Stock assessment of *Lates niloticus* (L.), *Oreochromis niloticus* (L.) and *Rastrineobola argentea* (Pellegrin) using fisheries-dependent data from Tanzania waters of LakeVictoria

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Abstract: Three commercially important fish species, *Lates niloticus* (L.) *Rastrineobola argentea* (Pellegrin) and *Oreochromis niloticus* (L.) that are fished by artisanal fishermen of Lake Victoria, Tanzania part were studied in Kagera, Mwanza and Mara beaches from October 1997 to July 1999. Catches, effort, exploitation and stock structure were investigated. Beaches for sampling were selected based on importance for landing the above named fish species. The number of boats found on beach that day, the number that lay idle and their means of propulsion were recorded. As many boats as possible were sampled for gear type and gear size. The catches were sorted into species and measured. Variation in the species and size composition of landings was observed between regions, between months and between gears used. The implications of the findings to management are discussed

Introduction

The best approach to managing inland fisheries depends on the availability of some measure of stock abundance or associated population parameters on which to formulate the decision-making process or evaluate the impact of a particular management activity (Cowx 1996). Stock assessment is considered necessary to gauge the effects of activities such as the impact of overfishing, a pollution event, land drainage improvement works, river regulation, habitat restoration, stocking, introduction of new species or to merely respond to requests for advice on the management of waters.

Traditionally two methods of stock assessment are used, based on fishery dependent and fishery independent data. Catch assessment surveys, based on the former, are complimentary to experimental, fishery independent surveys as a method of collecting data to assess the impact of fishing on the stock structure.

In Tanzania, fishery dependent data are collected by the Fisheries Department for statistical reasons. However, the strategy lacks rigour and the data exhibit vagaries which make their use questionable. Irrespective the use of fishery dependent methods is extremely valuable for identifying exploitation patterns and catch characteristics Consequently, a pilot study was set up to investigate the exploitation of the three main commercial species in the Tanzanian sector of Lake Victoria (Nsinda & Mrosso 1999). This study was used to determine the variability in fishery effort and catch composition between beaches. Four beaches were selected in the three main zones of Lake Victoria, i.e. Mara, Mwanza and Kagera. These were indicative of the zone and the main types of beaches in terms of species landed. Two well defined characteristics were elucidated from this study. The species and size of fish landed usually reflects the location of the fishery and the gear used by boats operating out of that beach. Also landings are usually dominated by one key species. It was also possible to discriminate cohort growth patterns over time, especially for *Lates niloticus* (L.) and *Rastrineobola argentea* (Pellegrin).

As a result of this pilot scale project, a more comprehensive catch assessment programme was established for the Tanzanian sector of Lake Victoria. This was justified on the quality of data provided at a relatively cheap cost, and to establish a long term data collection programme which will provide valuable insight into the exploitation trends in the fishery. The paper provides the output for the first few months of the revised programme and is the forerunner to annual reports on the fishery.

Materials and methods

In the pilot survey, three beaches, Kayenze, Chole, and Igombe, were selected for sampling on the basis of accessibility and their importance for *L. niloticus, Oreochromis niloticus* (L.) and *R. argentea* fisheries (Fig. 1).

Four trips were made to each beach in October 1997, and February, June and September 1998. The number of boats on beach that day, the number that lay idle and the number that went out fishing were recorded. For each beach as many active boats as possible were sampled to determine the type of gear, means of propulsion, number and mesh size of nets. The catch of each boat was sorted into species and recorded, and correlated against the principal gear used. Length (nearest cm below) and weight (nearest g) measurements of the entire sample or sub sample of *L. niloticus* and *O. niloticus* were taken from each sampled boat. For *R. argentea,* a sample of 0.125 kg was taken and preserved in 5% formalin for analysis in the laboratory.

The revised catch assessment surveys were conducted in three areas (Fig. 1): A - Mwanza to Bunda; B - Mara and C - Kagera. between April and July 1999. Five beaches in the Kagera zone , and seven each from the Mwanza and Mara zones were selected on the basis of their importance either for *L. niloticus, O. niloticus* or *R. argentea* fisheries. Due to resource limitations, the beaches were surveyed on a rota basis, i.e. all the beaches in a particular area were sampled on a three-monthly rotation. Sampling on the beaches used the same methods as in the pilot survey.

