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Suitability of brackish water tilapia species from the Ivory Coast for lagoon aquaculture. I - Reproduction

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Abstract

The main characteristics of the reproductive biology of *Tilapia guineensis* and *Sarotherodon melanotheron* have been studied in Ebrié lagoon (Ivory Coast), with a comparison between natural and cultured populations. In this lagoon, the two species breed throughout the year without interruption. However, seasonal variations in the intensity of the sexual activity have been observed and are more pronounced at the Layo aquaculture station, where the hydroclimate is more unstable than in other lagoon sectors studied. The proportion of mature individuals, the mean GSI, the relative fecundity and the spawning frequency are higher during the dry season than during the rainy season. In rearing enclosures, both species reach sexual maturity at a smaller size, and produce smaller but more numerous oocytes than in the wild. On the other hand, the relationship between the spawn weight and the female body weight are remarkably similar under both situations. For *S. melanotheron*, which is a male mouthbreeder, the number of brooded eggs or fry is positively related to the male body weight. In 2 m^3 concrete tanks, the mean elapsed time between two successive spawnings is about 2 weeks for *S. melanotheron* and about 3 weeks for *T. guineensis*.

Keywords : *Tilapia guineensis*, *Sarotherodon melanotheron*, reproduction, aquaculture, brackish water, Ivory Coast.

Potentiel aquacole des tilapias lagunaires de Côte-d'Ivoire. I-Reproduction.

Résumé

Les principales caractéristiques de la reproduction de *Tilapia guineensis* et de *Sarotherodon melanotheron* ont été étudiées en lagune Ebrié, avec une comparaison entre population naturelle et population d'élevage. Dans cette lagune, les deux espèces se reproduisent sans interruption tout au long de l'année. Des variations saisonnières dans l'intensité de l'activité sexuelle sont toutefois mises en évidence et apparaissent plus marquées à la station d'aquaculture de Layo, où l'hydroclimat est plus instable que dans les autres secteurs lagunaires étudiés. La proportion d'individus matures, le RGS moyen, la fécondité relative et la fréquence des pontes sont plus élevés en saison sèche qu'en saison des pluies. En enclos d'élevage, les deux espèces parviennent à maturité à une taille inférieure, et produisent des ovocytes plus petits et plus nombreux que dans le milieu naturel. En revanche, les relations entre poids de ponte et poids de femelle sont remarquablement voisines pour les deux milieux. Pour *S. melanotheron*, chez lequel le mâle pratique l'incubation buccale, le nombre d'œufs ou d'alevins incubés est corrélé positivement au poids des mâles. En bassins cimentés, l'intervalle de temps moyen séparant deux pontes successives est d'environ 2 semaines chez *S. melanotheron* et 3 semaines chez *T. guineensis*.

Mots-clés : *Tilapia guineensis*, *Sarotherodon melanotheron*, reproduction, aquaculture, eau saumâtre, Côte-d'Ivoire.

INTRODUCTION

Tilapia guineensis and *Sarotherodon melanotheron* are typical estuarine species which can be found in abundance in most of the lagoons and estuaries of West Africa. They can live and reproduce in a wide range of salinities, from 0 to $90\,g.l^{-1}$ (Albaret, 1987). Related to the wide surface area ($1\,200\,km^2$) of Ivory Coast's coastal lagoons, these fishes have a great economic importance, ranking among the major species caught within the lagoon fisheries (Durand and Skubich, 1982). They are also recognised as being of potential interest for aquaculture (Sivalingam, 1976; Pauly, 1976; Legendre, 1983), a point which has been further evaluated recently by various rearing trials (Legendre *et al.*, 1989).

Behavioural patterns related to reproduction and to parental care lavished on eggs and fry establish a clear distinction between *Tilapia guineensis* and *Sarotherodon melanotheron*; in a more general way these patterns represent one of the distinctive criteria between both genera, *i. e. Tilapia* and *Sarotherodon* (Trewavas, 1982).

– *T. guineensis* is a substrate-spawner. At spawning time, *T. guineensis* builds a nest in which it will closely watch the eggs and later the fry, thus limiting the action of possible predators. The nests, which are built by sucking up sediment and spitting it out around the site, have an aspect which varies according to the nature of the substrate on which they are based. On a sand bed, the nests have the shape of a basin, whereas on a harder substrate (e. g. hard silt) their structure is more complicated, including galleries excavated in the sediment. In lagoon enclosures (Hem, 1982), these galleries can reach impressive dimensions (up to 1 m deep), which limits the possibilities of rearing *T. guineensis* in such facilities (Legendre, 1983). When the substrate is not suitable for building a nest, e. g. in concrete tanks, the eggs are simply laid on the wall of the tank to which they adhere. It should be noted that eggs stuck on hard substrates have also been observed in enclosures, which shows that *T. guineensis* has a great capacity to adapt its reproductive behaviour to the environment.

