Observations on aspects of the biology of *Pseudocrenilabrus philander* (M. Weber, 1897) from a subtropical South African impoundment

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Abstract

Investigations were made into the biology of the small cichlid, *Pseudocrenilabrus philander*, from a newly formed man-made lake in the Northern Province, South Africa. Aspects including population composition, habitat and food preferences as well as condition, fecundity and breeding behaviour are discussed.

Introduction

Although a large number of small cichlid species occur on the African continent, only a few are found in South African waters. Of these, *Pseudocrenilabrus philander* (Weber, 1897) or Southern mouthbrooder, is one of the most abundant and widespread, being highly adaptable to a wide range of environmental conditions. It occurs mostly in the littoral zones of natural and man-made water bodies in this region. During prolonged periods of drought, which often occur in South Africa, *P. philander* is usually one of the last species to succumb to these adverse conditions. It is also one of the first to inhabit newly impounded water bodies.

The geographical distribution of *P. philander* in Africa is extensive, stretching from the Zaïre River Basin southwards down to the Orange River catchment (Daget et al., 1991). North of the Zaïre River System, this species is replaced by *P. multicolor* (Daget et al., 1991).

Sexually active males of *P. philander* are usually very colourful. Such males, when freshly caught, possess an overall bluish-green iridescence with an electric-blue line below the mouth. The dorsal fin, anal fin and upper ridge of the caudal fin are all fringed in red. Female fish and juveniles are greenish-grey dorsally with as many as 10 vertical dark bars on the trunk. The largest specimen caught during the present investigation was a male of 68.8 mm standard length (SL). The scale count of *P. philander* is: ll = 27-30; fin counts are: D = XIII-XV 9-11, A = III 8-9 (Jubb, 1967).

The present study, which took place from 1988 to 1989, deals with the biology of *P. philander* from Lake Middle Letaba in the Northern Province Lowveld (Fig. 1). This interesting small cichlid, together with juveniles of the Mozambique tilapia, *Oreochromis mossambicus* (Peters, 1852), constitutes a large proportion of the total number of fish caught by subsistence fishermen along the shores of this lake.

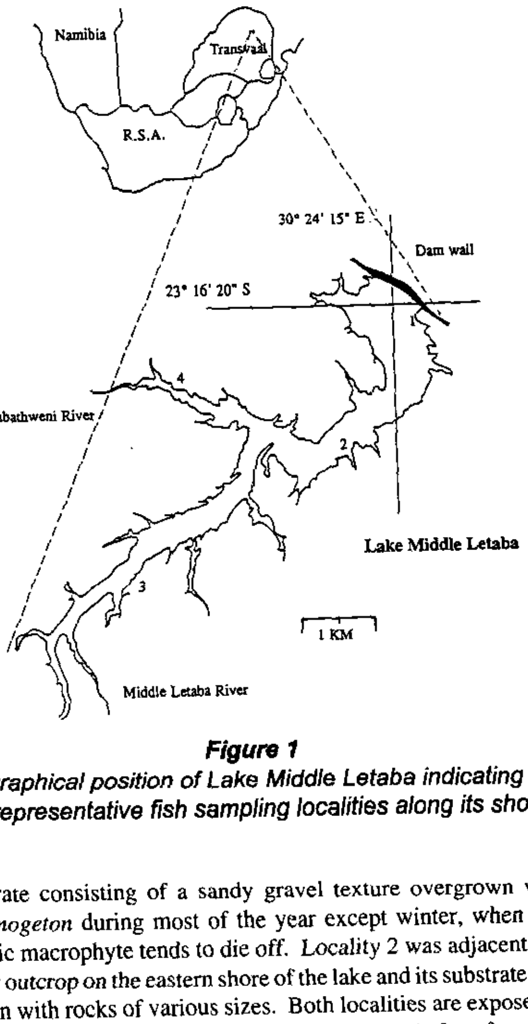

Figure 1
Geographical position of Lake Middle Letaba indicating the four representative fish sampling localities along its shores

