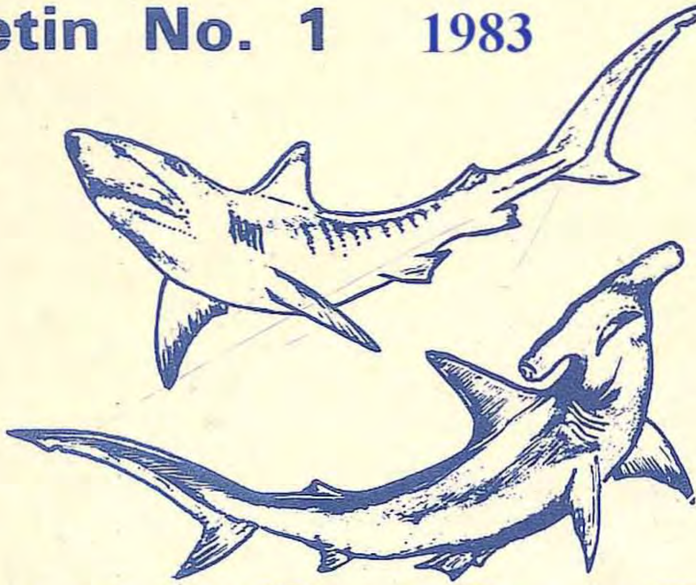
# KENYA AQUATICA

Bulletin No. 1 1983



A BULLETIN OF
KENYA MARINE & FISHERIES
RESEARCH INSTITUTE

# EDITORIAL NOTE

The need has been felt for a long time for a bulletin covering aquatic resources out-puts of the country quickly and comprehensively. The Board of Management of Kenya Marine and Fisheries Research Institute realised this need and directed the Institute to take immediate action for ensuring that information on aquatic resources is compiled for easy communication to the people.

The editorial group has decided to start reporting activities related to aquatic resources under the title "KENYA AQUATICA". As far as possible efforts will be made to include short scientific communications, critical reviews, seminar proceeding and other ad hoc publications. This comprehensive coverage will be possible only through cooperation of various Institutions, Departments, Societies and individuals who are concerned with aquatic resources.

**Kenya Aquatica** is a technical and extension series for rapid dissemination of information on aquatic resources and allied information from Research Officers, Fisheries Officers and any individual for transfer of Technology to the fishermen and industry and any other relevant information needed for National Development.

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# A REVIEW OF THE BIOLOGY OF TILAPIA SPECIES IN LAKE VICTORIA WITH SPECIAL REFERENCE TO ITS FEEDING AND BREEEDING HABITS

## BACK GROUND

Lake Victoria whose size is about 68,000 $km^2$ is the second largest freshwater lake in the world. It has a potential fish resources which has almost no match in many parts of the world. Of the 170 fish species. **Tilapia** species are regarded as the most important of the freshwater fishes in Kenya. In East Africa, there are at least 20 species of fish belonging to the genus, **Tilapia.** Because of its popularity, the exploitation of **Tilapia** sp. has been most severe.

Over the period between 1968 to 1977, the production of **Tilapia** sp. in the lake has undergone a gradual decline. For instance, in 1969 a high catch of 4,645 tonnes was recorded while a meagre catch of 642 tonnes was recorded in 1975. In recent times this apparent decline in **Tilapia** fishery was almostly been associated fishery has mostly been associated with the predatory behaviour of **Lates niliticus** (Mbuta). However there is no convincing evidence to support this explanation. The considerable rise in lake Victoria water levels in the period 1961 - 1964 is also thought to have contributed to the decline in **Tilapia** fishery. Welcomme (1969) explained that this rise in water levels submerged and destroyed the nusery grounds of most **Tilapia** species.

In particular, **T. esculenta** which inhabits lagoons and prefers sheltered swampy margins fror nursery grounds is thought to have been hardest hit by this rise in lake levels.

