SOME ASPECTS OF THE BIOLOGY OF KUHE, *BOULENGEROCHROMIS MICROLEPIS*, IN THE KIGOMA REGION, EASTERN COAST OF LAKE TANGANYIKA

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ABSTRACT Beach-seining surveys were carried out over a period of four years (from June 1984 to March 1987) in the littoral zone of the eastern coast of Lake Tanganyika. The total catch from 147 hauls of the beach-seines was 3.1 tons and Kuhe, *Boulengerochromis microlepis*, accounted for 8.8% of the total catch by weight. The catch per haul of Kuhe as a measure of relative abundance indicated that the species was more abundant between Kigoma and Sigunga than in other two Areas of the Kigoma Region. The seasonal peak in the catch was June to July. In the littoral zone, Kuhe seemed to prefer the sandy substrate with rocks or vegetation. Offshore-inshore movement of Kuhe, as observed over 24 hours, was associated with their feeding habits. The sex ratio of the Kuhe population, the body length at first maturity, and the growth superiority in male fish were also found during the study. Further studies on reproduction and seasonal change in distribution are recommended.

Key Words: Kuhe, *Boulengerochromis microlepis*; Beach-seine hauls; Alluvial deposits; Offshore-inshore movements; Asymptotic length; Malagarasi River.

INTRODUCTION

Kuhe, *Boulengerochromis microlepis*, is the largest cichlid fish in the world and one of the most delicious table fish from Lake Tanganyika. In the Lake, Kuhe is a predacious fish which inhabits mainly an open water environment. The species has an elongated and streamlined body which enables the fish to attain high speed. The adult fish is yellowish green in colour with three to four spots on the lateral side to suit its existence in sandy open water habitat, whereas juvenile fish have a copper-like colour to enhance survival in nursery areas with a sandy bottom.

Whilst Poll (1956) and Brichard (1978) provided a detailed taxonomic description of this species, little on the biology of Kuhe, such as feeding, growth, reproduction and suitable habitats was known (Matthes, 1961; Fryer & Iles, 1972; Brichard, 1978; Hori et al. 1983; Kuwamura, 1986; Kuwamura & Mihigo, 1988).

This paper presents some observations on species abundance, habitat selection, size at maturity, and sex ratio based on the results of the surveys carried out from June 1984 to March 1987 in the Kigoma Region of Lake Tanganyika. This information is considered imperative for the optimal exploitation and management of this species.

STUDY AREA AND METHODS

Sampling of fish by beach-seine was carried out in the waters of the Kigoma Region, stretching from Kagunga (the northern border of Kigoma Region) to Kasoge (the southern area in the neighbourhood of Rukwa Region). The Kigoma Region was divided into three sampling areas. and stations suitable for beach-seining within each area were established in a pilot survey (Fig. 1). Two fixed stations were chosen within each area and the other stations were selected randomly in a survey.

Sampling surveys were carried out four times during June 1984 to March 1987 (Table 1). The Tanzania Fisheries Research Institute research vessel, FAO81, provided transport, accommodation, and equipment storage, apart from furnishing the laboratory space. A metal dinghy towed by this vessel allowed access to shallow beaches and was also used for beach-seining and occasional gill-netting. A beach-seine of 200 m in length with mesh sizes of 50.8 mm for wings

