ASSESSMENT OF THE STATUS OF *LATES STAPPERSII* (CENTROPOMIDAE) STOCK IN LIFT-NET FISHERY IN LAKE TANGANYIKA, KIGOMA, TANZANIA

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ABSTRACT

An assessment of the status of Lates stappersii *(Boulenger, 1914) stock in the lift-net fishery in Lake Tanganyika, Kigoma area, was carried out from January to December 2003. Results indicated that breeding is seasonal with peaks in February, July-August and December, and so was catch composition, with peaks in March, May and July–August that followed the abundance of its prey,* Stolothrissa tanganicae. *Catch per unit effort was similar between wet and dry seasons and peaked synchronously at all study sites probably as an indication of its abundance during those months; but also it could mean that the fishes were caught from the same general area. The unselective nature of the lift-net, a common fishing gear in the lake, could be exerting pressure on the pelagic resource, that leads to local over-fishing if not controlled. There is need to institute minimum fish size and mesh size limits and licensing, on a lake-wide basis, as fisheries management measures to safeguard against overexploitation of this highly variable and mobile yet important pelagic fish resource.*

INTRODUCTION

There are four endemic *Lates* species to Lake Tanganyika, namely *Lates mariae* (Steindachner), *Lates microlepis* (Boulenger), *Lates angustifrons* (Boulenger), and *Lates stappersii* (Boulenger) (Coulter 1991). The first three species were once important but their catch has declined after years of exploitation (Coulter 1988, Pearce 1988, Roest 1992). They are to-date, incidental in the pelagic catch (Chitamwebwa and Kimirei 2005). Recent studies have concentrated on *L. stappersii* because of its increased importance in the pelagic fishery (Coulter 1988, 1991, Moreau and Nyakageni 1992) and its economic and nutritional importance to the riparian states. However, since the 1970s, *L. stappersii* catches have declined in the northern sector of the lake (Burundi) where it was once an important component of the pelagic fishery (Coulter 1970, 1976, Shirakihara *et al*. 1992, Coenen 1995, Mannini 1998). *L. stappersii* contributes between 30% and 50% of the pelagic catch in the Burundi sector (Roest 1988). *L. stappersii* is now important in the southern sector of the lake (Zambia) (Coenen *et al*. 1998, Phiri and Shirakihara 1999), where since the 1980s it has replaced *Stolothrissa tanganicae* in the industrial purse seine fishery. It now contributes up to 95% of the catch (Mannini 1998); however, a scenario of local over-fishing was reported by Coenen *et al*. (1998).

Local over-fishing is thought to have resulted in the observed decline of catch in the D.R. Congo (Mulimbwa, pers. comm.). *L. stappersii* was the main component of the pelagic fishery in the Kigoma area, making up over 60% of the pelagic catch, until the mid 1990s when an overall *S. tanganicae* dominance became apparent (Chitamwebwa and Kimirei 2005). To-date, *S. tanganicae* dominates the pelagic fishery landings contributing over 70% of the catch (Mannini 1998). The decline in *L. stappersii* catches is thought to be linked to both climatic changes and over-exploitation (Plisnier 1997, Mannini 1998, Coenen *et al*. 1998, Chitamwebwa and Kimirei 2005, Kimirei and Mgaya 2007). *L. stappersii* contributes substantially to the economy and dietary protein for the ever growing population around Kigoma. Fluctuations and decline in the *L. stappersii* catch not only affect the nutrition but also the economy of the population living in the area and the lake at large. The causes for the variability and decline are poorly understood.

The objectives of the present study were to examine the seasonal abundance of *L. stappersii* in the lift-net fishery catches and to identify possible causes of the fluctuations in its abundance in the Kigoma area (Tanzania).