Results

Catch by region

Catch rates varied considerably between months, and hence regions. The poorest catches were in May 1997 in the Mwanza region, whilst consistently higher catches were recorded for the other two regions. (Table 1). Once a full year
collected these will be used to estimated the total catch from the fishery based on raising factors collected from the recently completed frame survey.

The catch rates for the three species also varied between regions and months (Table 1), possibly reflecting seasonal/regional changes in the fishery. This will be examined more fully in the next reporting period.

The modal length for *O. niloticus* caught by 1-9" mesh sized gillnets and handlines and longlines with hook size 7 to 12, varied between months, but during the latter part of the programme, when more consistent data were collected, there was a modal progression from 29-30 cm in April to 36-37.5 cm TL in July (Fig. 2). A considerably greater number of smaller fish were caught in June 1998 and July 1999, presumably because juveniles were recruiting into the fishery. This will again be assessed during the later phases of the project. This influx of smaller fish was not, however, due to variation in the gears used between surveys (see later).

Lates niloticus, caught by gillnet with mesh sizes ranging from 4.5" to 7" and longline hook size numbers 7 to 13, showed evidence of recruitment, i.e. a decline in the median size of fish landed, in both June 1998 and June 1999, which is consistent with the growth of the smaller fish caught during the February survey (Fig. 3).

Rastrineobola argentea caught by seine and lift nets exhibited a modal progression in size with recruitment to the fishery possibly around the July to September period each year (Fig. 4), when a greater proportion of smaller fish and a bimodal distribution of the catch was observed. However, the latter could be due to two mesh sizes of lift net (5 and 10 mm) being operated in the fishery at this time.

Other species encountered in catches on the surveyed beaches included *Bagrus docmak* , *Clarias gariepinus* (Burchell), *Protopterus aethiopicus* Heckel, *Labeo victorianus* Boulenger, *Synodontis afrofischeri* Hilgendorf, *Synodontis victoriae* Boulenger, *Schilbe intermedius* , *Brycinus jacksonii* (Boulenger), *Mormyrus kannume* and haplochromine cichlids. The greatest fish species diversity was recorded in the Mwanza and Mara regions (all species), whilst only the first three species, plus haplochromines, were recorded in the Kagera zone.

Catch by gears

The catch distribution of the various fish species by different gears exhibits some marked difference. Gillnetting, the predominant gear used for *O. niloticus*, exhibited two modal distributions at around 19 cm and 32 cm TL, respectively. This almost certainly reflects the use of nets from 1
of nets employed were >5
which were >30 cm TL. The encircling gillnet catch distribution was distributed around a mode of 37 cm TL with few fish caught <29 cm TL. This was because the encircling nets used were 5-6

By contrast, the majority of *O. niloticus* landing from long lining and hand lining were <130 cm and as small as 12 cm TL. The modal length was around 21 cm, considerably lower than fish caught by netting. This is probably because small hook sizes (longline 7 and 9; hand line 10-12) are used in the fishery.

The size composition of Nile perch catches by gillnetting and long lining similarly exhibited marked differences. The mean length of capture by gillnetting was 46 cm TL but 55 cm by long lining. Few fish <30 cm were landed, but long lining caught a considerably larger proportion of fish greater than 80 cm TL.

Landing from the two main gears used for capture of *Rastrineobola* showed marked differences. A bimodal distribution (modes at 45 and 60 mm TL) was found for the lift net catches but a negatively skewed distribution with a mode around 55 mm TL was found for seine catches. The *Rastrineobola* data in July 1999 exhibited a measuring bias by the recorders, which has since been addressed. The recorders had a tendency to measure to the nearest 5 mm, hence the peaks at five mm intervals. However, the underlying trend in size at landing is still evident.

Discussion

The preliminary assessment of the commercial landings from the Tanzanian fishery exhibit some prominent characteristics which will have a bearing on the management of the fishery in the future.

Active fishing for *O. niloticus* using gillnets is illegal in the lake but is commonly practiced. However, size distribution of the catch from the netting operation was of larger fish, thus the damage done by this method is largely one of increasing capture efficiency and not necessarily exploiting smaller individuals. It must be borne in mind this scenario may change if catches decline and the fishermen reduce the mesh sizes employed.

