The successful introduction of *Oreochromis mossambicus* in salt pans along the Namib coast

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ABSTRACT

Twenty four *Oreochromis mossambicus* from the Hardap Dam, Namibia, were introduced during 1986, into salt pans at Swakopmund on the Namib coast. The salt concentration of the salt pans is 42042 mg/l TDS, 16,6% higher than that of seawater. The fish adapted well to the conditions, bred successfully and maintained a healthy population. The population in the Hardap Dam and those in the salt pans show similar growth rates with the Hardap Dam population having a somewhat better length/mass relationship.

INTRODUCTION

The occurrence of *O. mossambicus* in salt water is well documented. According to Kirk (1972) it is assumed that tilapia generally have evolved from a marine ancestor which penetrated fresh water and that this accounts for the large number of euryhaline species. Fowler (1934) reported that *O. mossambicus* occurs in Durban Bay, South Africa, in waters of high salinity. Potts *et al.* (1967) have shown that *O. mossambicus* fry can live and remain healthy in 200% (72000 mg/l TDS) sea water.

Experiments by Brock (1954) with a single brood of *O. mossambicus* divided into two groups, one reared in fresh water and the other in salt water, showed no significant difference in their growth rates and both groups spawned successfully. A similar experiment by Canagartnam (1968) showed that *O. mossambicus* grew better in 100% (36000 mg/l TDS) sea water than in fresh water. They also spawned successfully. This supported his earlier finding that euryhaline fish grow better in a saline medium and can thrive in a wide range of salinities (Canagartnam 1959). Hodgkiss and Man (1977) reported a slower growth rate of tilapia in Hong Kong when salinities decreased.

Whitfield and Blaber (1979) found that *O. mossambicus* could adapt to a salinity range of 0 - 120000 mg/l TDS, which occurred in their study area at Lake St. Lucia, South Africa. Whitfield and Blaber (1979) noted, however, the absence of *O. mossambicus* from most of the estuaries that are permanently open to the sea. They concluded that, while *O. mossambicus* is able to tolerate seawater as well as slow changes in salinity, it is incapable of withstanding rapid changes in salinity. Allanson *et al.* (1971) found that *O. mossambicus* is able to tolerate low temperatures in 5000 mg/l TDS sea water better than in fresh water.

Twenty four *O. mossambicus* were obtained from the Fresh Water Fish Institute at Hardap Dam and introduced into the salt pans at Swakopmund by the owner during the autumn of 1986. The study was initiated to determine the adaptability and to make growth comparisons of the same strain of *O. mossambicus* between high salinity and fresh water.

STUDY AREA AND METHODS

The salt pans (22°37'S;14°29'E) are situated outside Swakopmund, along the Namibian coast (Plate 1). The pans are manmade and are used for salt production. *Oreochromis mossambicus* was introduced and remains confined in pans A and B (surface areas approximately 29 ha and 11 ha, respectively). The depth of the two pans are approximately 2 m with a monthly water flow of 485 333 m³ from the ocean.