MATERIALS AND METHODS

Fishing on Lake Tanganyika is done at night by light attraction using pressure lamps. Bi-weekly catch (kg) and effort (number of lamps and hauls), mesh size, species composition, length – weight measurements, and sexual maturity stages/breeding season data of *L. stappersii* were collected from three landing stations, Kibirizi, Kigodeco and Katonga, around Kigoma area of Lake Tanganyika (Fig. 1). Five lift-net fishing units were sampled every sampling visit. The number of lamps (13.19 ± SD 2.66) was used as a measure of fishing effort to calculate catch per unit effort (CPUE) because the number of hauls (2.04 ± SD 0.51) seems to be constant and so its use as a measure of fishing effort would underestimate the magnitude of exploitation of this resource by the lift-net fishery in the area. Moreover, historical catch data for the period 1993 to 1996 were obtained from the Fisheries Division of the Ministry of Natural Resources and Tourism and used to shed light on the historical trends in the fishery.

Total catch in kilogrammes was obtained by multiplying the number of standard boxes filled with either *L. stappersii* or *S. tanganicae* by 60 kg. A sub-sample of about 5 kg for *L. stappersii* and because the lift-nets used for the multi-species fisheries are not selective in nature, 0.5 kg of the mixed catches of *S. tanganicae* and *L. stappersii* juveniles were collected for further laboratory analysis. In the laboratory, fishes in the mixed catch sample were sorted according to species and individual total length (from the snout to the tip of the largest caudal fin ray) measured to the nearest millimeter using a measuring board. Body weight was measured to the nearest gram using a top pan balance and a spring balance for juveniles and adults, respectively. Length and weight data were used to establish a length-weight relationship (equation 1) from which a monthly average Fulton's condition factor (K) (equation 2) was obtained:

$W = aL^b$ .... (1)

$K = (W/L^3)*10^x$........................... (2)

where W is weight of the fish in grammes, L is the total length (mm), K is the condition factor, *a* and *b* are constants, and 10^x is a scaling factor; $x = 4$ was used.

Maturity stages were recorded according to the six point scale adopted from King (1995). All individuals whose gonads were identified as immature were assigned maturity stage I, while stages II, III, IV, V and VI represented developing, mature, ripe-running, spawning and spent individuals respectively. However, for analysis purpose, stage VI was categorized as mature and grouped together with stage V. Stage IV individuals were not recorded at all over the study period. Size at the onset of maturity was taken as the minimum length at which 50% of the fishes, males and females separately, were mature (Ellis 1971, King 1995). All stages III to VI individuals were considered as mature while stages I and II were regarded immature. The values (percentage) corresponding to lengths of individual fishes were put in an ogive model to determine size at first maturity.