Materials and methods

Fish were collected from four localities (Fig. 1) with the aid of a Moore-type electrical fish shocker (Moore, 1968) and, where possible, with a 10 m-long Capenta beach seine net (5 mm stretched mesh size). Locality 1 included a section of the dam wall and a substrate consisting of a sandy gravel texture overgrown with *Potamogeton* during most of the year except winter, when this aquatic macrophyte tends to die off. Locality 2 was adjacent to a rocky outcrop on the eastern shore of the lake and its substrate was strewn with rocks of various sizes. Both localities are exposed to wave action. The substrate of Locality 3 consisted of a soft muddy structure, containing large quantities of organic material, mainly derived from cow dung. This location was characterised by fallen trees, reed beds and extensive growths of aquatic macrophytes, dominated by *Utricularia* spp., *Potamogeton* spp. and *Nymphaea lotus*. The fourth locality had an extensive rocky bottom interspaced with sand-filled gullies. A dense cover of floating, waterloving grass was present during most of the year. All localities were

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subjected to changing water levels as the impoundment is used for irrigation purposes and domestic water supply to the local population.

Fish were collected on a seasonal basis from each locality and immediately preserved in 10% formalin. After 24 h the catch was sorted into species and preserved in 4% formalin for further investigation. This included length/mass relationship (standard length to the nearest 0.1 mm and mass to the nearest mg), gender and fish condition (Le Cren, 1951).

A random sample was taken from each seasonal collection for stomach contents and fecundity analyses. Organisms present in the stomach contents were identified to the lowest possible taxonomic level. The number of times a specific food item appeared in the stomach contents was duly recorded (Hyslop, 1980). In this way, the frequency of occurrence, expressed as a percentage and, consequently, the preference for a particular food item by the fish could be ascertained. A total of 175 stomachs were analysed.

Data obtained during the survey allowed calculation of the relative condition factor (CF) for *P. philander*. The results are presented in Table 3. All calculations are based on SL. This parameter was used because the calculated estimate more closely approached that of the actual empirical mass than calculation done using total length (TL). Calculations were carried out using the formula described by Le Cren (1951) as:

$$C = \frac{M}{cL^n}$$

where M and L represent mass and length while c and n are calculated constants for a specific group of fish. This formula was adjusted by Du Toit (1971) and Schoonbee et al. (1972) to:

$$C = \frac{\bar{M}}{c\bar{L}^n}$$

in which $\bar{M}$ and $\bar{L}$ represent the mean mass and length while c and n are once again calculated constants for a particular group of fishes. Age groups could not be taken into consideration as age determination of *P. philander* from Lake Middle Letaba proved to be difficult. Only opercula obtained from some females showed indications of growth rings, which could also have been laid down during breeding. All recognisable males and females were therefore grouped separately, while those fish which could not be sexed were placed under juveniles. The CF for each fish was calculated, after which all CFs obtained for a particular group of fish were recalculated to obtain the mean value for that group.

Results

Physical and chemical conditions

This man-made lake covers, when full, almost 2 km² and has a maximum depth of 34 m. During the present survey the maximum surface water temperature varied between 29°C (summer) and 16°C (winter) while the bottom water temperature was, on average, 2°C lower. Oxygen contents of the water varied between 97% (spring, surface) and 56% (winter, bottom), while the pH ranged between 6.8 to 8.3. The conductivity of the water fluctuated with the influx of rain water and reached a low 160 $\mu S \cdot cm^{-1}$ during the summer of 1989 while the highest value (605 $\mu S \cdot cm^{-1}$) for this parameter was recorded the previous autumn. Secchi disk readings ranged between 0.6 and 1.3 m. Values for sodium, potassium, calcium, magnesium, silica and sulphates obtained during the study period were all within the limits laid down for river water qualities (Kempster et al., 1980) in South Africa. Highest concentrations of these parameters were recorded during the dry season. Values for alkalinity in the lake varied between 53 and 82 $mg \cdot \ell^{-1}$. Concentrations of ammonia, nitrite, nitrate as well as