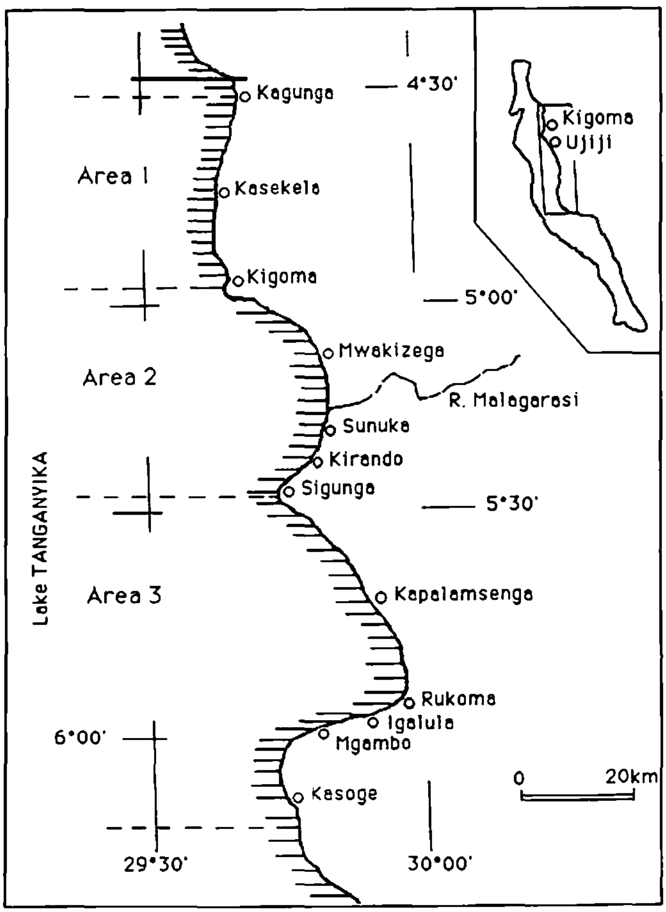

Fig. 1. Map of Lake Tanganyika showing sampling stations.

Table 1. Number of beach-seine hauls during surveys in three areas of Lake Tanganyika.

	Area 1	Area 2	Area 3	Total
1st survey (Jun. 20–Jul. 16, 1984)	16	15	13	44
2nd survey (Nov. 29–Dec. 4, 1985)	1	22	8	31
3rd survey (Sep. 24–Sep. 30, 1986)	19	17	18	54
4th survey (Mar. 19–Mar. 26, 1987)	—	—	18	18
Total	36	54	57	147

— : No beach-seining was conducted.

and 6.35 mm at the cod-end was hauled from 200 m offshore. Gill-nets with mesh sizes of 76 mm, 88.9 mm, 101.6 mm and 177.8 mm were also used to obtain samples in the offshore waters.

In every survey, beach-seine catches were retrieved six times a day at 06:00 HRS, 10:00 HRS, 14:00 HRS, 18:00 HRS, 22:00 HRS and 02:00 HRS. Samples of Kuhe were measured for body length and body weight, and then sex and stage of maturity were recorded. The sample was distinguished by four stages of maturity: immature, mature, spawning and spent. Some ovaries from selected fish were preserved in 4% formalin for laboratory analysis. Stomach contents were examined for the identification of prey species. Stomach conditions were recorded as full, digested and empty.

RESULTS AND DISCUSSION

1. Comparison of Beach-Seine Catches among Areas

In this study, a total of 147 beach-seine hauls landed a total catch of 3.1 tons of assorted species (Tables 1 and 2). The mean weight of Kuhe varied from 1.3 to

Table 2. The quantity of Kuhe and other fish caught during beach-seine surveys.

	Catch per haul (kg)						Mean		Total catch (kg)	
	Area 1		Area 2		Area 3					
	Kuhe	other fish	Kuhe	other fish	Kuhe	other fish	Kuhe	other fish	Kuhe	other fish
1st survey	0.5	9.5	5.9	48.5	2.1	39.3	2.8	31.6	124.1	1389.2
2nd survey	0.0	8.0	1.4	18.3	1.3	32.1	1.3	21.5	41.2	666.2
3rd survey	1.7	4.6	1.5	20.2	0.7	10.7	1.3	11.5	70.4	621.2
4th survey	—	—	—	—	2.2	10.2	2.2	10.2	40.2	184.1
Mean	1.1	6.9	2.7	27.2	1.6	20.1	1.9	18.7	69.0	715.2
Total Catch (kg)	40.8	~247.4	144.1	~1470.5	91.0	~1142.9			275.9	~2860.8

— : No beach-seining was conducted.

Table 3. Comparison of fish size of *Boulengerochromis microlepis* collected from three areas. Numbers represent the weighed individuals.

	Catch (number of fish)						
	Area 1		Area 2		Area 3		Total
	≤200 g	>200 g	≤200 g	>200 g	≤200 g	>200 g	
1st survey	148	24	203	155	57	24	611
2nd survey	0	0	57	64	30	26	177
3rd survey	4	43	69	31	71	14	232
4th sruvey	—	—	—	—	43	70	113
Total	152	67	329	250	201	134	1,133
Catch per haul	4	2	6	5	4	2	

— : No beach-seining was conducted.
Of 2413 fishincluding juveniles, 1,333 individuals were weighed. A fish of 200 g in body weight is approximately 10 cm in total length.

