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FISH PRODUCTIVITY IN LAKE NAINITAL

M. C. PANT, P. C. SHARMA AND A. P. SHARMA
Department of Zoology, Kumaun University,
Nainital 263 002, India.

THE fish potential depends much on the efficiency with which the energy is trapped, accumulated and dissipated at the different trophic levels in aquatic systems. The intense cultural activities in the drainage basin of Lake Nainital has converted it into a eutrophic[1] and polluted[2] water body. Consequently, the fish population is on the decline[3] and on occasions, massive fish mortality[4] is noted.

The present study was carried out from July 1977 to to June 1979. The physical and chemical parameters were analysed according to APHA[5]. Phytoplankters were filtered from water samples through Whatman 44 filter paper and were counted in a Haemocytometer. Zooplankters were collected by vertical net hauls and counted in a Sedgwick Rafter Cell. Phytoplankton primary production was measured by the light and dark bottle technique. The methodology is described by Sharma[6] and Gupta[7].

The plankton food web is remarkably short in this system (figure.1). This is attributable to the stressed environmental conditions. The blue-greens alone contribute 35.4% to the total annual mean phytoplankton biomass. The blue-greens *viz. Microcystis* and *Anabaena* being unpalatable are not consumed by the important fish species *Schizothorax, Tor, Cyprinus carpio* and *Punctius* of the lake. Of the three important second trophic level components, a calanoid copepod, *Phyllodiaptomus blanci.* alone accounts for over 60% of the total zooplankton standing crop (biomass) and remains confined to aphotic zone during the day. The other members feed a little upon blue-greens and mainly subsist on other phytoplankters.