– *S. melanotheron* is a mouth-breeder. At spawning time, *S. melanotheron* builds only slight depressions on the surface of the sediment; the eggs are laid and fertilized in these depressions and are taken into the mouth by the male shortly thereafter (Aronson, 1949). The hatching of eggs takes place in the buccal cavity and this mouth brooding behaviour continues until complete absorption of the yolk sac.

Although the reproduction of *S. melanotheron* has been widely studied (*see* Trewavas, 1983 for review), most of the work has been focused on behaviour observed under experimental conditions in aquaria. Data on the reproductive biology of *S. melanotheron* and *T. guineensis* in their natural West African environment are by contrast rather scarce (Pauly, 1976; Fagade, 1979; Payne, 1983; Eyeson, 1983), and almost nonexistant for Ivory Coast brackish waters. Recently, a research program on the reproduction of both species in Ebrié lagoon has been initiated at the Abidjan Oceanographic Research Centre, with a view to obtaining information which could be useful (1) for better management of the fisheries and, (2) for mass production of fry in aquaculture.

The purpose of this paper is to present a general review of the main reproductive characteristics of both species in Ebrié lagoon, with a comparison between wild and cultured populations. Aspects investigated are: size at first sexual maturity, seasonal cycles, fecundity, oocyte weight and spawn weight, mouth brooding for *S. melanotheron*, and spawning frequency.

MATERIAL AND METHODS

The observations and experiments were carried out between 1982 and 1985 at the Layo aquaculture research station, located 40 km West of Abidjan in an oligo- to mesohaline area of Ebrié lagoon. Size at first sexual maturity, seasonal cycles and fecundity were recorded simultaneously for natural and cultured populations, whereas mouth brooding for *S. melanotheron* and spawning frequency of both species were studied only in cultured fish.

Specimens from the wild were obtained from the Western sectors of Ebrié lagoon, They were bought directly from artisanal fishermen soon after being caught, and then treated at the laboratory the same day. The hydroclimate of the lagoon sectors studied, permanently oligohaline, have been extensively described in previous papers (Durand and Skubich, 1982; Durand and Chantraine, 1982).

In culture, individuals of various sizes of both species were mixed together in a $625\,m^2$ enclosure, at an initial stocking rate of 5 fish per m^2. They were fed with a 31% crude protein pelleted feed (Legendre, 1983), distributed twice daily, six days a week, with a daily rate fixed at 5% of the total fish biomass.

During a 16 month period, specimens of both species (usually more than 30 fish) were sampled monthly both in the wild and in enclosures. Fork length and body weight of each individual were determined to the nearest 1 mm and to the nearest 1 g respectively. The gonads were checked macroscopically for maturity stage and then removed and weight to the nearest 0.01 g for gonado-somatic index (GSI) calculation (gonad weight/total body weight × 100).

The maturity scale used for the determination of sexual stages by macroscopic examination of the ovaries was primarily established after characterization of each stage by the GSI, the size-frequency distribution of intraovarian oocytes and the histological appearence of the gonads. That scale includes seven stages:

– stage 1: immature;
– stage 2: in beginning maturation;
– stage 3: in maturation;
– stage 4: in advanced maturation;
– stage 5: ripe, oocytes can be expelled by a gentle pressure on the abdomen;
– stage 6-2: post-spawning;
– stage 6-3: recovery of maturation after spawning.

Besides the general aspect of the gonads, stages 6-2 and 6-3 are distinguished from stages 2 and 3 respectively by the presence of large-sized atretic residual oocytes, visible only in post-spawned individuals.

In the males, as the testis always remain very small, particularly for *S. melanotheron* (Peters, 1971), only three stages were considered:

– stage 1: immature;
– stage 2: maturing (absence of intratesticular sperm);
– stage 3: mature (presence of intratesticular sperm).

The size at first sexual maturity (L_{50}) was defined here as the fork length at which 50% of the fish are at an advanced stage (superior or equal to stage 3 of the maturity scale) of the first sexual cycle. Moreover, in order to define the spread of the size range in which first maturity is likely to take place, it is useful to determine, besides the L_{50}, the length of the smaller-sized mature fish as well as the size at which most of the fish (95%) are in an advanced maturity stage.

