in the upper part of the *Yenangyoungian* would fully agree with the opinion resulting from the occurence of species like *Turritella angulata* Sow. and *Vicarya verneuili*. Future researches will certainly shed light on this question.

If we examine the composition of the fauna, the *Yenangyoungian* has in common with the Miocene of Java we observe almost the same proportion between Pelecypoda and Gastropoda, as noticed in the species in common with the Gajian. The proportion of Gastropoda to Pelecypoda is 2.57 : 1 while, as we have seen, it ought to be 1.13 : 1.

The fact that the Gastropoda are so considerably in the majority of the species, the *Yenangyoungian* has in common both with the *Gajian* and the Miocene of Java, is certainly very remarkable. The only explanation I can offer is the theory of the great change the Pelecypoda underwent during Miocene time, while the Gastropoda remained more stabile. This theory would account for the small

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[1]) Theobald, The Geology of Pegu. Mem. Geolog. Survey of India vol. X pag. 87.

number of identical Pelecypoda, as well as for the large number of identical Gastropoda.

If we now compare those species which were found to be identical with the fauna of the *Gajian*, with those which are identical with the Miocene from Java, we find that it is almost the same number the *Yenangyoungian* has in common with both countries, particularly if we take only the number of Mollusca in consideration. Whether this similarity in number is only accidental, or really exists, I am unable to say. It might of course be expected that the Miocene of Burma, which is about half way between Java and Western India contains a certain number of species in common with either country, yet it would seem very remarkable if the number were almost the same in both cases.

The fact seems the more strange, because the species in common with the Miocene of Java are perfectly different from those in common with the *Gajian*. There seem to be only three species which the Miocene of Java has in common with the *Yenangyoungian* and *Gajian*, these are:

Solarium maximum Phil.
Ranella prototubercularis spec. nov.
Balanus tintinnabulum Lin.

The identity of the first two species, though undoubted with regard to the *Yenangyoungian* and *Gajian* is not beyond any question with regard to the *Yenangyoungian* and the Miocene of Java. I believe that the species described by me as *Solarium maximum* Phil. is probably identical with *Solarium perspectivum* K. Mart., and *Ranella prototubercularis* probably with *Ranella junghuhni* K. Martin, but I cannot state with certainty that this view is correct. If these species are not identical, *Balanus tintinnabulum* Lin. would be the only species which is common to the *Gajian* the *Yenangyoungian* and the Miocene of Java.

We see therefore that though in a general way we can correlate the *Yenangyoungian* to the Miocene of Java and to the Miocene of Western India (*Gajian*) we have no fossil evidence which would directly prove the correlation with the Miocene of Europe, and in order to obtain this end we must resort to a different argumentation

B. *The fauna of the Promeian.*

The small number of Pelecypoda and Gastropoda hitherto obtained from this subdivision renders a correlation of course impossible, particularly as all the species are the same which occur in higher horizons.

The *Promeian* represents unquestionably the Lower Miocene of Burma, but I am not in a position to state to which part of the Miocene of Java or the *Gajian* it can be correlated; the probability that it represents an estuarine facies which is not developed in either Java or Western India is by no means small, but further stratigraphical observations with regard to Java and Western India are required, before any definite opinion can be given.

6. DETERMINATION OF THE AGE OF THE YENANGYOUNGIAN BY THE LYELL-DESHAYES LAW OF PERCENTAGE.

In a previous chapter I fixed the position of the beds from which the fauna here described has been obtained as younger than Eocene but older than Pliocene. The stratigraphical probability that the *Pegu*-division represents the Miocene is therefore very great, but it remained to be seen whether this view is also born out by the fauna, that is to say whether the percentage of species identical with recent ones is the same, as that recognized for the Miocene of Europe.

