

Figure 20 (a) *Cyathochromis obliquidens*, Monkey Bay, 102 mm SL. (b) Lateral aspect of left premaxilla of *C. obliquidens* (Scale = 1 mm). (c) Anterior outer row tooth of *C. obliquidens*.

Chigubi (C), Monkey Bay (C), Mvunguti (C), Domwe I. (U), Chemwezi I. (U), Makanjila Point (U), Masinje (U), Thumbi West I. (U), Otter Point (C), Mumbo I. (C), Maleri I. (U), Nankoma I. (C), Mbenji I. (U), Likoma I. (N), Chisumulu I. (U), Nkhata Bay (C), Lion's Cove (U), Usisya (U), Chitande (U). Exporters of ornamental fishes have told us that *C. obliquidens* also occurs in Lake Malombe. As our survey concentrated upon the rocky zones it is possible that this species is present at sites such as Ruarwe where the shallow-water intermediate zone (its preferred habitat) was not studied.

Coloration. Nkhata Bay males: Body olive-green with brown shoulder and chest. Head olive-green with iridescent purple edges to the opercula. Dorsal fin green with a prominent black submarginal band running through the spinous region; lappets blue along their bases, but otherwise bright yellow; rayed region bluish with yellow trailing region. Caudal fin olive-green at base, greyish distally with blue inter-ray membranes. Anal fin turquoise, but black anteriorly and purple posteriorly; 2–3 large yellow egg-dummies. Pelvic fins purple with black submarginal bands and white leading edges.

Nkhata Bay females: Body and head olive-green, almost khaki, with 10–11 dark brown bars, a narrow, brown mid-lateral band and a similar dorso-lateral band. Fins pale brown with whitish-brown spots.

Geographical variation. The other populations of *C. obliquidens* found along the north-western coast were similar in coloration and markings to the Nkhata Bay form, but at Likoma I. the ground colour is slate-blue with only a hint of olive-green. At Mbenji I. and Maleri I. it is similar to the Likoma I. form. At Monkey Bay, males are blue-green with olive-green shoulders, yellow-green chests and bellies; 5 grey bars are apparent anteriorly on the flanks. Head olive-green, tending to yellow dorsally, but greyish ventrally with a yellow tinge to the chin and gular region. South of Monkey Bay, towards Mangochi, the chin, gular region, chest and belly become increasingly yellow until they are bright yellow in the southernmost populations. The Chemwezi population is similar to that of Mangochi but not quite as yellow. At Masinje Rocks and Makanjila Point, *C. obliquidens* is not as yellow as the southern populations and

the bodies are a deep slate-blue. Females showed virtually no geographical variation.

Habitat. Throughout its distribution *C. obliquidens* occupies intermediate habitats where sand and rock are mixed. It is also common in beds of *Vallisneria aethiopica* which are close to rocks. It is most numerous between 1.5 and 4 m, but has been seen to 6 m depth.

Territoriality. Males are aggressively territorial chasing conspecifics and other Mbuna species with which it shares the intermediate habitat, but other cichlids are attacked less often. Spawning sites are excavated either among the *V. aethiopica* or beneath rocks. In dense *V. aethiopica* beds some plants may be uprooted to accommodate the spawning site. Females, juveniles and non-territorial males occur singly or in small groups.

Feeding. Fryer (1959a) described the manner in which *C. obliquidens* brushes loose Aufwuchs from the rocks and from *V. aethiopica* fronds, and he found that stomach contents consisted almost entirely of loose Aufwuchs. We also found that stomach contents are dominated by loose Aufwuchs, and small proportions of C1, C2, plankton, insect larvae and benthic crustaceans were also present.

Genus *Microchromis* Johnson, 1975

A single species of an eleventh genus *Microchromis* was briefly and inadequately described in the aquarist literature and purported to come from Likoma Island. No such fish was found at Likoma Island nor was it recognized anywhere else during our survey. D.S.C. Lewis (pers. comm.) considers the description of this genus to be of doubtful validity.

OTHER CICHLIDS OF ROCKY HABITATS

In addition to the Mbuna, numerous other cichlids are sold as aquarium fishes. Table 14 lists some of the more common or colourful species which occur on the rocky shores. Where available, data on the distribution, coloration and role of these fishes within the rock-frequenting fish community are presented, but as the survey concentrated on the Mbuna many of the descriptions of the non-Mbuna are brief. Notes on piscivores, most members of the Utaka species-flock, and on several fishes which are adapted to

Table 14 Distribution of some of the non-Mbuna of the rocky shores. The distribution of each species is given according to the 14 major study areas which are depicted in Figure 4. Present (+), absent (-)

Species	Distribution													
	I	Ila	Ilb	Ilc	III	IV	V	VI	VII	VIII	IX	Xa	Xb	Xc
1. <i>Aristochromis christyi</i>	+	+	+	+	+	+	+	+	-	+	+	+	-	+
2. <i>Astatotilapia calliptera</i>	+	+	-	+	-	+	+	+	-	-	+	-	-	-
3. <i>Aulonocara</i> 'yellow collar'	+	-	-	-	-	+	-	-	-	-	+	-	-	-
4. <i>Aulonocara</i> 'blue collar'	+	-	-	-	-	+	-	-	-	-	+	+	-	-
5. <i>Aulonocara</i> 'maleri gold'	-	-	-	-	-	-	-	+	-	-	-	-	-	-
6. <i>Aulonocara</i> 'mbenji blue'	-	-	-	-	-	-	-	-	-	+	-	-	-	-
7. <i>Chilotilapia rhoadesii</i>	+	+	-	-	-	-	-	-	-	-	-	-	-	-
8. <i>Cyrtocara taeniolata</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+
9. <i>C. fenestrata</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+
10. <i>C.</i> 'pink dorsal'	-	-	-	-	-	+	-	-	-	-	-	-	-	-
11. <i>C. picta</i>	+	-	-	-	-	+	-	-	-	-	-	-	-	-
12. <i>C. intermedia</i>	+	+	-	-	-	+	-	-	-	-	-	-	-	-
13. <i>C. euchila</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+
14. <i>C.</i> 'labrosa'	+	+	+	-	-	+	+	+	-	+	-	-	-	-
15. <i>C.</i> 'maleri thick lip'	-	-	-	-	-	-	-	+	-	-	-	-	-	-
16. <i>C.</i> 'mbenji thick lip'	-	-	-	-	-	-	-	-	-	+	-	-	-	-
17. <i>C. ornata</i>	-	-	-	-	-	-	-	-	-	-	-	+	-	-
18. <i>C.</i> cf. <i>borleyi</i>	+	-	-	-	-	+	-	-	-	+	+	+	-	+
19. <i>C. chrysonota</i>	+	+	-	+	+	+	+	+	+	+	+	+	-	+
20. <i>C. quadrimaculata</i>	+	+	-	-	-	+	-	-	-	-	-	-	-	-
21. <i>C. eucinostoma</i>	+	-	-	-	-	+	-	-	-	-	-	+	-	-
22. <i>C. kiwinge</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+
23. <i>C. macrostoma</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+
24. <i>C. woodi</i>	+	+	-	-	+	+	-	-	-	-	-	-	-	-
25. <i>C. polyodon</i>	-	-	-	-	-	-	-	-	-	-	-	+	-	-
26. <i>C. pardalis</i>	-	-	-	-	-	-	-	-	-	-	-	+	-	-
27. <i>C. spilorhyncha</i>	+	+	-	+	-	+	-	-	+	-	-	-	-	-
28. <i>C. fuscotaeniata</i>	+	+	-	-	-	+	-	-	-	-	-	-	-	-
29. <i>C. linni</i>	+	+	+	+	+	+	+	+	-	+	+	+	-	+
30. <i>C. polystigma</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+
31. <i>C. livingstonii</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+
32. <i>C. venusta</i>	+	+	-	+	-	+	-	-	-	-	-	-	-	-
33. <i>C. compressiceps</i>	+	+	-	+	-	+	+	+	+	+	+	+	+	+
34. <i>C. rostrata</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+
35. <i>C. moori</i>	+	+	-	+	-	+	+	+	+	+	+	+	+	+
36. <i>C. sphaerodon</i>	-	-	-	-	+	-	-	-	-	-	+	+	-	-
37. <i>C. electra</i>	-	-	-	-	-	-	-	-	-	-	+	-	-	-
38. <i>C. johnstonii</i>	+	+	-	+	-	+	-	+	+	-	+	+	-	-
39. <i>C. similis</i>	+	+	-	-	-	+	-	-	-	-	+	-	-	-
40. <i>C. placodon</i>	+	+	-	-	-	+	-	-	-	-	-	-	-	-
41. <i>C. kirkii</i>	+	+	-	-	-	+	-	-	-	-	-	-	-	-
42. <i>C. mola</i>	+	+	-	-	-	+	-	-	-	-	-	-	-	-
43. <i>Docimodus evelynae</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+
44. <i>Hemilitilapia oxyrhynchus</i>	+	+	-	-	-	+	+	+	-	-	-	-	-	-
45. <i>Rhamphochromis longiceps</i>	+	+	+	?	+	+	?	?	?	?	+	-	-	-
46. <i>R. esox</i>	+	+	+	?	+	+	+	+	-	-	+	+	-	-
47. <i>Serranochromis robustus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+
48. <i>Trematocranus jacobfreibergi</i>	+	+	-	-	-	+	-	-	-	-	-	-	-	-

live in other habitats but which are regular visitors to the rocky shores, are particularly brief.

The list of non-Mbuna is far from complete and a separate survey of these fishes is required.

Genus *Aristochromis* Trewavas, 1935

1. *Aristochromis christyi* Trewavas, 1935

Synopsis. A bilaterally compressed, predatory fish which is characterized by large beak-like jaws.

Distribution. An uncommon to rare species which was found at most diving stations. It probably has a lake-wide distribution.

Coloration. Males: Blue with an oblique black band running from the centre of the caudal fin base to the occipital region and a second black band running dorso-medially from the top of the caudal peduncle to approximately half-way along the spinous portion of the dorsal fin.
Females: Yellowish-white with black bands similar to

males.

Habitat. This species has been seen over rocks of all sizes and in rock-sand and vegetated intermediate habitats. It occurs from surface waters down to at least 20 m depth.

Territoriality. Only solitary, non-territorial individuals were found.

Feeding. Stomach contents of 6 individuals caught in Monkey Bay, all comprised fish fry and 2 contained plant fragments. To catch its prey *A. christyi* approaches slowly, rolls onto its side and suddenly darts forwards. It is not understood how this behaviour helps it catch prey in open water where it was seen hunting on many occasions, but it does enable it to skim over rocks and thrust its bilaterally compressed head and beak into horizontal cracks and crevices among rocks. Since these cracks are the refuges of innumerable cichlid fry, the beak and bilateral compression of the head and body of *A. christyi* may be adaptations for penetrating such sanctuaries.

Genus *Astatotilapia* (Gunther, 1893)

1. *Astatotilapia calliptera* (Gunther, 1893)

Synopsis. A generalized omnivore of shallow vegetated areas.

Distribution. This species is not endemic to Lake Malawi (Fryer & Iles 1972). In Lake Malawi it occurs at virtually every vegetated intermediate zone on the mainland coast and we found it at the islands of Mpandi, Kanchedza, Thumbi West, Mumbo, Maleri and Likoma.

Coloration. Males: Body and head olive-green with a conspicuous purple patch on occipital region and snout. The eye-bar, chin, branchiostegal membranes and anterior chest are pitch-black. Dorsal and caudal fins bluish. Anal fin pale blue with a line of 5–11 yellow egg-dummies. Pelvic fins black with white leading edges.

Females: Body and head yellowish-green. Fins bluish-yellow.

Habitat. *A. calliptera* is found most often in beds of *Vallisneria aethiopica*, but also occurs among other plants, in rocky areas and where terrestrial plants hang into the water. It is most common at 2–4 m depth, but has been seen at 9 m.

Territoriality. Males hold territories among plants where they excavate saucer-shaped spawning sites. They are intraspecifically aggressive, but are also intolerant of all intruders which approach the spawning sites.

Feeding. This species has been observed feeding from the fronds of plants, from rock surfaces, from within the sand between the roots of plants and on plankton. This feeding behaviour and general nature of the jaws and dentition of *A. calliptera* suggest that it is an omnivore, but no stomachs were dissected for analysis. Fryer & Iles (1972) consider *A. calliptera* to be primarily carnivorous, but since it eats both plants and animal matter it qualifies for the designation 'omnivore'.

Genus *Aulonocara* Regan, 1921

1. *Aulonocara* 'yellow collar' (Plate 11j)

Synopsis. A yellow-collared fish with cephalic pits. It fre-

quents the sand-rock interface.

Distribution. Monkey Bay (C), Nankumba (C), Domwe I. (C), Thumbi West I. (C), Likoma I. (C).

Coloration. Males: Body and head yellowish with bright yellow shoulder, occipital region, gular region and chest; 9–11 grey bars. Ventral aspect of head iridescent-blue. Dorsal fin yellow with a black submarginal band. Caudal fin blue. Anal fin grey with a black submarginal band and 5–9 yellow egg-dummies. Pelvic fins grey with black submarginal bands and white leading edges.

Females: Whitish-grey with 9–11 dark grey bars.

Habitat. This species is found along the sand-rock interface from 4 to at least 40 m depth, but appears to be most numerous between 10 and 20 m.

Territoriality. Males construct turret-like spawning sites of sand and all fishes are excluded from this area except gravid conspecific females. Females form schools of up to 30 individuals.

Feeding. These fishes were seen feeding from the sand, but as none was caught we cannot comment on their diet.

2. *Aulonocara* 'blue collar' (Plate 12a)

Synopsis. A dark blue, barred species with cephalic pits. It inhabits the sand-rock interface.

Distribution. Monkey Bay (C), Nankumba (C), Domwe I. (C), Thumbi West I. (U), Likoma I. (U), Nkhata Bay (U).

Coloration. Males: Body dark blue with 8–9 black bars and brownish-yellow shoulder, pectoral region and chest. Head very dark blue. Dorsal fin black with white lap-pets. Caudal fin dark blue. Anal fin dark blue with numerous large yellow egg-dummies. Pelvic fins black with white leading edges.

Females: Body and head grey with dark grey bars.

Habitat. This species was found along the rock-sand interface from 6 to at least 40 m.

Territoriality. Males defend territories in which they construct turret-like nests. Females are not territorial, but gather in groups.

Feeding. This species feeds from the sand.

3. *Aulonocara* 'maleri gold' (Plate 12b)

Synopsis. A gold fish with cephalic pits. It lives in the intermediate zones.

Distribution. Nakantenga I. (C), Maleri I. (C), Nankoma I. (C).

Coloration. Males: Golden-yellow with grey-brown bars.
Females: Sandy-grey with dark grey bars.

Habitat. It occurs in the intermediate zones and over patches of sand among the rocks from 3 to 25 m depth.

Territoriality. Males are aggressively territorial and construct nests which are 8–12 m in diameter. Females are not territorial.

Feeding. Members of this species have been observed feeding from both sand and rock substrata, but no data on stomach contents are available.

4. *Aulonocara* 'mbenji blue' (Plate 12c)

Synopsis. A metallic royal blue fish with cephalic pits. It lives in the intermediate zones.

Distribution. Mbenji I. (C).

Coloration. Males: Body and head metallic-blue. Fins blue, but dorsal fin has white lappets with orange tips.

Females: Colours not recorded.

Habitat. This species occupies the sand-rock interface and other similar intermediate zones in water 3–25 m deep.

Territoriality. Males excavate sand-scrape nests alongside or beneath rocks and defend the area immediately around these nests. Females are not territorial but occur in small groups.

Feeding. No data are available.

Genus *Chilotilapia* Boulenger, 1908

1. *Chilotilapia rhoadesii* Boulenger, 1908

Synopsis. A deep-bodied fish with a blunt head.

Distribution. Nkudzi (U), Chemwezi I. (N), Mpandi I. (U), Monkey Bay (U).

Coloration. Males: Body and head blue with a black mid-lateral band and an oblique black band running from the top of the caudal peduncle to the occipital region.

Females: Greenish-brown with two black bands similar to those of males.

Habitat. *C. rhoadesii* is normally found over sand and among macrophytes, but is usually uncommon over rocks. At Chemwezi Island, however, it was numerous in the rocky habitat. It occurs from 3 to at least 25 m depth.