The fecundity was determined from preserved ovaries sampled from females at an advanced maturation stage (stage 4); in this case, fecundity represents the number of oocytes belonging to the largest diameter modal group which corresponds approximately to the number of eggs which would have been laid. The average oocyte weight was determined by weighing (to the nearest 1 mg) 50 oocytes for *S. melanotheron* and 100 oocytes for *T. guineensis.* The spawn weight (in fact it is more precisely the total weight of oocytes to be laid) was calculated as following: fecundity × average oocyte weight. Since that calculation is only meaningful for fish in which oocyte growth has been completed, only female fish having a GSI superior to 5 for *S. melanotheron* and superior to 7 for *T. guineensis* were taken into account for this study.

In order to evaluate the efficiency of oral incubation in *S. melanotheron,* the relationship between the number of brooded eggs or fry and the weight of the brooding male has been studied from 127 fish belonging to the enclosure population. The brooding males, identified underwater with scuba by their characteristic pouch under the lower jaw, were caught individuallly with a cast-net and quickly placed into a basin, where the eggs or fry were generally released out immediately. The progeny were subsequently totally counted, including the eggs or fry that could have been swallowed.

The spawning frequency, *i.e.* the elapsed time between two successive spawnings, was studied with three pairs of *S. melanotheron* and three pairs of *T. guineensis.* Each pair, composed of breeders weighing between 120 and 280 g on the average and fed with a 31% crude protein pelleted feed, was placed in a 4 m^2 concrete tank with a 0.5 m depth, and observed for a period varying between 398 and 601 days. Every week the tanks were drained and the spawns recorded (brooding male for *S. melanotheron* and eggs stuck on the walls of the tanks or schooling fry for *T. guineensis*). The actual date of spawning was estimated on the basis of the degree of development of the collected eggs or fry. In all cases the eggs were removed from the tanks as well as from the males' mouth (for *S. melanotheron*).

RESULTS

Size at first sexual maturity

The progressive sexual maturation of *T. guineensis* and of *S. melanotheron* in relation to their growth is plotted in *figure* 1, both for the natural and reared populations. The size of the smaller-sized mature fish caught during samplings, as well as the L_{50} and the L_{95}, determined graphically, are given in *table* 1.

In enclosure conditions, *S. melanotheron* females reach maturity at a much smaller size (140 mm) than under natural conditions (176 mm). For *T. guineensis,* although the L_{50} is nearly the same in the lagoon and in the rearing environment (159 and 154 mm respectively), a larger proportion of small-sized sexuality active fish can be observed in the enclosures (*fig.* 1). For both species, the size at first sexual maturity of males and females appears to be very similar, as is seen in the enclosure population results (*table* 1).

Seasonal cycle

Lagoon tilapias reproduce throughout the year, without a distinct reproductive season. Both under natural and rearing conditions, a high proportion of maturing fish (between 40 and 90%) were always observed in the monthly samples.

In the lagoon environment, the evolution of the average monthly GSI does not show a seasonal variation in the intensity of sexual activity in either *S. melanotheron* or *T. guineensis;* however, the average monthly GSI varies much more clearly among the fish population of the Layo station (*fig.* 2). In the case of *S. melanotheron,* sexual activity appears to be higher during the dry and hot season (January to April) than during the rainy season (June to August). In the case of *T. guineensis,* this trend is similar

Table 1. – Size (for length) at first sexual maturity for natural and reared populations of *S. melanotheron* and *T. guineensis*. SSMF: smaller-sized mature fish; L_{50}: size at which 50% of the fish are sexually mature; L_{95}: size at which 95% of the fish are sexually mature.

Species	Origin	Sex	Nb of fish observed	SSMF (mm)	L^{50} (mm)	L^{95} (mm)
S. melanotheron	Enclosure	F	783	100	140	180
		M	211	105	138	200
	Lagoon	F	365	146	176	223
		M	96	148	(1)	(1)
T. guineensis	Enclosure	F	628	100	154	195
		M	358	99	152	215
	Lagoon	F	620	130	159	197
		M	128	123	(1)	(1)

