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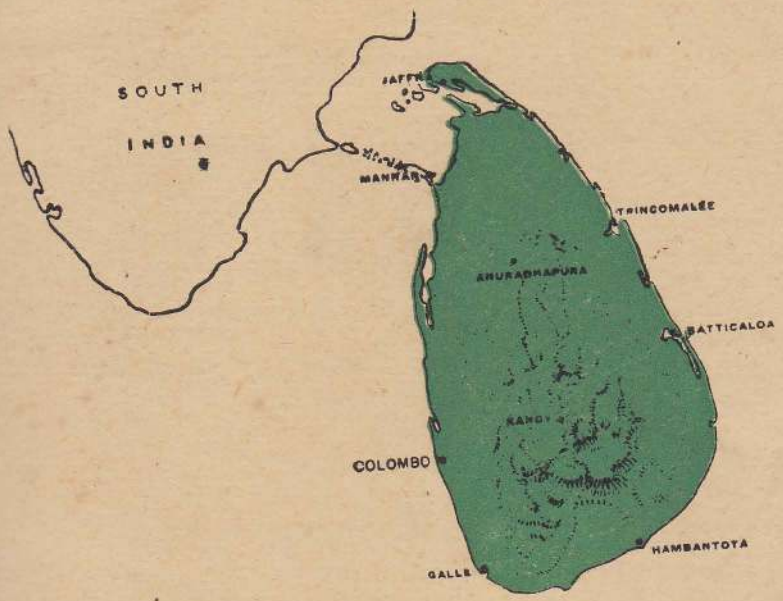
OF THE

CEYLON

GEOGRAPHICAL SOCIETY



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PROGRESS OF THE GEOLOGICAL SURVEY OF CEYLON

By L. J. D. Fernando

HISTORY OF THE DEPARTMENT OF MINERALOGY 1903—1935

Our early knowledge of the geology and mineral resources of the Island is derived from the reports of the Mineral Survey directed by the Imperial Institute during the period 1903 to 1918. The Mineral Survey was established in 1903 on the recommendation of Professor W. R. Dunstan, the then Director of the Imperial Institute, with Dr. Ananda Coomaraswamy as the first Principal Mineral Surveyor. The Mineral Survey had as its main objects the examination of mineral occurrences in the Island and the possibilities of developing its economic minerals. The laboratory work in connection with the Survey was carried out at the Imperial Institute. In 1922, Mr. J. S. Coates was appointed Government Mineralogist, and in 1924 this post was combined with that of Salt Adviser, an arrangement which existed until his retirement in 1934. Little geological work was done during this period with the exception of water supply investigations, and only annual reports were published which contained occasional reference to minerals. Coates gathered sufficient material, however, during the course of his traverses across the Island to publish a paper on the ' Geology of Ceylon ' which appeared in the Ceylon Journal of Science in 1935. A geological map of the Island on the scale 1 inch = 12 miles accompanied this paper.

Prior to the publication of Coates' paper and the accompanying geological map, two important papers on the geology of Ceylon had appeared. The first of these by Wayland contained a description of the important discovery of rocks of Jurassic age at Tabbowa, near Puttalam, and appeared in the Ceylon Journal of Science in 1925. The second was by Professor Frank Adams of McGill University. Professor Adams spent two brief seasons in Ceylon in 1924 and 1926, and based on rapid traverses he made across the Island, published a monograph on the ' Geology of Ceylon ' in the Canadian Journal of Research in 1929, and the map which accompanied the monograph was the first geological map of the Island to be ever produced. The map is a greatly over-simplified version of the actual geology of the Island, but its chief merit was that it was the first geological map of the Island to be published, and a start had been made.

1935—Present

With the retirement of Coates in 1934, the little geological work there had been was more or less completely suspended, and there was a break of nearly five years until the arrival of Mr. D. N. Wadia towards the end of 1938. Soon after his assumption of duties as Government Mineralogist, Mr. Wadia submitted a report on the future organisation of the Department so that it could carry out the functions for which it was intended. The chief of his recommendations was that a systematic geological survey of the Island should be carried out with a view to the preparation of a complete and accurate geological map, as such a map forms the basis on which all other geological work rests. Although the recommendation that a Geological Survey should be established was accepted by the Government, it is unfortunate that the new organisation continued to function under its old name—' Department of Mineralogy '. In its internal organisation the re-organised Department consists of a Geological Survey Branch and a Mines Branch. The main functions of the Geological Survey Branch are the geological survey of the Island and the preparation of geological maps. In the economic field, mineral deposits discovered during the course of geological mapping are studied in detail and sampled to determine the possibilities of their economic exploitation, while specific mineral investigations are undertaken in recognised mineral areas. Besides these important functions, the Geological Survey Branch performs important advisory duties in the field of engineering geology, which includes water supply and underground water supply investigations, advice on dam-sites, reservoirs, tunnels and other foundations, landslips, soil erosion, building stones and road metal. The main function of the Mines Branch is the administration of the mining enactments of the Island to ensure the health and safety of the workers. Besides these humanitarian objectives, the Mines Branch reports on all applications for prospecting licences, mining leases, fixes rents and royalties, and attends to the valuation of minerals won from lands in which the mineral rights are reserved to the Crown. It is important that the name of the Department should reflect these functions, and in order to avoid confusion and misunderstanding it is desirable that the Department should be re-named the ' Geological Survey and Mines Department ' ; this will also bring it into line with similar organisations in other parts of the world.

From the very start of the re-organisation in 1939, geological mapping was seriously hampered by the lack of qualified geologists, and when the writer took charge of the Department early in 1945 he found that he did not have a single qualified geologist to assist him in the work of geological mapping. Geological survey work is not the work of one man ; it is the work of a team, and it was clear that no progress could be made until adequately qualified staff was made available. Proposals put up to the Government for the training of staff were approved and two officers were sent overseas on a departmental scheme of training, one to the United Kingdom in 1948, and the other to the United States in 1949. Both officers have since returned after a very creditable record of work in their respective Universities. More recently, we have had the good fortune to make use of training facilities provided by various programmes of Technical Assistance, and under the Colombo Plan an officer has had the opportunity to qualify as a mining engineer in the United Kingdom. One of the Chemists is at present undergoing advanced

training in silicate chemistry and the modern techniques of silicate analysis in the United Kingdom under the Colombo Plan programme of technical assistance ; he is expected back towards the end of 1955.

The sanctioned staff for geological survey work is seven, including the Head of the Department, who is the Government Mineralogist. The remaining posts include the Deputy Government Mineralogist, an Assistant Government Mineralogist and four geologists ; of the four posts of geologists, two posts are vacant at present but it is hoped that two scholars who are now pursuing courses in geology at the University of Adelaide under the Colombo Plan programme of Technical Assistance will obtain the necessary qualifications for appointment to the vacant posts.

Geological mapping and the field activities of a Geological Survey cannot be adequately completed unless suitable laboratories manned with specialist staff are available. The Geological Survey Laboratory has facilities for chemical, mineralogical and petrological work, although these will need further extension in future. The laboratory staff includes two chemists who are responsible for the analytical work of the Department, not merely of material submitted by field officers but of material submitted by the general public and other institutions. The laboratory also contains facilities for research on ore-dressing problems, particularly of mineral sands, and is equipped with modern machinery for making thin sections of rocks and minerals. The library which is another indispensable requisite for a Geological Survey is still small, though several additions have been made to it recently ; it needs to be expanded considerably in the future.

PROGRESS OF GEOLOGICAL MAPPING

The Basement Complex

The Archaean, which includes the oldest rocks of the earth's crust, make up by far the greater part of the Island, and it has been estimated that nine-tenths of the surface area of the Island is covered by rocks of Archaean age, the only important exception being the north-west coastal belt which is built up of sedimentary rocks of Miocene age (PLATE 1). The Archaean complex comprises a very thick series of highly metamorphosed sediments which are generally accepted to rest on an older group of granites, gneisses and schists. The group of granites, gneisses and schists have been provisionally designated the Vijayan Series, while the metamorphosed sediments, presumably younger in age, have been termed the Khondalite Series.

The Vijayan Series

Coates in his ' Geology of Ceylon ' recognised several types of biotite gneisses and he classified them into three broad groups mainly on morphological and petrological grounds. The three groups include the ' Bintenne gneisses ' for the lustrous, banded gneisses mainly developed on the east coast of the Island ; the ' Wanni gneisses ' for the group of buff-coloured gneisses intruded by a hornblende-bearing granite and best developed in the broad expanse of low country north and north-west of the central hills ; and the ' Kadugannawa gneisses ' for the

biotite hornblende gneisses of the Kadugannawa—Dolosbage area. Wadia believed that these different types of gneisses were only local modifications of the same biotite-complex, and he stressed the essential unity of the groups of biotite gneisses. Wadia's classification was based on stratigraphical grounds since he believed that all these groups of biotite gneisses were older than the metamorphosed sediments of the Khondalite Series, which he believed to be the equivalent of the Dharwar system of India. Wadia introduced the term ' Vijaya gneiss ' for the uniform, more or less even-grained gneiss of the Colombo District and he believed this to be the typical representative of the fundamental gneiss All the groups of biotite gneisses were derived from this fundamental gneiss; either they were local modifications of this gneiss, or were derived from it by the interaction of one or more granites. One result of this view was that there was a tendency to map large tracts of biotite gneisses within the Khondalite area as inliers of the older fundamental gneiss, as for instance, the Dambulla gneisses, the Kurunegala gneisses, etc.

This view did not take into account the different modes of origin of the biotite gneisses. Although there is an apparent resemblance and some degree of uniformity, closer field examination and detailed petrological study show important differences in detail and it is dangerous to assume from superficial resemblances that the three main groups of gneisses have all been derived from the uniform ' Vijaya gneiss '. There is of course no uniformity when it comes to a question of classification and definition of rock-transformations. Such classification may be based on space, as in regional and local metamorphism, or purely on mechanics as in static and dynamic metamorphism, or yet purely on geological considerations, but whatever the attempted definitions may be it will generally be agreed that genetic considerations should play an important part. In a paper published in 1950, the author proposed the term ' Vijayan Series ' to include the heterogeneous group of biotite gneisses and schists as distinct from the metamorphic sediments of the Khondalite Series. Implicit in this was a recognition of the different modes of origin of the various members of the Series and that the Vijayan Series consisted of a complex of both ortho-gneisses and para-gneisses, migmatites, granitoid gneisses, schists, and the granitised remains of older crystalline rocks. This rejected the view that the ' Vijaya gneiss ' represented the fundamental gneiss of the Basement Complex.

Khondalite Series

In the older geological maps the metamorphic sediments of the Khondalite Series with the Quartzites as its principal member occupied the greater part of the central highlands and extended north eastwards in a narrow belt reaching the coast at Trincomalee. From their field relations they formed a distinct group which was separated from the rest of the gneisses—mainly biotitic—of the Island. Both on the east and the west the Khondalites were bounded by biotite gneisses, but geological mapping in recent years has extended the Khondalite boundaries considerably. On the west the Khondalite boundary has reached the coast on a broad front from south of Colombo extending down to Galle, while on the east the boundary has been shifted well east of Polonnaruwa and not far from the east coast. Further mapping is likely to continue this process of extension of the Khondalite boundary. During this process of extension many areas of biotite

gneisses have been included with the group of metamorphic sediments grouped under the Khondalites, and recent work has produced convincing evidence that some biotite gneisses cannot be separated from the rest of the members of the Khondalite group. The field evidence clearly establishes that these biotite gneisses are interbedded with quartzites, granulites, crystalline limestones, etc. all typical members of the great group of metamorphic sediments included under the Khondalite Series, and there is no means of separating these gneisses from the rest of the metamorphic sediments. One is forced to the conviction that some of the biotite gneisses as well as the rest of the Khondalite types represent a compact group of highly metamorphosed sediments of Pre-Cambrian age, which exhibit a remarkable variety in composition and in lithological and petrological detail.

While it is not suggested that all the biotite gneisses and the related rock types are metamorphic sediments belonging to the Khondalite Series, it is now clear that at least some of these gneisses are true representatives of Khondalite members. In a formation so varied as the Khondalites and exhibiting such a variety in petrological and lithological detail, it appears surprising that true pelitic and semi-pelitic rocks do not appear to be represented. The author's view is that some of the well foliated coarse, nassive quartz-felspar-biotite gneisses are felspathised pelitic rock types. Garnets may or may not be present, but they all show prominent evidence of injection in the form of irregular quartz-felspar stringers, lenses and streaks. Where the quartzo-felspathic stringers are apparently guided by the well developed schistosity of the rocks, they have the appearance of narrow discrete veins. On the other hand there are other types of gneisses formerly included as modifications of the homogeneous ' Vijaya gneiss ' which are clearly the result of alteration of rocks of charnockite type and their related members by injections of pegmatite. The gradual passage of charnockite into a streaky black and white gneiss is a common phenomenon, and good examples of both types are seen near Mirigama, Kurunegala, Narammala in the Colombo District, and in parts of the Polonnaruwa area. In such instances where the charnockite contains basic bands and lenses, these persist in the streaky black gneisses. Detailed petrological work is still required, as also mapping on much larger scales of the type areas, and it may well be that the banded biotite gneisses in other areas may be proved to have a similar origin. Studies of the heavy residues and the intimate structures in the associated charnockite types and the banded biotite gneisses may furnish conclusive proof.

Kadugannawa Gneisses

There remains the distinctive group of gneisses known as the Kadugannawa gneisses which are best developed in the Kadugannawa area and build up the Alagalla range. To the south these rocks extend to Dolosbage and Nawalapitiya, and in the north to Kurunegala and Rambodagala. The Kadugannawa gneisses form a vast injection complex with apparent intrusive relationships towards the Khondalite rocks which surround them. Crystalline limestones are found both on the east and the west of the injection complex, at Getambe on the east and at Palpatha on the west, although the continuity of these bands cannot be traced for great distances. The Kadugannawa gneisses are heavily intruded by two types

of granites, the charnockites and the Tonigala granite. Schists, amphibolites and pyroxenites appear to have been involved in the processes of injection, and it is likely that at least some of the types involved in the injection were semi-pelitic and pelitic types.

Problems of the Basement Complex

The exact relationships of the different types of biotite gneisses to one another and their relationship to the Khondalites, the relationship between regional metamorphism and igneous activity in its widest sense, the origin of the charnockites, the distribution of the rare earth minerals and their host rocks the pegmatites, the origin of the graphite deposits of the Island, are all problems which await solution, and which will require intensive and detailed geological mapping supplemented by intensive work in the laboratory. These are not merely academic questions for the amusement of geologists, but they have a bearing on the economic aspects of geology and the evaluation of mineral deposits. As mining operations progress and pass into old age, their continued life may well depend on the answers provided by geologists to some of these problems. Up till recently, geological mapping on the scale of 1 inch = 1 mile has been slow largely as a result of the lack of geologists, but this has been remedied to some extent and good progress has been made in the past two years. Our main task still remains unchanged, namely the completion of the one-inch geological map of Ceylon. Apart from the revision of geological maps which becomes necessary from time to time and the re-survey of areas of economic importance, once the primary task is completed, it is hoped to map on larger scales, e.g. four or five inches to a mile or even larger. One of the difficulties is the lack of large scale maps except for very restricted areas, but it is hoped that aerial photographs will be used in future as an aid to geological mapping.

The importance of photogeology to geological mapping has been recognised and there is no doubt that the use of aerial maps facilitates geological mapping, and in particular reduces the amount of ground work that has to be done by a field geologist. Unfortunately aerial surveys are very expensive and their high costs limit the use of this very valuable adjunct for mapping. While aerial surveys do not do away with the necessity for ground surveys, they do reduce the amount of ground work and thus facilitate and expedite geological mapping. It is hoped in due course to have mosaics of all areas of the Island for which air cover is at present available, and with these it should be possible to accelerate the rate of geological mapping with a view to the early completion of the one inch geological map of the Island. Apart from its importance in the investigation of the Island's mineral deposits, such a map would ensure the more efficient use of geological knowledge not only in industry and engineering but in the general reconstruction and development of our Island.

Mineral Investigations

In a small country such as ours it is not possible to have the huge organisations which some of the more advanced industrialised countries of the West have for the study and advancement of geology and the geological sciences, and the old orthodox 'survey' view which considered that the work of a Geological Survey

should be confined to geological mapping and studies of pure geological science, while prospecting and the investigation of economic deposits should be left to the enterprise of mining companies, has no place. Indeed, this old view has been rejected even in countries where the old ' survey ' tradition persisted into the late thirties. Active exploration forms an important part of the activities of the Geological Survey and much progress has been made in this direction in recent years. It is not possible in the course of a short paper to deal with the progress made in the investigation of a number of economically important minerals, but the writer wishes to deal with recent investigations on the monazite deposits of the Island.