The need for research to ensure an efficient management strategy cannot be over-emphasized. Knowledge of the Biology and Ecology of **Tilapia** sp. is therefore of utmost importance. In this report the feeding and breeding habits of two Tilapia species are highlighted. These are **Tilapia nilotica** and **T. esculenta.**

### General Introduction:

The Genera **Tilapia** belongs to the family cichlidae. In Africa cichlidae are the predominant freshwater percomorph fishes and have long attracted the attention of many Biologists, both from the scientific and economic viewpoints. In Lake Victoria there are six species. Two of them are endemic, namely T. **Esculenta** and T. **variabilis** and the other four are non-endemic i.e. T. **zillii**, T. **melanopleura**, T. **nilotica** and T. **leucosticta** (Greenwood 1966).

The genus **Tilapia** mainly consists of specialized harbivorers, and many of its species are known to adapt to lacustrine conditions. Such features account for their suitability to pond culture. Hence **Tilapia** sp. have been used quite extensively for this purpose throughout East and Central Africa, including other parts of the world.

According to Kirk, **Tilapia** species are able to survive in extremely adverse environmental conditions. Very often they have been found in habitats which most other fish genera cannot tolerate.

Myers (1938) and steinlitz (1954) have suggested that **Tilapia** sp. evolved from a marine ancestor which penetrated freshwater. Such an ancestor would certainly explain the marked euryhalinity of certain Tilapia species (Chervinski, 1961 a).

Typical example is T. **nilotica** L. which is able to survive direct transfer from freshwater to 60 - 70% sea water (20.2 - 25.0% salinity). Further Lotan (1960) reports that this species can withstand a medium of upto 150% sea water (53.5% salinity) through gradual adaptation.

The rate of growth of T. **nilotica** at high salinity levels has been investigated by Chervinski (1961 a). The results obtained indicate that the growth rate in 50% sea water is not signicantly different from that of the same species in freshwater. A further observation made is that T. **nilotica** are able to breed in their first year in 50% sea water. However, he was quick to add that the number of young produced may be somewhat smaller than their freshwater counterparts. Based on work done by El saby (1951), T. **nilotica**, T. **gallilala** and T. **zillii** are all known to breed in the great bitter lakes of Egypt at salinities ranging from 13.5 to 29.0%.

According to the way the young are reared, **Tilapia** can be classified into two main groups, namely 'guarders' and 'Brooders'. In the former group, the eggs are deposited on specially cleared areas of the substrate, to which they adhere. These are then guarded by the parents until they hatch. For the Brooders, the eggs are picked up by one of the parents almost immediately after being laid, and are brooded in the mouth until the larval are fully developed. In nearly all known cases this is the female.

Due to the difficult in obtaining individuals with their broods intact (Lowe, 1956), rather insufficient observations have been made in determining the nature of brood, size and eggs production. Recent changes in fish stocks and water levels of lake Victoria (Welcome, 1964), however, have made available large number of T. **leucosticta** has been found to be approximately equal to the square of the total length (Welcome, 1966). This relationship has been found by Lowe (1955) to hold for T. **esculenta** and other mouth breeding **Tilapia** species. More especially since **T. esculenta** has a similar egg production as for **T. nilotica** (Linne) and **T. variabilis** Boulenger (Lowe, 1955).

Further, under favourable and uniform conditions, may spawn at frequent intervals throughout their reproductive life. However, in cases of marked seasonal climate changes, they may have a brief and well defined annual breeding season reports Lowe (Mc Connel) 1955. The number of spawnings a year can be determined by two varibales namely:-

(a) the duration of the breeding seasons. This appears to depend on climatic conditions.

(b) the frequency of spawning during the season which may be characteristic of the species.

Despite the fact that in equatorial waters **Tilapia** sp. tend to spawn throughout the year, there are seasons when increased breeding activity has been observed (Lowe 1955).

Incidentally these periods seem to coincide with the two rainly seasons in East Africa. Aronson, underscores the fact that this may also **follow the rainy seasons** depend on changes in light intensity and temperature. Where individual fish may have spawned several times, Lowe, (1955) suggests that a reduced number of eggs is produced towards the end of such periods. For example,

**T. leucosticta** shows a higher mean ovarian egg production at the beginning of the rainy season (October) than towards the end. This indicates that some increase in breeding activity occurs during the rainy season.