(1) non available data

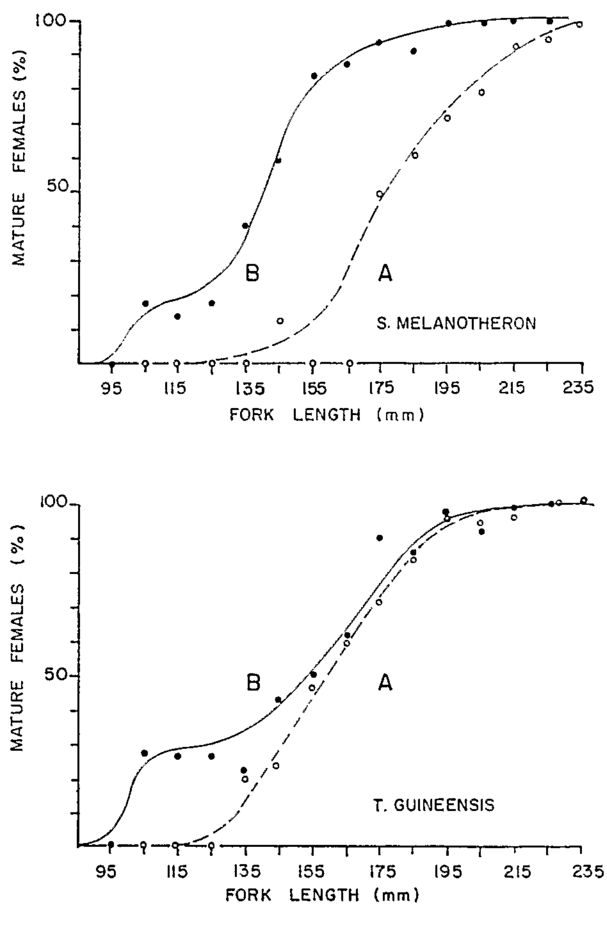

Figure 1. – Size at first sexual maturity of females for natural and reared populations of *S. melanotheron* and *T. guineensis*. A: lagoon; B: enclosure.

although less obvious than for *S. melanotheron* during the second half of the observation period (*fig.* 2).

Fecundity, oocyte weight and spawn weight

In all our species/environment combinations, both fecundity and spawn weight were significantly correlated with the female body weight (*fig.* 3). However, in all cases a stronger relationship exists between spawn weight and body weight than between fecundity and body weight (*table* 2).

Interesting differences in the reproductive strategy of *S. melanotheron* and of *T. guineensis* have also been noticed between natural and reared populations. For the same female weight, oocytes produced under enclosure conditions are smaller but more numerous than under natural conditions. On the other hand, the relationship between spawn weight and female body weight is similar in both environments (*fig.* 3; *table* 2).

Mouth brooding for *S. melanotheron*

A significant correlation ($r=0.793$) between the number of brooded eggs or fry and the weight of the brooding male was noticed (*fig.* 4). The linear regressions between the number of brooded eggs or fry and the male body weight on one hand, and between the fecundity and female body weight on the other hand, have been statistically compared using the Reeve multiple comparison of regression lines. No differences between the slopes were found, but the intercepts differed significantly ($p<0.01$). Therefore, the two regression lines can be considered as parallel.

Spawning frequency in concrete tanks

For the isolated pairs reared in $2\,m^3$ concrete tanks, the elapsed time between two successive spawnings is about 2 weeks for *S. melanotheron* and about 3 weeks for *T. guineensis* (*table* 3). The spawning frequency appears to be less regular for *T. guineensis* since rather long "resting periods" – up to 126 days –, were observed. The seasonal evolution of the average number of spawnings per month (*fig.* 5) shows a clear