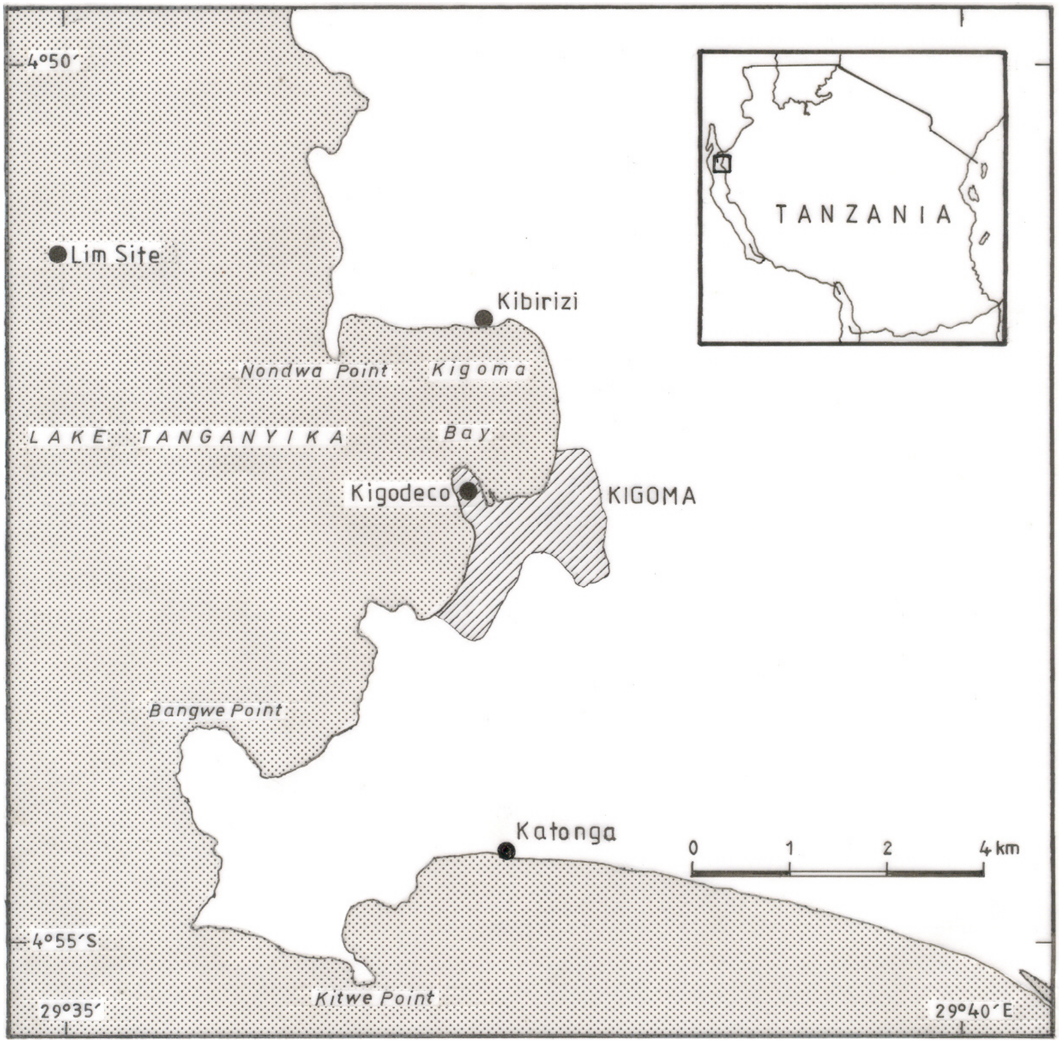

Figure 1: Map of Lake Tanganyika showing the sampling sites namely Kibirizi, Katonga and Kigodeco.

L. stappersii individuals were arbitrarily categorized as juveniles (<160 mm TL) or adults (>160 mm TL) for analysis purposes. The periods September – April and May – August were defined as wet and dry seasons, respectively.

Data analysis
Descriptive statistics were used to compute percentage compositions of *L. stappersii* in the catch. Seasonal trends in catch rates and breeding pattern were analyzed using a non-parametric Mann-Whitney U test, because the data were not normally distributed. Regression analysis and a special t-test were used to test for isometric growth pattern of *L. stappersii*. Monthly length frequency data were pooled to produce a frequency distribution histogram.

RESULTS

There were more *L. stappersii*, over the study period, in the area during February, May and July-August combined than during the other months (t = 6.349, DF = 7, p < 0.001) (Fig. 2A). Catch rates were similar for all the landing sites with peaks in February, May and July – August (Fig. 2B). This may indicate that all the fishes were caught from the same general area and that these are times when *L. stappersii* is most abundant in the pelagic catch in Kigoma area. There was no clear seasonality in CPUE in the area between wet and dry seasons (U' = 22.0, p = 0.35).

