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THE ROLE OF INVERTEBRATE ORGANISMS IN THE FISHERY POTENTIAL OF LAKE VICTORIA

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INTRODUCTION

Invertebrate organisms play a vital role in aquatic food chains. The activities of many invertebrates influence the release and cycling of nutrient materials that would otherwise remain locked up in bottom sediments. The nutrients, in turn, influence primary productivity, which forms the base of food chains and energy cycles.

The different organisms in an ecosystem are inseparably inter-related and interact with each other. Most of such relationships are dominated by feeding interactions. Many invertebrates are primary consumers grazing on algae, macrophytes and epiphytic materials; thereby converting plant material into animal protein for use by other organisms including fish. In Lake Victoria and, elsewhere the tremendous importance of invertebrate organisms rests largely upon their indispensable position in food webs and energy relations. The majority of fishes go through an early growth stage in which various invertebrates form a major component of their diet. Some fish species such as *Rastrineobola argentea* depend entirely on a diet of invertebrates throughout life (Wandera 1988). Others, like *Lates niloticus* which become piscivorous when adult remain fishes which usually feed upon the invertebrate community. The well-known phytoplanktivorous Nile tilapia, *Oreochromis niloticus* has been observed to incorporate in its diet, a variety of invertebrate food items (Balirwa, 1989).

In Lake Victoria and other tropical inland water bodies, the study of secondary production has lagged behind other aquatic studies mainly because of inadequate research funding. Lack of basic scientific knowledge of such a major ecosystem component has greatly limited the understanding and management capacity of a vital regional fishery resource. This paper reviews the major roles played by various invertebrate organisms in the functioning of aquatic systems and the contribution of secondary production studies to fishery production assessment and management.

Conversion of plant material into animal protein

The primary production of Lake Victoria is based largely on three groups of phytoplankton namely Chlorophyceae, Cyanophyceae and Bacillariophyceae. A small but significant proportion of the primary production comes from rooted macrophytes in the littoral and sub-littoral zones of the lake. Many members of the invertebrate community which constitute most of the secondary production are phytoplanktivorous. These include insect larvae, cladocera, copepods, gastropods, and bivalves. These invertebrates play a vital role in the conversion of green plant material into animal protein for use by other organisms including various fish species which depend on invertebrates as a food base.

Invertebrates as food for fish

Studies on the food and feeding habits of fishes have demonstrated the vital position of various categories of invertebrate organisms as a source of food to many fishes (Graham 1929, Corbet 1961, Greenwood 1966, Hamblyn, 1966, Hopson 1972, Okedi 1971, Mwebaza-Ndawula 1984). Prominent invertebrate categories which serve a food base for fishes include insects (larvae/pupae, nymphs and adults), zooplankton (mainly crustaceae), molluscs and prawns (*Caridina niloticus*). Corbet (1961) has reported that insects provide the most important food source of non-cichlid fishes in Lake Victoria basin, and has stressed that there are hardly any fish species that does not include insects in their
diet. In many fishes, insects and other invertebrates provide virtually the entire food. Lowe-McConnell (1975) has concluded that insects are the most widespread of the invertebrate food organisms of fish and require the least specialisation of these predators' feeding habits. Greenwood (1966) has shown that crustacean zooplankton, particularly copepods and cladocerans are a common feature of the diet of fishes.

The majority of fishes pass through an early growth stage, during which various invertebrate organisms are ingested. The young Nile perch in Lake Victoria and elsewhere has been reported to utilize a diet dominated by invertebrates (Ogutu-Ohwayo 1984, Ogari 1984, Hopson 1972). The adult Nile perch is mainly a piscivorous feeder and in Lake Victoria is reported to ingest substantial quantities of the zooplanktivorous Cyprinid, *Rastrineobola argentea*. The decapod prawn, *Caridina nilotica* has in recent years been reported to assume great prominence in the diet of both young and adult Nile perch in Lake Victoria (Ogutu-Ohwayo op. cit., Ogari, op. cit, Goudswaard and Witte 1984). Holden (1967) reported that in Lake Albert, *C. nilotica* was the chief prey of *Lates macrophthalamus* in the offshore waters. At certain times of the year, when *C. nilotica* apparently form dense aggregations, whole stomachs of Nile perch of different sizes have been found to be engorged with *C. nilotica*, with little or nothing else (Ogutu-Ohwayo, pers. comm.).

