

GROWTH, REPRODUCTION AND FOOD OF THE MUDSKIPPER, *PERIOPHTHALMUS BARBARUS* ON MUDFLATS OF FREETOWN, SIERRA LEONE¹

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ABSTRACT

This study, based on 364 specimens of mudskipper, *Periophthalmus barbarus* (Linnaeus, 1766) (Family Gobiidae) sampled from July 1992 to April 1993 on a small mudflat near Freetown, deals with the morphometrics, growth, reproduction and feeding habits of a species that is often studied in terms of its interesting amphibious behavior, but which, in Sierra Leone, represents a food resource for coastal dwellers. Results include length-weight relationships for females and males, a seasonally oscillating growth curve ($TL_{\infty} = 17$ cm, $K = 0.89 \pm 0.30$ year⁻¹, $C = 0.75$ and $WP = 0.95$), with a strong end-of-year reduction of growth related to the cold 'Harmattan' wind, and a spawning peak in May-June, at the onset of the rainy season. First maturity occurs at about 8 cm; the food consists of small crustaceans, polychaets, insects, mollusks and detritus.

INTRODUCTION

The Atlantic mudskipper, *Periophthalmus barbarus* (Linnaeus, 1766) (Family Gobiidae, SubFamily Oxudercinae, Order Perciformes, Figure 1, insert) is the most abundant fish in the mangrove swamps along the coast of Sierra Leone. People, notably around the coastal villages of Bonthe, Wale, Yeloboya and Shenge, catch mudskipper, locally known as 'jumbo fish', using traps made of binodal segments of bamboo cane. One node is cut off, and the cane is driven into the mud. Then, leaves and mud are used to turn the opening into the mouth of a trap (Figure 1).

Powdered okra or a substance locally known as 'gballar' is then used to smoothen the surface of the leaves, which may also be baited by a sprinkling of powder-dried crab, or additional 'gballar'. In neighboring Guinea, a broad leaf and a piece of broom stick are used, instead of bamboo cane, to construct a gear similar in operation to the above-described trap.

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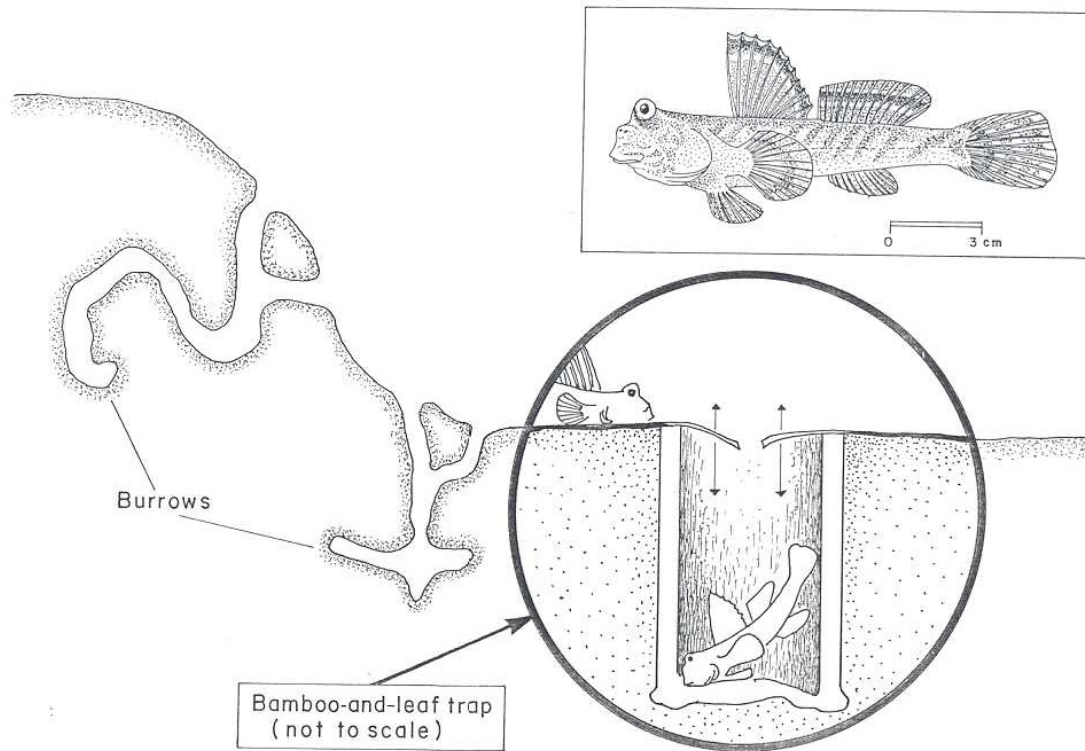