The occurence of certain losses of the eggs has been observed by picking up the eggs as they are laid. One therefore anticipates a gêneral oss of some fraction of the laid eggs before being picked on by the female. Welcôme (1966) has suggested that this is either due to the crowded condition of the lagoons, where fish may be interupted in the spawning act by other fish, or alternatively eggs being lost when the muddy bottom is stirred up.

There is also the possibility that in many lagoons, the developing embroys in the parents mouth may be subject to predation by a certain group of highly specialized predators. These are the **Haplochromis** described by Greenwood (1959) as eaters of fry and eggs of cichlids. However, it is yet to be established to what extent Tilapia sp. fall victim to this form of attack.

Many **Tilapia** species breed several times in succession within one breeding season. Lowe (1955) has observed that at least five B. A Tilapia species have three or four batches of young ones in succession.

Data on the frequency of spawning by individual fish in natural water are quite difficult to obtain. Nevertheless indirect evidence on the number of successive spawning can be obtained by examination of the ovaries. Evidence spawning can be seen in the ovaries as dark yellowish or brown flecks. While the number of size groups of small ova starting to develop indicates hatches of eggs that should ripen in future spawnings. By such examinations it is possible to tell whether a **Tilapia** is just staring, or is in the middle of, or is just completing a spawning period. Observation of the ovaries, suggest that many of the **Tilapia**, e.g. **T. esculenta**, **T. variabilis**, **T. nilotica**, etc. have 3, 4 or more batches of young in succession. But the duration which a particular batch of eggs may take to ripen is not known with any appreciable degree of accuracy (Lowe) (Mc Connel, 1955). On the contrary studies of the ovaries of some **Tilapia** living in open water in Lake Nyasa show that only one batch of eggs is normally produce per season.

One of the major problems in Tilapia culture is over population. This arises from the high rate of survival of the young ones. Consequently this leads into a marked fall in the growth rate, due to inadequate food supplies. Restricted growth rates are not only confined to pond populations. Stunted **Tilapia** from shallow lakes and lagoons have been reported (Lowe 'Mc Connel) 1958 and Coe, 1966). Several of the **Tilapia** sp. most suitable for culture have been found to breed at a very small size in a restricted environment. For instance, **T. nilotica**, which normally breeds at well over 20cm total length in large lakes, breed at 17 cm in experimental ponds (Lowe Mc Connel) 1958).

The realization of the fact that different **Tilapia** sp. possess different feeding and breeding habits, and that they differ in their ability to establish themselves in small bodies of water, has led to more interest being taken in the specific determination of these various **species**. In the genus, Tilapia, evolution appears to have been towards a reduction in the number of eggs produced and towards the development of a brooding habit.

Generally, in **Tilapia** sp. the number of eggs laid at a time increase with the size of the female (Lowe, 1955 c). In maternal brooders the larger females which lay more eggs also have larger mouths in which to brood. However, among paternal brooders there is no such relationship between the size of eggs produced.

In addition to the role of weed control, Tilapia sp. may be reared for recreational purposes, either as sport fish in their own right, or a folder for large conivorous fish. While Tilapia species might be expected to serve at a subsidiary level as consumers of unwanted vegetation, their main value, other than for angling purpose would be for consumption.

**Feeding habits**

General: The genus **Tilapia** comprises mainly of specialised harbivores. **Tilapia** species can be divided into two main types. The first type feeds on algae, being particularly adopted for filter feeding on plankton. This also broods the eggs and young in an oral pouch. **Tilapia** of the second type mainly feeds on macrophytes. The eggs and larvae develope into a nest on the substratum which the parents guard. Comparisons between fore and hind gut contents have shown that of the range of plant material eaten, only the diatomes are usually digested (Fish, 1955). Depending on the actual locality of feeding, four major types of stomach contents have been isolated in Tilapia sp. of Lake Victoria. These are:-

(i) Planktonic
(ii) Bottom
(iii) Epilithic or epithytic
(iv) Higher plants.