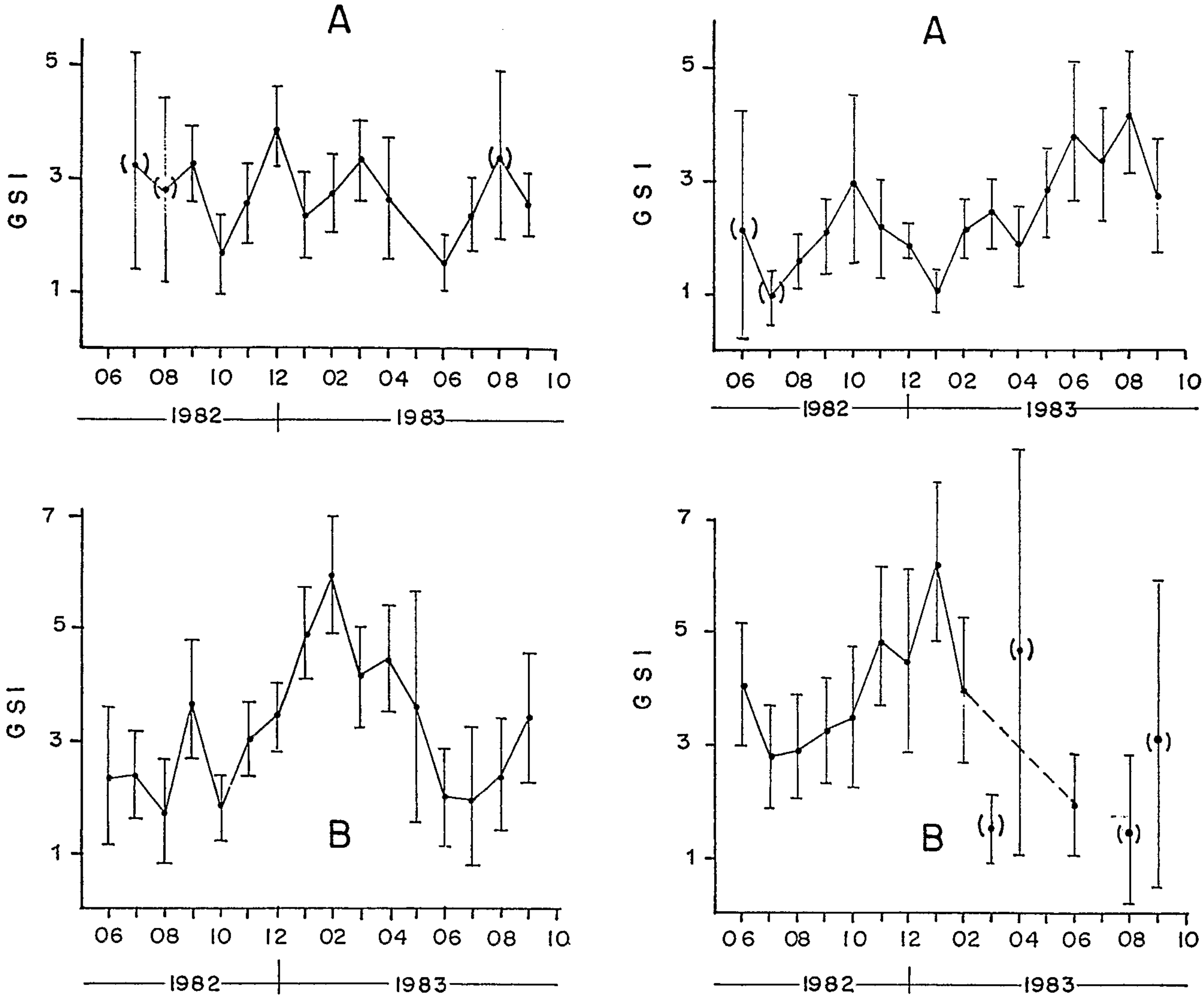

Figure 2. — Seasonal variations of the average GSI for females of *S. melanotheron* (on the left) and *T. guineensis* (on the right). A: lagoon; B: enclosure. Vertical bars refer to the confidence interval of the mean GSI at a 5%risk. Females which are considered here are only those which have a size superior to the size at first sexual maturity.

decrease in the sexual activity of both species during the rainy season (June-July), which corroborates the above mentioned observations concerning the seasonal reproductive cycle.

DISCUSSION AND CONCLUSION

Maturity size

It is known that under natural conditions, the maturation size of tilapia species tends to be smaller in small bodies of water than in larger ones (Lowe-McConnell, 1982). Since Ebrié lagoon is one of the largest brackishwater lagoons in West Africa, it is not surprising that the size at first maturity for wild populations of *T. guineensis* and *S. melanotheron* appears to be greater in this lagoon than in all other localities where it has been studied, with a possible exception in the case of *T. guineensis* from the Casamance River (Albaret, 1987).

For both species, but particularly for *S. melanotheron*, the size at first maturity is smaller under enclosure rearing conditions than in the wild. Under culture, sexual maturity is attained at between 6 and 8 months of age for *S. melanotheron* and between 7 and 9 months of age for *T. guineensis*. But because of a lack of data on the growth of tilapias under natural conditions, it is not possible to determine if the discrepancy observed between fish living under enclosure and under lagoon conditions is due only to a difference in growth rates or if it is also accompanied by a difference in the age at first maturity. Eyeson (1983) reported that in a confined environment *S. melanotheron* can be sexually active at 4 to 6 months old and at a size as small as 4 to 5 cm (SL). Lowe-McConnell (1982) demonstrated that populations of *Oreochromis niloticus* with low weight for

