THE MADRAS GEOGRAPHICAL ASSOCIATION

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1. Some aspects of the Geography of Madras.
2. The Geographical Evolution of Madras and its environs.

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THE MADRAS GEOGRAPHICAL ASSOCIATION

RULES.

1. The name of the Association shall be ' The Madras Geographical Association.'

Objects.

2. The objects of the Association shall be :—

(*A*) To promote geographical knowledge ;

(*B*) To secure for geography its proper place in the High School, the University and its constituent and affiliated colleges ;

(*C*) To help to improve the methods of teaching geography ;

(*D*) To work for a school of geography being started ;

(*E*) To promote studies about South India from various standpoints.

3. These objects shall be secured by :—

(*A*) Holding meetings and conferences, and publishing periodicals and occasional bulletins ;

(*B*) Organizing geographical exhibitions and excursions ;

(*C*) Helping in the preparation of geography books in the languages current in the Presidency ;

(*D*) Forming a central library of geographical literature, and collecting maps, charts, plans, models, slides and instruments ;

(*E*) Providing for circulation to members, of books, periodicals, and other collections ;

(*F*) And by such other ways as are deemed necessary to effectuate the objects of the Association.

Membership.

4. The membership of the Association shall be open to all those who are interested in the promotion of geographical knowledge or in the teaching of geography.

5. There shall be two classes of members, honorary and ordinary.

6. Honorary members are those who shall be so elected by the council by the majority thereof present at its meeting. They shall be exempt from liability to pay subscription, and shall have all the privileges of ordinary members, except voting.

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THE JOURNAL OF THE MADRAS GEOGRAPHICAL ASSOCIATION.

OURSELVES.

The Association has for its aims and objects :—

(*a*) the promotion of Geographical Knowledge ;

(*b*) the securing for Geography its proper place in the High School, the University and its constituent and affiliated colleges ;

(*c*) the improvement of methods of teaching Geography;

(*d*) the starting of a School of Geography ; and

(*e*) the promotion of studies about South India from various standpoints. For carrying out several of these objects, the Association, it was felt, should have an organ of its own. An appeal for a journal was issued in August last in these terms :—

"It has been decided to issue a Journal of the Madras Geographical Association. It will contain at least 128 pages of Royal Octavo in a year, and will be published in four to eight numbers, according to convenience.

"The articles appearing in it will be devoted to studies of South India on the lines of Modern Geography. The Journal will strive to maintain a standard of excellence consistent with its high purpose, and will not be a mere scrap-book of press-cuttings and ephemeral news-items. It will embody for the most part the papers read at the Meetings of the Association, and will be illustrated with graphs, charts, maps, diagrams and pictures, according to the requirements of Modern Geography. These will form integral parts of the articles, making them profitable reading.

"The subscription is Rs. 8 per annum. But members will receive copies of the Journal at the half-rate of Rs. 4. This is in addition to their membership subscription, which has been fixed at Rs. 2 so as to meet the bare maintenance charges of the Association. The first bulletin that has been issued will be treated as the first number of the magazine and may be considered as a specimen."

There has been a good response to this appeal; and this number is issued accordingly as the second number.

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The Long Term Session opened in August last, with a paper on, "Some Aspects of the Geography of Madras," by Miss E.D: Birdseye, B. Sc., Dip. in Geography (London), of The St. Christopher's Training College, Madras. It was followed in September by a paper on "The Geographical Evolution of Madras and its Environs", by Mr. H. Narayana Rao, M.A., I. E. S., (Retd.), Emeritus Professor of Geology in the Presidency College, Madras. A Report of these two meetings is contained in this Number of the Journal.

SOME ASPECTS OF THE GEOGRAPHY OF MADRAS.

I have chosen for my paper this evening some aspects only of the geography of Madras. First, it will be as well to define the limits within which I wish to speak. The boundaries of the area under discussion are the Arani river on the North, the Palar on the South and the Nagari Hills on the West. The area which will be spoken of in detail is that shown on the O. S. Map, but most of my remarks will apply to the larger one. Even so it must be remembered that this is only a part of a very much larger area, for the hinterland of Madras stretches to the Malabar coast on the west, if considered from the human standpoint, and as far as Lat. 20 on the east coast if considered from the physical one.

I do not propose to deal with the geography of Madras City, for the obvious reason that most of you know so much more about it than I do. I intend to discuss the physical conditions determining the geography of the area outside the City in the following order, Physical Structure, Geology, Drainage and Water supply, Climate, and then to try to see how these have resulted in the vegetation and crops grown and what influence they have had on the human occupations and interests of the area.

For the most part it will be a statement of facts the greater part of which I obtained from a short residence within the area and from Geological Memoirs, the Climatological Atlas, the Rainfall returns and the Crop Returns of the Madras Presidency which I consulted last year when I was working at a Thesis, of which the substance of this paper forms a part, for the London University Geography Diploma. I hope, if there is any controversial point, that you will discuss it after I have finished. I wish that I could have made the paper more interesting from this point of view but I have found it very difficult to find matter for discussion. This is doubtless because of the very limited extent of my knowledge and I am looking forward to your assistance at the end of this paper to increase this amount, to an appreciable extent, for I am very interested in the district in which we all live.

Remembering that we are dealing with a part only of a much larger area, *viz.*, the whole East Coast Plain, it is not surprising to find that the physical structure and indeed the geography generally of this district is extremely simple. The Peninsula has remained stable during many Geological ages but the coastal strip for some miles inland has undergone various oscillations of level. This has resulted in the following structures from West to East.

a. An elevated peneplain.

b. A steep cliff possibly of marine origin.

c. A comparatively wide plain of possibly marine denudation.

d. A mature coastal plain, which has become lateritic.

e. A younger coastal plain.

f. A still younger strand plain that is still in the process of formation. Of these divisions only the last three are represented in this area.

Dealing with them in the order of their formation we begin with the mature coastal plain which has become lateritic. The geological sketch (Map No. 6) will give some idea of the extent of this section. It is to the west of the district and here the rivers have already reached a mature stage of development so that travelling through the area it is impossible to distinguish the water partings between the valleys. The hills have very rounded contours and are all capped by laterite. This can be seen well at various places but one of the best is near Tinnanur station. The origin of this red soil and rock is uncertain and has been the subject of much discussion amongst geologists but it seems fairly well established now that it has been derived by a process of sub-aerial denudation of the underlying Jurassic beds. If this is the case it is another proof of the maturity of the plain.

