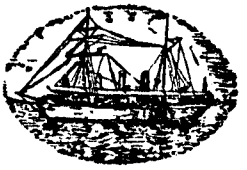

SYMPOSIUM ON CORALS AND CORAL REEFS

12 — 16 JANUARY 1969
MANDAPAM CAMP

SOUVENIR

MARINE BIOLOGICAL
ASSOCIATION OF INDIA

SYMPOSIUM ON
CORALS AND CORAL REEFS

SOUVENIR

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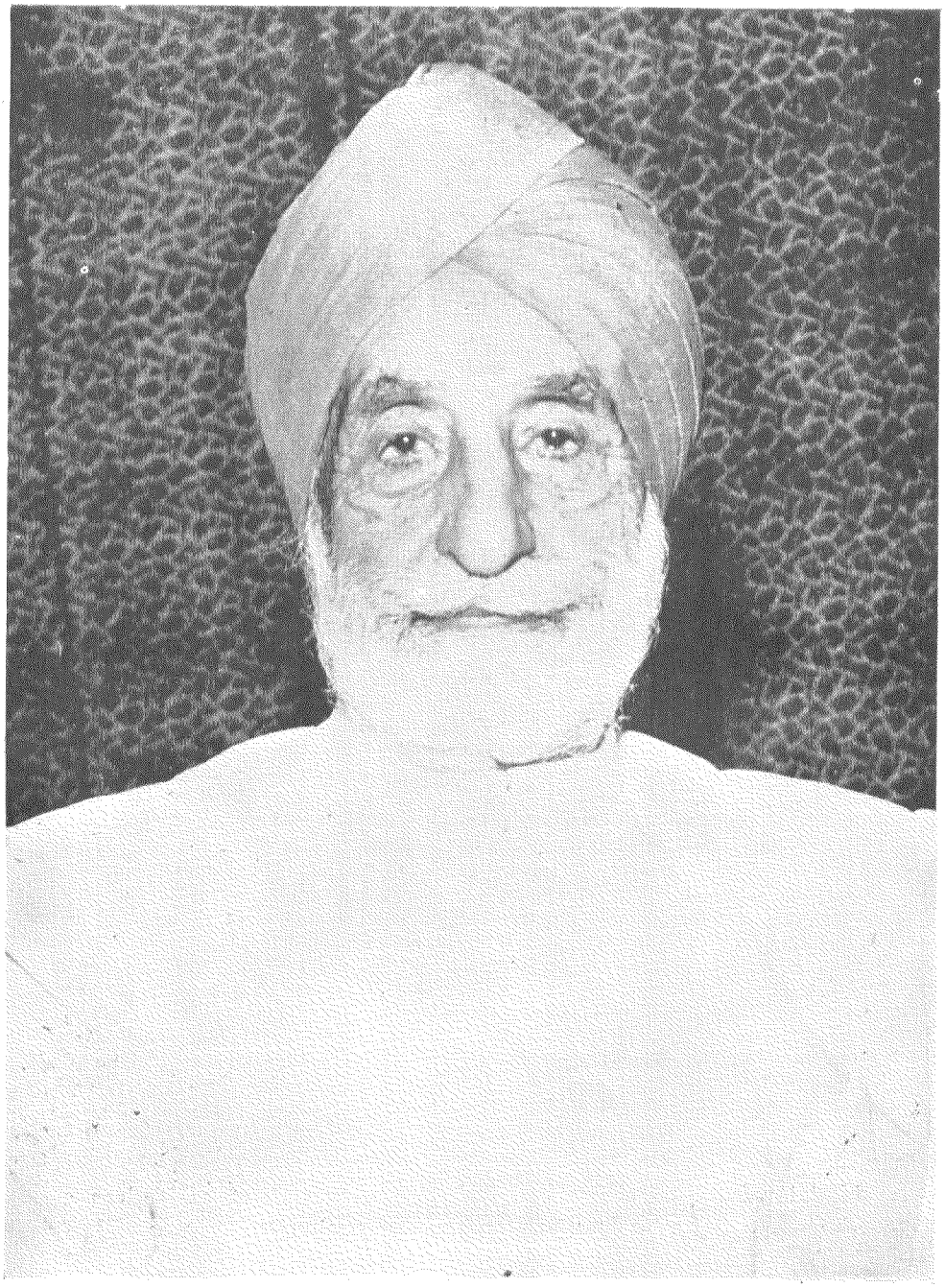

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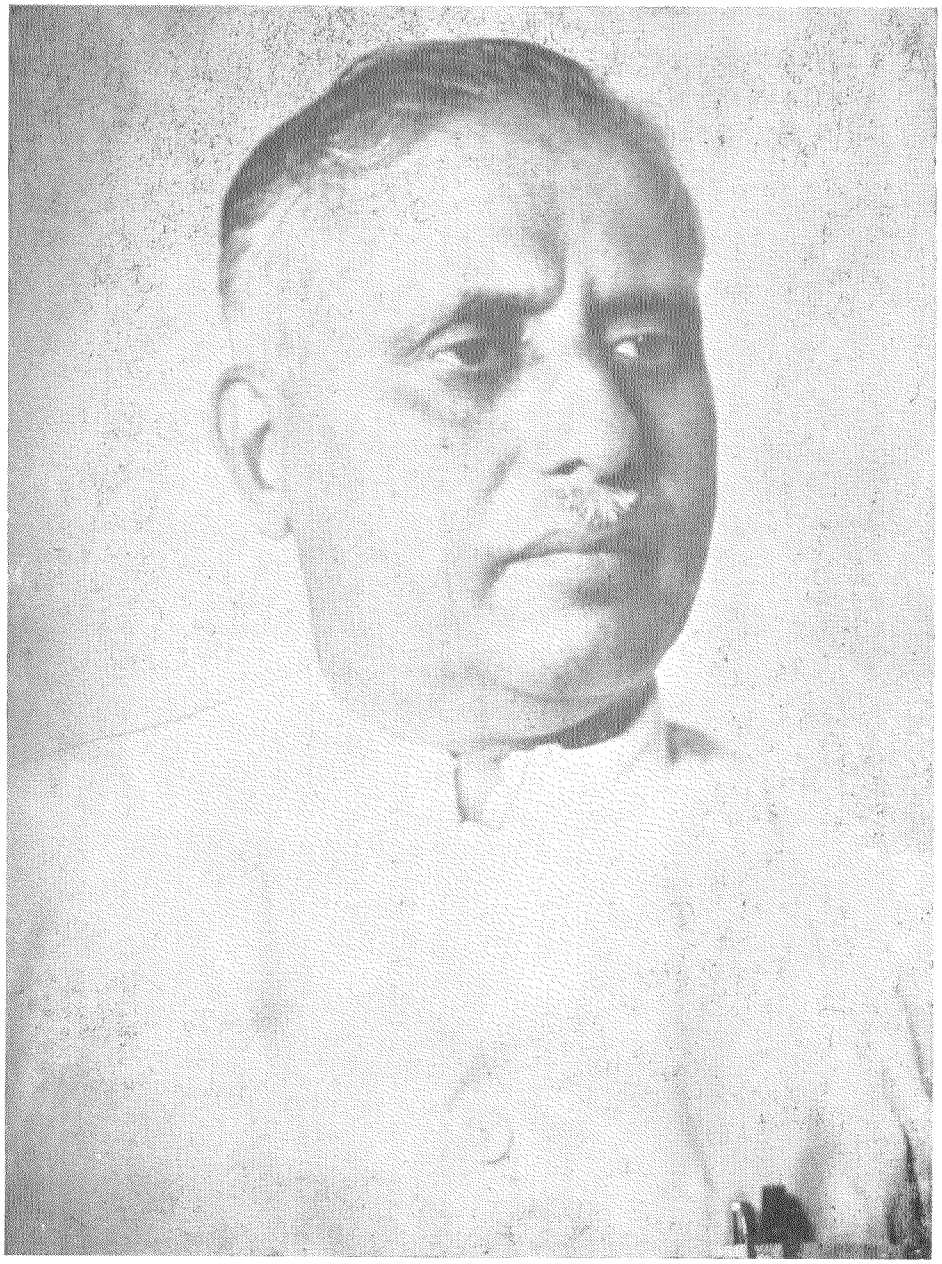

DR. S. JONES

President, Marine Biological Association of India

SHRI. K. S. KASIVISWANATHAN

Chairman, Reception Committee

THE MARINE BIOLOGICAL ASSOCIATION OF INDIA

A DECADE OF SERVICE TO SCIENCE

By
P. S. B. R. JAMES,
Secretary,
Marine Biological Association of India,
Mandapam Camp (Madras State).

THE Marine Biological Association of India, established in December 1958 with the chief aim of promoting the cause of marine sciences in the Indian region, completed ten years of useful service to science in December 1968. The present total membership of about 1 000 is nearly double that at the inception of the Association. Perhaps this is one of the few scientific bodies that has such a large membership of individuals and institutions spread over about 50 countries. It may also be unique in the sense that few organisations would have supported themselves on their own resources. This fortunately the Marine Biological Association of India has been able to do for the past ten years. The present status the Association enjoys amongst scientific bodies in the country and abroad is largely due to the continued interest and co-operation of its members In this regard the scientific staff of the Central Marine Fisheries Research Institute have greatly helped in stabilizing the Association by their co-operation and work in honorary capacity.

The past ten years have no doubt been a test for the Association for survival. It had to steer through odds at several stages and has successfully tided over difficult circumstances to a more sound position financially and otherwise. However, there is no room for complacency, for the present commitments and the future expansion programmes are far too heavy and would drain the available meagre resources. It is hoped that, as in the past ten years, it will be possible to progress in years to come, of course not without the enthusiasm and zeal of its members, scientists, institutions and the public.

What has been achieved by the Association is too well-known to be repeated here and I am sure it will be gratifying to all members, especially those from the foundation of the Association, to look back and realise that an young Association as this could do such praise-worthy work to put India on the map of marine sciences in general and fishery science in particular. However, a brief review of the work of the Association for the past ten years is given below to serve as a record.

The Marine Biological Association of India had several objectives to fulfil right from the beginning and the most important ones have been to publish the *Journal of the Marine Biological Association of India*, conduct symposia on specific subjects, issue occasional memoirs and monographs, and institute fellowships and studentships. It gives pride to note that these have been alrealy realised to some extent. The *Journal of the Marine Biological Association of India* is now recognised as one of the premier journals on marine biological sciences in the world, its very large circulation and demand standing as a testimony for this fact. Nine volumes have been published till to date. A second and significant achievement to the credit of the Association lies in the organising of symposia periodically. The first one on Scombroid Fishes was held at Mandapam Camp in 1962. The proceedings comprise four parts, of which three were issued and the fourth is in press. The second symposium on Crustacea was held at Ernakulam (Cochin) in 1965. The proceedings of this symposium are being published in six parts, of which five have already been issued. The third symposium on Mollusca was held at Ernakulam (Cochin) in 1968, the proceedings of which are now in press and are expected to be issued in a suitable number of parts. The proceedings of the first two symposia contain valuable contributions on two economically very important groups of marine animals which are found all over the world and hence remain useful works of reference. They have been well received and are in great demand from several parts of the world. The proceedings of the third symposium, also on another important group of marine animals, are of the same nature as the ones preceding it. All three symposia

were largely attended by scientists from within the country and from abroad. The Association, in this respect, made yet another landmark in the history of marine sciences in India, for few symposia held in this country are at par with these.

Furthermore, two memoirs, the first on the Ribbon-fishes of India and the second on the Dinophyceae of Indian Seas, I. Genus *Ceratium* Schrank were published by the Association in 1967 and 1968 respectively and rank as the most exhaustive accounts on specific subjects.

The Association has now come to a stage when it is able to provide some financial assistance in the form of loan scholarships. Beginning with 1968, two such scholarships are offered to qualified members for prosecuting post-graduate studies. One of them was actually awarded during the year. It is hoped to increase this number in course of time as funds permit. In addition to the service to science, the Association has been able to contribute its mite to the nation's economy by bringing in foreign exchange.

The foregoing is in brief what has happened in the years gone by. The future programmes are as ambitious as the ones already accomplished. Most immediate of these is the holding of the fourth symposium on Corals and Coral Reefs at Mandapam Camp in January 1969, in which connection the present souvenir is published. The response is quite encouraging and a number of scientists and specialists from India and abroad are expected to participate. The proceedings of this symposium will, as usual, be published.

The first two memoirs already issued will be followed by a few others on Goat-fishes, Corals, Sponges, and Echinoderms of India, which are now in various stages of preparation. As already announced, the fifth in the series of symposia by the Association on "Indian Ocean and Adjacent Seas—their origin, science and resources" to be held at Cochin (India) during January 12–18, 1971 is expected to be one of the biggest ever held in the field of marine sciences. [redacted] This is mainly intented to draw a large number of scientists from all parts

of the world to meet, discuss and exchange views on the latest trends in research and knowledge on marine sciences in Indian Ocean region. It will be of special significance to the countries bordering Indian Ocean and adjacent seas, especially for India.

The Association has a plan to construct its own building to house its Office, Library and Conference Hall. The permanent Laboratories of the Association which would ultimately provide facilities for independent research work for scientists from within and outside the country are being planned to set up on the lines of the Naples Zoological Station or the Laboratory of the Marine Biological Association of United Kingdom, Plymouth, with laboratory facilities for different aspects of marine work, library, running sea-water aquarium, reference museum etc.

