Growth Performance of *Oreochromis lidole*, *O. squamipinnis*, *O. shiranus* and *O. karongae*, New Candidate Species for Aquaculture in Open Waters and Fishponds in Malawi[a]

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Abstract

There are several tilapia species (Fam. Cichlidae) indigenous to Lake Malawi whose growth potential is little known outside their natural environment. Past aquaculture research efforts in Malawi have concentrated on *Oreochromis shiranus* and *Tilapia rendalli*. The performance of both species in ponds is limited by a high reproductive capacity and slow growth. Therefore, new candidate species for aquaculture, such as *Oreochromis lidole*, *O. squamipinnis* and *O. karongae*, are under investigation. *O. lidole* grows well in open waters ($\phi' = \log_{10}K + 2\log_{10}L_\infty = 2.79$) but does not spawn readily in ponds, while *O. squamipinnis* appears to have a low growth potential ($\phi = 2.58$, also based on standard lengths). *O. karongae*, on the other hand, breeds in ponds. Selected growth comparisons were made between their populations in Lake Malawi and those kept in fishponds at the National Aquaculture Centre, Domasi, Zomba. Their growth potential is high, with $\phi' = 2.76$ and 3.03 for the lake and fishpond populations, respectively. Thus, growth performance and spawning success in shallow pond make *O. karongae* an attractive candidate species for aquaculture.

Introduction

The need to increase fish production in Malawi to keep pace with increasing demand has been recognized (DEVPOL 1987; GOPA 1987). One approach is to expand and intensify fish farming activities. Most aquaculture research in Malawi has involved *Oreochromis shiranus* (a microphagous species) and *Tilapia rendalli* (predominantly macrophytophagous). *Tilapia rendalli* tastes good but is slow-growing and broodstocks produce relatively low numbers of fingerlings (Costa-Pierce and Chikafumbwa, this vol.). *O. shiranus* shows fast growth while young but matures early and can become stunted in fishponds (Msiska and Cantrell 1985; Pauly et al. 1988; Maluwa 1990).

The work of Lowe (1952) and Trewavas (1983) suggest that the search for indigenous tilapias that would perform

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better in aquaculture must consider *O. karongae* and *O. lidole*. Recently, the successful breeding of *O. karongae* in shallow ponds (O.V. Msiska, unpubl. obs.) has further spurred interest in this species (see Maluwa and Dixon, this vol.).

This paper compares the growth of *O. karongae*, *O. lidole* and *O. squamipinnis* from published data with preliminary growth studies in ponds, using ϕ' ($=\log_{10}K+2\log_{10}L_\infty$) (Pauly 1979; Pauly and Munro 1984) as an index of growth potential. The technique was chosen because of its demonstrated applicability to tilapias (Moreau et al. 1986; Pauly et al. 1988).

Methods

Capture Fisheries Data

Mean length-at-age estimates for *O. lidole*, *O. saka* (now regarded as a junior synonym of *O. karongae*), *O. shiranus shiranus* and *O. squamipinnis* as reported by Lowe (1952), based on samples collected in 1945-1947, were used to estimate the von Bertalanffy growth parameters (L_∞; K) from which the ϕ' values were calculated (Table 1).

Capture and Transportation of Live Fish to Ponds

Fingerlings were collected by beach seining, assisted by diving for specific schools of fish. For pond studies, fish were obtained from Cape Maclear and Kakoma Bay in Lake Malawi and from Lake Malombe (Fig. 1). The most successful fishing season was from January to March, after natural breeding, when most fry had become free-swimming.

Before transferring fingerlings to the National Aquaculture Centre (NAC), Domasi, Zomba, they were kept unfed in cages for at least 48 hours to allow them to void their guts. During this period, a prophylactic (terramycin) at 0.1 $mg \cdot l^{-1}$ and a vitamin premix were given by adding the powder forms of these medications into the cages. In the absence of terramycin, egocin (oxytetracycline hydrochloride and calcium pantothenate) was used. While the former drug is approved by the US Environmental Protection Agency (EPA) for use on food fish (Schnick 1988), the latter is commonly used for poultry.