2.8 kg per haul and their percentages within the total catch were 5.8%–17.9% (Table 2). The highest catch rate for Kuhe was 5.9 kg per haul during the survey, and the maximum catch rates for the second, third and fourth surveys were 1.4 kg/haul, 1.7 kg/haul and 2.2 kg/haul respectively. Kuhe was caught more abundantly in Area 2 than in Areas 1 and 3, averaging 2.7 kg per haul. Area 3 had a mean catch rate of 1.6 kg per haul and Area 1 had the smallest mean catch rate of 1.1 kg per haul.

The catch in Area 2 included a relatively higher proportion of juvenile and immature fish than in Areas 1 and 3 (Table 3). This means that Area 2 has relative importance for the spawning and nursery of alevin, apart from its capacity to support a higher density of adult fish (Bayona, 1991). Area 2 is influenced by the Malagarasi River which constantly supplies waters with nutrients and degradable matter. This enhances primary production and the supply of rich food organisms for fish. Coulter (1988) pointed out that primary production is the major factor influencing the timing of clupeid spawning and other centropomid perdators in Lake Tanganyika. It is also probable that Kuhe spawn preferentially in this area because the increased availability of food organisms from secondary production enhances the survival rate of juveniles. Also, a wide stretch of sand and alluvial deposits together with rocky pebbles in this area may provide good habitats for the nesting, spawning and refuge.

II. Annual and Seasonal Changes in Catch

Although the seasonal change in abundance of Kuhe in the near-shore was not investigated in the same year, a trend in the seasonal change could be observed in the beach-seine catch data from different years (Table 2). The mean catches of Kuhe were 2.8 kg per haul in June–July (1984, first survey), 1.3 kg per haul in November–December (1985, second survey), 1.3 kg per haul in August–September (1986, third survey), and 2.2 kg per haul in March (1987, fourth survey). These are representative of an annual fluctuation in relative abundance of Kuhe. However, if it is assumed that both Kuhe fishing and the environmental factors remained more or less uniform among the years, the catch per unit effort (CPUE), i.e. catch per haul, may tentatively indicate the seasonal change in abundance. Under this assumption, the biomass of this species in the littoral zone seems to increase gradually from March to a peak during June–July.

In fact, fishermen at Sigunga, Kapalamsenga and Mgambo reported much more promising harvests of Kuhe during June and July than the rest of the year (personal communication). This is probably because Kuhe move to near-shore waters from the offshore to spawn and to actively feed on clupeid fish during this period. It was reported that a population of a clupeid fish, *Stolothrissa tanganicae*, moved inshore to spawn between June–July so that their fry were able to feed on the abundant inshore plankton to enhance their survival (Roest, 1977; Coulter, 1978). Therefore, the increased influx of clupeid fish in the inshore area at this period and the availability of their fry as prey may force some predators of clupeid fish, including Kuhe, to move inshore. Matthes (1961) reported that Kuhe moved to the surface and went inshore at night to feed. Analysis of Kuhe gut contents during this study has shown that the adult Kuhe feed on clupeid fish, *Limnothrissa miodon*, *Stolothrissa tanganicae* and juveniles on *Grammatotria lameirei*. As the mature and the spawning females were more dominant in the catch for June–July than any other period, it supports the existence of the offshore-to-inshore movements of Kuhe for food and for spawning, coinciding with the observations of Matthes (1961) and Kuwamura (1986).

III. Diet Change in the Catch

The Kuhe catch from beach-seining surveys in the near-shore waters fluctuated with the time of the day, although the highest catch seemed to vary (Table 4). In six

Table 4. Diet change of Kuhe catches (kg).

	Hours					
	0800–1000	1200–1400	1600–1800	2000–2200	2400–0200	0400–0600
1st survey	38.3	24.2	12.1	31.3	5.2	13.1
2nd survey	2.5	12.3	10.2	10.4	0.4	5.4
3rd survey	11.2	6.9	2.8	16.9	32.6	—
4th survey	4.4	20.1	6.4	4.6	3.5	1.2
Total	56.4	63.5	31.5	63.2	41.7	19.7

— : No beach-seining was conducted.