Having achieved its aims in a humble way during the past ten years of existence, the Marine Biological Association of India will not spare any efforts to further the cause of marine sciences in India by sponsoring and aiding expeditions at the appropriate time and also institute suitable prizes for outstanding contributions in the field of marine sciences by research workers in India. A great deal of the realisation of future plans depends on the interest of members and public to co-operate and subscribe generously to the Association for organising marine biological studies of fundamental and applied nature which have a bearing on the economy of the country and also to help diffuse and spread the vast amount of knowledge gathered in this field of science to all countries of the world through the services of this young Association which is already held in esteem in the country and abroad. It is hoped that as days pass by, the activities of the Association will be better known in the country and elsewhere, attain greater strength, carry out more efficient work covering a wider field and thereby contribute to the development of marine biological sciences in India. Ten years hence should witness great progress and growth of the Marine Biological Association of India.

THE CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

By

S. JONES,
Director,
Central Marine Fisheries Research Institute,
Mandapam Camp (Madras State).

THE Central Marine Fisheries Research Institute was established early in 1947 at Madras and was shifted to its present headquarters at Mandapam Camp in 1949. The primary function of the Institute has been to collect detailed information on various aspects of the biology and fishery of the commercially important living resources of the seas around India like fishes, crustaceans, molluscs, seaweeds etc. The aspects of study include the distribution, habits, life-histories, age and growth, reproduction, food, movements, abundance and the relation between organisms and their environment, such information being essential for scientific exploitation of resources to obtain maximum sustainable yields, at the same time maintaining the stocks at optimum level. As more than three-fourths of the marine fish catches are landed along the west coast of India, and as the regional fisheries and species contributing to them differ, the work of the Institute is largely decentralised for a proper assessment of fish stocks and their rational utilization and is conducted at different sub-stations and units distributed along the coastline of India.

The various research problems are handled by three major divisions, viz., Fishery Biology, Marine Biology and Oceanography, and Fishery Survey. As a result of the work done at this Institute on the above subjects covering economically important groups or species of fishes, prawns etc. valuable fishery-based information has been gathered and their resources estimated. The sardines, mackerel, offshore and oceanic fishes, prawns and molluscs have received special attention and the related marine biological and oceanographic conditions have been studied.

The fluctuations in abundance of oil sardine and mackerel, the two most important pelagic species in our waters, have been studied in detail. The data collected on offshore and oceanic fishery resources have paved way for better commercial exploitation of the concerned species. The distribution pattern and seasonal fluctuations of the commercial species of prawns and lobsters are now known. Several interesting facts in the life-histories of a number of species of prawns which have a bearing on their commercial catches have been discovered. Investigations on a number of other minor fisheries have also yielded basic data useful for commercial exploitation. Extensive under-water survey of pearl and chank beds in the Gulf of Mannar were carried out for estimating their resources. The sea-weed resources have also been estimated by systematic surveys as a basis for the development of the industry and potentialities of *Gelidium* and *Sargassum* for the manufacture of high grade agar and alginate have been demonstrated giving birth to a new industry in the country. Investigations on marine biological and oceanographic factors affecting various fisheries along the west coast were initiated first on M. O. *KRISTENSEN* and then continued on R. V. *KALAVA* and R. V. *VARUNA* placed at the disposal of the Institute by the Indo-Norwegian Project. Considerable work has been carried out on the taxonomy and seasonal fluctuation of the standing crop of plankton and its distribution as well as physical and chemical factors influencing their production. The magnitude of organic production has been assessed and compared with fish landed; it was revealed that fish harvest could be increased 3 or more times the present level. Hydrographical studies have indicated upwelling of nutrient-rich waters over most of the west coast during south-west monsoon season which leads to high plankton production. A number of convergence and eddy zones occur on the shelf which are of fisheries interest, pelagic as well as demersal. A sampling design for collection of fisheries statistics was evolved for the first time and put into operation by this Institute from 1950 onwards, resulting in reasonably accurate estimates of the marine fish landings and their composition. Fishery survey work is continued to follow the relative fluctuations in fish catches on an all-India basis,

thereby contributing to the continuing resources survey. Initially fishery technological work was also carried out at this Institute. The Institute is recognised by the Inter-University Board for research work on marine sciences leading to the doctorate degree and a number of scholars of this Institute took their Ph.D. degrees from different universities.

Planned and systematic investigations on the marine resources based on collection of scientific data at national level have been conducted by this Institute for the past two decades. It was felt the time had come to evaluate the vast amount of knowlege gathered in this field and make available to the industry the useful information emerging therefrom, to help plan future programmes aimed at development and rational utitization of marine resources for the benefit of the country. With this object in view the Institute organised a symposium on the "Living resources of the seas around India" at Cochin in December 1968. The wide range of contributions presented and the useful discussions that took place more than justified the timely need of the same.

The Institute which was under the Ministry of Food, Agriculture, Community Development and Co-operation (Department of Agriculture), Government of India, was transferred to the Indian Council of Agricultural Research, New Delhi, with effect from 1st October 1967. The Institute's publications include (1) *The Indian Journal of Fisheries* (published earlier on behalf of the Ministry of Food, Agriculture, C.D. & Co-opn., Government of India) (2) *Advance Abstracts of Contributions on Fisheries and Aquatic Sciences in India* and (3) *Bulletin of the Central Marine Fisheries Research Institute*. The papers published by the scientific staff of this Institute number over 800 to-date.

Apart from the above publications, the Marine Biological Association of India which has been organised and run mainly by the co-operative efforts of the scientific staff of the Central Marine Fisheries Research Institute with its headquarters at Mandapam Camp, publishes regularly the *Journal of the Marine Biological Association of India*. Its other publications include the *Proceedings of Symposia* (i) on Scombroid Fishes held in 1962

(ii) on Crustacea held in 1965 (iii) on Mollusca held in 1968, and *Memoirs* (i) on Ribbonfishes of India (ii) on the Dinophyceae of Indian Seas. The service done by the Association to the cause of marine science has already received recognition within this country and outside.

The first symposium by the Marine Biological Association of India on "Scombroid Fishes" was held at the headquarters of this Institute at Mandapam Camp during January 12-15, 1962 and the present one on "Corals and Coral Reefs" is the second to be held here of the four conducted so far by the Association. It is hoped that the same will be as successful as the previous ones. The Institute has great pleasure in welcoming the participants and offering best wishes for the success of the Symposium.

CORALS AND CORAL REEFS

By

C. S. GOPINADHA PILLAI,
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Mandapam Camp (Madars State).

THE appealing architectural design and the impressive colours of the living corals as well as of the dried skeletons of corals cannot fail to satisfy our aesthetic sense. They are a spectacular group of aquatic denizens and are regarded coveted curios and objects of decorative value. Corals have had tremendous impact on the social, cultural and economic aspects of human society even from time immemmorial. They are instrumental in the formation of extensive reefs throughout the tropics by the continued activity of several multi-billions of them for thousands of years. They are assisted in their ceaseless task by the calcareous algae and by many other marine animals. A coral reef is thus a natural object built up in the sea, and is a centre of attraction for the naturalist, the geologist and the common man alike A reef may extend a few meters to several hundred kilometers and is composed of enormous masses of limestone, with multitudes of living animals, the dominant being reef-corals. They often project above the surface of ocean waters forming the foundation of panoramic islands, or may remain submerged, being capable of sinking even man's mightiest ship.

DISTRIBUTION OF CORALS IN SPACE AND TIME

The large number of fossil corals unearthed from the plains, valleys and mountain tops speaks of their wide distribution in the geological past. The oldest coral fauna known is of the Middle Triassic from Germany, Southern Alps and Sicily. These forms flourished in the Palaeozoic Era. Present day corals dominate many marine communities. Corals thrive best in the warm tropical waters of the Indian, the Pacific and the Atlantic Oceans. The reefs are distributed as a belt around the globe between the Lat. 35° 10'N and 32° S covering an area of approximately 50,000,000 square miles. In the Indo-Pacifc region they are found in the Red Sea, Gulf of Aden, Persian Gulf, Gulf of Oman, eastern coast of Africa, the Madagascar, Seychelles, Mauritius, Chagos, Maldive and Laccadive Archipelagoes, in Ceylon and south-eastern coast of India, the Andaman and Nicobar Islands, the Australian region, China Sea, throughout the tropical Pacific as far east as the Bay of Panama. In the Atlantic Ocean they occur chiefly in the Caribbean waters. The bathymetric distribution of corals ranges from a

few centimeters to several thousand meters. But the reef-building activity is generally restricted to about 45 meters though reef-builders may grow to about 90 meters depth.

WHAT IS A CORAL ?

The 'coral' is a comprehensive term, including the *Millepora*, *Heliopora*, *Tubipora* and various gorgonids, the black or thorny corals and hundreds of stony corals. There are two main components in the structure of a coral—the living soft polyp and the non-living calcareous skeleton. The conspicuous skeleton attracts the prime attention, so that the minute polyps are often overlooked. Each polyp, in essence, is similar to a sea anemone. It is fixed at its bottom in a separate cavity of the skeleton. The body is almost cylindrical in shape, and can be contracted and expanded. Generally during day time (this is, however, not axiomatic) they retreat into the protective skeleton expanding out after sunset to feed on the minute planktonic animals by means of their tentacles. The body wall consists of an outer secretive, a middle connective and an inner digestive and reproductive layers. The central space is hollow, which forms the 'stomach' of the animal. At the top there is an opening surrounded by tentacles that serves as the mouth and anus. Corals are exclusively carnivorous and food catching is mostly done at night. The fleshy tentacles, armed with batteries of stinging cells ('nematocysts') can administer sufficient doses of poison to paralize the small animals that swim or drift around unaware of the impending danger. These defensive and offensive weapons also protect the polyps from largescale predators.

All the vital activities such as capture of food, digestion, reproduction and building up of skeleton are carried out by the polyps. They reproduce both sexually and asexually. Sexual reproduction results in a small ciliated larva that swims about in the sea for some time prior to its settling on a hard object to start with a small skeleton. It multiplies asexually, resulting in huge colonies in due course.

To mankind the coral skeletons are more significant than the polyps. They grow from a few millimeters to several meters in height and spread. They may be solitary, colonial, cylindrical, flabellate, cuneate, encrusting, pulvinate, massive, ramose or foliaceous. Many of them resemble bushes and trees in their growth form. Chemically the skeleton is mostly of calcium carbonate with a small percentage of silicon oxide, magnesium oxide, phosphoric acid, minerals and water.

COLOUR

Living corals create a spectacular scenery of 'under-water garden exhibiting a diversity of form and colour. The washed and dried skeleton of stony corals exhibited in museums are mostly white or dull yellow or brown. But in nature they are in greens, yellows, lavenders, purples, reds and blues.

The colour is either due to the presence of the symbiotic algae in the subsurface skeleton or due to the presence of pigments of lipochromids or melanoids in the skeletal tissue. The symbiotic zooxanthellae provide yellow and the boring algae green colours. Under ultraviolet rays corals are known to produce a more spectacular play of colours than under the natural light. On removal from water most of the colours fade out.

THE SKELETAL FORMATION

How and why does a coral polyp secrete a skeleton? How much do they grow annually? We know only very little by way of answers to these questions. The skeleton will be giving 'board' to the sensitive polyp and may also afford protection by allowing them to retreat into the calices. The mechanism of skeleton formation is understood to depend on a few chemical reactions. It is believed that calcium is directly taken from the sea water that enters the coelenteron. The calcium ions are brought to the calicoblastic outer epidermal layer by means of active transport through the middle body layer. These ions then combine with bicarbonates formed by the metabolic activities of the cells to form calcium bicarbonate, which on dissociation gives calcium carbonate and carbonic acid. Calcium carbonate gets precipitated and deposited in the skeleton while carbonic acid is quickly removed from the site as carbondioxide and water. The form and size of the skeleton to a large extent is controlled by species specific factors, i. e. genetically. But, the prevailing physical factors such as food, wave action, degree of sedimentation and depth and intensity of light have marked influence. To put it in other words a coral skeleton is the end product of both heredity and environment. Probably here we get excellent examples of the impact of environment on genotype in shaping the phenotypic characters of animals especially in colonial forms. How much skeleton is deposited annually ? A general statement, however, is not possible since it varies from species to species or even specimen, to specimen depending on the prevailing environment. Availability of more food and optimum light may trigger a higher rate of calcium deposition. Massive corals such as *Porites* may grow 1 to 2 cm in height and spread annually. Branching forms may have still higher growth rate, where they may show increase of 5 or 6 cm. Generally younger colonies grow faster than the older. They often exhibit an almost total cessation of growth after attaining a maximum size.

CORALS IN ECONOMY AND MEDICINE

The precious coral *Corallium* is a highly esteemed marine product of commerce and has been priced from antiquity. Even at the dawn of the Christian era there existed a trade of this coral between Mediterranean countries and India. This continued till the second world war, when Japan stepped in to meet our requirements. The ancient Indian society regarded this coral

as a substance endowed with mysterious and sacred properties. Pliny remarks that previous to the Indian demand it was used by the Gauls as ornaments on the weapons and helmets. Among the Romans branches of corals were hung round children's neck to preserve them from danger. Even to-day the Italians consider it as a protection from the evil eye and for young women a cure for sterility. In India and Tibet it is highly priced and is used to make necklaces and amulets. The skeleton of thorny corals is used in the Far East as a cure for rheumatism and in manufacture of cigar pipes. The red-coloured *Tubipora* form an ingredient in many indigenous prescriptions of South Indian physicians. The gorgonids are coveted curios. The blue-coloured *Heliopora* is of decorative value. The massive skeleton of stony corals is a source of lime and they also serve as sturdy blocks for building purposes and in the construction of roads. In the Ramnad district of Madras State large quantities of corals are brought ashore, on which the calcium carbide industry of this area depends for the raw material. Coral quarrying has become an alternative means of livelihood for many a fisherman in this area.