Sir Charles Lyell's subdivision of the Tertiary formation into the three groups: Eocene, Miocene and Pliocene [1]) is chiefly based on the researches of Deshayes who after a comparison of 3000 tertiary and 5000 recent species could prove a gradual increase in the number of recent species from the Eocene towards the Pliocene; these figures which are for they

Pliocene.	35—50 %	of recent species.
Miocene.	17—25 %	„ „
Eocene.	3— 5 %	„ „

have now been generally accepted, though at the time they did not remain unchallenged. They appear to represent the conditions in Europe fairly well, but the great question arises; do the same figures also apply to the Tertiary formation outside the European Continent?

A definite answer to this question is of course of vital importance, if we wish to apply this rule to the Tertiary formation of Burma, and if we do not want to arrive at a totally wrong conclusion.

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[1]) Principles of Geology 1st Ed. vol. III Appendix, and Manual of Elementary Geology pag. 110.

Before entering into the discussion of the question, it seems to me of fundamental importance to know the region from which the 5000 recent species which served Deshayes as material for comparison came from. Unfortunately I am not able to form any opinion on this very important subject, but I think I am not wrong, if I suppose that Deshayes collection of recent species was not solely composed of species living in that oceanic region which is nearest to the countries, from which he obtained his fossil specimens, that is to say in the Lusitanian and Celtic provinces. I rather believe that he also, and in a goodly number too, compared the fossil species with recent species from the Indian ocean. If this view be correct, the value of the above figures looses considerably in importance, because it does not appear justifiable to compare the fauna of a certain Tertiary series in a certain country, with a recent fauna composed of elements collected all over the world. If the percentage of recent species is considered as a criterion, these species ought to be such, which occur in the nearest oceanic province. Deshayes' figures ought therefore to be revised from this point of view, and it may perhaps be questioned at once, whether in their present value they could be applied at all, when dealing with countries outside Europe.

We have seen above that the neogene species amount to 30 °/₀ of the total molluscan fauna. According to Deshayes' figures the *Yenangyoungian* could therefore not be older than *Miocene;* on the other hand the species which I termed neogene, are probably not quite identical with Deshayes' „recent" species, in as much as they only refer to species from the nearest oceanic province, while Deshayes „recent" species most probably include a number of species which have at present died out in the Lusitanian and Celtic provinces. These species would therefore be represented in the fauna of the *Yenangyoungian* by the group which I termed *Pacific* types, and in order to bring the figures I arrived at, in harmony with those of Deshayes' their number with 18.6 °/₀ ought to be added to that of the neogene species.

The total of „recent" species would thus be brought up to 48.6 °/₀ and according to Deshayes' figures we had to consider the *Yenangyoungian* as Pliocene.

The results obtained, if solely the percentage of recent species is taken in consideration, are therefore widely different; if we compare the fauna of the *Yenangyoungian* with the fauna of the Indian ocean only, a *Miocene* age would be deduced, but if compared with the fauna of the Indian ocean and that of the Western part of the Pacific, a *Pliocene* age would result. One view only can however be the correct one, and it remains to be seen which of the two has the greatest probability, by considering the stratigraphical conditions.

We have seen that there is the greatest probability of an unconformity between the *Yenangyoungian* and the *Irrawaddi*-series; in fact we may say it is almost certain that such a break exists. Disregarding all other characters it would for this single reason be impossible, to consider both as part of one and the same series. It would be in opposition to every observation, if we were to consider the *Yenangyoungian* as the lower part of the *Irrawaddi*-series. If one fact is certain, it is that there exists a great difference between the *Irrawaddi*-series and the *Yenangyoungian*, faunistically, as well as lithologically. Now it is almost certain that the *Irrawaddi*-series represents the Pliocene, and if according to the higher figure of percentage the *Yenangyoungian* had to be considered as Pliocene it would necessarily represent the Lower Pliocene and the *Irrawaddi*-series the Upper Pliocene, which assumption would mean a stratigraphical impossibility. The view of separating the *Yenangyoungian* from the *Promeian* and uniting it with the *Irrawaddi*-series, or to consider the whole of the *Pegu*-division as the lower part of the *Irrawaddi*-series would be so directly in opposition to the natural subdivision of the Tertiaries in Burma, that it would be absurd to adopt it solely on the strength of figures of problematical value.

