Genetic diversity distribution of *Lenthrinops* "pinkhead" in Lake Malombe

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Abstract
A study was carried out to determine the genetic diversity of *Lethrinops* "pinkhead", one of the dominant kambuzi species in Lake Malombe, at five microsatellite DNA loci. Most of the populations were not in Hardy-Weinberg equilibrium due to population mixing that is currently going on in the lake. Mean number of alleles ranged from 3.8±1.92 to 5.20±3.11 suggesting that the populations have relatively low genetic diversity probably due to overfishing and founder effects. However, pooled populations of southern part of the lake had higher genetic diversity than the northern populations, 6.6±0.30 and 5.4±0.01 for mean number of alleles, respectively; 3.68±0.08 and 3.3±0.00 for effective number of alleles, respectively. This suggests that the protected area in the southern part of the lake, which is part of the Liwonde National Park, contributes to sustaining genetic diversity of the species. Moreover, the migration rate of 4.25 individuals per generation indicates that there is continuous migration of the species between the protected area and fishing sites. Hence, if the protected area was properly managed it would serve as an effective fish recovery refugium.

Keywords: *Lethrinops*, migration, protected area

Introduction

Lake Malombe, the third largest lake in Malawi, ahs been important for fishing since early 1960s when commercial fishing was introduced. At that time, fish catches were dominated by *Oreochromis nyasalapia* sp. which was later replaced by small cichlids locally known as *kambuzi*. Continuous overfishing has resulted in the collapse of the fishery in the lake where even the catches of kambuzi have declined considerably. In order to reverse the trend of the collapse of Lake Malombe fishery, the government in collaboration with a German funded project placed scrap motor vehicle objects in selected areas of the lake as fish aggregation devices that would enhance recovery of the stocks in 1990s. These were mainly placed in the southern part to reinforce protection efforts that were already in place through the Liwonde National Park. The assumption was that the protected areas would reseed areas that are open to fishing. However, the geographical range of migration for *kambuzi* was not known. It was necessary to address these issues so that conservation potential of the efforts being put in place can be assessed.

The study was conducted using *Lethrinops* "pinkhead" because it is one of small cichlids species that for some time has dominated the catches contributing to more than 23% of total catches in late 1990s (Mwakiyongo & Weyl, 2001). In addition, the species was widely distributed in Lake Malombe, thus enabled analysis of populations from various areas. The species is among the zooplankton feeding fishes that face a great threat of reduction in biodiversity due to overfishing especially during breeding season (Reinthal, 1993).

Materials and Methods

The study was conducted in Lake Malombe. Sample sizes analyzed for the different sample sites are indicated in Table 1 and Figure 1, respectively. Sampling involved use of nkacha nets that be-

Table 1. Sample size and sites where samples of *Lethrinops* "pinkhead" were collected

Sampling site	Population code	Sample size
Western areas		
Likala	Lik	40
Lundu	Lundu	38
Ntanga	Nta	40
Chisumbi	Chis	40
Eastern areas		
Sili	Sili	32
Kadewere	Kad	40
Likulungwa	Likul	40
Sanctuary	Sanct	40

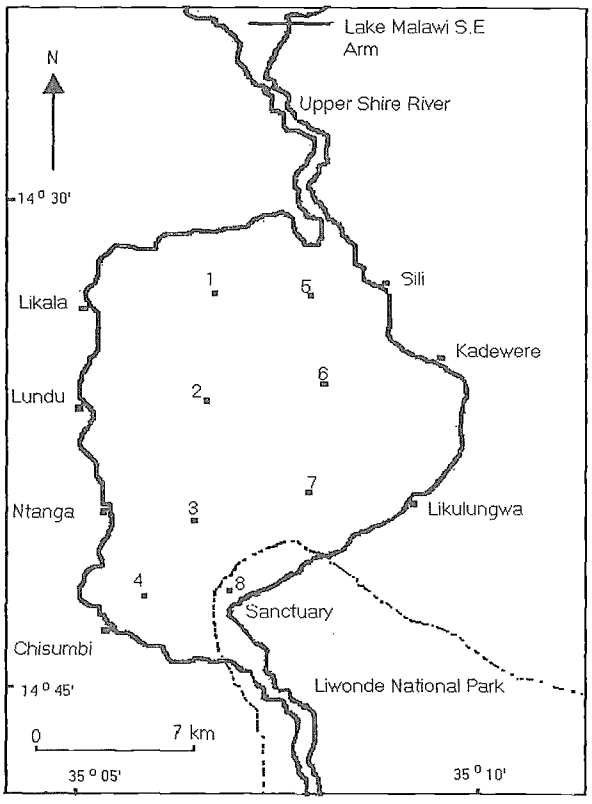

Figure 1. Sampling sites in Lake Malombe and adjacent fishing grounds against which the sites have been identified. Site numbers 1 is Likala, 2=Lundu, 3=Ntanga, 4=Chisumbi, 5=Sili, 6=Kadewere, 7=Likulungwa and 8=sanctuary which is the protected area.

longed to fishermen. DNA extraction and microsatellite DNA analysis were carried out using the protocols in Changadeya (2001).