Territoriality. Males were found defending territories among the rocks at Chemwezi Island. Females are not territorial.

Feeding. The stomachs of 33 specimens were examined; 11 were empty and 22 contained the soft remains of the gastropod *Lanistes nyassanus*.

Genus *Cyrtocara* Boulenger, 1902

(a) The Aufwuchs feeders

1. *Cyrtocara taeniolata* (Trewavas, 1935) (Plate 13a)

Synopsis. A small lithophilous member of the genus. It has a narrow mouth and small, widely spaced teeth.

Distribution. This species is common or numerous on all rocky shores studied except at Chigubi and Mazinzi Reef where it is rare.

Coloration. Monkey Bay males: Body and head bright metallic-blue with very faint traces of bars and bands.

Monkey Bay females: Silvery-grey with longitudinal bands and vertical bars.

Geographical variation. At Chinyankwazi I., Chinyamwezi I. and Boadzulu I. the chin, gular region and chest of males are yellow. At Namalenje I., Senga Point and Rifu the gular region, chest and belly of males are crimson. At Mbenji I. females are greyish-beige with black bands and bars that are broader than those of populations found elsewhere. These markings are also apparent in males.

Habitat. It is found over rocks of all sizes, but appears to favour large rocks for feeding and medium-sized rocks for territoriality. It occurs from the surface waters to at least 28 m depth being most numerous between 5 and 15 m.

Territoriality. Males are aggressively territorial, defending the upper surfaces of medium-sized rocks from all intruders. Females are not territorial and although they occur singly they usually form groups which remain close to the rock surfaces.

Feeding. *C. taeniolata* feeds by nipping at the Aufwuchs from which it collects mostly loose Aufwuchs and also some C1, C2 and benthic Invertebrata (particularly chironomid larvae). During plankton blooms the entire *C. taeniolata* population may feed in open water, 1–2 m above the substratum.

2. *Cyrtocara fenestrata* (Trewavas, 1935)

Synopsis. A black-barred species which frequents sediment-rich zones where it blows away the sediment to take food from the underlying substratum (Plate 13b).

Distribution. This species has lake-wide distribution. It is rare at Chinyankwazi I., Chinyamwezi I. and Zimbabwe I. Elsewhere it is uncommon to common on the rocky shores.

Coloration. Monkey Bay males: Body blue-grey with broad bars and orange flecks on the flanks; belly yellowish. Head blue with emerald-green sheen. Dorsal fin blue with prominent black submarginal band; lappets orange with white tips. Caudal fin bluish. Anal fin blue with a black submarginal band and yellow egg-dummies. Pelvic fins yellowish-blue, but black anteriorly.

Monkey Bay females: Body yellowish-grey with broad black irregularly shaped bars that usually extend into the dorsal fin, but do not always span the full depth of the body. Head yellowish-grey. Fins yellowish-white with black blotches in the dorsal and anal fin. Dorsal fin lappets orange.

Geographical variation. Slight differences in coloration and markings were found, but no details were recorded. In general, however, the populations of Likoma I., Chisumulu I. and the north-western shores of the lake are deeper yellow than the southerly populations.

Habitat. It is a lithophilous species which is most numerous in areas where sediment accumulates such as deepish water of exposed shores and in the shallows of sheltered areas. *C. fenestrata* also occurs over sand in intermediate zones.

Territoriality. Males have been seen defending territories, but they appear to be weakly territorial. Non-territorial individuals are usually solitary.

Feeding. It feeds by blowing away the sediment before pecking at the underlying substratum. Specimens caught in the shallows had fed almost exclusively upon chironomid larvae, but those caught in depths greater than 10 m had, in addition, other insect larvae, benthic crustaceans, C3 and loose Aufwuchs in their stomachs.

3. *Cyrtocara picta* (Trewavas, 1935)

Synopsis. A small lithophilous species of sediment-rich areas which feeds by sucking up loose material on rock surfaces.

Distribution. Monkey Bay (C), Nankumba (U), Domwe I.

(C), Thumbi West I. (C), Otter Point (C). Jackson (1961a) notes that this species also occurs in the northern part of the lake.

Coloration. Males: Body and head blue with three distinct black blotches on the flanks.

Females: Silvery-white with similar markings.

Habitat. *C. picta* occurs in areas where there is a sediment layer. Its depth distribution extends from the shallows to at least 30 m.

Territoriality. Only solitary individuals have been found and none was territorial.

Feeding. While swimming slowly, *C. picta* sucks up sediment and associated organisms from the rock surfaces by extending its highly protrusible mouth. At no stage during the extension of the mouth, or inward sucking and closing of the mouth, is contact made with the substratum. The fish behaves rather like a vacuum cleaner (Plate 13c). The principal food found in the stomachs of adults is benthic copepods, probably sifted from the ingested sediment by gill-rakers. Juveniles appear to be exclusively planktivorous.

4. *Cyrtocara euchila* (Trewavas, 1935)

Synopsis. A fish with markedly hypertrophied lips. It frequents both rocky and sandy shores.

Distribution. It has lake-wide distribution, though it is uncommon at all sites except Liwelo Bay (Chisumulu Island) where it is common.

Coloration. Males: Body and head blue with a broad black band running mid-laterally from the caudal fin to the posterior part of the orbit; a black dorso-medial band runs from the upper ridge of the caudal peduncle to the occipital region. Occipital bar and eye-band black.

Females: Body and head yellowish-brown with black markings similar to those of the males.

Habitat. *C. euchila* is a regular inhabitant of the rocky shores, but also occurs over sand and in weeded areas. It has been seen most often in water less than 10 m deep and rarely beyond this depth.

Territoriality. Members of this species are usually solitary, though occasionally small groups of less than 5 individuals occur. No territorial individuals were found.

Feeding. The large fleshy lips are used during feeding to seal grooves in the rocks, trapping prey which are then sucked and/or scraped into the mouth. *C. euchila* individuals appear to select feeding sites carefully, swimming from one to the next, poising over many, but selecting only a few for feeding. They also feed by nipping at rocky and sandy substrata from which they appear to collect visually located particles. Fryer (1959a) suggested that the hypertrophied lips are sensitive appendages which assist in the detection of prey. We have no data to support or refute this idea. The stomachs examined contained the remains of insect larvae as well as benthic crustaceans, and the intestines contained a high proportion of ostracods. Fryer (1959a) found that *C. euchila* feeds predominantly on insect larvae and nymphs as well as crustaceans. He found small snails in the stomach of one specimen.

5. *Cyrtocara labrosa* (Plate 12d)

Synopsis. A thick-lipped species characterized by 4–5 broad

vertical bars on the flanks.

Distribution. Monkey Bay (U), Boadzulu I. (U), Nkudzii (U), Nankumba (U), Zimbabwe I. (U), Thumbi West I. (U), Mumbo I. (C), Nakantenga I. (C), Maleri I. (C), Mbenji I. (U).

Coloration. Males: Blue with dark blue bars.

Females: Beige with dark brown bars.

Habitat. This species was found only among rocks, apparently favouring medium-large rocks. It is most common between 10 and 20 m depth, but its full depth range is from 4 to at least 35 m.

Territoriality. In March/April 1980, at Nakantenga Island a group of 6 males, situated about 4 m apart in 12–15 m depth, was found defending territories. Normally, however, this fish is solitary and not territorial.

Feeding. This species appears to feed in the same way as *C. euchila*, but frequents deeper areas and apparently does not feed over sand.

6. *Cyrtocara 'maleri thick lip'* (Plate 12e)

Synopsis. A pale brown species with dark brown bars and slightly enlarged lips, it inhabits shallow water in sediment-rich areas.

Distribution. This species was found on the western shores of Maleri I. (U) and at Nankoma I. (U).

Coloration. Pale brownish-yellow with incomplete, irregular, dark brown barring.

Habitat. It lives among small and medium-sized rocks in water less than 10 m deep.

Territoriality. The individuals of this species are solitary and no evidence of territoriality was found.

Feeding. Members of this species were seen to feed from the rock surfaces.

7. *Cyrtocara 'mbenji thick lip'* (Plate 12f)

Synopsis. A dark, brown-and-black fish with thickened lips.

Distribution. Mbenji I. (C).

Coloration. Males and females: Brownish-grey tending to black ventrally with irregular black bars and mid-lateral and dorso-lateral black bands. Males in breeding dress with a blue cast.

Habitat. This species was found most commonly in the intermediate zones of the western shore of Mbenji Island, but it was also present along all rocky shores. Its depth range is from the surface waters to at least 23 m.

Feeding. It feeds in a manner similar to that of *C. euchila*, but no data on stomach contents are available.

8. *Cyrtocara ornata* (Regan 1921)

Synopsis. A colourful fish (male) of shallow rocky and intermediate habitats. It has an elongate pointed snout and moderately hypertrophied lips.

Distribution. Nkhata Bay (U).

Coloration. Males: Body dark blue dorsally with orange spots in each scale; light blue ventrally with a grey mid-lateral line; chest and belly yellow. Head iridescent-blue with bright blue lips; chin and gular region yellow. Dor-

sal fin bright blue with orange patches; submarginal band black; lappets white with yellow tips. Caudal fin blue with orange streaks and orange trailing edge. Anal fin grey with yellow edges and 4–8 orange-yellow egg-dummies. Pelvic fins yellow with black submarginal bands and yellow leading edges.

Females: No data available.

Habitat. It was found among rocks and in the intermediate zones between 2 and 10 m depth.

Territoriality. Males hold territories beneath rocks, usually where they can construct small, sand-turret spawning-sites. They chase all intruders. As territorial individuals are far apart intraspecific interactions are rare.

Feeding. Fryer (1959a) found chironomid larvae, ostracods, mayfly nymphs, other insect larvae and nymphs as well as mites and algae in the stomachs of *C. ornata*.

(b) The planktivores (Utaka)

9. *Cyrtocara* cf. *borleyi* (Plate 12g)

Synopsis. A deep-bodied member of the Utaka group which frequents the rocky shores, and, unlike other members of this species-flock, it apparently does not form large schools.

Distribution. Monkey Bay (U), Nankumba (U), Domwe I. (U), Zimbabwe I. (U), Mbenji I. (U), Likoma I. (U), Makulawe Point (C), Nkhata Bay (U), Lion's Cove (U), Ruarwe (U).

Coloration. Males: Body blue with a khaki-gold cast. Head iridescent-blue. Dorsal fin blue with a narrow black submarginal band and white lappets. Caudal fin blue with pale blue streaks. Anal fin dark red with whitish-yellow egg-dummies. Pelvic fins black with white leading edges.
Females: Silvery-grey.

Habitat. This species is found among medium-sized and large rocks, in sediment-free exposed areas at a depth of 2–25 m, but is most numerous between 3 and 12 m.

Territoriality. Males defend territories among the rocks, but are not highly aggressive. Females occur singly or in small groups usually numbering less than 5 individuals.

Feeding. It feeds on plankton and also from the Aufwuchs mat.

Notes on other Utaka species

In addition to *Cyrtocara* cf. *borleyi* a number of other Utaka species periodically move inshore and use the rocky areas for breeding and feeding, and thousands of Utaka fry shelter and feed in rocky zones. Since Utaka males are attractive blue fishes (Plate 12h), many species are popular in the aquarium trade. Important among these are *C. chrysonota* (Boulenger, 1908) and *C. quadrimaculata* Regan, 1921, which are common on the rocky shores and have a wide distribution in the lake. Males hold territories in open water at certain times of the year. These territories are usually near to rocky shores, but may also be over sand and weeded areas (Eccles & Lewis 1981).

A sand-dwelling species *C. eucinostoma* (Regan, 1921), has an unusual impact on the rocky shore communities. In areas close to sand at Monkey Bay, along the Nankumba Peninsula, at Domwe Island and at Otter Point territorial males construct prominent spawning sites by carrying sand

to the top of rocks. Sometimes sand is carried to the top of 4 m high rocks which represents an enormous expenditure of energy. The nests in Monkey Bay were 23 ± 1.5 cm in diameter at the apex ($N=38$). This is the same size as those built on sand by conspecifics. As the defended area extends about 50 cm around the nest, these fishes occupy a part of the rocky shore which is then unavailable to truly lithophilous species. Furthermore, since they cover the Aufwuchs with sand these fishes undoubtedly reduce the productivity of each rocky surface which they cover.

Iles (1960) and Fryer & Iles (1972) noted that Utaka shoals gather in large numbers at submerged reefs. We found that, in addition, these shoals congregate around small exposed rocky islands. At Chemwezi Island, Chinyankwazi Island, Chinyamwezi Island, Zimbabwe Island and also at Ndumbi Rocks and Mazimbwe Islet off Likoma Island, huge shoals were common.

At Chinyamwezi Island Utaka dominate the shallows and sometimes more than 20 individual cichlids were found in every square metre (see p.260). About 25% of the Utaka population at Chinyamwezi are a golden-yellow colour, but it is not known whether these are colour forms of a polychromatic species or whether they are a separate species.

At Likoma Island a popular aquarium fish of the Utaka species-flock is caught at the rock-sand interface, where territorial males build turret nests. Males of this species are predominantly black with a contrastingly blue flare on the head. This species is sold as *C. mloto* but it is not the same fish as that described by Iles (1960).

(c) Notes on piscivores of the genus *Cyrtocara*

In addition to predatory pressures exerted by other genera, the fishes of the rocky zones are subject to predation by specialized piscivores of the genus *Cyrtocara*. Most predatory species are themselves small and therefore predatory pressure on fry and juveniles is most intense. Pursuit predators, *C. kiwinge* Ahl, 1927, *C. macrostoma* Regan, 1921 and *C. woodi* Regan, 1921, appear to have lake-wide distribution. All three are most numerous in the shallows. *C. polyodon* Trewavas, 1935 and *C. pardalis* Trewavas, 1935 are piscivores of the north-western coast.

The rocky shores are also visited by *C. spilorhyncha* Regan, 1921 and *C. fuscotaeniata* Regan, 1921 which are primarily fishes of the vegetated and sandy zones of the south-eastern arm of the lake, but which also occur at Otter Point.

All ambush predators listed here are popular aquarium fishes by virtue of their attractive markings and interesting behaviour. *C. linni* Burgess & Axelrod, 1975 is a lithophilous species found in less than 10 m depth and appears to have lake-wide distribution. At most sites it is uncommon or rare, but at Thumbi West Island and at Chisumulu Island it is common. *C. polystigma* Regan, 1921 is a fairly common member of the rocky shores, but also occurs commonly on sandy areas and in a variety of intermediate habitats. It is most numerous in the shallows, but has been seen to 28 m depth. It appears to have lake-wide distribution. *C. livingstonii* (Gunther, 1893) is common on the rocky shores of Likoma and Chisumulu Islands, but uncommon in rocky habitats elsewhere. It occurs in sandy and vegetated areas. As well as having lake-wide distribution it inhabits the Upper Shire River and local fishermen report its presence in Lake Malombe. It is most numerous in shallow water, but has been seen at 33 m depth at Chinyankwazi Island.

C. compressiceps (Boulenger, 1908) is adapted to catch prey in *Vallisneria aethiopica* beds since its markings mimic the fronds of this plant. However, it frequently hunts over rocks and at Membe Islet, off Chisumulu Island, it was seen in a purely rocky habitat more than 300 m from the nearest vegetated area.

* * *

A great many fishes adapted for life over sand visit the rocky shores to release their fry. Most of the species are unknown to us and few were caught for identification. Other species live along the fringe of the rocks either in sandy or vegetated areas and make excursions onto the rocks to feed or to release fry. A few of the common members are listed below. *C. rostrata* (Boulenger, 1909) frequently spawns among rocks, and females protecting newly released broods occur frequently over the upper surfaces of large rocks in shallow water. *C. moori* Boulenger, 1902 and *C. sphaerodon* Regan, 1921 are sand-dwellers which may occupy rocky sites during the guarding phase of parental care. Both appear to have lake-wide distribution and *C. moori* also occurs in the Upper Shire River and in Lake Malombe.