Perhaps of more concern is the high proportion of smaller fish caught by the hook and line methods, especially hand lining. The majority of these fish are below the age at first maturity for Nile tilapia which is >30 cm TL (Ojuok 1999). Managing the hook and line fishery is considered to be difficult, mainly because it is widely practised on a subsistence basis. However, effort must be made to prevent expansion of the fishery and ban hook and line fishing in known nursery areas. Importantly, the majority of Nile tilapia landed by gill netting is >30 cm, and efforts must be made to ensure the mesh sizes do not reduce if catches decline.

Nile perch catch statistics again exhibited variation in size distribution of landed fish between gears used; long lining tended to catch more larger fish. The major cause of concern is that the majority of fish caught by gillnetting was below 50 cm TL. The majority of these fish are below the size of maturity (55 cm in Tanzanian waters, Mkumbo & Ezekeil 1999), suggesting that overfishing is prevalent in the fishery and action must be taken to reduce the problem.

The size distribution of the exploited stock of *Rastrineobola* varied between gears, probably as a result of seasonal variability in the monitoring. It is possible that the records covered recruitment of cohorts of juveniles into the fishery, especially in October 1997 and July 1999 sampling which was more prevalent in the lift net catches, or differences in mesh size of nets used (i.e. 5 and 10 mm mesh) may influence the size distribution. Irrespective, the size of fish exploited by the fisheries is mainly above 45 cm, the size at maturity of *Rastrineobola* in Ugandan waters in Lake Victoria (Wandera 1999).

The output of the catch assessment studies on Tanzanian waters of Lake Victoria shows the importance of integrating fishery dependent data with biological information. It also justifies the need to expand on this aspect of stock assessment in all three countries. This is being developed in Uganda (PhD studies of L. Muhoozi), and existing assessment in Tanzania and Kenya will be intensified to monitor the exploitation patterns of the commercial fisheries. In addition, once more data become available, further analysis will be carried out to determine the exploitation characteristics of the three major fisheries using stock assessment tools. Much of this analysis will be carried out in time for the next FIDAWOG workshop.

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Table 1. Estimated daily landings for (kg day^{-1}) the three major commercial fish species at monitored landing beaches between October 1997 and July 1999

	Effort (no of boats)	No. of boats sampled	CPUE (kg.boat^{-1})	Estimated catch (kg day^{-1})
Oreochromis niloticus				
October 1997	24		5.7	143.3
February 1998	9		2.5	16.3
June 1998	22		3.1	40.3
September 1998	18		2.7	70.4
April 1999	30	13	9.5	282.9
May 1999	10	2	20.0	193.0
June 1999	16	12	4.0	59.0
July 1999	16	8	37.0	1248.0
Rastrineobola argentea				
October 1997	107		125.0	10500.0
February 1998	76		160.8	12584.5
June 1998	36		20.3	1458.0
September 1998	34		141.1	9593.1
April 1999	34	10	89.1	3029.9
May 1999	5	5	33.0	166.0
June 1999	14	8	172.0	2541.0
July 1999	12	7	187.0	2242.0
Lates niloticus				
October 1997	96		41.5	6825.3
February 1998	42		101.2	3333.7
June 1998	46		55.6	2559.3
September 1998	83		64.5	5671.3
April 1999	41	10	40.7	1668.7
May 1999	89	9	134.0	187.0
June 1999	26	7	98.0	2479.0
July 1999	24	10	56.0	1278.0

