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Maturity, fecundity, and breeding seasons of the major catfishes (suborder: siluroidea) in Lake Victoria, East Africa

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Three of the five major species of catfishes in Lake Victoria displayed continuous, protracted (fractional) spawning activity with half or more of the population in gonadal stages IV–VI. Pulses in reproductive activity occurred in all species and were generally positioned between the established, rainy seasons for East Africa. Although highly variable, relative fecundity was positively correlated with body length and weight of fish in all species. All five species matured sexually between their first and third year of life.

I. INTRODUCTION

Of the five major siluroid catfish species present in Lake Victoria, East Africa, (*Bagrus docmac, Clarias mossambicus, Schilbe mystus, Synodontus afro-fisheri* and *S. victoriae*: suborder siluroidea), the reproductive biology of only *B. docmac* (Elder, 1960) and *C. mossambicus* (Greenwood, 1955) have been studied previously. These two species are becoming increasingly important in fishermen's catches (Marten, 1979; Benda, 1979) and constitute a major food source for the rapidly growing human population in the region. The other three species, although not a commercial staple catch, comprise a substantial part of net and seine catches (Muller *et al.*, 1982) and locally are considered excellent sources of food and protein. Compounding a general increase in catch and corresponding decline in catch per unit effort (Benda, 1979) is a proposed bottom trawl fishery on Lake Victoria (Jackson, 1971, 1973; Payne, 1976). All five species have been captured by bottom trawling in varying abundances relative to depth (Kudhongania & Cordone, 1974). Combined, these factors deem it important to examine the basic biology of these species. This paper reports several aspects of the reproductive biology of the five siluroids in Lake Victoria.

II. METHODS

Fishes were collected by bottom trawling and gillnetting throughout Lake Victoria. Most specimens captured by trawling were taken during the 1969–1970 UNDP lake icthyomass surveys and additional specimens were obtained by bottom trawling with the UNDP 'Ibis' in 1974–1975 (Table I).

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1357

TABLE I. Monthly samples of each of the five species of Siluroid catfishes collected from Lake Victoria, 1969–1975

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Bagrus docmac	610	610	1008	153	959	580	746	525	376	347	218	790	6922
Clarias mossambicus	162	17	276		264	71	108	14	25	14	17	173	1141
Synodontis victoriae	327	625	390	237	542	364	159	31	311	111	69	707	3873
Synodontis afro-fisheri	89	15	323	52	262	49	232	36	101	119	25	68	1371
Schilbe mystus	52	55	70	9	394	111	83	101	6	47	10	241	1179

Fork length (F.L., cm) and weight (g) were measured and size at maturity determined as the length at which gonad stage IV was observed in an appreciable (> 10%) number of specimens. Relative fecundity (Nikolsky, 1963) was determined by the subsample weight methodology (Kesteven, 1960) and is defined here as 'the number of eggs per female as observed in individuals of gonadal stages V and VI'. Two subsamples were taken from each ovary of known weight, weighed on an electric balance, and number of eggs per subsample counted. A mean value and confidence limits were then calculated to estimate total number of eggs per female. Only the largest, developed (primary) ova were counted.

Regression analysis was performed to determine fecundity relative to both length and weight of fish. Breeding seasons were indirectly delineated based on the relative percentages of reproductive activity (i.e. breeding individuals or those in gonadal stages IV–VI) in temporal samples.

III. RESULTS

SIZE AT MATURITY

About 6% of female *B. docmac* were mature at 20–24 cm F.L.; however, it was not until fish reach 25 cm that more than 10% become mature (Fig. 1). A similar pattern of maturation existed for males, but maturity of more than 10% of individuals does not occur until 35 cm F.L. Both sexes of *C. mossambicus* mature abruptly at 40 cm F.L. in size (Fig. 1); however, a few males (4%) attained Stage IV at less than this size.