C. electra Burgess, 1979 lives over sand at the edge of the rock-sand interface at Likoma Island. It frequently holds territories in the intermediate zone and its members feed among the rocks. It occurs from 7 to at least 40 m depth. *C. johnstonii* (Gunther, 1893), *C. similis* Regan, 1921, *C. placodon* Regan, 1921, *C. kirkii* (Gunther, 1893), *C. mola* Trewavas, 1935, *C. venusta* Boulenger, 1908 and *C. 'pink dorsal'* usually inhabit sand and intermediate zones (often of vegetated areas), but may also visit rocky shores. Similarly *Hemitilapia oxyrhynchus* Boulenger, 1902 is usually found in weeded areas, but is nonetheless common in intermediate habitats and a frequent visitor to rocky shores in southern Lake Malawi.

Genus *Docimodus* Boulenger, 1896

This genus has two species of which one, *D. evelynae* Eccles & Lewis, 1976, is found on the rocky shores. It has lake-wide distribution, but is uncommon or rare on all shores except Thumbi West Island where it is common. It occurs from the surface waters to at least 40 m depth. As juveniles, *D. evelynae* individuals may behave as cleaners, but as they grow their diet changes so that they feed on scales, skin and fins of other species (Ribbink in press).

Genus *Rhamphochromis* Regan, 1921

This is a group of silvery, elongate fishes which are essentially pursuit predators, but which also ambush their prey among the rocks. At least one species and sometimes as many as four species (e.g. at Chinyankwazi Island) were found at each rocky shore. While it is possible to recognize that species are different, positive identification is a problem. Probably the two most common species associated with rocky zones are *R. longiceps* (Gunther, 1864) and *R. esox* (Boulenger, 1908).

Genus *Serranochromis* Regan, 1920

S. robustus (Gunther, 1864) is the only member of this genus found in Lake Malawi. It is a non-endemic piscivore which frequents a variety of habitats, preferring vegetated areas. It is, nevertheless, frequently found on the rocky shores. It has lake-wide distribution and is also found in numerous other water bodies (Greenwood, 1979b).

Genus *Trematocranus* Trewavas, 1935

Those members of this genus which inhabit intermediate zones in shallow water are colourful fishes which are currently popular in the aquarium trade.

1. *Trematocranus jacobfreibergeri* Johnson, 1974

Synopsis. This species is found in rocky caves over sand in shallow water. Its members have cephalic pits. Males are golden-red, females are grey-brown with dark grey bars.

Distribution. Nkudzi (R), Monkey Bay (R), Nankumba (R), Domwe I. (R), Otter Point (U – C).

Coloration. *Males:* Body light blue with a reddish-gold patch over the shoulder, pectoral region and along the dorsal part of the body; 9 grey bars. Head light blue ventrally, golden-red dorsally, with grey snout and black eye-bar. Dorsal fin pale bluish-white with orange interspine membranes, but black inter-ray membranes. Caudal fin light blue. Anal fin orange-red with a light blue leading edge. Pelvic fins black with red submarginal bands and white leading edges.

Females: Greyish-brown with 8 – 10 dark grey bars.

Habitat. This species inhabits the rock-sand interface where it lives over sandy substrata in rocky caves or beneath rock overhangs. It is most often associated with large rocks. It follows the rock-sand interface from about 2 m to at least 35 m depth, but appears to be most numerous between 4 and 12 m.

Territoriality. Males are territorial, but females form small schools of up to 30 individuals which also occur in rocky caves.

Feeding. It feeds from the sand. Stomachs of two specimens were examined, both contained insect larvae and one had a few ostracods.

* * *

A number of similar species, but of different coloration have been seen occasionally on various coasts, but these fishes are rare and by virtue of their tendency to remain hidden in rocky caves they are difficult to catch. Consequently, very little is known about them.

* * *

In addition to the fishes listed above many other non-Mbuna species which feed from the rock surface, presumably taking components of the Aufwuchs or its invertebrate inhabitants, are permanent members of the rocky communities. Some of these such as *Cyrtocara intermedia* of Monkey Bay, Nankumba and Thumbi West Island are described, but most, such as the elongate blue-fish with the red dorsal fin (Plate 12i) are undescribed. Very little is known about any of these fishes.

The cichlid communities of the rocky shores

In this section we describe the various areas studied and list the Mbuna species found at each, noting the habitat preference of these species. Where possible an indication of numerical abundance is given for each species. The non-Mbuna are dealt with briefly.

Area 1: Monkey Bay, Nankumba, Domwe Island and Zimbabwe Island

The area that forms the focus for this section of the paper

extends from Harbour Island, at the southerly entrance of Monkey Bay, to Zimbabwe Island, just north of Cape Maclear which is the northern-most point of Domwe Island (Figure 21). Most of the shoreline within this study area is rocky, but its continuity is broken by sandy beaches at Monkey Bay, Chizali, Zambo and Mvunguti and by the short stretches of open water which separate islands. The rocky shores of this region shelf steeply and, with the exception of Zimbabwe, all reach sand in less than 40 m depth (Figure 21). A characteristic of this entire area, particularly Domwe Island and Zimbabwe Island is that it is dominated by medium-large and large rocks; boulders and slabs are also common. Pockets of small rocks are found only occasionally.

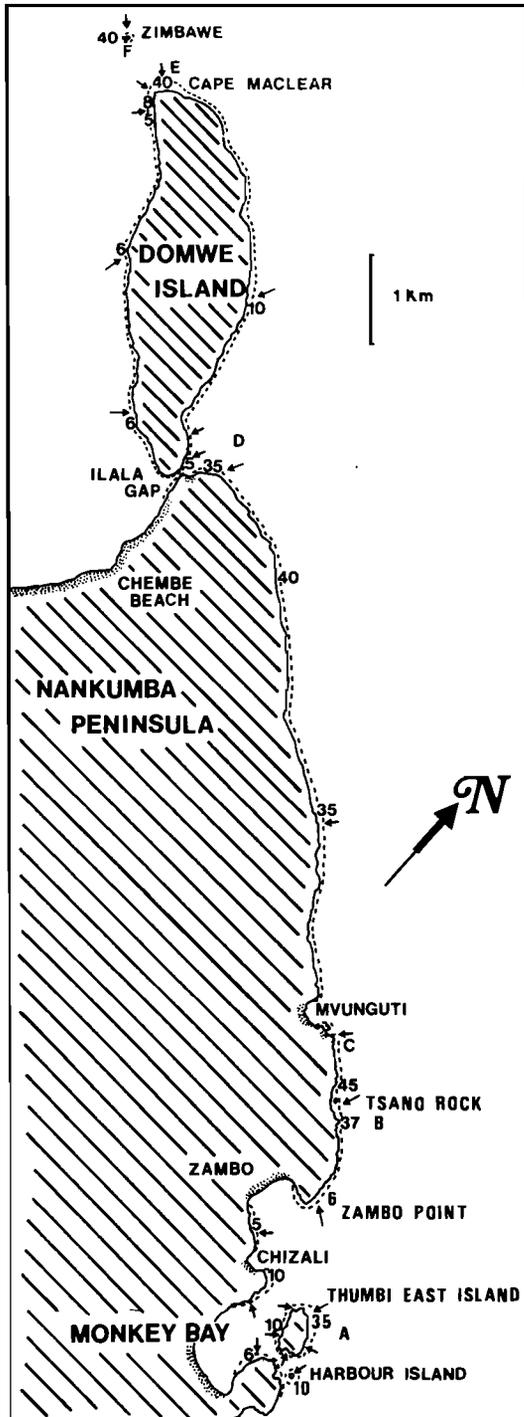


Figure 21 The study sites in area I are indicated by arrows. Letters A – F show the positions of transect sites. The dotted lines indicate the extent of the rocky shore and the numerals within these lines give the depth at which rocks meet the sandy plain. Sandy beaches are stippled.

Aquatic macrophytes (*Vallisneria aethiopica*, *Ceratophyllum demersum*, *Myriophyllum spicatum*, *Potamogeton pectinatus* and *P. schweinfurthii*) grow in shallow sandy areas and are particularly abundant in Monkey Bay. Shallow wave-washed regions are free of sediment, but in deep water and in sheltered bays a layer of organic sediment covers the rocks and sand. In the deeper central parts of Monkey Bay (15 – 17 m) the organic ooze overlying the sand is at least a metre deep. *C. demersum* and *P. schweinfurthii* may grow in this soft sediment, but *V. aethiopica* is found in cleaner, shallow areas. Within the shallow sheltered waters of Monkey Bay the rocky zones quite frequently give way to weeded areas.

The fishes of this area were studied at 24 diving stations indicated by the arrows on Figure 21. Line transects were laid at the island of Thumbi East, at Tsano Rock and at Mvunguti. Point transects were conducted at the Ilala Gap, Cape Maclear and Zimbabwe.

Diving stations

Monkey Bay. The rocky shores of Monkey Bay considered here include not only those within the bay itself, but also those adjacent to Chizali and Zambo and those of Harbour Island and Thumbi East Island. Transect A was laid on the exposed shore of Thumbi East Island (Figure 21). Medium-large broken rocks predominated, but at 2 – 8 m pockets of small rocks were also included in the transect. The rocks gave way to sand at 36 m, but sandy patches occurred among the rocks from 29 m.

Tsano Rock. The rocky region included in this section runs from Zambo Point, which gives way to a coarse gravel at 6 – 8 m, to Tsano Rock where rocks give way to sediment-covered sand at about 40 m. Transect B was laid approximately 70 m south of Tsano Rock, over broken medium-sized rocks. A patch of small rocks was encompassed by the shallowest transect markers and a few pockets of sand were included in the 10 m transect contour. At 20 m the transect included 12 m² of a rocky slab.

Mvunguti. The stretch of rocky shore from Tsano Rock to the beach at Mvunguti is considered here. In addition to the Mvunguti Beach, a considerably smaller beach lies just south of Mvunguti Point. The transect was conducted approximately 40 m south of this beach (C, Figure 21). The habitat comprises medium-sized and large rocks from the surface to the sand-rock interface at 24 m.

Nankumba Peninsula. The rocky shores from Mvunguti to the south-western portion of the Ilala Gap are characterized by large rocks. There are two tiny beaches, one on each side of the Ilala Gap. The eastern coast of Nankumba shelves very steeply to the sandy plains. A point transect was conducted within the funnel of the Ilala Gap (D, Figure 21) where boulders give way to coarse gravel at 33 m depth.

Domwe Island. With the exception of the northern-most point, which is 40 m deep, the large rocks and boulders of Domwe Island reach sand in less than 12 m. A point transect was conducted at site E on the northern tip of Domwe Island (Figure 21).

Zimbabwe Island. Zimbabwe Island is a rocky pinnacle situated about 500 m west of Domwe Island. It comprises horizontal and vertical slabs, boulders and large rocks with very few smaller rocks. It shelves very steeply, sometimes

vertically, to a depth which is greater than 40 m. The point transect (F, Figure 21) was conducted on its north-eastern side.

The communities

The Mbuna community of this study region comprises 25 species of which 14 have been previously described (Table 15). Nineteen of the Mbuna are essentially lithophilous, four occur mainly in intermediate habitats and two are sand-dwellers (Figure 28).

At Monkey Bay 23 Mbuna species were found of which 16 occurred in the transect (Figure 22). Of the 18 species found at Tsano Rock 17 are recorded in the transect (Figure 23). Only 13 of the 19 species which inhabit the Mvunguti area were recorded in the transect (Figure 24). At the Ilala Gap 13 species were recorded in the transect (D, Figure 25).

The other species found there all occurred in the intermediate habitats of the shallows adjacent to the beaches. At Cape Maclear 14 of the 18 Mbuna of Domwe Island were represented in the point transect (Figure 26). In about 40 diving hours at Zimbabwe Island we found only nine Mbuna species all of which are represented in the transect (Figure 27). Zimbabwe proved to be the only rocky site in the lake without a representative of the genus *Petrotilapia*. *Labeotropheus trewavasae* is present at Zimbabwe, but absent from the other sites in this area.

An indication of the number of territorial male *Cyrtocara taeniolata* is given in transects A and B (Figures 22 & 23).

More species of Mbuna inhabit the shallows than deeper water, and in general the numerical density of cichlid individuals also decreases with depth (Table 16). At Thumbi East, however, a shoal of Utaka was present at 20 m at the time the transect was laid, elevating the number of cichlid fishes recorded at that depth.

In addition to the territorial fishes depicted in the transect figures there are numerous non-territorial Mbuna living

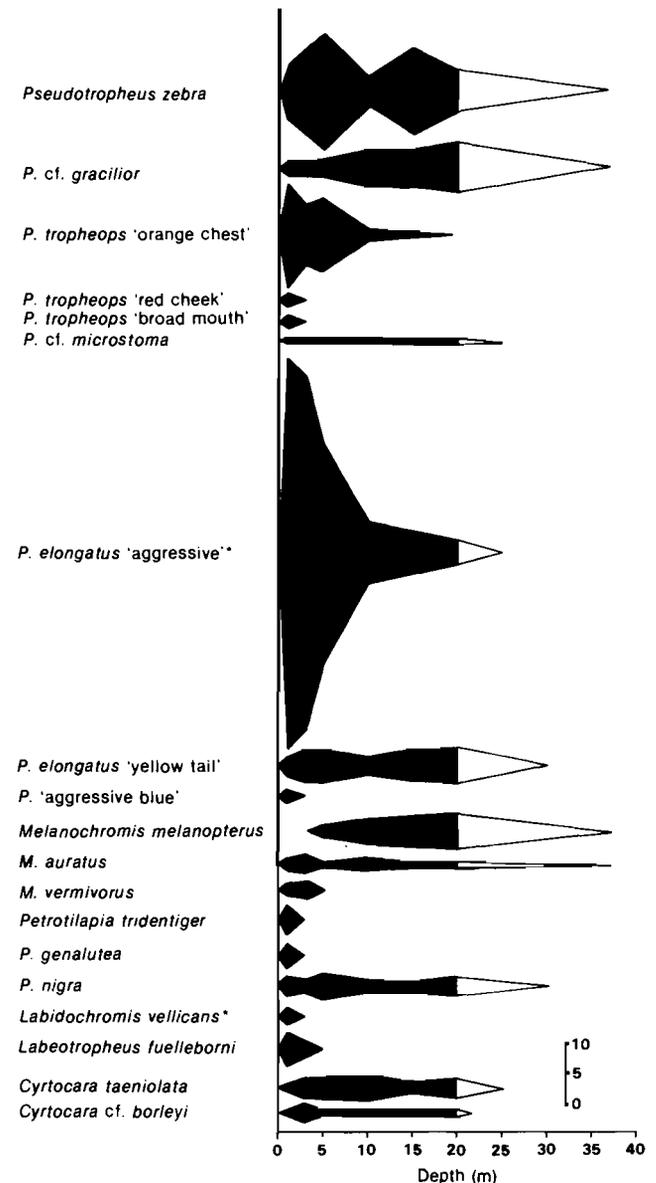
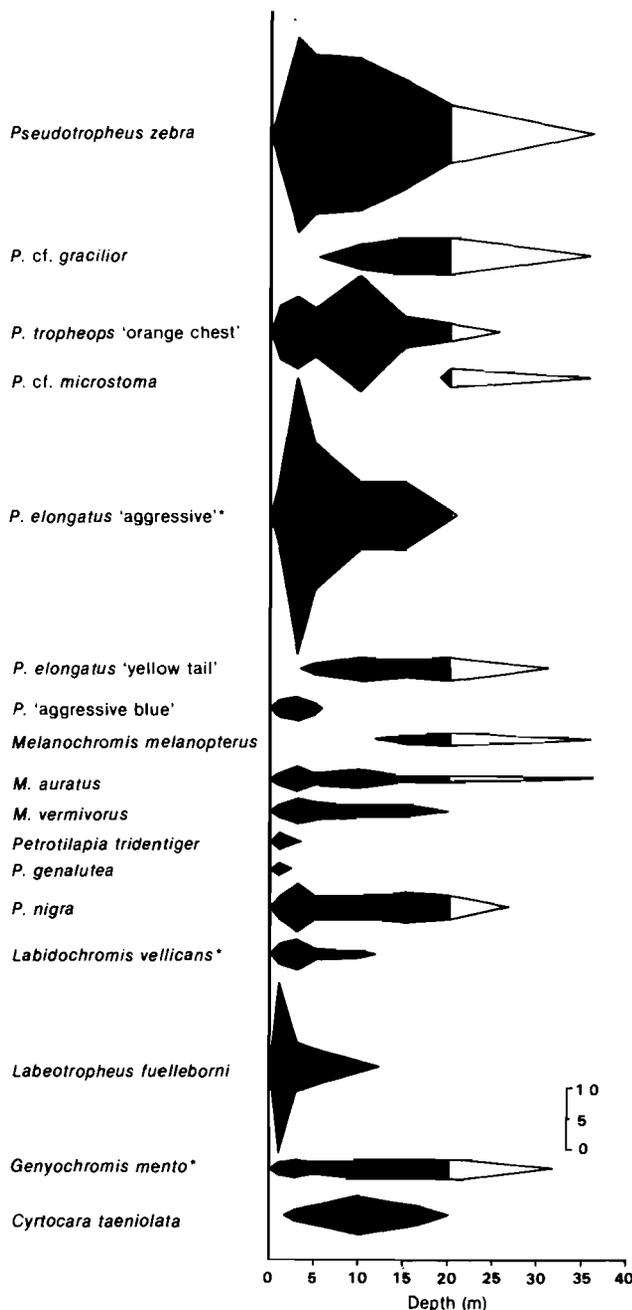