**1. Tilapia esculenta**

The food of this species comprises almost entirely of phytoplankton. Only the diatoms are digested (Lowe 1955 b;) Wothington, 1929; Graham 1929; Fish, 1955). Insect larvae and planktonic crustaceans occur less frequently, although they may contribute to the diet of young fishes.

In essence, T. **esculenta** is a plankton feeder. In dams, it does not seem to grow well, rarely exceeding 20cm. In Lake Victoria **T. esculenta** occurs in the sheltered gulfs, where the bottom consists of algaceas mud (Lowe, 1955). Although the food of **T. esculenta** mainly consists of phytoplankton, zooplankton and insect larvae have occasionally been recorded. According to Greenwoods (1953), Diatoms are the most important food elements of the phytoplankton, particularly the filamentous melosira.

In the evidence for his 'low of the distribution of the Ngege' Graham concluded that the simple gill-rakers of **T. esculenta** were not adapted for straining phytoplankton. Consequently, the species obtained its food from the living layer of diatoms in the bottom deposits. According to recent work on the feeding habits of this fish, it seems that a considerable proportion of the diatoms taken must be considered as trully planktonic and that the fish strains them from the water.

According to payne (1971), blue-green algae predominates in the stomach of **T. esculenta.** Moreover, diatoms in particular, Navicula and Rhopalodia are also common. Rotifers were encountered, whereas filamentours green algae occured occasionally, while Flagillates were common. In his work, he made monthly records of mean length and weight for experimental populations of **T. zillii** and **T. esculenta.**

The general observations was that the former grew faster and attained a greater final length and weight than the latter. This is largely attributable to the depression of the growth of **T. esculentas** which occured between the second and fifth months.

Payne related the reduce growth rate to two variables, namely:-

(i) The planktivorous habit of the species;
(ii) The low phytoplankton density prevailing in the ponds between the second and fifth months.

However, after the addition of ammonium sulphate ($NH_4(_2 SO_4)$) with consequent Phytoplankton bloom, both the growth and the number of ripe fish found in the sub-sample increased. Throughout the cause of his experiment, the stomachs of **T. esculenta** contained little of the supplementary food. It was only during the fourth and fifth months, during which the phytoplankton density was low, that large quantities of pawpaw leaves and rice waste were found in the stomachs. According to Payne, it seems therefore that **T. esculenta** would not use the supplementary food, unless its natural food is scarce.

The suitability of fish culture of a planktivorous species depends upon its ability to use the supplementary food given or upon the application of fertilizers to encourage the natural food. Supplementary food in African situations is rarely refined, both in rural and government schemes. This is due to lack of funds in both cases. Yet it is these very foods, e.g. cassava leaves, pawpaw leaves and rice waste, which the planktivorous species must be able to use. Whereas, **T. macrocheir** (Dumeril) which is basically planktivorous and algae feeding can use the above foods. **T. esculenta** cannot use these foods effectively (Payne. Accôrding to Hepher (1962) fertilizers are generally said to increase the carrying capacity and yield.

**T. nilotica**

The food of this species is principally phytoplankton (either in suspension or from the bottom deposits if which the diatoms provide the main nourishment (Worthington, 1929 a; fish, 1955; Poll and Damas, op. cit). Insects and crustaceans are also eaten and digested. In Lake Rudolf, **T. nilotica** is said to feed on Blue-green algae, but in other lakes, these algae are not digested by .this or other fishes. For the **T. nilotica** living in Lake Kivu, certain Bacteria are reported as forming a substantial part of its diet.

Other authors (Lowe, 1958) are also of the opinion that **T. nilotica** mainly feeds on algae. He concludes that, this species has more generalized feeding habits than **T. esculenta** Graham, which feeds almost entirely on phytoplankton. In one of this findings, Daget (1964) reports that **T. nilotica** feeds on phytoplankton, bottom animals and also swallows mud particles. Further, Yashouv and Chervinski (1961) have made the suggestion that in lakes, **T. nilotica** feeds on phytoplankton and empithytic diatoms, and when confined in ponds and lagoons on bottom organic debris.