Nothwithstanding the high percentage of recent species in the meaning of Deshayes, of 48.6 %, or in my more restricted meaning of 30 % of neogene species, we cannot attribute any other but Miocene age to the *Yenangyoungian* and we have therefore to consider the *Yenangyoungian* as Upper and the *Promeian* as Lower Miocene.

Inversely we can conclude that in India and Burma the Miocene has a higher percentage of neogene or recent species than in Europe. Such view was, if I am not mistaken, first hinted at by Jenkins [1]) with regard to the Miocene of Java, and Professor Martin [2]) has come from a purely hypothetical point of view to the same conclusion which he expresses in the following words: „dass bei relativ gleichaltrigen Schichten Indiens einerseits, und Europas andrerseits, wir einen bei weitem höheren Procentsatz recenter Arten im indischen Tertiär antreffen werden, als im europäischen

[1]) Quarterly Journ. of Geolog. Soc. of London. 1864 vol. XX. pag. 63.

[2]) Die Tertiärschichten auf Java. General part. pag. 24.

und zwar muss der Unterschied grösser werden je jünger die Schichten sind, welche gleichzeitig hier wie dort abgesetzt wurden."

The average percentage of Mollusca, which Professor Martin states the Miocene of Java has in common with the Indian ocean is 33.5 °/₀, but he thinks that for various reasons the figure ought to be 50 °/₀. Though apparently obtained by a somewhat different reasoning, Professor Martins figures agree so well with those obtained by me, that the similarity is really striking.

I calculated the number of neogene species to be 30 °/₀ of the total, but when the pacific types are included this figure rises to 48.6 °/₀.

Similar figures obtained by different authors at different times must certainly possess a great degree of probability, and we can therefore conclude that Deshayes' figures do not hold good for the Tertiaries in tropical countries. A new standard will have to be established, and for the Miocene of India-Burma and Java we may assume that the proportion is 30 °/₀ of neogene species, or about 50 °/₀ when all „recent" species irrespective of their present habitat are included.

7. SUMMARY.

The main facts arrived at in the foregoing chapters can be briefly summarized as follows:

1. The vertical range of the fossils is a very short one only 16 species occuring in more than four horizons, the vast majority being restricted to one or two horizons only.

2. The fauna is composed of two classes which may be called *Palaeogene* and *Neogene* species; the former representing all such which have no connection with species occuring at present in the Indian ocean, the latter having relatives among that fauna. If only the Mollusca are considered the Palaeogene species represent 70 °/₀ the Neogene species 30 °/₀ of the fauna.

3. The *Palaeogene* species are composed of four different groups viz. Indigenous types 36.2 °/₀ Gallic types 13.8 °/₀ Pacific types 18.6 °/₀ and Mediterranean types 1.2 °/₀ of the Molluscan fauna.

4. The *Neogene* species are composed of three different groups viz. Identical species 11.4 °/₀ Subidentical species 11.4 °/₀ Evolutionary species 4.8 °/₀ of the Molluscan fauna.

5. The percentage of each of these seven groups varies considerably in the fauna of the different horizons, yet if taken as a whole, Palaeogene and Neogene species remain fairly constant throughout the series.

6. The fauna is almost exclusively composed of Pelecypoda and Gastropoda amounting to 86.88 °/$_{o}$ of the total of known species.

7. The fauna of the Lower *Yenangyoungian* is purely marine and indicates a littoral facies, not existing in greater depth than 25 meter. The fauna of the Upper *Yenangyoungian* is probably estuarine througout.

8. The fauna of the *Promeian* contains a curious mixture of marine and terrestric animals towards its top, but the *Promeian* as a whole is probably of estuarine origin.

9. There is not a single species in common with the Miocene of Europe.

10. The fauna of the *Yenangyoungian* contains 20 species, most of which are Gastropoda, in common with the Gajian of Western India, though this figure is probably smaller than the true amount.