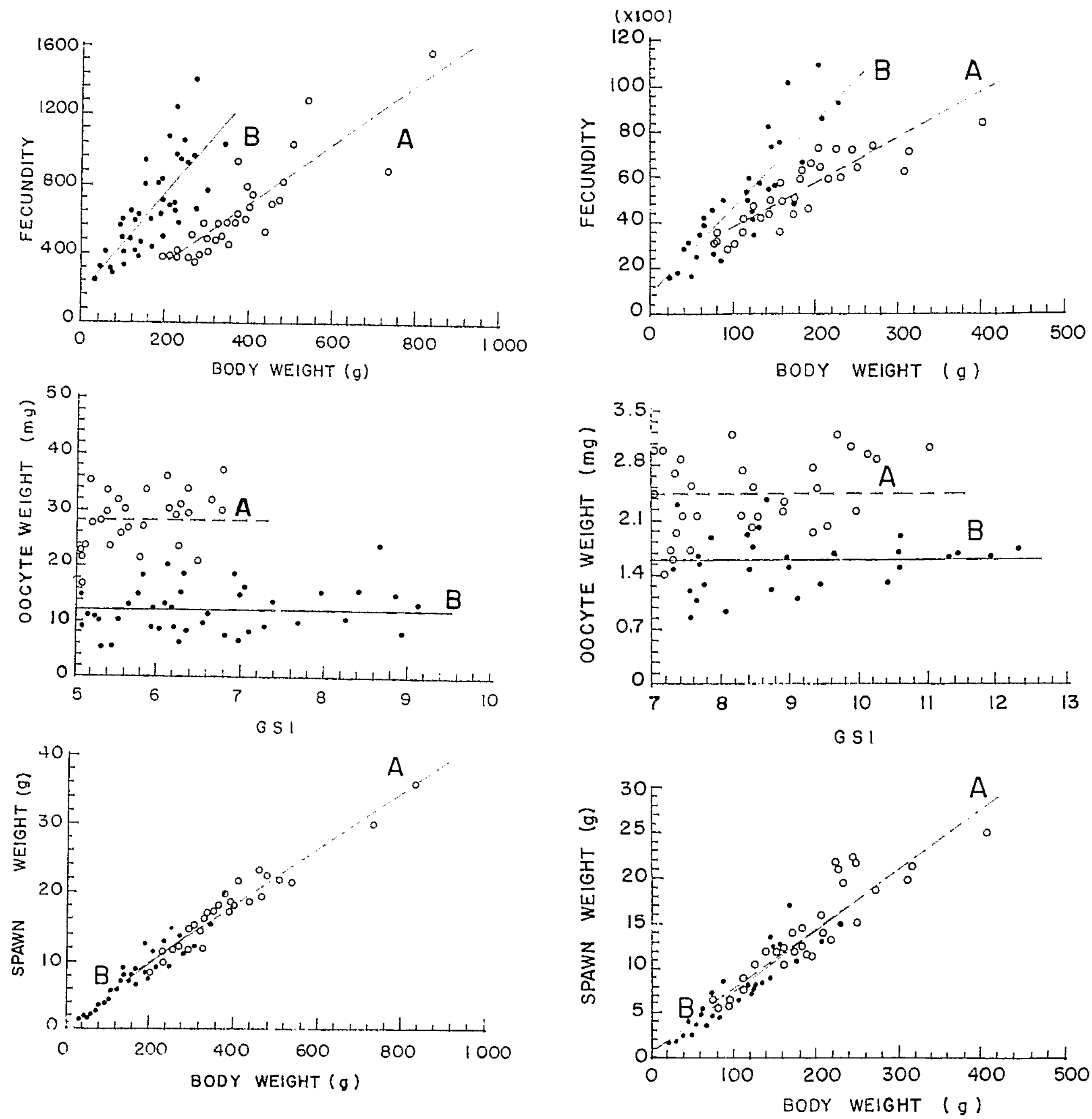

Figure 3. – Comparison between the following relations: Absolute fecundity to female body weight, oocyte weight to GSI and spawning weight to female body weight, for natural and reared populations of *S. melanotheron* (on the left) and of *T. guineensis* (on the right). A: lagoon; B: enclosure. In the middle graphs, horizontal lines refer to the mean oocyte weight.

length switch to reproduction at a smaller size than those in which the fish are in better condition. In our study, we also found an average condition factor (W/L^3) lower for the fish under culture (2.06 and 2.09) than for the fish from the wild (2.24 and 2.34, for *T. guineensis* and for *S. melanotheron* respectively). Moreover, it is interesting to note that in "acadja-enclos", a particular form of extensive rearing (Hem, 1988), where the condition factors for *S. melanotheron* are as high as in the lagoon, the size at first maturity (L_{50}) is about 18 cm, very similar to that observed under natural conditions.

Seasonal cycle

In Ebrié lagoon, *S. melanotheron* and *T. guineensis* reproduce throughout the year, either under natural or culture conditions. However, seasonal variations

Table 2. — Statistical relationships of absolute fecundity (F) to female body weight (W) and of spawn weight (Sp.Wt) to female body weight, and mean oocyte weight for natural and reared populations of *S. melanotheron* and *T. guineensis*.