In an experiment set up to determine the range of naturally occuring food organisms eaten by **T. nilotica,** rotifers, copepods, insect larvae, blue-green algae, diatoms and nannoplankton were found in fish all sizes. Cladocerans, were found only in the guts of fish upto 50 mm total length. While Euglena, filamentous algae and higher plants were found in the gut contents of all but the smallest fish of upto 20 mm (Yashouv and Charvinski, 1961).

In an evaluation of the various food items in the diet of **T. nilotica,** the fish were fed on phytoplankton, water bugs (Corixa), chironomids and cotton seeds, cakes either singly in various combinations. Though it was not possible to make valid comparisons of the nutritional value of various food items, the results show that the natural food spectrum of **T. nilotica** is very wide. Infact, even Juveniles weighing only 2.5 g weight were found to feed on plankton water bugs, other insects and cotton-seed cake, Kirk reports.

The fact that **T. nilotica** feeds both on planktonic and bottom material (Fish, 1955) is evidenced by the fact that both remains are present in its stomach contents. The origin of the planktonic material could either be from the plankton or from the flocculent deposits found in the bottom of some shallow bays (Welcome). The percentage of fish found with each type of food was

(a) Bottom material only.............................................. 5.7%
(b) Bottom material and apparent planktonic material..................37.1 %
(c) Apparent planktonic material only................................. 57.2%

The principal stomach contents of some 35 **T. nilotica** (18.8 + 2.0 cm .) are given in table 1.

TABLE 1

**The principle items in the gut contents of Tilapia nilotica**

| Item | percentage Occurrence |
|---|---|
| **Filamentous green algae** | 17.2 |
| **Chlorophycea general** | 74.4 |
| Pediastrum | 71.5 |
| Scenedesmus | 60.0 |
| **Ankistrodesmus** | 34.2 |
| Staurastrum | 60.0 |
| Botryococcus | 37.2 |
| Diatoms | 100.0 |
| **Amphora** | 22.4 |
| Cymbella | 20.0 |
| Fragillaria | 2.8 |
| Gomphonema | 8.5 |
| **Melpsira** | 91.5 |
| Navicula | 22.4 |
| Pinnularia | 17.2 |
| Rhopalodia | 5.7 |
| Nitzchia | 20.0 |
| **Surirella** | 57.2 |

| | |
|---|---|
| **Cyanophycea** | |
| Lyngbya | 80.0 |
| Oscillotoria | 17.2 |
| Anaboena | 22.4 |
| Microcystis | 40.0 |
| Merismopedia | 40.0 |
| Dinoflagellates | 11.4 |
| Flagellates | 22.8 |
| Rhizopods | 8.5 |
| Rotifera | 2.8 |
| Crustacea | 17.2 |
| Insect remains | 14.3 |
| Bottom plants | 40.0 |
| Portions bitten off plants | 2.8 |

On the other hand, food analysis results (Ogari, 1975) indicatė that phytoplankton in suspension or bottom living diatoms as the most important. While insect larvae and planktonic crustacea are of lesser importance. The blue greens, spirulina plantensis, S. laxisima, Anaboena spiroides, chroococus minutes were the dominating algae. In addition some microcystis species were observed. The diatoms included navicula lineolata, Ananeoneasis species with cymbella species forming the reminder of the phtoplankton in gut.

The insects found included Corixisa, chironomid larvae and planktonic crustacea, copepods and ostracods. In a few cases, watermites (hydrocarina) were identified Zooplankers were in general scare. So were mesocyclopes, Tropodiatomus Banforanus and Diaphranosoma exciseem.

Moreover, for fish less than 10 cm total length, the stomach contents indicated the presence of small crustacea. While those above 10 cm TL contained a variety of food organisms in their stomachs.

The nature of food taken seems to depend on its availability factor. For instance the **T. nilotica** caught in ALLTA Bay, contained percentage of diatoms, whereas those caught in FERGUSON'S GULF (L. Rudolf) showed a higher percentage of both the blue green algae and crustacea.