Monazite

The mineral monazite is a phosphate of the rare earth minerals (cerium, lanthanum, yttrium, etc.) with varying amounts of thoria ($Th O_2$). Its principal use was as a source of thorium for the manufacture of gas mantles, but with the introduction of the tungsten lamp the use of thorium for this purpose has gradually declined. At present the principal use of monazite is as a source of cerium for the manufacture of various cerium salts, principally the nitrate and fluoride, which are used in the cores of carbons required for floodlights, searchlights, motion picture projectors, therapy lamps, etc. Pyrophoric alloys of the rare earths either in combination with iron or aluminium are also used in the manufacture of gas and cigarette lighters, and various chemical compounds of the rare earths are used in several industrial applications. The rare earths are more needed in industry than thorium, and it is for this reason that commercial specifications for monazite stipulate a minimum content of rare earth oxides. Thorium has recently found a new use in the production of nuclear power, but its use is still probably restricted to experimental quantities.

World Sources

For many years India used to be the world's chief source of monazite, the mineral being derived from the beach mineral sands of Travancore, but in 1948 the Indian Government placed an embargo on the export of monazite and the world supplies were thus suddenly stopped. Brazilian production of monazite, which used to be important in the early years of the present century and then declined, came into its own with the Indian embargo and most of the world's supply thereafter came from Brazil. But this was short-lived and Brazil soon followed the Indian example, with the result that monazite became a critical mineral commodity and an active search began for alternate sources. This search has been notably successful as several deposits capable of being worked have been discovered in the African Colonies, but more important than these has been the discovery of a new ore-field in the Cape Province of South Africa. The discovery was made in 1950, and the South African monazite is a heavy brown mineral unlike the Ceylon monazite and is derived from a bed-rock reef. The deposit has been extensively drilled by the Anglo-American Corporation of South Africa Ltd., to whom the rights to mine, concentrate and export the ore has been granted. Production commenced at the end of 1952 and production is to be maintained at approximately 8,000 tons per annum. Most of the production will go to the United States.

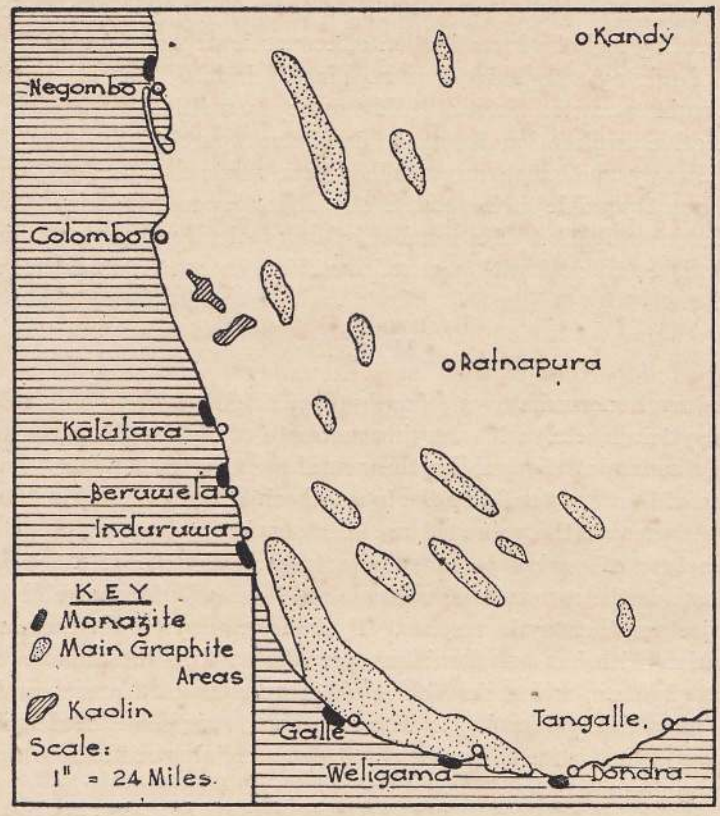


Fig. 1.—Seasonal Monazite concentrates along the south-west coast of Ceylon.

Occurrences in Ceylon

The primary occurrences of monazite in Ceylon are of no commercial importance, and the only deposits of any significance are the placer deposits formed by the disintegration and the decomposition of monazite-bearing rocks and the subsequent concentration of these products by wave action. As a result of the work of the former Mineral Survey, two monazite-bearing deposits of some importance were discovered. The first of these was at Kaikawela, near Induruwa, and the second in the sheltered bay not far from Kudremalai Point, 40 miles south of Mannar (Fig. 1). The monazite is associated with ilmenite, rutile, zircon, garnet, spinel, etc. and the Kaikawela deposit was worked in a small experimental plant during the years 1918 to 1922 when the operations ceased due to the fall in the price of monazite. During this period nearly 450 tons of monazite were recovered, all of it being exported. More recently, in the past five years or so, a survey of the coast has been carried out ; the survey included a radiometric survey with the aid of Geiger-Muller counters, and has had valuable results. The survey has proved that heavy mineral sand concentrates are seasonally formed at several points along the south-west coast of the Island, from Puttalam down to Hambantota (Fig. 2). These seasonal concentrates are black in colour due to the predominance of ilmenite and are referred to as ' black sands '. Besides the ilmenite the other constituents of the heavy mineral sands include rutile, zircon, monazite,

garnet, spinels, etc. In the more southerly of these deposits (beyond Galle), garnet becomes an important constituent of the mineral sands, and may increase to such an extent that the sands are red in colour, as for example the heavy mineral sands round Tangalle, Hambantota and Kirinde. The mineral concentrates are formed in the months of May to July and they have been observed near Chilaw ; north of the Negombo lagoon ; north of the mouth of the Kalu-ganga ; near Beruwela and Kaikawela ; at Kaluwella, near Galle ; and near Weligama and Dondra. In all these localities, the deposits are seasonal, strictly limited in extent and formed over localised areas.

Beruwela Deposit

The most important of these seasonal mineral sand deposits is the one at Beruwela with its unusually high percentage of monazite. The mineral sand concentrates are formed over a half-mile stretch of the beach in the bay formed by the headlands of Maggona and Beruwela, the bay itself being about two and a half miles wide. The concentrates first appear at the end of April or early May and the formation of the concentrates goes on till the end of July. As a result of tests carried out on the beach, it has been proved conclusively that as the mineral sand concentrates are scraped up, fresh concentrates are brought in by the action of waves, and in this way it is possible to harvest several crops of concentrates. If the beach is left alone without any disturbance by outside agencies, the building up of the concentrates goes on until a certain equilibrium is reached, and no further piling of mineral sands takes place. Once the beach is scraped clean of mineral sands a 24-hour period of rest must follow before a second collection can be made ; almost double the quantity collected in a 24-hour test was made in a number of 48-hour tests, but thereafter the piling up of the mineral sands decreased sharply. The monazite content of the mineral sands varies considerably, not merely from day to day, but from one area to another. Rich, localised patches with monazite concentrations of 15 per cent. and over may adjoin areas with concentrations as low as 4 per cent. A few random analyses of the monazite bearing concentrates from Beruwela are given below in Table 1.

Table 1.

ANALYSIS OF BERUWELA SANDS

Date of Collection		Monazite	Ilmenite	Non-Magnetics
17-6-49	...	11·25%	67·15%	21·50%
7-8-50	...	14·68%	63-65%	20·92%
18-6-52	...	14·18%	65·32%	19·94%
17-7-53	...	5·44%	70·74%	23·46%
6-5-54	...	13·24%	64·20%	22·28%
12-5-54	...	9·12%	70·72%	19·88%
18-5-54	...	6·52%	70·52%	22·48%
25-5-54	...	8·88%	66·48%	23·56%
4-6-54	...	7·76%	66·20%	25·96%
14-6-54	...	9·72%	62·00%	28·00%
18-6-54	...	10·52%	68·00%	21·20%
25-6-54	...	4·80%	69·88%	25·24%

All the separations were effected on a Franz-Isodynamic separator at a constant current. The non-magnetics include mainly rutile, zircon, a little garnet and quartz. The mineral sands are remarkably even-grained and concentrates collected in different years and widely separated days in the same season show more or less the same grading with well defined limits (Table 2). The highest concentration of monazite recorded was 28·68% on June 23, 1954.

Table 2

MECHANICAL ANALYSES OF BEACH SANDS, BERUWELA

Sieve No.	+36	—36+60	—60+72	—72+120	—120+150	—150	Total.
Mesh Diam	0.422 mm.	0.251	0.211	0.124	0.104		
Sample Number							
1. (25.5.'54)	1.52%	12.32%	11.15%	65.60%	3:84%	5:39%	99.89
2. (4.6. 54)	2.22	15.28	14.38	60.38	4.20	3.84	100.00
3. (14.6.'54)	8.23	26.72	16.14	46.49	1.86	0.52	99.96
4. (18.6.'54)	1.40	11.18	10.66	64.02	4.56	8.29	100.11
5. (25.6.'54)	0.08	11.65	11.30	65.44	4.52	6.29	100.01

The concentrates collected from the Beruwela beach are treated in an experimental plant for the recovery of monazite, and a high quality monazite of over 98% purity is produced. Besides making handsome profits, this experimental plant serves as a pilot plant for research on the ore-dressing and production of minerals such as ilmenite, rutile, zircon and other heavy minerals from beach sands which form one of the most important mineral resources of the country, but whose value has not yet been fully recognised. The successful working of this experimental plant has more than amply demonstrated the value of the Island's mineral sands, and that a sound mineral industry can be based on their exploitation on scientific lines. The plant has also served as a training ground for a small nucleus of workers who should prove very useful when plans are developed for the exploitation of the permanent mineral sand deposits of the Island.

References Cited

Adams, F. D., 1929 : The Geology of Ceylon. Canadian Journal of Research, 1, 425-511.

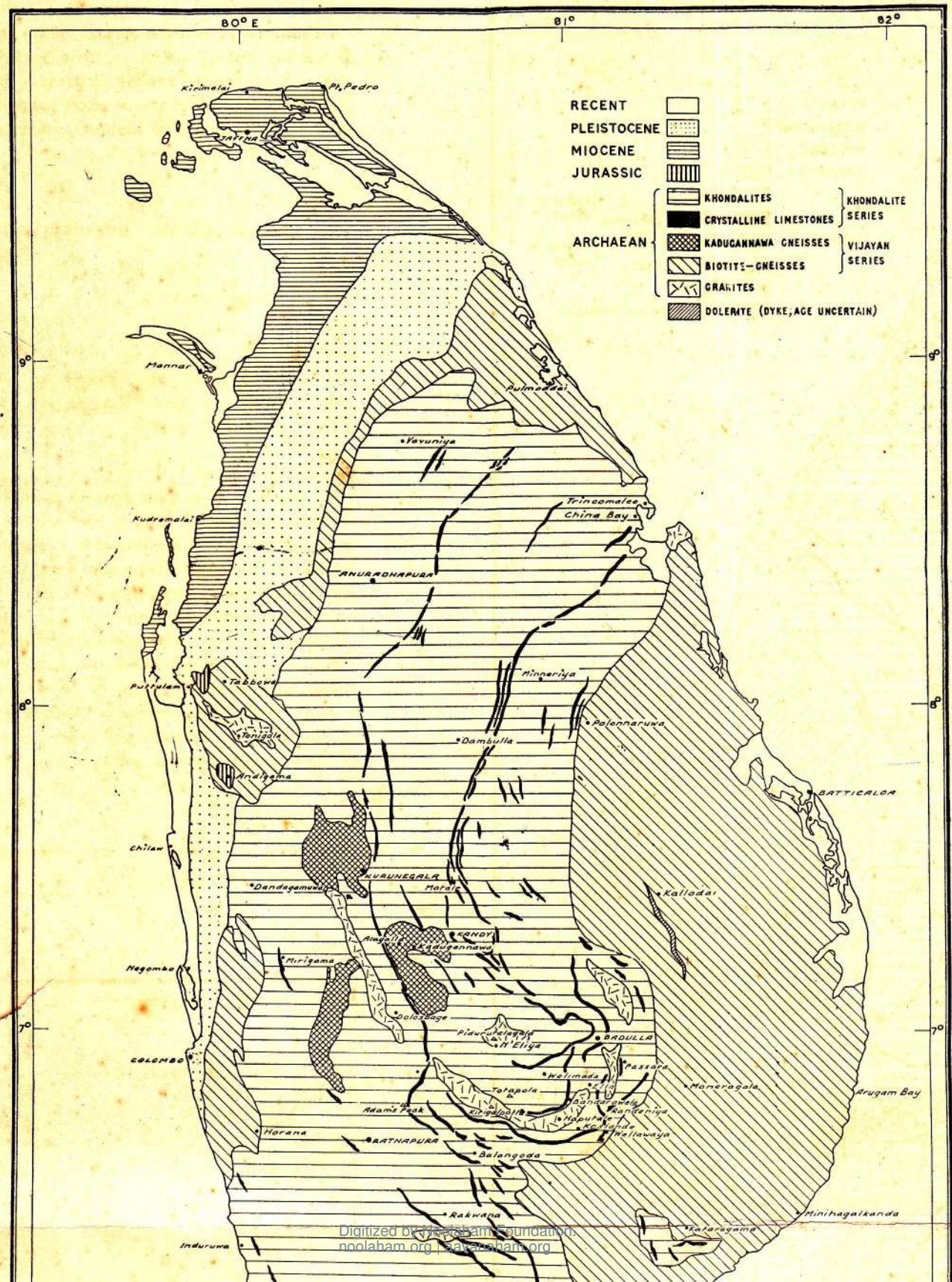
Coates, J. S., 1935 : The Geology of Ceylon. Ceylon Journal of Science, Vol. XIX' pt. 2, 101-191.

Wadia, D. N., 1939 : Administration Report of the Govt. Mineralogist.

Wadia, D. N., 1940 : Administration Report of the Govt. Mineralogist.

Wayland, E. J., 1925 : The Jurassic Rocks of Tabbowa, Spolia Zeyl:, XIII, pt. 12, 195—.

Fernando, L. J. D., 1950 : The Geology and Mineral Deposits of Ceylon. Bull. Imp. Inst. (Reprint), XLVI, Nos. 2-4, 303-325.



PROVINSIONAL GEOLOGICAL MAP OF CEYLON

THE GAL OYA BOARD AND ITS ASSIGNMENTS

A REVIEW OF FOUR YEARS' ACTIVITIES

By R. L. Brohier

The Gal Oya Development Board Act which received assent in November, 1949, made provision for the area of authority of the Board to be declared by order of the Minister of Lands and Land Development. It provided the Board with its own fund which was to include such sums as may be voted by Parliament for its use. It vested in the Board several functions which would tend towards making all the latent possibilities and resources of the Valley work together for the benefit of the people. Nevertheless, it is the explicit direction of the Minister of Lands and Land Development which sets out the principal object of the scheme, which is " to establish within the Area of Authority the maximum number of families of Ceylon citizens that the area can carry at a reasonable standard of good and comfortable living conditions, and generally to promote agricultural and industrial development, and the economic and cultural progress of these citizens ". In endeavouring to attain this principal object the Board was expected to :—

(i) provide water for the cultivation of the maximum acreage of land within its Area of Authority, and with this end in view it will devise a channel system whereby water is made available to the farthest geographical limit to which it can be carried with the best economic advantage ;

(ii) adopt in the main the principle of peasant colonisation in defining the extent of holdings of Crown land within its Area, whilst at the same time encouraging the growth of co-operative agricultural and industrial undertakings among such peasant colonists ;

(iii) organise within its Area of Authority a system of planned cultivation of the most suitable crops arranging for such rotation as is deemed agriculturally necessary or advisable, and for the profitable marketing of the produce ;

(iv) provide electricity for both domestic and industrial use, and especially seek to promote the use of hydro-electric power in the development of cottage industries ;

(v) so regulate water in the Gal Oya Reservoir as to reduce the dangers of flooding within its Area of Authority ; and finally

(vi) so direct activities as to generally improve the economic conditions of the inhabitants within its Area of Authority.

It would be interesting to examine the manner in which a moisture-starved tract of country has benefited by this integrated resources development during the four years which have elapsed since the Board started to function. Today's picture and trends of the six factors listed are dealt with severally.

