

A HISTORICAL RESUMÉ OF INDIAN LIMNOLOGY

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Abstract

A broad categorisation of Indian freshwater investigations published so far is presented. The lacunae are pointed out. Problems and priorities for further limnological researches in the context of India's limited water resources are high-lighted.

Studies on Indian freshwaters extend back to the latter half of last century and were in the nature of presenting species lists and descriptions of taxa new to the then Indian sub-continent (Carter, 1855; Baird, 1859, 1860; Sars, 1887, 1900; Anderson, 1889; Alcock, 1897; Gurney, 1906, 1907, 1925a, b, 1930; Bhatia, 1930, 1936; Arora, 1931; Prasad, 1916; Bond, 1934; Edmondson and Hutchinson, 1934; Brehm, 1936, 1950, 1953, 1963; Brehm & Woltereck, 1939; Hauer, 1936, 1937a, b; Kiefer, 1936, 1939). For purposes of brevity the references on algae and nekton are excluded from this review, although some of the significant Monographs on algae are those of Desikachary (1959) on Cyanophyta, Philipose (1967) on Chlorococcales, Venkataraman (1961) on Vaucheriaceae and of Ramanathan (1964) on Ulotrichiales containing extensive bibliographies on the subject.

After a lapse of nearly three decades there had been quite a resurgence of interest, mostly among Indian workers, on different freshwater organisms, particularly on the zooplankton. These were on Protozoa (Naidu, 1962, 1965a, b; 1966), on rotifers (Donner, 1949; George, 1961a; Pasha, 1961; Arora, 1962, 1963a, b, 1965, 1966a; Nayar, 1965, 1968; Nayar & Nayyar, 1969, 1971; Michael, 1966a, 1973; Naidu, 1967; Wycliffe & Michael, 1968; Wulfert, 1966; Vasisht and Gupta, 1967; Vasisht & Dawar, 1968; Vasisht & Bhattish, 1969, 1970, 1971a, b, c, d; Rajendran, 1971; Dhanapathi, 1973, 1974a, b, 1975a, b, 1976a, b, c, 1978; Das and Akhtar, 1976; Sharma, 1976a, b, 1977, 1978a, b, c, 1979a, b, c, d, e; Sharma & Michael, 1979; Laal & Nasar, 1977; Tiwari & Sharma, 1977; Patil, 1978), on copepods (Seghal, 1960, 1967; Reddiah, 1964a,

b, 1965; Rajendran, 1971a, 1973; Radhakrishna & Reddy, 1977a, 1977b), on cladocerans (Biswas, 1964a, b, 1965, 1971; Nayar, 1971; Michael, 1973; Das & Akhtar, 1970; Patil, 1976; Nasar, 1977; Qadri & Yousuf, 1977; Sharma, 1978; Michael & Sharma, 1979), on ostracods (Bhatia & Singh, 1970; Bhatia, 1971; Deb, 1972, 1973; Victor, 1973, 1976; Victor & Michael, 1975; Victor & Fernando, 1976, 1979; Michael & Victor, 1975; Bhattish, 1977, 1978; Nasar, 1977a; Deb & Nasar, 1977) and other branchiopods (Tiwari, 1951, 1952, 1958, 1959, 1965, 1971; Raj, 1951, 1961; Quadri & Baqai, 1956; Karande and Inamdar, 1960; Nayar, 1965, 1968; Isaac, 1970; Malhotra & Duda, 1970; Royan & Alfred, 1971; Royan, 1972; Radhakrishna & Durga Prasad, 1975, 1976a, b). Based on a decade of taxonomic and ecological studies on the freshwater organisms of the Southeastern peninsular India, a preliminary guide to the study of the freshwater organisms was attempted (Michael, 1973).

It may be pointed out that in spite of the works enumerated above, still many groups need to be tackled taxonomically. Non availability of extensive taxonomic treatises for zooplankton, weed and benthic fauna acts as a deterrent and many a junior worker has 'fallen by the wayside'. In these days of instrumental sophistication, less and less of younger workers are attracted towards taxonomic work, but increasing application of computerised numerical methods, enzyme electrophoresis and SEM in taxonomic studies should be a challenge to many investigators in the field.

The primary attempts on the seasonality of Indian freshwater plankton were that of Sewell (1934) on the fauna of the tank (pond) in the Indian Museum Compound, Calcutta. Earlier, Pruthi (1933) described the seasonal changes of the physical and chemical characteristics of the water in the same system. Following this, there were a long series of hydrobiological studies of freshwater impoundments mostly on ponds and reservoirs, in different parts of the country. Many of these were initiated to obtain baseline information of plankton and

water chemistry to be of use in fishery practices since it was pointed out that such a gap proved to be a serious handicap to Indian fishery workers (Hora, 1951; Job, 1951).

