Preliminary Observations on Fish Communities of the Okavango Delta

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Introduction

Freshwater ecosystems subject to seasonal flooding and following of the surrounding land are considered to be amongst the most naturally productive. Although there has been considerable speculation about the productivity of Okavango fisheries (Hall, 1971, Maar, 1965, Dibbs, 1965), it now seems that the fish stock density is not as great as in other sub-tropical and tropical floodplain ecosystems. While this may be partly due to obvious constraints such as nutrient deficient water or habitat unpredictability, it has also been suggested (Maar, 1955) that a temporary predator imbalance is involved. Another contributory factor which may be peculiar to systems with a delayed flood cycle, is that the flood is largely withheld until after the best season for fish growth.

This paper describes Okavango fish communities as a whole and discusses several mechanisms which appear to be important in determining fish stocks.

Nesting technique

In this study, a seine net, 60 m by 4 m of 1.5 cm mesh with a 10 m wide cod end is used to sample fish populations in rivers and lagoons. The net is set in a straight line parallel to and approximately 80-100 m from the shoreline. By means of end ropes the net is winched towards the shore. As the wings gradually close the enclosed fish move into the cod end. By calculating the area netted in a single haul, the fish stock density is estimated.

Using essentially the same method, Lagier et al (1971) found that fish stock density estimates underestimated the true figure by 8%.

In densely-vegetated areas where seine netting is impractical, a set of gill nets with a range of mesh sizes is used.

The community structure

There are 70-80 species recorded from the Okavango Delta. These are listed and described elsewhere (Jubb, 1967, Jubb and Gaigher, 1971). Rarely are more than 15-20 species found to be common in any one community and it is usual to find three or four species comprising the largest proportion of the biomass.

There is a widely-held belief that the Okavango fish fauna is dominated by predatory fish and that the community is somehow evolving towards a more balanced state. It is true that piscivorous fish occupy a fairly large proportion of the biomass, but overestimates in earlier surveys were caused by the use of techniques (gill nets) which selected certain species disproportionately. Analysis of stomach contents of fish captured by the less selective seine netting technique indicates that the food range of the community is well balanced. Fig. 1 shows the apportionment by volume of different foodstuffs in the stomachs of fish netted from lagoons in the southern Delta.

This is a preliminary review of dietary habits and more detailed studies are being conducted by Caroline Gilmore. For convenience, common species have been grouped into ten genera and the general position of each genus in the food range is indicated. Although some species show food preference, many are omnivorous. For instance, the diets of Mummus, Synodontis and Serranochromis species include inverte-
brates. *Clarias* spp. in particular appear to have a very broad food range including fish, invertebrates and decaying organic material (detrivus).

Seine net samples indicate that over 50% of the fish biomass is comprised of *Tilapia* spp. of which the three spot bream (*T. menders*) and red-breasted bream (*T. melanocephala*) usually contribute the largest proportion. Both are predominately herbivorous, the former preferring algae and periphyton, while the latter grazes on vascular plants. A third common but smaller species, the banded bream (*T. sparrmani*), also consumes large quantities of dead and decaying organic matter.

These observations suggest that the major energy input comes from vegetation and detritus. Insects and other invertebrates, although consumed by a wide variety of species, appear to contribute a fairly small proportion of the total community diet. It is interesting to compare this type of system with that of temperate latitudes in which herbivorous fish are not abundant. Invertebrates provide the major energy input.

Though field observations are far from complete, our results suggest that the system described above may be the most widespread type of fish community within the Delta. There are however, variations in the species distribution and food according to season and habitat. Species such as the Tiger fish (*Hydrocynus vitiaasi*) a fish predator, and the Mudcracker (*Lepto fundus*) occur only in the northern permanent swamps. There are indications that the proportion of insects and other invertebrates in the diet increases in riverine communities and that the detritus component increases as floods rise. Rising flood-waters also cause marked changes in the distribution of species. *Tilapia* spp. rapidly move from deeper water onto more shallow floodplains and small *Barbus* spp. congregate in the faster flowing waters.

Perhaps the most interesting ecosystem variation occurs in small lagoons as a result of organic enrichment by livestock. Such lagoons are common at low water along the populated northern and western perimeters of the Delta. Dense blooms of phytoplankton and zooplankton indicate an increase in the nutrient status of the water. Preliminary studies of one such lagoon near Tukau indicated that in addition to very large fish stocks (see Table 1) the basic pattern of energy flow within the ecosystem was radically different from those previously described. Forty percent of the total weight of fish was found to consist of the Bulkin fish (*Gnathoscopus nauculateus*), a species normally found in low numbers. This species was feeding almost entirely on zooplankton. The food range of this community suggests, therefore, that most of the energy is derived indirectly from phytoplankton by way of a zooplankton food chain.

In Lake Ngami, another highly-enriched habitat, fish biomass at the end of the low water season is dominated by catfish (*Clarias* spp.) and small *Barbus* and *Alestes*. At present one can only speculate on the factors which influence this system, but it seems plausible that oxygen depletion may be one factor determining species composition.

