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ALGAL FLORISTICS IN INDIA AND ANDAMANS

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Mr. President, Members of Indian Botanical Society, ladies and gentlemen,

I propose to speak today on Algal Floristics with particular reference to the Andaman and Nicobar Islands an area in which I have lately been interested. Before taking you to Kalapani, perhaps, it will be desirable to give a background of algal floristics in India as a whole and indicate to you how the story of our endeavour in this sub-continent has developed over the years. About 45,000 species of plants are estimated to be occurring in our country. Out of these, nearly 15,000 are vascular plants while twice the number comprise non-vascular plants. I have been interested in the algae for nearly forty years now and still suffer from a feeling of insufficiency with respect to our knowledge of Indian algae. I still feel that our knowledge is inadequate and we do not properly know the algal wealth of our country.

With the growing realisation of the importance of algae as primary producers in the aquatic ecosystem and their role in soil environment and chemistry, it is certain that the contributions made through their metabolites during their life and after death are of immense significance. Therefore, the study of the algal flora has considerable relevance both from the theoretical and practical points of view.

The dawn of studies on Indian algae was heralded in 1768 when John Gerard Koenig, who came to India as a member of Morivian Mission to Tranquebar, South India, collected, studied and described algae. This was followed in the 19th century by a galaxy of famous names e. g. Agardh (1824) Turner (1892), Kuetzing (1949), Ehrenberg (1854) Rabenhörst (1861) etc. During this period, all workers were Europeans except K. R. Kirtikar who was the first Indian phycologist to publish a paper as early as 1886.

During the nineteenth century, a number of expeditions were undertaken for study of the marine algal flora of India. Noteworthy among them were :

1. Galathea Expedition (1845-1847) to the Nicobar Islands.
2. Novara Expedition (1857-1859) to the Nicobar Islands.
3. Preussische Expedition (1859-1863) to several important Indian coasts.
4. Investigator Expedition (1890-1892) to the Bay of Bengal.
5. Valdiviya Expedition (1898-1899) to Nicobar Islands and Bay of Bengal.
6. Siboga Expedition (1890-1910) to Nicobar Islands and some Indian coasts.

The 20th century saw a mighty spurt in the study of algae. During the initial 35 years of this century, we

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mostly had British and European workers e. g. Allen (1925), Prain (1905), Carter (1926) and Groves (1924) to name a few. A European marine algologist Boergesen was invited at Bombay and he collected a lot of algae from Okha, Dwarka, Bombay and the West coast. In fact, he took a boat and traversed large tracts on the Arabian sea shore. Later, he visited Madras at the invitation of M. O. P. Iyengar. Boergesen described the algae collected by him in a series of publications (1929, 1930, 1931, 1932, 1933), and these still constitute an important source of our knowledge of Indian marine algae. During this period, S. L. Ghose was contributing to our knowledge of fresh-water algae from Lahore.

However, during the thirties, a new era dawned and Indian workers came into the lead. Y. Bharadwaja and M. O. P. Iyengar both returned after their Ph. D. degrees taken from London under Professor F. E. Fritsch. Bharadwaja had specialised in Blue-green algae while Iyengar did so in the sphere of Green algae. They established schools of phycological research at Benares (Varanasi) and Madras respectively and their students Ram Nagina Singh and T. V. Desikachary respectively, ably carried the torch onward. Even today, these two places are like Mecca and Madina for phycologists in India. Several other centres of active research came up later but, many of them originated or are academically sustained by one of these two centres. In the early thirties of this century, the Sea Lark Expedition (1932) to Ladakh and John Murray Expedition (1933-1934) to Maldives were notable efforts of interests outside Benares and Madras.

While most of the studies during this period are confined to relatively small geographic areas, they have added up to considerable size, so that we now have an appreciable amount of information. Studies on the basis of habitat are comparatively fewer, although some workers, in the course of their descriptions, have mentioned the habitats. The usual habitatwise grouping of algae for study broadly consists of (i) Fresh-water Forms, (ii) Terrestrial Flora, (iii) High-altitude Algae, (iv) Crop-field Forms, (v) 'Usar'-soil Flora, (vi) Thermal Spring Forms, (vii) Algae of Polluted Systems and (viii) Marine Algae.

Fresh-water Forms :

Excepting the Phaeophyceae, almost all the algal classes are represented in fresh-water habitats of India like rivers, lakes, streams, ponds etc. in our country. Approximately 300 genera comprising of about 4,000 species of algae are recorded from India out of over 1,120 genera and 14,400 species reported from freshwater habitats of the world. Considerable work has been done by Iyengar (1920-1936), Biswas (1926-1940), Bharadwaja (1933-1963), R. N. Singh (1938-1954), Desikachary (1950-1982) and Randhawa (1936a-1959) in recording the algal flora of such habitats. Currently, Patel, Prasad and Sinha are engaged in this work. Although considerable information has accumulated concerning fresh-water algae, there is considerable scope for further exploratory studies.