Assignment I.—*To provide water for the cultivation of the maximum acreage of land within its Area of Authority, and with this end in view it will devise a channel system whereby water is made available to the farthest geographical limit to which it can be carried with the best economic advantage :*

Until recently diverse views were held concerning the resources in irrigable land and water which are basic concepts in turning to productive use the land under cover of jungle in the Gal Oya Valley. On a firm computation the gross extent of irrigable land potentially panned for developing within the Area of Authority of the Board is 124,140 acres. Of this extent, 51,640 acres are under-developed, privately owned fields cultivated in paddy partly by irrigation with a net-work of alternately silted and scoured drains and water courses leading from small tanks or the river, and partly by the uncertain and traditional method of sowing with the rains. The remaining 72,500 acres represent undeveloped jungle land which can be converted to grow rice and other food or commercial crops on a rotation basis. Categorically, these under-developed and undeveloped extents are confined to the right or the left bank of the Gal Oya, as follows :—

Location	Old Paddy Under-developed	Convertible to Growing Paddy Undeveloped	Total
Left Bank ...	36,140 acres	36,800 acres	72,940 acres
Right Bank ...	15,500 acres	35,700 acres	51,200 acres
Total ...	51,640 acres	72,500 acres	124,140 acres

Besides the attention given to plans which will foster economic development of the private fields in order to establish the solvency of the under-developed resources which has passed into its charge, the Board has prepared an over-all regional development programme to reconcile the two paramount factors of land and water to the best economic advantage. It has also executed these responsibilities with benefit to the Valley by opening up new land on three annual programmes as follows :—

	Homestead Allotments Cleared and Prepared	Irrigable Crop-lands made ready for Cultivation	Reservations, Communal Reserves etc., Patterned and Defined
1950-51 ...	934 acres	1,168 acres	398 acres
1951-52 ...	4,443 acres	5,924 acres	3,383 acres
1952-53 ...	5,385 acres	7,180 acres	7,435 acres
Total ...	10,762 acres	14,272 acres	11,216 acres

The assignment that the Board should devise a channel system to make water available to furthest geographical limits with best economic advantage must necessarily materialise when the generalised programme for the whole Valley has been carried out. A substantial contribution has already been made, as the next statistical Table shows :

	Major Distributary Channels	Minor Distributary Channels	Fields and Drainage Channels
1950-51 ...	nil miles	4·25 miles	23 miles
1951-52 ...	9 miles	22·9 miles	93 miles
1952-53 ...	3·5 miles	10·6 miles	100 miles
Total ...	12·5 miles	37·75 miles	216 miles

In a class of work which might be called " tributary watershed development ", working from pioneer tracks through jungle, preliminary dam axis lines have been located for the Pannel Oya, Pallang Oya, Namal Oya and Ekgal Oya Reservoirs. The results of these constructional investigations within the drainage of the Gal Oya which are underway on a modest scale for the present will result in a certainty that all the water in the basin is utilized to best advantage and add to the irrigable area estimated for the project. Four tanks with a capacity of 99,995 acre feet of water, have been constructed to divert drainage into the Left Bank Transmission Channel.

One other important aspect of water utilization to receive attention has been the remodelling or restoration of small tanks. The part they play in the domestic economy of the Village is traditional. Their constitution as a means of raising the water table of the surrounding country is factual.

Assignment II.—*To adopt in the main the principle of peasant colonisation in defining the extent of holdings of Crown land within its Area, whilst at the same time encouraging the growth of co-operative agricultural and industrial undertakings among such peasant colonists :*

In the implementation and maintenance of the basic concepts of peasant colonisation three factors have undergone changes after the initial planning, namely, the size of the holdings, the size of the cottage allotted to the colonists, and the financial assistance to settlers. The reduction in the size of the type-plan cottage was forced on the Board by rising cost of material. The other two items have been patterned on the recommendations of the Mission organised by the International Bank for Reconstruction and Development at the request of the Government of Ceylon, and as dictated by Governmental policy.

The number of families settled in the Area since the scheme became operative is as follows :—

	Number of Families	Average Size of Family	Estimated Number of Settlers
1950-51 ...	300	5	1,500
1951-52 ...	1,500	8	12,000
1952-53 ...	1,765	9	15,885
Total ...	3,565		29,385

The following schedule indicates from where these families were brought :—

1950-51	1951-52		1952-53	
Moved from the Reservoir Bed before flooding and resettled : 141 families	Batticaloa Dist.	750 families	Batticaloa Dist.	852 families
	Kandy Dist.	200 ,,	Kandy Dist.	213 ,,
	Kegalle Dist.	300 ,,	Kegalle Dist.	275 ,,
	N'Eliya Dist.	117 ,,	Uva Dist.	250 ,,
	Chilaw Dist.	20 ,,	H'bantota Dist.	175 ,,
	Colombo Dist.	113 ,,		
From the immediate upper catchment of the Reservoir resettled : 68 families				
Displaced in process of development and resettled : 91 families				

The rehabilitation of such a large number of people who were living in unproductive conditions, on land which three years ago lay waste and under-utilised, is in itself significant. The actual process of clearing the jungle, preparing the crop-lands for cultivation, devising a system of irrigation, constructing cottages, transporting the families from the districts selected by the Minister, and subsidising them until they can support themselves, can hardly be accounted a process which is simple.

Irrigable crop-lands were blocked out in holdings of 4 acres per family, since reduced to 3 acres in the 1953/54 programme. The homestead units are patterned on a flexible basis of two acres high land, or a maximum holding of 5 acres irrigable land with a cottage, where no high land was available for siting homesteads. To ensure careful administering of the colonisation programmes, a suitably delimited group of approximately 150 houses are reckoned to be a village unit. Twenty-six village units have been established during the last 3 years of development, each with a community and recreation centre, a village hall, boutiques, blacksmith and carpentry shop and a site for a village fair. Buildings for education and medical services have been constructed in consultation with the respective Ministeries. Cutting costs where possible, major effort has been directed to fit these and other phases of resource development into the Government's policy, or in such a way as to encourage local initiative. By arrangement, a school is provided for every village unit, one branch dispensary for every 9 villages or 1,350 families together

with a peripheral medical set-up including an anti-malarial unit. A Colonisation Officer administers a group of village units assisted by a Village Officer to every unit. A Sanitary Assistant is allocated for every 9, and a mid-wife for every 3 village units. Other facilities provided under the colonisation programme are : milk-feeding centres, postal and policing services by arrangement.

As regards the promotion of co-operative agricultural undertakings, a general service co-operative society is established in each village as colonists are settled. In order that the whole community may be served by the movement, membership in the Society is made a condition in the permit issued to a colonist to occupy an allotment. The objects of the Society are multi-purpose, viz., credit facilities, the systematic issue of selected seed and planting material, tools, and implements, working animals and poultry.

Thirteen registered General Service Co-operative Societies have been established to date in the area colonised. Managers are recruited and receive a year's training at the instance of the Board.

A better standard of rural life, partial solution to the problems in over-populated areas, an increase in the nation's food supply, and the development of a seriously economically depressed area by rapid methods, are the direct results reflected by these colonisation operations carried out under the aegis of the Board.

STATISTICS OF BUILDINGS IN VILLAGE CONSTRUCTION AREAS

	Number of Colonist Cottages	Educational Bldgs. Schools	Staff Buildings	Medical Buildings Dispensaries	Staff Buildings	Administrative Bldgs. Village Centres etc.	Other Buildings	Total
1950-51	300	2	12	—	3	6	6	329
1951-52	1,500	10	60	—	—	30	—	1,600
1952-53	1,765	12	39	4	19	38	15	1,892
Total	3,565	24	111	4	22	74	21	3,821

BUILDINGS IN ADMINISTRATIVE CENTRES

	Staff Qrs. Permanent	Staff Qrs. Temporary	Labour Lines & Dormitories Permanent	Temporary	Administrative Bldgs. Permanent	Temporary	Canteens & Misc. Bldgs. Permanent	Temporary	Medical Bldgs. Hospital	Staff Qrs.	Police Buildings Police Station	Staff Qrs.	Educational Bldgs Schools	Staff Qrs.	Total
1950-51 ...	14	57	25	15	13	6	6	32	—	—	—	—	—	—	168
1951-52 ...	34	—	12	9	3	3	3	3	—	—	—	—	—	—	69
1952-53 ...	34	—	25	—	8	—	26	2	2	5	1	8	3	6	120
Total ...	82	57	62	24	24	9	35	39	2	5	1	8	3	6	357

Assignment III.—*To organise within its Area of Authority a system of planned cultivation of the most suitable crops arranging for such rotation as is deemed agriculturally necessary or advisable, and for the profitable marketing of the produce :*

In organising a system of planned cultivation of the most suitable crops the the Board has adhered rigidly to the principle that the programme should be dedicated to the improvement of Ceylon's food supply. It has not overlooked the need for rotating crops, growing green manures and resting the soil. With emphasis on the cultivation of paddy for the production of rice as the main crop, what might be accomplished through a concerted attack involving soil management, conservation methods, the development of better crop-varieties, pest control and the introduction of modern farm machinery as aids to raising the economic standards of the peasantry and for obtaining greater yield, has received due attention. Very full plans for rotational cultivation under irrigation have been drawn up, and these show that the basic tenets of soil and husbandry, and soil and water conservation have found a new place in the level of agricultural practices in the colonisation areas of the Gal Oya Valley. These are demonstrated in an agricultural station and in several experimental plots, and made available to the peasant by Village Officers who have had a special training. From the start the programme has received the support of the officials of the Department of Agriculture, and co-ordination of the long period of research by Government has been made available to, and used by the Board.

Despite these efforts, the progress, as reflected by the present level of agricultural efficiency, and in yield, is disappointing, but obviously, it is only by experience gained over a few years and by adjusting traditional methods to new conditions, that the colonist can be made to farm satisfactorily. One of the causes of the set-back to planned cultivation has been the agriculturally inexperienced community scattered over the catchment and tank bed which circumstances compelled the Board to take over initially in 1950/51.

It merits notice that there are 51,640 acres of privately owned lands within the Board's Area of Authority, cultivated in paddy on primitive systems and producing smaller yields than could readily be achieved. These fields principally under the Pattipola Aar, have long held pride of place as the largest unbroken expanse of rice-growing land in the Island. Consequently, if the Board is to keep faith with the Act under which it operates, and to its dictates to foster a system of planned agriculture to fullest limits, it must concurrently with its planned technique for bringing new areas into productivity face the problem of nursing these old lands which have been so heavily and unscientfically worked in the past. The problems which face the Board from this angle are major ones. How they will be resolved depends far more on the Board's approach and outlook than on the nature of those problems. Hence, investigations have first to be done, and those being pursued might well result in raising the productivity of these fields to a high level over generations to come.

The most profitable terms are offered to the colonists for marketing produce through the General Services Co-operative Society established in each village unit,

and where a cropping programme advised by the Board is followed, standard governmental purchase prices are guaranteed. Advances against the expected income from a first crop are made.

Assignment IV.—*To provide electricity for both domestic and industrial use, and especially seek to promote the use of hydro-electric power in the development of cottage industries :*

The important assignment which calls on the Board to provide electricity for both domestic and industrial use was pursued in two aspects, namely, appraisal of the rational utilization of water in the Senanayake Samudra for hydro-electric generation without subordinating cultivation requirements.

A 33 KV transmission line has been constructed by the Board from Inginiyagala to Amparai, and consultations for assistance under Canada's capital equipment contributions to Ceylon under the Colombo Plan towards the extension of the transmission line and rural electrification are proceeding.

Hydro-electric generation based on the theoretical capacity of the Gal Oya catchment above the Senanayake Samudra is not free of the difficulties to be met within a water-control project serving three primary purposes: agricultural development, flood control and generation of power. This is all the more evident in the Inginiyagala set-up since the primary purpose for which the project was authorised or constructed was not for the production of hydro-electric power. Power generation at Inginiyagala is consequently less promising than it has hitherto been made to appear. Any undertaking to feed large quantities of power into the Island's grid or to large-scale industry cannot be met from the optimum potential at Inginiyagala. The necessity for the link-up with Norton Bridge therefore merits emphasis if a more extensive programme of industrial electrification is eventually planned and is not to be wasted effort.

Assignment V.—*To so regulate water in the Gal Oya Reservoir as to reduce the dangers of flooding within its Area of Authority :*

The hazards of flooding within the Area of Authority is a responsibility in regard to which the Board has not been able to allay public disquiet, rumour and doubt. The problem chiefly applies to the lower Valley and the old uncultivated fields bordering the coast.

The consequences of flooding are both indirect and direct. The former is inter-related to the defects in the primitive irrigation system used to this day by the cultivators. The latter falls under three heads : first, the danger to crops and property, and the interference with optimum sowing ; second, the delay caused to cultivation until all possibility of using direct rainfall passes : third, the additional burden the floods throw on the already inadequate storage.

The king-pin in the scheme reducing floods in the Valley is the dam at Inginiyagala. It throws back the average rainfall of 70 inches a year draining from the 300 square mile upper catchment. In other words 30 times the volume of water in the Colombo Harbour is prevented from over-running the lower Valley. This in itself must be counted a notable contribution to flood protection, but it was unfortunately not initially publicised as being only the first phase in the task of freeing the lower basin from floods.

From the bund site at Inginiyagala the Gal Oya winds its way through 28 river miles before reaching the outlet to the sea at Kallodai. No less than 13 tributaries empty their waters into the main river in this section. The second phase in flood protection is therefore directed to ensure that these streams when surcharged by rain are disciplined. The detention reservoirs as planned in the tributary watersheds, will trap some of the water which today over-runs the river channel.

The initial step which this task in its second phase demands has already been taken. The entrance to several old and disused channels eroded by the floods from the Gal Oya have been bunded. Progressive step by step construction of these flood bunds will eventually train the surcharged waters to keep to the main river-channel. The importance of close investigation before construction is undertaken cannot be under-rated because the flooding of the Lagoon in the recent past increases the likelihood of the problem being more widespread than was at first anticipated. Consequently, these and other beneficial developments to reduce the danger of floods cannot be hurried. They wait the time when judgment as to aims, possibilities, and achievements is reached. This is by no means easy to come by.

Assignment VI.—*To so direct activities as to generally improve the economic condition of the inhabitants within its Area of Authority :*

It is too early to recognise direct results in economic conditions within the Board's Area of Authority, or of the impact of the developments effected on the inhabitants. Consequently, to this end, it is only possible to evaluate conditions from the trends observable in the recent past and on new factors which can be brought into play in the future. In order to maintain proper perspective these will be considered in three periods—before the Board was charged with the development of the Area of Authority, the present, and the future.

The only portion of the Area of Authority which in the beginning had a fair density of population is the coastal strip between the chain of lagoons and the sea. Across the lagoons lie the old paddy fields, most of them worked to this day for absentee proprietors by cultivators who live on the coastal strip. This tenurial factor explains the paucity of population in the only part of the area which might be capable of raising the living standards of the people.

Further west, across the foothills and on the mountain slopes where the feeders of the Gal Oya rise, there is a semi-arid tract of country partly covered by secondary dry-zone forest and partly by expanses of thorny jungle or stretches of park-land locally called *dammana*. Here live a few semi-nomadic families in widely scattered and isolated settlements, under most primitive conditions. They subsist on the produce of shifting cultivation pursued by clearing and burning a patch of forest, growing grain and vegetable during the rainy season, and abandoning the land thereafter.

From what has been stated it is clear that the country subsequently delimited and named the Area of Authority of the Board, was both unfavourably circumstanced economically, and was materially backward. And yet there is ample evidence that at some time in the past an economy which was largely agricultural had existed.

History shows that internecine wars retarded continuous development. In the aftermath, the wasted organisations failed to maintain that priceless asset so indispensable to dry-zone agricultural economy : the irrigation system. Consequently, many of these works with the fields they irrigated, passed on to jungle and may be seen in their decay to this day.

Ever since, for a variety of reasons, this eastern river-valley had no share in the general increase of wealth and standards of living attained in other parts of Ceylon. Practically the sole economic asset which existed when the Board was assigned the development of the Area was the 51,640 acres of under-developed paddy growing tract, already alluded to, and a rice industry based on tenant farming for absentee owners, at a subsistence level.

From the beginning the Board recognised that there were two factors which would determine the success or failure of the project from an economic angle. The first, that it had to seek to mobilize all the natural resources in order to meet the demand for cultivable land to settle the population ; the second, that the land would have to be managed in such a manner as would afford the greatest good to the community for the money expended. In broad outline, the implementation of these factors cannot but bring about far-reaching changes. For instance, neither the absentee proprietor nor the conservative Ceylon peasant steeped in traditional cultivation methods can be expected to view with favour the curtailment of his annual two-crop paddy cultivation in order to save his land from exhaustion without any appreciable loss in output. Neither can they be expected to approve efforts towards conservation and economy in the use of water, even though by doing so more land would be brought under irrigable command.