The fish stocks

Increases in the area covered by water during flood are in the order of 1 to 2 km in the northern permanent swamps and 1 to 3 km in southern areas of the Delta. (Dines pers. comm.) After December rains, the flood takes six months to reach southern regions of the Delta. In any one place however, the main increase in water level is rapid (2-3 weeks). The increase in the size of the aquatic environment reduces fish density and seine net catches fall by up to 95%. Fig. 2 depicts the hydrological cycle in the southern Delta and summarises the alternations in fish populations which occur in each phase of the cycle.
In many other floodplain systems, increases in fish growth and reproductive activity coincide with the start of the floods (University of Idaho et al., 1971; Welcomme, 1975). In much of the Delta the flood arrives during the coldest part of the year (July water temperature range 13.1-19°C) and breeding activity does not appear to be tied to the floods. Whilst some species are rearing eggs at the start of the floods, most lay in the warmer months between September and March.

The fall in water level is gradual and continues throughout the remainder of the cycle. Due to a concentration effect and population growth there are increases in fish density. In some areas particularly, diminishing water levels frequently concentrate fish stocks so that they exceed the habitat carrying capacity. Such densely-concentrated fish stocks are a short-lived phenomenon because they attract predatory birds and in some areas local fishermen.

To compare Okavango fish stocks with those of other aquatic systems, stock densities at the end of the low water season are, in terms of biotic potential, the most meaningful. The left hand column in Table I contains estimates of fish stocks at the end of the low-water season for the Okavango and floodplain systems elsewhere in Africa (cited in Welcomme, 1975). In selecting published estimates, very high figures which appear to be of freshly “drained in” lagoons, have been avoided.

The right-hand column outlines examples of maximum standing stocks in natural and cultured situations in which there has been no supplementary feeding. The stock estimate for a European chalk stream has been included because this system represents one of the most naturally productive freshwater habitats at temperature latitudes.

### TABLE I

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<tr>
<th>Floodplain systems</th>
<th>Other freshwaters</th>
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<tr>
<td>Vaeres River lagoon (one)</td>
<td>S. Rhodesia fishponds unferilised</td>
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<tr>
<td>Okavango lagoon enriched 7-9 ha</td>
<td>(van der Lingen, 1957)</td>
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<tr>
<td>Kafue lagoon</td>
<td>Zambian managed dam (5-10 ha)</td>
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<td>(Mortimer, 1962)</td>
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<td>Sokoto River lagoons</td>
<td>Israel fishponds fertilised</td>
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<td>(Yashou, 1959)</td>
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<td>Kafue River</td>
<td>Europe chalk stream (Mann, 1971)</td>
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<td>Israel fishponds (Yashou, 1959)</td>
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<td>Okavango lagoon enriched 3 ha</td>
<td>Arkansas rice field (Hickling, 1962)</td>
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<td>Thamalakane River, Okavango</td>
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<td>Senegal River lagoons</td>
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Estimates of standing stocks do not necessarily indicate the yield of fish which could be sustained, but they do give an impression of the relative potential for cropping. Our stock estimates for small unenriched lagoons in the southern delta are between 100 and 200 kg/ha, while that for the Thamalakane River is slightly less. The highest estimate so far recorded in the Okavango, 700 kg/ha, comes from the small, highly enriched lagoon mentioned earlier. This estimate is slightly higher than that of the Kafue flood-plain lagoons (Lagter et al., 1971) where there are also large numbers of game and cattle. Yashou’s (1959) figures for fishponds in Israel suggest a three to four-fold increase in maximum standing stock may be expected as a result of fertilisation. It is interesting that this is the difference between stock estimates for unenriched and enriched lagoons in the Okavango Delta.

There is further evidence that waters in the sparsely populated central and lower Okavango Delta are less productive than those in peripheral regions used for cattle farming. Data in Fig. 3, derived from Maat (1965), shows the average nightly catches per net of a set of gill nets fished at different sites during 1963-64.

![Fig. 3. Average catch per gill net at a series of sites through the Delta](image)

The results of this sample series suggest that as water flows down into the Okavango Delta it becomes progressively less productive. However, catches at the southern end of the delta indicate increasing fish stocks as water flows through cattle country towards Lake Ngami.

**Discussion: Natural constraints on the potential of the fishery**

Although Okavango waters are no poorer than some unferilised waters used for fish culture, stock estimates are low when compared with other flood-plain systems. What then are the factors limiting productivity?

During the rise in water levels there is an abundance of food in the form of decomposing vegetation. As low temperatures are likely to affect the efficiency with which fish can utilise food, it is a disadvantage that much of the Okavango floods during the cold months.
Another reason that Okavango waters are not more fully exploited by fish is due to the dense growth of aquatic vegetation. At high and low water, most of the flooded area is comprised of reed, grass-swamp and in the north *Papyrus* mats. In these areas light penetration is poor, particularly under papyrus. Respiration exceeds photosynthesis and dissolved oxygen concentrations are frequently low. In addition, masses of decomposing vegetation create a substantial oxygen demand. Such areas generally support low numbers of fish and only species such as the air-breathing catfish (*Clarias* spp.) are sufficiently tolerant to cope with severe oxygen depletion.

Other papers in this Symposium discuss nutrient concentrations and primary productivity in the Okavango Delta. It is sufficient to mention that although Reavell et al. (1973) report moderate nutrient concentrations in Okavango waters, Thompson (1974) points out the growth and species composition of aquatic flora indicate that the water is nutrient deficient. In particular, the poor growth of algae and phytoplankton in Okavango waters is the most important factor limiting fish productivity.

In view of the observed effects of organic enrichment, it is reasonable to expect an increase in fish stocks as new areas become available for cattle farming. It is worth considering that when the pressures on undeveloped resources in Botswana increase, livestock husbandry may be modified to complement fish production.

**REFERENCES**