Figure 22 Transect A at Thumbi East Island, Monkey Bay, giving the depth distribution and numerical abundance of Mbuna species and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

Figure 23 Transect B at Tsano Rock, Nankumba Peninsula, giving the depth distribution and numerical abundance of Mbuna species and of two species of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

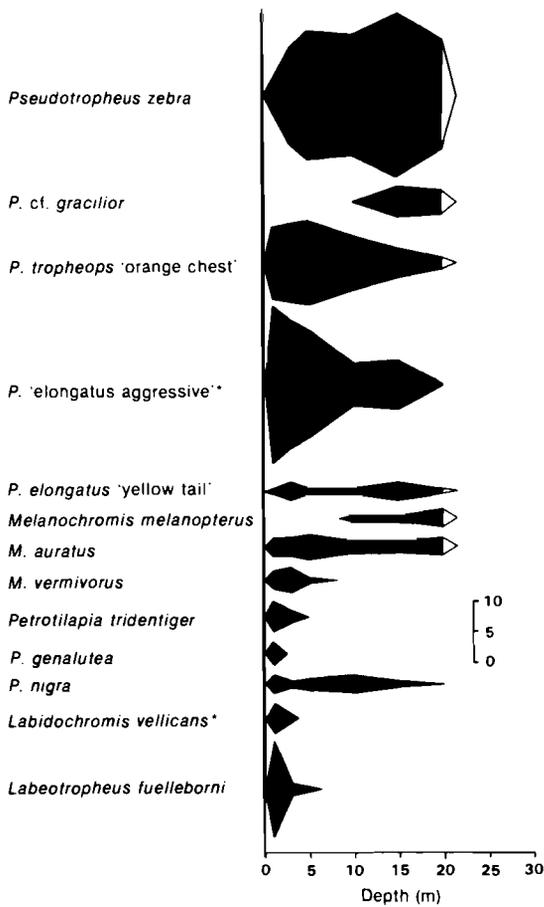


Figure 24 Transect C at Mvunguti, Nankumba Peninsula, giving the depth distribution and numerical abundance of Mbuna species. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

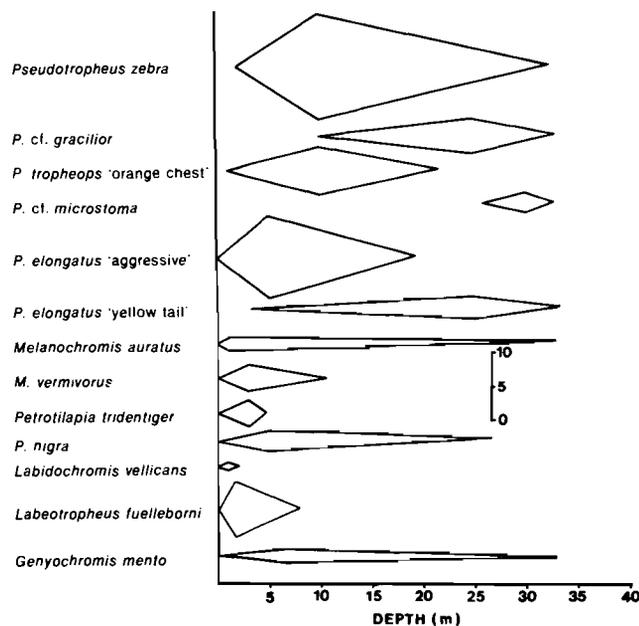


Figure 25 The point transect at the Ilala Gap (site D, Figure 21) giving the depth distribution and an estimate of numerical abundance of Mbuna species. Estimated numerical abundance is expressed as the number of individual fishes in 50 m².

among the rocks. The extreme shallows are dominated by large groups of juvenile and subadult *Labeotropheus fuelleborni* and *Pseudotropheus tropheops* 'orange chest'. In the

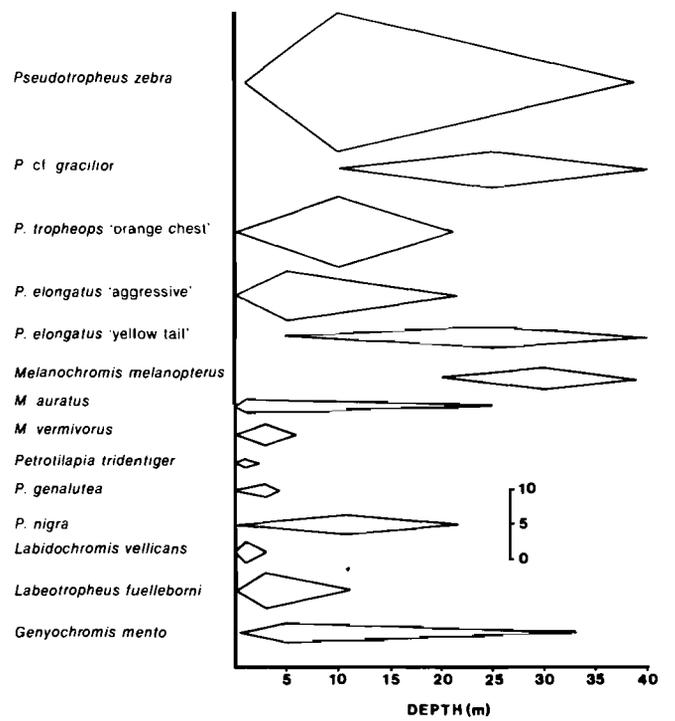


Figure 26 The point transect at Cape Maclear (site E, Figure 21) giving the depth distribution and an estimate of numerical abundance of Mbuna species. Estimated numerical abundance is expressed as the number of individual fishes in 50 m².

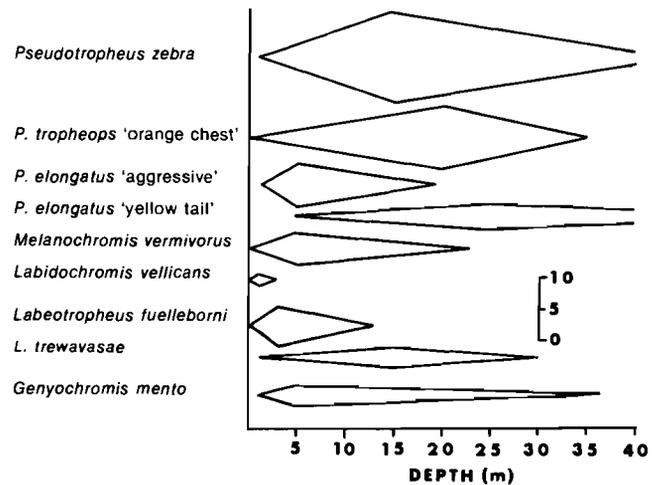


Figure 27 The point transect at Zimbabwe Island (site F, Figure 21) giving the depth distribution and an estimate of numerical abundance of Mbuna species. Estimated numerical abundance is expressed as the number of individual fishes in 50 m².

shallows, among medium-sized and large rocks there are many adult females, juveniles of both sexes and supernumerary adult male *Petrotilapia* spp., *Labeotropheus fuelleborni*, *Pseudotropheus tropheops* 'orange-chest', *P. cf. gracilior*, *Melanochromis auratus* and *M. vermivorus*. Indeed, *Petrotilapia tridentiger* and *P. genalutea* are considerably more common in these habitats than the census of territorial males suggests (Figures 22 – 24). All of these species feed from the rocks and congregate in mixed groups over the upper surfaces of large rocks, boulders and slabs, often in the company of *Cyrtocara taeniolata* and *C. fenestrata*. A striking feature of the rocky shores of this area is that

Table 15 The distribution of the Mbuna in area 1. Present (+), absent (-)

Species	Transect stations					
	Monkey Bay	Tsano Rock	Mvunguti	Ilala gap	Domwe Island	Zimbabwe
1. <i>Pseudotropheus zebra</i>	+	+	+	+	+	+
2. <i>P. livingstonii</i>	+	-	+	+	+	-
3. <i>P. elegans</i>	+	-	-	-	-	-
4. <i>P. cf. gracilior</i>	+	+	+	+	+	-
5. <i>P. tropheops</i> 'orange chest'	+	+	+	+	+	+
6. <i>P. tropheops</i> 'red cheek'	-	+	-	-	-	-
7. <i>P. tropheops</i> 'broad mouth'	+	+	+	+	+	-
8. <i>P. cf. microstoma</i>	+	+	+	+	+	-
9. <i>P. cf. novemfasciatus</i>	+	-	+	+	-	-
10. <i>P. williamsi</i> 'nkudzi'	+	-	-	-	-	-
11. <i>P. elongatus</i> 'aggressive'	+	+	+	+	+	+
12. <i>P. elongatus</i> 'yellow tail'	+	+	+	+	+	+
13. <i>P.</i> 'aggressive blue'	+	+	-	-	-	-
14. <i>Melanochromis melanopterus</i>	+	+	+	+	+	-
15. <i>M. auratus</i>	+	+	+	+	+	-
16. <i>M. vermivorus</i>	+	+	+	+	+	+
17. <i>M. cf. brevis</i>	+	-	-	-	-	-
18. <i>Petrotilapia tridentiger</i>	+	+	+	+	+	-
19. <i>P. genalutea</i>	+	+	+	+	+	-
20. <i>P. nigra</i>	+	+	+	+	+	-
21. <i>Labidochromis vellicans</i>	+	+	+	+	+	+
22. <i>Labeotropheus fuelleborni</i>	+	+	+	+	+	+
23. <i>L. trewavasae</i>	-	-	-	-	-	+
24. <i>Genyochromis mento</i>	+	+	+	+	+	+
25. <i>Cyathochromis obliquidens</i>	+	-	+	+	+	-
Totals	23	18	19	19	18	9

Table 16 The number of Mbuna species and the number of individual cichlids of all species counted at different depths in transects A - C in area 1. Dashes indicate depths at which counts of individuals were not made

	Depth (m)									
	1	3	5	10	15	20	25	30	35	40
Transect A										
No. Mbuna species	12	10	11	11	11	10	9	7	5	-
No. individuals all cichlids	370	340	330	320	340	380	-	-	-	-
No. individuals m ⁻²	7,4	6,8	6,6	5,4	6,8	7,6	-	-	-	-
Transect B										
No. Mbuna species	18	18	12	9	9	8	6	4	4	4
No. individuals all cichlids	305	274	230	210	240	140	-	-	-	-
No. individuals m ⁻²	6,1	5,5	4,6	4,2	4,4	2,8	-	-	-	-
Transect C										
No. Mbuna species	13	13	12	8	8	8	7			
No. individuals all cichlids	260	280	275	230	140	140	-			
No. individuals m ⁻²	5,2	5,6	5,5	4,6	2,8	2,8	-			

shoals of several hundred non-territorial *Pseudotropheus zebra* individuals are always to be found in the water column above the rocks which are tenanted by conspecific territorial males. At times of plankton blooms these shoals may be joined by other species of Mbuna, but most of these

species do not rise more than a metre or two above the substratum whereas *P. zebra* has been seen 8 - 12 m above the rocks.

Pseudotropheus tropheops 'broad-mouth' and *P. cf. microstoma* occur among the rocks, but are usually most

numerous in intermediate habitats and are therefore poorly represented in the transects. *P. williamsi* 'nkudzi' and *Melanochromis* cf. *brevis* were found at Harbour Island and Thumbi East Island, but they are rare and were not represented in the transects.

The sand-rock interface is frequented by *Pseudotropheus* cf. *microstoma*, *P. cf. gracilior*, *Aulonocara* 'yellow collar', *A.* 'blue collar' and *Trematocranus jacobfreibergi* which are distributed all along this intermediate zone as it extends from 3 m to 40 m depth. None of these fishes are numerous in this zone, though large groups of female *Aulonocara* spp. sometimes occur under rocky overhangs.

Pseudotropheus cf. *novemfasciatus* and *Cyathochromis obliquidens* inhabit the shallow intermediate areas, particularly where macrophytes are present, and as the transects were laid over rocky habitats these species were not represented. Both of these species are common in suitable habitats, and become numerous within the sheltered, vegetated regions of Monkey Bay.

All Zimbabwe species are unique in coloration and are, in general, darker and more sombre than conspecifics elsewhere in this study area. Furthermore, all adult territorial Mbuna, *Cyrtocara taeniolata* and *C. fenestrata* are larger at Zimbabwe than conspecifics at the other sites in this area (unpubl. data).

The preferred habitat, depth distribution and degree of territoriality of most Mbuna species of Monkey Bay and Zimbabwe Island are summarized in Figure 28.

Area 2: The south-eastern arm

The south-eastern arm of Lake Malawi is relatively shallow, it is rich in nutrients and supports the major food fishery

(Fryer & Iles 1972; Turner 1977a, 1977b). Most of the coastline in this area is sandy, although vegetated and marshy areas are also common. Rocky regions are scarce and are usually small, seldom extending to depths greater than 15 m.

Diving stations

The fishes were studied at a) the rocky shores of the west coast, b) Boadzulu Island and c) the rocky shores of the east coast.

The west coast. Seven rocky zones were studied from Kanchedza Island to Nkopola (Figure 29). In addition to the areas studied, several other small rocky zones occur along the coast between Mpandi Island and Nkopola, the largest of which is Ndala Chikowa (14°14'S).

- (i) Kanchedza is a rocky island of about 70 m diameter which comprises mainly medium-sized rocks in 3 – 8 m of water. *Vallisneria aethiopica* beds surround much of the island and are particularly dense on its north-western shores.
- (ii) Chigubi Point is an area of small broken rocks on a gently shelving sandy bottom. Almost all of the area is of an intermediate habitat which extends to a depth of 6 – 9 m.
- (iii) Mazinzi Reef is a rocky area of about 200 m² which was at a depth of 3 – 8 m below the surface in 1980.
- (iv) Nkudzi is the largest rocky shore in this study area being 2,2 km in length. It is a rocky peninsula which is flanked by a long sandy beach to the north, but to the south there is a small marsh and then a long sandy beach. Rocks on this shore are of a variety of sizes, but medium-large rocks predominate. At its deepest

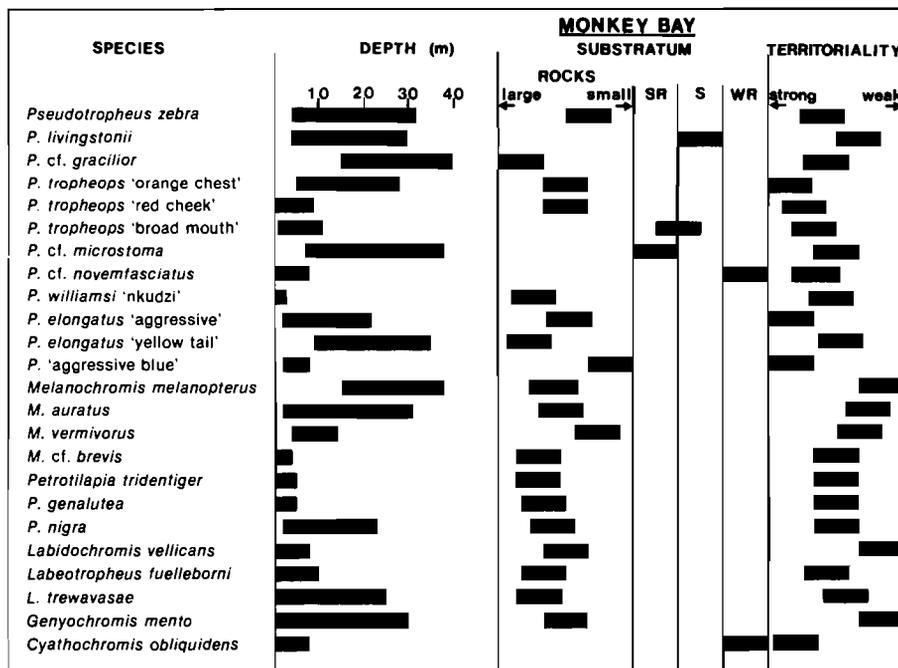


Figure 28 A summary of resource utilization of the Mbuna community in area 1. Blocks indicating preferred depth are based on quantified and observational data. Those indicating a habitat preference are based on unquantified observations. Preferences for habitats of rocks of a particular size, intermediate zones of sand-rock (SR) or weed-rock (WR) or a tendency to favour sandy environs (S) are indicated by the position of the blocks. The positions of blocks do not indicate the full depth range of species, nor do they indicate an absolute restriction to a particular habitat; they give the depths and habitat types in which most individuals are likely to be found.