CORAL REEFS

A coral reef is a ridge of limestone, the top of which may be exposed at low tides. It is mostly built by corals, assisted by the calcareous algae and the dead parts of a variety of marine animals. The diversity of form and colour of corals, with multitudes of brilliantly coloured fishes moving about with elegance among other reef-dwellers and reef-building animals is a most fascinating sight. The mighty waves lashing the seaward side of a reef to become nothing but frothy masses bring about a deep contrast with the calm and quiet waters of the lagoon with hardly anything more than an occasional ripple.

TYPES OF REEFS AND THEIR DISTRIBUTION

Reefs are classified into fringing reefs, barrier reefs and atolls. A few coral formations that may not fit in with any of the above are called patch reefs. Generally speaking a reef has an outer wind-ward side that is exposed to the ocean waves and steeps down to several meters, a middle reef crust often with a boulder zone strewn with negro-heads, and an inner protected side with a reef flat.

Fringing reefs are about 500 to 800 metres in width, built on insular shores, a few metres away from the shore. Their lagoons are comparatively shallow. Reefs of this type occur in the Red Sea, eastern coast of Africa, Ceylon, south-eastern coast of India and Andamans and Nicobar Islands, Mergui Archipelago and the East Indies. The Galaxea Reef and the Manauli Reef and the Pulli reef, in the Gulf of Mannar, the Katchuvallimuni Reef, the Vellapertumuni Reef and the Kanthe Thurke Reef in the Palk Bay around Mandapam and the Little and Great Basses Reef of South Ceylon are all of fringing type.

The barrier reefs are situated far from the continent, their lagoons are 40 to 75 metres deep. The outer side slopes to greater depths. Their inner side may be clothed with fringing reefs. The structure may be broken up by deep channels, giving passage to ocean-going vessels. The classical example is the Great Barrier Reef of Australia, the largest coral formation in the world. This natural barrier extends about 1100 nautical miles, 20 - 70 miles away from the east coast of Australia. They may be several small islands between the barrier and the main land.

The name 'atoll' seems to have originated from the Maldivian word 'atollan' that denotes the ring-shaped reef of that area. Atolls are horse-shoe-shaped or circular reefs enclosing a lagoon. They are mostly found several miles away from the land. There is notable diversity in the size, shape and form of different atolls. An atoll might be elevated several metres, may be at sea level, with or without dry land or may even permanently be sunk below the surface. Atolls are found scattered throughout the tropics, albeit their concentration in the central Pacific. There are about 136 in Polynesia, 92 in Micronesia, 66 in Melenesia and 15 in Indonesia. There are 5 to the north-west of Australia and 68 in the rest of the Indian Ocean, including the Maldives, Laccadives, Chagos etc. There are about 25 atolls in the Caribbean and one in the Atlantic. Several atolls have been later elevated by natural causes and such elevated ones are not accounted above.

Sethu dam : The coral reef has found a place in the legend and mythology of India. Below the Pamban bridge, between Raman Point and Rameswaram Island, there extends a rocky barrier that has attracted the attention of the scientists as well as the religious-minded. Most of this structure can be seen while crossing the Pamban Pass in the train. It is composed of large square-cut sandstone masses similar in structure to the one used in the construction of the famous Sree Ramanathaswami Temple at Rameswaram. The western part of this structure is called the 'Great Dam'. The blocks measure one to two metres in length and breadth and are submerged at high tide. These are believed to be remnants of an ancient causeway to the island. Another version is that they are parts of a coral reef that had been subjected to many changes. From the very nature of the square-cut sandstone blocks, it appears that they are remnants of a man-made causeway rather than a natural reef. Who mede it? and at what period? These are the real problems. What precludes one from thinking that the erstwhile Dravidian rulers of this area and their industrious subjects who could afford to construct large temples of imposing architectural beauty, could also make a simple causeway to the island to worship their deity? It is possible that the Pamban channel got widened and deepened in due course probably during tidal waves caused by cyclonic storms, submerging the causeway. Investigations on the archaeology and geology of this area may throw more light on this.

The 'Adam's Bridge' extending between Dhanushkodi at the eastern end of Rameswaram Island and the Mannar Island in Ceylon is a ridge of sand that dries up to get exposed in parts at low tides. It is encumbered with islets, rocks and intricate channels. The depth ranges between one and one and a half metres. This is suggestive of a land connection from the Indian mainland to Ceylon in the past. It is believed, though not by all, that the 'Adam's Bridge ' is the remnant of the causeway built by Lord Rama with the help of an army of monkeys, during his invasion of Lanka. The story is told in the great epic of *Ramayana*, how the demon-king Ravana abducted Rama's wife Sita and carried her away to Lanka and how Rama crossed over to the island kingdom to regain her.

UNITY OUT OF DIVERSITY

Reefs are well known for their luxurient and diversified fauna and flora. The dominant animals on a reef are the reef-building corals of different sizes and shapes. The Atlantic reefs are poor in the reef-dwelling and reef-building animals compared to those of the Indo-Pacific. In the Indo-Pacific reefs, many alcyonarious hydroides, sponges, bryozoans, polychaetes, crustaceans, molluscs, echinoderms and fishes are found in constant association. Sponges are found as encrustations or as true borers on corals. A good many of them are in reds, yellows, greens and lavenders, adding colours to the reef. Bryozoans are mostly attached and encrusting. Both errant and tube-dwelling polychaetes are in plenty. Molluscs are numerous. The gastropods crawl around the coral colonies and many bivalves bore into the skeleton causing destruction to the framework of the reef. The most destructive among the boring bivalves is *Lithophaga*. Stomatopods, copepods and decapods are fairly common. The sea stars, sea cucumbers, sea urchins and brittle stars find excellent habitat among corals. Multi-coloured fishes are fairly common in the reef. But from this diversity the reef dewellers forge an appearance of unity and an atmosphere of co-existence by living together and letting others live in association.

THEORIES ON CORAL REEF FORMATION

The bottom of many reefs extends to several hundred meters deep in the sea bottom. But the present day reef corals can flourish only to a limited depth in carrying out their reef-building activity. How did the reef bottom happen to be at this greater depth ? This has been a subject of much controversy among the biologists as well as the geologists from the dawn of the 19th century. Many scientists, for the last century and a half, have come forward with ingenious hypotheses to explain the same. It was Charles Darwin - the father of the theory of Organic Evolution - who first suggested a satisfactory explanation in 1848. His contention, supported and later amplified by Dana in 1853, was that the barrier and atoll reefs were formed initally as fringing reefs comparatively at shallow waters. These fringing reefs first developed around the inshore regions of volcanic islands.

With the passage of time, the volcanoes sank with the reef. But the corals kept their upward growth in pace with the rate of subsidence of the inshore region of the valcano, finally causing the development of a barrier reef situated far away from the land. If such a volcanic island surrounded by fringing reefs, totally disappears under the sea, the central part of the island forms a lagoon, the reefs forming an atoll.

A second hypothesis suggests the possibility of the solution of limestone at the shore-ward side of a fringing reef by sea and rain waters, thus causing the formation of a wider and deeper lagoon. Fringing reefs could grow on the top of rising foundations caused by volcanic eruptions or by the accumulation of animal and plant remnants at the sea bottom. Corals in due course reached the surface by their upward and outward growth. Those on the top that reach surface die out and their solution gives rise an atoll. This hypothesis has to face the objection that the alkaline waters of the tropical seas are unable to dissolve any appreciable amount of calcium carbonate. Rain water might have played a significant role but the springs of several areas are alkaline due to the presence of bicarbonates. Further it has been pointed out that at present the lagoons in several areas are getting filled by sediment and not widening by erosion and solution as this theory demands.

A third hypothesis put forward in the early nineteen hundreds links the Pleistocoene glaciation to the coral reef formation. During the Pleistocoene glaciation large bodies of waters were drawn out from the tropical seas for the formation of polar ice caps causing a lowering of sea level. Most of the then existing reef-corals also died out due to the lowering of the temperature. With the amelioration of the climate and the melting of the ice caps the water level in the tropical oceans returned to the pre-glaciation level. The depth of platforms that were so cut could have been 55 to 99 meters below the present sea level. As the water temperature gradually rose, the reef corals that survived the period of glaciation began to reproduce actively and the planulae found congenial habitats on the wave-cut platforms. The reef kept up the pace as the sea level rose. This theory also is not accepted by all. It has been estimated that one-fifth of the Pleistocoene Era experienced the glacial condition. Of this, waves were cutting at levels intermediate between the present and the lowest glacial strand for 80% of the glacial period and only 20% of the glacial period (i. e. 4% of the entire Pleistocoene) experienced a low-enough wave cutting to form any major platforms as required by this theory. But in support of this theory it has been calculated that the Samoan reefs could have been formed after the glaciation.

A fourth hypothesis envisages anticedent platform at the ocean basin, probably formed by the erosion of volcanic cinder cones. Such platforms might have been further elevated by the deposition of the skeletal remains of the marine animals to make them ideal for the colonisation of the corals. The formation of the Maldives and the Laccadives in the Indian Oceans and

some of the reefs in the eastern Pacific including the Great Barrier Reef, have been explained by this hypothesis.

Recent investigations have proved the reliability of the Darwinian contention. Darwin's hypothesis alone required much vertical thickness of the reefs. Borings at the Faunafuti Atoll to a depth of 334 metres and at the Bikini Atoll in the eastern Pacific to depths of 1,246 and 1,383 meters respectively have revealed the calcareous reef basement, upholding Darwain's hopothesis. It appears that planation plus subsidence can account for most of the reefs ,though no single factor will explain the formation of all reefs.

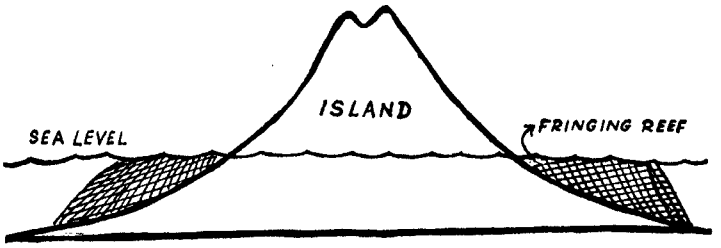
CORAL REEFS AND THE FORMATION OF CORAL ISLAND

Coral reefs have played a substantial role in moulding out many present day inhabited islands in the tropics. It is no exaggeration that "in no branch of biology we are so close to the earth science as in the study of coral reefs." Many exhilarating palm-fringed islands of *Micronesia Polyuasia, Melanesia* in the central and eastern Pacific and the Maldives and Laccadives in the central Indian ocean are formed out of coral reefs. A coral reef, when raised above the sea-leavel by natural means such as earthquake, volcanic erruption etc. is exposed to rain and sun causing the formation of sand. Waves may also deposit sand enabling sustenance ot vegetation. Many of the atolls are now being inhabited by people who ventured out from the mainland. The human habitation has changed the face of many atolls all over the world. Reefs were cut to make way for boats, lagoons were dredged and pits were sunk in the land to draw out fresh water. Natural vegetation has been removed and exotic plants and animals were introduced. Several interesting indigenous elements in the fauna were partly or fully destroyed leading to their extinction.

Figures 1 to 3. Formation of barrier reef (Fig. 2) and atoll (Fig. 3) from a fringing reef (Fig. 1) according to Darwin's hypothesis.

Figure 4. Secton illustrating the formation of platform by wave action in the marginal seas during glaciation (*After*, Browand, 1957).

Figure 5. Formation of atoll from submerged banks. A. Basis of primitive rock cut down by currents. B. Upgrowth of shoals by means of deep sea corals assisted by other organisms. C. outward extenssion of reefs. D. Surface reefs formed by reef corals. E. L and formed by elevation. F. Lagoon (*After* Gardiner, 1904).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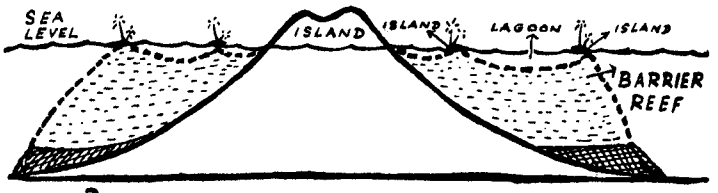
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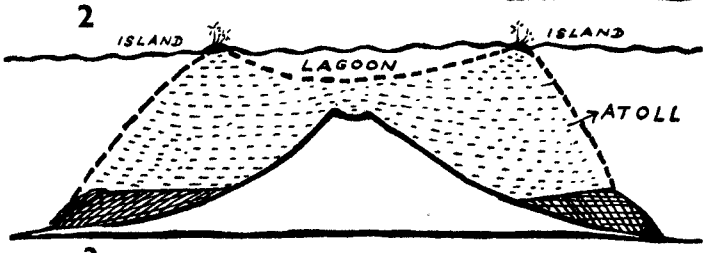
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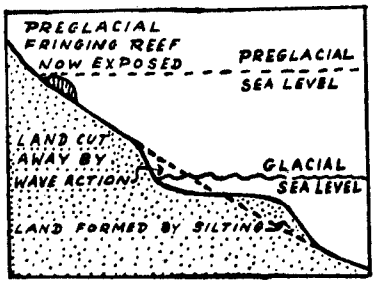
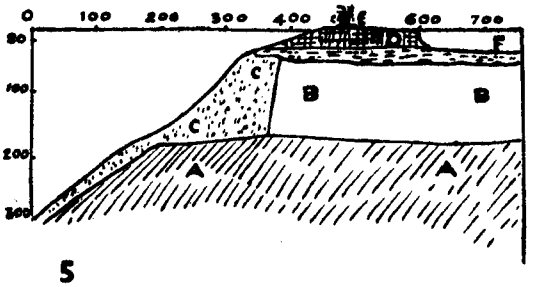

PREGLACIAL FRINGING REEF NOW EXPOSED
PREGLACIAL SEA LEVEL
LAND CUT AWAY BY WAVE ACTION
GLACIAL SEA LEVEL
LAND FORMED BY SILTING

4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THE INDUSTRIAL USES OF CORALS IN INDIA

By
N. KRISHNAMOORTI
The Travancore Electro-Chemical Industries Ltd.,
Chingavanam (Kerala).