Table 5. Diel change in stomach condition of Kuhe collected by beach-seining at the Kasekela and Mgambo stations.

Hours	0800–1000	1200–1400	1600–1800	2000–2200	0400–0600
Kasekela					
Total	0	16	0	35	3
Empty		2(12.5%)		2(5.7%)	3(100%)
Digested		4(25.0%)		8(22.9%)	0
Full		10(62.5%)		25(71.4%)	0
Mgambo					
Total	5	43	5	15	6
Empty	2(40.0%)	0	0	0	4(66.7%)
Digested	3(60.0%)	25(58.1%)	5(100%)	3(20.0%)	2(33.3%)
Full	0	18(41.9%)	0	12(80.0%)	0

Numbers indicate the number of individuals.
No observations were made from 2400 HRS to 0200 HRS due to administrative reasons.

hauls per day, the quantity of catch had a tendency to increase at two daily peaks. One peak in the catch was observed during 08:00 HRS to 14:00 HRS, whereas the other peak was observed during 20:00 HRS to 22:00 HRS. This tendency coincid-

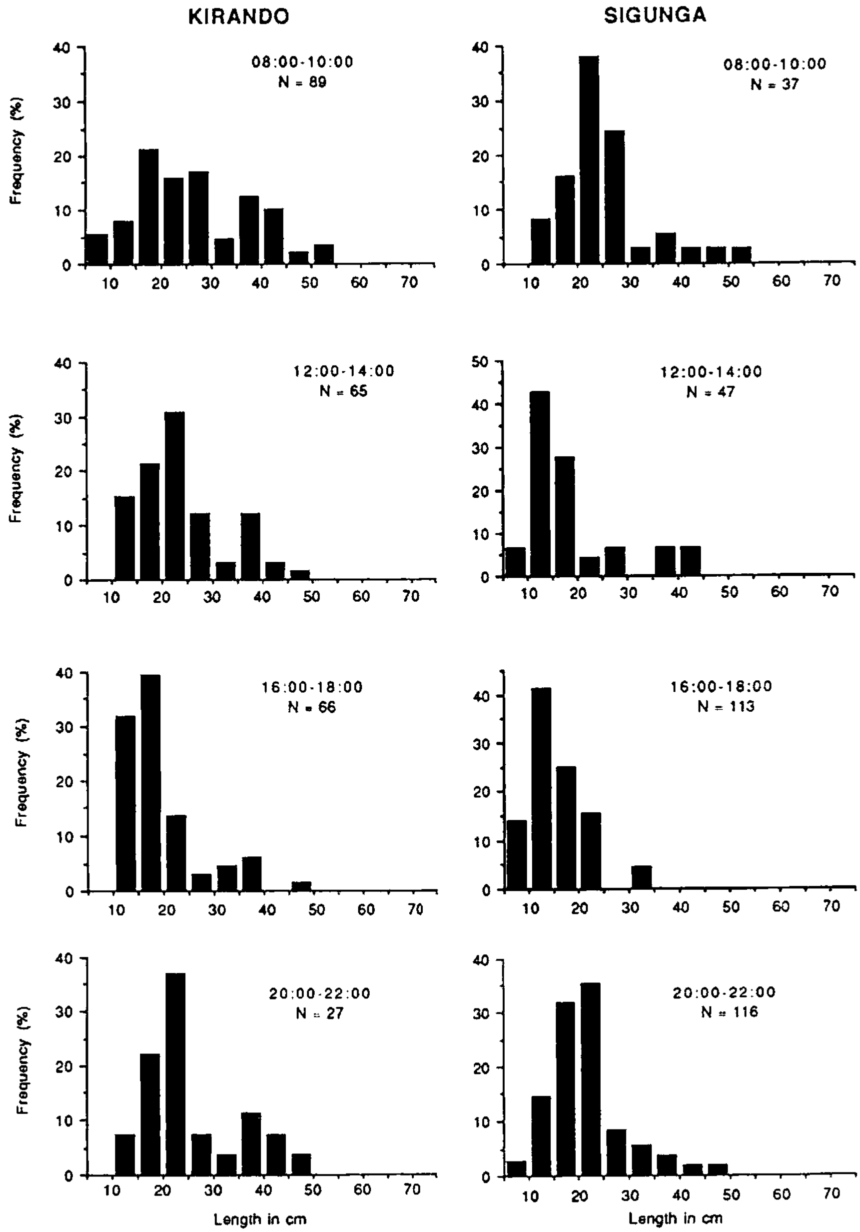

Fig. 2. Size frequency distributions of beach-seine samples collected at different times at the two sampling stations, Kirando and Sigunga.