Suffice to say, the fullness of the stomacn of Tilapia species has been found to depend on both the gonad state and the time of the day of the year. Most **Tilapia** sp. had either empty or almost empty stomachs around 0700 hours. However, in the cause of the day, the stomach fullness increased, infact by 16.00 hours some **Tilapia** had full stomachs. Thus, Tilapia species seemingly appear to start feeding early in the morning and ending up late in the evening, Further, spawning females with eggs in their mouth and breeding males had empty stomachs (Ogari)

## BREEDING HABITS:

### General:

Depending on the way the young ones are reared, Tilapia sp. can be classified into two main groups, namely 'guarders' and Broodeers. In the former, the males and females pair up before spawning. They then stay together until their young becomes independent. The number of young produced will therefore depend on the number of fishwhichpair up. For the latter, the females carries the young in the mouth. The ripe females makes a very brief visit to the spawning grounds. As soon as the eggs are fertilized, she collects them and then moves off to the brooding grounds. The males, remain in the spawning grounds, each one guarding a nest in his own particular territory. Thus segregation of males and females occurs after spawning.

Since the male fish can continue to fertilize over a long period, the number of eggs fertilized appears to be determined more by the number of ripe females than the number of males (Lowe Mc Connel, 1955). All species of Tilapia reared in ponds appear to start breeding at a very small size and to overpopulate the ponds very quickly.

According to Lowe, the male breeding colours of the maternal brooders serve for advertisement of the spawning grounds. This effect is further enhanced by the habit of many males congregating together in certain places to spawn. This advertisement effect is particularly marked among the species endemic to Lake Nyasa, where the breeding season is very much restricted.

The males congregate on well defined spawning grounds and are characterized by very definite breeding colours. This is black in several species. Furthermore, it shows little variation in intensity throughout the short breeding season. Infact the colour is even retained in the dead fish.

Nevertheless, in Lakes Victoria where some ripe **Tilapia** are normally found virtually at all times of the year, the breeding grounds are not so well defined. Moreover, the male breeding colours are not so intense. Infact in aquaria, Lowe reports that the colours are of the lake Victoria **Tilapia** show great variations in intensity with the activity of the fish. In any case, the colour halffades on the death of fish.

The fact that there are no so such sharp distributions between feeding and breeding areas in Lake Victoria is suggested as possibly due to the fact that the water inhabited by the **Tilapia** in this relatively shallow lake is more uniform than in Lake Nyasa.

In maternal brooders male breeding colours may also play an important role in species recognition and stimulating the female to lay.

For these species, the pre-spawning courtship is normally very short. The ripe females wonder from nest to nest to then suddently spawn in one nest, sometimes without any preliminary courtship. Further for maternal brooders nest formation occurs in addition to breeding colours. Moreover, associated behaviour may also be important for species recognition and release of egg laying; as the nests often have a characteristics form in different species, although this form may somewhat vary with the substratum.

Hence, for both subtratum - spawners and maternal brooders, the breeding dress assumed by both sexes in the former and the male only in the latter serves in advertising the spawning territory. The congregation of many males on the spawning grounds, among maternal brooders enhances this effect (Lowe).

Lowe further notes that the presence or absence of defined breeding seasons among **Tilapia** species depend on hydrological conditions. These are primarily dependant on the geographical latitude. For instance, Lake Nyasa which lies between 90 and 15°S, has a well defined annual hydrological, cycle quite in a cordance with annual wind and rainfall cycles (Beauchamp, 1940). On the other hand for equatorial lake Victoria, the hydrological cycle is less definite and differs in the main lake and the gulf (Fish, 1957).

**Tilapia Nilotica**

**T. nilotica** is a mouth brooder. Thus, the females carries the young. It is a very plastic species and on the whole grows well in dams and does not seem to breed so freely or runt as badly as some other species.

Breeding T. nilotica has been found over all types of bottom, but principally over sand in shallow waters between 10 and 30 feet deep. The onset of maturation in both males and females is at about 13 cm as indicated by the smallest sizes of fish with inactive gonads. The smallest ripe fish recorded by Welcome was a male 15.5 cm SL and a female 15.8 cm SL. Otherwise most fishes were still immature at 20.0 cm.