Results and discussion

Most populations did not conform to Hardy Weinberg Equilibrium (HWE) ($p<0.05$) probably due to sampling error caused by mixing of populations in the lake. Samples in this case comprise of a mixture of fish stock from different subpopulations within the collection areas.

Mean number of alleles per population ranged from 3.8 ± 1.92 to 5.20 ± 3.11. There was no significant difference in allele diversity among all the populations analyzed ($p>0.05$). Effective number of alleles as a measure that corrects for rare alleles was not significantly different from number of alleles ($p>0.05$) and there was no significant difference between observed heterozygosity and expected heterozygosity in all the populations (Figure 2).

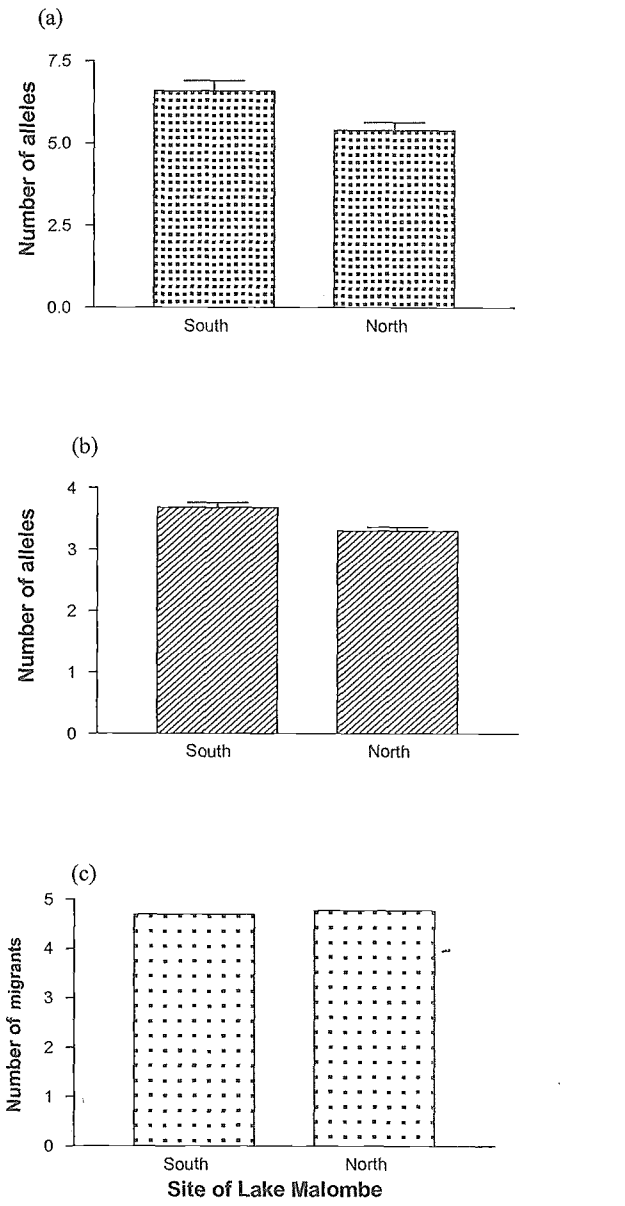

Figure 2. Genetic diversity indices between the western and eastern sides of Lake Malombe populations of *Lethrinops* pinkhead (a=observed number of alleles, b=effective number of alleles and c=rate of migration per generation)

Allelic diversity is a useful measure of genetic variability within a population (Norris *et al.*, 1999). Genetic variation in *Lethrinops* "pinkhead" populations of Lake Malombe was generally moderate with average heterozygosity of 0.647 recorded at all loci. High heterozygosity values indicates large spectrum of genotypes for adaptive response to changing situation whereby heterozygous individu-

als are superior to homozygous ones in many economically important traits such as growth, fertility and disease resistance.

Allelic diversity of pooled population of southern sites was not significantly different from the northern sites (Figure 2), although the southern sites had higher diversity than the northern sites. Fishing in the northern part of the lake is not restricted while restrictions are imposed on the southern sites because they include protected area. These results suggest that fishing intensity in the northern areas might have reduced the genetic variation compared to the southern sites, although not significantly.

Migration rate of 4.25 individuals per generation indicates that there is a single population of *L.* "pinkhead" hence there is continuous migration between the protected area and fishing sites (Figure 2). This implies that if the protected area was properly managed it would serve as an effective fish recovery refugium.

In summary, *Lethrinops* "pinkhead" in Lake Malombe has moderate genetic diversity. The species and several other kambuzi species have been subjected to heavy fishing to the effect that catches are declining with time. Although Liwonde National Park provides protection to the southern populations of the lake, lack of sustainable management of the area may have resulted in poaching by fishermen. However, the protected area offers an opportunity for stock recovery and maintenance of genetic diversity as it has been observed in this study, genetic diversity was higher in the southern part of the lake compared to the northern part.

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