Both sexes of *S. victoriae* were mature by 9 cm F.L. and 40% plus of all specimens 11 cm F.L. or greater were reproductively active. Some (7%) female *S. afro-fisheri* and 26% of males mature at 8 cm F.L. Almost half (40%) of both females and males, however, did not mature until 9 cm F.L.

Female *Schilbe* mature by 11 cm F.L. and males by 13 cm F.L. (Fig. 1).

FECUNDITY

With the exception of *S. afro-fisheri* the correlation [$r = 0{\cdot}78$; Fig. 2(b)] of fecundity to either body length or weight in the other species, although positive, was generally low ($r = <0{\cdot}60$). Estimated fecundity in *B. docmac* varied from 2000 eggs in a 45-cm fish to 88 000 eggs in a 54-cm individual (Fig. 3). Fecundity limits for 28 *C. mossambicus* varied from 5000 eggs in a 63-cm fish to 192 000 eggs in a 77-cm fish. Fecundity was much lower in the two species of *Synodontis*. Estimated limits of fecundity were from 1500 to 15 799 and 200 to 15 000 eggs in *S. victoriae* and *S. afro-fisheri*, respectively (Fig. 2). Estimated fecundity in

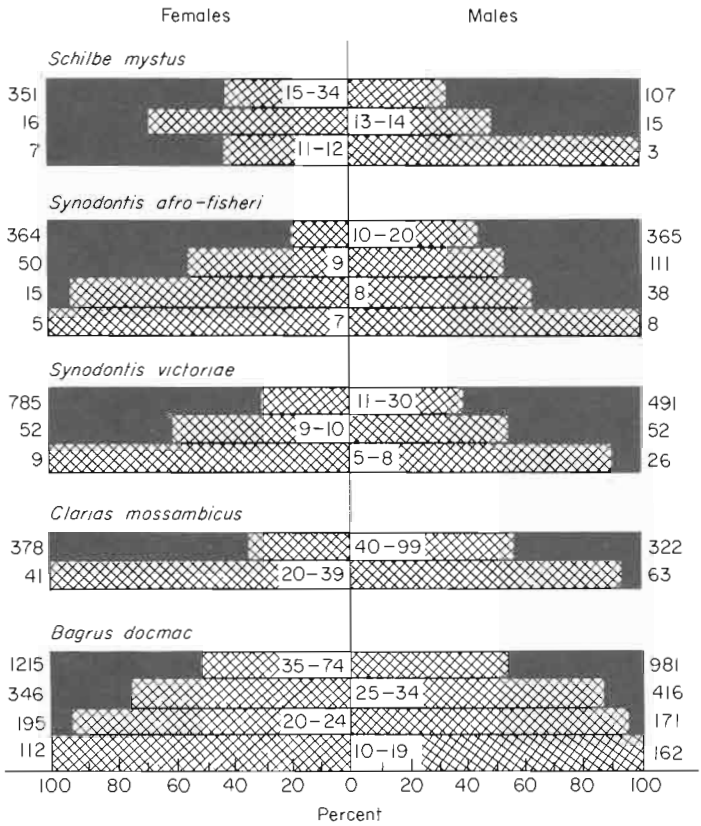

FIG. 1. Size at maturity of five siluroid catfishes in Lake Victoria. Percentage of females and males mature (gonadal stages ≥IV, solid bar) or immature (gonadal stages ≤III, cross hatching) by respective size limits (mm) are shown. Sample sizes are on the left (females) and right (males).

Schilbe mystus was greater (48% of 40 specimens >16 000 eggs) than in the two *Synodontis* spp., but less than the other two siluroids.

BREEDING SEASONS

Almost 7000 *B. docmac* were examined to determine the period of apparent peak reproductive activity (Table I). A single although slight reproductive pulse occurred in August–September (Fig. 4). During the remainder of the year only a fifth of the individuals examined were gravid and in spawning condition and 80% of the population was in developing state (gonadal stages I–III).