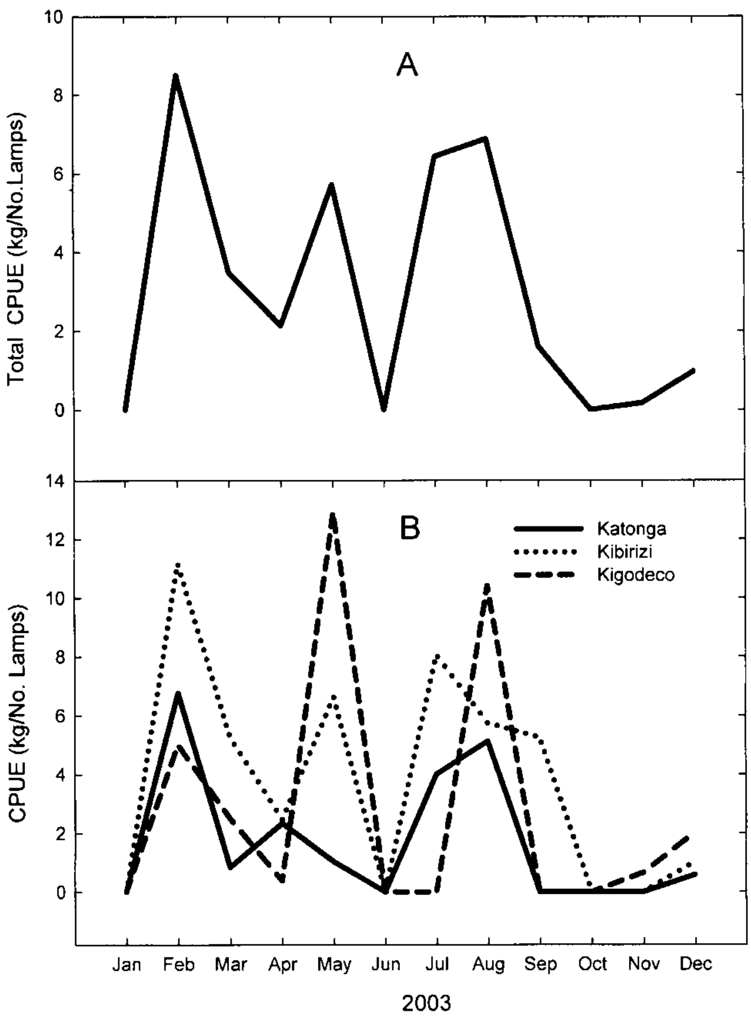

Figure 2: A: Seasonal variations in total CPUE for *Lates stappersii* in Kigoma area of Lake Tanganyika. B: Seasonal variations by site of *Lates stappersii* abundance in the Kigoma area of Lake Tanganyika.

Compared with other components of the pelagic fishery (*Stolothrissa tanganicae* and *Limnothrissa miodon*), *L. stappersii* was the second most important species in the catch with the minimum percentage recorded during September – December, at the onset of rains. It contributed only 14.19% of the total catch over the study period with the clupeid *S. tanganicae* dominating the catch (84.51%) and the rest (1.3%) being contributed by another relatively less important clupeid, *L. miodon*, in the Kigoma area. Generally, *L. stappersii* made a substantial but statistically insignificant (U' = 1572.5, p = 0.239) contribution to the catch during the rainy season (January – May). *L. stappersii* contribution varied from 0 to 33.85% (Fig. 3A). Historical catch data analyzed for the period 1993 to 1996 indicated that *L. stappersii* was very important, almost equaled the contribution by clupeids in 1993 and 1994, however, from 1995 its contribution declined leaving *S. tanganicae* to dominate the catch. *L. stappersii* contributed less than 25 and 40% in 1995 and 1996 respectively (Fig. 3B).

Length-frequency distribution from pooled monthly length-frequency data for *L. stappersii* is presented in Fig. 4. Several groups/cohorts are discernible; however, there seems to be little/negligible amount of individuals with size classes between 200 and 260 mm. Juveniles (<160 mm TL) of *L. stappersii* were always present in the catch however, they were more abundant during the rainy season, September- October and February – May.

Immature individuals (stage I) dominated the catch of *L. stappersii* over the sampling period. Although the seasonal abundance of immature individuals was statistically not significant (U' = 20, p = 0.570), these individuals were dominant during the wet season (September/October – April/May) (Fig. 5). Stage V individuals were always present except in January, September and November where over 80% of all *L. stappersii* sampled were juveniles/immature. All individuals caught in December were mature giving a sense of breeding aggregations for this species. There was a seasonal variation in Fulton's condition factor (K) of *L. stappersii*. It increased during the main spawning periods (February, July-August and December) while a drop was observed during January, March-May, and September-November when the catch constituted more of the immature, stage I, individuals of *L. stappersii*. The Fulton's condition factor (K) remained high for stage V individuals indicating that spawning individuals were in good condition (Fig. 6).