TABLE 1
NUMERICAL COMPOSITION OF THE MALES, FEMALES AND JUVENILES OF *PSEUDOCRENILABRUS PHILANDER* COLLECTED IN LAKE MIDDLE LETABA FROM FOUR REPRESENTATIVE LOCALITIES USING ELECTROFISHING AND SEINE NET COLLECTION METHODS (JUV = JUVENILES)

Gender	Size range (SL) in mm	N	Mean mass range in g
Station 1			
♂	26.0 - 68.8	126	0.547 - 9.486
♀	28.8 - 51.6	53	0.605 - 3.649
juv	16.5 - 41.2	49	0.100 - 1.878
Station 2			
♂	25.2 - 68.3	124	0.500 - 8.650
♀	25.7 - 51.6	41	0.562 - 3.758
juv	16.0 - 45.4	53	0.[illegible]14 - 2.414
Station 3			
♂	25.2 - 62.7	70	0.391 - 6.934
♀	26.0 - 48.1	36	0.552 - 3.063
juv	12.3 - 37.8	56	0.064 - 1.423
Station 4			
♂	28.5 - 67.1	104	0.614 - 8.168
♀	28.4 - 58.2	45	0.556 - 4.603
juv	19.5 - 42.1	63	0.2[illegible]4 - 1.766

TABLE 2 LENGTH FREQUENCIES FOR *PSEUDOCRENILABRUS PHILANDER* COLLECTED AT THE FOUR LOCALITIES IN LAKE MIDDLE LETABA				
SL range in mm.	**Loc. 1**	**Loc. 2**	**Loc. 3**	**Loc. 4**
25 - 29.9	4(3%)	1(1%)	7(10%)	4(4%)
30 - 39.9	57(45%)	34(27%)	31(44%)	40(39%)
40 - 49.9	51(41%)	47(38%)	26(37%)	38(36%)
50 - 59.9	12(9%)	28(23%)	5(7%)	16(15%)
60 - 68.5	2(2%)	14(11%)	2(3%)	6(6%)
Totals:	126	124	70	104

soluble reactive phosphorus never reached levels which would suggest organic pollution of the water entering the lake. At worst, conditions were mildly eutrophic.

Population structure

A total of 820 specimens of *P. philander* were caught at random at representative localities around the lake during the investigation. Results showed a male, female and juvenile fish ratio of approximately 2.5:1:1.5 (Table 1). It can be assumed that the component of juvenile fish will probably be much higher since the seine net employed usually did not collect fish smaller than 12 mm SL. Due to the comparatively small size of the juveniles, electro-fishing was found to be less effective in collecting juveniles of this species than adults. The relative composition of males, females and juveniles of *P. philander* collected from the four selected sampling localities on the lake is illustrated in Table 1.

P. philander occurs throughout the littoral zone of the lake, preferring the more rocky habitats (Table 1). This is substantiated by the fact that Locality 3, where no rocky substrate occurs, harboured the lowest number of fish (19.8% of the sample). Males and females collected from this locality also had a lower mean SL than those collected from the other three localities.

At Locality 1, the large numbers of crevices between the rocks stacked against the dam wall provided suitable habitat for numerous males, which tended to be smaller in SL than males from Localities 2 and 4. This tendency is repeated at Locality 3 where the bulk of the males present were also less than 50 mm SL (89% and 90% respectively, Table 2). However, at Locality 2 only 66% of the males in the sample were under 50 mm SL, 23% were between 50 and 59.9 mm SL and 11% over 60 mm SL, a phenomenon which appeared to be associated with the presence of the natural rocky substrate, the outcrops of which created numerous isolated breeding territories, each with its own dominant (and larger) sexually active male in attendance. Although not as obvious, this situation was repeated at Locality 4 where 21% of the males in the sample were larger than 50 mm SL (Table 2). Once again this can be ascribed to the establishment of sufficiently large breeding territories, as a result of the presence of an extensive stony bottom habitat at that particular site.