THE air and water are absolutely essential for the existence of mankind. Like that for the existence of industry, there are minerals of various nature. Of these, limestone and lime are cheap materials and mostly used in industries in one form or the other, directly or indirectly in the process. Even the use of other raw materials such as iron ore, coal, crude oil, sulphur and salt are only second or at best equal to the quantity of limestone used in industry. Limestone is available in abundance to the extent of 3 to 4% of the elements in the earth's crust. Of the very many varieties of its occurrence in nature, coral limestone is one in which dominant part is the fossilised coral.

Availability in India

From the surveys so far conducted the coral reefs either living or dead have been located in Gulf of Kutch, Laccadives, Maldives, Palk Bay and Gulf of Mannar. On the Maldive corals some study has been made and its growth rate has been found to be 25.6 mm per annum. Mr. R. Bruce Foote was the first to mention about the presence of coral reefs and coral islands off the Tirunelveli and Ramnad coasts in his Memoir on the Geology of Madurai and Tirunelveli Districts. There is a chain of small islands, from Hare Island near Tuticorin upto Kutchathivu near Rameswaram. The islands are five to nine miles from the coast. The areas of these islands range from 60 acres to 600 acres. The coral reefs are found in abundance around all these islands. The islands contain only hard calcareous sandstone and certain islands have coral reefs covered with thick layers of sand. Large quantities of coral reefs broken by waves are

washed ashore in these islands indicating the presence of large reefs around. In the Laccadives the fishermen find these coral reefs an obstruction to the free approach to the shore in their fishing boats. Generally the coral reefs are a hazard for navigation and in many cases, in the fringing reefs and atolls, portions of the reefs have had to be cut away and removed in order to provide a navigable channel to the harbour or the lagoon.

The Rameswaram Island contains large deposits of coral limestone on the land and in the fringing reefs around the island on the northern side from Mandapam to Rameswaram. On the land under the swamps roughly 9,000 tonnes per acre can be recovered as limestone. The deposits are about five feet thick containing all varieties of semi-fossilised corals.

In the Kutch the beach sand itself contains fragments of shells and corals very rich in lime, and these are used for manufacturing cement. Coral stones are also available in the dead reefs.

The corals are very rich in lime with a specific gravity of 1.6. The other elements present such as silica, alumina, iron and magnesia are very low. Since it is taken out of sea water, washable salts absorbed by corals are present in very small quantities. The following analysis will give an idea of its high purity and composition:

$CaCO_3$	....	....	99.5%
$MgCO_3$	....	....	0.5%
$Ca_3P_2O_5$	....	....	0.2%

The upraised reefs of Rameswaram are of slightly inferior quality as the following analysis shows.

CaO	....	....	49.25 %
Al_2O_3	....	....	0. 2 %
Fe_2O_3	....	....	0. 8 %
SiO_2	....	....	5. 8 %
MgO	....	....	0. 7 %
K_2O	....	....	Trace.
P_2O_3	....	....	0. 3 %
Loss in ignition		....	40. 0 %

The coral limestone is very porous and the fine sand rich in silica enters these pores and increases the silica and alumina content.

Industries Based on Corals

1. Cement

In Australia after the Great Barrier Reef Expedition the value of these calcareous material and coralline deposits was realised and the Queensland Cement and Lime Company was started to exploit these reserves. In our country in Gulf of Kutch one cement unit is already using these materials in Sikka Even the sand in that area contains rich calcium because of the presence of shell grits and coral fragments. From this sand cement is manufactured and to some extent to supplement this raw material coralline material is added. The advantage of these raw materials unlike other stones is that the whole deposit is uniform in character. The physical and chemical properties are most satisfactory as a basic raw material for manufacture of high-grade portland cement.

In the south a detailed survey has shown that these coralline deposits of Rameswaram island will be useful for manufacture of portland cement of Indian Standard Specification. The daily capacity of the plant can be 600 tonnes (2,00,000 tonnes per annum) and the deposits will last for over a period of 40 years

The analysis of the limestone available in Rameswaram is as follows and is suitable for cement manufacture :

$CaCO_3$: 86 %
MgCO : 0·5%

2. Chemicals

It is under very strange circumstances that the coral became useful for manufacture of chemicals in India. When the manufacture of calcium carbide started in the south the availability of low-phosphorus raw material was very difficult. This industry was facing a closure unless the phosphorus problem was solved Phosphorus in carbide is highly detrimental, since it will catch

fire due to auto-ignition and explosion. It had been earlier published in a report that coral limestone is useless for manufacture of carbide. Also the reports by one or two technical collaborators from abroad discouraged the use of coral. As most of the inventions happened by accident coral also came to be used by accident just to solve the phosphorus problem. Analysis of a piece of coral revealed that its P_2O_5 is as low as 0.02%, but the silica content was high in the particular piece. A further study on this, on the basis of the Great Barrier Reef Expedition, proved that it is possible to get low-phosphorus and high-calcium coral. It has been found by the scientists of Great Barrier Reef Expedition that in the case of reef-building coral a very great amount of phosphorus is excreted into water. The purity of lime in the coral reef is as high as 98% $CaCo_3$. The particular capacity of the coral to remove sediments by themselves makes the reef free from silica. The other impurities in the reef such as magnesium carbonate, sulphur are very very low. In the manufacture of chemicals the presence of magnesia and sulphur are highly objectionable. Magnesia is very hard to burn and thus increases the cost of production. Sulphur compounds affect the purity of the end products. Today about 20,000 tonnes of corals are used for the manufacture of calcium carbide by the Industrial Chemicals Ltd., Sankarnagar, in South India.

3 Metallurgical Uses.

Coral limestone has got considerable mechanical strength. For every tonne of pig iron produced a flux limestone of 300 kg. is required. This removes the silica, alumina, manganese and sulphur Since the coral is of very low phosphorus content in the steel making process this will be a boon. The calcium content of the coral reacts with the above impurities to form a slag in the iron furnaces which is tapped out. This slag can again give a product of slag cement for construction purposes. Normally with 55% pure iron about half tonne of slag is formed per tonne of pig iron produced. A normal analysis of slag will be as follows:-

SiO_2	....	36.0 %
Al_2O_3	....	12.4 %
CaO	....	41.5 %

MgO	....	6. 2 %
FeO	....	0.48 %
MnO	....	1.34 %
S	....	1.29 %

Many iron foundries and non-ferrous smelters will also be requiring small-scale fluxing for which coral stones are suitable.

In making glass this can be added to improve its mechanical properties by making it less fragile and stronger. The corals are low cost fluxes.

4. Paper Industry.

For recovery of caustic which will otherwise go waste coral lime can be used.

Coral stones can be used for acid neutralisation, for manufacture of calcium cynamide, calcium-based chemicals, lime, cement, in agriculture, mineral food, water treatment and in metallurgy.

5. Agricultural Uses.

Agriculture requires a large amount of calcium for mixed fertilizers, animal mineral food, poultry grits and neutralising agents. The present day indiscriminate use of chemical fertilisers in the soil makes the soil acidic quickly. The approximate pH value of the soil should be maintained at less than 7 to get a good yield and for plants to absorb more fertiliser added. In the course of the last three years in a small circle of about 200 miles about three thousand tonnes of lime have been consumed annually for which a large proportion of coral lime was utilised.

From one of the reports in 1881 by Col. Baker, the then Port Master of Pamban, we find that Ceylon was importing shiploads of corals for her estates. Coral stone is applied directly to soil or as lime.

6. *Other Uses.*

The coral limestone can be used in industry both for its physical and chemical properties. Physical uses are :

Masonry Unit,
Construction aggregate,
Ornamental buildings,
Filter and filter aid.

Coral limestone filter can be used for abrasives, calcium-calking compounds, ceramics, chewing gum, fabrics, floor coverings, insecticides, leather goods, paint, paper, phonograph records, putty, rubber, plastics, pottery and poultry grits.

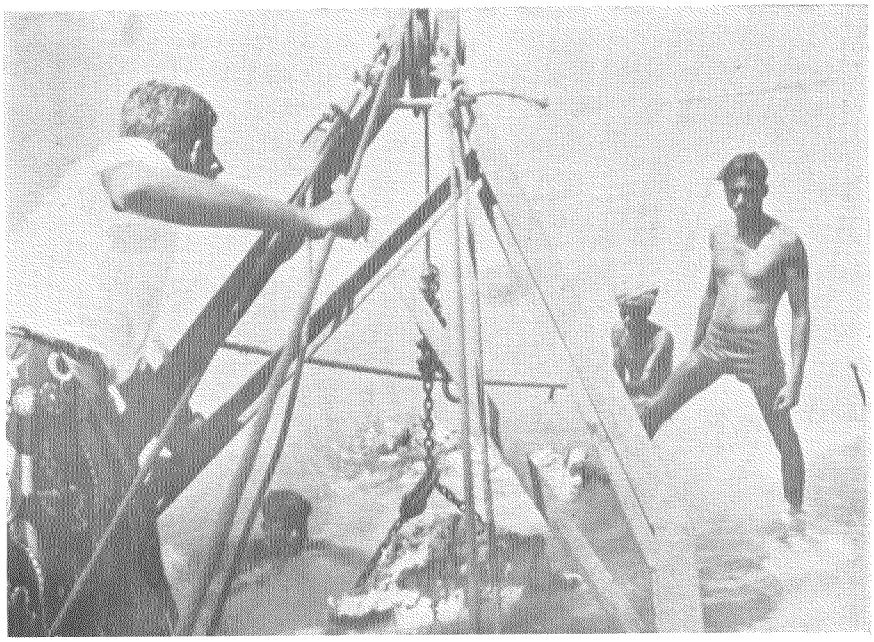
Corals in the coastal region of Ramnad and Tirunelveli have been widely used as building material. Big buildings, churches, naval dockyards have been constructed out of this. Very recently the road connecting Ramnad and Mandapam has been laid over a coral stone base. This road is about 24 miles and every furlong consumed roughly 1,500 tonnes. Apart from this on account of the cheapness of the material the rural roads are all formed out of this material.

How Coral is Mined

The present way of cutting coral stones are manual. The sailing boats from the shores opposite the reef reach the reefs during the low tide. The boatmen drive a long crowbar called 'Alavangu' into the soft reefs and lever it to break the stones. The broken pieces are loaded into the boat during high tide so that the boats will get sufficient water to come out of the reefs after loading. They reach the shore before evening and unload them. There is no systematic way of cutting the reefs as the boats sail according to the wind directions. The whole area of coral reefs gets disturbed.

There is at present a restriction imposed by the Government on the quantity of corals that can be cut and removed. This is meant as an aid in conservation, but is causing some hardship for the industry. It is not possible now to say with any certainty to what extent this is helpful since we have at present no idea about the rate of growth of the corals of this area and their rate of replenishment. There is need here for work on this aspect, from the results of which both the agencies of conservation and the industry can benefit.

The corals must be preserved, exploited and if possible cultivated so that it will be available for ever. This is possible only by scientific exploition by organised industries. The individuals who are at present mining it in a careless way will only spoil the reserves and the further growth and will not help the industry. It is time for us to set up a research wing for the study of corals around our country for the commercial exploitation since it is proved to be a valuable mineral for industry. This can be achieved only by the industries themselves coming forward to support such research and development, and it is hoped that the Central Marine Fisheries Research Institute would give necessary technical advice and facilities for work. The present symposium, therefore, is a timely one and the deliberations are being awaited with interest not only by the scientists but by the industrialists as well.



Coral Stones Being Collected from the Reefs

The Corals Unloaded on the Shore

CORALS IN THE CARBIDE INDUSTRY

By

K. S. KASIVISWANATHAN,
Industrial Chemicals Ltd., Sankarnagar, Tirunelveli (Madras State).

THE carbide industry in India had till very recently depended for raw material largely on imported petroleum coke. Nearly a decade ago Industrial Chemicals Ltd., Sankarnagar, in Tirunelveli District, the pioneer manufacturers of calcim carbide in the country, started looking for indigenous raw material. In processing calcium carbide from lime and carbon, they knew they could very well put local wood charcoal to use, but the samples of limestone from all over India tried, were found far from adequate to make first-class carbide conforming to the rigid international standard. Ultimately, the corals available in the seas around Rameswaram, on analysis, were found to conform to all the requirements as per standard specification to make 'A' grade calcium carbide. The company soon put it on commercial basis and to date they appear to be the only concern to exploit corals on a large scale for the industrial manufacture of calcium carbide.