It was around this time that many general limnological surveys and studies of somewhat regional nature were published from various parts of the country. Of these, many were from central and Northern regions (Das, 1957, 1961, 1966, 1970; Das & Srivastava, 1956, 1959; Das *et al.*, 1969, 1970; George, 1961a, 1966a; Verma, 1964; Krishnamoorthi & Visweswara, 1965; Khan & Qayyum, 1966; Vasisht, 1968; Vasisht & Dhir, 1970; Vasisht & Sharma, 1975; Vyas & Kumar, 1968; Sahai & Sinha, 1969; Khan *et al.*, 1970; Unni, 1971, 1972; Tandon & Singh, 1972; Saxena & Adoni, 1973; Zutshi & Vaas, 1973; Zutshi & Khan, 1977; Grover *et al.*, 1978; Vaas & Zutshi, 1978; Swarup & Singh, 1979; Qadri & Yousuf, 1979; Yousuf, 1979; Mishra & Yadav, 1978), some from southern India (Ganapati, 1940, 1941, 1943, 1949, 1950, 1955, 1957a, b, 1960, 1962, 1964; Ganapati & Chacko, 1951; Chacko & Krishnamurthy, 1954; Zafar, 1959, 1964, 1966; Jayangondar, 1964; Subbarao & Govind, 1964; Sreenivasan, 1964a, b, 1965, 1968, 1969, 1970, 1971, 1974, 1976; Sreenivasan *et al.*, 1964; Sitaramaiah, 1966; Hussainy, 1965a, 1967; Sumitra, 1969; Munawar, 1970; Rao, 1971; Seenayya, 1971), while the rest are from Eastern (Mookerjee & Bhattacharya, 1949; Michael, 1965, 1969; Moitra & Bhattacharya, 1965; Moitra & Mukherji, 1972; Saha *et al.*, 1971; Nasar & Munshi, 1974, 1975; Jana, 1973a, 1974; Sircar & Sen, 1975; Bohra *et al.*, 1978; Chowdhury *et al.*, 1979) and Western India (Patil, 1977). A good number of such investigations are also published by fishery workers in this country and are available in various fishery journals.

Apart from the above general works, there have been specific studies on zooplanktonic organisms as to their ecology (Karande & Inamdar, 1961; George, 1966a; Bernice, 1970, 1971a, 1972a; Nayar, 1970; Moitra & Bhowmick, 1968; Sumitra, 1970; Michael, 1968; Seenayya, 1973; Prabhavathy & Sreenivasan, 1977; Nasar, 1977b), life cycle (Michael, 1962; Navaneethakrishnan & Michael, 1971; Murugan & Sivaramakrishnan, 1973, 1976; Murugan, 1975a, b; Murugan & Venkataraman, 1977), cyclo-morphosis (Nayar, 1964, 1965; Arora, 1966b; George, 1966b; Sharma, 1976), feeding relationships (Kader & Krishnaswamy, 1975; Arumugaswamy *et al.*, 1971; Kader *et al.*, 1976; Royan, 1976), diurnal variations (George, 1961b; Krishnamoorthi & Visweswara, 1965; Michael, 1966; Verma, 1967; Verma & Gupta, 1974; Sumitra, 1967,

1971; Khan *et al.*, 1970; Singh, 1972; Jana, 1974; Saksena & Adoni, 1973) and on biochemical aspects (Srinivasagam & Michael, 1966; Bernice & Srinivasagam, 1967; Michael & Chandran, 1967; Bernice, 1971b, 1972b; Khan & Siddique, 1971a, b).

In the past years some interest had been shown on the general ecology of aquatic insects (Tonapi, 1959; Tonapi & Ozarkar, 1969; Julka, 1965, 1969, 1973, 1977; Alfred, 1974; Swamy & Rao, 1974; Rao, 1976; Tagore *et al.*, 1974; Tagore, 1977; Sen, 1979). Vazirani (1955, 1966, 1970, 1974) had done considerable taxonomic work on aquatic beetles. Nevertheless, the taxonomic hurdles associated with the larva-pupa-adult links are serious bottlenecks for a thorough study of various orders of aquatic insects. However, pioneering attempts in this direction are being made to correlate larval and adult taxonomy along with detailed ecological studies. In this context two significant works, one on family Chironomidae (Alfred, 1973) and the other on Ephemeroptera (Gupta, 1979) are worth mentioning. The larval taxonomic works on Indian Odonata by Kumar (1972, 1973a, b) are valuable. Studies on the role of aquatic insects in relation to fish culture are carried out at this laboratory (Ahmed, 1979). Many more systematic and long term investigations for different geographic regions of this country are very much needed.