Figure 2 illustrates the total composition of males, females and juveniles collected at all four localities over the period of the investigation. The number of males in the 32 to 68 mm SL size range is clearly indicated by the data. Both sexes reach maturity at around 26 mm SL, although immature specimens were still found in the length groups up to 44 mm SL. The number of immature specimens of fish over 32 mm SL shows a drastic decline indicating

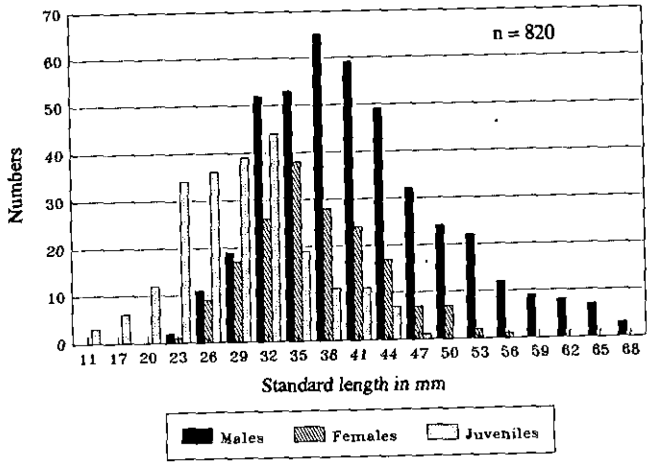

Figure 2
Population size distribution of Pseudocrenilabrus philander *in Lake Middle Letaba during the period of investigation of 1988 to 1989*

gonadal maturation and consequently recruitment of young fish from this size range into the adult ranks.

Relative condition factor

Although some individual relative CF values obtained were lower than 1, the mean CF for each group was always above 1, an indication that the general condition of *P. philander* in Lake Middle Letaba was good (Table 3). The highest CF for males was found during winter at all localities, which might be connected to the lower reproductive behaviour and possible build-up of body fat during that season. Females, on the other hand, had a somewhat lower CF in general during all seasons with the lowest values for this group being recorded during autumn at Locality 3 (1.005) and during winter at Locality 4 (1.002). Juveniles had a greater variation in CF than either males or females and their CF ranged from a low 1.003 at Locality 2 during autumn to a high of 1.147 at the same locality during winter.

Comparative length of the intestinal tract

According to Fig. 3 there is a marked decline in the relative length of the intestinal tract of *P. philander* with an increase in size, varying almost from twice the standard length in the younger

TABLE 3
RELATIVE CONDITION FACTOR CALCULATED FOR A POPULATION OF *PSEUDOCRENILABRUS PHILANDER* IN LAKE MIDDLE LETABA OVER A PERIOD OF FOUR SUCCESSIVE SEASONS

		Loc. 1		Loc. 2		Loc. 3		Loc. 4	
Season	Gender	N	CF	N	CF	N	CF	N	CF
Spring	♂	35	1.071	21	1.040	22	1.031	19	1.109
	♀	5	1.028	11	1.058	1	1.081	15	1.041
	juv	-		8	1.038	9	1.076	6	1.022
Summer	♂	24	1.078	27	1.104	17	1.089	28	1.070
	♀	17	1.047	-		10	1.036	6	1.047
	juv	6	1.059	14	1.102	12	1.043	6	1.031
Autumn	♂	8	1.042	22	1.047	14	1.126	10	1.070
	♀	14	1.021	12	1.028	5	1.005	8	1.043
	juv	17	1.069	5	1.003	19	1.157	24	1.056
Winter	♂	36	1.125	26	1.189	-		26	1.145
	♀	5	1.068	7	1.036	-		2	1.002
	juv	19	1.022	12	1.147	2	1.030	12	1.095