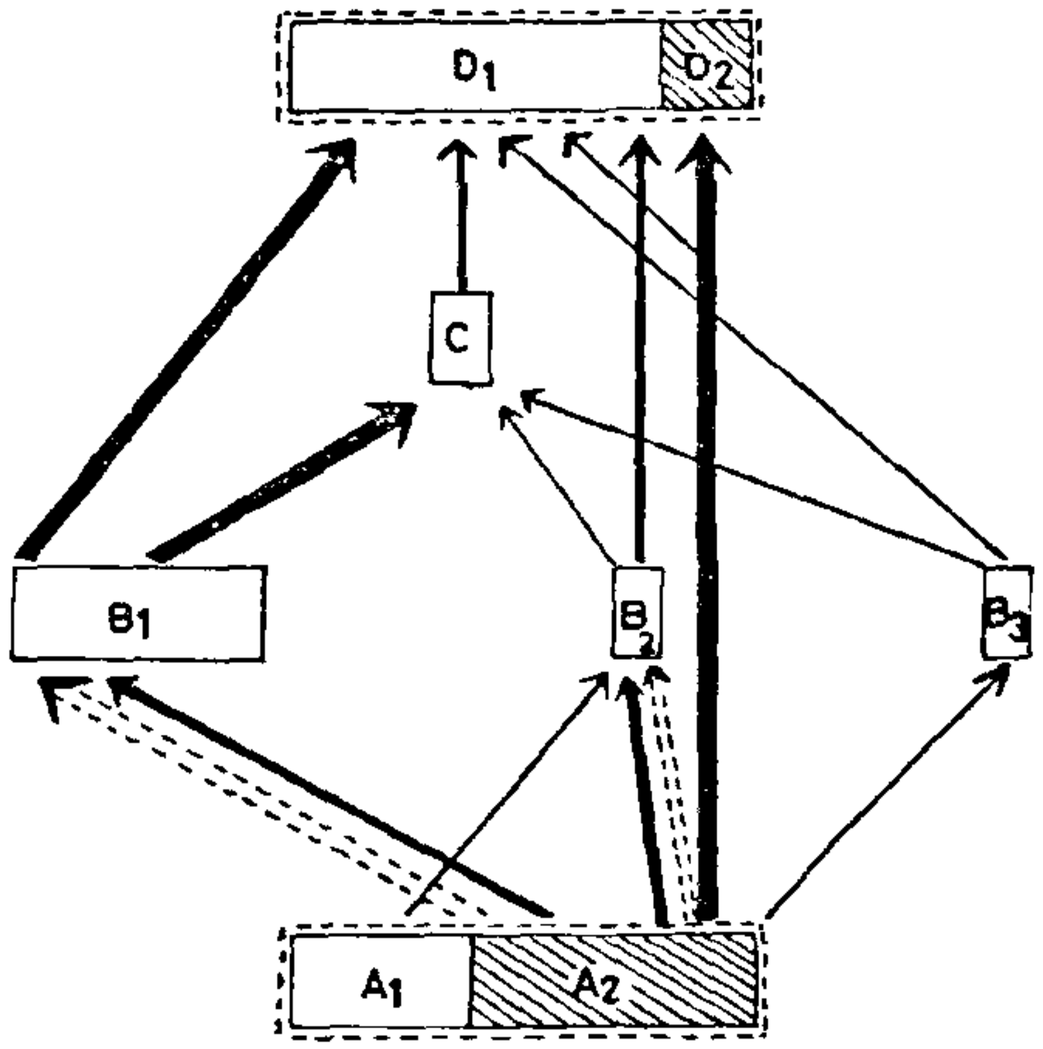

Figure 1. Basic diagram of plankton food-web in Naintal Lake. Arrows of different sizes indicate relative proportions of food taken by heterotrophic organisms. Unbroken and broken lines show biophagy and saprophagy modes of feeding. Boxes of varying sizes indicate percentage biomass of different components. Abbreviations used: A_1 = blue greens, A_2 = phytoplankton (except blue-greens) B_1 = *Phyllodiaptomus blanci* (adults + juveniles), B_2 = rotifers, B_3 = *Eucylops serrulatus* (adults + juveniles), C = *Mesocyclops leuckarti* (adults + juveniles), D_1 = Omnivorous fish, D_2 = Herbivorous fish.

Meso cyclops leuckarti represents the sole carnivore (third trophic level), feeding mainly upon rotifers and juveniles of other crustaceans. Thus, it occupies a pivotal position in the basic food web of the lake.

The annual gross primary production in the lake is 630.5 g Cm^{-2}. Since *P. blanci* and a few rotifers are mainly saprophagous, the phytplankton community seems to be little utilized by the biophagous zooplankters. It implies therefore that a larger fraction of energy fixed by autotrophs is not used by grazers (both fish and zooplankton) and passes on to the bottom sediments, resulting in the accumulation of organic matter (ditritus) particularly in the profundal zone where the macrobenthic invertebrate fauna is absent[7]. This ditritus remains undisturbed and undergoes partial biodegradation under anaerobic conditions. Consequently toxic substances, such as NH_3, H_2S etc., are produced and the fish mortality occurs from time to time, particularly during winter.

The high values of community respiration (807.5 g $Cm^{-2}yr^{-1}$) in euphotic zone can only be accounted for

by bacteria, since the dominant heterotroph *P. blanci* does not remain in this zone. Pant *et al*[2] found a high load of coliform bacteria in this system. Given that only a fraction of NPP is available for the herbivores, they appear to have adapted themselves to feed upon ditritus. Thus, detritus forms the major food source to macrobenthos and a supplementary one to zooplankton.

Exclusively, carp fish are found in the lake and among them the important food fish are: *Schizothorax, Tor* and *Cyprinus carpio*. The first one is a herbivore whereas the latter two are omnivores. Since the profundal zone is uninhabitable due to pollution, toxic gases and anoxic conditions[7], these fish remain more or less confined to the epilimnetic waters. Omnivorous fish feed on a variety of food items. However, the utilization of the food depends upon the relative abundance of the developing stages both of these fish and their prey species. Since most of the energy in the plankton component is dissipated through decomposer chains, very little is available to sustain the biomass of fish. It is therefore believed that the lake Nainital has lost the potential to increase the productivity of indigenous (carps) fish.

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LESION-PRODUCING NEMATODES OF *MUSA PARADISIACA*—HISTOPATHOLOGY AND ABUNDANCE

S. SUDHA AND N. R. PRABHOO
Department of Zoology, University of Kerala, Kariavattom 695 581, India.

PLANT parasitic nematodes are considered[1] as the most important non-insect pests that hamper agriculture production in India. Cultivars of the banana plant, *Musa paradisiaca* in Kerala have been known[2] to be attacked by eight species of root-infesting nematodes, *viz. Radopholus similis, Helicotylenchus multicinctus, Helicotylenchus crenacauda, Rotylenchulus reniformis, Dolichodorus microannulatus, Xiphinema elongatum, Longidorus saginus* and *Meloidogyne incognita*. The first seven species contributed to necrosis and consequent lesioning of roots to a greater or lesser extent. Earlier studies on these nematodes carried out in this state reported their occurrence[2,3] and estimated their population[4,5]. The present study was to obtain information on the histological changes in roots of *M.paradisiaca* (cultivar 'palayamthodan') infested by these nematodes and to estimate their population under different intensities of necrotic lesioning.

To study the histopathology of the infected roots, hand sections of fresh roots fixed in FAA (40% formalin 6.5 ml, glacial acetic acid 2.5 ml, 50% ethanol 100ml) were taken, stained with appropriate animal stains (0.1% acid fuchsin lactophenol) or plant stains (0.5% aqueous safranin) and examined. The weighed samples of the infected roots in sufficient quantities of water were mechanically macerated in a waring blendor and nematodes isolated from the macerated tissue by the seive method[6] utilising their natural motility and then identified to species level.

Reddish brown lesions were reported[5,7] on roots infested by the nematodes. When lesioned roots were examined, cell necrosis was localized in the epidermis and peripheral cortical region only (figure 1). Nematodes were located both intercellularly and intracellularly (figures 3 and 4) in the cortex. Intracellular location was not reported in *M. ornata*[6], but in the present study, this was more frequently observed (figures 4,5 and 6). Nematodes apparently ingested the cytoplasmic contents of the cell, the cell wall ruptured and an irregular cavity formed in place of the cell