According to (Lowe, 1958), fish populations in poor condition start to breed at a smaller size than those in good condition. Thus by virtue of their high condition factor, the maturation size of fish from lake Victoria is smaller than would be expected.

The percentage of fish that are ripe varies little from month to month and breeding fish are present throughout the year. However, in Lake George, **T. nilotica** shows an increase in breeding activity during the rainy months (Fry and Kimsey, 1959). In non-equatorial waters, the species has a seasonal breeding cycle, usually associated with rains (Lowe, 1958). Nevertheless, no evidence is available to suggest that such seasonal fluctuations occur in the lake Victoria stocks.

As stated earlier on, occurance of defined breeding season among **Tilapia**, depends on hydrological conditions, e.g. the Geographical latitude. Lowe has observed that the effect of latitude and hydrological conditions on Tilapia breeding seasons is clearly shown in those species found over a wide latitudinal range. Thus **Tilapia nilotica** in northern Nigeria (about 10° to 13° N) have a restricted breeding season, breeding only in the rains, whereas in equatorial waters breeding fish are found at all times of the year (Lowe, 1958).

Both **T. nilotica** and **T. esculenta** are reported to have a black and red male breeding dress, unlike that of any other known **Tilapia**. The breeding dress is almost identical in the two species. This supports the view that these geographical replacement species are closely related as well as ecological counterparts in their respective waters.

Bayley (1972), conducted studies on **T. nilotica,** in an aquaria. In his study he placed both ripe male and female **T. nilotica** in an aquaria. The male was seen constructing nests in the substarate after obtaining the breeding colonation. This was carried out, by the fish staying vertically to the substrate. Then using its mouth, it picked up sand particles and deposited on the nest. This activity went on for two hours, during which 4 nests were constructed. After this activity both the male and female were seen occupying one of the largest nests.

Next the courtship period followed, continuing for another 2 hours, after which the female was seen depositing eggs. This was the time of mating and immediately after this, the female had eggs in its mouth, while the male was busy defending the territory the females stayed within the nests. Half an hour later, with alight distrubance, the female left the nest, but kept holding the eggs within the mouth. On the 2nd day the male began feeding and at the same time was loosing its breeding colour. On the fifth day both fish were rapidly loosing their breeding colors and after the sixth day eye ova were noticed.

Futher, on the ninth day, Alvelins were seen escaping through both the mouth and gills of the mother, but were collected alsmost immediately. On the tenth day. Alvelins were swimming freely and for the first time the female was seen feeding. The following day, the fry were noticed feeding.

The duration of the parental care is said to vary with the brood fish and individual fry. From the observations done, it seems if after the third day, the fry becomes less willing to re-enter the mouth of the female, and the number retrieved thereafter gradually declines.

Unlike in **T. galilaea,** where both the sexes share the duties it is the female, **T. nilotica** that carries the incubation duties. The smallest ripe T. nilotica female recorded 24.5 cm TL, whereas the average breeding size for the species is between 32 cm - 39.0 cm TL. gonad analysis of **T. nilotica** throughout the year show that breeding occurs throughout the year, but there appears to be periods of climax spawning.

This was manifested by the data collected both from the fry caught from foot seines and the number of ripe female per month. Most ripe female were caught between April and June. Moreover, it was during the same period that most Tilapia fry of TL between 1.5 cm - 4.0 cm were caught in foot seine. This is the period, when rains come and the rivers flood resulting in lake level rise. Thus, for L. Rudolf it has been suggested (Ogari) that although breeding occurs throughout the year, there is at least a peak period during which most of the Tilapia breed. This period lies between April and June.

Some scattered observations exist in the literature concerning the number of eggs produced by **Tilapia.** Worthington, recorded a large female **T. nilotica** of unspecified length from L. Albert to be containing 2,000 eggs in her mouth. Further from a lagoon off from the lake Albert, three female **T. nilotica** between 12 cm and 31 cm long were reported to be carrying 50 and 24 eggs and 7 young fish respectively.