LOC. = LOCALITY; N = NUMBERS; CF = CONDITION FACTOR; JUV = JUVENILE

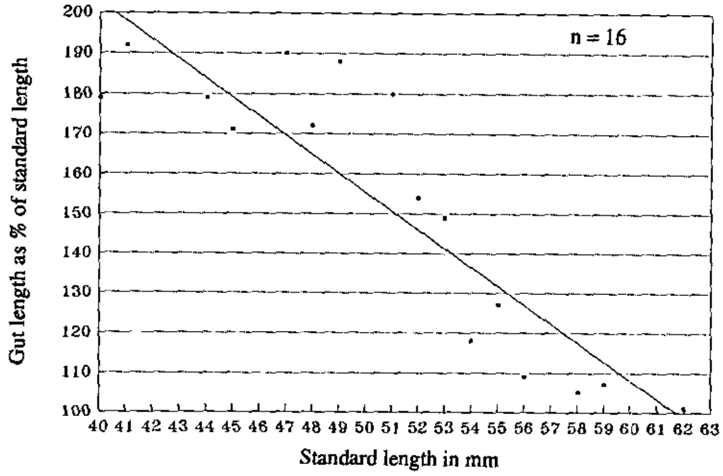

Figure 3
Length of intestinal tract expressed as a percentage of standard length (SL) for Pseudocrenilabrus philander *from Lake Middle Letaba, Northern Province*

specimens to approximately an equal length with SL when fish exceed 62 mm in size. This tendency represents, according to Nikolsky (1963), a shift in diet of the animal from a primarily herbivorous or omnivorous feeding habit amongst the younger specimens to a predominantly carnivorous feeding habit in the late adult stages. Investigations into the dietary habit of the various size groups of this fish confirmed this assumption for *P. philander*.

Food and feeding habits

The contents of 175 stomachs analysed indicated that *P. philander* utilise a wide variety of food items available in the lake, including their own young. They also prey on other fish species or at least consume the remains of fish, as no less than 34 of the stomachs examined contained fish scales (Table 4). Recognisable remains of small cichlids were found in 6 stomachs. One large male had 14 young, partly digested fish in its stomach and an additional 19 in the foregut. The juvenile fish present in stomach samples could, by their shape, be identified as belonging to one species only. A young fish ingested by another large male could be positively identified as *P. philander*, the mass of which was 1.5% of that of the predating male.

P. philander is also shown to prey on larger crustaceans including the shrimp *Caridina nilotica* and small crabs of the genus *Potamonautes*. Although not specifically indicated in Table 4, juvenile fish were found to consume substantial quantities of diatoms which were either absent, or present in small quantities in stomachs of adults. This noticeable change in diet with size coincides with the shortening of gut length relative to standard length (Fig. 3) as the specimens grow larger. A number of empty stomachs were encountered in the sample consisting of 10.7% of the total number of fish analysed (Table 4). Most of these were found to be brooding females, which do not actively feed during the incubation period of several weeks. The lowest number of empty

TABLE 4
NUMERICAL OCCURRENCE OF FOOD ITEMS ENCOUNTERED IN 175 STOMACHS FROM *PSEUDOCRENILABRUS PHILANDER* COLLECTED IN MIDDLE LETABA DAM, LISTED PER SEASON, IN TOTAL AND AS A PERCENTAGE