Terrestrial Forms :

The terrestrial algae are usually classified into several categories e. g. (i) soil flora (ii) aerial epiphytic algae (iii) aerophytes and (iv) aerial epilithic.

Not much work has been done in India on the distribution of terrestrial

species. The chief classes of algae represented as terrestrial forms include members of Cyanophyceae, Bacillariophyceae, Chlorophyceae and Xanthophyceae. Noteworthy Indian contributors to the study of terrestrial algae include Iyengar (1925, 1932a, 1933b), R. N. Singh (1930, 1947), Mitra, (1950, 1951a, 1951b), Pandey (1965), Gupte (1964), Marathe (1966, 1967) and Marathe and Annatani (1972), Vaidya (1965) and Subbaraju (1972).

An interesting feature worth mentioning here is that in the tropical regions of the world, including India, a preponderance of Cyanophyceae over other classes of algae is observed, although, in the temperate regions, the Chlorophyceae or Bacillariophyceae are more richly represented (c. f. Schields and Durell, 1964). The terrestrial algae known so far are represented by 127 genera and 613 species in India.

High Altitude Forms :

Only a few workers (Dutt *et al.*, 1973, 1974, 1976; Suxena and Venkateswarlu, 1968; Suxena *et al.*, 1972) have attempted to study the high altitude algal flora of this country. The chief classes of algae represented in the high altitude flora are the Cyanophyceae and the Bacillariophyceae with a preponderance of Bacillariophyceae.

Crop-field Forms :

Ever since the potential capacity of Cyanophyceae to fix atmospheric nitrogen was established by De (1939) working under Fritsch, many workers e.g. R. N. Singh (1939) were attracted to this aspect of Phycology and started screening crop-field algal taxa, particularly those found in water-logged paddy fields. Gradually, the attention of workers shifted from paddy to other crop fields as well. Mitra (1951a & b) studied the algal flora of some wheat fields and Gonzalves and Yalavigi (1959) studied the algal flora of wheat, cotton and 'jowar' rhizospheres. Dutta and Venkataraman (1958) and R. N. Singh (1950, 1961) also made ecological and taxonomic investigations on algal flora of certain fields. Bharati and Pai (1972b) described some members of Oedogoniales from some brinjal fields of Mysore. Bongale and Bharati (1980) described the algal flora of paddy, sugarcane, 'Jwar' and cotton fields.

Prasad and Mehrotra (1977a-e) and Prasad, Mehrotra and Singh (1976) have described over 300 taxa, including fifty-four new taxa belonging to groups Cyanophyceae and Desmidiaceae from sixteen different types of crop-fields of Northern India.

'Usar' Soil Forms :

Singh (1950) emphasized the role of algae in the reclamation of large tracts of saline or alkaline-'Usar'-lands in India. Prasad and Srivastava (1968) have enumerated forty-six taxa of Blue-green algae from 'Usar' soils only. No further significant attempt seems to have been made to study the algal flora of alkaline or saline soils.

Thermal Spring Forms :

The algal flora of thermal springs and its evolutionary significance triggered a chain of investigations on such forms. The noteworthy contributions in this field are by Gonzalves (1947), Money and John (1963), Prasad and Srivastava (1965) on Himalayan hot-springs, Thomas and Gonzalves (1965a-g), Vasishta (1968), and Patel (1974). Most of the above workers recorded

only Cyanophyceae but Thomas and Gonzalves (1965a-g) have given an account of the diatoms of such habitats also.

Algae of Polluted Waters :

Lately, the study of algae in relation to pollution has attracted attention of workers in various parts of the country. Since this is an applied aspect, I shall not go into detail but it deserves to be mentioned that algae have been investigated as Biological Indices or Markers of the degree of pollution. Groups of species have been identified as being tolerant to various degrees of pollution. This aspect has been reviewed by Prasad and Singh (1980, 1981) in some detail elsewhere.

Marine Forms :

Marine members belonging to most classes of algae are known from India, predominant among them being the Phaeophyceae and Rhodophyceae. The long coast-line of India harbours a rich flora of tropical marine forms. Approximately 318 genera and 1,222 species are recorded from Indian waters as compared to a total of 1,368 genera and 10,350 species from oceans of the world. The important Indian contributions to marine Phycology are by Sreenivasan (1966), Rao and Sreeramulu (1970), Gopalakrishnan (1969, 1972), Misra (1966), Thivy and Chauhan (1963), Thivy and Visalalakshimi (1963), Subrahmanyan (1946, 1971), Ganesan (1963, 1965), Krishnamurthy (1966) and Krishnamurthy and Thomas (1977). Besides these, Marathe (1965) and some other workers studied the algal flora of mangrove soils.