The Raw Material

Regarding the availability of raw material in sufficient quantities, the coral formations around the islands in the Gulf of Mannar, running parellel to the Ramnad and Tirunelveli coasts, constitute a good source. These islands, particularly those from Pamban island to Valinokam Point, are surrounded by fringing coral reefs, which extend from one island to the other. These reefs vary in width and thickness from place to place, their form depending upon currents, action of waves and wind etc. The width varies from a few yards to as much as 400 to 500 yards. The reef itself is composed of dead and decaying coral with colonies of living coral on the surface.

The dead reefs of these waters were being exploited for other purposes locally, even before its use as raw material for the carbide industry was found out. As building stones such as granite, laterite or bricks are not readily available in the locality, it has been an established practice to cut and remove coral limestones for making buildings and roads. The removal of coral stones has thus been going on for many years.

The coral skeleton is deposited by the living polyps and therefore the reserves can be replenished in the course of years if conditions are favourable for the growth of corals. Though not much scientific work has been done to determine the rate of growth of corals in the Gulf of Mannar, some interesting experiments carried out on the coral reefs of the Maldives and the islands in the Pacific Ocean showed that massive corals grow about an inch in height per year while their lateral growth may be still greater. If the corals are worked carefully and systematically at selected spots in the different islands, without harm to the living corals, it should be possible to obtain limited supplies of the material for a reasonable length of time. However, there is need for a study of the rate of growth of these local forms, and until that is done nothing positive can be said about it.

M/s. Industrial Chemicals Ltd. started exploiting coral limestones from 1960 onwards. Because of the restrictions imposed as per the agreement entered into by the company wtth the Government the industry is unable to collect coral stones in sufficient quantity to work to full capacity. And in the experiences of the industry, no other raw material can replace the corals in quality for the production 'A' grade calcium carbide.

The Process

Calcium carbide is prepared from quicklime and carbon at 2000 to 2200°C in an electric arc furnace. The source of carbon is usually coke and charcoal, with a low ash content. The quicklime is produced by burning coral limestone containing at least 97 per cent calcium carbonate. The process involves the chemical reaction :—

1. $CaC0_3 \longrightarrow Ca0 + C0_2$
2. $Ca0 + 3C \longrightarrow CaC_2 + C0\uparrow$

The limestone suitable for calcium carbide manufacture should comply with the following requirements, as per LS: 3204–1965.

Loss on ignition, per cent by wt. max.	46.0
Silica (as SiO_2) per cent by wt. max.	1.0
Alumina (as Al_2O_3) and Ferric oxide (as Fe_2O_3) together, per cent by wt. max.	0.5
Calcium (as CaO) per cent by wt min.	54.0
Magnesium (as MgO) per cent by wt. max.	0.8
Sulphur per cent by wt max	0.1
Phosphorus per cent by wt. max.	0.01

The presence of silica and iron influences the course of the reaction and often yields ferro-silicon, thus affecting the gas yield of calcium carbide. Magnesium oxide has a deleterious effect in increasing the temperature of furnace charge and the energy consumption, thereby affecting the production. Phosphorus in limestone comes out as phosphide in the finished product which yields poisonous PH_3 gas when calcium carbide is treated with water to manufacture C_2H_2. So phosphorus in limestone should not be more than 0.01 per cent by weight.

Coral limestone gives the following analysis which complies with the above requirements :—

Loss on ignition	44.00 %
Silica (as SiO_2)	0.50 %
Combined oxides of Alumina & Iron	0 30 %
CaO	54.30 %
MgO	0.40 %
Sulphur	0.05 %
Phosphorus	0.009 %

Coral limestone also stands the process of calcination in kilns well and the lime obtained after calcination does not crumble to powder and so is better suited for the carbide furnace.

Uses of Carbide

Calcium carbide is consumed mostly in the manufacture of acetylene by reaction with water. Acetylene which is a com-

bustible gas is essential for a great variety of chemical syntheses and as a fuel for welding torches.

Thus the significance of the coral reefs of our shallow waters from the point of view of the carbide industry in this country is considerable. But more has to be known about these in order to arrive at the proper sustainable level of exploitation. In this connection it is a happy augury that the "Symposium on Corals and Coral Reefs" is being conducted at Mandapam Camp, so near to the site of these coral beds. This should serve to focus attention on this resource of ours and act as an impetus for much specific work on these lines in the near future.

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THE MARINE BIOLOGICAL ASSOCIATION OF INDIA

Marine Fisheries P. O.,
Ramanathapuram District, Madras State,
INDIA.

A NOTE ON TAMIL LITERATURE

By

A. SRINIVASA RAGHAVAN,
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IN the far south of our country, in a strip the land some 600 miles long between the Western Ghats and the eastern sea, lies the home of the Tamils. It is an ancient land, some say it extended into the Indian Ocean as part of the now submerged continent of Lemuria, a land with a highly cultivated language and a literature over two thousand years old. The earliest Tamil literature now available is, all of it, in verse and contains an astonishing wealth of poetry. It has all the vigour and directness of early works. The poet of those days wrote with his eye on the panorama of life and was concerned more with the aspects of things and man's emotional response to them than with philosophic speculation. The air is clear and unclouded and we see a thousand and one details of the land and the people springing to life at the voice of the poet. The dark rain-clouds sail from the north-east, cranes come white-winged and coral-beaked beating against them and the green shoots up from the glad earth. The sun returns, the hunting dog strains at the leash, the elephant tramples on the bamboo copse, and the *amla* leaf flutters in the golden light. In the hospitable courts of kings, poets gather and sing of the livableness of life and *panars* (minstrels) with white flowers on their *yal* scatter love and joy and beauty with their songs. Chieftains go out on their campaigns decked in garlands, and on the burning pyre their bodies are laid on *kusha* grass, broken with a sword, and burnt

The themes of these poems are generally war and love. And, in the love poem, a wonderful symbolism, delicate and restrained, is the accepted mode and is evidence of the richly developed state

of literary expression. This is to be expected because the poems of those days were written for the courts of kings and chieftains and under the aegis of *Sangams* or literary academies. An unusual blending of directness with symbolism, vividness, concreteness, freedom from over-refined speculation and the impediments of theological terms—these are the qualities of this early work. The poems are ancient but have nothing of the crudeness of the primitive. They are gems highly polished and the light that breaks from them is clear and bright and is of a world essentially of the here and now.

The light deepens and something that is not of the sea or land enters it in the second era of Tamil literature. Immediately preceding this era and during its early decades, mainly through the influence of Jainism and Buddhism, Tamil poets occupied themselves with ethical questions. A number of didactic works were produced during this period, the greatest of them being *Tirukkural,* a string of 1330 profound aphorisms by the poet Valluvar. It was during this period that the Buddhist epic *Manimekalai* and the Jain epic *Jivaka Chintamani* were composed. *Silappatikaram,* the epic of the anklet, based on the tragic life of one Kannaki who goes with her husband to Madurai and loses him there through a mischance, also belongs to this period. All these epics are storehouses of information on Tamil life of the times and have great poetic merit.

Tamil then came into greater contact with Sanskrit, the Hindu religious revival in the south being partly the cause and partly the result of this cultural interplay. Puranic legends rich with poetry and religious significance swept through the land and created a sumptuous background on which the poet could work with telling effect. The first fruits of this new influence were the mystical hymns of the Alwars and Nayanmars. The Alwars were Vaishnava devotees while the Nayanmars belonged to the Saiva faith. The twelve Alwars and the four Nayanmars to whom we owe the first and the finest mystical poetry in the language were all of them God-intoxicated souls. Their poems express the yearning of the finite for the infinite and the passion of the transient for the eternal. The symbolism derived from the early Sangam poems and the wealth of legends

that came through Sanskrit were now pressed into service to express the ineffable and to lend local habitation and name to the Absolute. Profound philosophical concepts were rendered into exquisite verse of a matchless simplicity. In these poems the earth becomes a window opening into beyond and we see through it as through a glass but not darkly, the voyagings of the human spirit towards an ultimate heaven. These Odysseys of the spirit reflect all facets of religious experience and their very intensity makes words break into a flood of melody.

The great epic poet, Kamban, inherited this threefold heritage of Sanskrit thought and philosophy, Sangam simplicity and Sangam ethical leanings, and the mystical symbolism and intensity of the religious poets. By his time, the Tamils had built great empires, Tamil colonies had sprung up in far-off, Bengal and in Malaya. Sumatra and Java across the sea and Tamil national life had touched the highwater mark of material prosperity and splendour. Kamban chose Rama's life as his theme and got the details of the story from Valmiki's Sanskrit epic, the *Ramayana*. But the whole story was re-created by him in Tamil and his long epic of some 42,000 lines enshrines all that is significant in Tamil tradition and culture. He is the most learned of Tamil poets and a study of his epic is "the last reward of consummate scholarship". With a remarkable knowledge of human nature, an unfailing sense of the dramatic, a keen mind reaching out towards profound truths with ease and precision, and a diction, rich, multi-toned and singularly poetic, Kamban has created in his poem a spacious allegory of human life and while expressing the highest achievements of the Tamil race, has at the same time tried to justify the ways of God to man.

After Kamban, that is after the 10th century, came a long period of comparative poetic sterility. But during this period, Tamil saw the great commentators and Tamil prose was born. The commentaries were on the old secular Sangam classics and also on the religious literature of a later period. They reveal great acuteness and scholarship but the prose in which they are written is either a clumsy mixture of Sanskrit and Tamil or a crabbed artificial limping towards aphoristic terseness. Also, during this period a number of a new literary forms called the

prabandhas came into vogue and though some of them are of considerable poetic value, there is nothing in them either of the grasp of life that the Sangam poets had, or of the emotional and spiritual sweep and the wide horizon of later works. They are mostly imitative and timid.

Tamil life itself had shrunk to mediocrity by the 16th century. The Muslims and then the Mahrattas and after them the British got control over the land and Tamil literature took refuge in the *Matalayams* or the monastic houses of the religious and interested itself in arid theological hair-splittings or in erotic vulgarity and sensuousness. During this period, however, the impact of Islam and Christianity gave Tamil a few works based on Islamic and Christian beliefs, works like *Seera Puranam* dealing with the life of the Prophet Muhammud and *Tempavani* by the foreign missionary Father Beschi on the life and teachings of Christ.

The modern period may be said to have begun here. With the mounting tide of nationalism early in this century, the Tamils began to look back with pride on their past and set about freeing the present from the degradation that had set in. Bharati, the poet, was the voice of this newly-awakened national consciousness. He is the father of the present era in Tamil and though it is now over forty years since he passed away, his influence is still powerful. He rescued Tamil literature from the stagnation of the *matalayams* and the petty courts of zamindars and brought it into the main current of national life. Tamil verse regained its vigour and naturalness and a new Tamil prose, direct, plastic and functional, was born. Contact with English and through it with the vast treasures of modern European thought had expanded the horizon and Tamil literature today is marked by a renascent activity. It has returned to its old secularism and democratic outlook without, however, losing its eclecticism and the wealth of tradition built through it. Novels, short stories, plays and a new literary criticism based on the aesthetics of the West have all come into being and work of a high literary quality is being produced. Tamil literature is very much alive today; it is the voice of over forty million people; it has a glorious past to inspire it and a more glorious future beckoning it towards greater achievement.

ARCHITECTURE OF TAMILNAD

By

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FROM a reference to Sangam classics, assigned to 3rd century B. C.— 2nd century A. D., it may be seen that both secular and religious architecture had reached a high state of proficiency from very early times. Texts dealing with the science of architecture are referred to in Sangam classics ; especially the Maya school of architecture was in vogue. The "Nedunal Vadai", one of the idylls, refers to the construction of a royal palace and to its interior decorations. In this the laying out of the plan of the building on an auspicious day, erecting a storeyed palace suited to the taste and dignity of the king etc. are referred to.

The victorious march of Cheran Senguttuvan to the Himalayas to bring a stone to carve the image of Kannagi and the crection of a temple dedicated to her by skilled architects form the celebrated theme of *Silappadikaram*. The *Silappadikaram* also gives the layout of the ancient city of Kaveripoompattinam, which seems to have been built on a well-laid plan. The fortification of Madurai and its various defenses are of great interest to a student of Tamil architecture

The recent excavations at Kaveripoompattinam have proved the high proficiency attained by Tamil architects. One of the unearthed structures was a wharf, employed to tie boats and other vessels which used to frequent the ports of Puhar. A few wooden posts unearthed in the structure have been dated to 3rd century B. C. with the help of radio carbon dating. This would be the earliest secular structure so far noticed in Tamilnad. Another structure of secular nature was a trough

used for dyeing cloths, datable to 1st century B. C., at Uraiyur. The excavations at Arikkamedu have yielded a Roman settlement dating back to 1st century B. C.

The remains of a Buddha Vihara, unearthed at Kaveripoompattinam, is perhaps the earliest religious structure noticed so far in Tamilnad. The structure is built of large-sized bricks, which are overlaid with plaster and paint. Being a Buddhist structure, it resembles the Buddha Viharas unearthed at Nagarjunakonda, Amaravati and other Buddhist sites in Andhradesa. A few stucco heads with traces of paintings have been unearthed at Kaveripattinam. The stucco artists (மண்ணீட்டாளர்) were held in high esteem in the Sangam and post-Sangam era.