Figure 1 The mudskipper, *Periophthalmus barbarus* (Linnaeus, 1766) (Family Gobiidae, insert adapted from FAO), with schematic representations of burrows and of the bamboo-and-leaves trap used in Sierra Leone (adapted from Den-Khadhri, 1984).

MATERIALS AND METHODS

Catch composition statistics relating to the mudskipper do not appear to exist, and this study is thus entirely based on 364 specimens caught by the first author from July 1992 to April 1993 by digging into mudskipper burrows in the mudflat of Congotown, a 'quartier' of Freetown (8° 29' 10' N; 13° 15' 30' E).

Morphometric measurements were done on 348 samples, to the nearest mm, using a vernier caliper; the measurements taken included total (TL) and standard length (SL) and some others presented in Turay (1993), but the measurements presented below refer to TL in cm. Individual fish weights were determined to the nearest 0.01 g. The length-frequency analyses were all performed using the FiSAT software (Gayanilo *et al.*, 1996).

Reproduction was studied by noting gonad maturity stages, by computing gonadosomatic indices ($GSI = \text{gonad weight} \cdot 100 / \text{body weight}$) and by estimating 'fecundity', i.e., the number of eggs in the gonads of mature female mudskipper.

Food and feeding habits were studied through examination of stomach contents, and the 'point' and 'occurrence' methods (Hynes, 1950).

RESULTS AND DISCUSSION

The largest mudskipper observed was a male of 15.4 cm; the largest female measured 13.0 cm. Figure 2A shows the length-weight relationship of female and male mudskippers; the corresponding relationship for the population as a whole is $W = 0.0072 \cdot TL^{3.19}$ for which $n = 348$ and whose log linear version has an $r^2 = 0.961$. The relationship between standard length and total length is given by:

$$SL \text{ (cm)} = 0.86 \cdot TL \text{ (cm)}^{-0.0914} \text{ (Figure 2B)}$$

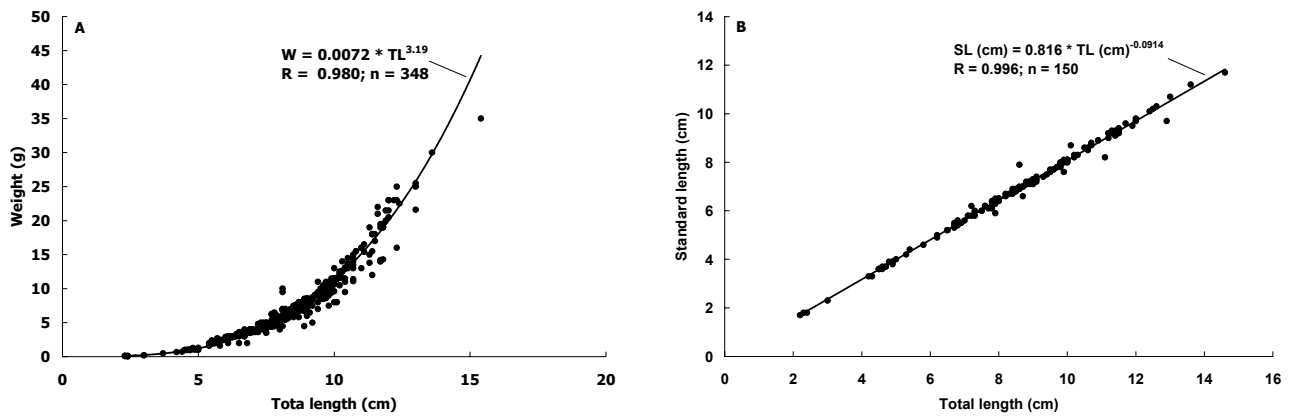


Figure 2 Relationships of length to weight (A) and total to standard lengths (B) of male and female *Periophthalmus barbarus* (Linnaeus, 1766) (Family Gobiidae), removed from their burrows in the mudflats of Congotown, Freetown, Sierra Leone from July 1992 to April 1993.