11. The fauna of the *Yenangyoungian* contains 27 species, most of which are Gastropoda, in common with the Miocene of Java.

12. Except perhaps one or two, none of these 47 species range from Java to Western India.

13. There are indications that the Miocene of Java and the Gajian of Western India have a common coralline facies which is either not developed in Burma, or has not been discovered yet.

14. The Deshayes-Lyell' figures for the determination of the age of the Tertiary beds do not hold good for India-Burma, the figures being decidedly higher, and are for the Miocene 30 °/$_{o}$ of recent species still occuring in the same region or 50 °/$_{o}$ if those extinct among the fauna of the Indian ocean, but occuring elsewhere in a recent state are included. (Neogene + Pacific + Mediterranean types).

15. A migration of species from West towards East commenced with the Eocene and lasted up to quite recent times. This migration accounts for the relationship the fauna of the *Yenangyoungian* shows on one side with the Eocene of France, and on the other side with the recent fauna of the Western Pacific. It also accounts for the relationship of the fauna of the Miocene formation of Europe with that of the Indian ocean. Jenkins hypothesis has been confirmed, but the results arrived at from the examination of the fauna of the *Yenangyoungian*, are in direct opposition with Dr. Semper's theory.

16. It seems that the Pelecypoda chiefly represented the migratory element, while the Gastropoda remained more stationary.

17. The fauna of the Miocene of Burma contains 30 °/₀ of species which are the direct ancestors of such, living at present in the Indian ocean.

18. The fauna of the Indian ocean, though in part descended from the local Miocene fauna, contains a foreign, probably European Miocene element.

19. The *Yenangyoungian* must be considered as equivalent to the Miocene of Europe, though its percentage of recent species is considerably higher than that of the European Miocene and corresponds more to the Pliocene of Europe.

20. The history of the Miocene of Burma can therefore be sketched as follows:

During the Eocene period a shallow sea existed in Burma; this sea was gradually filled up by the detritus of large rivers which also carried large quantities of vegetabilic and animal matter seawards; these gave birth to coal seams and petroleum deposits which we now find in the *Promeian*. Towards the end of the *Promeian* a probably rapid subsidence took place, which was not perhaps without structural influence on the previously deposited strata. A marine fauna made its appearence, yet the transport of terrestric remains did not quite stop, but finally ceases with the termination of the *Promeian* and a shallow sea in which a rich fauna thrives, extends all over Burma. But it is an area of subsidence; a fauna exists only for a short time at a certain place; it soon dies out and is replaced by an other one which has hardly one species in common with its predecessor. Contemporaneously with these marine beds, estuarine deposits are formed, probably indicating the mouth of large rivers. The fauna as a whole was in a state of transformation by which the Pelecypoda were chiefly affected; an immigration of a foreign, European of an older origin element lasted throughout the Miocene period.

Towards the end of the *Yenangyoungian* probably an increased influx of sweet water took place, the marine fauna disappears, though at a few localities it still survives in the shape of oyster beds, but these disappear too, and estuarine beds apparently conclude the Miocene throughout Burma. We cannot quite say yet when the Miocene terminated, because it is evident that at least in upper Burma part of it has been eroded. After the termination of the Miocene, a large part of the *Yenangyoungian* was denuded, previous to the deposit of that vast thickness of strata, known as Siwaliks in India and *Irrawaddi*-Series in Burma.

We are unable to say what became of the marine fauna during the deposit of the *Irrawaddi*-series, because no marine equivalent of this series is known yet. We can however positively say, that while the remarkable terrestric fauna contained in these beds made its appearence, lived, died out, and was replaced by a perfectly different one, the marine fauna underwent a small change only; some of its types died out, others migrated in eastern direction, while a foreign element coming from West filled up their places, but a considerable percentage of species persisted, and the descendants still live in the same region where the ancestors are buried in Miocene beds.