Hence, the Board has planned its moves on a broad front, proving by demonstration in the colonisation areas the advantages of the changes which have to be introduced, and leaving the hitherto established agricultural economy which is synonymous with rice cultivation, to deem what is agriculturally bad practice from the results of the new policy.

Looking on the situation, there is one aspect of overall economic development which has not been mentioned earlier because it has followed normal planning. This is the construction of roads. Most of the new roads referred in mileages which follow, run through what was but recently tractless jungle :

	A Class	B Class	Agricultural and Service Roads	Access Roads to Forward Development Areas
Roads taken over up to Financial Year 1951/52 ...	—	26·2 mls.	63·3 mls.	—
Roads built up to Financial Year 1951/52 ...	37 mls.	—	57·5 mls.	—
Roads taken over in Financial Year 1952/53 ...	3 mls.	3·5 mls.	8·5 mls.	—
Roads built in Year 1952/53 ...	3 mls.	3 mls.	21 mls.	226 mls.
Total ...	43 mls.	32·7 mls.	150·3 mls.	226 mls.

Aside from road transport, the Board has inaugurated water-transport from rail-head at Batticaloa to the southern end of the lagoon off Kalmunai, a distance 27 miles. Along this water-stretch nine 25-ton steel barges built in the Board's workshop have moved, towed by power craft, carrying 4,482 tons of freight during the year 1952-53. Bearing in mind that a huge plantation crop and commercial goods will need to be handled when the agricultural land is developed and population settles in these areas, this scheme, leased perhaps to private operators, holds out the future prospects of cheap and ready communications.

Among the resources directly supporting the economy of the scheme, it is particularly water and the potential irrigable land which is of the first importance as a means of increasing the productive capacity of the region. Land development through irrigation and drainage would create new farming opportunities for at least 25-thousand families. This will provide, directly or indirectly, permanent employment for 100-thousand wage earners in local enterprises other than farming. The ultimate creation of a total of 125-thousand to 150-thousand employment opportunities and the basis of support for a total population of over a quarter of a million persons would be attributable to the land development envisaged alone.

The results of colonisation so far effected in the Valley are striking, but agriculture is beset with problems and has a long way to go if it is to become permanently profitable. A start was made on the collection of agricultural statistics with the Yala season of 1953 (May-September). Despite initial irrigation disabilities, hasty preparation of sowing plots, the absence of any cultural crop-yielding practices, and crop damage by rodents, elephant and wild boar, a gross extent of 3,200 acres under paddy yielded 59,000 bushels or 18·4 bushels per acre. Eliminating a calculated 29% of the gross extent as the average allowance for bunds, channels, rocks and unlevelled land, the nett yield per acre is 25·9 bushels. Against this moderate result, in one village where 600 acres were cultivated systematically under better conditions, a yield as high as 57 bushels per acre was secured. In the same village unit a large number of cultivators realised yields well over 40 bushels per acre.

The statistics revealing gross income of the 1,778 colonist families settled between 1950 and 1952 also refer only to calculations based on yields of paddy and minor crops in the Yala season of 1953. This at least provides an indication of the minimum income which accrued in a less propitious cultivation season than the Maha, and serves as an index to economic well-being to be anticipated. The total income from minor crops which included vegetables, roots and tubers, pulses, grains, chillies and onions, was Rs. 133,366/25 ; and that from paddy Rs. 704,796/00. One village consisting of 150 families obtained an average income of Rs. 945/46 per family for the season's cultivations, and 300 other families secured incomes ranging from Rs. 855/09 to Rs. 911/06.

In general the soils are of relatively low fertility, and erosion is a problem. Consequently higher crop yields depend on fertilizers and careful nursing of the soil. There are too many incompetent cultivators, and the size of the family trying to subsist on the income from a holding is too large. As against these

difficulties there are favourable factors which can be utilized fully to offset the handicaps. This review is not intended to create the impression that every aspect of agricultural development in the Valley has been investigated. Much remains to be done.

As against the handicaps encountered and the prospects for good incomes from agriculture when the full irrigable area is brought into productivity the statistics collected on " family cards " introduced in 1952/53 are most striking and revealing.

The following figures reveal the pathetically meagre assets of the 1,778 colonist families settled in 1950-51 and 1951-52 on their arrival in the Valley :—

	Household Goods	Personal Goods and Assets	Agricultural Goods	Livestock	Total
Total ...	Rs. 21,038	Rs. 40,188	Rs. 9,869	Rs. 38,169	Rs. 109,265
Average per Colonist ...	Rs. 11/84	Rs. 22/60	Rs. 5/55	Rs. 21/46	Rs. 61/45

The families who moved in from the Batticaloa District showed a higher average in assets per family than those brought in from more distant districts. This might be accounted for by the fact that the latter sold the bulkier possessions prior to making the trek, but if so, this was not revealed in money which is included under the head " Personal Goods and Assets ". The details of the livestock wealth on arrival poses the serious problem confronting the Board of the inadequacy of livestock for an agricultural community.

Looking to the future, the impact of industrial development on the people and institutions of this region must eventually increase both the wealth of the Valley and the income per capita by absorbing the surplus of unprofitable agricultural labour. The sugar industry, which the Board desires to introduce is presently the subject of a research programme. It seems probable that the effect of industrialization both in respect of cottage industries, and large plant, will bring about more economic and social changes in the Valley than any other single influence now visible.

There are still within the region some very special problems which the generalised programme has not yet reached. For instance there is the idea of capitalizing on the recreational value of the Senanayake Samudra and the subsidiary lakes, as well as on the Sanctuary and National Park.

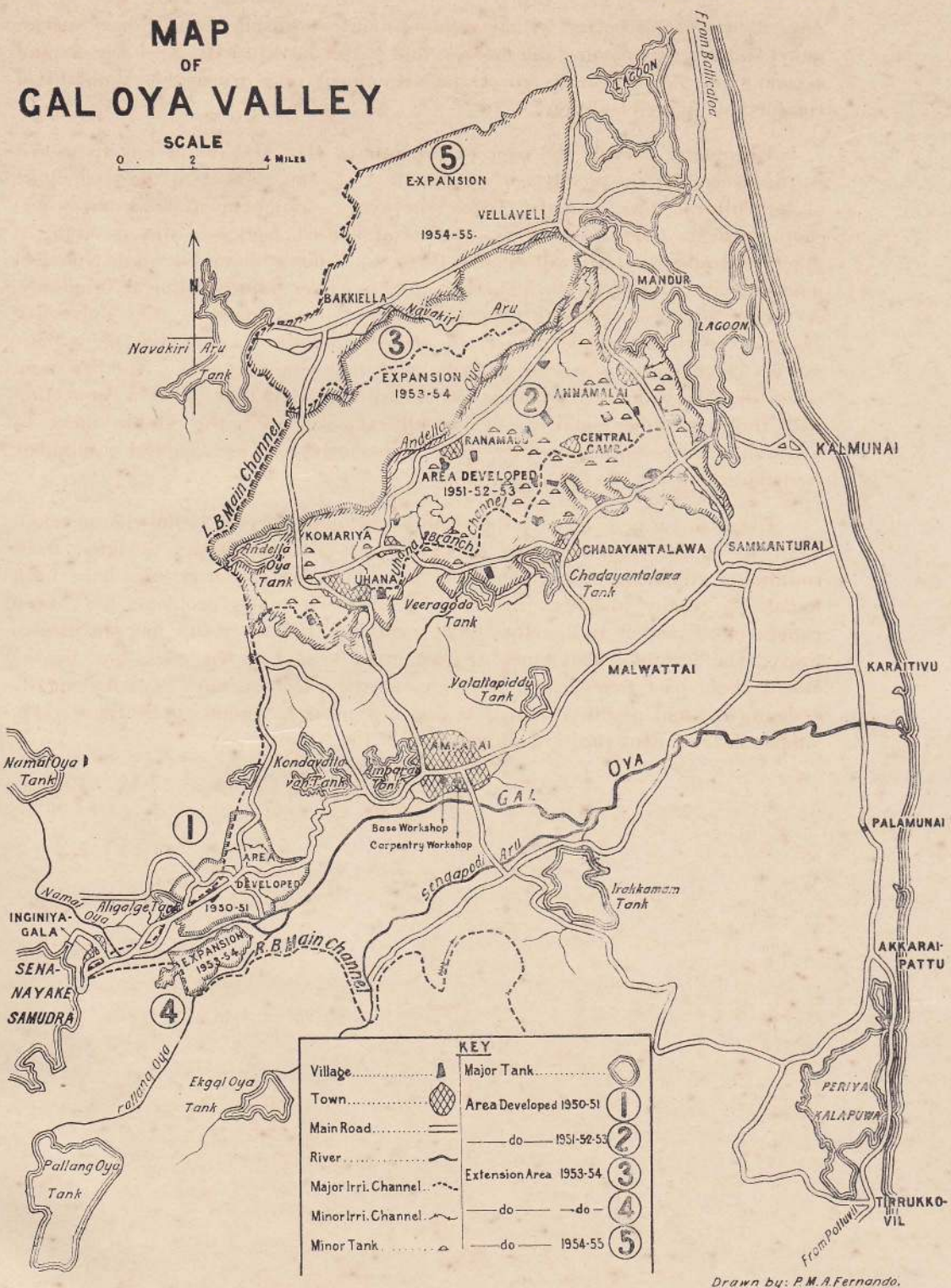
The changes witnessed are obviously the beginning. There will eventually be 33-thousand acres of open water in the Valley, and the combination of scenic attractions, of good roads into the upper catchment forests and attractive opportunities for boating and fishing will obviously bring an increasing number of visitors to the area.

With the economic well-being which makes for better things it should be possible to have a well-planned central town at Amparai and a visitors' centre at Inginiyagala. Likewise, in the changing social environment of the undeveloped

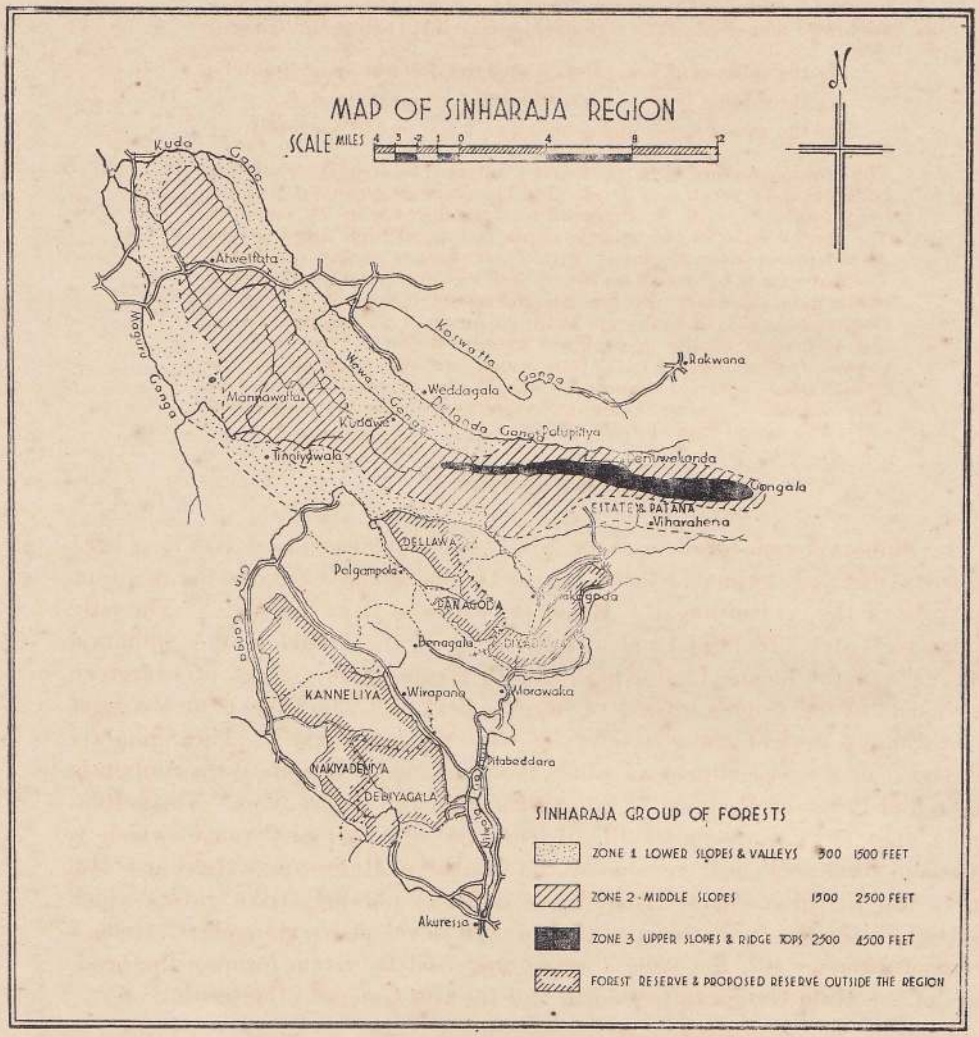
area it will be necessary to have some satellite townships, where open spaces, more sanitary and comfortable houses, and better health, with good schools and a good base hospital, will reflect the attainment of a reasonable standard of comfortable living conditions.

An integral part of the over-all programme that the Board has sponsored is to ensure the reasonably early attainment of staff trained in the technology of agricultural development. Today surveyors, draughtsmen, field and workshop foremen, tractor operators, and even skilled workmen are receiving a practical training which will enable them to achieve a measure of technical independence and fulfil their various functions on sound technical standards. A more advanced training scheme affords the opportunity for University graduates with a science degree to acquire practical knowledge of various aspects of engineering practice in both workshops and the field. Another basic policy decision which will advance and co-ordinate related activities in connection with the management and use of agricultural resources is the establishment of a training centre and laboratory which is being erected as a capital equipment contribution under the Colombo Plan.

The Board was assigned responsibilities in multi-purpose basin-wide development never before undertaken in Ceylon. It has sometimes deviated from traditional approach, and changed old procedures where better ones have been found. In many instances the Board's approach to its problems have been experimental, and it is therefore to be expected that the result has not always proved 100% right. This much at least must be said on the work done by the Board these past four years: it has pioneered effective ways of achieving its assignments, and produced new data and new ideas for broad applications where similar development projects are initiated in the future.



Drawn by: P.M.A. Fernando.
Draughtsman, G.O.D.B.,
Colombo, 11.11.54.



*A RECONNAISSANCE OF SINHARAJA RAIN FOREST

R. A. DE ROSAYRO

ABSTRACT

The Sinharaja group of forests lying in the south-west part of Ceylon has long been considered the only primeval rain forest left in Ceylon. Recent reconnaissances have been made on foot and by air by officers of the Forest Department and the results of these are briefly described. The region is classified into three main zones :—

(1) the valleys and lower slopes—300 to 1,500 feet approximately;

(2) the middle slopes—1,500 to 2,500 feet approximately ;

(3) the upper slopes and ridge tops—2,500 feet to 4,500 feet.

The first zone has been profoundly altered by repeated shifting cultivation to scrub and fernland. This zone is observed to have been originally rich in *Dipterocarpus zeylanicus* and *D. hispidus*. The second zone of the middle slopes is typical high forest of the *Mesua-Doona-(Shorea)* climax with *Dipterocarpus* locally dominant. The last zone is bordering on the stunted wet evergreen forest typical of the montane zone. From ecological considerations of the vegetation, it is held that Sinharaja is by no means a unique rain forest, but is typical of the general wet evergreen forest type found in Ceylon. Other forests in Ceylon which are characterized by the *Mesua-Doona-(Shorea)* community should also be considered as true primeval forest, whose character may however have been somewhat altered by recent exploitation.

INTRODUCTION

The Sinharaja rain forest, a name which is almost legendary, has long been regarded as the only primeval forest left in Ceylon, if one excludes the montane forest type of the central massif. Baker (1) writes of it as follows :—" The only considerable patch of virgin tropical rain forest in the Island is the Sinharaja forest. The name means Lion King. Another considerable tract of evergreen forest exists in the neighbourhood of Adam's Peak.....but this is at too great an elevation to present the characters of tropical rain forest ". The Sinharaja " Adaviya " or region comprises a whole group of forests including the Sinharaja Reserve and Proposed Reserve, all constituting about 117,000 acres. The accompanying map (PLATE 3.) shows the distribution of this forest range which is situated in the geological region of the Southern Ridges and Rakwana Hill Country (3), a region characterized by a series of parallel strike ridges which stand out distinctly from the air, with a well developed rectangular " trellis " pattern of drainage (6), the valleys being traversed by rivers forming the headwaters of the Kalu Ganga to the north and the Gin Ganga to the south.