An assessment of the degree of territoriality is given by the position of blocks in a range from non-territorial fishes (extreme right) to strongly territorial species which possess algal gardens (extreme left). Those species which are centrally placed are aggressive almost entirely to conspecifics. The evaluation of the degree of territoriality is based largely on unquantified observations and the positioning of the blocks on the continuum was made relative to the three reference points given above (i.e. left, right or central).

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point the rocky zone extends to 18 m (1980) before giving way to sand.

- (v) Mpandi Island comprises medium-sized rocks in 3–8 m of water. It has a diameter of about 100 m. Beds of *V. aethiopica* surround the island.
- (vi) Crocodile Rock is actually a group of large rocks submerged in 3–8 m of water.
- (vii) Nkopola is a sandy beach, but to its south there is a gradually shelving rocky shore, comprising mainly small and medium-sized rocks which extend to a depth of 5 m. To the north of the beach there is a group of medium-large rocks in 4 m of water. The Mbuna at both of these rocky shores were studied.

Boadzulu Island. This is an elongate island approximately 600 m in length and a little more than 200 m at its widest point (Site 8, Figure 29). It is usually inhabited by a large colony of white-fronted cormorants, (*Phalacrocorax carbo* Linnaeus). The island's western shore consists of large rocks and boulders which plunge steeply to at least 40 m. A few small patches of sand have accumulated among the rocks of the shallows. The point transect was conducted at Site A and an exploratory dive to 40 m at Site B (Figure 29). The eastern side of Boadzulu Island is not as deep as the western coast and it shelves more gradually. A line transect was laid at Site C where medium and medium-large rocks predominate in the extreme shallows; small and medium-small rocks occur between 3–10 m and from 10–15 m the rocks are large. At 20 m the habitat is of an inter-

mediate nature and the bottom is sandy at 24 m. At Site D large rocks and small slabs dominate the shallows, but give way suddenly, at about 5 m, to a gently shelving bed of small rocks. By 12 m an intermediate sand-rock zone predominates giving way at 14 m to a sandy bottom covered by a mantle of filamentous algae (*Lyngbia* spp.) which is 60 cm thick in places.

The east coast. The eastern shores of the south-east arm are predominantly sandy, but the rocky outcrop of Chemwezi occurs in the south, and numerous rocky reefs which were submerged in 1980 occur off Makanjila Point. In addition, a rocky shore occurs in the northern part of this study region. The stations (9–13; Figure 29) studied in this region are:

- (9) Chemwezi is an outcrop of large rocks and boulders situated on a sandy bottom. In 1980 Chemwezi was about 30 m in diameter at water level and its base was at 10 m depth.
- (10) Eccles Reef is a collection of medium-sized and large rocks: From its base at 15 m in 1980, it rose to within 3 m of the surface.
- (11) West Reef is a smaller submerged reef of large rocks, boulders and slabs. In 1980 its base was at 13 m, its apex 3–4 m below the surface.
- (12) A number of scattered, submerged offshore rocky reefs are included as Makanjila Point (Cape Ngombo). Three different reefs were visited.
- (13) Masinje Rocks is a short stretch of rocky shoreline about 6 km south of Masinje River. This ribbon of rocks is no deeper than 8 m, shelves gradually and is interspersed with many sand patches so that much of the area below 3–4 m is an intermediate habitat.

The communities

Forty-two Mbuna species of which 20 have been described, were recorded in this study area, but at no two diving stations were the species assemblages identical (Table 17). The differences between species assemblages increased progressively as the distance between diving stations became greater. A total of 24 species was found at the stations of the western shore and 25 at those along the eastern shores; 11 species are common to both shores. Chemwezi is the southern-most station of the eastern shores (Figure 29), but it has more species in common with the stations of the western shores. Boadzulu Island has 16 Mbuna species, of which 11 are common to the western shores and nine are common to the eastern shores. Only *Genyochromis mento* was found at all diving stations.

Fifteen of the species occurring in the south-eastern arm were not found elsewhere. The Mbuna communities of this study area are unusual in that the *Pseudotropheus* 'aggressive' species-group and the genus *Cynotilapia* are not represented. Furthermore, the *Pseudotropheus* 'miscellaneous' species-group is represented by only one species. In contrast, the genus *Melanochromis* has nine members and is therefore better represented in this region than anywhere else in the lake. The depth distribution and numerical abundance of the Mbuna at Boadzulu Island are indicated by the line and point transects (Figures 30 & 31). *Pseudotropheus zebra*, two members of the *P. tropheops* species-complex, *Labidochromis heterodon* and *Iodotropheus sprengerae* dominate the Mbuna community numerically. A general characteristic of the members of the

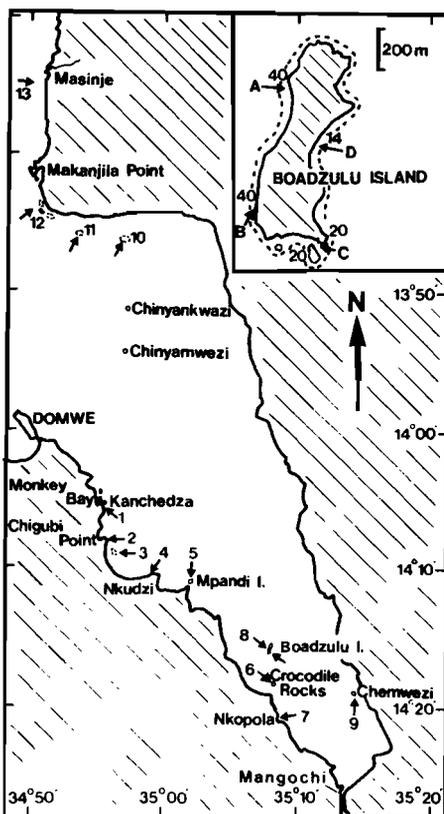


Figure 29 The locations of study sites in area 2 are indicated by the numerals and arrows. 1 = Kanchedza, 2 = Chigubi Point, 3 = Masinje Reef, 4 = Nkudzi Point, 5 = Mpandi Island, 6 = Crocodile Rocks, 7 = Nkopola, 8 = Boadzulu Island, 9 = Chemwezi Rocks, 10 = Eccles Reef, 11 = West Reef, 12 = Makanjila Reef, 13 = Masinje Rocks. The inset of Boadzulu Island shows the positions of diving stations A–D. The positions of Chinyankwazi and Chinyamwezi Islands (area 3) are given in the main map.

Table 17 The Mbuna at the principal diving stations in the south-eastern arm of Lake Malawi. Present (+); absent (-); found in this study area only (*)

Species	Western Shores							Eastern Shores					
	Kanchedza 1	Chigubi 2	Mazinzi 3	Nkudzi 4	Mpandi 5	Croc. Rocks 6	Nkopola 7	Boadzulu Island 8	Chemwezi 9	Eccles Reef 10	West Reef 11	Makanjila Pt 12	Masinje 13
1. <i>Pseudotropheus zebra</i>	+	-	-	+	+	-	-	+	-	+	+	+	+
2. <i>P. livingstonii</i>	+	-	+	+	-	+	-	+	-	-	-	+	-
3. <i>P. zebra</i> 'mazinzi'	*	-	+	-	-	-	-	-	-	-	-	-	-
4. <i>P. elegans</i>	-	-	+	+	-	+	-	+	+	-	+	-	-
5. <i>P. zebra</i> 'fusco'	-	-	+	+	-	-	-	-	-	-	-	-	-
6. <i>P. zebra</i> 'masinje'	*	-	-	-	-	-	-	-	-	-	-	-	+
7. <i>P. cf. gracilior</i>	+	-	-	+	-	-	-	-	-	-	-	-	-
8. <i>P. tropheops</i> 'orange chest'	+	+	-	+	+	+	+	+	+	-	-	-	-
9. <i>P. tropheops</i> 'broad mouth'	+	+	-	+	+	-	+	-	+	-	-	+	-
10. <i>P. cf. novemfasciatus</i>	+	+	-	+	+	-	+	-	-	-	-	-	-
11. <i>P. tropheops</i> 'boadzulu'	*	-	-	-	-	-	-	+	-	-	-	-	-
12. <i>P. tropheops</i> 'black dorsal'	*	-	-	-	-	-	-	-	-	+	+	-	-
13. <i>P. tropheops</i> 'yellow gular'	*	-	-	-	-	-	-	-	-	+	+	+	+
14. <i>P. williamsi</i> 'nkudzi'	-	-	-	+	-	-	-	+	-	-	-	-	-
15. <i>P. williamsi</i> 'makanjila'	*	-	-	-	-	-	-	-	-	-	-	+	+
16. <i>P. elongatus</i> 'aggressive'	+	-	-	+	+	-	-	-	-	-	-	-	-
17. <i>P. elongatus</i> 'yellow tail'	+	-	-	+	+	-	-	-	-	-	-	-	-
18. <i>P. elongatus</i> 'boadzulu'	*	-	-	-	-	-	-	+	-	-	-	-	-
19. <i>P. elongatus</i> 'reef'	*	-	-	-	-	-	-	-	-	+	+	-	-
20. <i>P. elongatus</i> 'brown'	*	-	-	-	-	-	-	-	-	+	+	-	-
21. <i>P. lucerna</i> 'brown'	*	+	+	-	+	+	-	+	-	-	-	-	-
22. <i>Melanochromis melanopterus</i>	-	-	-	+	-	-	-	+	-	+	-	-	-
23. <i>M. auratus</i>	+	+	+	+	+	+	+	-	-	-	-	-	+
24. <i>M. vermivorus</i>	-	-	-	-	-	-	-	-	-	+	+	-	-
25. <i>M. simulans</i>	*	-	-	-	-	-	-	-	-	-	-	-	+
26. <i>M. johanni</i>	*	-	-	-	-	-	-	-	-	-	-	-	+
27. <i>M.</i> 'blotch'	-	-	-	-	-	-	-	-	-	-	-	-	+
28. <i>M.</i> 'lepidophage'	*	-	-	-	-	-	-	-	-	-	-	+	-
29. <i>M. cf. brevis</i>	-	-	-	+	-	-	-	+	-	-	-	-	-
30. <i>M. crabro</i>	-	-	-	-	-	-	-	-	-	+	+	-	-
31. <i>Petrotilapia tridentiger</i>	+	-	+	+	+	+	+	+	+	-	-	-	-
32. <i>P. genalutea</i>	+	-	+	+	+	+	+	+	-	-	-	+	-
33. <i>P. nigra</i>	+	-	-	-	-	-	-	-	-	-	-	-	-
34. <i>P.</i> 'yellow chin'	-	-	-	-	-	-	-	-	-	+	+	+	+
35. <i>Labidochromis vellicans</i>	+	-	-	+	-	-	-	-	-	-	-	-	-
36. <i>L. shiranus</i>	*	-	-	-	+	+	+	+	-	-	-	-	-
37. <i>L. heterodon</i>	*	-	-	-	-	-	-	+	-	-	-	-	-
38. <i>Labeotropheus fuelleborni</i>	+	+	-	+	+	+	+	+	-	+	+	+	+
39. <i>L. trewasasae</i>	-	-	-	-	-	-	-	+	-	-	-	-	-
40. <i>Genyochromis mento</i>	+	+	+	+	+	+	+	+	+	+	+	+	+
41. <i>Iodotropheus sprengerae</i>	-	-	-	-	-	-	-	+	-	-	-	-	-
42. <i>Cyathochromis obliquidens</i>	+	+	-	+	+	-	+	-	+	-	-	+	+
Totals	15	17	8	8	22	14	9	11	16	6	11	11	12

genus *Labidochromis* is that they occur singly or in small groups and nowhere are they numerous. *L. heterodon* is the exception being the only member which occurs in large schools. *I. sprengerae* occurs singly or in small groups which are normally widely spaced, but at the time the transect was laid several groups had gathered in the area, possibly to feed upon particulate sediment stirred up by divers. The transect

data, therefore, overestimate the abundance of this species.

The bimodal distribution of the two *Petrotilapia* species (Figure 30) is attributed to the presence of small rocks at 3 – 10 m depth, which are unsuitable for habitation by these large Mbuna. It is not known why these two species are found more deeply at Boadzulu Island than elsewhere in their distribution.

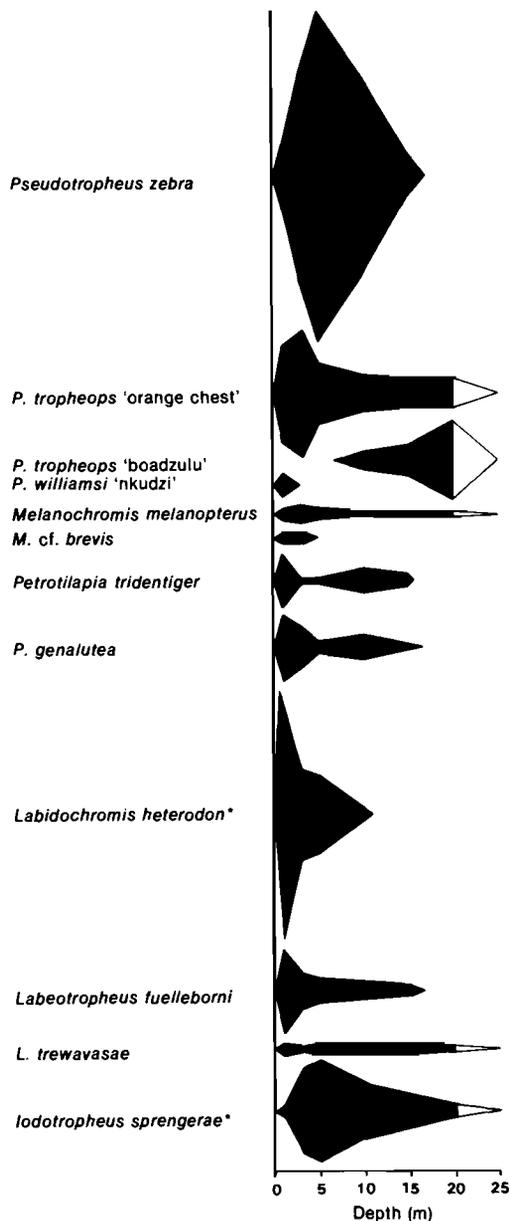


Figure 30 Transect at site C, Boadzulu Island, giving the depth distribution and numerical abundance of the Mbuna species. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

The shallows at Boadzulu support a larger number of Mbuna species and a greater number of cichlid individuals than the deeper waters (Table 18).

A summary of the habitat and depth preferenda and an indication of the degree of territoriality of the Mbuna of Boadzulu Island is given (Figure 32). The community is unusual in that none of its members may be classed as an inhabitant of the intermediate zones. *Pseudotropheus livingstonii* and *P. elegans* are rare visitors to the island and both are sand-dwelling Mbuna.

As there are no representatives of the *Pseudotropheus* 'aggressive' species-group at Boadzulu, its Mbuna community has only one interspecifically aggressive territorial fish, *Pseudotropheus tropheops* 'orange chest'.