	Spring	Summer	Autumn	Winter	Total
Empty	20 (11.6)	18 (22.5)	14 (11.7)	3 (2.0)	55 (10.7)
Sand	8 (4.6)	6 (7.5)	9 (7.5)	18 (12.0)	41 (8.0)
Detritus	11 (6.4)	9 (11.3)	15 (12.5)	24 (16.0)	59 (11.5)
Und. pl. mat.	1 (0.6)	2 (2.5)	2 (1.7)	-	5 (1.0)
Und. an. mat.	1 (0.6)	-	-	1 (0.7)	2 (0.4)
Diatoms	18 (10.4)	7 (8.8)	5 (4.2)	8 (5.3)	38 (7.4)
Bryozoa	-	-	-	4 (2.7)	4 (0.8)
Rotifera	12 (6.9)	1 (1.8)	7 (5.8)	6 (4.0)	26 (5.0)
Cladocera	1 (0.6)	-	5 (4.2)	14 (9.3)	20 (3.9)
Ostracoda	2 (1.2)	1 (1.8)	4 (3.3)	5 (3.3)	12 (2.3)
Cal. Copepoda	12 (6.9)	3 (3.8)	10 (8.3)	7 (4.7)	32 (6.2)
Cycl. Copepoda	15 (8.7)	4 (5.0)	17 (14.2)	16 (10.7)	52 (10.1)
Decapoda	5 (2.9)	-	-	4 (2.7)	9 (1.8)
Ephemeroptera	7 (4.0)	1 (1.8)	6 (5.0)	1 (0.7)	15 (2.9)
Hemiptera	1 (0.6)	-	-	1 (0.7)	2 (0.4)
Gerridae	1 (0.6)	-	1 (0.8)	-	2 (0.4)
Trichoptera	2 (1.2)	1 (1.8)	2 (1.7)	2 (1.3)	7 (1.4)
Chaoborus	3 (1.7)	4 (5.0)	4 (3.3)	6 (4.0)	17 (3.3)
Chironomids	12 (6.9)	9 (11.3)	5 (4.2)	8 (5.3)	34 (6.6)
Algae	3 (1.7)	1 (1.8)	-	-	4 (0.8)
Ter. insects	8 (4.6)	3 (3.8)	5 (4.2)	12 (8.0)	28 (5.5)
Fish remains	6 (3.5)	1 (1.8)	-	1 (0.7)	8 (1.6)
Fish scales	13 (7.5)	9 (11.3)	7 (5.8)	5 (3.3)	34 (6.6)
Plant seeds	1 (0.6)	-	2 (1.7)	4 (2.7)	7 (1.4)

UND. PL. MAT. = UNIDENTIFIED PLANT MATERIALS; UND. AN. MAT. = UNIDENTIFIED ANIMAL MATERIALS;
CAL. COPEPODA = CALANOIDA COPEPODA; CYCL. COPEPODA = CYCLOPOIDA COPEPODA;
TER. INSECTS = TERRESTRIAL INSECTS.
FIGURES BETWEEN BRACKETS INDICATE PERCENTAGES

stomachs were found during winter.

Detritus and copepoda were the items most frequently encountered (11.5% detritus, 6.2% calanoid copepoda and 10.1% cyclopoid copepoda). Copepoda, which consisted of both calanoida and cyclopoida, were consumed by *P. philander*. There was a marked preference for cyclopoid copepods over calanoids (10.1% against 6.2%). The next most important item was sand with an 8% occurrence. Sand appears to be either taken on purpose for its coating of bacteria or might be ingested involuntarily while feeding on the substrate. Observations showed that in addition to diatoms, rotifera also occurred in relatively large numbers in the stomachs of young fish. A small number of stomachs from adult fish also contained this food item.

Other items encountered in significant numbers of fish stomachs analysed were chironomids (6.6%), fish scales (6.6%), terrestrial insects (5.5%) and cladocera (3.9%)(Table 4). Terrestrial insects included numerous termites (*Hodotermes* sp.) as well as small grasshoppers. Ants were normally ingested whole while the grasshoppers clearly showed evidence of being macerated before ingestion. Ostracoda (2.3%) were eaten throughout the year by a number of fish while Ephemeroptera was especially utilised during spring and autumn when this item was recovered from 2.9% of all stomachs analysed. *Chaoborus* (3.3%) was ingested by a number of fish analysed and occurred in significant numbers during all seasons except spring. Other items taken as food by relatively few *P. philander* were Hemiptera including Gerridae (two occasions only), while Trichoptera was also encountered in seven of the stomachs analysed. A similar number of fish ingested some plant seeds, mainly of aquatic macrophytes while only four stomachs yielded some filamentous algae. Although well represented in the impoundment, Bryozoan statoblasts were only eaten by one fish in winter.

Fecundity and breeding habits

Being a mouthbrooder, the fecundity of this species is relatively low. The largest female encountered during this survey measured 44.2 mm SL with ovaries containing 66 ripe eggs (Table 5). No clear indication could be obtained from the ovaries of how frequently *P. philander* might spawn during the breeding season of the year as only maturing eggs are easily recognisable. Recruitment egg stock appears to be quite small.