The general topography of the region, as observed from the air, is rugged, though this feature is somewhat obscured by the vegetation, with steep scarp slopes particularly on the southern aspects, and deep valleys. Almost continuous with the Sinharaja range of forests are a series of forests, which though not referred to as Sinharaja are actually part and parcel of this forest region. These are also indicated on the map.

* Reprinted from The Ceylon Forester, Vol. I No. iii (New Series), Jan., 1954.

HISTORY

The region has been little traversed in the past because of its comparative inaccessibility which entails even today covering long distances on foot. Apart from the occasional visits of surveyors and forest officers, chiefly F. Lewis (7), the first intensive study of the region was carried out by John R. Baker of the University of Oxford in 1936, with the assistance of local workers, chiefly Mr. T. B. Worthington and the staff of the Forest Department. His study which was carried out from the end of July to the middle of September was confined to the geographical, climatological and to some extent, botanical aspects of the tract (1 and 2). His work has naturally been accepted as authoritative in its findings.

RECONNAISSANCES

Primarily with the object of exploring the possibility of working this group of forests and the routes of transport of forest produce in this area, two reconnaissances were recently undertaken by the Forest Department, one from the southern aspect along the valley of the Gin Ganga and the other from the north along the valleys of the tributaries of the Kalu Ganga, namely, the Wewa, Delgoda and Koswatte Gangas which run parallel to each other meeting at the north-western end to form the Kukulu Ganga, the chief source of the Kalu Ganga. The main region of the Sinharaja forest group lies in between the Wewa and the Gin Gangas. These reconnaissances were made on foot, the first by the writer accompanied by the F. A. O. Expert, Mr. A. Decamps and Forester Mr. S. Bandaranayake in August, 1951. The party covered approximately 70 miles in one week going on foot along the Gin-ganga from Nelluwa to Pallegama, inspecting the forest at various points and proceeding to about 2,500 feet altitude of the main ridge.

The second was made by Mr. M. Wright, Junior Assistant Conservator of Forests and a party of forest officers in July, 1952, along the valleys of the tributaries of the Kukulu Ganga, about 100 miles being covered on foot in a week. In addition, a special reconnaissance flight was carried out in an Air Academy aircraft with the writer, Mr. Decamps, Mr. M. Wright and other officers of the Forest Department. About 300 miles were covered on this reconnaissance, the general direction of the flight being north-west to south-east and *vice versa*, parallel to the main strike ridges. Although, admittedly, these reconnaissance inspections were not in the nature of intensive studies, the information collected in them has been valuable and apart from the study of the problems of extraction of timber, information of ecological importance was also recorded.

CLIMATIC AND TOPOGRAPHICAL REGIONS

The conditions of climate, rock and soil are typical of the wet evergreen forests of Ceylon in general, which have been described in an earlier paper by the writer in this journal (5) to which reference may be made. Baker (1) has made a more detailed study of the meteorological conditions of Sinharaja during the period of his work in the tract in 1936. The data obtained are interesting and show that climatically the region is by no means unique for Ceylon and in fact,

in comparison with recorded data from other tropical countries (figures given by him for typical stations in Puerto Rico Borneo, Sumatra and New Hebrides) are characteristic of the world type of tropical rain forest.

SHIFTING (CHENA) CULTIVATION AND VILLAGE SETTLEMENTS

The existing high forest in the Sinharaja range is part of a large extent of original primeval forest which has gradually been encroached upon by shifting cultivation resulting in the replacement of forest especially in the valleys and lower slopes of the range, by scrub and fernland. The most extensive development of shifting cultivation has been in the northern section of the region falling in the Kukul Korale around Kalawana. Here there are considerable extents of forest claimed as private. The chief reason for the extensive areas of shifting cultivation found in this region are the absence of suitable land for permanent cultivation. Paddy cultivation is mainly confined to groups of villages in the vicinity of the Gin Ganga, that is, on the southern boundary of the region around Nelluwa and Mediripitiya. The intermediate stretch of country between these two villages (*vide* map) and the entire tract on the northern boundary of the forest lacks suitable land for paddy cultivation. Shifting cultivation is the chief means of subsistance and has probably been going on continuously for centuries, though its progress has been retarded in recent years after the reservation of the forest in this region.

The permanent village settlements in this region which are not dependent on paddy cultivation have a number of other interests in addition to the pursuit of shifting cultivation. The region is well known for the production of jaggery from the *Kitul* palm (*Caryota urens L.*) which is found in every village and previously cultivated secondary forest, and for the fine quality of canes (*Calamus* spp.) collected from the forests.

FOREST TYPES

The forest in this region can conveniently be divided into three topographical zones, as suggested by Wright (9) :—

(1) the valleys and lower slopes of the chain of hills and central mountain range. Altitudinal range 300 to 1,500 feet approximately ;

(2) the middle slopes of the main mountain range. Altitudinal range 1,500 to 2,500 feet approximately ;

(3) the upper slopes and ridge tops. Altitudinal range 2,500 to 4,500 feet ; the highest peak lies in the extreme south-east of the main range, namely, the summit of Gongala 4,456 feet, where the Gin-ganga takes its source. This peak is part of the geological region of the Rakwana massif (6). These topographical zones are indicated on the map.

(1) The Valleys and Lower Slopes—300 to 1,500 feet.

Apart from small holdings of rubber and tea and a few capitalist-owned rubber estates lying on the southern slopes near the Gin Ganga, the lower slopes of the range are mostly in scrub, characterized by the *Osbeckia octandra*, *Melastoma malabathricum* and *Hedyotis fruticosa* associes, or fernland of *Gleichenia linearis*.

These are the earliest sub-seres following the removal of the original forest cover for shifting cultivation and the impoverishment of the soil in the case of fernland, by repeated burning. The forest found here is the remnant of the original forest much modified by felling and burning. *Dipterocarpus zeylanicus* and *D. hispidus*, characteristic of similar sites in other wet evergreen forests, are most abundant in this zone and occur in almost pure stands along the stream banks and in the valleys. The existence of trees of these species of extremely large proportions, and the frequency of stumps and particularly burnt trees in cleared land indicate that *Dipterocarpus* was the chief species of this zone in the past. Where succession is more advanced, secondary forest of *Aporosa latifolia*, *Chaetocarpus* spp., *Wormia triquetra*, *Dillenia retusa*, *Vitex pinnata* and *Anisophyllea cinnamomoides* predominate associated with lighter hardwoods such as *Mastixia tetrandra* var. *thwaitesii*, *Litsea glutinosa*, *Semecarpus* spp., *Mangifera zeylanica* and *Myristica dactyloides*. In between the earliest and later sub-seres, all stages of secondary succession are found, with early pioneer tree species of *Macaranga subpeltata*, *Acronychia laurifolia*, *Trema orientalis*, &c. locally referred to as low jungle.

(2) The Middle Slopes—1,500 to 2,500 feet.

The middle and upper slopes of the ridges referred to by the villagers as "Maha-Sinharaja", is the forest proper, which has escaped the depredations of the shifting cultivator. The actual remaining high forest including the upper slopes is estimated by the writer at about 50,000 acres, based on the aerial reconnaissance. This is the zone of the best stocking and growth, characterised mainly by the *Mesua-Doona-(Shorea)* community. There are probably several *duns* which form this community. Specimens of the commoner varieties collected and identified, indicate that the typical hardwood *duns* found here are *Doona macrophylla*, *D. cordifolia*, *D. nervosa* and *Shorea oblongifolia*. The light hardwood *duns* also characteristic of this zone, are *Doona congestifolia* which is often found growing gregariously especially on the upper reaches of this zone and *Shorea stipularis* (*hulanidda*, locally called *naboda*). *Mesua ferrea* and *M. thwaitesii* are more gregarious and confined to the vicinities of streams. Both *Dipterocarpus zeylanicus* and *D. hispidus* are also frequent and easily identified in certain seasons (February-March) by the light-green crowns during the period of leaf-flushing. The forest shows excellent height growth up to 150 feet, with recorded girths (by Wright) of 6 feet to 10 feet. An important and interesting feature of this forest community is that from the air, the crowns of the trees of the upper canopy are clearly seen to almost touch each other forming a mosaic crown cover with few gaps. There are no emergents as such forming a discontinuous layer. This type of statification is more characteristic of rain forests with a single species of dominant but not of forest of mixed dominants (*vide* Richards, "The Tropical Rain Forest" (8), pages 25—39). *Syzygium* spp. may also be distinguished by the predominant red hues produced by leaf-flushing. The light hardwood faciation of mainly *Durio zeylanicus* and *Palaquium petiolare* which are characteristic of this community elsewhere, are also characteristic of this zone. The second storey iucludes species characteristic of secondary forest of the lower slopes mentioned earlier; among other typical species are:—*Syzygium* spp., *Calophyllum* spp., *Homalium zeylanicum* and *Campnosperma zeylanicum*. Wright records the average girth of this layer as 4 to 6 feet.

The calamander, *Diospyros quaesita* and *nedun—Pericopis mooniania*, both highly prized cabinet-woods were found here, but are now comparatively rare. Regeneration of the chief species of the community is dense and frequent, particularly the *Mesua*, *Doona*, *Palaquium* species and *Durio zeylanicus*. The understorey layer is characterized by the tall shrubs *Agrostistachys longifolia* and *A. coriacea*, *Schumacheria castaneaefolia* and the low shrub *Apama siliquosa*. Woody climbers are few, except for the canes *Calamus* spp. which are especially abundant on the lower middle slopes, where secondary forest species predominate.

(3) The Upper Slopes—2,500 to 4,500 feet.

The upper slopes including the summits of the ridges have been examined by Wright in the eastern section of Sinharaja Reserve along the Hinipitagala ridge which contains the highest peaks in the Reserve, namely, Wanduragala 3,038 feet and Rupahinakanda, 3,838 feet, and across the ridge up to the boundary of the forest where it adjoins Beverley Estate, 3,000 feet.

Wright observed that " there was a gradual decrease in girth, size and form with altitude, especially in the eastern end of the Reserve. The upper slopes and ridge tops show a predominance of *Wormia triquetra* and *Dillenia retusa*..... The average girth at the Hinipitagala ridge (over 3,000 feet) was 2 feet to 3 feet 6 inches while the average height decreased to 20 to 30 feet. There was an accompanying increase in branchiness till at the ridge top, the majority of trees assumed almost stunted proportions of a montane type. The gradual change is quite likely due to exposure to wind which is considerable at this elevation. A similar zonation of girth, height, form and species was observed in the descent from the Hinipitagala ridge to Beverley Estate in the Matara District ".

His observations agree closely with those of Baker (2), who mentions also the abundance of *Doona congestifolia* which is also the largest tree at this elevation. The other species of this montane community are *Calophyllum calaba* and *Syzygium* species. *Ochlandra stridula*, the *bata* bamboo, is now a frequent species in the undergrowth, replacing the *Agrostistachys* species.

CONCLUSIONS

The observations made of the vegetation in the reconnaissances of Sinharaja clearly show that the forest types conform almost exactly with those analysed and described by the writer for the general wet evergreen forest zone of Ceylon (4). The most recent analysis of enumerations in the Kanneliya-Dediyagala-Nakiadeniya group, comprising 28,700 acres of forest (the location of this group of forests is also indicated on the map) have shown that the *Mesua-Doona-(Shorea)* community is, wiith the exception of the *Dipterocarpus* community, the most highly developed of wet evergreen communities and may be regarded as the true climax community of wet evergreen forests in Ceylon.

The Sinharaja group of forests which has always been held to be primeval forest is, therefore, by no means unique in its composition but is closely and intimately allied to the other forests of this region. These forests described in

the writer's last paper in this journal (5) must therefore be also considered virgin forests and actually show far less degradation of the original forest type, as shifting cultivation in these is much more restricted. The range of height and girth in Sinharaja appears to be however somewhat better than in the forests outside this region. The popular view, therefore, that Sinharaja is the last vestige of primeval rain forest in Ceylon may be discredited and due recognition made of the fact that most of the truly high forest types are also virgin forests, though their character may have been somewhat altered by recent exploitation.

References

(1) Baker John R. : 1937—The Sinharaja Rain Forest, Ceylon. *The Geographical Journal*, 89 (6), 539—551.

(2) Baker, John R. : 1938—Rain Forest in Ceylon. *Kew Bulletin* No. 1, 1—8.

(3) Cook, E. K. : 1931—*A Geography of Ceylon.* MacMillan & Co., 360 pages.

(4) de Rosayro, R. A. : 1953—The Soils and Ecology of the Wet Evergreen Forests of Ceylon. *Tropical Agriculturist* (Ceylon) 98, (2), 4—14, (3) 13—35.

(5) de Rosayro, R. A. : 1953—Ecological Considerations in the Management of Wet Evergreen Forests in Ceylon. *The Ceylon Forester*, 1, (2) (New Series), 80—90.

(6) Kularatnam, K. : 1951—Some evidences of Post-Jurassic Tectonic (Dislocational) Movements in Ceylon. *Proceedings of the Ceylon Association of Science*, 1951, Part II, 22—23 (abstract).

(7) Lewis, F. 1896—Notes on an Expedition through Sinharaja Forest, *The Ceylon Forester*, 2, (6) 84—87 and (7) 106—109.

(8) Richards, P. W. : 1952—The Tropical Rain Forest, Cambridge University Press, 450 pp.

(9) Wright, M. : 1952—Reconnaissance of Sinharaja Proposed Reserve and Reserve (Northern Section) and other attendant Proposed Reserves and Reserves in Kukul Korale—Official Report, unpublished.

FIG. 2

FIG. 3

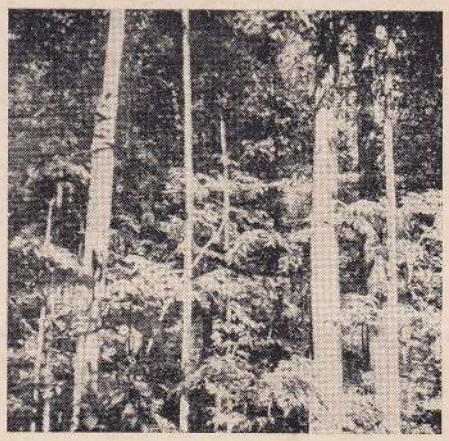


FIG. 4

FIG. 5

FIG. 2.—View of a section of Sinharaja Reserved Forest. The foothills in the foreground have been partly cleared and are partly in *Kekilla* and scrub. The ridge in the background is part of the main range with virgin forest, rising up to roughly 2,000 feet altitude.

FIG. 3.—A part of Sinharaja Reserve. The lower slopes are mainly in *Hedyotis-Osbeekia* scrub. The peak in the background is Kolontotugala, part of a steep ridge of rock, roughly 1,900 feet altitude, with little tree growth.

FIG. 4.—Typical stand of virgin high forest in Sinharaja Reserve near the Aranuwa-dola. The large trees are mostly of ' na '—*Mesua ferrea*.

FIG. 5.—Typical cane bridge across the Gin Ganga at Kolontotuwa.

NOTES ON A REGIONAL SURVEY OF THE HALI-ELA AREA*

C. H. L. SIRIMANNE

(Summary of a Paper read before the Sessions of the Ceylon Association of Science, 1945)

INTRODUCTION.

The Hali-Ela region is a small area on the Eastern margin of the Uva Basin. The area consists of four villages and the small town which forms the focus of their human activities, and is called the *Hali-ela Region* from the name of the town. Though it is only a little over 4 sq. miles in area, four unit areas may be demarcated, and these combine in a remarkable way to give this Region its " Personality ".

The geology, soils and topography of the area were surveyed on base maps prepared from the 16-chain village diagrams, on to which topographical detail was transferred from the 1 inch Ceylon Survey Map. Climatic data was collected from the Observatory Reports and from Estates which kept meteorological records. Vegetation types were established in the field. The human response to the environmental factors of the physical background can be measured by the degree of development of agriculture and industry in the area, which is clearly illustrated in the results of the Land Utilisation Survey. Trends in population growth and distribution, and the development of the small town which serves as the focal point for the area in its relation to its " hinterland " were deduced from the Census figures and field observations of settlement groups.