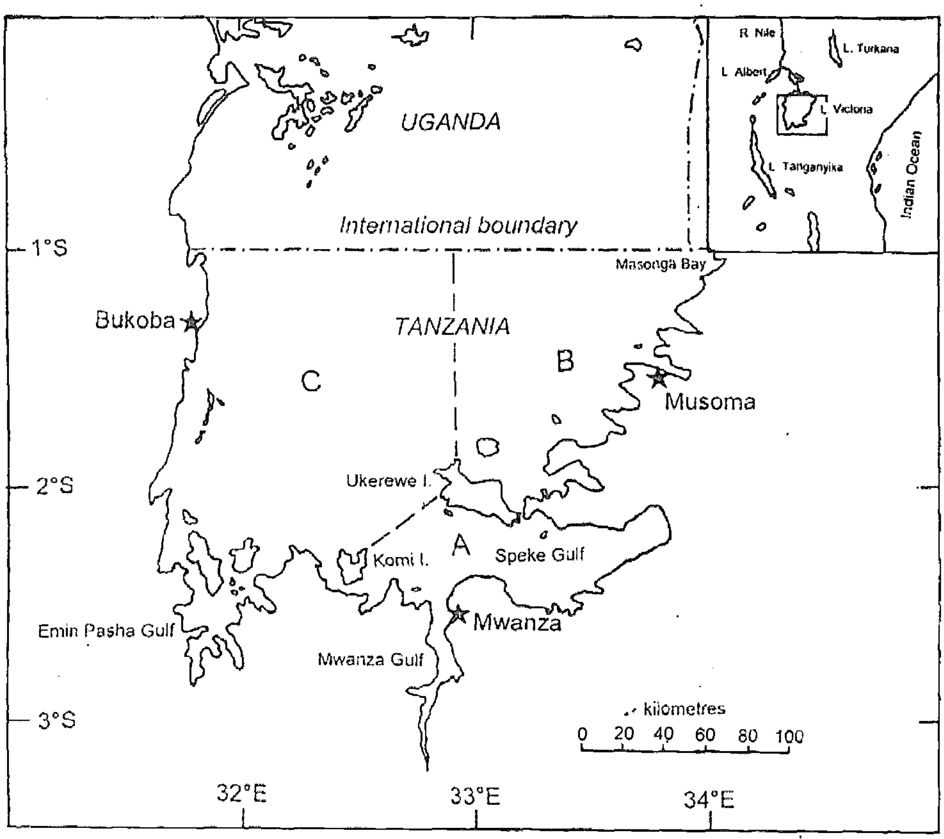

Fig. 1. Map of the Tanzanian waters of Lake Victoria.

