THE POSSmLE ROLE OF MARGINAL LAGOONS AND BEACHES IN THE IMPROVEMENT OF THE QUANTITY OF *TILAPIA* STOCKS IN LAKE VICTORIA

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INTRODUCTION

Since 1962 the level of the Lake Victoria has increased by one metre over the previous highest record (I, 2). The effects of this rise within the lake have been most obvious on the shallow marginal waters where the inundation of the previous lake shore has produced a series of beaches or lagoons. In such places open water has replaced what were either areas choked with aquatic vegetation or were dry land. In time some of these places may become overgrown once more and in fact in the three years of their existence they have already become partly weed-covered in some instances. This period, therefore, is a transitory phase in the lake's history but one that points a way towards some artificial improvements of the quantity of *Tilapia* stocks in Lake Victoria.

THE LAKE BEACHES

The shores of Lake Victoria are of several types including those shallow shelving areas that may be termed beaches. These beaches show much variation in morphology including differences in type of bottom, slope, degree of shelter and vegetation cover. At one end of this range is found the exposed, steeply sloping sand or rock shore and at the other the very sheltered and shallow mud-bottomed areas. Corresponding to this morphological diversity are differences in the hydrology which are based principally on the capacity of the beach to produce thermal gradients between shallow and deep ends. Thus a classification of beaches may be made into *(a)* Gradient: i.e. those beaches which will support a thermal gradient for at least part of the day, and *(b)* Non-Gradient: those beaches which will not support a thermal gradient at all. Although Non-Gradient beaches show considerable similarity in their hydrology with that of the lake, the Gradient beaches show much variation, mainly in their dissolved oxygen concentrations which are usually associated with specific types of bottom and varying degrees of exposure. By this means it is possible to separate the Gradient beaches themselves into hard-bottomed areas with a moderate degree of exposure, having high dissolved oxygens (D.O.s) and soft-bottomed areas with no exposure, often with extremely low D.O.s. Intermediate types also exist and they all have in common an extreme shallowness.

These Gradient beaches are of great importance to the young of all the *Tilapia* species present in Lake Victoria. As fish of this genus have a considerable resistance to high temperatures (3) they are able to inhabit the warm waters presented by these habitats. Other fish, especially those of the genus *Haplochromis*, whose thermal resistance is lower, are effectively barred from these regions while Gradient conditions exist. On Non-Gradient beaches it has been observed that most *Tilapia* fry were excluded by the presence of the aggressive *Haplochromis*. As the young *Tilapia* and the adult fish of the *Haplochromis obliquidens*/*H. lividus* group share the same food, i.e. epiphytic diatoms (4), and as the *Haplochromis* are larger and more pugnacious, it is obviously of great advantage to the *Tilapia* to be able to colonize an area that is free of these competitors. In addition it has been noted in laboratory tests on *Tilapia* species (5) that both the survival rate and the growth rate were increased when the fish were kept at moderately high temperature.

The flooding of the new beaches by the rise in lake level was followed by a wave of colonization by young *Tilapia* and a similar influx may be observed whenever shallow areas with thick aquatic vegetation are artificially cleared for boat landings, etc. It has been possible on certain beaches to make some estimates of population by the tag-and-return method; figures varying between ten to fifteen fish per square metre of beach have been thus obtained. However, as only the innermost fringe of the shore is colonized to any extent, it is probably more convenient to consider the number of fish per metre of shore line; on the beaches examined this calculation gave results of about 250 fish per metre. In other words, 250,000 fish below 9 em. standard length are present per kilometre of suitable lake shore at anyone time. Beaches with a very shallow slope are, however, obviously more productive than those of steeper slope as the area of warm water, and hence the area of colonization, extends farther from the water's edge.

To some extent the young of the various *Tilapia* species differ in their ecological requirements. Thus while *T. zillii* and to a lesser degree *T. variabilis* can exploit hard-bottomed, often moderately exposed areas, *T. esculenta* and *T. leucosticta* are dependent on the sheltered mud-bottomed beaches.

Survival of the young *Tilapia* on these Gradient beaches, as observed from the decline in numbers with increasing length of fish, is at least 50 per cent up to the 6 em. length class (standard length) and 10 per cent up to the 8 em. length class. It is likely that the actual survival is considerably higher as the young *Tilapia* begin to leave the beach in search of other habitats at around the 6 em. class.

With the lake at its previous low level comparatively few suitable areas existed for use as nursery grounds for the juvenile *Tilapia* spp., and if the present high level persists such new nursery areas as have been made by the increase will slowly be lost by silting with mud and over-growth with aquatic vegetation. As a measure to improve the survival of *Tilapia* fry, such Gradient beaches as exist at this time could be cleared and kept clear of the encroaching aquatic vegetation.

As a further measure artificial beaches could be constructed in the otherwise useless ground that in most places fringes the lake. Ideally such places should measure several square metres in surface area and should be not more than 10 em. in depth; there should be some degree of shelter either by siting the beach on a sheltered shore or by the erection of some type of barrier to wave action.

THE LAGOONS

The second effect of increased level on the lake margins has been the production of lagoons. These are of two main types: the papyrus lagoon, where the rising water has flooded low-lying ground behind the thick papyrus fringe, and secondly, drowned-forest lagoon, where the marginal forest has become inundated and the trees killed. These two areas are similar in their chemical composition; with moderate dissolved oxygen tensions of between 2-4 p.p.m., a conductivity of about 500 m.mhos. and a pH of 7.2 to 7.4. Some at least of the lagoons show a nocturnal recuction in dissolved oxygen as has been described for some dams in Uganda (5). Generally the water is between 0.5-2.5 metres deep in the forest lagoons, although the level fluctuates with that of the lake. The bottom is usually mud and there is much variation in surface area; pools of up to 1 hectare are common in the case of the papyrus lagoons and the pools of the drowned-forest lagoons are sometimes up to ten times more extensive. The structure of the two types of lagoons are different; in the papyrus lagoon there is a central relatively deep mass of clear water surrounded by grass swamps and shallower pools, but the forest lagoons lack the grass swamp fringes and are mainly choked with dead wood.

It also seems highly probable that the larger males present in the lagoons suppress breeding in the smaller but potentially mature individuals by aggressively preventing access to suitable breeding territories. This is indicated by an increase in the minimum breeding size of individual fish of the population over the last two years.

The migration into the lagoons from either adjacent lagoons or the lake can occur as shown by the repopulation of a small pond that was previously completely cropped. Several subsequent fishings carried out produced a quantity of fish which made equivalent to a replacement rate of between fifteen to twenty fish per day.

The importance of these lagoons in the ecology of *Tilapia* species is two-fold. First, these areas appear to produce a relatively high standing crop of adult fish that is suitable for exploitation on the domestic level or perhaps commercially if properly controlled. Secondly, parts of the papyrus lagoon system, namely the shallower pools and grass fringes, playa very significant part in the reproductive process of several *Tilapia* species in that they act as nurseries. The nurseries of the lagoons as well as those of the lake beaches are particularly important in that there is little competition and much food, and hence a high survival rate of *Tilapia.*

To this end it is important that existing lagoons and shallow grass swamps should be cleared and maintained clear of vegetation. Later, if the need arises, artificial lagoons could be created by excavation, by clearing the papyrus mass or by closing off shallow inlets by bunds.

Finally it must be emphasized that experiments with these areas have only reached the initial stages and no doubt the picture will have to be modified as more is known. For instance further changes may be expected in the lake level in future and in the ecology of the introduced species of *Tilapia* as they increase their numbers.

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