Species	Origin	N	Relationship	*r*	Mean oocyte weight (mg)
S. melanotheron	Enclosure	46	F=2.61 W+203.9 Sp.Wt=0.045 W+0.32	0.777 0.939	12.06±1.28
	Lagoon	31	F=1.72 W−15.0 Sp.Wt=0.041 W+1.60	0.871 0.963	28.03±1.90
T. guineensis	Enclosure	34	F=38.02 W+783.2 Sp.Wt=0.07 W+0.34	0.864 0.924	1.58±0.12
	Lagoon	34	F=18.61 W+2018.0 Sp.Wt=0.07 W+0.83	0.883 0.916	2.41±0.17

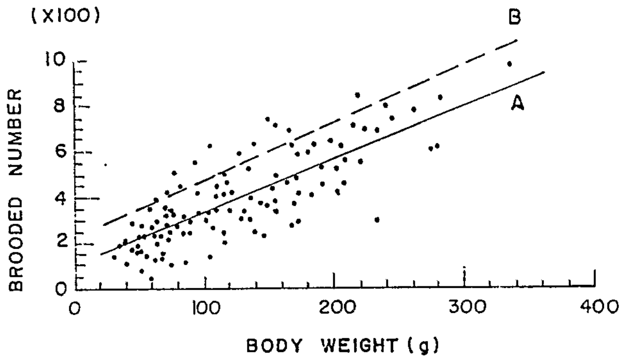

Figure 4. — Relation of the number of brooded eggs or fry to male body weight for *S. melanotheron* reared in enclosure (A) ($N=2.29\,W+107.15$; $r=0.739$); (B) linear relationship of absolute fecundity to female body weight for *S. melanotheron* reared in enclosure ($F=2.61\,W+203.91$; $r=0.777$).

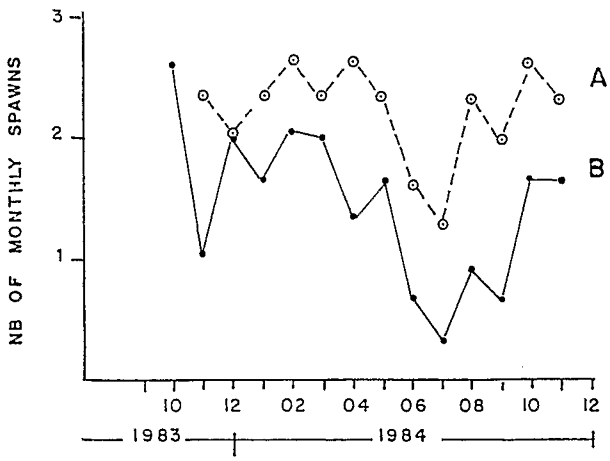

Figure 5. — Seasonal changes in the spawning frequency for *S. melanotheron* (A) and *T. guineensis* (B) in concrete tanks.

Table 3. — Spawning frequency for *S. melanotheron* and *T. guineensis* in concrete tanks.

Species	Pair (No.)	Observation period (day)	Average weight of breeding-fish (gram)		Nb. of spawning observed	Number of days between spawnings
			Female	Male		
S. melanotheron	1	587	172	194	43	14.0± 1.7
	2	475	164	130	30	15.8± 3.5
	3	398	152	269	34	12.1± 0.9
T. guineensis	1	601	171	213	38	16.2± 2.7
	2	433	132	154	18	25.5± 7.3
	3	408	112	286	20	21.5±12.1

in the intensity of the sexual activity have been observed. For both species, the proportion of maturing individuals, the mean GSI and the spawning frequency are higher during the dry season than during the rainy season. The fact that seasonal fluctuations in reproductive intensity are more evident at the Layo Station than in the Western sectors of Ebrié lagoon seems to be related to the higher hydroclimate stability of the latter (Durand and Skubich, 1982). At the station, the hydroclimate, strongly influenced by the vicinity of the Agneby river estuary in the lagoon, is subjected to a dominating continental influence during the flood season (Albaret and Legendre, 1983; Guiral, 1983). However, for any given environment, seasonal variations in relative fecundity have been observed for both species. In all the situations which have been studied, the relative fecundity is on the average higher during the dry season than during the rainy season (Ecoutin and Legendre, unpubl.). In a general way, these findings are consistent with those reported in the literature. For *S. melanotheron*, at a constant temperature in a laboratory greenhouse, spawnings increases during periods of bright sunny days and falls noticeably during extended periods of dull weather (Aronson, 1951). In an estuary in Sierra Leone, *T. guineensis* and *S. melanotheron* both spawned during the dry season when the estuary became cut off from the sea by a sand bar (Payne, 1983). In other West African lagoons, both species are reported to reproduce all year round, although possible seasonal variations in the sexual activity were not clearly investigated (Pauly, 1976; Fagade, 1979; Eyeson, 1983).