The general tilt of the whole area is eastwards and it is very slight. In the southern section of the district it is impossible to miss the interesting isolated hill masses at Vandalur, Pallaveram, and St. Thomas Mount. They are obviously of a different type from the softly rounded contoured hills of the West. They rise abruptly from the Plain, are steep-sided, and for the most part, are covered with scrubby vegetation. The explanation of their presence seems to lie in the geological formation. They are the result of differential

erosion, having been left standing when the rivers were carving out the lower parts of their courses, and so now rising above the mature plain ; but the reason that they have been so left is probably partly because they are of a different rock, which intruded into the surrounding gneiss, and, being harder, even if only to a slight extent, presented a greater resistance to the forces of erosion. Geographically, the interest of these hills lies in two directions; they provide a pleasant break in the general monotony of the scenery and they are the source of building stone and stone for use in domestic ways for the City of Madras. Without these it would be difficult to obtain sufficient stone from an area which is largely alluvial.

To the east of this mature plain with its isolated hills, a younger one has been developed. This consists of marine alluvium entirely. It is not very wide, being little more than a mile in some places. It is of recent elevation and of very gentle slope. The rivers have therefore practically no fall and meander across it, breaking into distributaries, as the Kortalliyar before it discharges into the Ennore backwater. They leave lagoons and marshes which they are unable to drain and therefore this area is of small human interest. It is impossible to cultivate the marshy area and in consequence the population is very small or non-existent. The lack of fall on the rivers in flood time is another disadvantage which is specially noticeable in this section of the district.

To the east of this marshy belt and shutting in the lagoons a slightly younger plain is being formed to-day. The currents along the coast set N.N.E. and S.S.W. alternately for six months at a time. They are therefore always parallel to the coast, They bring with them vast quantities of sand which is being continuously deposited and forms the typical straight line of a recently elevated coast. Bars are formed at the mouths of all the rivers, which except in flood time are not broken through, the quantity of water brought down not being sufficient to allow of this. With this type of rising coast it is impossible to find a natural harbour site ; moreover the continuous set of the currents always parallel to the coast has resulted in the silting up of the artificial harbour which has had to be made to deal with the trade of the City, built up, rather in spite of, than as the result of, natural causes.

The backwater formed by the sand bars has been utilised by the Buckingham Canal so that some advantage has

been obtained even from these adverse conditions; for, the rivers are quite useless for navigation and although roads and railways can be very easily constructed over the level surface the type of commodity to be carried locally is not of sufficient value to warrant the use of either of them if it is at all possible for water transport to be obtained. Casuarina wood from the surface, and shells for lime from the alluvial beds, form almost the entire commercial products of this strand plain. These are bulky and cheap, and therefore the Canal is the best means of transport for them.

The uniformity of the structure of the area as a whole has been of advantage in the construction of routes over the wide level plain. The difficulty usually encountered in country of this type, *viz.*, floods, is not met with here. This is the result of the very small volume brought down by the rivers during the greater part of the year, especially after the necessary quantity for irrigation has been removed. The marshy land immediately to the north of the city is the only district in which, owing either to the lack of population, or to the difficult nature of the country, good roads have not been constructed.

This is a predominantly agricultural district. In such an area the soil is bound to be a controlling factor in the life of the people. This is dependent on the geological formation and so we shall consider that next. Geologically, the area forms part of Peninsular India, the two chief characters of which are, the great age of the rocks and the comparative lack of movement over a wide area during many geological ages. This has resulted in very little variation in the type of soil, since the greater part of the southern end of the Peninsula is composed of an acid crystalline rock and so the alluvium derived from it is of the same character. The lack of movement has resulted in the juxta-position of very new and very old rock, the alluvium resting in some cases on the Fundamental Complex and in others on beds of Jurassic age.

The following series is now exposed at the surface.

Recent	Blown Sand
	Marino and fluviatile Alluvia
	Laterite
Pre-Cambrian	Charnockite
	Gneiss

The Gneiss underlies all the other beds and is part of the fundamental complex of the Peninsula. Here it is very little foliated and is generally acid in character weathering to a sandy soil. This soil cover is not very thick, and is porous, and the underlying rock often appears at the surface, none of which things is advantageous to agriculture. The general axis of folding runs N.N.E. and S.S.W. parallel to the present coast-line. This general direction can be traced for many miles beyond the area under discussion and seems to point to the fact that the coast was in its original formation in Pre-Cambrian times trending in the same direction as to-day.

As we have said previously, intruding into the fundamental complex we find another acid crystalline rock known as Charnockite. This forms all the large hill masses in the south; consequently Pallaveram Hills and the Mount belong to this formation. It is so similar to the rock around that for a long time it was not distinguished from the Gneiss but now it is recognised as a distinct formation.

There is a great gap in the sequence now, for the next beds belong to Geologically Recent series. This is the laterite of the Red Hills area. Unlike all the rest, this is a sedimentary rock. It belongs to what is known as Low Level Laterite, and as far as can be seen, it has been derived by subaerial denudation from the underlying Jurassic beds. These latter are not exposed at the surface but they can be seen in a section near Tinnanur Railway Station underlying the laterite. They represent the result of the only depression between Pre-Cambrian and Recent times. They consist of a series of coarse sandy shales and the laterite derived from them is therefore sandy in character. The best exposure is near Red Hills where the laterite is more argillaceous than it is further west but this seems to produce a particullarly infertile soil resulting in a very poor population as can be seen from the Population Map.

By the type of fossils found when boring in the City for wells, it is evident that some portions of the coastal strip have been recently submerged. The extent of this area of alluvium may be seen by reference to the geological sketch. Part of this area is covered by purely marine and partly by fluviatile alluvium and it is difficult in places to distinguish between the two. For geographical purposes this does not matter. The interesting thing for our purpose is to notice that these beds provide shells which can be used for lime

and the Buckingham Canal is used to convey them into the City.

The most recent beds are those forming a narrow strip all along the coast. Reference has already been made to these as the Strand Plain. These beds of Blown Sand are still in the course of formation. They are covered with casuarina trees except in the City itself. This tree has the advantage not only of binding together the sand and so preventing the drift inland of the wind-borne sand of the coast, but the recently discovered nitrifying bacteria of its root nodules tends to increase the value of the soil so that in time this area may be used for agricultural purposes. At present the other value of the tree is its use as firewood, so that this area of scanty population and apparently negative agricultural value is utilised for the domestic wants of the local population.

Speaking generally, the geology exercises nothing but a negative control on the human activities of the area; the uniformity in structure resulting in uniformity of soil type is the cause of this. Agriculture has to contend with a poor soil, with little hope of renewal as well as an inadequate water supply for the temperature. In addition to this the geological formation of a gently rising coast has precluded the possibility of any good harbour.