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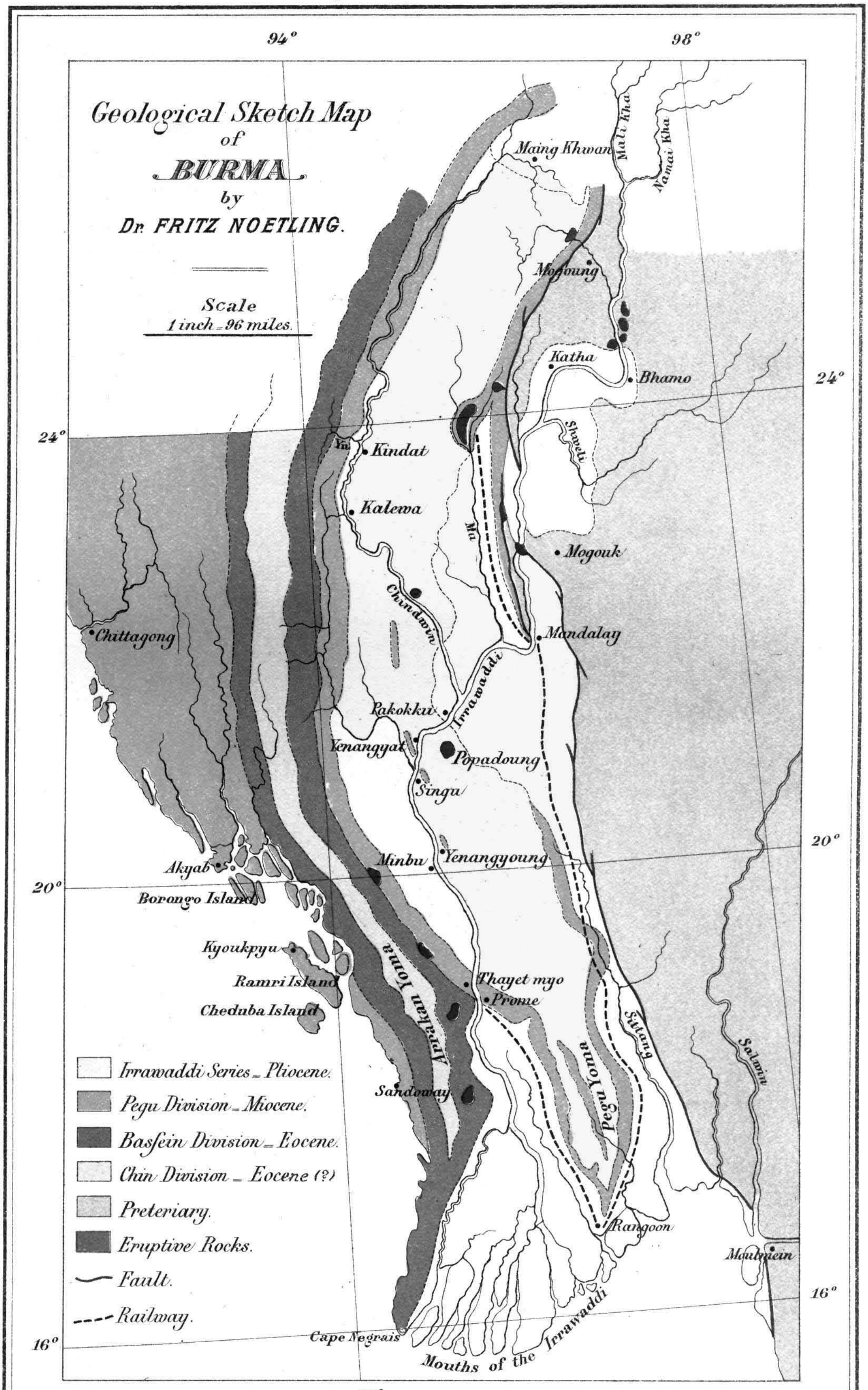

Lith. Gebrs J. & H. v. Langenhuysen.

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