The non-Mbuna are both speciose and numerically abundant in the south-east arm and often dominate rocky shores and intermediate habitats. For example, some species of the Utaka group are particularly numerous at submerged reefs

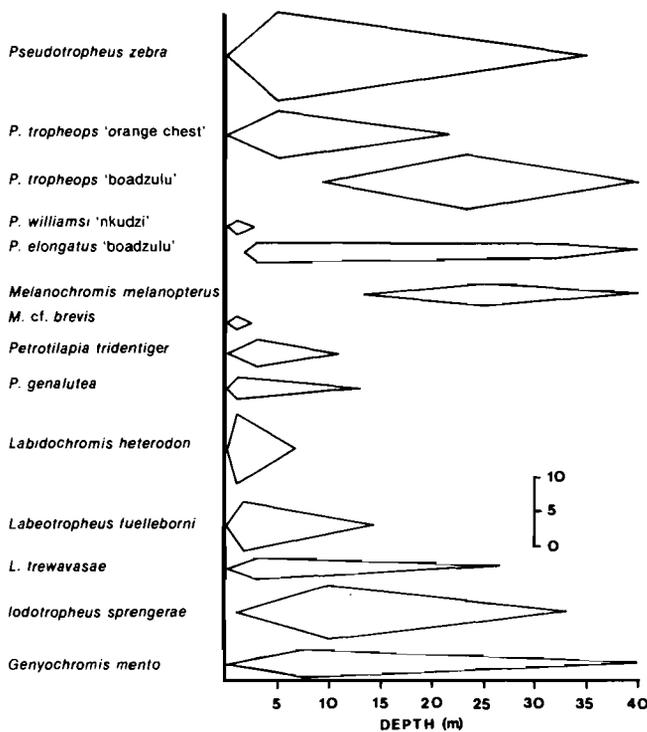


Figure 31 The point transect at site A, Boadzulu Island, giving the depth distribution and an estimate of numerical abundance of the Mbuna species. Estimated numerical abundance is expressed as the number of individual fishes in 50 m².

Table 18 The number of Mbuna species and the number of individual cichlids of all species recorded at different depths in the transect at Boadzulu Island

	Depth (m)					
	1	3	5	10	15	20
No. Mbuna species	14	14	13	13	13	12
No. of individuals all cichlids	340	370	480	255	159	250
No. of individuals m ⁻²	6,8	7,4	9,6	5,1	3,2	5,0

and around islands.

Many of these non-Mbuna are unidentified, but some of the more regular inhabitants of rocky, intermediate and weeded zones are well represented. Among these are the predators *Cyrtocara kiwinge*, *C. macrostoma*, *C. livingstonii*, *C. linni*, *C. venusta*, *C. fuscotaeniata*, *Serranochromis robustus*, *Aristochromis christyi* and several *Rhamphochromis* spp.

The benthic feeders include *Cyrtocara fenestrata*, which was more common than *C. taeniolata* in most areas, possibly owing to higher sediment levels in the south-east arm. *C. euchila* occurred at all sites and *C. labrosa* was found at Boadzulu, Eccles Reef and West Reef. *C. rostrata* is widespread in the study area, even on the rocky reefs. *Astatotilapia calliptera* is common in weeded zones. *Chilotilapia rhoadesii* does not usually venture onto the rocky shore but at Chemwezi it was very common and some males in breeding livery were territorial over the rocks.

A *Trematocranus* sp. from Boadzulu Island and a golden-headed *Cyrtocara* sp. from West Reef are attractive undescribed aquarium fishes of the rock-sand interface.

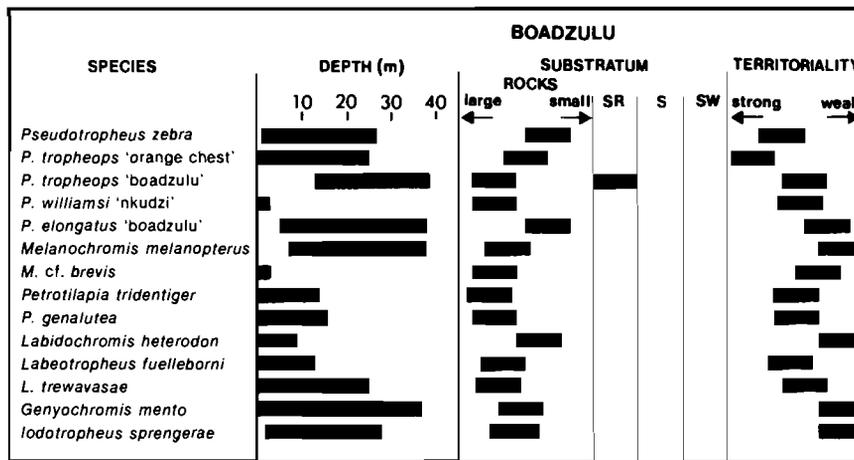


Figure 32 A summary of resource utilization of the Mbuna community at Boadzulu Island. For rest of legend see Figure 28 (p.254).

Area 3: The islands of Chinyankwazi and Chinyamwezi

Chinyankwazi and Chinyamwezi are small islands between Monkey Bay and Makanjila in the south-east arm of the lake (Figure 29). Chinyankwazi, the larger island, is almost circular in shape with an estimated diameter of 100 m at lake level. It is 8 km from Makanjila, the nearest mainland shore, and a little more than 5 km from Chinyamwezi which is about 12 km from the mainland. The water separating Chinyankwazi from other land is at least 76 m deep. The shallows at Chinyankwazi are dominated by slabs and boulders, but from about 5 m depth smaller broken rocks occur and from 7–10 m small-medium rocks become abundant, though in places, such as the eastern side of the island, slabs and boulders remain a feature of the topography. The shore shelves gradually to about 12 m, then more steeply (about 60° from the horizontal) into deeper water. The island is exposed to wave action and frequently to currents which are so strong at times that divers cannot swim up-current without the aid of ropes. These currents appeared to be wind-generated; they moved in the same direction as the prevailing winds and were particularly strong in the upper 5 m, though still noticeable at 25 m depth. At 40 m depth pockets of sand occur among the rocks, suggesting that the sandy plain is not much deeper than this, though it could not be seen from 40 m. The sediment layers covering the rocks appeared to be thin, presumably being carried away by currents.

Chinyamwezi is oval, about 30 m in length and 10 m in width at water level. Most rocks are medium-large with a few small rocks interspersed among them. The gradient is fairly steep; at about 100 m off-shore the depth was 43 m. This island is also subject to strong currents and wave action. At 43 m depth the sediment layer is negligible and there is no indication that the rocky zone is meeting the sandy plain.

Diving stations

One transect was laid on the north-western shore of each island. The entire shore of Chinyamwezi was explored and all but the south-eastern section of Chinyankwazi was studied.

Chinyankwazi. The transect at the 1-m contour was laid over slabs with few areas of broken rock in which fish could

find refuge. At 3 m, slabs and medium-sized rocks were encompassed by the transect markers. Medium-sized rocks predominated to 6 m depth, then a gradually shelving area of small and medium-sized rocks continued to 12 m. From 12 m to 40 m medium-sized and medium-large rocks predominated.

Chinyamwezi. The entire transect was laid over medium-sized and medium-large rocks.

The communities

The species assemblage at each island is unique, each possessing its own endemic species and colour forms. Seventeen species of Mbuna were recorded at the islands of which 10 are endemic, but only nine species are common to both (Table 19). Only six species have been described.

The Mbuna community at Chinyankwazi comprises 14

Table 19 The Mbuna found at Chinyankwazi and Chinyamwezi, (+) present, (-) absent and (*) endemic to the area

Species	Transect stations	
	Chinyankwazi	Chinyamwezi
1. <i>Pseudotropheus tropheops</i> 'chinyankwazi'	*	+
2. <i>P. tropheops</i> 'chinyamwezi'	*	-
3. <i>P. elongatus</i> 'dinghani'	*	+
4. <i>P. elongatus</i> 'chinyamwezi'	*	-
5. <i>P. elongatus</i> 'black'	*	+
6. <i>P.</i> 'chinyankwazi'	*	+
7. <i>Melanochromis vermicorus</i>	+	-
8. <i>M.</i> 'chinyamwezi'	*	+
9. <i>M. crabro</i>	+	+
10. <i>M. cf. brevis</i>	+	+
11. <i>M.</i> 'brown'	*	+
12. <i>Petrotilapia</i> 'gold'	*	+
13. <i>Labidochromis vellicans</i>	+	-
14. <i>Cynotilapia</i> 'chinyankwazi'	*	+
15. <i>Labeotropheus fuelleborni</i>	+	+
16. <i>Iodotropheus sprengerae</i>	+	+
17. <i>Genyochromis mento</i>	+	+
Totals	10	12

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species of which 12 are recorded in the transect (Figure 33). Only *Melanochromis crabro* and a rare reddish-brown *Melanochromis* sp. were not in the transect. There are 12 Mbuna species at Chinyamwezi, 10 of which are recorded in the transect (Figure 34). Only *Genyochromis mento* (few) and *Melanochromis crabro* (1 seen) were not recorded in the transects, but are given in the summary of depth and

habitat preferences (Figure 35).

Although there are relatively few species found at each island, the number of individual fishes is high. The greatest number of individual cichlids and also the greatest number of Mbuna species occur in less than 10 m (Table 20). At Chinyamwezi the number of fishes per unit area was very high owing to the presence of large numbers of Utaka and schools of *Melanochromis* 'chinyamwezi'.

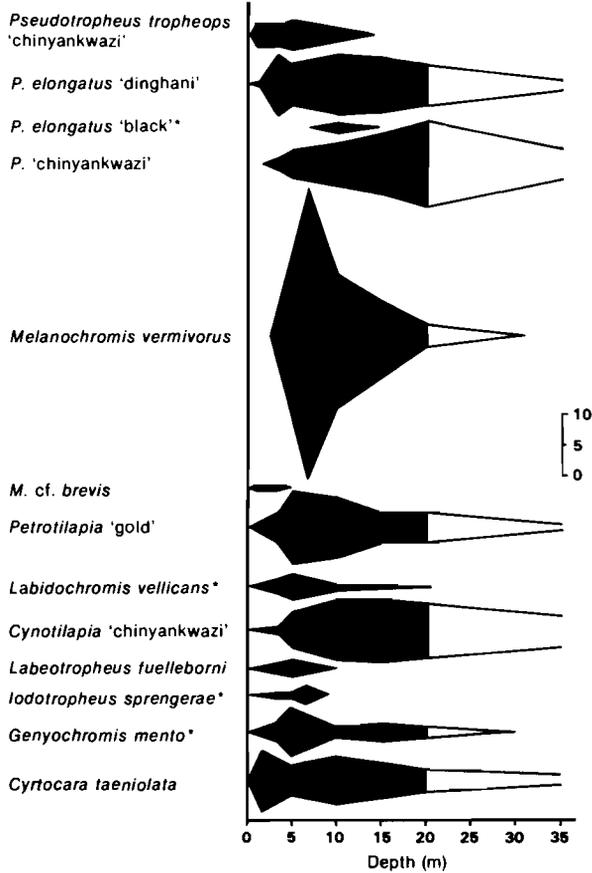


Figure 33 The transect at Chinyankwazi Island giving the depth distribution and numerical abundance of the Mbuna species and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

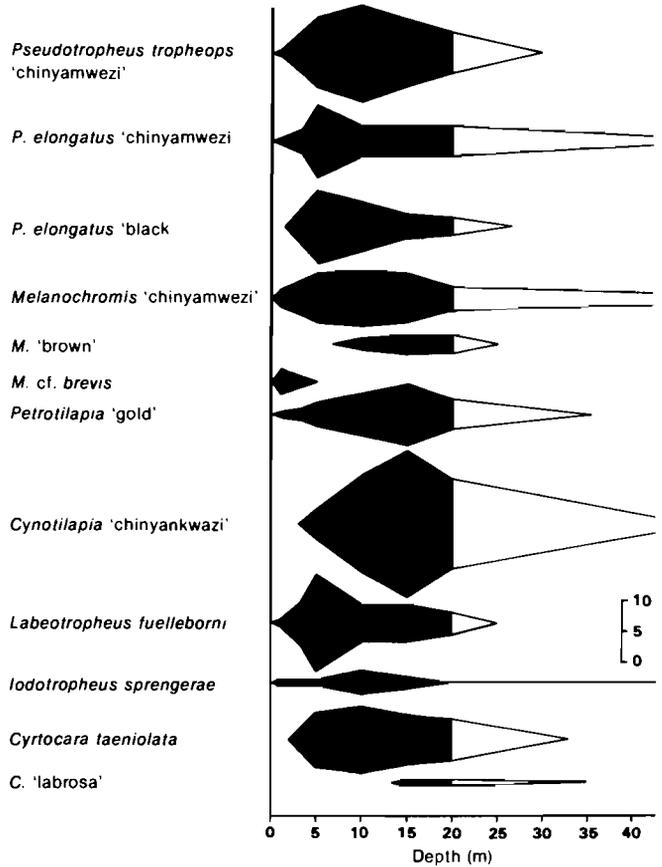


Figure 34 The transect at Chinyamwezi Island giving the depth distribution and numerical abundance of the Mbuna species. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

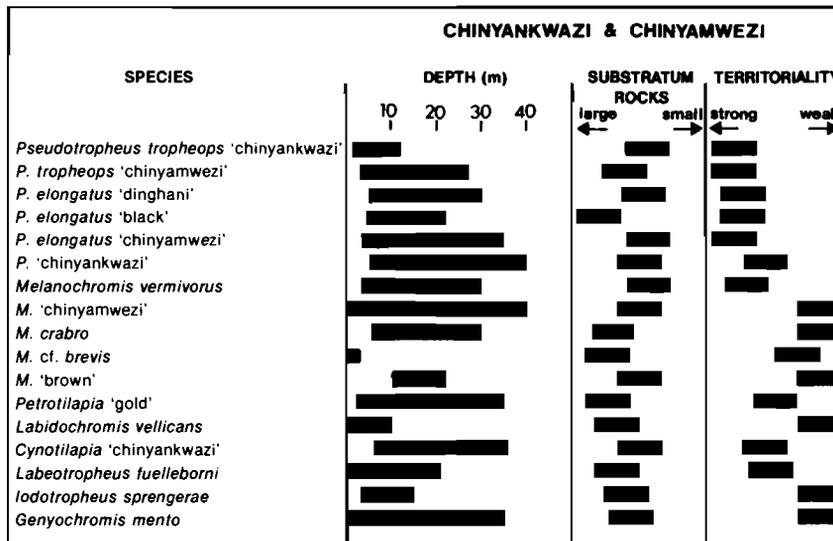


Figure 35 A summary of resource utilization of the Mbuna communities at Chinyankwazi and Chinyamwezi Islands; all species from Chinyamwezi Island have the suffix 'Chinyamwezi'. For rest of legend see Figure 28 (p.254).

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Table 20 The number of Mbuna species and the number of all cichlid individuals counted at different depths at Chinyankwazi and Chinyamwezi. Dashes indicate depths at which counts of individuals were not made

	Depth (m)									
	1	3	5	10	15	20	25	30	35	40
Chinyankwazi										
No. Mbuna species	9	11	10	9	7	6	6	4	4	4
No. individuals										
all cichlids in 50 m ²	122	546	441	483	548	539	–	–	–	–
No. individuals m ⁻²	2,4	10,9	8,8	9,7	10,9	10,8	–	–	–	–
Chinyamwezi										
No. Mbuna species	7	8	9	9	9	9	6	5	4	4
No. individuals										
all cichlids in 50 m ²	ca1200	ca900	570	510	570	630	–	–	–	–
No. individuals m ⁻²	ca 24	ca 18	11,4	10,2	11,4	12,6	–	–	–	–

At Chinyankwazi, however, the extreme shallows are characterized by slabs which do not provide refuges for Mbuna and are therefore tenanted by few fishes. Feeding fishes, particularly juvenile *Labeotropheus fuelleborni*, *Pseudotropheus tropheops* 'chinyankwazi', *P. elongatus* 'dinghani' and *Cyrtocara taeniolata*, do frequent the open rocks and were estimated to number 12–14 individuals m⁻² at times, but most of these fishes fled from the exposed regions when approached by divers who were counting fishes; therefore the number of fishes recorded at 1 m depth is low.