ed with the occurrence of Kuhe whose stomachs were filled with prey during that time (Table 5). Also, the frequency distribution of Kuhe, collected from Kirando and Sigunga at different sampling time indicates that large fish tend to be caught in the morning and at night than in the day time (Fig.2). Therefore, the offshore-to-inshore movement of Kuhe may be associated with feeding in the near-shore waters. Exploitation can consequently take advantage of the timing of the influx of this species in the in-shore waters.

IV. Distribution of Kuhe with Different Types of Substrate

Table 6 shows the habitat selection of Kuhe on different types of substrate. The catch by substrate composition was as follows: 37.9% from sandy-rocky bottom, 32.4% from muddy bottom, 29.3% from sandy bottom and 0.5% from rocky bottom. Sampling in both muddy and sandy stations, with outgrowth of vegetation, yielded much more fish than in similar stations without vegetation. However, high catch was not associated with vegetation in sandy-rocky stations. Also, the preference of Kuhe for different types of substrate seemed to be size dependent (Fig. 3). Adult Kuhe of 30–45 cm dominated the catch from the rocky substrate at Kasekela whereas two sizes groups of 10–15 cm (juvenile) and 40–45 cm (adult) occurred more frequently in a sandy-rocky substrate at Mgambo than other size groups. At both Sigunga and Kirando, stations with sandy and muddy substrates respectively, juveniles of 10–25 cm dominated in the catch. These observations suggest that the juveniles of 10–25 cm were more numerous in sandy and/or muddy substrates than the adult fishes of more than 30 cm, which seemed to prefer the rocky bottom.

These results agree with the observations by Matthes (1961) who reported that the juvenile fish of 10–15 cm preferred sandy, muddy or gravelly bottoms in littoral and sublittoral waters (depth of 3–15 m). The author also indicated that the

Table 6. Comparison of Kuhe catches among different types of substrate.

Type of substrate	Catch (kg)	%
Sandy		
with vegetation	50.5	19.2
without vegetation	26.4	10.1
total	76.9	29.3
Muddy		
with vegetation	80.4	30.7
without vegetation	4.5	1.7
total	84.9	32.4
Rocky		
with vegetation	1.3	0.5
without vegetation	0	0
total	1.3	0.5
Sandy-Rocky		
with vegetation	34.9	13.3
without vegetation	64.6	24.6
total	99.5	37.9

The sample includes 147 beach-seine hauls but catches for Rukoma and Igalula (3 hauls) are not included.

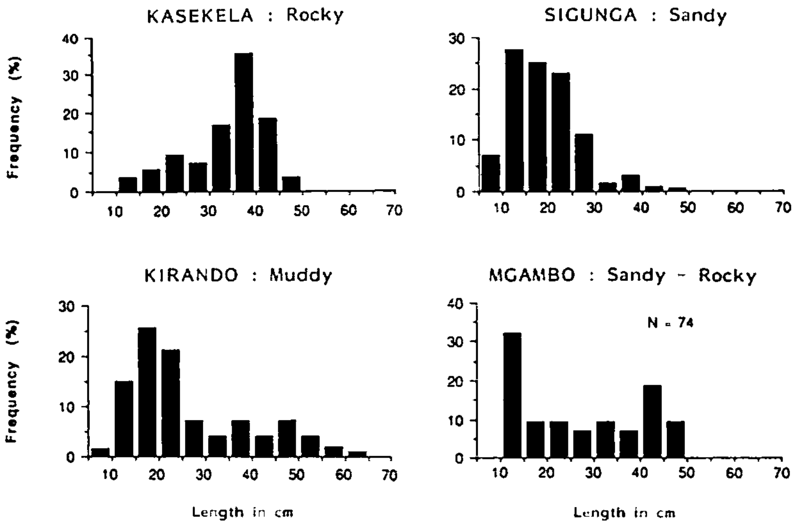

Fig. 3. Size frequency distributions of beach-seine samples by substrate types at four different stations.

juvenile fish measuring 17–26 cm in standard length are hardly exploited by seine fishing because they occupy the deep waters, and it is only when they attain 33 cm in length or more that they migrate to the littoral area of rocky substrate. In the current observations, however, there is no indication that juveniles measuring 17–26 cm are less represented in the beach-seine samples.