Notes on particular aspects of the region are given below, and a TRANSECT CHART (PLATE 4) has been constructed, which gives a composite picture of the regional geography of the area. The sketch map (FIG. 1) shows the component units of the region.

STRUCTURE

The area is a " junction basin ", at the intersection of a narrow longitudinal strike valley and a transverse valley—formed by erosion of a plane of weakness (FIG. 1). The main longitudinal valley whose bottom is at an elevation of 2,400′—2,500′ strikes in a N.W. direction and is due to erosion of an *anti-clinorium*. The transverse valley is at right angles to this direction—(N.E. by S.W.). Streams and roads occupy these two systems of valleys at whose intersection lies Hali-ela Town. The four villages occupy the slopes of the Ridge and converge towards this point. Rising westwards from the main valley is the Moretota Ridge at a height of 4,000′ in the south, dropping to 3,600′ in the north. This ridge forms the western limit of the area. The lower Unugalla Ridge—3,500′ in the south to 3,000′ in the north, limits it on the east. Southwards the valley narrows and a spur from the Unugalla Ridge shuts in the area on this side. The boundary on the north is the low Mylaathena Hill rising to 2,900′. Thus we see that the area is clearly a morphological unit.

* Reprinted from Bulletin of the Ceylon Geographical Society. Vol. I, No. 4, 1946. pp. 29-33.

GEOLOGY

The western part of the area consists entirely of intrusive Charnockite granite with a westerly dip and a North by West strike. The eastern ridge consists of rocks of the Khondalite system with easterly dips and with North by West strike which in the neighbourhood of the Hali-ela town veers round to a North-easterly direction, in which direction it continues for a mile and a half before it changes back to its dominant North by West direction. Sills of charnockite have intruded into the Khondalites of this area. Quartzites, crystalline limestone and Type Khondalites occupy the valley slopes, while the valley bottom is covered with alluvial clays and sands.

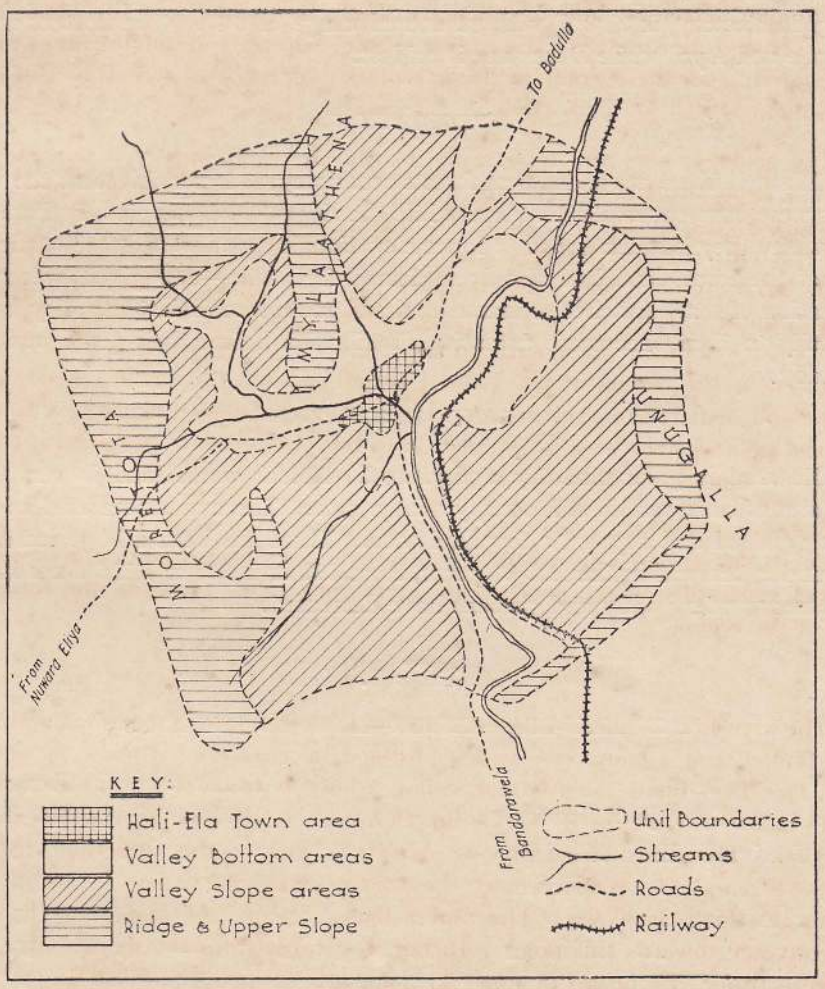


Fig. 1.—Component Unit Areas of the Hali-Ela Region. (Scale : 2 inches=1 mile.)

SOILS

The acid charnockites and the quartzites weather into poor acid soil—light in colour and texture, poor in lime but likely to be rich in potash, and are, in the main, Patana country. The basic Charnockites and the Type Khondalites weather into a rich loamy soil with high Fe and Mn content, darker red in colour and

heavier in texture—rich in lime derived from the crystalline limestone bands interbedded with the Khondalites. These areas are given over to tea cultivation, though it must be noted that the "tea" does not thrive on the limestone belt itself. The alluvium of the valley bottom is well drained and supports paddy.

CLIMATE

The rainfall of the area varies according to elevation, the Moretota Ridge gets an annual rainfall of over 100″ while the Unugalla Ridge gets from 70″—80″ and the valley bottom 60″—70″. The driest months are June and February while the wettest are April and November. The mean average temperature (Unugalla Factory) is 71·8°F with an annual range of 6·1°. The hottest months are June and April while December is coldest.

VEGETATION

Although there are no natural forests remaining, it is possible that the valley slopes were once covered with them, while the ridges were occupied by Patanas—from where they have extended to lower elevations by patana and forest "firing". Most of the forest land had also been cleared for coffee—now given over to the cultivation of tea. Patches of marsh land and reeds remain in the valley bottom to testify to their once more extensive distribution before their place was taken by paddy.

LAND UTILISATION

The area is predominantly agricultural. Actual waste land is very small, but Patanas have and do still occupy a large area. These areas are used as rough grazing ground and support a few herdsmen. There has been a large increase in area under tea within the last 30 years, from 381 in 1905, to 1,115 acres in 1936 while areas under paddy and gardens have decreased.

Table 1.

THE HALI-ELA REGION—LAND UTILISATION

Type of Utilisation	Total Area (in Acres) 1905—07	1936—37
Cultivated Land...Paddy	148	106
...Gardens	383	129
Plantation ... ...Tea	381	1,115
... ...Timber	—	16
Chena Land	202	64
Patana Land	602	474
Jungle and Waste Land	92	70
Buildings and Allotments	—	27
Water Surface, etc.	3	3
	1,811	2,004

AGRICULTURE

Though the area is very small it is interesting to note that here are contained the three types of agriculture, characteristic of the Island of Ceylon. These are (1) the very primitive Chena cultivation, (2) the Sinhalese village agriculture which goes back to ancient times with equally ancient methods and (3) the modern plantation agriculture with foreign capital, immigrant labour and under scientific management. How far back chena agriculture goes is not known. Village agriculture with rice cultivation as basis goes back to Vijayan times. The opening up of forests began with the great "Coffee Era" of Governor Barnes' time in 1824. Coffee has, since the blight of 1870, given place to tea.

POPULATION AND TYPES OF SETTLEMENT

The population of 800 inhabitants in the *Town Area* is distributed along the main arteries of traffic. The density here is about 25 per acre. The settlements in the *Valley bottom* areas are either "nucleated" as in the upper reaches of the valleys (Uva, Dompe Village), or "lineated" along irrigation channels or roads. The density here is 2 per acre.

The population of the *Valley Slope Area* which is entirely given over to the cultivation of tea, is composed of estate labour. The labourers are housed in 'lines' situated at convenient points for them to get to their divisions, and where water supply is available. Each 'line' houses about 30 people. In 1937 the total estate population was 1,500—entirely immigrant labour. The density for this area is $1\frac{1}{2}$ persons per acre. *The Ridge and Upper Slope Area* forming nearly $\frac{1}{4}$ of the total area has a density of 1 per 10 acres.

The villages of Medapitagama and Kairatnagama, although having a small population, are relatively stable, the latter increasing gradually, while the former shows a drop—this was due to part of the village being included in the town. Watugederagama shows an increase up to 1921 since when she has been stable. The population of Halielagama dropped in 1901—this was due to two reasons: (1) separation of the town population from the village—done for the first time in the Census of 1901, (2) migration of traders to Bandarawela with the opening of the railway to that place. An increase in population in 1921 may have been due to the influx of labourers when the railway was being constructed there (1924). In 1923 the Town Limits were defined and portions of this village and others were included with the town. This may account for a drop in 1931. There has been a rapid growth of the town—from a population of 240 in 1911 to nearly 620 in 1931 and nearly 900 in 1937.

UNIT AREAS OF THE REGION

The following component unit areas can be recognised from the study of the foregoing (Fig. I):—

(*a*) *The Hali-ela Town Area* (2,400′): It is the administration, trade, transport and Civic Centre of the area and is admirably suited by reason of its position at the point of convergence of the valleys. Hence the cosmopolitan nature of the population which numbers about 800 (Table 2).

Table 2.

RACIAL COMPOSITION OF HALI-ELA TOWN

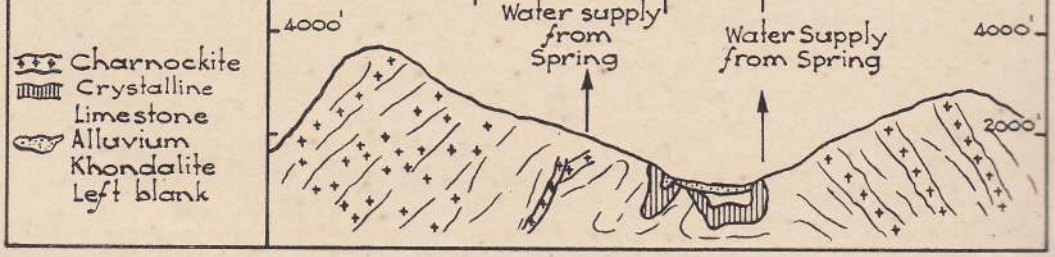
Kandyan Sinhalese	...	200	Farmers; transport workers; labourers in P. W. D. and Railway. Carpenters and masons.
Low-Country Sinhalese	...	110	Traders, jewellers, smiths, hotel-keepers.
Ceylon Moors	...	250	Merchants.
Ceylon Tamils	...	50	Cigar merchants, P. W. D. labourers.
Indian Tamils	...	180	Brokers, merchants, labourers.

(*b*) *The Valley Bottom Areas :* These include most of the area between 2,400′ and 2,600′ and are mainly devoted to village agriculture, viz. cultivation of paddy and gardens. Population about 400, predominantly Kandyan Sinhalese.

(*c*) *The Valley Slope Areas :* Include land about 2,600′—the upper limit is not easily defined. In the Moretota Ridge, it is the elevation at which there is a change of gradient, where the slope becomes steeper, *i.e.* at about 3,500′. In other areas the soil factor is predominant and the Patana belt may be taken as its upper boundary. This area is mainly devoted to cultivation and manufacture of tea under scientific management. It is well served with systems of roads and housing. Population about 1,650, of which only 150 belong to the villages. The balance being a " floating " estate population of Indian extraction.

(*d*) *The Ridges and Upper Slope Areas:* Above 3,500′. These are the Patana areas and may invade lower elevations. The upper reaches have no permanent settlements and afford rough pasture while in the lower reaches are the isolated dwellings of the " chena " cultivator. These vast tracts, with an area over $\frac{1}{4}$ of the total, have only about 50 people.

REGION AND UNIT AREAS	REGIONAL LIMITS						
SETTLEMENTS AND COMMUNICATIONS	No permanent settlements	Isolated dwellings	Large labour population in Lines' Factories estate bungalows Estate roads.	Agricultural villages and Towns Railway Roads	Estate population Lines, factories bungalows Estate roads	Isolated dwellings	No permanent Settlement
	Cattle tracks only						
MINERAL PRODUCTS	Quarrying of road metal and building stone		Lime kilns	Brick and Tile Kilns	Lime kilns	Mica pegmatite old working	
AGRICULTURE	Rough Pasture	Chena Cultivation	Tea Plantations	Paddy and Garden cultivation		Tea Plantations	Rough Pasture and Chena
VEGETATION	Patana	Scrub jungle	Forests (?) (Now cleared)	Marshes and reeds	Forests (?) (Now cleared)		Patana
SOIL	Soil mantle thin; acidic, poor - due to forest and patana firing. Bare rock exposed in places		Soil cover thicker, loamy; iron and manganese. Rich in humus Soil over quartzites poor and acidic	Alluvial clays and Sands	Acid loamy Soil Rich in humus, poor in lime		Thin patana soil
CLIMATE	HUMIDITY: Low		Higher				Low
	TEMP: Cooler						Mean Annual Temp: 71·8°F Range: 6·1°
	RAINFALL: Wettest months - April, November. Driest months - June, February						
	← 100"	70"-80"	60"-70"	70"-80"		100" →	
RELIEF AND DRAINAGE	Ridge and Upper slope		Lower slope	Valley Bottom	Valley slope		Ridge
	Rapid run-off	Good drainage	Irrigated Lands		Good drainage		Rapid run-off
GEOLOGY	Charnockite granite		Khondalite System:- Type khondalite, quartzite, crystalline limestone.	Alluvial clays and Sands	Khondalite System:- Type khondalite and quartzites with intrusive sets of charnockite.		



TRANSECT CHART OF THE HALI-ELA AREA

THE CITRONELLA OIL INDUSTRY OF CEYLON*

By P. G. Cooray

INTRODUCTION AND HISTORY

The extraction of citronella oil from what is popularly called " mana grass " is an old industry in Ceylon, localised in the southern part of the Island. Its place in the economic life of the peasants of that region is vital ; it is, in fact, one of the chief economic products of the Southern Province, and an important export from Ceylon. But the industry is in a bad state today, and drastic re-organisation is necessary before it can be of real benefit to the people.

The distillation of citronella oil in Ceylon was first observed in the second half of the seventeenth century by two army surgeons—Hermann and Grimm—who reported its use by the indigenous population for medicinal purposes only. The first samples began to reach Europe by the beginning of the eighteenth century, but exports were sporadic. There was little demand for the oil as the use of soap and cheap perfumery was not widespread at that time ; it was not till a century later that the demand increased and justified a regular export—a demand that was stimulated by samples of the oil displayed at the World Expositions in London (1851) and Paris (1857). By 1890, Ceylon had become the sole supplier of citronella oil to Europe, but Java soon entered the field, though with a type of oil that had different applications. The beginning of the 20th century saw a rapid increase in production, due chiefly to the use of citronella oil in the manufacture of soaps and perfumes ; and a filip was given to the industry after 1914—1918, when methods of extracting synthetic menthol from citronella oil were developed.

USES

The commercial uses of citronella oil today are wide, but a distinction must be made between the Java and Ceylon oils. " Java oil " is used mainly for the manufacture of synthetic isolates, *e.g.* geraniol, citronellol and their esters, citronellal, hydroxy-citronellal, and especially synthetic menthol. " Ceylon oil " on the other hand holds first place for soaps, perfumery, and all kinds of technical preparations, *e.g.* insecticides, polishes, 3-in-1 oil, etc.

BOTANY

It is probable that the parent plant of all citronella grass is mana grass (*Cympobogon confertiflorus stapf*) which grows wild in Ceylon and belongs to the family *Gramineae* (others being ginger-grass, lemon-grass, palmarosa). Two main types of cultivated citronella grass are found in Ceylon which, though morphologically similar, differ in habitat and oil.

The first is " Maha Pangiri " (*Cympobogon Winterianus Jowitt*) commonly called " Winter-grass " or " old " citronella grass because it was grown a long time ago by a well-known distiller Winter. It is a more exacting type and requires a fertile soil, much cultivation, and more frequent replanting ; and though har-

* Reprinted from Bulletin of the Ceylon Geographical Society, Vol. II, No. 1, 1947, pp. 1-11.

vesting is at longer intervals, the yield and quality of oil are good, the geraniol content being 85%. The superior Java oil is from this type, and it has recently been introduced in Guatemala and Formosa. Its extent in Ceylon is limited.

The second type, "LENA BATU" (*Cympobogon Rendle Lenabatu*), is the main type in Ceylon, and was thought by Jowitt to be a product of the crossing of wild "MAHA PANGIRI". "Lena batu" is found only in Ceylon. It is a hardy grass, and grows well with little cultivation, even on poor soil. The yield of oil is lower than from "maha pangiri," and the geraniol content 55%—60%.