Observations on fish in captivity showed that incubation takes 18 to 21 d, depending on temperature. The female will harbour post-larvae for another 3 to 4 weeks after which a new spawn might be incubated. If this pattern is repeated in nature, between 5 to 6

TABLE 5
FECUNDITY DATA OF PSEUDOCRENILABRUS PHILANDER FROM LAKE MIDDLE LETABA DURING THE SURVEY OF 1988-1989

SL (mm)	Body mass (g)	Gonad mass (mg)	Total ova
Spring (N=7)			
44.2	2.724	211.4	66
39.2	1.746	29.1	43
38.9	1.569	116.4	27
36.3	1.346	59.9	25
35.6	1.303	39.9	27
32.3	0.933	49.5	23
31.9	0.978	88.1	20
Summer (N=7)			
42.1	1.999	127.9	36
41.6	1.413	10.2	43
40.4	1.652	82.4	77
37.5	1.316	97.1	27
35.2	1.180	80.2	27
33.4	1.046	98.9	28
33.2	0.910	69.1	20

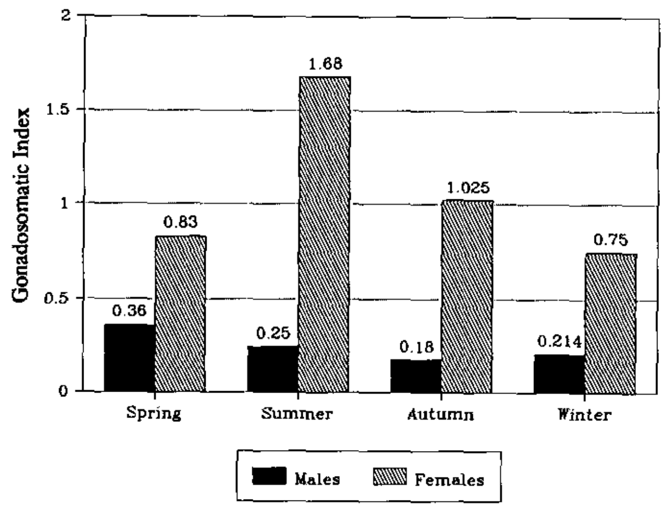

Figure 4
Mean seasonal gonadosomatic indexes for male and female Pseudocrenilabrus philander *collected from Lake Middle Letaba during 1988 to 1989*

batches of young fish could be raised within a time span of 8 to 9 months (spring to autumn), the seasons during which environmental conditions are normally favourable for breeding.

Gonadosomatic indexes for females over the four seasons indicated that the highest reproductive activity took place during spring, followed by summer. The lowest figure was obtained for winter, as could be expected (Fig. 4). However, indications are that males are most active during spring with the lowest GSI during autumn. During winter a build-up to the spring spawning season was evident in the increasing GSI for that season.

Reproductive behaviour

Observations under captive conditions showed that a sexually active male occupies a territory of varying size, depending on the physical conditions of the habitat provided. Somewhere in his chosen territory the male forms a shallow pit by making quick, short turning movements to excavate a spawning site. Other adult but sexually less active males are kept at a distance, provided sufficient space is available. If this is not the case, the dominant male will eventually kill other sexually active males. Juveniles and females are allowed to enter the breeding area. The dominant male attracts as many females as possible to the spawning area. After spawning the female remains in the territory or nearby for the duration of egg incubation.

When a gravid female approaches the spawning site, the male will display courtship behaviour to lure her to the nest. Here, the male will execute several fast turns after which the female, when ready, will lay some of her rather large yellow/orange-coloured eggs at the prepared site. The female will then turn around and take these eggs into her mouth. According to Ribbink (1971) and Chang and Ribbink (1990), such eggs are either fertilised in the mouth of the female before the next batch of eggs are spawned or they are fertilised while still in the nestpit. In both cases they might well be fertilised by some other male while the territorial male is chasing other intruders. This so-called sneak fertilisation is also observed for other cichlid species (Chang and Ribbink, 1990). Mating will continue until the female has laid all available ripe eggs and has taken them into her mouth. The female then loses interest in the spawning process and withdraws to a more or less protected spot in or near the territory of the male. Several brooding females can be observed near such nesting spots. During breeding the female will consume little food, if anything at all, until such time as the eggs are hatched. This period takes up to 21 d, depending on ambient water temperature. The post-larvae are then released and the female will resume feeding. If in danger, the youngsters return to the buccal cavity of the female for protection.