A striking feature of the Mbuna community at Chinyankwazi is the high numerical abundance of territorial and especially non-territorial *Pseudotropheus* 'chinyankwazi', *P. elongatus* 'dinghani', *Petrotilapia* 'gold', *Cynotilapia* 'chinyankwazi' and particularly *Melanochromis vermivorus*. Indeed, the number of *M. vermivorus* at Chinyankwazi per unit area is much greater than that at any of the other study areas and concomitantly there is an apparent increase in territorial aggressiveness (see p.203). At Chinyankwazi, where *M. vermivorus* is the most numerous Mbuna species, males are involved in intense, highly active defence of territories and intraspecific interactions are frequent.

At Chinyamwezi Island, large schools of non-territorial *Melanochromis* 'chinyamwezi' were perpetually around divers and frequently nipped at exposed skin and at spots on the diving suits. The presence of these schools led to the impression, which might be correct, that this is the most numerous Mbuna species at the island. *Pseudotropheus tropheops* 'chinyamwezi', *P. elongatus* 'chinyamwezi' and *Cynotilapia* 'chinyankwazi' were also numerous, particularly the non-territorial individuals.

Chinyankwazi and Chinyamwezi are unusual in that not a single member of the *Pseudotropheus zebra* species-complex inhabits them.

Of the non-Mbuna, the Utaka make the largest numerical contribution to the communities at Chinyankwazi and Chinyamwezi. In addition to the Utaka, the following piscivorous species occur at both islands:

Aristochromis christyi was more numerous at Chinyankwazi than at any other site studied. *Cyrtocara kiwinge* is the most common piscivore at both islands. The three ambush

predators, *Cyrtocara linni*, *C. polystigma* and *C. livingstonii* are also present, the last two occurring there in a purely rocky habitat which is vastly different from the intermediate habitat with which they are normally associated. Other piscivores recorded are *Cyrtocara woodi*, *C. spilorhyncha*, *Docimodus evelynae*, *Serranochromis robustus*, and at least three species of *Rhamphochromis*.

Cyrtocara taeniolata is the most common benthic feeder after the Mbuna. It occupies a relatively wide depth range living from the surface to 35 m, but it is most numerous between 3 and 15 m (Figures 33 & 34). Of the large-lipped species, *C. euchila* is uncommon, but *C. 'labrosa'* is common between 15 and 25 m.

Many other non-Mbuna cichlids were seen among the rocks but not identified.

Area 4: Thumbi West and Otter Point

Otter Point, its associated islets, and the island of Thumbi West are the principal foci of the newly declared Lake Malawi National Park. In addition to its primary objectives this study provides information required for a guide to the fishes of the park. Thumbi West is thickly forested. Its shoreline is rocky apart from two tiny sand/weed areas. The rocks at Thumbi West are variable in size and the sand-rock interface occurs from the shallows to about 40 m deep. Otter Point is characterized by large rocks and boulders set in water that is less than 10 m deep. A coarse sandy grit, covered by a thin sediment layer separates the rocky zones at Otter Point. Macrophytes occur in the shallow sandy areas among the rocks.

The mainland rocky shore at the Ilala Gap is separated from the rocks of Otter Point by 3,6 km of sandy beach (Figure 36). Thumbi West is 1,5 km from Otter Point and 2,6 km from Domwe Island. As far as is known the bottom which separates the rocky shores of these areas is entirely sandy. The maximum depth of water between Mitande Rocks and Chembe Beach is at least 40 m; elsewhere the water separating Thumbi West from other nearby land areas is deeper than this.

The fishes were studied at 11 diving stations at Thumbi West and line transects were laid at six of these (Figure 36). At Otter Point the fishes were studied at four stations.

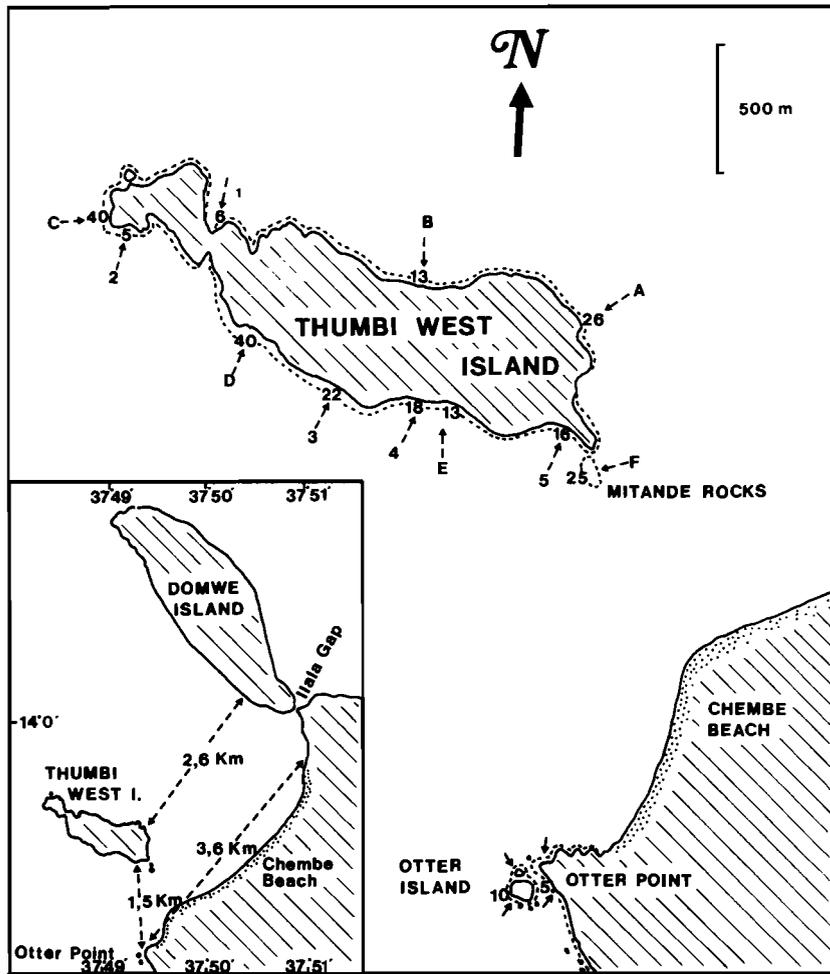


Figure 36 The diving stations at Otter Point and Thumbi West Island are indicated by arrows. Letters A – F show the positions of transect sites. Numerals 1 – 5 identify the other diving stations at Thumbi West. The dotted lines indicate the extent of the rocky shore and the numerals within these lines give the depth at which rocks meet the sandy plain. Sandy beaches are stippled.

Diving stations

Site A. In the shallows, the shore shelves steeply and comprises rounded, medium-sized rocks which are covered by a thick green mat of Aufwuchs. The middle depths are characterized by large rocks and small sediment-covered slabs. From 18 m the bottom begins to shelf more gradually and rocky regions are interspersed with small sand patches. Between 21 and 26 m, small to medium-sized rocks and sand are mixed and at 26 m rocks give way to sand. The shallow area immediately south of the transect site is characterized by slabs and also contains a sandy patch in which submerged macrophytes grow. The area to the north-west is composed of prominent boulders rising out of a bed of medium-sized rocks. A few small slabs are also present.

Sites B and 1. In the extreme shallows medium-sized rocks predominate. From 1,5 to 5 m depth the bottom shelves gradually and is dominated by a mixture of small and medium-sized rocks. At about 5 m the incline becomes steeper and rocks are medium-sized. A few slabs and small pockets of sand occur between 3 and 10 m. Sand pockets are interspersed more commonly among the rocks beyond 10 m and at 14 – 16 m the rocky shore terminates. The rocks of the areas flanking the transect site are similar to those within it though several scattered clusters of boulders rise above the rocky floor. Diving station 1 is in a shallow bay in which intermediate habitats predominate.

Sites C and 2. At the western-most tip of Thumbi West the

rocks descend steeply to at least 40 m. The topography here is varied. In the extreme shallows a mixture of small and medium-sized rocks predominates, but a few scattered groups of large rocks occur. At 3 m a bed of closely packed small rocks slopes gradually into deeper water. The rocks are larger at 5 m and continue to increase in size as depth increases. By 10 m the bottom slopes steeply downwards and is dominated by large rocks and boulders. Rocks are medium-sized at 15 – 20 m, but large rocks and boulders predominate in deeper water. Diving station 2 is sheltered from winds and wave-action and although it is shallow, sediment accumulates. The intermediate rock-sand bottom shelves gradually from the shore-line, but is traversed by large rocky ridges which run parallel to the axis of the island.

Site D. The rocks of the extreme shallows are medium-sized, but from 3 to 40 m where rocks give way to sand, a mixture of slabs, boulders, medium-sized rocks and occasional pockets of small rocks and sand occur.

Sites E, 3, 4 and 5. Eastwards from transect station D the rocky shore becomes shallower and is dominated by medium-sized and small rocks. At the transect station the rocky shore shelves gradually giving way to sand at 12 m. The extreme shallows are composed of medium-sized rocks. Small, rounded, closely packed rocks predominate between 3 and 7 m. Thereafter medium-sized, angular rocks continue to the sand-rock interface.

Table 21 The distribution of Mbuna at Thumbi West and Otter Point indicating those species which were introduced. Present (+), absent (–), if uncertain whether a species was introduced (?). Species believed to be endemic to the area (*)

Species	Introduced	Thumbi West stations						Otter Point	
		A	B+1	C+2	D	E+3,4,5	F		
1. <i>Pseudotropheus zebra</i>	–	+	+	+	+	+	+	+	
2. <i>P. zebra</i> 'cobalt'	+	+	+	+	+	+	+	–	
3. <i>P. zebra</i> 'fusco'	?	–	–	–	–	+	–	–	
4. <i>P. cf. heteropictus</i> *	–	+	+	+	+	+	+	–	
5. <i>P. aurora</i>	+	+	+	–	–	+	–	+	
6. <i>P. livingstonii</i>	–	+	–	+	–	+	–	+	
7. <i>P. livingstonii</i> 'likoma'	+	–	–	–	–	+	–	–	
8. <i>P. tropheops</i> 'lilac' *	–	+	+	+	+	+	+	+	
9. <i>P. tropheops</i> 'orange chest'	–	+	+	+	+	+	+	+	
10. <i>P. tropheops</i> 'red cheek'	?	–	+	+	+	+	+	+	
11. <i>P. cf. gracilior</i>	–	+	+	+	+	+	+	+	
12. <i>P. tropheops</i> 'intermediate' *	–	+	+	+	+	+	+	–	
13. <i>P. tropheops</i> 'broad mouth'	–	–	–	+	+	–	–	+	
14. <i>P. cf. microstoma</i>	–	–	–	–	–	–	–	+	
15. <i>P. tropheops</i> 'gold otter'	?	–	–	–	–	–	–	+	
16. <i>P. elongatus</i> 'slab'	–	+	+	+	+	+	+	–	
17. <i>P. elongatus</i> 'yellow tail'	–	–	–	+	+	–	–	–	
18. <i>P. elongatus</i> 'aggressive'	–	+	+	+	+	–	+	–	
19. <i>P.</i> 'aggressive brown' *	–	–	–	+	+	+	+	–	
20. <i>P.</i> 'aggressive blue'	–	–	+	+	+	+	–	–	
21. <i>P.</i> 'tiny' *	–	–	+	+	+	+	+	–	
22. <i>P. socolofi</i>	?	–	–	–	–	+	–	+	
23. <i>Melanochromis melanopterus</i>	–	–	–	+	–	+	–	–	
24. <i>M. cf. chipokae</i>	–	+	+	+	+	+	+	–	
25. <i>M. auratus</i>	–	+	+	+	+	+	+	+	
26. <i>M. vermivorus</i>	–	+	+	+	+	+	+	–	
27. <i>M. parallelus</i>	+	–	–	+	–	–	+	–	
28. <i>M.</i> 'red'	+	–	–	–	–	+	+	–	
29. <i>M.</i> 'black-white johanni'	+	–	+	–	–	+	–	+	
30. <i>M. joanjohnsonae</i>	+	+	+	+	+	+	+	–	
31. <i>Petrotilapia tridentiger</i>	–	–	–	–	–	–	–	+	
32. <i>P. genalutea</i>	–	+	+	+	+	+	+	–	
33. <i>P. nigra</i>	–	+	+	+	+	+	+	+	
34. <i>P.</i> 'mumbo blue'	–	+	+	+	+	+	+	–	
35. <i>Labidochromis vellicans</i>	–	+	+	+	+	+	+	+	
36. <i>L. pallidus</i>	?	+	+	+	+	+	+	+	
37. <i>L.</i> 'blue bar'	?	–	–	–	–	–	+	–	
38. <i>L. gigas</i>	+	–	+	–	–	–	+	+	
39. <i>L. strigatus</i>	+	–	–	–	–	+	–	–	
40. <i>L. freibergi</i>	+	–	–	–	–	+	–	–	
41. <i>Cynotilapia afra</i>	+	–	–	–	–	–	+	–	
42. <i>Labeotropheus fuelleborni</i>	–	+	+	+	+	+	+	+	
43. <i>L. fuelleborni</i> 'yellow-flank'	+	–	–	–	–	–	+	–	
44. <i>L. trewavasae</i>	–	+	+	+	+	+	+	+	
45. <i>Cyathochromis obliquidens</i>	–	+	–	+	–	+	–	+	
46. <i>Genyochromis mento</i>	–	+	+	+	+	+	+	+	
Totals	5	12(+), 6(?)	24	27	32	27	35	30	22

Site F. This transect was laid westwards from the apex of Mitande Rocks down to the sand base surrounding the rocky outcrop at 25 m depth. The peak of Mitande Rocks

was 1–2 m below the surface during 1979/1980. This area is characterized by slabs, boulders and large rocks, interspersed with areas of broken medium-sized rocks. Small

rocks are rare. Occasional pockets of sand occur below 10 m.

The communities

Forty-six species of Mbuna and one introduced colour form (*Labeotropheus fuelleborni* 'yellow flank') were found in this study area; 44 of these species occur at Thumbi West, 22 are at Otter Point and there are 19 species which occur at both localities (Table 21).

Pseudotropheus cf. microstoma, *P. tropheops* 'gold otter' and *Petrotilapia tridentiger* are the only species present at Otter Point which are absent from Thumbi West. In addition to the introduced colour form, 18 species are believed to have been introduced into this area (Table 21) during 1972–1974 by an exporter of aquarium fishes. Twenty-four species of this area are undescribed.

Thirty-four species are essentially lithophilous, 10 occur mainly in intermediate habitats and two are sand-dwellers (Figure 43).

The total number of species found at each diving station is given by Table 21. The discrepancy between the number of species found at diving stations and recorded in the transects is accounted for by the fact that the area studied at each diving station is large relative to that covered by the transect. This means that fishes in habitats which were not traversed by the transect could be missed. Similarly, rare

and uncommon species might not be present in the transect during the study period. At Thumbi West, therefore, fishes of the shallow intermediate habitats such as *Cyathochromis obliquidens*, *Pseudotropheus aurora* and *P. tropheops* 'broad mouth' as well as rare or uncommon species, such as some of the introduced species (e.g. *Labidochromis strigatus*, *L. freibergi*, *L. gigas*, *Pseudotropheus livingstonii* 'likoma', *Melanochromis* 'black-white johanni' were either absent from the transects or so poorly represented in them that they were not included in the figures. Similarly, *P. livingstonii* and other endemic species which are rare on the rocky shore were not found in any transect.

The numerical density and the depth distribution of the fishes recorded in the transects are presented in Figures 37–42. The number of Mbuna species and the number of individual cichlids is greatest in the shallows (Table 22). Indeed, at station D, six times as many species were recorded in the shallows as at 40 m. At all stations the number of species and individuals was greatest at 3 m, except at station D where a shoal of non-territorial *P. zebra* entered the transect.