The two types of grass are generally mixed on Ceylon plantations, but "lena batu" is the predominant type and more widespread.

HABITAT AND DISTRIBUTION

The total acreage under citronella grass was 33,000 acres in 1944 (40,000 in 1940), confined to the Matara and Hambantota Districts, with a little in the Ratnapura District.

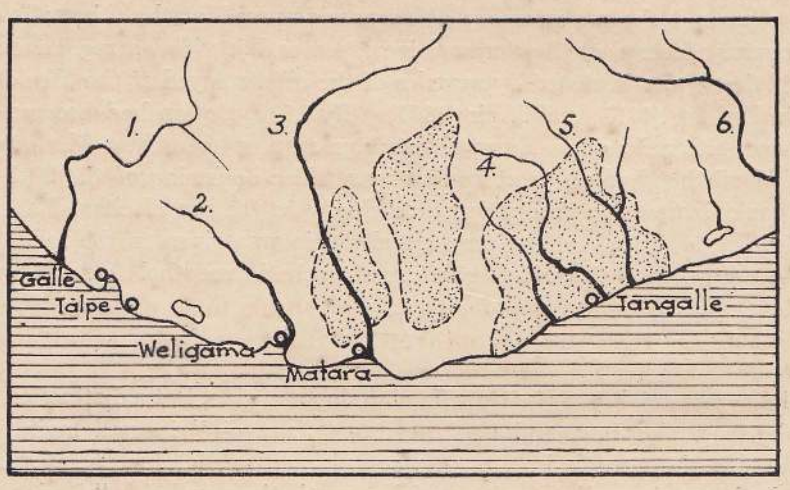


Fig. 1.—Main citronella-growing areas in South Ceylon. (Scale: 1 inch = 16 miles approx.) Rivers: (1) Gin Ganga, (2) Polwatte Ganga, (3) Nilwala Ganga, (4) Kirama Oya, (5) Urubokke Oya, (6) Walawe Ganga.

FIG. 1 shows the distribution of the main citronella-growing areas—(a) the lower basin of the Nilwala-ganga (3); (b) the basins of the Sinimodera Oya, Kirama Oya and Urubokka Oya (4, 5); and (c) the area between. Westwards cinnamon takes the place of citronella as the chief crop, and eastwards, towards Hambantota, scrubland predominates.

Citronella grass generally grows below the 2,000 ft. contour and on almost any soil. It requires a hot, moist, climate, though a low annual rainfall (about 40") is not inimical to its growth. Such a habitat is common to many parts of Ceylon. The reason for the localisation of the citronella industry in the south must therefore be sought in the fact that it is native to those parts, and that the region is not suitable for any other economic crop, *e.g.* rubber, tea; "geographical inertia" has also had a hand in confining the industry to the Southern region.

OWNERSHIP

The ownership of citronella grasslands is wholly in the hands of the Sinhalese and cultivation is essentially a peasant industry. Most of the land is owned in half- to one-acre blocks which are widely scattered. There are however a few large estates of 100 to 300 acres. Some of these, though not many, are run on " plantation " lines, while others are rented out in small blocks to small producers on the share-crop arrangement. Ownership is exclusive in most parts (*e.g.* five out of six villages surveyed by Dr. Das Gupta), and absentee ownership is extremely rare.

METHOD OF CULTIVATION

All citronella grass is " cultivated ", except the semi-wild grass which grows on neglected estates.

Before planting the grass some preliminary preparation of the soil is necessary, viz.: the burning of old grass and weeds, and subsequent hoeing. Cuttings are planted during (1) May-August, (2) November-January, and are placed (in rows) from $1\frac{1}{2}$ to 4 feet apart, depending on the slope of the locality. The period of growth is generally 8 months (sometimes 12 months), at the end of which period the plant is 4 to 5 feet tall. During the period of growth, weeding is the only work necessary. On some of the better-run estates a biannual manuring is given to the soil with the ashes of distilled and burned citronella grass ; but generally there is very little manuring.

Thereafter the leaves are cut two or three times a year, during March-April, June-July, and November-mid-January. No cutting takes place during spells of rain, because the grass would ferment while lying in the fields before distillation, and would be too wet for distillation itself. The cut grass dries in the fields from one to three days ; it is then bundled and stacked for further drying and finally transported by bullock-cart or wire-shute to the nearest distillery.

The cultivation of the citronella grass is therefore relatively easy, compared with the cultivation of the other crops in this Island. " This ease of cultivation has both a good and bad side. Where nothing else will grow, the citronella will. Much land which would otherwise perhaps have remained barren is thus now growing a money crop. But it prevents the owner from growing a more exacting but more profitable crop. He tends to lose agricultural enterprise and initiative ". (Das Gupta).

If well taken care of, a plantation may last about fifteen years, when it must be replanted.

DISTILLATION

In 1940, there were 395 citronella distilleries in Ceylon serving the cultivated areas, and located in general, on the larger estates. These distilleries are comparatively modern and efficient, and though not as advanced as some in Java, are far superior to those in South India (for distillation of lemon grass).

Distilleries in Ceylon are housed in small buildings or under protecting sheds, and each is a small manufacturing unit with a separate boiler for generating steam. Briefly, the process is as follows :—Steam is passed over the grass and then condensed by leading the steam pipe through a cooling tank. The stills are of heavy galvanized iron and the standard size is 6 feet high by $4\frac{1}{2}$ feet wide, though on the larger estates 8-foot stills are sometimes used.

In a typical distillery (Fig. 2), two stills working alternately are usually connected with one condenser which is inserted into a rectangular concrete water-tank (normally $20' \times 10' \times 6'$) embedded in the ground. A Florentine flask (where oil and water separate) and an oil container are located in the oil room below the level of the ground and reached by steps. The charge of dried grass for a standard size still is about half a ton. The distillation of a single charge takes six to eight hours ; this is rather long, and may be one cause of the low geraniol content of Ceylon oil. The exhausted grass is used as fuel for the steam boiler.

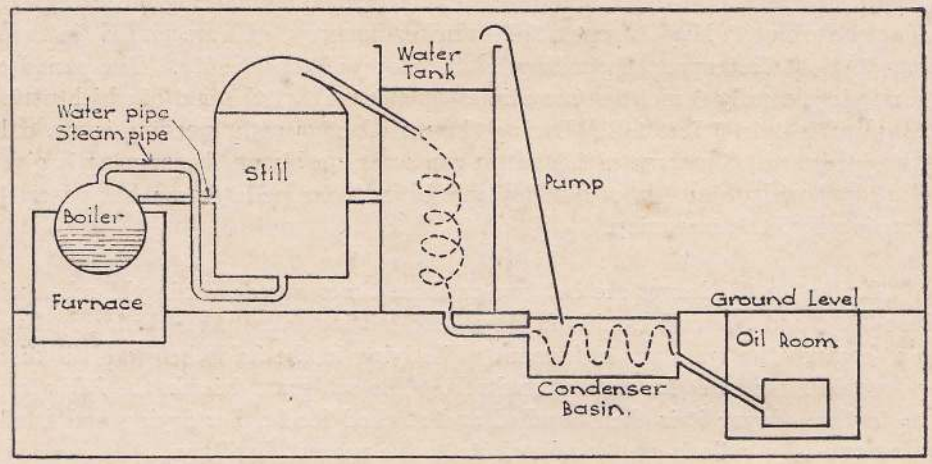


Fig. 2.—Diagrammatic cross-section of citronella-oil distillery.

Mention must be made here of two by-products of the distillation process. A liquid residue is released from the bottom of the still after each " wadia ". It is known as " goda ", and is thrown away at present. It would be a good idea to have this residue analysed for any possible utilization.

The spent leaves, after being dried, are used as fuel for the boiler. The ashes form the main artificial manure of the paddy fields in these areas. There is a proposal, however, to use the spent leaves in the manufacture of paper in a factory at Matara. Anyone contemplating such a step would be well advised, however, to take into consideration the value of the ash to the peasant, before making a final decision about the factory.

YIELD

The unit of measurement of the gross crop is the " wadia ". It is the load required for a standard boiler (6 ft.) and generally weighs half a ton.

Average output of grass per acre per crop — 3 wadias ($1\frac{1}{2}$ tons).
Average output of grass per acre per year — 9 wadias ($4\frac{1}{2}$ to 5 tons).
The unit of measurement of oil is 1 bottle of 24 ozs. ($1\frac{1}{2}$ lbs.).
Average yield of oil per acre per crop — 15 bottles
..... per year — 45 bottles
= 70 lbs.

The yield of oil varies, of course, with season, age of plantation, and locality. Certain areas are said to be better, *e.g.* Ranna in Tangalla, but opinion about this varies. Although the average yield of oil per acre for a year is given as 45 bottles or 70 lbs., there is a marked decline in yield after about the fifth year, when it drops to about 40 lbs. Again, though the average number of crops per year is estimated at three, the younger plantations give four, and the older and neglected ones, two.

The yield of oil is lower than the yield in Java.

COST OF PRODUCTION

Of the total cost of production of citronella oil (*i.e.* of planting, harvesting, distillation, transport, etc.), labour costs form the greater proportion, since little or no artificial fertiliser is used, and no expensive machinery is required. Wage rates increased considerably (by about 200%) between 1941 and 1944.

Table 1

	1941	1944
Males ...	·40—·50 cts. per day	Re. 1·25 per day
Females ...	·20—·25 cts. per day	·75 cts. per day

There are four items of cost which form the greater part of the total :

(*a*) Weeding—generally by men, once a year. Requires 20 labourers per acre.

(*b*) Reaping and binding—women and children. Also 20 per acre.

(*c*) Transport—cost varies with situation of boiler in relation to the fields.
Estimated average ... 50 cents per wadia ($1\frac{1}{2}$ ton)
Rs. 4·50 per acre per year ($4\frac{1}{2}$ tons)
(cf. 1941 : 25 cents per wadia = Rs. 2·25 per acre per year).

(*d*) Boiler—100 acres would provide continuous work for one boiler, and estates of 100 acres or more generally have their own boiler. Small-holders, and some estates, hire boilers and pay 1/6 of the distillate, which must be taken into account in total costs. Boiler crew—2 men ; and 2 women for drying grass.

Table 2 gives the estimated total working costs on a large estate with its one distillery.

Table 2

PER ACRE PER ANNUM

Item	1941 Rs.	c.	1944 Rs.	c.
Weeding	10	00	30	00
Reaping and Binding ...	15	00	45	00
Transport	2	25	4	50
	27	25	79	50
Boiler Expenses	9	00	18	65
	36	25	98	15
Overheads (including carter, conductor and one juvenile labourer)	4	20	8	40
	40	45	106	55

Hence cost per lb. of processed oil (taking 45 bot. or 68 lbs. as yield per acre per year) = Rs. 1·566 (1941 = Rs. 0·595).

A small holder using a hired boiler would have no overheads, as the owner supplies all labour for superintendence. There would be no boiler expenses or depreciation charges, but he would have to pay the labour charges for the boiler crew ; he also foregoes 1/6 share of his distillate. Hence his cost per lb. = Rs. 1·66 (1941—Rs. 0·60). Hence average cost for Estate and Small holder — Rs. 1·60 per lb. (1941—Rs. 0·60).

Table 3 shows the relation of selling price to cost of production.

Table 3

Year	Average Price Realised Rs.	Total Estimated Cost Rs.	Margin to Producer
1940 ...	0·83 ...	0·87 ...	−0·04
1941 ...	1·74 ...	1·35 ...	+0·38
1942 ...	2·56 ...	1·82 ...	+0·74
1943 ...	2·00 ...	2·29 ...	—0·29
Controlled Price	1·80 ...	2·29 ...	—0·49

It will be seen that the fortunes of the producer varied considerably between 1940 and 1944 ; that the peak year was 1942, when the price of oil was high owing to demand, but labour costs had not risen proportionately ; and that the controlled price was fixed below the 1944 total cost of production. An important point to

note is that when cost of production is likely to be more than the selling price (*e.g.* 1943, 1944) the average small holder tends to neglect the essential operation of weeding, one of his highest items of cost, to the deterioration of his crop, because in such cases mana grass tends to overrun the plot.

MARKETING

On the larger estates with modern distilleries the oil is handled with care and is decanted, filtered, and properly stored until sold direct to the exporter. The exporters are the big buying agencies in Galle and Matara, *e.g.* Hayley & Kenny, Volkart Bros., Vavasseur & Co., and Samarasekera Bros.

The small holder, however, has no proper marketing facilities and his oil is handled by a middleman called the " field broker ", who makes Re. 1 to Rs. 2 on the transactions. In many cases the smaller producers are financed by the middlemen themselves, who, by charging interest on loans, make quite handsome profits ; these middlemen very often are boutique-keepers. The small producer therefore, selling as he does in small quantities, and with practically little or no knowledge of market conditions, seldom gets a square deal. All he wants is to obtain some cash for his immediate purchases of rice, kerosene oil, matches, currystuffs and other necessities. If the middleman is a boutique-keeper, these articles are given to him on credit or in lieu of cash advances. This is a common practice in Ceylon and elsewhere in the East, and is undoubtedly responsible for much of the chronic indebtedness of the rural population. Since the producer is already in debt to the middleman, his bargaining power is severely handicapped and he seldom, if ever, gets full value for his product.

The manager of a big buying agency has his own difficulties to contend with. Numerous small lots of varying quality are brought in daily by middlemen, and these must be tested immediately for a quick decision.

The common test today is Schimmel's Solubility Test. It tests for the solubility of the oil in 80% alcohol and determines the specific gravity of the oil, which at room temperature (28 deg. Cent.), should be about 0·900 or higher. Schimmel's test has remained till today the basis of all contracts, though it has been attacked by producers, buyers and exporters alike, a state of affairs brought about by its abuse. Originally intended as an aid to the field buyer to test quickly the amount of adulteration in the numerous small purchases he makes, it has deteriorated into the criterion of the amount of adulteration permissible in a certain " market quality " of oil.

If a lot is accepted the field broker is paid in cash or paid on credit ; if rejected, he offers it to a competing exporter. When oil is in shortage middlemen frequently play one exporter against the other to their own profit.

The purchased oil is bulked in tanks in storehouses at Galle and Matara, until clear enough to be filtered. Impurities settle at the bottom, and often this decantation is so effective that filtration is unnecessary. Storage however cannot be for too long, as, after about 3 months, the oil's specific gravity increases, solubility decreases and colour changes from yellowish to greenish.

The oil is finally shipped from Galle, Matara and Colombo in galvanized iron drums. There is no Governmental control over the quality of oil exported, as the testing is done by each buyer. During the war when all citronella oil was shipped by the Government, tests were made by the Government Analyst. Before the war, and now, when no control exists, the only samples that reach the Analyst come through Government channels, viz.: the Government Storekeeper and the Civil Medical Stores. Government has therefore no indication whatever of the quality of oil that is being exported.

Ceylon citronella oil is marketed in two grades :—

(1) " Estate " or " superior "—usually pure. Minimum geraniol content is 60%. Forms about 5% of the total export.

(2) " Ordinary " or " fair average quality " f.a.q.—consists of the bulking of small lots, and is sometimes produced on larger estates. The addition of anything up to 7% petroleum products (kerosene) is allowed in this grade, on the basis of the Schimmel test in the contract. Forms about 95% of the total export.

The difference in price is comparatively small, about 2 cents U. S. currency (Rs. -/06 cents).

The value of the oil in the market is decided by its geraniol content which by local methods of distillation is 53—63%. The Java oil has a higher geraniol content—about 80%, but the slight difference in price is not commensurate with the difference in quality between the " pure " Java oil and the " adulterated " Ceylon oil. Further, whereas the Java oil is used in the manufacture of high grade scents, Ceylon oil is used for soaps and cheap perfumery. Even if it were possible to extend the cultivation of ' maha pangiri ', in view of the general infertility of the growing areas, it would hardly be advisable, since over-production of the Java oil would reduce its price for both competitors. (It should be noticed that the low price of Ceylon oil is due to its geraniol content and to the existing competition with Java).

ADULTERATION

Opinion is divided on the question of adulteration. Local opinion is that the industry has adjusted itself to the system of organised adulteration ; on the other hand, American opinion is that it would be more economical for U. S. buyers to import pure oil and mix the kerosene there if necessary. The argument that pure oil has no special advantage is met by the statement that manufacturers could use 7% less oil in their formulae and thus save money. U. S. Customs officials are not bound by any stipulation in a private contract between buyers and sellers. F.a.q. oil is therefore a " compound " and duty and heavy fines are, and could be, imposed. The excuse that the trade is used to adulterated oil is a dangerous one, since by the same logic, it could be supplied to all essential oils on the pretext of a " standard " or " test ".