Fecundity, oocyte weight and spawn weight

From the present study it has emerged that, for all our species/environment combinations, the spawn weight is more closely related to the female body weight than is the absolute fecundity. As far as spawn weight is concerned, individual fecundity variations are indeed compensated for by opposite variations of the oocyte weight; females having the highest fecundity rates generally lay smaller eggs, which was also observed by Peters (1983).

Drastic differences in absolute fecundity and oocyte weight have been recorded for both species between natural and reared populations. For the same female weight, eggs laid under enclosure conditions are smaller but more numerous than under natural conditions. On the other hand, the relationship between spawn weight and female body weight is similar in both environments. For the two species, the amount of gonadal tissue elaborated during the reproductive cycle (measured through the spawn weight) seems to represent a specific constant which may be genetically determined; the environment has an effect on how the gonadal matter is divided and on the reproductive strategy: small and numerous eggs or larger and less numerous eggs. In this particular study, the observed modifications in the egg weight and fecundity could be related to rather unfavourable rearing conditions reflected in the lower condition factor observed for the fish from the enclosures.

It is known that artificial feed is poorly used by these tilapia species under culture, as expressed by the high feed conversion ratio generally obtained (Legendre *et al.*, 1989). For *O. mossambicus*, a restricted food supply tends to reduce the number of eggs produced per spawn, but increase the spawning frequency (Miranova, 1977). For another cichlid fish, *Cichlasoma nigrofasciatum*, Townshend and Wooton (1984) also observed a reduction of fecundity at the lowest feeding rates. Thus, in our case it is difficult to explain both low condition factors and high fecundities simply by inappropriate feeding. As the daily rate of food distributed to the fish was high (5% of fish biomass), it also raises the question of food quality rather than quantity.

Other environmental clues, such as reduced living space, increased density and periodic fishing in the enclosures, might constitute stress factors which could also have an influence on egg production, either directly or indirectly through behavioural interactions. For example, the changes in fecundity reported by De Silva (1986) for different *O. mossambicus* populations of Sri Lankan reservoirs did not seem to be related to feeding, but were positively related to the fishing pressure on the water-body. In the enclosures, the division of the gonadal matter into smaller and more numerous eggs than in the wild should perhaps be interpreted as an adaptative response to stimuli perceived by the fish as a lower chance of success in fry survival. In fact, the precise nature and role of environmental and behavioural factors implicated in the different steps of egg production remain poorly understood in tilapia species, and there is a need for further research based on precise experimental procedures.

Mouth-brooding

For *S. melanotheron*, the number of fry produced per spawning for a given pair depends on the size of the female and also on that of the male (Aronson, 1949). Indeed, the number of eggs which can be taken into the mouth for brooding is limited by the volume of the buccal cavity; this volume is itself related to the weight of the male through a simple biometrical relationship (Legendre, unpubl.). A positive relationship was found between the number of brooded eggs or fry and the male body weight, this relation being parallel to the linear regression between the absolute fecundity and the female body weight. This argues for the existence of a size relationship between the male and female of a pair. From aquaria experiments, Barlow and Green (1970) found that the proportion of successful pairing was the highest when the male was of similar size or slightly smaller than the female, and tended to decrease when the male was larger than the female. It should be noted however, that for this species the highest and more regular spawning frequency was observed in our experiment for pairs in which the male was much larger than the female (*table* 3). If one considers that pairing of the breeders is preferably made between similar-sized males and females, then a loss of eggs (around 100) should occur when the male takes them into his mouth. Consequently, the efficiency of mouth brooding for *S. melanotheron* should be optimal when a female mates with a larger-sized male.

Applications: fry production in tanks

On the basis of the previous results, it is known that it is possible to produce *T. guineensis* and *S. melanotheron* fry throughout the year; however, during the rainy season a slight decrease in sexual activity takes place. Since we have predictive patterns of fecundity according to the female's size and of the number of brooded fry according to the male's size (for *S. melanotheron*) on one hand, and since we know the average spawning frequency of these species in concrete tanks on the other hand, it is possible to establish a program of fry production for a fish farm over a year. As an indication, it has been shown that for *S. melanotheron* in 2 m^3 concrete tanks the spawning frequency was nearly the same with a group of 10 fish (sex ratio of 1 : 1) as with an isolated pair (Legendre, unpubl.). Under these conditions and with five 200 g females and five 300 g males, the theoretical yearly production is of about 90 000 eggs per tank.

Thus, contrary to what has been observed for most other cultured species, the reproduction of tilapias is spontaneous and sustained under rearing conditions. It is therefore quite easy to obtain a massive and regular production of fry, provided that there is good management of broodstock. In practice, the main difficulty lies in the simultaneous production of a great number of fry having a graded size.

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