The drainage is effected by four rivers, only one of which, the Adyar, lies wholly within the area. All of them flow through mature valleys which have been practically reduced to their base level. This means that the fall is very slight and the velocity is insufficient to allow them to scour out the bed. All of them are depositing alluvium in their course. They rise in the Eastern Ghats and therefore are dependent on the N.E. Monsoon rains for their water supply. At their source this averages about 30-35 inches a year. This is not sufficient to allow a continuous flow. In November the rivers are all in flood but very soon afterwards only a trickle of water is to be found in the beds. This is due partly to the insufficient water supply, since,

a. More than 50% of the rain falls in the last three months in the year ;

b. The lowest rainfall is in the hottest months *viz.*, February, March, April and May ;

and partly to the artificial means used to conserve the water for agricultural purposes.

If to these two factors *viz.*, too slight a fall to allow of scouring, and an intermittent flow, a third factor is added *viz.*, the presence of a bar at the mouth of each river due to the set of the currents as previously stated, the explanation of the uselessness of these rivers as means of communication is obvious. They cannot now be used as means of transport even by small boats but their previous history has resulted in the formation of such a level plain that this is not a serious difficulty, for roads can be made with ease. The fact that for nine months at least there is only a very small flow of water in the beds makes it possible for the rivers to be crossed at fords, and so obviates the necessity for the building of bridges.

These rivers have a great part to play in the human activities of the district, for, without them, all agricultural work would have to cease for the greater part of the year. It is for their value as a source of water for irrigation purposes that they are important. Since the rain comes in the colder part of the year and the porosity of the soil increases the rate at which this is removed from the surface, it becomes essential that some of it at least shall be preserved for the rest of the year. This is effected by storage in shallow tanks which are formed in the valleys of small local drainages. Some attempt to regulate the supply has been made by the Red Hills and the Chembrambakkam schemes, but even so this method is rather a wasteful one. For, even if the monsoon does not fail or an extra amount of rain causes no disaster by the bursting of the tank bund, a great deal of the water is lost by evaporation from the surface of the shallow storage receptacles. The large number of the tanks is well shown on any map and the comparatively small number in which the water is permanent gives some indication of the uncertainty of the farmers' life in our district. The total area occupied by tanks which for some part of the year at least become waste ground is great in comparison with the total area of the district under discussion. To this unproductive area must be added that occupied by salt pans, marshy soil, and scrub. Even when all these are taken into consideration, this district, especially that part of it near the City, is more productive per acre than that to the North or to the South.

Climatically our year is usually divided into four seasons of unequal length, viz.,

Middle of December to end of February, the cold weather.

March, April and May, the hot weather.

June to the middle of October, the period of the S. W. Monsoon.

Middle of October to the middle of December, the period of the N. E. Monsoon.

It is interesting to notice that two of these divisions are based on temperature and two on rainfall, since by 'Monsoon' we now always mean in ordinary speech the rain brought by the monsoon rather than the wind itself. This is natural, for to us the rain is of supreme importance to life in Madras.

The term, 'cold weather,' is only comparative as all such loose expression as hot and cold must be. The mean annual range in Madras is only 15° F., and the drop in the temperature which comes with the setting in of the monsoon in October is only 3° F. The total drop from October to December is only 7° F. Nevertheless, as we all know, the cold weather is a very pleasant time of the year, except for the excessive dews in the early morning. The pressure conditions typical of the cold weather can be seen on the map and it will be noticed that the pressure gradient is very shallow, a difference of '05 inches only being discernible over the whole of the peninsula. The winds are variable in direction and comparatively light. This is what would be expected, since it is the period of change from the N. E. to the S. W. Monsoon.

In January, a return of the pressure conditions typical of the N. E. Monsoon frequently causes rain which we know as the Pongal Showers. In this district fortunately they are not usually serious, although to the South of us they often cause floods.

Temperatures rise rapidly from about the middle of March to the end of May. This is our most difficult time, as evaporation is increasing rapidly and the greater part of the water in the tanks has already been used for irrigation. This of course is the time of ripening crops and falling leaves. The new leaves which come immediately, not as in colder climate after a period of rest for the trees, make our City very beautiful for a short period, but soon the increasing temperature results in a generally withered appearance of all the vegetation, as if that too, like the human inhabitants, were panting for the coolness which comes with the break of the S. W. Monsoon on the West Coast.

These months are particularly uncomfortable, for the temperature is at a maximum of about 90—94° F. at the beginning of the period and then seems to be capable of holding the maximum amount of moisture without depositing it. Strong southerly winds blow along the coast, causing heavy breakers on the shore and whirling the fallen leaves from place to place on land. The strength of this wind causes large quantities of spray to be tossed into the air all along the coast. The temperature is sufficiently high for a good deal of moisture to be absorbed by the wind as it passes over this belt; and in consequence the atmosphere of Madras during March and April is uncomfortably damp. A short distance inland, say at Poonamalee, this damp condition is not found, showing that this explanation is probably correct.

Although the cold and the hot weather are usually dry when compared with the other two seasons, "mango showers" fall towards the end of the hot weather. These seem to be thunder showers created by the meeting of the damp winds of the coast with the dry winds of the interior.

By the middle of June the S. W. Monsoon has broken on the coast. We do not derive a great deal of benefit from it especially in the City, but a rainfall of 4—5 inches is useful in replenishing the domestic water supply which sometimes has become uncomfortably short in the "hot" weather. The Southern and western portions of the area benefit more directly as may be seen from the map. Since the Northern portion gets less rain by the N. E. Monsoon than these parts it follows that this is distinctly less valuable as agricultural land.

The real advantage that is gained by the S.W. Monsoon however is the drop in temperature. The July average is 3° F. lower than that for May; and it continues to drop steadily to the end of the year with one break, when it remains the same during August, due to the return of the Sun; but the temperature does not rise to the same height as it did in May when the Sun last passed overhead, being kept lower by the cloudy Monsoon sky.

In September the wind changes, the low pressure centre over the Indus valley is gradually filled up and the S. E. current which has been flowing strongly up the Ganges valley all through the summer months changes its direction and becomes a N. E. current, which, crossing the Bay of Bengal, strikes the East Coast about the latitude of Madras. This is

not nearly so strong a current as the S. W. one is, as can be seen by the much shallower pressure gradient in the two monsoons. Nevertheless it is sufficiently strong to produce rain all along the coast. The distribution of the rainfall may be seen from the map, the heaviest amount falls in a belt just South of the City and parallel to the coast. It is interesting to compare the annual distribution with that of the N. E. Monsoon, and to see how much the former is dependent on the latter. Three belts of rainfall are found in the area, which, although the difference in amount is slight, are sufficient to mark out belts of differing agricultural value.

It is obvious that the rainfall is a far greater factor in our climate than temperature. The distribution in time of this fall is even more important than the amount, since none of the districts within the area has too small a fall in a normal year for agriculture to be carried on successfully. Our difficulty arises from the fact that by far the greater part of our fall comes in the last three months of the year and must therefore be stored for use and husbanded with such extreme care. While this is true the rains of the other part of the year are still of considerable importance *e.g.*, the Mango showers of April, and the S.W. Monsoon period rains, which enable the farmer to plough his fields once more after the "hot" weather has passed.