With the rise of the Pallavas to supremacy in the 6th century A. D., Tamilnad witnessed a great era of building activity. A great number of cave temples were excavated in rocks, by Mahendravarman I who ruled from 600 A. D. to 630 A. D. Excavated caves of Mahendravarman are found from Kanchi in the north to Tiruchi in the south. The cave at Tiruchirapalli carries a beautiful image of Siva as Gangadhara. Mahendra's caves are simple rectangular halls supported by plain pillars.

The building activity was continued by his successors, among whom Narasimhavarman II, familiarly known as Rajasimha, stands supreme. He lavished all his wealth on constructing temples. His works are concentrated at Kanchipuram and Mamallapuram. At Mamallapuram three types of architecture could be noticed, viz, (i) Rock-cut caves (ii) monolithic temples and (iii) structural temples. Besides, there are sculptures carved on the faces of the rocks.

The five monoliths depict five varieties of architecture. The tallest monolith called "Dharmaraja ratha" is a three-storeyed temple, with a *garbhagraha* in each story. The next one called "Bhima ratha" is a rectangular wagon roofed temple; the third one called "Arjuna ratha" is a two-storeyed temple with a *garbhagraha* on the ground floor. The next, in the form of a hut, is called "Draupadi ratha," while the apsidal *ratha* in front, is called "Sahadeva ratha." Besides these, there are three more

rathas on the western end of the village. All these monoliths are probably replicas of the then existing structures.

The Kailasanatha Temple of Kanchi, the seashore temple of Mamallapuram, and the Talagirisvara Temple of Panamalai are the structural temples erected by Rajasimha. These temples were built entirely of stone from base to the finial.

From 700 A. D. onwards all-stone temples were built in large numbers. A number of structural temples of the Pallava period are found at Kanchi. A temple at Tiruvadigai built in the reign of Paramesvaravarman I and renovated in the reign of Nrupatunga is of great interest as it served as the model for the big temple of Tanjore. The temples of Pallavas are built of sand stone, a soft medium. Thus from 600 to 850 A. D. the Pallavas have built a large number of temples. Their temples are all marked by an exhuberence of sculptures

The Cholas who rose to prominence by about 850 A. D. were benefited from the experience gained by the Pallavas in architecture. The Chola period (850 to 1300) witnessed mastery over architecture. Temples rising to a height of 200 feet were built. Sculpture was subordinated to the heights of architecture The big temple of Tanjore, built entirely of granite from the base to the *sikhara*, is a marvel in architectural science. This was followed by similar temples at Gangaikonda Cholapuram, Darasuram and Tribhuvanam.

It would be appropriate at this stage to note the difference between two terms generally employed in South Indian temples, namely *Vimana* and *Gopura*. A *vimana* means a tower over the sanctum while a *gopura* means a tower over the entrance. Till about 12th century A. D., great attention was bestowed on the tower over the sanctum. Thus the temples at Tanjore, Gangaikondacholapuram, and Tribhuvanam have tall *vimanas* over the sanctum. During this period two entrance towers *(gopuras)* were also erected in front of the *vimana;* but these *gopuras* were invariably shorter than the *vimana*.

During the 12th century A. D. *gopuras* of equal height came to be built at the four cardinal directions. Thus at Chidambaram

four *gopuras* were erected on all the four sides. As times rolled on *gopuras* assumed greater importance and came to be built taller and taller. Very great heights were reached in the reign of the Vijayanagara ruler, Krishnadevarayar, in 16th century A. D.

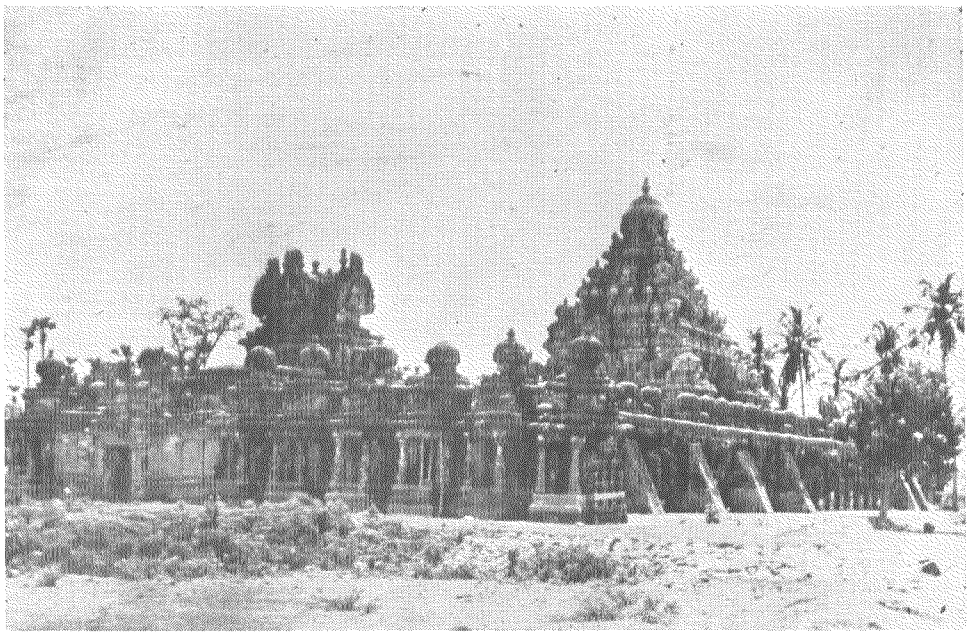
The *vimanas* lost their importance and began to appear small in front of the lofty *gopuras*. During the 17th and 18th century A. D. the lofty *gopuras* were embellished with a profusion of stucco figures, painted with appropriate colours. The *gopura* of Meenakshi Temple at Madurai is the best example of this school. This new move initiated by the Nayaks continues to this day.

There are a number of books which guide the traditional builders. They are called *Vastu Sastras* or *Manainuls*. Mention has been made of the Maya School of Architecture. A book called "Mayamata" sets out the details of various constructions. "Visvakarma Vastu Sastra," "Manasara" and other texts are also available. They are generally divided into four sections dealing with *vastu*, *prasada*, *yana* and *sana*, namely land, buildings, vehicles, and furniture.

Before erecting any structure, the texts give the method of testing the ground for density, stability and the residential worthiness of the surroundings. It would be amazing for a student of history that this traditional method of testing the ground has stood the test of time. Buildings erected over 1300 years ago are standing even to this day with little or no settlement.

The *vastu* texts deal with various measurements in use and the names of various parts, and then give in detail the method of constructing both religious and secular structures. The lay-outs of villages, towns, capitals, military cantonments, forts, ramparts, royal palaces, residential buildings suited for every class of people are all dealt with. These texts devote a considerable number of chapters for building temples and carving icons. A chapter is also devoted to painting

A body of literature called *Silpa Sastras* also grew from about 13th century A. D They mainly deal with the various aspects of Siva and Vishnu images



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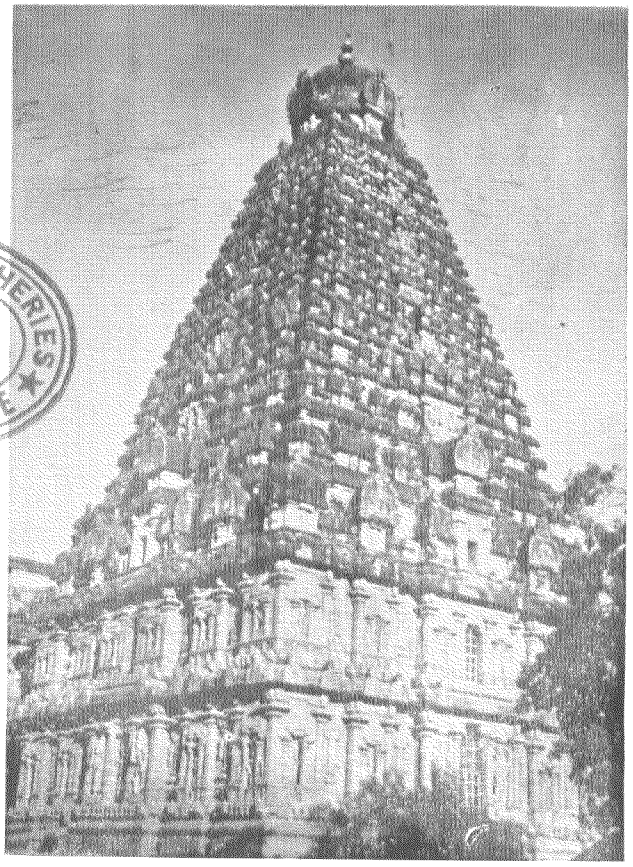
KAILASANATHA TEMPLE AT KANCHI,
BUILT BY RAJASIMHA
(8th Century A. D.)



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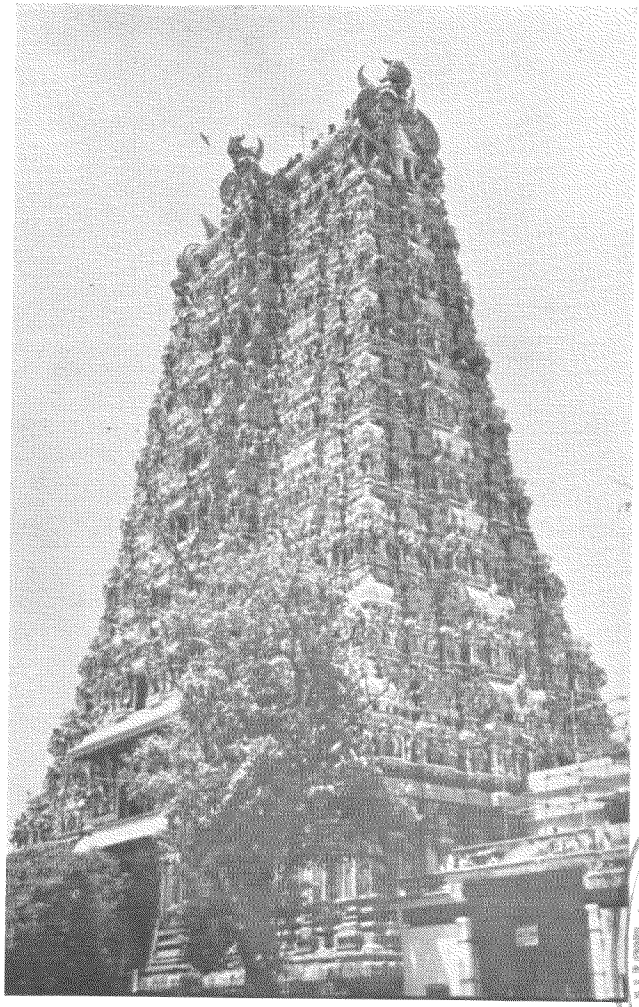
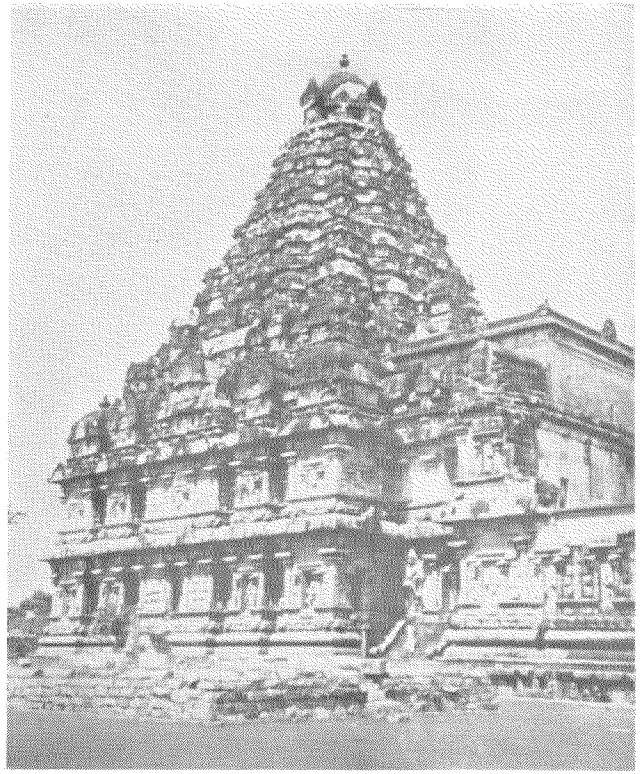
A CHOLA STONE TEMPLE AT TANJORE,
BUILT BY RAJARAJA I
(11th Century A. D.)



The Gopura of Angayarkanni Temple at Madurai (17th Century A. D.)



A Chola Temple at Gangaikondasolapuram, built by Rajendra I (11th Century A. D.)

THE FISH IN TAMIL CULTURE

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THE fish has played its own part in the history and culture of the Tamil country from very early times. We come across copious references to fish and fishermen in ancient Sangam classics.

According to Tamil tradition the land is divided into five classes as *Kurinji* (mountaneous region), *Mullai* (forest region), *Marudam* (cultivable lands), *Neidal* (littoral region) and *Palai* (desert region). References to *neidal* in Sangam classics almost invariably contain descriptions of marine animals and the life of fishermen. According to "Tolkappiyam." Varuna is said to be the presiding deity of *neidal*.