Even though *P. philander* is a multiple spawner, this is not always clear from the condition of the ovaries of an adult female, which normally appear to contain only ova of one particular size. Also, only one ovary contains ripe ova at a particular time. However, very small developing eggs can occasionally be observed under magnification. It thus seems that this species only matures a new batch of eggs after commencement of feeding and following the release of the post-larvae from its mouth. Eggs develop and mature rather quickly in the gonads: one particular female has been observed to spawn within 4 weeks following the release of a previous batch of post-larvae.

Discussion

P. philander occurs throughout the lake area in fair numbers but seems to concentrate in the littoral zone in the vicinity of rocky areas, where they are numerically dominant amongst the small fish which occur there. Associated fish species include juveniles of *Oreochromis mossambicus*, *Clarias gariepinus* (Burchell, 1822), and of *Labeo cylindricus* (Peters, 1852). Males, being more active and colourful than females, appear to be easier targets for predators. It is therefore interesting to note that at each locality in Lake Middle Letaba, only a small proportion of males display brood colours. Such males are sexually active and attract a number of females. When this dominant male is removed, either by predation or artificially, it is only days until one of the remaining males takes over the territory and becomes sexually active. Females and juveniles, by contrast, are more inclined to seek shelter and are consequently less prone to predation.

P. philander and the closely related *P. multicolor* have been subjected to intensive behavioural studies (Peters, 1937; Ribbink, 1971; Mrowka, 1981, 1982, 1985, 1987a and b; Chang and Ribbink, 1990). They are known to be rather aggressive as aquarium fish (Bell-Cross and Minshull, 1988). However, a group of specimens collected from the same habitat is found to contain a number of sexually mature males but only one male, or at most two males, are sexually active at a particular stage. Sexually active or dominant males of several other African cichlids appear to suppress all other males under aquarium conditions and consequently tend to mate with all available females (Polling, personal observation). Their breeding territory, extending up to 1 m^2 but depending on available space, has normally a centrally placed nest pit. The occupying male need not be the largest specimen in the group, but is certainly the more aggressive one. Its colours are also far more vividly displayed and the testes of such specimens were found to be better developed (1.14% to 1.68% against 0.12% to 0.36% over body mass) than equal-sized or even bigger non-breeding males from the same area.

The importance of *P. philander*, as a possible controlling agent of disease vectors, for instance larvae of malaria mosquitoes, might be found in their general preference for the littoral zone (Theron, 1987). In the present study, adults were found to feed actively on a variety of macro-invertebrate organisms including chironomid larvae which are normally present in high densities in the sediments of the shallow waters of the lake. The abundance of small fish (including *P. philander*) along the shore of this lake may thus account for the general scarcity of mosquitoes in Lake Middle Letaba.

P. philander serves as an important food source for piscivorous birds and is also preyed upon by the omnivorous sharptooth catfish *Clarias gariepinus* (Van Senus, 1989). *P. philander* is relatively free of ichthyoparasites which occur in the lake and only a few specimens were found to be infected with parasitic nematodes. This is in contrast to the smaller cyprinids in the same lake which were found to be heavily infested with a number of fish parasites (Polling et al., 1992a and b).

It was observed that smaller fish species, including *P. philander*, serve as a food source for local inhabitants fishing in the lake. Such small fishes are collected with make-shift seine nets and cooked whole. After cooking, the broth is strained to remove fishbones and scales and used as a sauce with porridge.

The present study provides some ecological data on *P. philander* in a man-made impoundment. Much more work need to be done to evaluate the interrelationship of this and other fish species within the various food-chains of the lake ecosystem.

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