Vegetation.

We turn now to the application of all the facts that we have been considering, soil conditions, water supply and climate, and see how both the natural vegetation and the cultivated crops are distributed over the area. The natural vegetation is that of a typically overporous soil and a country in which the possibility of drought is always present. It is true that for the greater part of the year we have a green covering over the ground but this gets very parched if we have an extra dry season. It consists of two types of plant for the most part, rough grass whose long roots can cover a large area in the search for water, and plants such as the prickly pear, which store water. Near the coast the grasses predominate as they are specially well adapted for living in sand and they do a great deal in binding the soil together, so making the dunes permanent. The greater part of this work however is being done by the casuarina which is specially well adapted for this purpose.

One term on our O.S. map is most misleading. I refer to the term, "Forest". Who on looking at the Vandalur Hills, for instance, would consider that they were covered by forest, yet they are so marked on the map. Scrubby jungle would be a much better term for the type of growth found. This consists of grass and shrubs with some small trees, these latter usually of the thorny acacia type, another adaptation to drought conditions. This natural vegetation is turned to account and according to the last statistics the chief forest revenue in the Chingleput district is derived from grass and firewood, a comment on the term "forest". The amount derived from timber is only Rs. 81 compared with Rs. 58,046 from the grass and firewood.

Although natural forest cover is absent from this area there is a considerable amount of tree growth where it has been planted and cared for in the early stages of its development. Along our roads and around all our villages, shade trees have been planted; and we cannot imagine life without them, but they are the result of the human activity of the district. Even these trees show adaptations to a dry environment, *e.g.*, the thick leaves of the banyan and the closing leaflets of the rain tree as well as the numerous thorns of the various species of the acacia.

Passing now to those trees which can be considered as cultivated crops, we must mention the mango, which is so useful as a shade tree, the cocoanut and the plantain. All these are found throughout the area but they all, especially the two latter, make great demands on the precarious water supply and must be reckoned as irrigation crops.

The palmyra is of a different type. Its uses are well known to all of us and it has the distinct advantage of not requiring nearly so much cultivation as the cocoanut and not nearly so much water. This is an important matter to us.

The interesting thing about the other crops is that the overwhelming percentage of the area is under food crops. In the Chingleput district, (figures are not available for smaller areas than districts) in 1921-22,71% was under paddy, 88 % under cereals, 3 % under other food crops, in the total area cultivated. This seems to be a natural thing in an area such as ours, where the local supply is about sufficient for the local demand, where the poverty of the majority of the population is such that food is nearly the only necessity. It is one advantage of our climate that, during the greater part of the

year, the temperature is so high and the atmosphere so dry that little attention need be paid to clothing and shelter. It is only in the few wet months at the end of the year that we have to trouble to any great extent about these things. Therefore our attention can be concentrated on the task of providing sufficient food-supply for a very dense population.

Of the possible cereals the two that are of greatest importance are rice and ragi. Paddy has the greatest yield per acre of any cereal and therefore is of special value to this densely populated, poverty-stricken community. Ragi on the other hand has the advantage of not requiring so much water and of being richer in food value.

The amount of each which is grown, varies in the different parts of the area. In the South the figures are Paddy 71 %, Ragi and other cereals 17 %. In the North East the figures are Paddy 16 % Ragi and other cereals 66 % and in the North West Paddy 21 % Ragi and other cereals 65 %. The reason for these differences is the difference in the water supply. In Chingleput District the total number of tanks is 2614 while the Nellore District which is much larger in actual area has only 733. In these circumstances, it is impossible to grow paddy to any large extent.

The other food crops will be seeds, either ground-nuts or gingelly oil seeds. The first of these forms the only exported food stuff of any importance in Madras. The latter are used locally. In addition, the betel and vegetable gardens of the district around Poonamallee must be taken into consideration but here again it is a case of local supply for the local demand.

Another interesting fact about the crops grown in the area is the non-existence of any fodder crops. This is again an instance of the control of physical conditions on the human activities of the area. The necessity to provide food for human consumption in an area where there is such a dense population and where there is no natural product either in the form of raw material or in a manufactured state, which can be exported in exchange for food, makes it impossible to provide for cattle. It is true that we must have draught animals for agricultural purposes and that these must be fed; but we depend on the natural vegetation which as we saw before is very poor, and on the waste from the oil seeds.

One other product we do possess which can be conveniently treated here. I refer to the herds of goats which feed on the waste land of the district and which provide the one exported product, which is of importance, from this area. It is true that we referred to the export of ground-nuts but these are not of great importance till we get further South than the area treated here. The hides and skins both raw and tanned from the goats are however of considerable importance and may be considered as a truly local product.

In conclusion, let us try to summarise the effect of the Physical Environment on the Human Activities of the area. The fundamental structure provides us with a comparatively poor soil and an extremely poor harbour. But against that must be set the advantage of a wide plain over which routes are very easily made and one which is not subject to flooding in spite of the numerous streams and the general levelness of the surface. The lack of a good harbour has tended to produce a local rather than a foreign trade outside the City of Madras. The ease of communication has tended to the establishment of numerous small self-contained villages which can easily communicate with one another rather than one or two large towns at strategic points which would naturally collect the products of the varying geographical regions which met at those points. More fundamental than this, however, is the control which the structure exercises over the human geography. The uniformity of the structure and the uniformity of the soil has necessarily resulted in a uniformity of crop and therefore of occupation. When everyone in a given area is interested in one thing the tendency to conservatism is bound to be great. When, in addition to this, the thing in which they are interested is the means of earning a living from rather precarious sources and under generally adverse physical conditions, the tendency is increased tenfold. This is a great disadvantage to our district. The climatic control is such that in a normal year it is possible to get a living from the soil. But if anything untoward happens such as the failure of the monsoon or an excessive monsoon involving perhaps floods, disaster arises. In these circumstances it is incumbent upon us to try to lay aside in the good years to provide for the poor ones. This we find impossible to do, for, in the best of times the supply only just meets the demand. But is it necessary that this should be the case? With our present means of agriculture it seems

to be so but is it not possible for us to improve our machinery and our fertilisers to such an extent that we shall be able to tide over these recurring bad years? With physical conditions such as ours, it seems imperative that we should do so. We are bound to utilise all the means in our power to improve our prospects if we are to make use to the utmost of the provision that Nature has given to us. I do not know much about agriculture and I expect that there are people here who have a practical acquaintance with it, and it is time that they had a chance of saying what they think about these conclusions.

Miss E. D. Birdseye, B. Sc., Dip. in Geography (Lond.)