General works on the weed fauna (Michael, 1968a) and benthos (Srivastava, 1956, 1959; Hussainy, 1965b; Michael, 1968b; Mandal & Moitra, 1975; Gupta, 1979) are still very limited.

In recent years few studies on aquatic macrophytes and their production were conducted (Kaul, 1971; Unni, 1971a, 1976; Nasar & Datta Munshi, 1971; Rai & Munshi, 1979). A comparative account of soil-water relationship in three tropical ponds was described by Sumitra (1973). A set of interesting papers on Indian thermal springs were published recently (Jana, 1970, 1973b; Jana & Sarkar, 1971a, b; 1972; 1978).

Among functional aspects pertaining to Indian freshwaters, primary productivity and energy flow studies are the two largely attempted areas of research and are based on the well known dark and light bottle technique and theoretical computations respectively (Sreenivasan, 1963, 1964, 1965, 1966, 1968, 1976; Hussainy, 1967; Karunakaran *et al.*, 1970; Ganapati & Sreenivasan, 1970; Kaul, 1971; Khan & Siddiqui, 1971; Sumitra, 1971b; Nasar & Munshi, 1975a; Michael & Anselm, 1978; Haniffa & Pandian, 1978). Khan and Zutshi (1979) had recently reported on the primary production of lower Siwalik lakes using ¹⁴C-technique.

It is now well known that there is an increasing interest on the dynamics of the extracellular release of dissolved organic matter (DOM) by the phytoplankton in marine and freshwater environments. Such studies are still lacking in tropical waters as pointed out by Fogg (1971). The dissolved carbohydrate (DCHO) levels and their diurnal cycles had been studied in a few South Indian ponds (Sumitra *et al.*, 1969; Radha *et al.*, 1975). The kinetics of carbon synthesis, extracellular release of carbon and microbial carbon assimilation were reported in three South Indian ponds (Saunders *et al.*, 1975). The results when compared with similar studies made in North temperate lakes showed certain fundamental similarities between temperate and tropical water bodies.

Other current research areas in limnology such as prey-predator relationships, water-sediment dynamics, role of dissolved organics and microbial limnology are yet to be taken up in the Indian context. On the applied side, composite culture of six or more carp species (*Catla catla*, *Labeo rohita*, *Cirrhina mrigala*, *Cyprinus carpio*, *Hypophthalmichthys molitrix* and *Ctenopharyngodon idella*) in Indian fish ponds with supplementary feeding using rice bran and oil cake is a very common practice. This approach minimises or even eliminates the importance of natural plankton cycles in these systems. Understanding the plankton dynamics with reference to trophic relationships of the fish community in such systems will be of interest.

Chaturvedi (1976) points out that the dynamics of India's population growth is such that it will double within the next thirty to fifty years. It means that a Second India will be added to that now exists around 2000 A.D. The multipurpose use of water for rapid industrial growth, reservoir development, agriculture and aquaculture are real needs. Further, one has to place these demands in relation to inputs of natural organic wastes from human use which increasingly eutrophicate our limited freshwaters. What the impacts are on the fauna and flora are questions which need to be answered. Unlike in other tropical countries like Africa, India is not endowed with many natural lakes especially at the peninsular latitudes. Even the pristine Kashmir lakes are under heavy human pressure. There is much demand for large water resources for fish culture as India is all set for an aquaplosion in inland fish culture. The study of available water resources and judicious management of the same offers newer challenges, in contrast to conventional limnological approach hitherto applied to our freshwaters.

These problems are briefly highlighted so that Indian

limnologists take cognizance of the priorities to be set in the light of our country's practical demands on one hand and the pure academic pursuits of exploring and understanding the structure and dynamics of aquatic systems on the other.

Freshwater biologists from developing countries are faced with this dilemma, whether their time and energy should be directed to measure and maximise productive efficiencies for aquaculture and meet the protein dearth of their people, or to indulge in characterising the molecular size fractions of the DOM and their limnological implications. Even developed countries are not altogether free from problems, though they are of different dimensions.

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