Worthington noted and I quote, "the eggs fo these small Ngege (**T. nilotica**) are about the same size as those of the large Ngege from the open lake, but the number in the broods is very small compared with the 2,000 from the mouth of the large Ngege. Perhaps this is a modification due to the cramped environment."

Lowe, 1955) proposes that the small number of eggs in the small female is related to the size of the parents, and not related to the size or depth of the lagoons. The maximum number of fertilized eggs recorded by (Worthington) from the mouth of a 30.5 cm long female **T. nilotica** were 705 eggs. Further, in all species where the young are brooded, they are retained until after occlusion of the yolk sac. The maximum size of the young recorded by the author from the broods of **T. nilotica** were 13.5 mm long, sac accluded (18 in brood).

Based on the size of young in which the yolk sac is occluded or nearly so, it seems probable that **T. nilotica** does not brood young ones larger than 13.5 cm long.

### Tilapia esculenta

**T. esculenta** is a female mouth brooder. It has no well-marked spawning seasons. Greenwood (1966) has reported that the greatest breeding activity occurs between September and May. Further Lowe, (1955 b) gives a detailed account of its breeding biology. In lakes Victoria, most **T. esculenta** are sexually mature at a length of 25 - 26 cm. However, the modal adult size ranges from 30 to 32 cm TL.

**The two Lakes Victoria species T. esculenta and variabilis (bith mouth** brooders) occur naturally in lakes Victoria and Kyoga only. Nevertheless, they are now widely distributed in dams in Uganda and parts of Kenya and Tanzania within the L. Victoria drainage basin. According to Lowe (Mc Connel) 1955. Fry from brooding females of both species were taken to the fish farm at Korogwe in June 1950 and were breeding there at 16 - 19 cm long, six months later.

To mention on passing, the egg production in **T. esculenta** is approximately equal to the square of the total length, as for the case of **T. leucosticta** and **T. nilotica**. The growth rate of the species is difficult to determine but estimates done by Lowe (1957) from a variety of waters range from 0.55 cm TL per month to 1.25 cm per month. In the lake Victoria lagoons an estimate of the growth rate of juvenile fish (1.0 - 4.0 cm) was found to be 0.67 cm SL per month.

The signific of the growth rate is that it has a direct bearing on the fertility of the fish in influencing the increase in parent length between broods and thus brood number.

Criddland (1961) has showed that amongst **T. esculenta** in the laboratory, the number of eggs in successive broods increases. He records **T. esculenta** as spawning seven times in 24 months with individual broods as close together as 39 days.

**Data on the frequency of spawning by individual fish in natural waters are** difficult to obtain and the only direct evidence so far comes from two marked fish recovered by the Lake Victoria Fisheries Service (Lowe Connel, 1975).

(a) The **T. esculenta** Graham, when marked on 13th April, 1953 had fry in the mouth, and on being recaptured nine and a half weeks later (20th June, 1953) had eggs in the mouth.

(b) Another **T. esculenta** when marked on 4th March, 1953 had fry in the mouth and when recaptured 7 weeks later (26th April, the ovary was ripening again).

Worthington, recorded from the mouth of a female 29 cm **T. esculenta** a maximum of 711 yolked young fertilized eggs. On the other hand the

**maximum size of the young he recorded from the brood was 15 mm long yolk sac occluded and the young had started to feed (80 in brood). Thus from the size of the young in which the yolk sac is occluded or nearly so, T. variabilis and T. esculenta** probably do not brood young much larger than 15 mm long.

Another interesting aspect is that all Tilapia species reared in ponds appear to start breeding at a very small size. This over - populates the ponds very quickly. This information is based on (Lowe (Mc Connel) 1955) personal observations on **T. esculenta, T. variabilis, T. nilotica T. leucisticta, T. zillii** and species from lake Jipe and the **Pangani** river, amongst others.

Lowe further reports that **T. esculenta which replaces T. nilotica** in the Nile **system above the Murchison fall, and T. nilotica both have a black and red** male breeding dress. This is unlike that of any other **Tilapia**. It is almost identical in the two species (Lowe, 1958) and supports therefore the fact that these geographical replacement species are closely related, as well as being ecological counterparts in their respective waters.

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