An ordinary meeting of the Association was held in August 1926 at the Presidency College, *when Miss E. D. Birdseye, B. Sc., Dip. in Geo. (London)* read the above paper on "The Physical Geography of Madras and its environs." Mr. Sami Venkatachalam Chetty, President of the Corporation of Madras occupied the chair.

Mr. Sami Venkatachalam Chetty emphasized the value of geographical studies for obtaining real knowledge of our environment, and deplored the lifeless way it used to be taught and the scandalous neglect of geography in schools and colleges here.

Rao Bahadur Mr. H. Narayana Rao showed the connection of the region with the Cuddappah series and explained therewith the general trend of the coast, plain, and hills. He also explained the shape and the formation of the conspicuous hills of Pallavaram, St. Thomas Mount, etc.

Mr. Dann wondered how Madras became the capital of South India, having none of the physical advantages that usually account for the rise of towns. It looked as if God Almighty never meant that this coast should have a harbour, and that Madras should be a Capital.

Mr. Anstead called attention to the effects of malaria on population, the insufficiency of tank-supply accounting for the distribution of ragi and paddy, and to the effect of casuarina upon the soil. He pointed out how the poor sandy soil of the coastal strip may be reclaimed with organic matter. This would be available in large quantities, if the drainage of Madras be treated by the activated sludge-process as in Shanghai and partially in Bombay.

Messrs. N. S. Narasimha Ayyangar and Y. S. Singh wanted that the human side also should be treated.

Mr. M. Subramaniam explained how the whole region is dominated by the hill and the sea and the sun, and how the city came to be founded here.

With the usual vote of thanks, this very interesting meeting came to a close.

The Geographical Evolution of Madras and its Environs.

The area dealt with in this paper comprises the Collectorates of Madras and Chingleput. Before proceeding to give an account of the geology or the former geography of this area, which is the primary object of this paper, it would be well to refer briefly to the present physical features or the physical geography of the area, as this is really the outcome of the former. For it is a well-known fact that the present geographical features of any country are determined by, and are really the result of, its previous geological history, the present geography being only the last stage in the process of evolution which has taken place in that area.

The general features of this area are those of a gently inclined plane sloping gradually down to the sea, broken though here and there by wide shallow river-valleys and along the coast by backwaters and lagoons. Only the north-west and south-east parts are hilly, the Sathiavedu and Alicoor Hills lying in the north-west and several ridges of low hills in the south-east running roughly parallel with the coast-line at a distance of about eight or ten miles inland. A smaller set of parallel ridges occur around and north of Chingleput. To the north of these are several detached and isolated hills such as Guduvancherry, Vandaloor, Pallavaram, St. Thomas Mount, Pulicaranei Hills, etc., none of these smaller hills reaching an elevation of more than 900 feet above the sea-level. The principal rivers draining the area are the Palar in the south the Corteliar and Nagari rivers in the centre and the Narnavaram river in the north, all falling into the Bay of Bengal. The Palar is the chief river of the area. It rises in the Mysore Plateau, and after draining North Arcot District, is joined by the river Cheyyar and falls into the sea three miles south of Sadras. The Corteliar has its origin in the surplus waters from the outflow channel or Kalangal of the large Kaveripakkam tank in North Arcot District. Swelled with the surplus waters from the tanks of Wallajah Taluk and by two jungle streams, it flows through Tiruvallur and Ponneri Taluks. By means of anicuts in its course, it is made to supply some of the large

irrigation tanks in the district such as the Sholavaram and Red Hills tanks, and it falls into the Ennore Backwaters, a little to the north of Madras. The Cheyyar river rises in the hills which lie between North Arcot and Salem districts. It also gives off numerous irrigation channels, and it fills also the large irrigation tank of the Uttaramerur village and joins the Palar river. The Aranyanadi or Naranavaram river passes across the Ponneri Taluq and enters the sea near Pulicat. The Coum river is formed by the surplus waters of a tank of the same name in Conjeeveram Taluk. It irrigates a number of villages such as Kadambattur, Tinnanur, and other villages along the line of M. S. M. Ry., and by means of an anicut, supplies the big irrigation tank of Chembarampakkam ; and passing through Madras, joins the sea near the Marine Villa. The Adyar can be traced as far as Guduvancherry ; and it hardly assumes the appearance of a respectable river till it reaches Madras after receiving the overflow water from the Chembarambakkam tank. As the level of the stream is much below that of the surrounding country, it is not largely used for irrigation.

GEOLOGY OF THE AREA

(See the sketch geological map No 7.)

Metamorphic or Gneissose series—These form the western margin of the area. They also form the isolated and scattered hill-masses rising suddenly from the alluvial plain such as Pallavaram Hills, St. Thomas Mount, etc. These rocks form the oldest and bottom-most rocks on which the younger or stratified formations are deposited, being uniformly met with at some depth underneath the mantle of overlying later sedimentary formations. The precise mode of origin of these rocks is matter of speculation, as they everywhere show signs of intense change from their original condition, under the action of intense heat and pressure. So far as the present area is concerned, we can recognize two distinct types of these old rocks, (1) The Gneisses, and (2) The Charnockites. The Gneisses form the older series through which the Charnockites have pushed their way or injected while in a molten condition, or in other words, are "intrusive" into the gneisses. One remarkable feature of these gneisses is that they are cut up by divisional planes or planes of cleavage so that the rock is easily cleavable or separable along these planes. This property or arrangement in layers is

called 'foliation'. It is worthy of note that these planes of cleavage or foliation run in a definite direction north-east to south-west, which is coincident with the general direction of the coast-line, showing that they are both the result of the same cause, which is pressure of earth-movement which acting in a direction at right angles gave rise to the land and determined the general direction of the coast-line and gave rise also to these planes of foliation. For, it can be shown by experiment that when a mass is pressed down, it will not only flatten out in a direction at right angles to the direction of the pressure but it will also develop planes of cleavage at right angles to the direction of the pressure. The Charnockite masses are found wedged in along the foliation planes of the gneisses, having been squeezed in while in a molten condition along the foliation planes of the gneisses, this being the direction of least resistence to the invading molten rock, see a specimen of gneiss showing foliation. It is remarkable that all the Charnockite masses forming hills as at St. Thomas Mount, Pallavaram, etc., show the same general trend see this features on the Map as the direction of the planes of foliation. The charnockite rock being the harder, more compact rock, has withstood the forces of sub-aerial erosion, and is now found standing out as hills, while the gneisses, being cut up by these divisional planes and being also softer and more friable, have been worn down, and are now found forming the plains. This is why the Charnockite rocks are found forming hills, while the gneisses form the low-lying plains. Another striking feature of the Charnockite hills is their lenticular form, how they rise abruptly from the plains and are very steep-sided. This is quite in keeping with their origin. (See figure of an intrusive boss). The gneisses are characterised not only by these planes of foliation or division but also by the crumpling or extreme folding like the folds of a carpet when compressed, showing that they were subjected to intense earth-movements after they were formed. They furnish therefore strong evidence that this area in this early stage of its history was greatly susceptible of movement unlike the rigid and stable condition which it has attained since. When we come to the next stage in the history, *i.e.*, the Cuddappah age, we find from the character and the distribution of the rocks of this age, that Peninsular India had attained by this time the character of rigidity and stability. The general trend of the coast-line on the east coast