Compared to *Bagrus*, fewer individuals of *Clarias* were available for examination and half the months were represented by small sample size (<25 fish, Table I, Fig. 4). Reproductive activity in this species was greatest in June and August–October; however, sample sizes were meagre for the August–October peak when about half (45%) of all *Clarias* were in Stages IV–VII.

Overall, the two species of *Synodontis* were similar in breeding season (Fig. 5). From 45% (*S. victoriae*) to 65% (*S. afro-fisheri*) of the populations were in constant

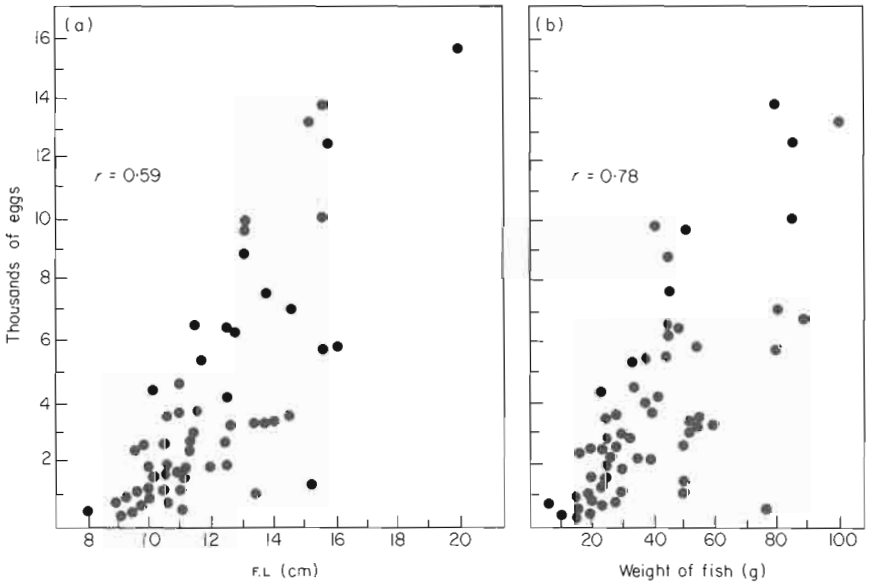

FIG. 2. Relationship between body length (a) and weight (b) and fecundity for *Synodontis afro-fisheri*.

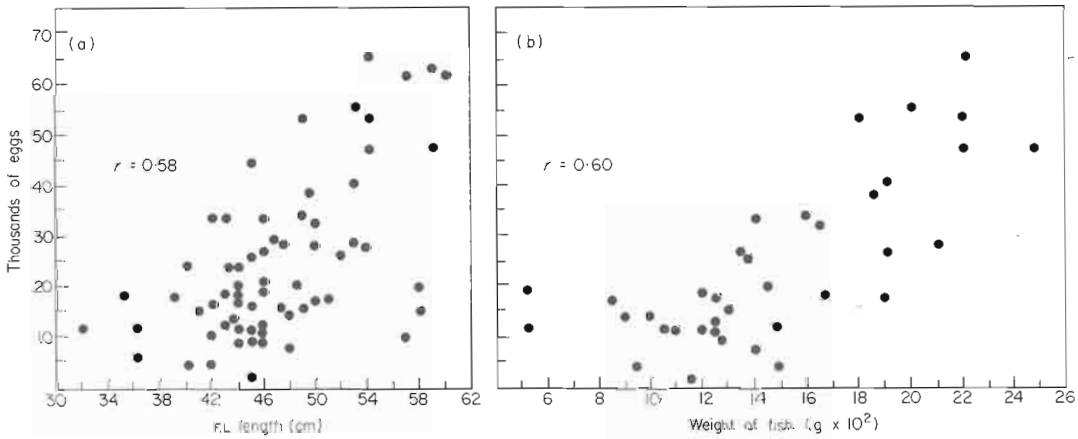

FIG. 3. Relationship between body length (a) and weight (b) and fecundity of *Bagrus docmac* collected in Kenya waters of Lake Victoria.

gravid condition or spawning readiness, and a half to a third, respectively, were in developing stages throughout the year. Slightly elevated reproductive activity occurred in *S. victoriae* in January and as in *Bagrus*, in August–September. By comparison, 90% of *S. afro-fisheri* were gravid in January, April and August.