Table 1 summarizes the length-frequency (L/F) data used for the growth analyses, whose results are given in some details (including some intermediate outputs), as they nicely illustrate how gentle ‘massaging’ of an L/F data set can lead to improved estimates of growth parameters, here those of the von Bertalanffy model (von Bertalanffy, 1938) and one of its seasonally oscillating variants (Pauly, 1987).

The method of Wetherall (1986) was applied to an accumulation of the data in Table 1; it led to estimates of L_{∞} ranging from 16 to 18 cm, depending on which length range was included in the analysis. Hence a value of $L_{\infty} = 17$ cm was retained for all analyses using ELEFAN, a routine of the FiSAT software.

A first pass of the ELEFAN subroutine in which K values are scanned, in very small steps, from $K = 0.1$ to $K = 10 \text{ year}^{-1}$, yielded an essentially flat structure (Figure 3a). This was attributed to the class interval (0.5 cm) of the L/F data in Table 1, which was too small

Table 1 Length-frequency data for 348 mudskippers, *Periophthalmus barbarus* (Linnaeus, 1766) (Family Gobiidae), removed from their burrows in the mudflats of Congotown, Freetown, Sierra Leone.

Midlength (TL, cm)	Jul 1992	Aug	Oct	Nov	Dec	Jan 1993	Feb	Mar	Apr
0.25	0	0	0	0	0	0	0	0	0
0.75	0	0	0	0	0	0	0	0	0
1.25	0	0	0	0	0	0	0	0	0
1.75	0	0	0	0	0	0	0	0	0
2.25	5	1	0	0	0	0	0	0	0
2.75	1	1	0	0	0	0	0	0	0
3.25	0	0	0	0	0	0	0	0	0
3.75	0	0	1	0	0	0	0	0	0
4.25	1	2	1	0	0	0	0	0	0
4.75	2	4	1	2	2	0	0	0	1
5.25	1	1	3	1	0	1	0	0	0
5.75	0	2	1	2	2	1	1	1	1
6.25	0	2	2	1	2	3	1	4	1
6.75	3	5	1	1	2	0	2	9	0
7.25	1	3	2	1	3	2	2	8	2
7.75	4	6	3	1	2	3	1	16	1
8.25	5	3	4	2	4	1	3	5	4
8.75	10	8	1	2	2	5	1	11	2
9.25	4	2	2	1	4	1	4	6	1
9.75	10	3	4	2	2	3	4	4	1
10.25	4	3	2	3	2	1	5	2	1
10.75	1	1	1	1	1	2	2	1	2
11.25	3	4	1	0	1	0	3	0	0
11.75	5	2	3	4	0	0	1	1	1
12.25	1	0	1	1	1	0	0	0	1
12.75	1	0	1	1	0	0	0	0	0
13.25	0	0	0	0	0	0	0	0	0
13.75	1	0	0	0	0	0	0	0	0
14.25	0	0	0	0	0	0	0	0	0
14.75	0	0	0	0	0	0	0	0	0
15.25	0	0	0	0	0	0	0	0	1
15.75	0	0	0	0	0	0	0	0	0
16.25	0	0	0	0	0	0	0	0	0
Total	63	53	35	26	30	23	30	68	20

to clearly indicate the progression of cohorts. Subsequent analysis of L/F files with gradually increasing intervals did not yield a marked improvement (Figures 3b-3g, easily done with the 'slicing' routine of FiSAT).