seems to have been already determined by this time. (See here the Cuddappah area and its western margin). Judging from the rocks or sediments that are found forming the western margin of this basin, the coast-line at the time of the deposition of these rocks appears to follow the general trend of the present coast-line, only it was further inland and seems to have gradually shifted outwards to its present position. For, the rocks making up this western margin of the Cuddappah are all coarse-grained fragmental deposits characteristic of the shallow sea very near the coast. In the area under discussion the rocks of the Cuddappah series are found making up the Nagari Nose and the main mass of the Nagari Hills, and it is likely that these rocks may have extended further south and covered the gneisses which now form the base of the Naickenpollium Hills, and they have since been removed by denudation. For here we find a quartzite conglomerate at the base of the next overlying and younger Jurassic rocks on the south-west slopes of the Naikenpollium ridge. The deposits found here are conglomerates, etc., identical with the coarse-grained fragmentary deposits forming the western margin of the main Cuddappah area, clearly proving that they were formed very near the coast. They mark the general line of the sea-coast of this period which it, will be seen, is parallel to the present coast-line, only further inland. (See on the map No. 7.) In contrast with this early determination of the east coast-line as early as the Pre Cambrian period (for the Cuddappahs belong to this period), I may mention that the westcoast was determined very much later. It was only about the end of the Mesozoic age that the coast-line on the west coast was formed. Till then a big continent had extended right up from Peninsular India to South Africa, and at one period even to Australia across what is now the Arabian Sea and the Indian Ocean. This continent was called Gondwana land by geologists and Lemuria by zoologists. At about the end of the Mesozoic and the beginning of the Tertiary Epoch, a series of mighty changes took place resulting in the submergence of a portion of this vast continent, the emergence of the Arabian Sea and the west coast bounded by it, and the simultaneous upheaval and formation of the Himalayan range of hills on the site of what till then was an arm of the sea. These changes were heralded by a series of volcanic eruptions on a gigantic scale, evidences of which are so abundant and conspicuous in the Bombay Presidency and in the

Deccan ; but this is another story, foreign to the subject of this paper.

Rajmahal or Jurassic Rocks.—The area covered by these rocks is an irregular patch stretching northward from the north bank of the Palar about four miles west of Conjeeveram to the western extremity of the southern part of Alicoor Hills. Then it follows the westerly base of these hills and of the Sathiavedu Hills. At the northern extremity of the Sathiavedu Hills, the boundary of the area bends and winds along their eastern flank down to the banks of the Narnavaram river. If the boundary be thence continued to Poonamallee and across the Apoor Hill to the bank of the Palar, it would enclose all the localities covered by the Rajmahal rocks. The rocks are generally covered and obscured by the laterite formations and occupy the broad area in the central part of the region. (See the distribution of these beds on the map No. 7) The western boundary of these rocks marks the ancient coast-line of the period. A study of these rocks shows in general that the coarsest rocks are conglomerate and boulder-beds on the western margin *i.e.*, near the coast ; and there is a gradual decrease in coarseness as we proceed eastwards, the finest and most homogeneous clays and shales being found at the most distant point from the source from which the constituents are derived. Standing on the Alicoor Hill, one can notice the broad valley running north north-east from Nagalapuram formed by great beds of conglomerates and sandstones running as far as the present Sathiavedu Hills and the slopes of Ramgiri and Cambaucum Droog Ridge. The enormously coarse conglomerates of Sathiavedu Hills were formed by masses rounded by the action of a tremendous surf battering against the base of a great line of cliffs forming the grand and most conspicuous precipices along the side of that fine mountain ridge. From the top of the Alicoor Hills, gazing similarly in a north-western direction at the enormous scarps of quartzite which cap the Nagari Nose, the Narnavaram Peak and the Suddheswar Malai, one can notice the great boulder-like masses of quartzite which occur alone on the eastern part of Alicoor Hill and the gneissose boulders occurring on the western and southern sides of the hills and at comparatively low levels. These boulders must have been washed into the sea on the inclined plane which abutted on the base of these huge lines of ancient sea-cliffs. The violence of these currents requisite to move such huge

weighty masses is further indicated by the extreme disorder in which the materials of most of the boulder-beds and conglomerates are seen to occur. In contrast with this, the very fine-grained shales of Sriperumbudur, and also those occurring in the valley of the Kullar and Atrampakkam Nullahs indicate deposition in tranquil water and at greater depths, and away from the coast. The fragmentary nature of the fronds and the leaves formed in these clay-beds show that they were drifted out to sea.

Laterite formation.—This formation which is the next in the order of age forms the greater part of the surface of higher tracts of land between the different alluvial valleys and lies on the Rajmahal series or directly on the gneisses. Laterite as it is seen in this area is a typically sedimentary formation, though devoid of organic remains. It is most probably of marine origin. The several patches in which it is found are clearly the remnants of one continuous formation cut across and separated by the action of the larger rivers as the land was gradually emerging from the sea; this would naturally result in the lengthening of the course of the rivers. When the laterite formation was being deposited in the bed of the sea, the rivers opened straight into this sea and when the sea receded and land was being widened, the rivers would automatically lengthen their courses. The parallelism of the bands of laterite with the coast on one side and with the general strike of the high ground of the peninsula on the other is well marked and this is an indication that it must have been deposited in the bed of a continuous sea. The typical laterite may be well studied in the Red Hills near Madras. No organic remains are found in this rock though chipped stone implements of human manufacture are found imbedded in it here and there and at some places in large numbers, showing that man had appeared prior to the formation of these gravels and conglomerates. The laterites, though they cover a large area of the surface, are of very small thickness, not more than a few inches thick. They lie unconformably on the older rocks such as the Jurassic and sometimes overlap these rising directly in the gneiss, showing that the laterite had in some places extended further inland. If we proceed westwards we notice a gradual and steady increase in coarseness of the quartz particles till the source from which they were derived is reached. This clearly proves that the beds are of sedimentary origin and that