Growth Trials in Ponds

All tilapia fingerlings were initially stocked into separate ponds, according to their origin. Various attempts at visually separating these immature forms into species proved futile, as were similar attempts by other workers (Lowe 1952; Tarbit 1969; Trewavas 1983; Turner et al. 1989). Thus, identification of fish was not confirmed until they had attained large sizes of over 100 g when breeding colors became conspicuous.

Sixty *O. karongae* fingerlings were stocked in each of the two 500-m^2 ponds. One of the most reliable characteristics used to help separate the three tilapias of subgenus *Nyasalapia* (*O.N. lidole*, *O.N. karongae* and *O.N. squamipinnis*) is the number of tooth rows on the lower jaw and their mode of arrangement (Turner and Robinson 1991). Because this parameter could be used without killing fish, it was extensively utilized in this study and fish which were classified as *O. karongae* but had over four rows were stocked separately from those whose rows were less than four. The two groups had, in an earlier study, been observed to differ in spawning requirements (Msiska, unpubl. obs.). The mean size at stocking was (+SD) 19.5+1.8 cm TL and 134.2+38.2 g body weight. Further, morphometric measurements

Table 1. Estimates of growth of *Oreochromis* spp. in Lake Malawi (adapted from Lowe 1952). The mean length-at-age estimates (total length) were obtained by length-frequency analysis and the counting of rings on the opercular bone. Standard lengths are in brackets.

Species		Age groups							
		I		II		III		IV	
O. shiranus shiranus	Length (cm)	10.0	(7.8)	18.0	(15.8)	22.0	(19.8)	25.5	(23.3)
	Weight (g)	16.0		110.0		210.0		342.0	
O. karongae	Length (cm)	12.0	(9.3)	22.0	(19.3)	27.5	(24.8)	30.0	(27.3)
	Weight (g)	28.0		198.0		412.5		545.5	
O. squamipinnis	Length (cm)	9.0	(7.0)	17.0	(14.3)	24.0	(21.3)	26.5	(23.8)
	Weight (g)	12.0		86.0		264.0		366.0	
O. lidole	Length (cm)	13.0	(10.3)	23.0	(20.3)	28.5	(25.8)	31.0	(28.3)
	Weight (g)	40.0		220.0		463.5		609.0	

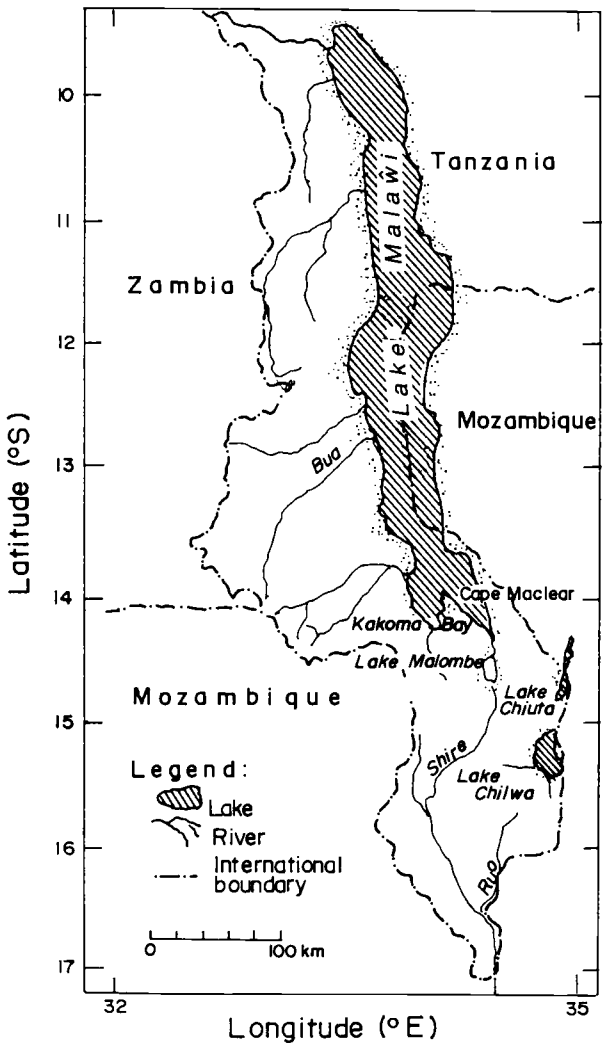

Fig. 1. Distribution of species of *Oreochromis* subgenus *Nyasalapia*: Lakes Malombe and Malawi.

were obtained for the two populations according to recommendations by Turner et al. (1989).