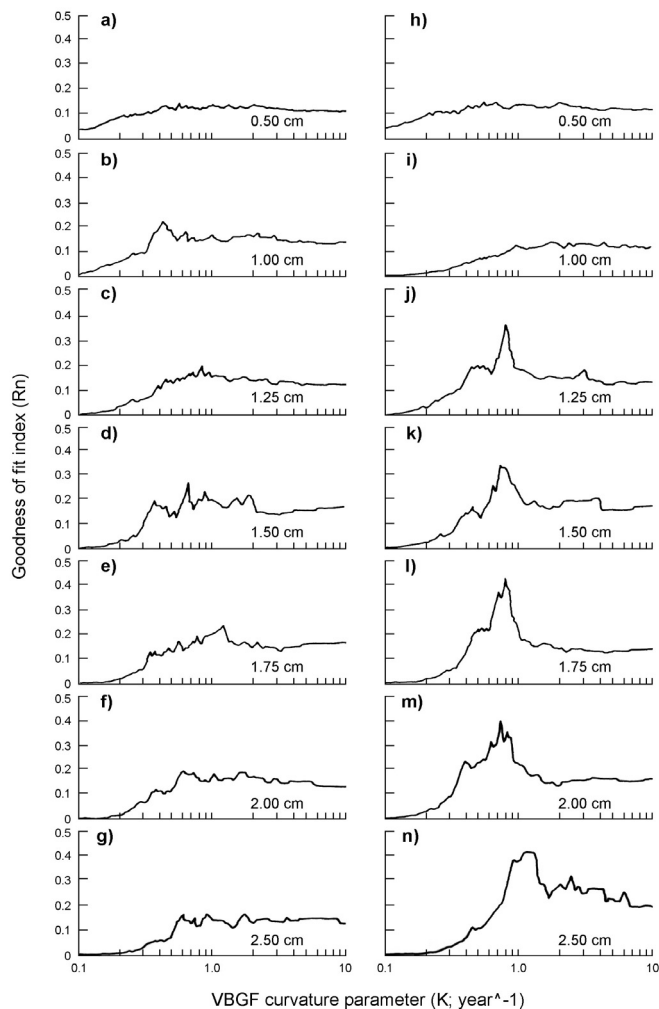


Figure 3 Response surface analysis of the parameter K of the von Bertalanffy growth function showing the increasing resolution of ELEFAN following modification of the length-frequency data in Table 1, for $TL_{\infty} = 17$ cm.

the seasonal growth oscillations, which are here rather strong given that C can take values between 0 and 1, and where $WP = 0.95$ is the 'winter point', i.e., the time of the year (expressed as fraction of 1) when growth is slowest; WP corresponds here to late November 1992, which falls in the wet, 'intermediate' season (Vakily and Pauly, 1993).

This growth curve, which also fits very small mudskippers, has its origin in mid June, suggesting this period as the main spawning season. There is some indication of a second minor spawning at the end of the year, leading to a second, minor cohort (lower panel of Figure 4).

Table 2 presents the key results of the maturity study, from which a length at first maturity of about 9 cm can be inferred for the females and 7 cm for the males. The means of these two values yield $L_m/L_{\infty} = 0.65$, as estimate of the 'reproductive load' (Cushing 1981) for mudskippers.

The second pass, which assumed seasonal growth ($C = 0.5$, $WP = 0.2$, commonly occurring in fish) led to the identification of a peak, associated with $K = 0.80$ year⁻¹ and a class interval of 1.25 cm (Figure 3j). This was used, along with $L_{\infty} = 17$ cm, to (partly) correct the L/F file for the effect of incomplete selection by and incomplete recruitment to the gear, using the catch-curve approach of Pauly (1987).

This led, in the third pass, to the emergence of a clear peak, centered around $K = 0.81$ year⁻¹.

The fourth and final pass consisted of optimizing the parameter related to seasonal growth oscillations, likely to occur in fish exposed to seasonal differences in (air) temperature of about 10°C (Findlay, 1978). This was done using the 'automatic search routine' of ELEFAN, with K , C and WP as free parameters, then using the best estimates of C and WP thus obtained, by running the K scanning routine with C and WP fixed at 0.75 and 0.95, respectively (and L_{∞} at 17 cm as for all previous analyses).

Figure 4 (upper panel) shows the growth curve obtained as a result of this work. The asymptotic length (L_{∞}) is 17 cm, $K = 0.89$ year⁻¹ is the rate at which L_{∞} is approached, $C = 0.75$ expresses the amplitude of