The length and weight data were tested for isometry using regression analysis and a special t-test was used to test if the slope b = 3. The results (t = 1.960, p < 0.0001) indicated that *L. stappersii* exhibited an isometric growth pattern with a length-weight relationship defined by the equation: $W\ (g) = 3*10^{-06}TL^{3.1783}$ ($n = 1428$, $r^2 = 0.9901$). The size at first maturity for females *L. stappersii* was 218 mm TL and that of males was 202 mm TL.

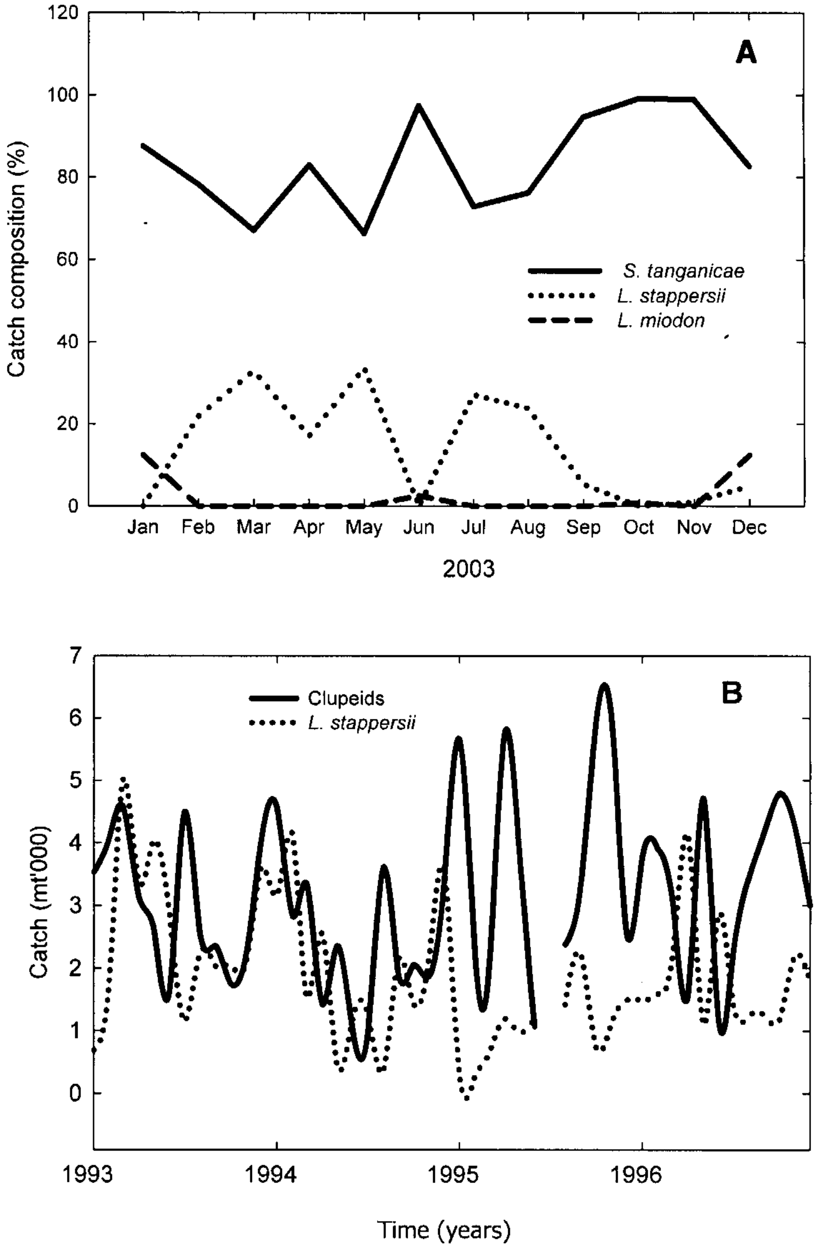

Figure 3: A: Catch compositions of the three most important pelagic fish species in the Kigoma area, Lake Tanganyika, indicating the relative importance of *Lates stappersii* in the pelagic fish catch. B: Historical catch composition of the pelagic fishery in the Kigoma area of Lake Tanganyika indicating the declining relative importance of *Lates stappersii* in the pelagic catches after December 1994.