If the futility of adulteration could be recognised, easy measures are recommended (by Dr. Guenther) for stopping the practice. Apart from Government control, the basis of contracts between buyers abroad and local exporting agents should be pure unadulterated oil; the Essential Oil Association of the United States to insist on imports of pure oil; deterrent fines by U. S. Customs authorities.

The amount of adulteration practiced is seen from the fact that the large buying agencies purchase 25—33% 'Estate' oil, whereas the export of this quality is only 5%. A large amount is therefore "cut" with kerosene to produce f.a.q., or bulked with "ordinary" (already adulterated by distillers and middlemen) in order to improve solubility.

TRADE

From Tables 4 and 5 it will be seen that in 1939 Ceylon's export of citronella amounted to 1½ million lbs. valued at Rs. 1¼ million. After 1940 there was a big increase in production and export and a corresponding rise in the value (Fig. 3A.) About 70% of this was absorbed by the U. S. A., the U. K., and Germany, the U. S. A. being the most important buyer (Fig. 3B.) Of the balance, countries of the Commonwealth take the greater portion, viz.: India, Australia, Egypt, Canada, South Africa and New Zealand. Only a few thousand pounds are retained for home consumption.

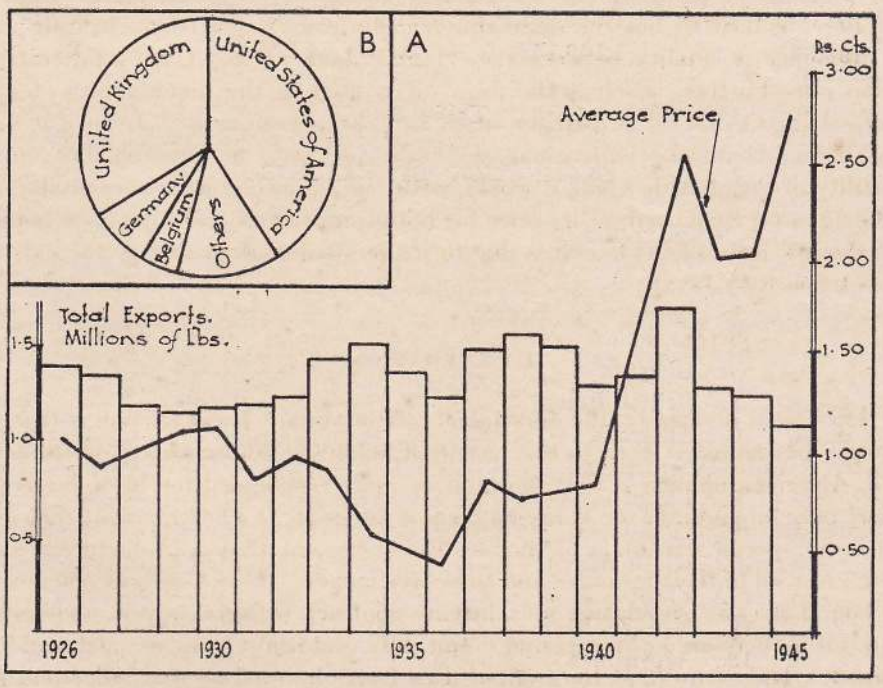


Fig. 3A.—Graphs of Total Exports and Average Price, 1926-1945.
Fig. 3B.—Importers of Ceylon citronella oil, 1939.

Table 4

TOTAL EXPORTS

Year	Quantity	Value Rs.	Price per Lb. Rs. c.
1925	—	—	1 37
1926	1,431,351 lbs.	1,774,346	0 99
1927	1,358,191 ,,	1,264,745	0 77
1928	1,200,001 ,,	1,046,598	0 93
1929	1,183,239 ,,	1,226,452	1 06
1930	1,213,452 ,,	1,346,034	1 12
1931	1,203,482 ,,	948,298	0 80
1932	1,279,801 ,,	1,202,918	0 94
1933	1,459,423 ,,	1,273,832	0 87
1934	1,527,868 ,,	803,820	0 55
1935	1,399,764 ,,	686,418	0 47
1936	1,276,039 ,,	593,268	0 42
1937	1,521,755 ,,	1,328,601	0 87
1938	1,603,890 ,,	1,182,031	0 73
1939	1,548,141 ,,	1,230,800	0 79
1940	1,334,721 ,,	1,109,830	0 83
1941	1,385,089 ,,	2,323,298	1 74
1942	1,782,189 ,,	4,450,476	2 56
1943	1,354,668 ,,	2,755,165	2 01
1944	1,314,287 ,,	2,888,778	2 18
1945	1,143,132 ,,	3,319,397	2 80

Table 5

DESTINATION OF EXPORTS

	Exports to	1939
1.	U. S. A.	604,364 lbs.
2.	U. K.	494,689 ,,
3.	Germany	90,109 ,,
4.	Belgium	71,274 ,,
5.	British India	69,404 ,,
6.	Australia	84,090 ,,
7.	Netherlands	39,907 ,,
8.	Egypt	27,170 ,,
9.	Canada	22,666 ,,
10.	South Africa	18,419 ,,
11.	France	12,142 ,,
12.	New Zealand	10,728 ,,
13.	Argentine	6,720 ,,
	Total	1,531,682 lbs.

It is also evident that though the amount exported in 1939 was slightly more than in 1926, the value was much less. The price of oil has fluctuated between Rs. 1·37 in 1925 and Rs. 2·80 in 1945. These two facts indicate a serious state of affairs in the industry ; nor is any complacency justifiable when this condition is compared with that of Java. In Java, the entire industry and in particular the quality of the exports is organised by the Dutch Government, though the export itself is handled by 32 firms. The exports from the N. E. I. (almost entirely from Java) between 1935 and 1938 are given in Table 6 :—

Table 6

Year	Amount	Value
1935 ...	4,755,520 lbs.	Rs. 2,259,000 (1,265,000 guilders)
1936 ...	4,509,120 ,,	,, 1,991,000 (1,115,000 ,,)
1937 ...	3,946,880 ,,	,, 3,695,000 (2,069,000 ,,)
1938 ...	5,216,960 ,,	,, 4,200,000 (2,352,000 ,,)

Ceylon and Java hold a virtual monopoly over the world supply of citronella oil, but Ceylon is rapidly losing her part of it to Java. One result of the expansion of Javanese industry has been the rapid fall in price in the world market.

Table 7

Year	Java	Ceylon	Price
1930 ...	815 tons ...	543 tons ...	Re. 1·12 per lb.
1940 ...	1,778 ,, ...	687 ,, ...	,, 0·55 ,, ,,

CONCLUSIONS

The citronella oil industry in Ceylon is in a state of decay. The days are almost past when Ceylon, being the only supplier to the U. S. A. and U. K., could neglect the quality of her product. As Javanese competition in the world market returns, much reorganisation of structure and technique will be necessary to meet this competition, which before 1942 was seriously undermining the industry in this country. A curious lethargy has seized the industry in Ceylon ; and there is no inducement to improve the position to meet the changed conditions of the present period. It is a state for which both local and foreign buyers are largely to blame (by their connivance at adulteration).

And more important, the peasantry of the Southern Province, to whom this citronella industry is a vital part of their economy, being the only important cash crop, is being caught in the tentacles of a destructive system—" the middle middlemen ". If organised on a sound basis, irrespective of the objections of vested interests, the citronella industry could, and should be a valuable element in Southern economy and of incalculable benefit to the whole peasantry.

The first step in such a course of reorganisation would be governmental control of all outgoing shipments (as in Java). It would of course involve the maintenance of an efficient analytical laboratory, possibly in Galle. Next would be the compulsory accompaniment of a " certificate of purity " of each shipment. These two

steps should be taken in conjunction with the Governments of importing agents, chiefly the U. S. A. and U. K. If such action were insisted upon by them, and it seems probable that the U. S. Government would quickly approve of such action, a standard quality of export could easily be assured. Nobody can gainsay the past benefits of such methods to the Java industry, nor to the dairying, pig, and poultry industries of Holland, by the standardization of all exports.

In the absence of a State monopoly, the next best thing for the Government to do to encourage better production by the peasantry would be the immediate establishment of a Co-operative Marketing System, and later, Co-operative Distilleries. It is essential that the Government should take direct steps to rehabilitate the industry by direct intervention and encouragement, and the co-operative method seems to be the most feasible and most suitable method for the industry. A government-sponsored Experimental Station in the Southern Province is also very necessary, where, among other things, more scientific methods of cultivation including the regular use of manures, instead of the primitive and haphazard methods now in use could be worked out. Systematic research in (*a*) the commercial utilization of the oil and its by-products, and (*b*) for a shorter and more efficient distillation process to raise the geraniol content, should be part of the functions of this station.

At the same time, active propaganda by advertisement and exhibition, especially in World Expositions, is very necessary. The success of the palm oil industry in Malaya must be attributed in part to the very attractive and successful advertisement and propaganda carried on by the trade, *e.g.* at the biennial Agri-horti-cultural Exhibition of Malaya. At the same time proper steps should be taken to look after the trade and production interests of the industry.

Today, yields and prices in Ceylon's citronella oil industry are low. The organisation of the industry and of marketing have grown up without any directive whatever, under the now obsolete policy of " laissez faire ", and the industry is unable to hold its own against a better organized competitor. Java may soon oust Ceylon from the world market. Unless, therefore, rapid steps are taken to see the industry on a scientific and well-equipped basis, the citronella oil industry appears to have little future in this country.

References

1. Dr. Ernest S. Guenther : Ceylon Citronella—*Soap and Sanitary Chemicals. September and October, 1940.*

2. Dr. B. B. Das Gupta : Report on Economic Survey of six villages in the Matara District.

3. Dr. A. W. R. Joachim : Present position of the Trade in Ceylon Citronella Oil. *Tropical Agriculturist, February, 1937.*

4. The Citronella Oil Industry : *Tropical Agriculturist, February, 1937.*

5. The Director of Commerce & Industries for cost of production figures.

GEOGRAPHICAL RECORD

SOME RECENT ARTICLES IN EUROPEAN PERIODICALS

The articles whose contents are summarized here have all appeared in British and Continental European periodicals in the past year or so ; I have attempted to select from a great mass of material that which is of greatest interest and importance to geographers in Ceylon. I shall first consider papers dealing with the methodology and history of geography and with other general topics ; then those dealing with geomorphology and climatology ; finally those dealing with human and regional geography.

History and Methodology of Geography.—The veteran French geographer and geologist Emmanuel de Margerie died on 21 December, 1953, at the great age of 91 ; he formed a link with the great period when Suess and W. M. Davis and Vidal de la Blache were all active. The study of his life and work which Henri Gaulig has written for the *Annales de Geographie* is an invaluable reminder of the range and nature of his writings, and will intrigue all those who are interested in the history of ideas in the border-land between geology and geography. De Margerie shone particularly in the orderly arrangement of knowledge in a wide range of fields, but according to Baulig his masterpiece was the French edition of Eduard Suess' *Das Antlitz der Erde*, to which he supplied an extensive bibliography. He himself, however, considered his work on the Jura to be more important. It is worthy of note that although so interested in geomorphology he denied it the autonomy which he freely conceded to geology.

De Margerie joined the editorial board of *Annales de Geographie* only three years after its first appearance. The early days of another journal which is now firmly established, *The Transactions of the Institute of British Geographers*, are recalled in a Presidential Address by Professor R. Ogilvie Buchanan which commemorated the twenty-first anniversary of the Institute. Professor Buchanan traced the origins of the movement which led to the foundation of the Institute, and reviewed its subsequent progress and its relations with other bodies. His address will form an important document when the history of twentieth century British geography comes to be written.

The Institute was also responsible for the publication of a paper by Professor H. C. Darby which concerns both the methods and the history of our subject. Entitled " On the Relations of Geography and History ", it surveys the " debatable land " between history and geography into three parcels : " the geography behind history ", " the geographies of the past " and " the history behind geography ". Professor Darby's paper is to be commended if only because it separates the field in this way and thus demonstrates a method of avoiding the confusion which has, in my experience, clouded much writing and talking on the historical aspects of geography.

Geomorphology.—Contributions to geomorphology which take the form of a review of general theory are rare enough to be worthy of comment. M. P. Birot has attempted such a review in a paper on karst topography which has appeared in the *Annales de Geographie*. Reviewing literature from places as far apart as Portugal and Java, he concludes that classical views on karst remain valid in their insistence that the end-product of karstic erosion is a vast near-flat surface developed in relation to the general base-level and that this end-product is the same for almost all climates. But, he says, at earlier stages local planation surfaces tend to develop, due to structure or to an impermeable layer or to slowness of rejuvenation. His study is stimulating, but perhaps over-bold in the present state of knowledge.

The spate of worthy geomorphological studies continues, but I do not suppose that many of them will interest Ceylonese geographers. There is, however, one exception, a modest paper by J. B. Auden which considers the problem of the geometric alignment of valleys in various Indian areas. His study of the effect on drainage of joint patterns in Vindhyan quartzites in the Rohtas plateau and of fractures in the Cardamoms may be of interest to students of the geomorphology of Ceylon.

Climatology.—The only other contribution on physical aspects of geography which seems worthy of a note here is a useful review of current knowledge on tropical hurricanes by Professor

T. Bergeron of the University of Uppsala ; he begins with the contribution of the Bergen school and his own postulate nearly 30 years ago that front and air-mass methods were applicable to low latitudes, and then considers subsequent work in many other countries. There is a full bibliography.

Human and Regional Geography.—There seems to be no pieces of work on systematic aspects of human geography to report ; but there are a few papers which, because of their Asian or Indian Ocean regional interest, may be worth recording. New work on China now rarely appears in the West, so that T. R. Tregear's little paper on " Shih Hui Yao : a Chinese river port with a future " is to be welcomed. Dr. Tregear was in Wuchang until 1951, and is now in the University of Hong Kong ; and Shih Hui Yao is some 50 miles below Hankow on the Yangtse. Professor Robequain, whose work on Asia will be well known, has recently published an interesting study of Mauritius which, after all, is not a very distant neighbour of Ceylon's. He brings out such problems as the over-population, the dependence on sugar and the Indian problem. Finally there is my own paper on land use in the Dry Zone of Ceylon ; because it is on Ceylon, I suppose I must mention it although it is clearly poor etiquette to review one's own papers and I shall forbear to pass judgment on its quality ! It considers the Dry Zone environment and attempts a regional classification of indigenous land use systems, saying most, however, about *Nuwara-kalawiya* and adumbrating on the chena problem. It finally discusses modern changes and considers some of the problems thus created, and reaches the conclusion that the problem of the use of high land is the crux of the matter.

B. H. Farmer.

REFERENCES CITED

1. H. Baulig : " La vie et L'oeuvre d'Emmanuel de Margerie ", *Annales de Geographie*, vol. 63 (1954), pp. 82–7.

2. R. Ogilvie Buchanan : " The I. B. G.: Retrospect and Prospect ", *Transactions of the Institute of British Geographers*, No. 20 (1954), pp. 1–14.

3. H. C. Darby : " On the Relations of Geography and History ", *Transactions of the Institute of British Geographers*, No. 19 (1953), pp. 1–11.

4. P. Birot : " Problems de morphologie karstique ", *Annales de Geographie*, vol. 83 (1954), pp. 161–192.

5. J. B. Auden : " Erosional patterns and fracture zones in Peninsular India ", *Geological Magazine*, vol. 91 (1954), pp. 89–102.

6. T. Bergeron : " The problem of tropical hurricanes ", *Quarterly Journal of the Royal Meteorological Society*, vol. 80 (1954), pp. 131–164.

7. T. R. Tregear : " Shih Hui Yao ", *Geography*, vol. 39 (1954), pp. 113–7.

8. Ch. Robequain : " Destin d'une Ile de sucre ! l'economie et le peuplement de Maurice ", *Annales de Geographie*, vol. 63 (1954), pp. 255–273.

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1. **Manuscripts** should be typewritten on one side of paper only, with double spacing and wide margins, and should as far as possible be original copies.

2. Each major article should contain an **abstract** which gives a concise summary of the content, including both major and minor points. It should not exceed 100 words.

3. **References** should be given at the end of the article under the heading REFERENCES CITED, and not in footnotes. They should be arranged in alphabetic order of authors' names, and chronologically under each author as shown below :—

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