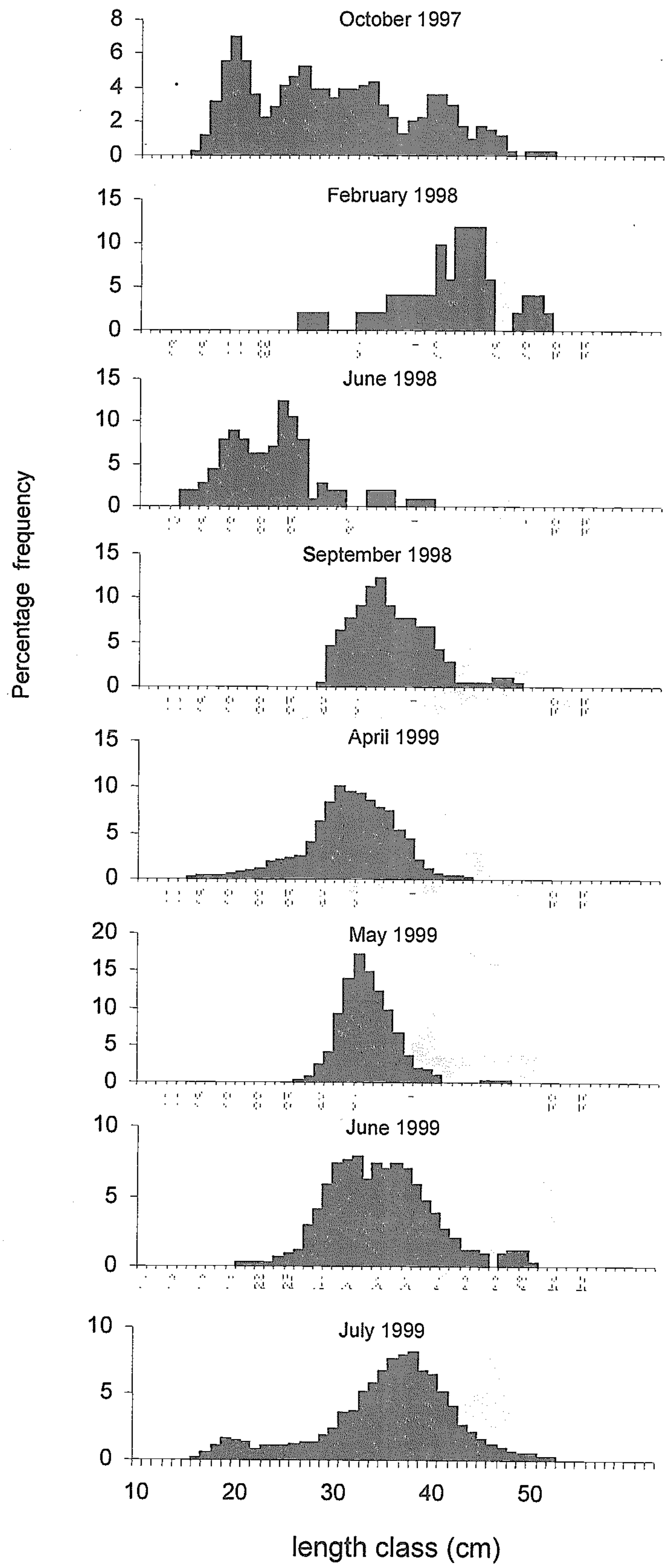

Fig. 2. Length distribution of *Oreochromis niloticus* caught by commercial fisheries in Tanzania.

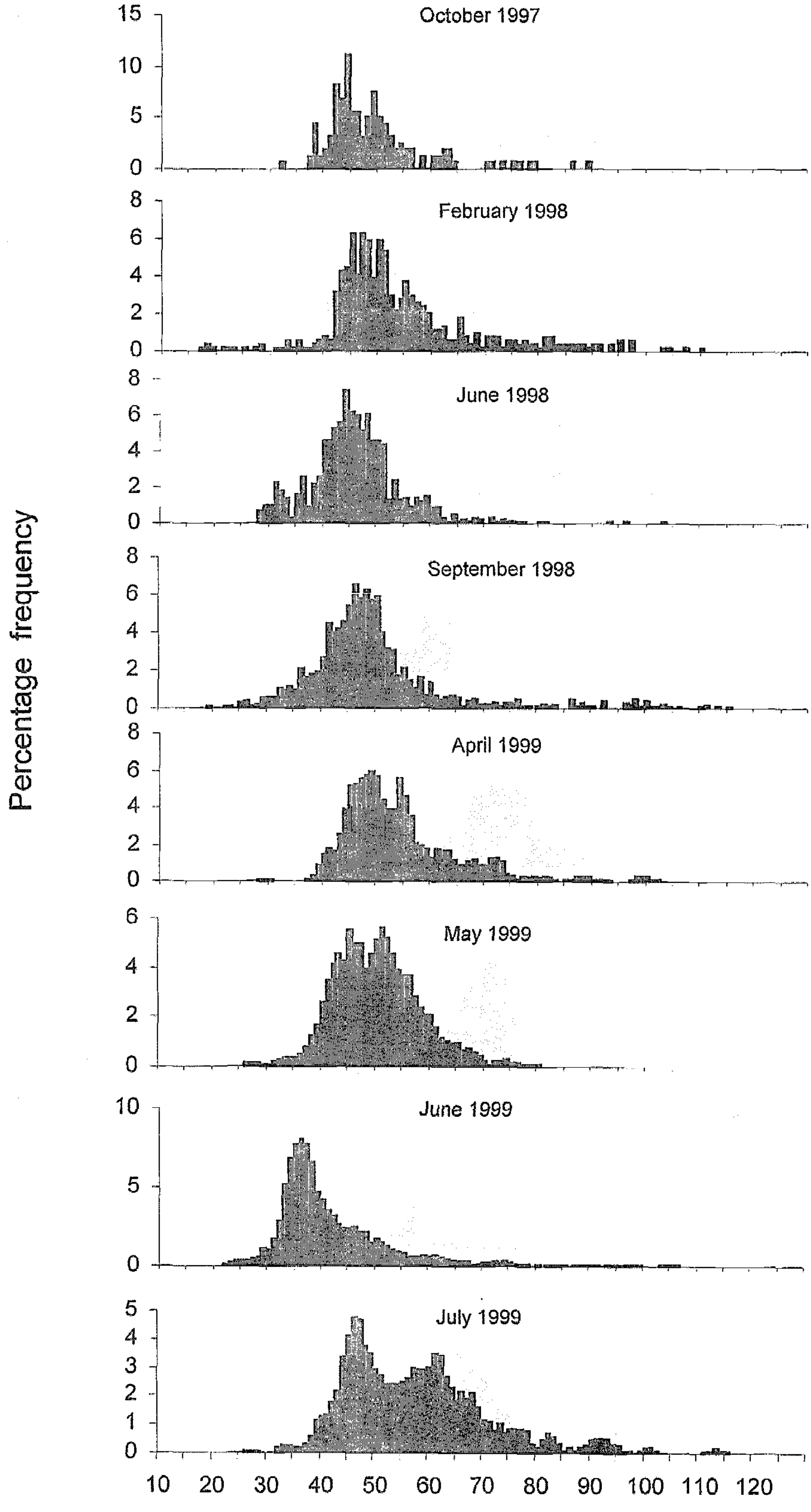

Fig. 3. Length distribution of *Lates niloticus* caught by commercial fisheries in Tanzania.