V. Size Composition of Fish in Catch Samples

Mean length of Kuhe from 9 samples over a series of surveys varied between 14.5–40.2 cm (Table 7). The mean length may be slightly biased towards larger size. Fish of 5–9 cm in fork length, accounting for 20% of the total samples, were eliminated from the calculation. This size was treated as alevin following Matthes (1961) who categorised alevin as young fish between 3–5 cm in standard length.

Table 7. Mean length of Kuhe collected by beach-seine.

	Mean-length of fish (cm)				Calculated statistics		
	Area 1	Area 2	Area 3	Total Samples (n)	Overall mean length (cm)	Standard error (s/n)	Confidence interval (CI)
1st survey (Jun. 20–Jul. 16, 1984)	14.5	25.7	26.4	615	22.7	0.5	0.9
2nd survey (Nov. 29–Dec. 4, 1985)		27.9	26.1	177	27.7	0.7	1.4
3rd-survey (Sep. 24–Sep. 30, 1986)	40.2	26.6	22.4	232	29.7	0.7	1.4
4th survey (Mar. 19–Mar. 26, 1987)	—	—	25.3	113	25.3	1.2	2.4

— : No beach-seining was conducted.
The data is based on samples of above 9 cm in fork-length, accounting for 80% of the total catch.

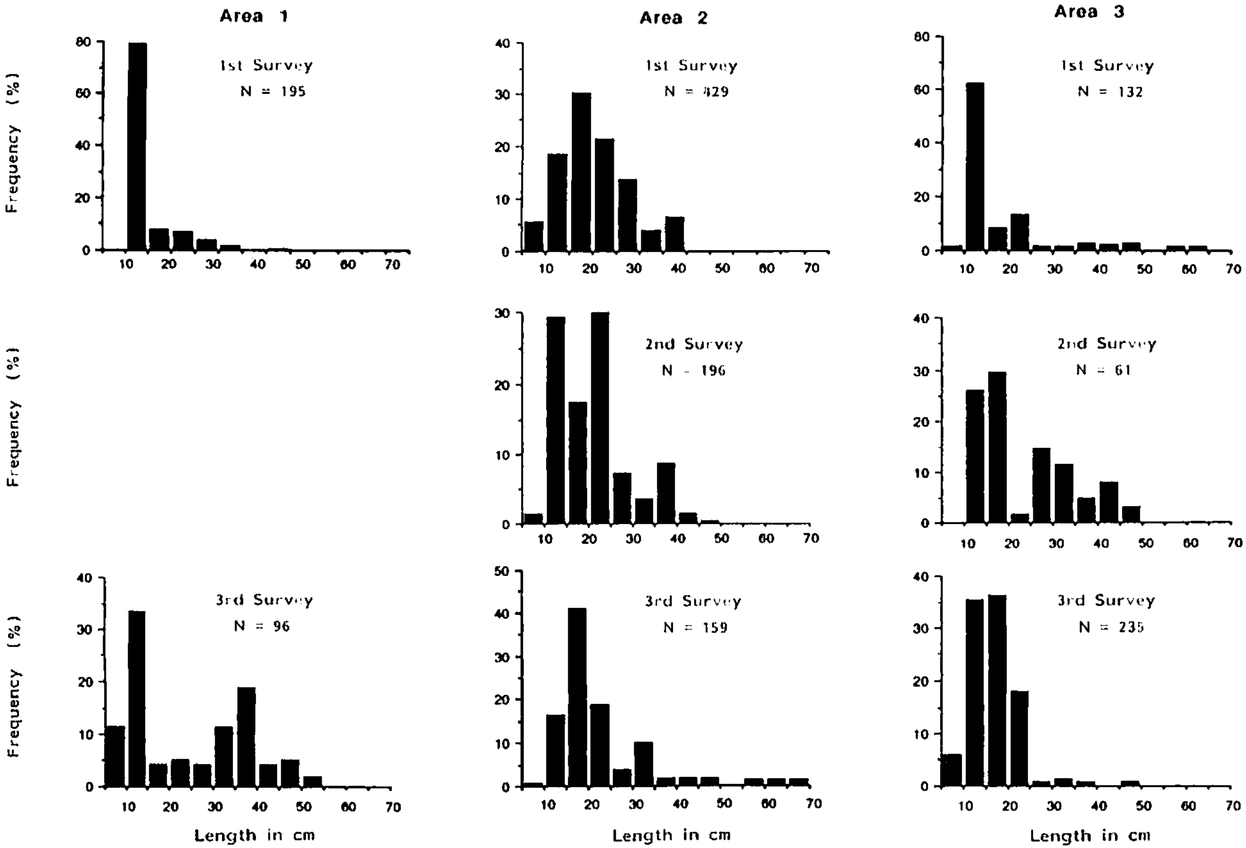

Fig. 4. Size frequency distributions of beach-seine samples for different surveys by areas.

The standard length, 3–5 cm is approximately equivalent to 5–9 cm in fork length.

The largest fish, collected by anglers, was 80 cm in length and about 4.5 kg in weight (Brichard, 1978). In our samples, the largest individual was 70 cm in length and 3.1 kg in weight. The reason no specimens equal to or greater than 80 cm in length were caught in this study may be due to mesh selection of the sampling gear or because of a probable decline in asymptotic length due to the influence of exploitation (fishing).

Along the coast, mean length in the four surveys varied slightly more in Areas 2 and 3 than in Area 1 (Table 7). Area 1 has both extremely low (14.5 cm) and extremely high (40.2 cm) values. Mean size in Area 2 was generally bigger than in the other Areas. The trend is also noted in size frequency distributions for each survey (Fig. 4). Fishes measuring 15–25 cm constitute a higher bulk of the catch in Area 2 (in all the three surveys) than in the Areas 1 and 3.

VI. Length-Weight Relationship of Kuhe Population