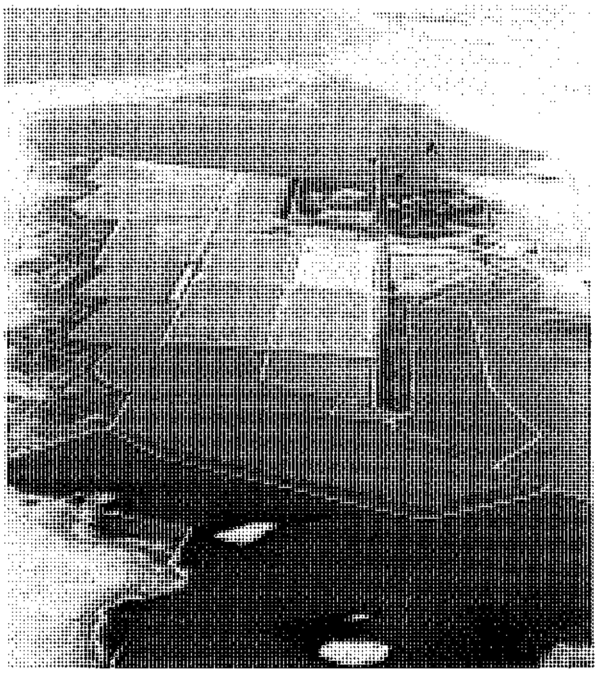

PLATE 1. Aerial photograph of the Swakopmund Salt Pans, Namibia, showing the two pans (A and B) into which *Oreochromis mossambicus* were placed.

A full range of gill-nets consisting of 35, 45, 57, 73, 93, 118 and 150 mm stretch mesh, each 30 m long were used. The nets were set for 72 h and were cleaned every 12 h.

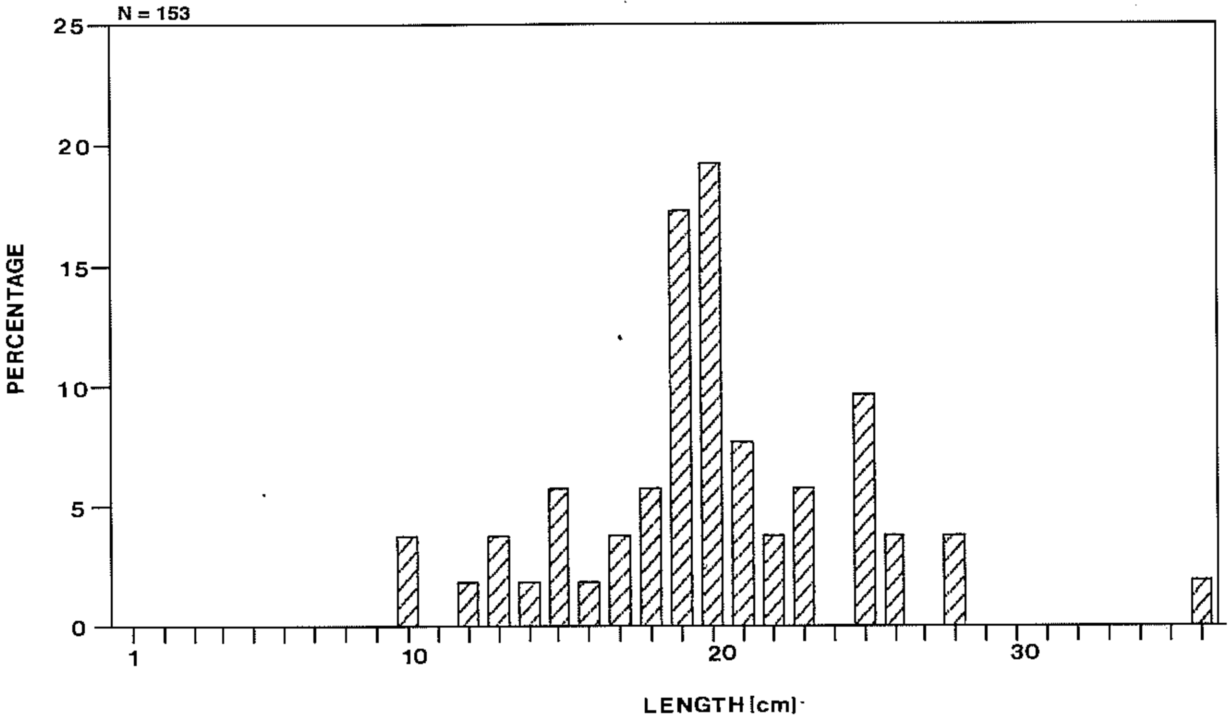

FIGURE 1. Length frequency of *Oreochromis mossambicus* in Salt Pans at Swakopmund.