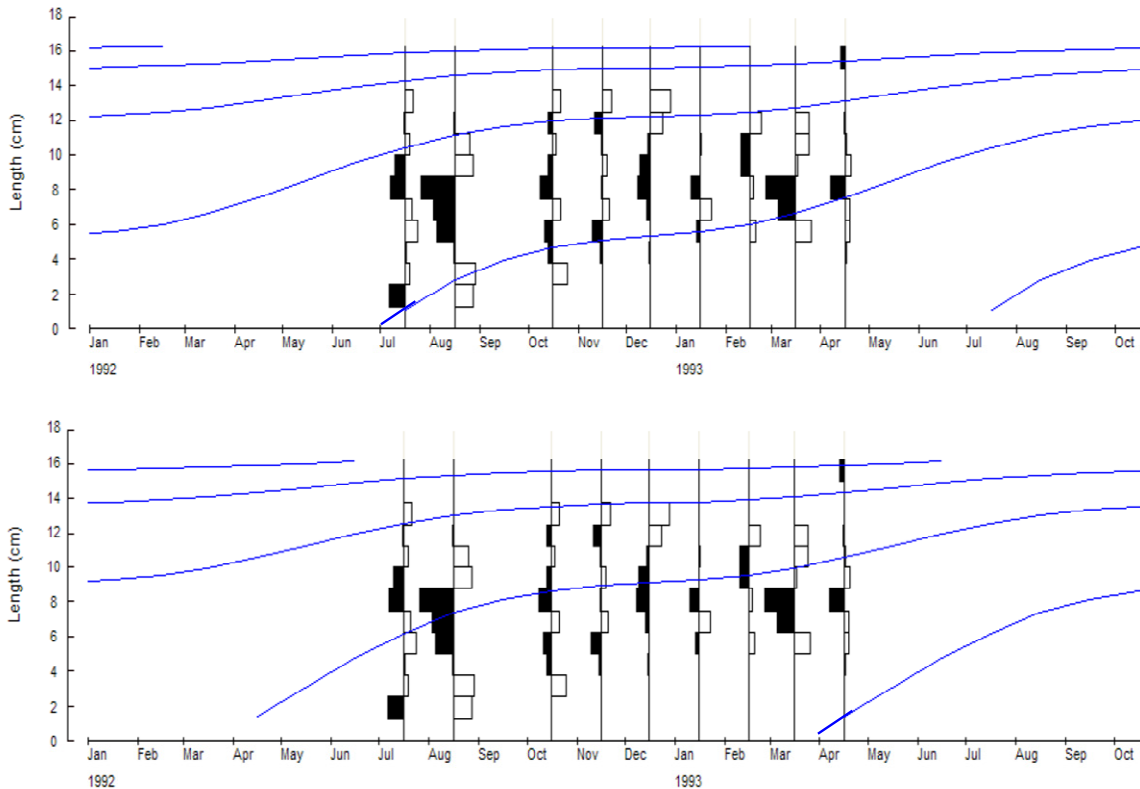


Figure 4 Von Bertalanffy Growth Function for *Periophthalmus barbarus* (Linnaeus, 1766) (Family Gobiidae), removed from their burrows in the mudflats of Congotown, Freetown, Sierra Leone from July 1992 to April 1993, with $TL_{\infty} = 17$ cm, $K = 0.89$ year⁻¹, $C = 0.75$ and $WP = 0.95$. Upper panel: main cohort, originating in June. Lower panel: second cohort, originating earlier in the year.

GSI ranged in females from 2.0 to 3.5, with a mean of 2.5 GSI and % of mature fish were plotted against months. However, low sample size and gaps in the series rendered these data inconclusive; all that emerged is that they did not contradict the timing of the spawning season(s) proposed above.

Apparent fecundity was 11400 eggs g⁻¹ of female gonads, in fish of 8 cm TL, i.e., about 2,100 eggs g⁻¹ body weight. However, spawning probably occurs several times during (and outside) the main spawning season, and hence this estimate of fecundity represents only a minimum.

Table 2 Relative frequency of immature and mature mudskipper, *Periophthalmus barbarus* (Linnaeus, 1766) (Family Gobiidae), removed from their burrows in the mudflats of Congotown, Freetown, Sierra Leone from July 1992 to April 1993.

Midlength (TL, cm)	Females Immature/mature	Males Immature/mature
3.0	0/0	2/0
5.0	1/0	20/0
7.0	10/0	24/44
9.0	22/56	17/47
11.0	3/38	10/19
13.0	0/7	0/6
15.0	0/0	0/1

The food items occurring most frequently in mudskipper stomachs were crustaceans (3 1%), polychaets (26%), insects (9%), and mollusks (3%) with detritus forming the rest. There was a slight tendency for the occurrence of crustaceans to increase and for polychaets to decrease with increasing mudskipper size.

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