The "Perumbanatruppadai" gives a graphic description of fishermen's hamlets. These abodes are small and built of poles, with woven grass covering the roof. In the sandy yards in front were small pandals where the young and the old rested during the day. They caught fish with nets in the nearby ponds which had an abundance of the red-striped *Kayal* (கயல்) and the greenish *Iraa* (இறா). The same passage also refers to another kind of fish called *Vaalai* (வாளை) which often manages to escape the hook. The fishermen entertained visitors with delicious food consisting of cooked rice and fried fish.

The "Pattinappalai," which gives a detailed description of the ancient city of Kaviripoompattinam, throws valuable light on the life of the fishermen. The women of the community, clad in garments of the leaves, creepers and flowers, joined with the fishermen to propitiate their favourite deity by planting the protruding saw-like bone of the saw-fish in the sand. They decked themselves with flowers, drank plenty of toddy and sported on the sands. They bathed in the sea to wash off their sins and got rid

of the saline water by bathing again in the river. The fishermen, who went far into the sea during the night, returned in the early hours of the morning when the lamps lit on the storeyed mansions of the town guided them to the shore.

The fishermen are known by a number of names in Tamil literature which speaks of them as *Paradavar* (பரதவர்), *Nulaiyar* (நுளையர்), *Tamilar* (திமிலர்), *Savar* (சாவர்), *Kadavar* (கடவர்), *Kaliyar* (கழையர்), *Valaignar* (வலைஞர்), and *Pattinaver* (பட்டினவர்) The "Chudamani Nighantu" gives the names of various kinds of fish like *Kalai* (கலை), *Sura* (சுறா) and *Meeneru* (மீனேறு) which are the names of larger fish. Another kind is called elephant fish, and the one that swallows the elephant fish is called *Timingilam* (திமிங்கிலம்), Further, fishes called *Iraal* (இரால்), *Aaral* (ஆரல்), *Kendai* (கெண்டை), and *Cel* (சேல்) are also mentioned.

Fish was the royal insignia of the Pandya dynasty that ruled from Madurai. The Pandyas were themselves called "Meenavar" in early literature and inscriptions. The royal banners of the Pandyas carried the fish as emblem and so did the royal seals. The early coins of the Pandyas carry the figure of one fish only. In the later coins two fish are noticed, sometimes facing the same side and sometimes facing each other. In some coins a rod is seen in between. The two-fish-rod motif is seen in the mediaeval coins of the Pandyas and also on buildings like the *gopuras*, *prakaras*, etc. erected by them. Such emblems are seen even to this day at places like Chidambaram, Thiruvadigai, Thiruvannaikkaval and Madurai. The Cholas also embossed the fish design on their seals and coins as a mark of their conquest over the Pandyas. Thus the seals and coins of Uttama Chola, Raja Raja and others carry the fish design.

Fish in various designs are often represented in the sculptures of ancient Tamilnad. The incarnation of Vishnu as a fish was a favourite theme of the Vaishnavites. The crocodile, *makara* (மகரம்), is often met with as an architectural motif in ancient buildings.

The fish was a favourite motif with ancient jewellers. A number of precious ornaments made and gifted to the temples by rulers are in the form of fish set with precious gemes. Some of them are also in the *makara* form.

Megasthanes has the following to say about the *makara* and other sea monsters off the coast of South India: "All the energy of the inhabitants of the Island of Taprobane is devoted to catching fish and the monsters of the deep; for the sea encircling the island is reported to breed an incredible number of fish, both of the smaller fry and of the monstrous sort.... ..Some fish are in appearance like women, but, instead of having locks of hair, are furnished with prickles. They say whales also frequent this sea.....The dolphins are reported to be of two sorts—one,fierce and armed with sharp-pointed teeth, which gives endless trouble to the fishermen and is of a remorselessly cruel disposition, while the other kind, which is mild and tame, swims about in the friskiest way and is quite like a fawning dog. It does not run away when any one tries to strike it and takes with pleasure any food it si offered".

Regarding fishing off the coast of the Maldive (*Maladvipa*) islands, Ibn Batuta, a mediaeval traveller, has the following to say: "All the Maldive Islands are destitute of grains except that a cereal resembling millet is grown in the region of Sawid and transported thence to Mahal. The people subsist on a fish similar to *lairun* and called *Qulb-ul-mas*. It has red flesh; it has no fat, but it smells like mutton. When they cut each fish into four, cook it lightly and then place it in a palm-leaf basket and smoke it. They eat it when it is quite dry. From here it is also exported to India, China and Yemen".

The fabulous wealth of the Pandyas was mainly due to pearl fishing. Korkai was the main port where this industry flourished. Early travellers like Ptolemy have made references to pearl fishing at Colchi (Korkai). The *Mahabharata* refers to the pearls of the Pandya country.

Aealian, an early classical writer, refers to pearl fishing in Tamilnadu in the following terms: "The Indian pearl-oyster (I have already spoken of the Erythraean kind) is caught in the following manner: There is a city which a man of royal extraction called Soras (சேரர்) governed at the time when Eukratides governed the Baktrians and the name of that city is Perimuda. It is inhabited by a race of fish-eaters who are said to go off with nets

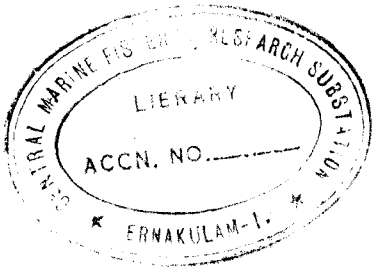
and catch the kind of oysters mentioned in a great bay by which a vast extent of the coast is indented. It is said that the pearl grows upon a shell like that of a large mussel and that the oysters swim in great shoals and have leaders, just as bees in their hives have their queen - bees. I learn further that the leader is bigger and more beautifully coloured than the others and that in consequence the divers have a keen struggle in the depths which of them shall catch him, since, when he is taken, they catch also the entire shoal, now left, so to speak, forlorn and leaderless, so that it stirs not and, like a flock of sheep that has lost its shepherd, no longer moves forward against any incipient danger. As long, however, as the leader escapes and skilfully evades capture, he guides their movements and upholds discipline. Such as are caught are put into tubs to decay and, when the flesh has rotted and run off, nothing is left but the round pebble. The best sort of pearl is the Indian and that of the Red Sea. It is produced also in the Western Ocean where the island of Britain is. This sort seems to be of a yellowish colour, like gold, while its lustre is dull and dusky. Juba tells us that the pearl produced in the straits of the Bosphorus is inferior to the British and, not for a moment, to be compared with the Indian and Red Sea kind".

This may be compared with the account of Marco Polo "You must know that the sea here forms a gulf between the Island of Seilan and the mainland. And all round this gulf the water has a depth of no more than 10 or 12 fathoms and, in some places, no more than two fathoms. The peral - fishers take their vessels, great and small, and proceed into this gulf, where they stop from the beginning of April till the middle of May. They go first to a place called Bettelar and (then) go 60 miles into the gulf. Here they cast anchor and shift from their large vessels into small boats. You must know that the many merchants who go divide into various companies and each of these must engage a number of men on wages, hiring them for April and half of May. Of all the produce they have first to pay the king, as his royalty, the tenth part. And they must also pay those men, who charm the great fishes to prevent them from injuring the divers whilst engaged in seeking pearls under water one-twentieth part of all that they take. These fish-charmers are termed Abraiaman and their charm

holds good for that day only, for at night they dissolve the charm so that the fishes can work mischief at their will. These Abraiaman know also how to charm beasts and birds and every living thing. When the men have got into the small boats they jump into the water and dive to the bottom, which may be at a depth of from 4 to 12 fathoms, and therethey remain as long as they are able to. And there they find the shells that contain the pearls (and these they put into a net bag tied round the waist and mount up to the surface with them and then dive anew. When they can't hold their breath any longer they come up again and after a little, down they go once more and so they go on all day). The shells are in fashion like oysters or sea-hoods. And in these shells are found pearls, great and small, of every kind, sticking in the flesh of the shell-fish.

In this manner pearls are fished in great quantities, for thence in fact come the pearls which are spread all over the world. And I can tell you the king of that State hath a very great receipt and treasure from his dues upon those pearls.

"As soon as the middle of May is past no more of those pearl-shells are found there. It is true, however, that a long way from that spot, some 300 miles distant, they are also found; but that is in September and the first half of October".



INDIAN CULTURE REBORN

By
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PEOPLE are everywhere today discussing the renaissance of art and the rebirth of Indian Culture. But with very few exceptions, how many of us really know what art is or have a true conception of the nature of culture ? As a matter of fact it is impossible to define culture. I have not discovered any book, or any person, who has given its full meaning. The books on the subject are usually descriptions of certain archaeological proofs of culture in different civilizations.

Culture is not mere outer education. Culture cannot be manufactured as we do culture pearls. Culture is not created with words. Culture is much more. It is indefinable and subtle.

Let us imagine what culture really is. Let us go beyond the words and try to understand the real significance of the word, especially in terms of everyday life. Culture is more than art. It is beauty and a direct manifestation of beauty. It is impossible for a nation to be cultured without the manifest expression of beauty, and it isthe very fine thread of culture that weaves all the activities of the nation, whether political, educational, artistic, religious, philosophic or any other, into one splendid whole.

Yet it is not the mere form that determines culture. It is not the beauty of the printed letter that makes a work of literature a fine example of art. It is the inspiration of the artist that expresses itself in the form of the printed letter. Even without the expression it would be literature if only we could see and hear. Unfortunately without the form we cannot see or hear.

People often think that culture is a system of living, of good manners established according to certain ideas. But we see that every civilisation has its own idea of culture. The Chinese, for

example, are highly cultured and are a wonderful race of people. And yet a perfect Chinese or Indian gentleman might express himself in all sorts of ways very different from the code of life of a perfect European gentleman. Culture is not etiquette. Culture does not depend upon a certain system of training, a certain habit of ideas.

It is really the spirit that is culture. Culture is an unconscious thing, and it exists everywhere in every civilization in every class of life. Culture is expressed in such small things as gesture speaking to a friend, walking along a road knowing how to meet the ordinary people of everyday life, knowing what to do from moment to moment; all this is the real expression of culture, a culture which is an expression of a great background that has existed for ages.

There is beauty in the life of the village. Every artist is inspired by that beauty. While we often see lovely paintings of country scenes and peasants, how seldom is an artist inspired to paint a picture showing the setting of Western city life ? Unconsciously we pay tribute to the unpretentious villagers, because we derive our inspiration from them.

What is the form of culture that India can express ? What is the form of culture that India has expressed ? I am very strong on the point of view that India is, and still more was, one of the most cultured countries of the world. It is really a mistake when people think that they must have a foreign education in order to derive culture. I personally feel that there comes about a deterioration of culture of a result of copying, and badly copying at that, the veneer of culture of another civilization.

Are there not writings, monuments and frescoes that stand today as living witnesses of the highest pinnacle of culture reached by the Indian mind ? Are there not examples in the lives of great women and men of India whose words can bring happiness and salvation to the world at all times ? Akbar, the great Emperor, tried to bring the philosophies of all religions together; Bhishma, the great Hero, gave codes of chivalry which, if followed today, could make the world really great; women like Maitreyi and Queen Mirabai were examples of perfect womanhood;

the wonderful poetry of all languages, and of the great Saints of the Tamil land-these and the traditions that they left prove that India reached not only great but eternal hights. In modern India the same spirit can be reborn. We can leave for our children and for future generations something eqally splendid for which they may be grateful. But in order to do this it is necessary to realise that we must know India and feel her heart.

We must enter into the soul, of Indian life to know what India is. Only if we can express the culture that is behind India, can we be not only true to ourselves, but really great. And only when that magnificent culture is born again in India, can India once more express her own genius.

What are some of the essential qualities of that ancient culture which was so uniquely Indian ?

The genius of India is spirituality, and I hold that all art is inextricably linked with spiritual ideas. To me religion is above narrowness, religion is the power to lift the heart and mind to great things and to bring down the inspiration of this into the things of everyday life. Even a so-called 'atheist' can be religious if he is greatly inspired. I should say to all who are working for the rebirth of Indian culture : Let Beauty itself become your religion, for without that power to give yourself whole-heartedly, to sacrifice your entire being to an ideal I do not think it is possible to bring culture into the world. It is obvious that every phase of Indian life, every form of Indian art even in the simplest things of everyday use, are influenced by religious ideals, as has been true in the past of nearly every nation in the world.

The next important quality is reverence to life - the power to see divinity in all things and to see in every form of creation the Divine Artist at work. A human artist creates in the arts, while the Divine Artist creates in all the forms of life.

Another characteristic of Indian culture is chivalry, which is the Fatherhood and the Motherhood of life born of reverence, of a desire to protect.

Refinement is another essential and inherent part of Indian culture, for without refinement there could be neither culture nor the arts. Our ancient arts are great living examples of that which separates are from the ordinary and lifts it to the heights of inspiration.

When the greatness or spirituality of heaven has touched the earth of everyday life, that is culture. It is not enough to read spiritual and wonderful books; to be cultured we must express our higher selves. Nothing ugly, vulgar or cruel can ever be an expression of culture. Cruelty in any form is the sign of the savage, the uncultured man. The spirit of refinement is the true heritage of every Indian.