the coarser bed marks the proximity to the coast. It is likely that the marine currents at work in the sea of the time may have deposited masses of sand of a mixed character, siliceous in some places, ferruginous in other places (like magnetic iron sand) which when elevated above sea-level and exposed to atmospheric agents, might in course of time be oxidised and according to the poverty or the richness of the sand in iron, remained as simple sands or became sands with laterite grains or laterite gravels (formed by the joining together of the grains under the action of the cementing material, peroxide of iron; and when pebbles existed very near the coast-line, laterite conglomerate was formed. This is the explanation generally offered for the formation of the laterites here. The occurrence of chipped stone implements in the conglomerates is quite natural as these implements would naturally be dropped down near the coast on which dwelt these primitive implement-makers. It is remarkable that these laterite formations with the human implements imbedded in them are all found at elavations of 200 or 300 feet at the present day, showing the extent to which land has been upheaved after the deposition of these beds. It is likely that the laterite beds were deposited at the bottom of a shallow sea studded with mountainous islands in the straits between which flowed currents of great rapidity and strength. The sea flowed far up among the quartzite and gneiss hills of Nagari, Tirupati, Kalahasti, while the Sathiavedu and Alicoor hills and the scattered hills of St. Thomas Mount, Pallavaram, Vandalur, Guduvancherry, Chingleput, Tirukkalikundram, etc., stood as islands in this laterite sea. This laterite sea was probably washing a low gneissose coast-line trending north-north-east direction (parallel to the present coast-line) only much further inland from near Kaveripak to the neighbourhood of Nagari Nose (See on the map.) These islands in the laterite sea were inhabited or visited by the people who manufactured these stone implements which form the only record of the existence of these people.

Marine and Estuarine Alluvium.—Beds containing abundant remains of marine and estuarine shells are found all along the coast and to a considerable distance inland from Madras to the south as far as Sadras. The whole of Madras is built entirely of such beds as will be seen whenever an excavation for a well, a foundation for a house or for laying down the municipal water-pipes is made. It is

a well-known experience of every builder in Madras to come across such shells when digging for house foundation. The Buckingham Canal from Adyar southwards, cuts through a series of these marine beds, black or grey clays and sandy clays full of marine shells which are thrown up on the sides of the canal. The fact that these shells are all of species now found living in the Arabian Sea proves the recent age of these beds. It is clear therefore that at the deposition of these beds Madras was nowhere and that a shallow sea covered the whole of this area. The sea of the lateritic time seems to have continued, though shifted a little further eastward and it is only sometime later that an elevatory movement took place giving rise to land and the shifting still further outward to the east of the coastline to its present position. From the disposition of these beds we can have an idea of the Geography of the area. (See the map No 7.) The sea must have extended westwards as far as the Pallavaram Hills and several of the isolated hills as St. Thomas Mount, Pallavaram, Mahabalipuram, Pulikaranai Hills must have formed islands in this sea. From the top of St. Thomas Mount one can have an idea of this vast stretch of marine alluvium. The presence of backwaters and lagoons, saltwater lakes and salt-pans such as Covelong, Ennore, Pulicat and the innumerable salt-pans found all along the coast form another evidence of the existence of the sea in this region, as these are only remnants of the sea which have persisted in some of the lowlying portions of the plains near the coast even after the coast-line shifted outward to its present position. These marine and estuarine beds form a narrow belt running along the coast varying in width from one to four or five miles. West of San Thome this belt widens greatly forming a deep bay extending beyond Poonamalle Cantonment where these beds are overlaid by the alluvium of the rivers. To the north-west-west of Madras (Georgetown) this belt of marine alluvium is bounded by the laterite beds of the Red Hills and the belt narrows to about six miles, but immediately north of it, it widens out again and attains its maximum width in the delta of the Cortelliar and Narnavaram rivers till we reach the Pulicat lake. The islands of Sri Harikota, etc., which separate the Pulicat lake from the sea are entirely made up of these marine beds. It is well-known that these islands furnish innumerable shells which form such an important article of export, being used in the

manufacture of chunam used for building purposes. The shells are conveyed in boats along the Buckingham Canal to Madras and other places. These shells are all shells of marine animals belonging to the same species as are now living in the Bay of Bengal. (See on the map No. 7 the distribution of these beds.)

River Alluvium.—The rivers rising in the higher ground on the west must have flowed into the lateritic sea at the time of deposition of the laterite and must have lengthened their courses as the coast line was being gradually shifted outward and accretion of land was taking place by the receding of the s a. The river alluvia are also of great interest. The distribution of the river alluvia clearly proves that at some past period within the human era, the courses of some of the principal rivers were different from their present courses. As it is at present, the Palar after joining the Cheyyar is seen joining the sea a few miles south of Sadras. There are strong grounds for believing that this river had at one time flowed in a northerly direction in the valley through which the Cortelliar is now flowing, opening into the sea somewhere near the present mouth of the Cortelliar River. The reasons for this inference are these :— (1) The broad open valley through which the Cortelliar now flows is very much bigger and broader and altogether disproportionate for the present size of the river now flowing in it. (2) There is a stream now actually in existence connecting the Palar and flowing in a northerly direction, and joining the Cortelliar. The valley in which this stream flows is a broad and open valley out of proportion to the river now flowing in it, and it is interesting to note that this small stream is called by a Sanskrit name Vriddhakshira which means Old Palar. The broad valley of this small stream is continued into the broad valley of the present Cortelliar, so that a much bigger river had once flowed in this valley and had carved that valley. (3) The nature of the alluvium : It is a well-known fact that the alluvium deposited by a river varies with the nature of the rock making up the area drained by that river. The Palar being a big river, taking its origin, as already mentioned, in the Mysore Plateau, is characterised by its alluvium being made up entirely of debris of coarse granitoid rocks occurring so largely in North Arcot District. It is generally a coarse gritty sand, rarely clayey or loamy. It is noteworty that the alluvium making up the banks of the valley in which the Cortelliar now flows, is identical with this

The deposits of the Cortelliar on the other hand are easily distinguishable from the coarse sandy alluvium of the Old Palar. As we have already seen, the Cortelliar takes its origin from the surplus waters of the large Kaveripakkam tank in North Arcot District, and drains the Wallajah, Trivellore, and Ponneri Taluks, areas which are largely covered with laterite rocks, so that the alluvium brought down and deposited by the Cortelliar, therefore, is largely made up of reddish loam or sandy clay; and this is exactly the alluvium found covering the sloping sides of the old and deep valley now occupied by the Cortelliar and unlike the alluvium found on the higher banks of the same valley.

Nagari river is another river which seems to have undergone a similar change. Of course this river now joins the Cortelliar river. It must have originally opened into the Naranavaram river, a little to the south of the Nagalapuram village. A board alluvial valley can be seen stretching eastward along the foot of the Nagari Hills towards the Nagalapuram Range. This marks the site of the old Nagari river valley. It is now found cutting its passage through a neck of gneissic rocks at a point two and a half miles eastwards of Nagari town and joins the river Cortelliar.

Blown Sand.—The last and youngest formation in the area is the blown sand. It is found forming low hillocks fringing the beach and it may be found forming ridges considerably inland. These sand dunes are entirely due to the action of winds, their further inroads being checked by vegetation. This marks the last stage in the process of evolution of the geographical features of the area.