The fish were weighed with a Mettler P20 balance and their total lengths were measured to the nearest cm. All the fish were sexed by an internal gonad examination. Scales were collected in order to determine annuli. The Bhattacharya method was used to determine cohorts while Munro's method was used to determine the phi prime (Ø) (Sparre *et al.* 1989). The VONBER programme in the LFSA software was used for the determination of the Von Bertalanffy growth parameters (L_∞ = L-infinity, k = curvature parameter). A chi-square test was performed to examine the sex ratio statistically.

RESULTS AND DISCUSSION

The salinity of the salt pans was 42042 mg/l TDS, 16,6 % higher than that of sea water (Table 1). Water quality and water temperature in the salt pans fall within the range for suitable growth for tilapia (Van Zyl 1988). The minimum and maximum critical water temperature for *O. mossambicus* are 10°C and 38,25°C respectively (Allanson 1966; Du Plessis & Groenewald 1953; Lombard 1959; Allanson & Noble 1964; Caulton 1980). Nel (1978) found that *O. mossambicus* survived nitrite concentration up to 8,71 mg/l. According to Muir and Roberts (1982) pH levels between 4,0 and 11,0 are suitable for the survival of *O. mossambicus*. High potassium and magnesium concentrations may influence the taste of the fish. This could be an important factor when aquaculture is considered.

A total of 153 specimens were caught. Their length distribution varied between 10 cm TL and 36 cm TL (Figure 1). The fish had clearly bred successfully in the high salinity pans. Their sex ratio was found to be of 1,5:1,0 (male:female) which does not differ significantly from a 1:1 ratio (Chi-square = 2,283302, DF = 1, $p \geq 0{,}05$). The fish were in good condition and had adapted well to the high salinity in the salt pans.

pH			8,1
Conductivity			6370,0 mS/m
Total dissolved solids (TDS)			42042,0 mg/l
Nitrate			< O,5 mg/l
Nitrite			< 0,1 mg/l
Chloride			26400,0 mg/l
Potassium			460,0 mg/l
Magnesium			6712,0 mg/l
Turbidity			4,0 NTU
Temperature	(Summer)	Max	27,0°C
		Min	20,0°C
	(Winter)	Max	20,0°C
		Min	12,0°C

TABLE 1. Water quality and water temperature of the salt pans.

Locality	Growth parameters			PHI prime
	L_∞	k	t_0	Ø
Salt Pan (1991)	56,2	0,14	-1,11	6,0980
Hardap Dam (1988)	54,8	0,17	0,51	6,2354

	Length/mass relationship			
	a	b	r	N
Salt Pan (1991)	0,0136	3,0470	0,99	153
Hardap Dam (1988)	0,0105	3,1942	0,99	93

r = correlation coefficient
N = sample size

TABLE 2. Von Bertalanffy growth parameters, PHI prime and the length/mass relationship of *O. mossambicus* from the salt pans and Hardap Dam.

Studies of the annuli on scales, and results of the Von Bertalanffy growth parameters show that *O. mossambicus* in the saltpans grew well but that their weight gain was less than fish in Hardap Dam (Table 2). This is supported by the fact that *O. mossambicus* from Hardap Dam also had a better length/mass relationship (Table 2). The latter is a power curve, where $M = aL^b$ (M = mass, L = total length, a and b = constants). This result differs from the findings of Canagartman (1968). One must bear in mind, however, that the findings obtained by Canagartman (1968) were the result of experimental studies.

Although tilapia culture is limited primarily to fresh and brackish water, it has been widely suggested that euryhaline tilapias could be cultured in higher salinity and marine systems (Watanabe *et al.* 1984). This is also possible in Namibia, with its vast coastline and protected rocky bays at Lüderitz, as well as in the Cuvelai regions with it's brackish groundwater. It is recommended, however, that a study addressing the following factors be done prior to any aquaculture project in saline water: (a) temperature tolerance at different salinities (b) growth experiments, in order to determine the growth rate, food conversion, stocking densities and economical implications.

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