From data collected during the third survey, the relationship between length (L) and weight (W) was estimated as follows:

$$\log W = \log 2.58 + 3.2 \log L$$

This function shows that growth is isometric for Kuhe because the slope (b = 3.2) falls between 2 and 3.5. Detailed discussion on the species growth constant (k) and mortality (z) are cited elsewhere by Bayona (in press).

VII. Size at Maturity and Sex Composition

A total of 788 individuals of Kuhe were sex checked and distinguished by four stages of development, namely: immature, mature, spawning and spent (Table 8). About 76% of fish were immature while 17%, 4% and 3% were respectively

Table 8. Level of maturity and sex composition of Kuhe collected by beach-seine.

	Number of fish	Mean length (cm)	Standard error
Immature	599(76.0%)		
Male	306	24.9	0.3
Female	293	24.8	0.3
Mature	132(16.8%)		
Male	49	46.7	1.1
Female	83	40.0	0.7
Spawning	34 (4.3%)		
Male	9	52.9	2.0
Female	25	41.5	0.9
Spent	23 (2.9%)		
Male	23		
Female	0		
Total	788 (100%)		
Male	387		
Female	401		

mature, spawning and spent. Mean length at maturity was calculated at 40.0 cm for females and 46.7 cm for males. Matthes (1961) reported 30 cm in female and 33 cm in male as the length at first maturity. This suggests that females tend to mature earlier (at smaller size) than males. This indicates that males grow faster than females. Fryer & Iles (1972) and Kuwamura (1986) observed a similar phenomenon. It is, however, necessary to continue the studies on gonad development in order to precisely determine sizes at first maturity, the time of peak spawning, and spawning modes.

The observed sex ratio (male to female) in Table 8 was 387:401. A test for the difference between male and female indicates that a null hypothesis (Ho: $U_m = U_f$) cannot be rejected ($p = 0.05$). This implies that there is no significant difference between male and female numbers which might be considered to depend on the reproductive habits, such as the pairing of one male and one female during spawning period and following parental guarding of young. This behaviour is fully discussed by Matthes (1961), Fryer & Iles (1972) and Kuwamura (1986).

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