We may sum up briefly the history thus: There have been the successive stages in the process of outward march of the sea-coast, and the consequent lengthening of the courses of rivers, together with changes in the courses of some of the rivers.

H. Narayana Rao, M.A., I.E.S. (Retd.)

An ordinary meeting of the Association was held in the Presidency College on Wednesday, the 15th September, 1926, with Miss I.H. Lowe, M. Sc., F. G. S., F. R. G. S., Deputy Directress of Public Instruction, in the chair, when Rao Bahadur M.R.Ry., H. Narayana Rao, M.A., I. E. S., (Retired), read the above paper on "The Geographical Evolution of Madras and its Environs."

After a brief introductory speech from the chair, Mr. H. Narayana Rao read his paper (printed above), at the end of which there was an interesting discussion.

Miss Lowe observed that the origin of the laterite was still in dispute, and that there was no compelling reason to hold it to be of Marine origin. The changes in the course of South Indian rivers await research. Past history showed that the coast-line had been extending eastwards from the Nagari Hills, and in this Geological Evolution, what the future of Madras would be as a seaport, would make an interesting study.

Mr. P. F. Fyson remarked on the formation of laterites and the evidentiary value of the type found near Waltair. He noted the peculiarity of South Indian rivers taking a southerly bend near the coast.

Dr. M. S. Krishnan of the Indian Geological Survey spoke on the formation of laterite, and referred to his experiences in Orissa, where there is neither marine nor riverine origins to account for it. He was of opinion that it was due to sub-aerial causes.

Mr. N. Subrahmanyam referred to the sands between Takkolam and Palur Railway Station to show the change in the Palar river-bed, as well as to there being tradition of there having been a change in the course of the river.

Mr. H. Narayana Rao referred to the vast unbroken stretch of the laterite area as rebutting the riverine origin, and suggested the probability of there being two kinds of laterite formations, one marine and the other sub-aerial.

The meeting then came to a close with the vote of thanks to the Chairman and the Lecturer.

* * * *

Mr. R. Ramamritham raised the question whether the coast-line of Madras was fixed or determined as early as the Cuddappah period in view of the Peninsular India being connected with Gondwana Land which stretched to Australia, and referred to Hobbs: *Earth Evolution and its facial expression* pp. 90 to 92; R. D. Oldham: *Manual of the Geology of India*, p. 211; D. N. Wadia: *Geology of India*, pp. 109, 110.

Mr. H. Narayana Rao's answer is as follows:—

"With regard to Mr. Ramamritham's letter taking exception to my remark that the general direction of the East Coast was determined much earlier than that of the West Coast and maintaining that the East and the West Coasts were formed simultaneously with the submergence of the Gondwana Continent and the upheaval of the Himalayan range

about the end of the cretaceous or the beginning of the Tertiary epoch, I would invite attention to these facts.

"All along the East Coast from Trichinopoly *i.e.*, from Lat. 11° N. to Lat. 25° N., a series of patches of upper Gondwana beds, containing fragmentary remains of plant life washed down into the sea from the neighbouring Gondwana land, and associated also with *marine fossils*, is found resting on the edge of the gneiss on the western side, and showing a *general parallelism* to the present coast-line which is found lying a little further east. It shows clearly that a *continuous* sea washed the eastern edge of the Gondwana land while *the Gondwana land was still intact*, and before it broke up at the close of the cretaceous or the beginning of the Tertiary epoch. It is well known also that marine cretaceous beds of more or less shallow water or littoral origin are found in the Trichinopoly and Pondicherry areas and also in distant Assam containing fossils identical with those found in the Trichy and Pondicherry areas. From that, it is clear that the sea continued to wash the eastern edge of the Gondwana in the Cretaceous epoch also and that this coast-line in the cretaceous epoch extended as far as Assam.

This Assam Range occupies a peculiar position. The northern flank of this Range looking towards the Brahmaputra has a gentle slope made up of gneiss and granite. This gneiss is precisely similar to that which forms the Peninsula. On the southern side, it is made up of Vindhyan rocks, a continuation of the rocks of Behar and a series of fossiliferous beds in quick succession forming the tableland such as cretacean beds (similar to Trichy cretacean). The character of the cretaceous beds is such as to suggest that the northern shores of the Cretacean sea once extended across this tableland.

"In the face of these distinct evidences, I fail to see how it can be held that the east and the west coasts were formed simultaneously with the submergence of the Gondwana land about the beginning of the Tertiary epoch.

"As regards Mr. Krishna Kumar's letter, I maintain that connection of the Gondwana land with Australia was maintained not through a stretch of land extending across what is now the Bay of Bengal, but through a stretch of land running in the N. E. direction from the Peninsula passing through Bengal, Assam, Burma, Malay Archipelago and finally linking it with Australia. (*Vide* my paper 'Geographical Evolution of India' read before the Madras University as Sir Subramania Iyer Lecture for 1922 and published in the Indian Review, Madras, Aug. 1922). Vide also map 8."

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7. A person shall become an ordinary member upon the proposal by a member, the seconding by another member and approval by the cou cil by the majority thereof present at its meeting. He shall pay an annual subscription of rupees *two* payable in one instalment or in two equal half-yearly instalments at his option.

8. Those who pay an amount of hundred rupees in two years become LIFE MEMBERS, and they shall be exempt from payment of any further subscriptions.

Officers.

9. There shall be the following officers for the Association :—

Patrons, Vice-Patrons, President, one or more Vice-Presidents, Secretary and Treasurer.

Management.

10. The management of the Association shall vest in a working Council, which shall consist of the president, the vice-presidents, the secretary and the treasurer as ex-officio members, and four others elected by the general body, one at least of whom shall be from amongst the mofussil members.

11. The *Quorum* for a meeting of the working council shall be three.

The Powers and Duties of the Working Council.

12. The duties of the Working Council shall be:—

(*A*) To receive and approve all applications for membership;

(*B*) To arrange for the annual and other meetings of the Association;

(*C*) To provide for the custody and utilisation of the funds and other property of the Association;

(*D*) To appoint committees and assign duties to them;

(*E*) To act in all respects on behalf of and with the powers of the general body, except when it is actually sitting.

13. The working council shall have the powers, subject to the veto of the general body, to issue, modify or rescind bye-laws, for the regulation of the work and activities of the Association.

Miscellaneous.

14. The official year of the Association shall be from 1st January to 31st December, and shall be divided into two sessions.

15. The Annual Meeting of the Association shall be held in December, when the officers for the coming year shall be elected.

16. All life membership subscriptions, all unspecified donations and one-third of all ordinary subscriptions shall be carried to the capital fund of the Association.

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The Secretary,
The Madras Geographical Association,
Y. M. C. A., Vepery, Madras.