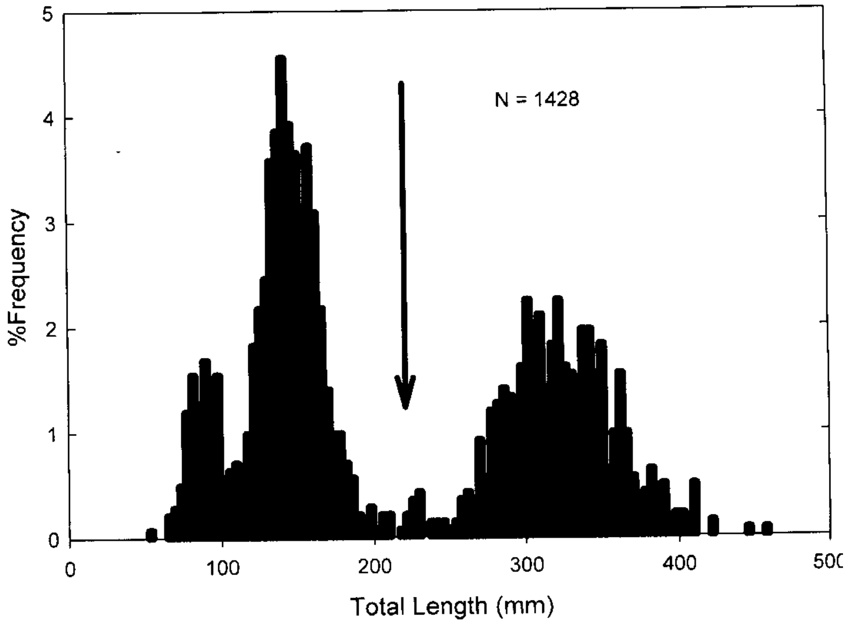

Figure 4: Length-frequency distribution for the pooled length frequency data of *Lates stappersii* over the sampling period (Jan – Dec 2003). The arrow indicates the absence of the new spawning individuals (200 -250 mm).

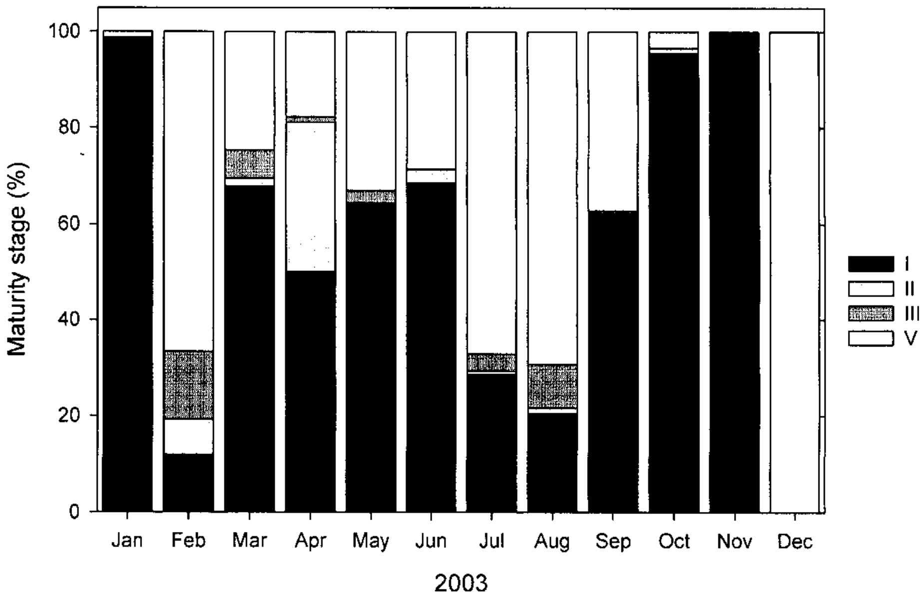

Figure 5: Seasonal variation in maturity stages of *Lates stappersii* in the Kigoma area of Lake Tanganyika. I - immature, II - developing, III - mature and V - spawning; stage IV was not encountered while stage VI was grouped with stage V for analysis purpose.