Five hundred *O. squamipinnis* fingerlings were stocked in a 500-m^2 pond. The mean size at stocking (±SD) was 16.4±1.7 cm TL and 91.3±28.0 g body weight. Confirmation regarding the identification of these fish was done in consultation with G.F. Turner who has extensively studied the taxonomy and ecology of the wild stocks of *Oreochromis* subgenus *Nyasalapia* in Lake Malawi.

Every month, a sample of 20 to 30 fish per pond was taken to record lengths and weights. During sampling, fish were anesthetized using benzocaine (Ross and Ross 1984). All the fish were fed maize bran at 4% body weight which was adjusted downwards to 2.5% body weight per day six days per week, after the fish attained an average weight of over 200 g. Data were collected for a period of 275 days and ϕ' values were calculated from the von Bertalanffy parameters L_∞ (SL; in cm) and K ($year^{-1}$) following Vakily (1988). Morphometric measurements taken on the two groups of *O. karongae* were first converted to fractions of standard length and the Microstat program of Ecosoft Inc. was used to analyze the data on an IBM compatible personal computer.

Results

Table 2 summarizes the growth parameter estimated from wild and cultured tilapia populations. Pond data are restricted to *O. karongae* and *O. squamipinnis* following confirmation by G.F. Turner that these pond populations did not contain *O. lidole*.

Discussion

The values of ϕ' determined for *O. karongae*, *O. lidole* and *O. squamipinnis* are comparable to or higher than those published for tilapias regarded as having acceptable growth performance: *O. niloticus* (2.30-3.11), *O. aureus* (2.31-2.61), *O. andersonii* (2.46-2.63) and *O. mossambicus* (2.05-2.60) (Pauly et al. 1988). If growth performance using ϕ' were the only criterion for selecting species for aquaculture, then *O. lidole*

Table 2. Growth performance index (ϕ')[a] and related statistics of wild (Lake Malawi) and captive (National Aquaculture Centre, Zomba) stocks of Lake Malawi tilapia species.

Species	Stock	W_∞ (g)	W_{max} (g)	L_∞ (cm)	L_{max} (cm)	K($year^{-1}$)	ϕ'	Source
O. shiranus shiranus	Wild	-	-	27.8	39.0	0.481	2.57	This study
	Captive	53.5	-	11.0	-	9.87	3.08	Pauly et al. (1988)
O. karongae	Wild	781	857	30.3	34.0	0.631	2.76	Lowe (1952)
	Captive	656	-	27.7	-	1.391	3.03	This study
O. squamipinnis	Wild	760	758	31.9	33.0	0.375	2.58	Lowe (1952)
	Captive	537	-	23.6	-	1.739	2.99	This study
O. lidole	Wild	891	1.110	31.3	38.0	0.631	2.79	Lowe (1952)
	Captive	-	-	-	-	-	-	

[a] $\phi' = \log_{10}K + 2\log_{10}L_\infty$; K($year^{-1}$). L_∞(cm: SL).

would rank highest, with $\phi' = 2.79$. However, its reluctance to breed in fishponds should first be resolved before using it in aquaculture (A.O.H. Maluwa and M. Dickson, pers. comm.).

Our morphometric data (not shown) suggest at least two variants of *O. karongae* in the pond populations. The presence of several strains in the wild has since been confirmed by differences in spawning success and nest characteristics, and tooth row arrangements and pharyngeal dentition (Turner and Robinson 1991). Consequently, it has been suggested that *O. karongae* is a nominal species comprising several variants of which *O. saka* is a junior synonym (Turner et al. 1989).

According to Lowe (1952) and Trewavas (1983). *O. lidole* is the fastest growing *Oreochromis* in Lake Malawi, followed by *O. saka* (now *O. karongae*), *O. squamipinnis* and *O. shiranus shiranus*. Such differences could not, however, be distinguished by calculating specific growth rates. Thus, the estimation of ϕ' appears to have more practical value during initial screening of candidate fish species than the conventional specific growth rate. More research needs to be done using this index of growth potential to examine other species of *Oreochromis* and/or *Nyasalapia*.

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