**Invertebrates as promoters of primary production**

The physical and chemical nature of the aquatic environment is constantly influenced by activities of organisms which return new compounds and energy sources. In Lake Victoria, the role of detritus feeding organisms including various zooplankton species, benthos and the prawn, *Caridina nilotica* is of particular importance in the regeneration of soluble nutrients from the bottom sediments. Release of nutrients and their subsequent recycling in the water is a major factor influencing primary productivity which form the base of aquatic food chains and energy cycles. Fryer (1960) observed that by collecting detrital food particles from submerged plants *C. nilotica* promote photosynthetic production of those plants through exposure of their leaf surface to light.

Molluscs play a valuable part in the biological balance of aquatic habitats. They digest plant material which is indigestible by most other animals and therefore contribute to the fertility of the water (Beauchamp, 1953). The feaces of molluscs have been reported to be an important and highly nutritive source of food for many animals including young fish (EAFFRO, 1954/55).

Shortage of sulphate nutrients constitutes a primary chemical deficiency in many African lakes. Stainton (pers. comm) has recorded strikingly low levels of sulphate in sediment samples from Lake Victoria. Molluscs are however reported to secrete sulphuric acid in their digestive process (Fish. 1955) and add this essential nutrient to the water, thus promoting primary productivity.

**Invertebrate studies, fishery production and management**

A wide variety of invertebrate organisms have formed a distinctive feature of the food webs in Lake Victoria during both the pre — and post — Nile perch eras. Before the establishment of the Nile perch, Lake Victoria supported a multi-species fishery comprising some 300 species, dominated by the Cichlid haplochromine flock (Fryer and Iles 1972). The lake ecosystem then exhibited a complex food web in which a number of specialised trophic groups such as phyto — and zoo — planktivores insectivores, molluscivores, detritivores and piscivores thrived. Even without-delving into fine details of this original food web, the vital position of a variety of invertebrates is quite clearly discernible. The observations of Corbet (961) and of several other reports on the food of fishes in Lake Victoria render support to this notion.
Following the establishment of the Nile perch, there have been wide-ranging and far-reaching changes on the original food web (Ligtvoet et al., 1989) resulting mainly from the virtual comprising of three species (*Lates niloticus*, *Oreochromis niloticus* and *Rastrineobola argentea*) in based on two main energy flows, namely the phytoplankton and the detritus food chain. In former, energy flows via zooplankton, *Rastrineobola*, juvenile Nile perch culminating into adult Nile perch; while in the latter energy flows via *Caridina* and insect larvae also culminating in the Nile perch (Ligtvoet et al. op. cit.). The two food chains also portray the importance of invertebrate organisms to the present fishery.

The problem of fishery management is in most cases complex and requires an integrated research effort. Much of the complexity arises from the intricate nature of interactions between different ecosystem components (both biotic and abiotic). As a result of the complex interrelationships, changes in one component of the community are likely to influence patterns of other components. This may in part explain the profound impact which the introduction of the Nile perch has had on the Lake Victoria ecosystem. With the depletion of certain trophic groups especially of the haplochromine flock, the dynamics of many of food resources of fish, mainly the invertebrates have undergone radical changes giving rise to new patterns in the food web relationships. The molluscs, for example appear to be largely unexploited following the disappearance of the haplochromine molluscivores and decline in abundance of *Protopterus aethiopicus*. Zooplankton, phytoplankton and insects currently exploited by *R. argentea*, *O. niloticus* and young *L. niloticus* may be under harvested. *Caridina nilotica* which in the pre-perch time was at most an incidental food item in fish stomachs is now reported to be one of the major constituents of the diet of Nile perch (Ogutu-Ohwayo 1984, Ogari 1984, Goudswaard & Witte 1984) suggesting an increase of this food item in the lake.

It is today recognized that in order to gain a clear insight of the status of fish stocks, explain their patterns and predict their future trends, measurement of secondary production (Downing, 1984) is an essential line of research. This is true despite the fact that in terms of aquatic resources management, the target species remains fish. But because of the great dependence of fish on certain invertebrates, an understanding of the production biology of the food organisms will facilitate management of fish stocks (Waters 1977, Williams et al. 1977) and prediction of rates of fish production (Johnson & Brinkhurst 1971, Johnson 1974). The relationship between fish yield and mean standing biomass of macrobenthos has been demonstrated by Hanson and Legget (1982).

On the other hand Mathias (1971) has pointed out that the importance of secondary producers to the dynamics of fishes is derived from their intermediate position between fish populations and energy sources. In a summary on the subject of aquatic productivity, Lagler (1973) has stressed that integrated studies of both forage and fish populations hold much interest for the future of fishery management.

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