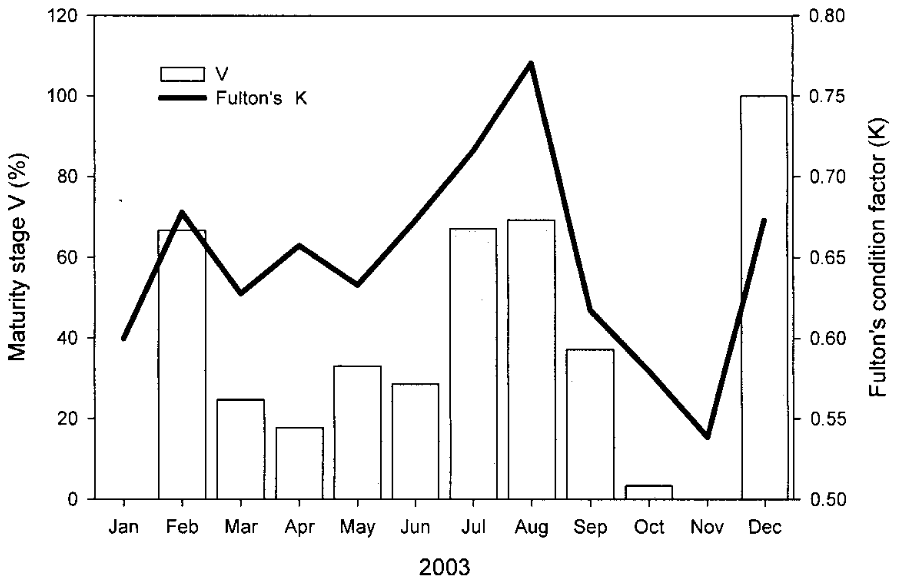

Figure 6: Seasonal variations between the condition factor (K) and stage V individuals of *Lates stappersii* in the Kigoma area of Lake Tanganyika.

DISCUSSION

Lates stappersii is known to be highly mobile capable of moving across the whole length of the lake (FAO 1978, Roest 1992). However, there is still no concrete evidence regarding large scale movements of this species (Mannini 1998), despite the fact that Phiri and Shirakihara (1999) have reported considerable seasonal movements of this species out of the Zambian waters. From the analysis of catch rates presented herein, *L. stappersii* seems to be evenly distributed in the Kigoma area; however, a lake-wide uneven distribution of this species has recently been reported by Mannini (1998). Mannini (1998) reported that *L. stappersii* occurs in all lake areas with the central lake area from Kigoma to East Marungu (D.R. Congo), characterized by steep shores, reduced shelf and where the deepest areas are located, being the optimal habitats for this species. The present study has revealed that relative abundance and composition of *L. stappersii* declined, followed by an increase in *S. tanganicae* (Figures 3 & 4), an indication of a strong predator-prey relationship (Chapman and van Well 1978, Roest 1988).

The study by Mannini (1998), using lake-wide acoustic and pelagic trawl surveys between June 1995 and February 1998, indicated the dominance of *L. stappersii* in the south and *S. tanganicae* in the northern half. *L. stappersii* seems to have been important in the catch during breeding times when larger, mature, individuals were dominant. The decline in *L. stappersii*, therefore, may indicate biomass decay of these large breeding individuals. However, *L. stappersii* is the principal predator of *S. tanganicae*; and their catches are strongly negatively correlated (Coulter 1991, Mannini 1998). Its movements therefore, seem to be determined in part by the movements of its prey, *S. tanganicae*. The high relative abundance observed in February and July-August coincided with the annual maximum abundance of its prey also reported by Mannini (1998) and Kimirei and Mgaya (2007). Because lift-nets are legally constructed with net webbing of 10 mm, large catches of only juvenile *L.*

stappersii are sometimes realized. The juveniles are also caught with adults of *S. tanganicae*. The mixed occurrence of juvenile *L. stappersii* and adult *S. tanganicae* could be explained by competition for food between them, rather than light attraction, as the two species are zooplanktivorous (Coulter 1991).