On an annual basis, monthly averages indicated that generally half of the population of *Schilbe* was in continuous spawning readiness (Fig. 4). Pulses of reproductive activity based on gonadal stages occurred in January, May–July, and October–November.

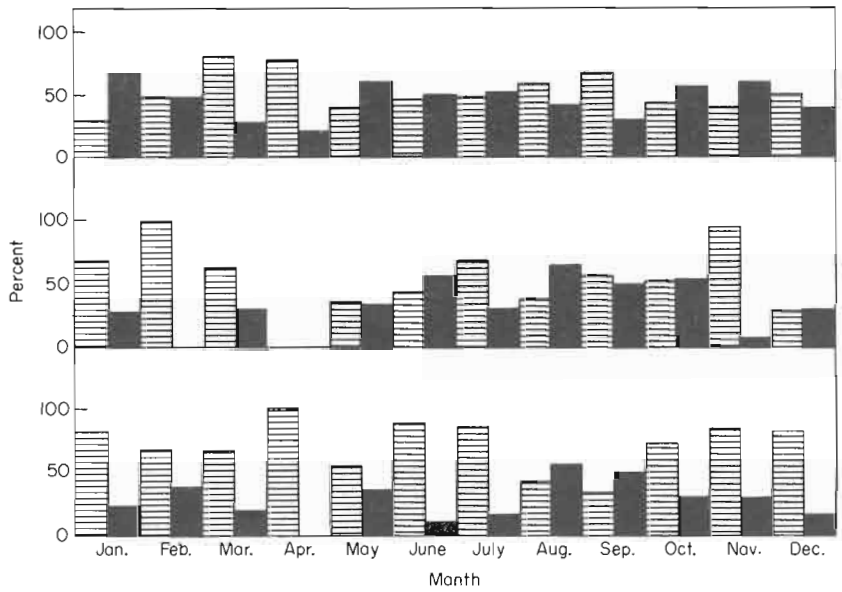

FIG. 4. Breeding seasons of *Bagrus docmac* (lower), *Clarias mossambicus* (middle), and *Schilbe mystus* (upper) based on percentages of developing (gonadal stages I–III; cross-hatched) and gravid/spawning (gonadal stages IV–VII; solid) males and females annually. Specimens are from throughout the Lake. See Table I for monthly sample sizes.

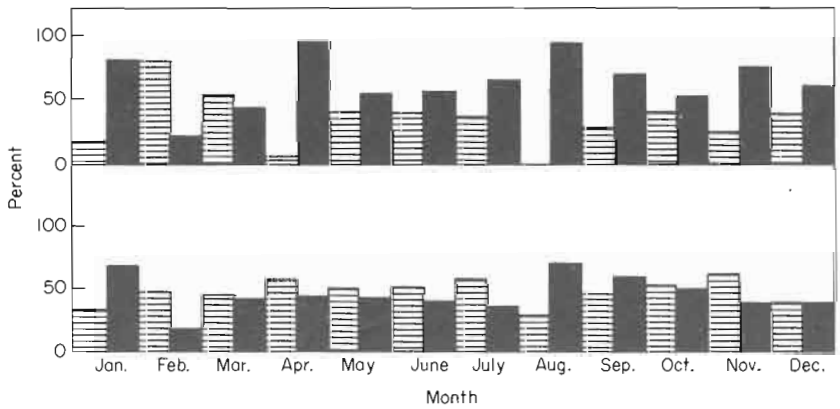

FIG. 5. Breeding seasons of *Synodontis victoriae* (lower) and *S. afro-fisheri* (upper) in Lake Victoria. Legend is the same as given for Fig. 4. See Table I for sample sizes.