Taking an overall view, we find that, out of a world total of 2,475 genera and 28,305 species of algae, 666 genera and 5,136 species are represented in India. This amounts to a proportion of 28.3 per cent of global generic representation and 18.1 per cent of world species. Thus, a greater variety in the flora is found at the generic level than at the level of species in India. If the proportion of representation of different classes of algae at the generic level in India is compared with that in the world, we find that the groups Cyanophyceae, Dinophyceae, Chlorophyceae and Bacillariophyceae are better represented in India as they constitute greater percentages of the total algal flora here than in the world as a whole. On the other hand, the groups Xanthophyceae, Chrysophyceae, Rhodophyceae and Phaeophyceae are distinctly poorer in the Indian flora. The causes for such disparity must be many and may be difficult to decipher. One of the reasons may be the inadequacy of our exploration. The greater representation of Cyanophyceae and Chlorophyceae may be simply due to Bharadwaja and Iyengar having given a boost to the study of these groups. Conversely, the lower representation of Rhodophyceae and Phaeophyceae may be due to the fact that the climate in temperate and arctic regions is more favourable for many members of these groups, where they find greater scope for development and diversification. Or else, plants belonging to these two groups still sit and await the attention of phycologists in India.

Coming to the level of species, on comparing the world flora with the Indian flora, we again find that the Green algae (Chlorophyceae), Blue-green algae (Cyanophyceae), Diatoms (Bacillariophyceae) and Dinophyceae show a better ratio of representation in the Indian flora than in the world. The

groups Rhodophyceae (Red algae), Phaophyceae or Brown algae, Chrysophyta and Xanthophyta, on the other hand, exhibit a poorer representation. The causes for these disparities are again difficult to elucidate. Thus, the representation of different groups of algae in India shows a similar pattern at the generic and specific levels.

Let us now move to the Andaman and Nicobar Islands. Island floras have a fascination of their own-especially from the days of Charles Darwin. It is interesting to look into the relation of island communities with those of the nearest mainlands. Darwin was impressed by the difficulty that some organisms had in reaching oceanic islands and by the fact that inhabitants of islands are related to but frequently are different from, those of the nearest continent. It was clear to him, as it is to us, that the endemic species on an oceanic island mostly come from the nearest continent and then evolved their pecularities on the island. The other aspect of islands that impressed Darwin was the difficulty in dispersal and he ascribed the smaller number of species entitites on islands to this factor. In his view, the biota on islands are impoverished because of lack of equilibrium. The Species-Area effect of Williamson (1981) concerns this aspect also. The importance of isolation for speciation is now realised although Darwin was not quite convinced that this was a general rule. Genetic isolation of mendelian populations often lies at the root of speciation and genetic isolation is well-known to have arisen commonly by geographical isolation. It is now considered by some that isolation leads to speciation. The communities are insulated from interactions and influences, from those on the mainlands, resulting in an altered and different level of competition and survival conditions. This, coupled with the varied ecological conditions, pushes the environment of the biota to a different equilibrium plateau which acts as an influence, often compelling, towards a shift in the characters of species. This, naturally, often results in independent lines of evolution which may remain in the isolated confines of the islands. This is the essence of endemism.

Our information regarding the floras and faunas of small tropical islands round the globe is meagre at present. This is glaringly true for the Andaman and Nicobar group of islands. When I initially toyed, 7 years ago, with the idea of studying the algal flora of these islands, I was amazed to find that not a single algal species had been recorded from their freshwaters. It came both as a challenge and an opportunity at the same time and I decided to study the fresh-water algal flora there.

The Andamans and Nicobars are a dual group of islands comprising 323 islands covering a total area of 8,293 sq. kms. They sprawl in the Bay of Bengal in a North-South direction separated by 1,176 kms. from the Coromandal Coast of India and 515 kms. from the coast of Burma. The island of Sumatra in Indonesia is only about 200 kms. from the southernmost island in the Nicobar group. The Andamans are believed to be continental fragments of the ancient Gondwanaland while the Nicobars are of volcanic origin. The administrative headquarters of these islands is Port Blair which has some features of civilization. Due to its distance from India, it was used by the British for keeping murderers and dangerous political prisoners in isolation. Out of this fear complex, it was known as 'Kala Pani' or 'Black Waters', although otherwise, the

islands are known as the 'Land of the Yellow Sun'. Sitting close to the busy sea-lanes of South Asia, these islands have been in contact with the adjoining continental coasts for thousands of years. Thus, there has been movement of smaller animals and plants—especially microorganisms like the algae—since the dawn of maritime civilization.