Juveniles and adults of *L. stappersii* co-occur within a geographical area although their inshore-offshore distribution differs (Mannini 1998). Because of the unselective nature of the nets used in catching the pelagic fishes, sometimes codends of <6 mm stretched mesh size are used (Pers. Obs) resulting in heavy exploitation of juveniles of *L. stappersii*. Large amounts of juvenile *L. stappersii* are caught together with adults of *S. tanganicae* (Pers. Obs.). The Kigoma area may serve both as a spawning and nursery ground due to the presence of both juveniles and sexually mature individuals. With the intensity of the lift-net fishing and its efficiency experienced today, it is likely that both recruitment and growth over-fishing of *L. stappersii* might have occurred resulting in the current overall dominance of the clupeid, *S. tanganicae*, in the catches. This is reflected by the mode of sexually mature and spawning individuals at 230–250 mm (Ellis 1978) is negligibly small from a frequency distribution of the pooled length frequency data.

Migration alone, of *L. stappersii* stock from the Kigoma area to other areas, especially the southern part of the lake, cannot explain its observed decline in the pelagic catch in the area and the northern end of the lake. Migration together with the predator-prey relationship between this species and the clupeids could account for seasonal abundance. Although no concrete evidence exists for local over-fishing (Shirakihara *et al*. 1992) and the suggestion by Mannini (1998) that the fishery can still be sustained in the southern part of the lake, the fishing pressure in the area is mounting. Chitamwebwa and Kimirei (2005) reported a fishing intensity to the tune of more than 400 lift-net units in the study area alone, which could also be an underestimate. If fishing effort is not monitored/controlled the end result will be a total collapse of the *L. stappersii* fishery in the Kigoma area and probably the whole lake, as this is probably an important spawning and nursery ground. A little expansion of the pelagic fishery in this area and the East Marungu, another spawning and nursery ground (Mannini 1998), or any move of the industrial fishing units in the south to follow the *L. stappersii* stock in these lightly fished areas, could result in a serious decline of the stocks. To-date, the pelagic catches are dominated by *S. tanganicae*, which contributes over 80%. This is in line with Coulter's (1981) predictions that with increasing fishing pressure *L. stappersii* will become scarce. Unlike *S. tanganicae* which is short lived (approximately 1 year), *L. stappersii* has a life span of about 5 to 7 years (Mulimbwa and Mannini 1993, Mannini 1998) and so would be depleted faster than *S. tanganicae*.

In conclusion, looking at the fishery from a 'classical' fisheries management perspective, the fishing effort may be high and could be the major factor affecting the realization of good catches in the area (Chitamwebwa and Kimirei 2005). However, from an ecosystem perspective, climate change cannot be ignored as one of the contributing factors to the observed declining stocks as suggested by O'Reilly et al. (2003) and Verburg et al. (2003). Several management measures can be applied on the fishery, after appropriate research on a suitable mesh size to be used in the fishery has been conducted, in order to minimize the exploitation pressure on *L. stappersii* and the pelagic fishery at large. These may include but not limited to closures, both spatial and temporal, minimum mesh sizes and size limits where minimum legal lengths are set. The last two have been successful in Lake Victoria. In addition, expansion of the fishery should be limited by allowing a limited number of fishers and fishing vessels through licensing. However, licensing should be used as a means of controlling the fishery rather than for revenue collection sake. It is also important to harmonize enforcement of management measures in all the riparian countries since the depletion of stocks in one part will consequently affect other areas.

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