IV. DISCUSSION AND CONCLUSIONS

Ageing of tropical fishes is problematic; however, based on a combination of length frequency (Chilvers, 1968), vertebrae analysis (Rinne, 1974, 1975), and tag return data (Muller *et al.*, 1982), size at maturity is interpreted as follows: *Bagrus* matures between its second and third year of life, and *Clarias* breeds by its third year of life. Cursory analyses of length frequency data suggest *S. victoriae* matures

between Year 1 and 2, *S. afro-fisheri* after Year 1, and *Schilbe* matures at the beginning of the second year.

Although highly variable, fecundity was directly correlated with both body length and weight in all five species. The amount of variation in relative fecundity is partially explainable by these siluroids' continuous, multiple or fractional spawning nature. Protracted spawning is common in tropical species of fish and serves as an adaptive mechanism to availability of food and favourable spawning conditions (Nikolsky, 1963: 141). Nevertheless, low correlations preclude any reliable predictions of relative fecundity based on either catfish length or weight.

Worthington (1932) reported *B. docmac* spawned in May in the White Nile. Only the breeding season of *B. docmac* has been previously reported in Lake Victoria. Based on 2000 fish Elder (1960) concluded there was a single breeding season, but he placed that peak in January, as opposed to August–September (our data). His data are based on gillnetted fishes while the majority of the present data are from bottom trawling. Difference in capture depths between these two gear types could influence data but no apparent differences in spawning activity by depth of capture could be detected. Further, gonadal states only indicate reproductive readiness, however, local meteorological conditions as discussed by Chilvers (1968) most likely trigger the actual spawning event.

Clarias has been reported to breed during the rainy seasons—primarily April and December—in tributary streams of Lake Victoria (Greenwood, 1955; Whitehead, 1959). This is in contrast to the reproductive status of *Clarias* we examined from the Lake (Fig. 4). Differences may be attributable to river- and lake-spawning cohorts. The two species of *Synodontis* had bi- to tri-modal reproductive pulses. Similar to *Bagrus*, both displayed an August–September spawning peak in addition to a January pulse (Fig. 5).

Of the five siluroids we examined from Lake Victoria, three appear to have half or more of the population in constant gravid/spawning condition (gonadal stages IV–VII). All species displayed either January or August pulses. As in *Tilapia* species and another Lake Victoria catfish, *Xenoclarias* (Rinne, 1980), the two species of *Synodontis* and *Schilbe* displayed a reproductive pulse in January. Reproductive surges occurred in August in *Clarias, Bagrus,* and the two species of *Synodontis.* In addition, *Clarias, S. afro-fisheri* and *Schilbe* displayed a pulse in the May–July period. Only *Schilbe* had an October–November pulse which synchronizes with the general period of the 'short-rains'.

It is open to interpretation if these reproductive peaks of the other four species are pre- or post-rainy season. That is, the August–September and January reproductive peaks are interposed between the two rainy seasons and suggest in general that except for *Schilbe,* catfishes considered here have spawning pulses either prior to, or following the long (March–June) and short (October–November) rains. In either case, such a reproductive strategy could be synchronized with increased food and favourable spawning and rearing areas.

Samples of the five catfish species were collected spanning a 6-year period (1969–1975), over the entire lake, and at various depths. The massive size of the lake, timing and variability of the rainy seasons (Rhode & Virji, 1976), and sampling over half a decade all add variability to the data and combined, these factors render interpretation difficult. As suggested for *Xenoclarias* (Rinne, 1980) and implied by Chilvers (1968) variation in any of the reproductive parameters is

undoubtedly linked to local meteorological and hydrological conditions and to be meaningful, definition of reproductive biology has to be done on a local or regional basis by reliable spatial-temporal sampling within the lake (Rinne, 1980). *Bagrus* and *Clarias* are currently very important in the fishery of the lake (Benda, 1979) and their reproductive biology should be better defined to facilitate future, effective management of the species within the lake.

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