Character is culture; and for the rebirth of the Indian nation, to bring into being all that is beautiful and inspiring, to bring the young to appreciate beauty and therefore, to live it, is one of the great tasks of all of us who are Indian. With the rebirth of culture will be born not only great masterpieces of art for future generations to admire. but masterpieces of character, the birth into the present day of great geniuses who alone can lift the the world from the ordinary to the extraordinary, from the uncivilised to the civilised and so will help to lift the entire nation to a standard of life, which, even at its worst, can never be ugly, vulgar or cruel. Only with the rebirth of this culture will there ever be lasting peace and happiness.

CENTRES OF TOURIST INTEREST IN SOUTH INDIA

Compiled from brochures and pamphlets issued by the Department of Tourism, Government of India.

THE states of Madras, Kerala, Mysore and Andhra project an image different from the North. In contrast to the even plains of the North, the landscape in the South is undulating, dotted with low hills, plains and valleys, full of coconut and mango groves, paddy fields, winding roads to hill-tops, glittering streams, enchanting back-waters and soaring temple-towers of exquisite architectural skill.

A few centres of interest for the visitor to this country are briefly described below.

Rameswaram

The town of Rameswaram is situated on the Rameswaram Island and is 20 km. (12 miles) east of Mandapam Camp connected only by rail. The renowned Ramanathaswami Temple is magnificent with its stone-cut pillared corridors. The largest straight corridor in the world with a length of 1000 feet and a breadth of 650 feet is found here. A Hindu pilgrimage is not considered complete without a visit to Banaras in the North and Rameswaram in the South.

Madurai

Perhaps the best-known temple-city of the South, Madurai was once the capital city of the Pandyas, celebrated in ballads and legends. The city is famous for the Meenakshi Temple with its pillared halls and nine soaring towers. The tallest of these towers is 58 metres (190 ft.) high. Another place of interest at Madurai is the Thirumalai Nayak Palace, a 17th Century palace of the then rulers of Madurai, the Nayaks. 18 km. (11 miles) from the city is situated the Alagar Koil—a Hindu temple built at the base of the beautiful Alagar Hill. The Mariamman Teppakulam, about 5 km. east of the railway station, is a huge freshwater tank with a centrally situated pavilion.

Tiruchirapalli

The city is connected to Madurai by rail, road and air. It is famous for the Rock Temple, a landmark that stands on a rock rising abruptly 83 m. (270 ft.) above the city. About 8 km (5 miles) from here is Sreerangam, an island formed by the bifurcation of the Cauvery river. The ancient temple of Sree Ranganatha here is very famous and has seven surrounding walls. The colonnaded courts and gigantic carvings are of great artistic worth.

Tiruchirapalli is also famous for its cigar (as is clear from the anglicised place name of Trichinopoly), glass bangles, handloom clothes and wooden and clay toys. The huge stone dam - the Grand Anicut - 329 m. (1,080 ft.) long and 18 m. (60 ft.) broad diverting the Cauveri waters to Tanjore is an achievement of 11-century builders.

Tanjore

This town, 50 km. (31 miles) from Tiruchirapalli, is most famous for the temple of Brihadeeswara, considered one of the finest examples of South Indian architectural monuments. Built by the illustrious Raja Raja Chola in

985 A. D., its tower 66 m. (216 ft.) high is capped by a massive dome that rests on a single granite block.

Tanjore is also famous for its beautiful bronzes, ancient specimens of which are housed in the local Art Museum.

11 km. (7 miles) from Tanjore is the village of Tiruvaiyar, the birth-place of the great saint-composer, Thyagaraja.

Madras

Madras, the capital of Madras State is a spacious city. Its first claim to fame is the Marina,a wonderful foreshore of fine sandy beach, considered the second longest in the world. The centres of interest in the city include the 300-year-old Fort St. George with its historical associations with Robert Clive who lived here in 1753 and the Duke of Wellington who lived here in 1798. The San Thome Cathedral is closely associated with the name of St. Thomas, one of the twelve Apostles of Christ, who, it is said, came here to preach and founded a church at the site of the present Cathedral. He is believed to have been burried here after his Martyrdom.

The Church of St. Mary dating from 1680 is perhaps the oldest Anglican church in India. The interest here is also in the fact that amongst, the contributors to the construction of this church was the famous Elihu Yale who, starting as a clerk in the East India Company, became the Governor and amassed a fortune, a good part of which he devoted to establishing the American University that bears his name.

Some famous Hindu temples are in the city. The Mallikarjuna and Chennakesava Temples are among the oldest. The Saivite Kapaleeswarar Temple at Mylapore is famous in ancient song and story, and so is the Vaishnavite Parthasarathi Temple in Triplicane.

The centre and headquarters of the Theosophical Movement is here at Adayar where the Society runs the famous Kalakshetra which offers courses in Indian classical dances and other fine arts.

Mahabalipuram (Mamallapuram)

Mahabalipuram is situated 60 km. (37 miles) south of Madras. It is famous for the rock-cut temples of the 12th century, constructed by the Pallava kings. The *rathas*, carved out in the form of temple chariots, deserve close study. A bas-relief showing the penance of Arjuna is among the largest in the world and measures 27.5 m. (90 ft.) long and 9 m. (30 ft.) high. No visit to India is complete without one to Mahabalipuram.

Kancheepuram

About 84 km. (52 miles) to the south-west of Madras, Kancheepuram is a temple - town whose history dates back over 23 centuries. It was once the capital of the Pallavas. The oldest of the temples here, the Kailasanatha Temple, is about 1, 200 years old. Kancheepuram is also world-famous for its beautiful, hand - woven silk sarees.

If one proceeds from Mahabalipuram to Kancheepuram by road he would skirt the Tirukazhikunram hill where the famous two kites come every day at noon to be fed by the temple priest. Not very far from here is the Vedanthangal Bird Sanctuary.

The Periyar Wild Life Sanctuary

A pleasant way to reach Thekkady, the site of the sanctuary, would be by road from Madurai. For the most part this road passes through push green

forest and tea and rubber plantations. It is one of India's loveliest wild life sanctuaries. It is in a valley surrounded by thick forests that encircle a vast artificial lake made by damming the river Periyar at Kerala's high ranges. Sailing across the lake one can see herds of elephants, the sambar, the bison, the deer, the panther and several other wild animals in their natural setting. From Thekkady a steeply-winding road through the rich tea and rubber plantations lead to Trivandrum, the capital of Kerala.

Trivandrum

It is a modern city built on low hill - tops. Places of interest at Trivandrum are the Sreepadmanabhaswami Temple, the beautifuly laidout zoo and the public gardens, the Art Gallery, the Water Works, the Aquarium, the ivory and bronze shops that deal in handicrafts of exquisite workmanship and a large number of educational institutions. 16 km. (10 miles) from Trivandrum, connected by road, lies the beautiful Kovalam beach ideal for picnics, zoological collections and a fine sea bath.

Padmanabhapuram

Padmanabhapuram is situated a mile and a half from the Trivandrum-Kanyakumari (Cape Comorin) trunk road. A detour from Thekkady at the 33rd mile from Trivandrum leads to this place, which was the seat of the Travancore maharajas till the middle of 18th century. Their old palace is a monument of artistic and archaeological skill.

Suchindram

74 kilometres from Trivandrum is situated Suchindram with its famous temple of superb sculpture.

Cape Comorin

Cape Comorin, the Land's End of India, is a place of seductive charm. To watch the sun set and the moon rise from here is a thrilling experience. The Kanyakumari Devi Temple and the recently-built Vivekananda Memorial are places to visit.

Cochin

Kerala has been a meeting place of many peoples and religions and Cochin is a typical example of this, its historical landmarks including the ancient Synagogue in the oldest jewish settlement in India, Portugese churches (the Santa Cruz Cathedral and St. Francis Church in Cochin Fort are among the oldest European churches in India), Dutch architecture (exemplified by the Dutch Palace at Mattanchery with its world-famous murals), besides temples and mosques. Cochin is, in addition, a fine natural harbour.

Bangalore

Bangalore, the capital of Mysore State, is connected by air, rail and road with Madras and Trivandrum. The city is situated at an altitude of 914 m. (3,000 ft.) from sea level and enjoys a salubrious climate for the better part of the year. The 16th century fort of Kempe Gowda, rebuilt by Hyder Ali and Tippu Sultan two centuries later, is a tourist attraction. The Botanical Gardens of Lal Bag, the Cubbon Park with its Museum, the Vidhan Soudha are all centres of attraction. The Botanical Gardens extend over several hectares with centuries-old trees, lakes, lotus-filled pools and deer parks and contain a large collection of rare and exotic tropical and sub-tropical plants.

About 61 km. (38 miles) from Bangalore is the Nandi Hill, a popular hill station.

Mysore

A fine road from Bangalore (138 km. / 86 miles) connects it with Mysore, a city of parks and palaces, and the famous Dusserah festival (in October). Nearby is the Chamundi Hill with its ancient temple Chamundeswari, the titular diety of the Mysore royal family, and the Maharaja's summer palace. Half way down the hill by a flight of steps lies the 4.8 m. (16 ft.) - high *Nandi* (bull) carved out of a single stone. Nearly 19 km. (12 miles) from Mysore by road are the famous Brindavan Gardens laid out below a Krishnaraya Sagar Dam. Under artificial illumination this terraced garden with multi-coloured cascades, fountains and flower-beds are an enchanting sight.

About 15 km. (9 miles) from Mysore is the island-town of Srirangapatnam, the old capital of Tippu Sultan.

Sravanabelgola, Belur And Halebid

About 170 km. (100 miles) from Mysore is Sravanabelgola, a Jain pilgrimage centre, with the main atttraction of the gigantic 17 m.- (57 ft -) high monolithic statue of the Jain apostle, Gomateswara carved in 983 A.D.

Nearly 160 km. (99 miles) from Mysore by road is Belur and another 13 km. (8 miles) farther is Halebid. Both are famous for the fabulously carved 12-century temples. For sheer wealth of sculptured details Hoysaleswara Temple at Halebid is unrivalled.

Jog Falls

The Jog falls in the densely wooded, mountanious areas to the West of Mysore is in impressive sight. From the nearest railway station at Talguppa, a half-hour drive takes one to the spot where the Shravati river, mild and graceful up to here, takes a spectacular leap into a chasm 253 m. (830 ft.) deep, in four separate falls. A play of flitting rainbows above the frothy masses of white foam below gives a fairly-land touch to the Jog falls. The beauty of the Jag falls in moonlight is particularly irresistible.

A NOTE OF THANKS

In the publication of this Souvenir the Committee has drawn freely on the good-will and co-operation so willingly extended by so many, and to all of them we offer our thanks - in particular to the authors of the articles for their contributions, to the advertisers for their ready response, to the De Nobili Press for their prompt and neat work and, individually, to Messers. D. M. Punwani, P. R. S. Tampi, K. Alagarswami and K. M. S. Ameer Hamsa for various help at different stages in the publication.

CONVENER,
Souvenir Committee,
Symposium on Corals and
Coral Reefs.

MARINE BIOLOGICAL ASSOCIATION OF INDIA

Symposium on Indian Ocean and Adjacent Seas-
Their Origin, Science and Resources

THE MARINE BIOLOGICAL ASSOCIATION OF INDIA has great pleasure in announcing the Symposium on Indian Ocean and Adjacent Seas-Their Origin, Science and Resources, the fifth in its Symposium Series, scheduled to be held at Cochin (India) during 12-18, 1971

The Indian Ocean, occupying an area of about 75 million square kilometres, which is about one-seventh of the total area of the globe and next only to the Pacific and Atlantic in extent, has paradoxically remained one of the scientifically least explored regions. It has been felt by many that it would be useful at this stage to bring together the accumulated information on various aspects of the Indian Ocean and the adjacent seas and discuss the same at a common forum. To facilitate such a meeting of specialists from different parts of the world with an interest in the Indian Ocean, the Marine Biological Association of India is organising the SYMPOSIUM ON INDIAN OCEAN AND ADJACENT SEAS-THEIR ORIGIN, SCIENCE AND RESOURCES at Cochin (India) during January 12-18, 1971.

It will be appreciated if intending authors could correspond with the secretariat of the Symposium so that invitations for contributions could be sent. Papers of a casual nature and descriptive accounts will not be suitable for the symposium.

Contributions to the Symposium could relate to the following subjects on the Indian Ocean and adjacent seas: Geological History, Geology, Geochemistry, Geophysics, Marine Sediments, Minerals, Biogeography, Pelagic Fauna, Abyssal Fauna, Benthos, Bioacoustics, Radioecology and Marine Radioactivity, Primary Production, Planktology, Oceanography, Marine Meteorology, Fisheries and Resources.

Abstracts of papers, in duplicate, consisting of the main theme of the paper written in about 250 words should reach the convener by July 15, 1970 for consideration. Manuscripts of accepted papers, preferably in duplicate, should reach by November 15, 1970. The paper should not ordinarily exceed 50 printed pages with the exception of Reviews by specialists.

In connection with the symposium it is proposed to organise a FISHERIES AND MARINE SCIENCE EXHIBITION at Cochin (India) with the co-operation of various other organisations to highlight the recent developments in marine exploration, world fisheris and fisheries technology. Along with this an exhibition of scientific books and periodicals relating to aquatic sciences will also be set up.

All correspondence may be addressed to : The Convener, Symposium on Indian Ocean, Marine Biological Association of India, Marine Fisheries P. O., Ramanathapuram District, Madras State, India.