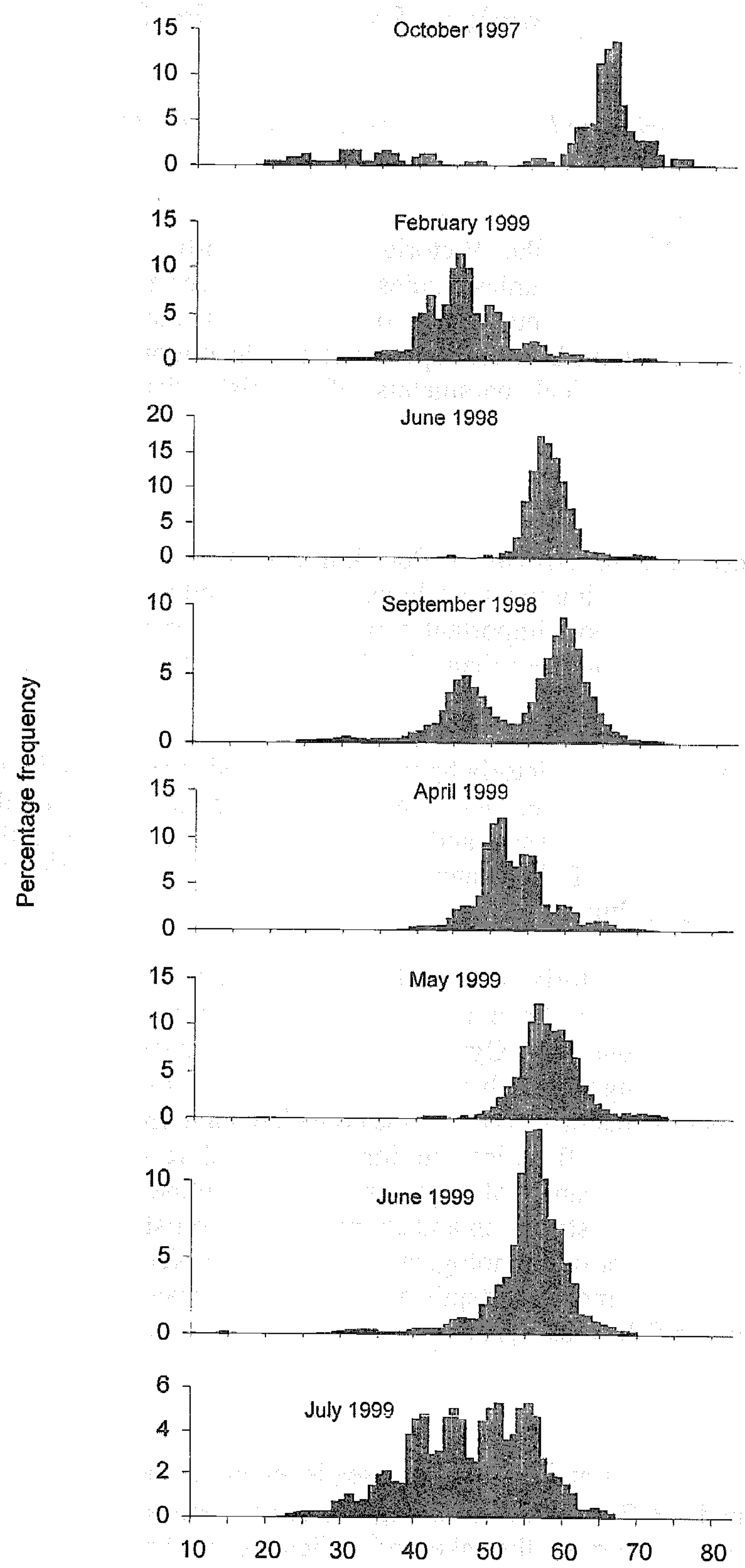

Fig. 4. Length distribution of *Rastrineobola argentea* caught by commercial fisheries in Tanzania.