There are several endemic human tribes like the Jarawas and the Great Andamanese on some islands. The Jarawas are dangerous and have killed parties of men straying into their dense forests. A large number of islands have no human beings on them. There are no large carnivorous mammals. The islands support dense tropical rain-forests. In order to reach the algae in the interior recesses of the forests, one has to contend with snakes, lizards, millipedes and centipedes, scorpions, leeches and insects of innumerable kinds. It is their domain. Roads and lines of communication are few. Safe drinking water is hard to find. Going into interior or to remote places can be dangerous. But, it is thrilling and is also great fun.

Our study on this area was spread over 5 years and we concentrated on only three groups of fresh-water algae : the Chlorophyceae or Green lagae, the Cyanophyceae or Blue-green algae and the Bacillariophyceae or Diatoms. A few members of Xanthophyceae were also collected. My two students, Pradeep Kumar Misra and Mahendra Nath Srivastava were closely associated with me in the course of this study.

On tabulating the number of taxa belonging to each of the three groups that were collected, we find that 15 Greens, and 7 Diatoms were new to science while as many as 104 constituted new records for the Indian flora.

Thus, we may say tht 22 taxa of fresh-water algae were found endemic to these islands. It is interesting to note that exactly ten times i. e. 220 species of vascular plants are, so far, known to be endemic to Andaman and Nicobar islalands.

Now, if we cast a glance at the proportion of representation of algae at generic level in Andaman-Nicobar area to that of the Indian mainland, we find that only 20% of the Green algae or Chlorophyceae, about 27% of the Blue-green algae or Cyanophyceae and 55% of Diatoms or Bacillariophyceae found in India are also found in the fresh-waters of Andaman-Nicobar islands. Considering the small size and the total area of the islands, this constitutes very good representation.

At the level of species, we find on comparison that only about 12% of the Green algae, 29% of Diatoms and approximately 16% of the Blue-green algae out of the total representation of these groups in India are found in the Andaman-Nicobar area. It is obvious from these comparisons that the algae are more successful in colonising these islands at the generic level than at the specific level. Why should it be so, is a matter for future work to decide when our knowledge grows a good deal more. But, it must be commented that the feature is of great interest because the differences are quite pronounced and significant. I am not in a position to offer any explanations for it. It defies elucidation at the present state of our knowledge.

Proportion of Andaman : S-E Asian Genera & Species :

While we have considered the affinity and the algal floristic picture of Andaman-Nicobar area with that of Indian mainland, we must not lose sight of the

fact that these islands are geographically much closer to some South-East Asian countries e. g. Burma, Indonesia and Malaysia. Since it is believed that contiguity of land existed between these islands and these regions in the remote geological past, it is natural to expect some similarity in their floras. Further, such a comparison may shed light on aspects of plant geography as well as plant migration from the mainland regions to the islands and, may be, in the reverse direction also. The comparison may also help in throwing light on the degree of isolation of the flora and the extent of endemism.

We find that about 25% of Andaman Green algal genera are common to South-East Asian countries. Similarly, about 31% of Blue-green algae and 44% of Diatoms of the Andaman area are represented in South-East Asian countries at the generic level. At the specific level, only about 14% of Green algae (Chlorophyceae), 40% of Blue-greens and 23% of Diatoms are common to both regions. It will be seen that except the Cyanophyceae, the other two groups show a higher expression and greater representation at the generic level than at the specific level in the Andaman flora. Why should this be so and why should the Cyanophyceae be an exception, are again mute questions. However, I must say here that these conclusions may be considered preliminary and tentative to some extent because, firstly, I think the algal floras of Burma, Malaysia and Indonesia have not been exhaustively studied so far and many many more taxa will be added in future. Secondly, it is entirely possible that I may not have been able to reach certain references.

Finally, if we compare the ratio of representation of fresh-water algae between India and Andamans on the one hand and Andamans and South-East Asia on the other, we find that more taxa of the Green algae on Andamans are common with India. Similarly, more of Diatoms and Blue-green algae are common with India as compared to the South-East Asian regions.

The overall picture that emerges, therefore, clearly shows that, in spite of geographical proximity with South-East Asia, the fresh-water algal flora of Andaman-Nicobar area shows a distinct closeness to the Indian flora than to that of other S-E Asian regions. It may, perhaps, be accounted for by the greater contact and communication with India in the course of our long history.

THANK YOU.

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