Stations A, C and F supported a significantly ($P < .001$) greater population density in the 1–5 m zone than stations B, D and E. As stations A, C and F are more exposed than the other stations (Figure 36), they are subject to wave action and currents, reduced sediment, clearer water and are

Table 22 The number of Mbuna species found at the diving stations A–F and the number of individual cichlids of all species counted at different depths in the transects at Thumbi West. Dashes indicate depths at which counts of individuals were not made

	Depth (m)									
	1	3	5	10	15	20	25	30	35	40
Station A										
No. Mbuna species	20	21	16	14	12	12	11			
No. individuals, all cichlids	467	518	333	251	210	168	–			
No. individuals m ⁻²	9,3	10,4	6,7	5,0	4,2	3,4	–			
Station B										
No. Mbuna species	17	23	20	20	9					
No. individuals, all cichlids	290	310	270	120	155					
No. individuals m ⁻²	5,8	6,2	5,4	2,4	3,1					
Station C										
No. Mbuna species	22	16	17	14	12	10	10	7	7	5
No. individuals	260	480	253	166	170	230	–	–	–	–
No. individuals m ⁻²	5,2	9,6	5,6	3,3	3,4	4,6	–	–	–	–
Station D										
No. Mbuna species	19	25	21	14	11	11	10	8	4	4
No. individuals all cichlids	270	292	288	308	171	158	–	–	–	–
No. individuals m ⁻²	5,4	5,8	5,8	6,2	3,4	3,2	–	–	–	–
Station E										
No. Mbuna species	19	23	20	14						
No. individuals all cichlids	367	384	292	201						
No. individuals m ⁻²	7,3	7,7	5,8	4,0						
Station F										
No. Mbuna species	27	29	21	18	15	15	8			
No. individuals all cichlids	405	520	434	370	244	220	–			
No. individuals m ⁻²	8,1	10,4	8,5	6,4	4,9	4,4	–			

likely to have a more rapid replenishment of current-borne nutrients. These factors are likely to promote primary productivity. We believe that the greater abundance of fishes at those exposed sites reflects a greater primary productivity.

More species of Mbuna occur naturally at Thumbi West than any of the rocky shores closest to it (Table 21), and if the introduced species are included in the list then the species richness at Thumbi West is impressive. Only five of the species at Thumbi West are endemic.

The majority of the species which were introduced to Thumbi West were still restricted to small parts of the island in 1980 despite the four and a half to eight years which had elapsed since they were first released at the island.

Most *Pseudotropheus zebra* 'cobalt' occur between stations 3 and 5 where they were probably released. This species is relatively poorly represented at other sites (Figures 37 to 42). Similarly *Pseudotropheus livingstonii* 'likoma', *P. socolofi*, *Melanochromis parallelus*, *M.* 'red', *M.* 'black-white johanni', *Labidochromis gigas* *L. strigatus*, *L. freibergeri* and the yellow-flanked form of *Labeotropheus fuelleborni* are all concentrated around sites E and F which is the area in which these species were released. Only *Pseudotropheus aurora* and *Melanochromis joanjohnsonae* are found all round the island. *P. aurora* appears to have

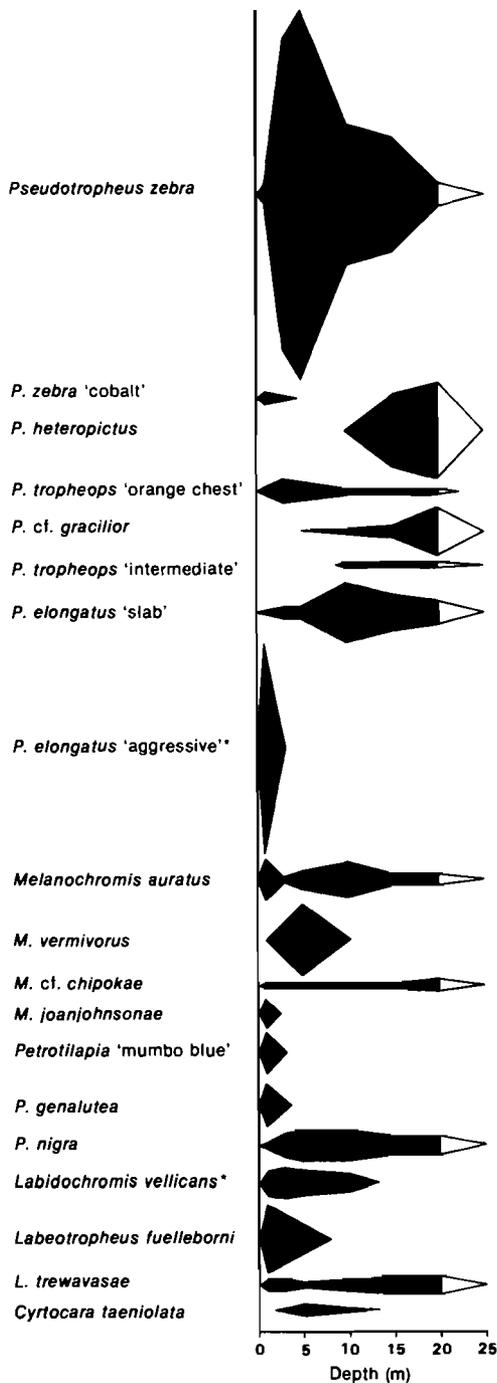


Figure 37 Transect A at Thumbi West Island, giving the depth distribution and numerical abundance of the Mbuna species and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻²

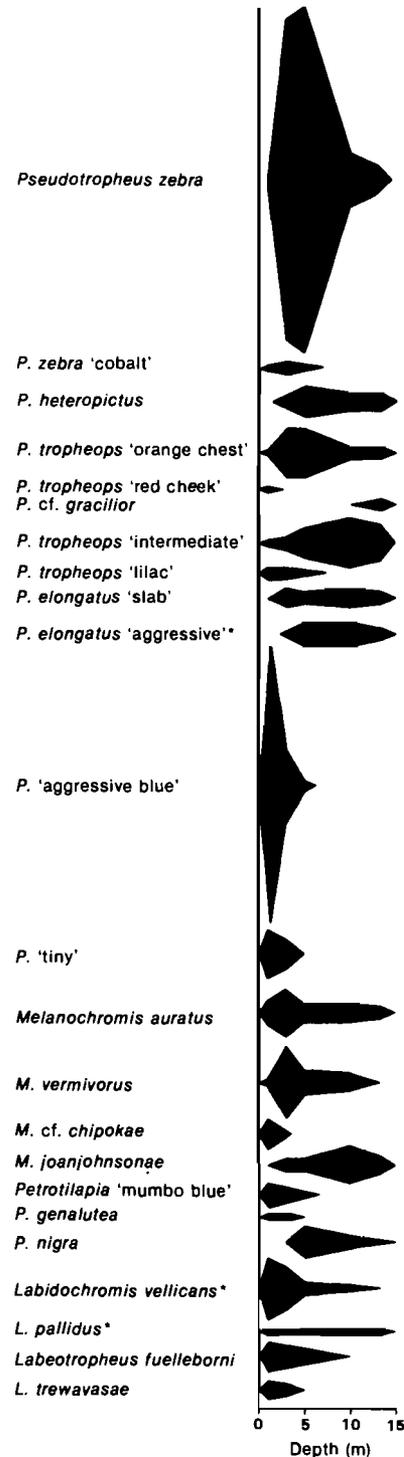


Figure 38 Transect B at Thumbi West Island, giving the depth distribution and numerical abundance of the Mbuna species. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

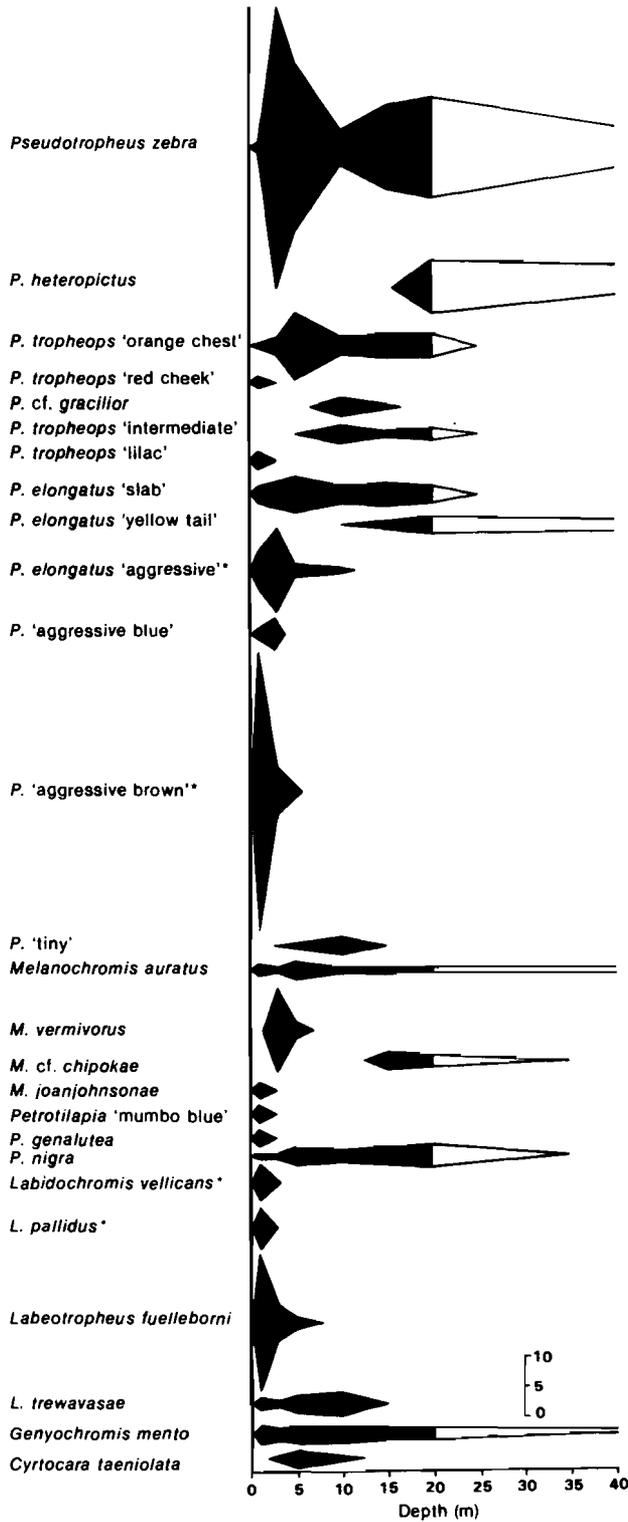


Figure 39 Transect C at Thumbi West Island, giving the depth distribution and numerical abundance of the Mbuna species and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

followed the sand-rock intermediate zone around Thumbi West though it also occurs in purely rocky regions. *P. aurora* is absent from stations D and F where the habitat appears unsuitable. *M. joanjohnsonae* has spread around the island in the 0–4 m depth zone.

The sedentary nature of Mbuna is also demonstrated by some of the indigenous species. For example, *Labeotropheus trewavasae* is well represented at all rocky

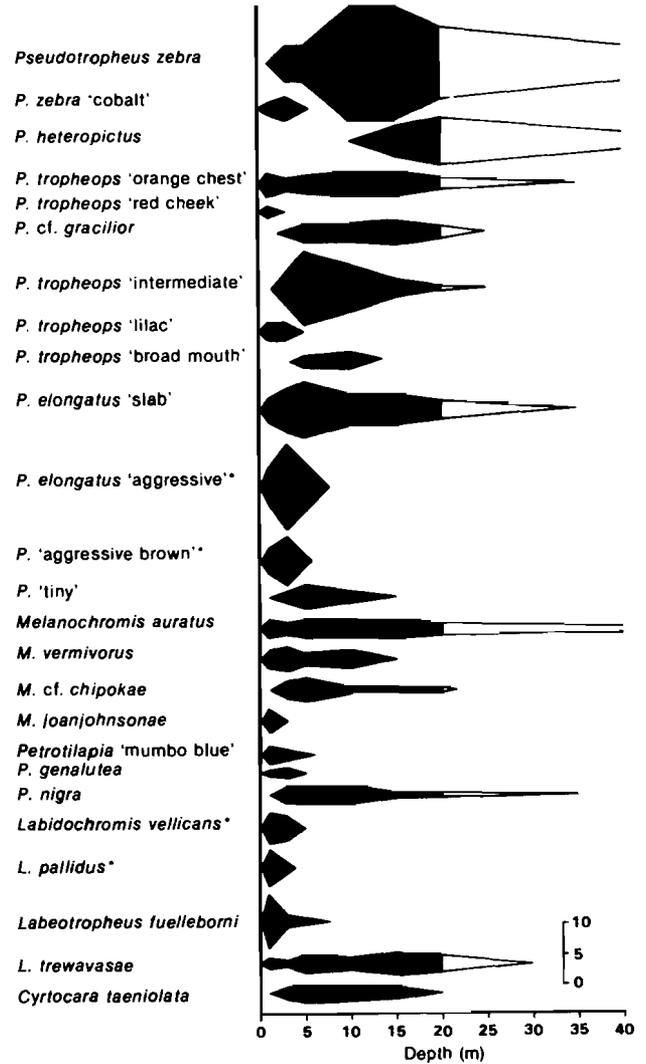


Figure 40 Transect D at Thumbi West Island, giving the depth distribution and numerical abundance of the Mbuna species and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

shores of Thumbi West but the orange morph which comprises about 25% of the females at Mitande Rocks is rare at stations E and 5 and absent elsewhere. Similarly, the pinkish-yellow morph of *Pseudotropheus zebra*, which is common at Mitande Rocks is absent elsewhere. Males of *P. zebra* at the mainland rocks of Otter Point have different head markings from those of Otter Island, not 50 m away.

A summary of the depth distribution, habitat preference and degree of territoriality of the Mbuna of Thumbi West is given in Figure 43. Very few species appear to have identical habitat preferences, but since our survey was performed superficially, further studies of the ecological interrelationships are required to establish the extent of resource partitioning among the Mbuna of Thumbi West. The ecological summary and the transect data focus mainly on territorial fishes, but non-territorial individuals are usually more numerous in the community. The non-territorial individuals of most species are solitary or occur in small groups, usually feeding from those rocks which are not guarded by territorial fishes. *Pseudotropheus zebra* and *Melanochromis vermivorus*, however, form large schools which feed upon the plankton in the water column. Both of these species are found at every station around Thumbi West, but *M. ver-*

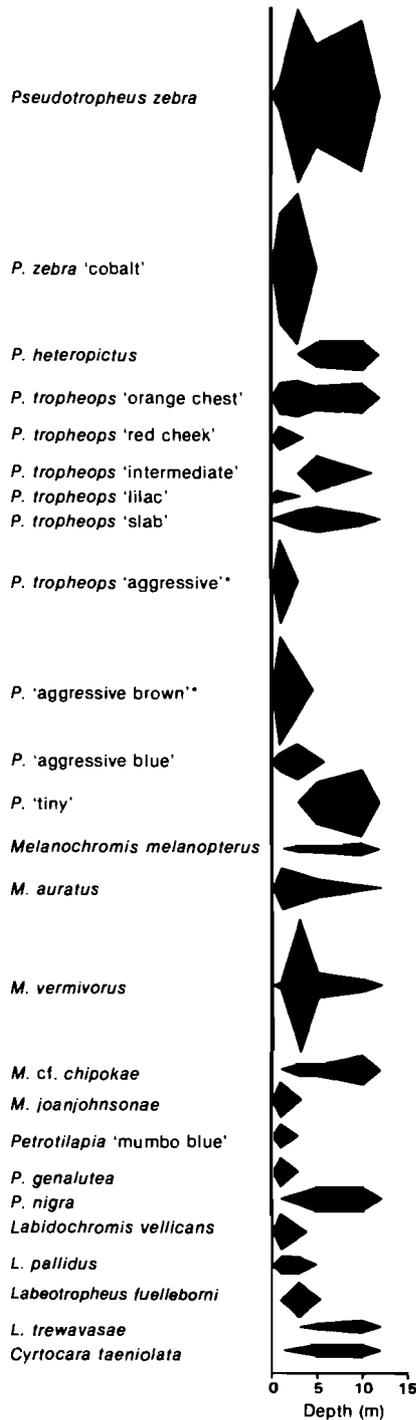


Figure 41 Transect E at Thumbi West Island, giving the depth distribution and numerical abundance of the Mbuna species and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

mivorus is particularly numerous at Mitande Rocks. *Pseudotropheus elongatus* 'slab' forms feeding schools over the upper surfaces of slabs and boulders and in the extreme shallows the schools may mix with juveniles of *Labeotropheus* spp. and *Pseudotropheus tropheops* 'orange chest'. *Labeotropheus trewasasae* is usually not as numerous as *L. fuelleborni* in the shallows, but at Mitande Rocks it is more numerous (Figure 42).

In addition to the Mbuna, many other cichlids inhabit the rocky and intermediate zones of this area. Some of the more common species which feed from the substratum are: *Astatotilapia calliptera*, *Cyrtocara picta*, *C. fenestrata*, *C.*

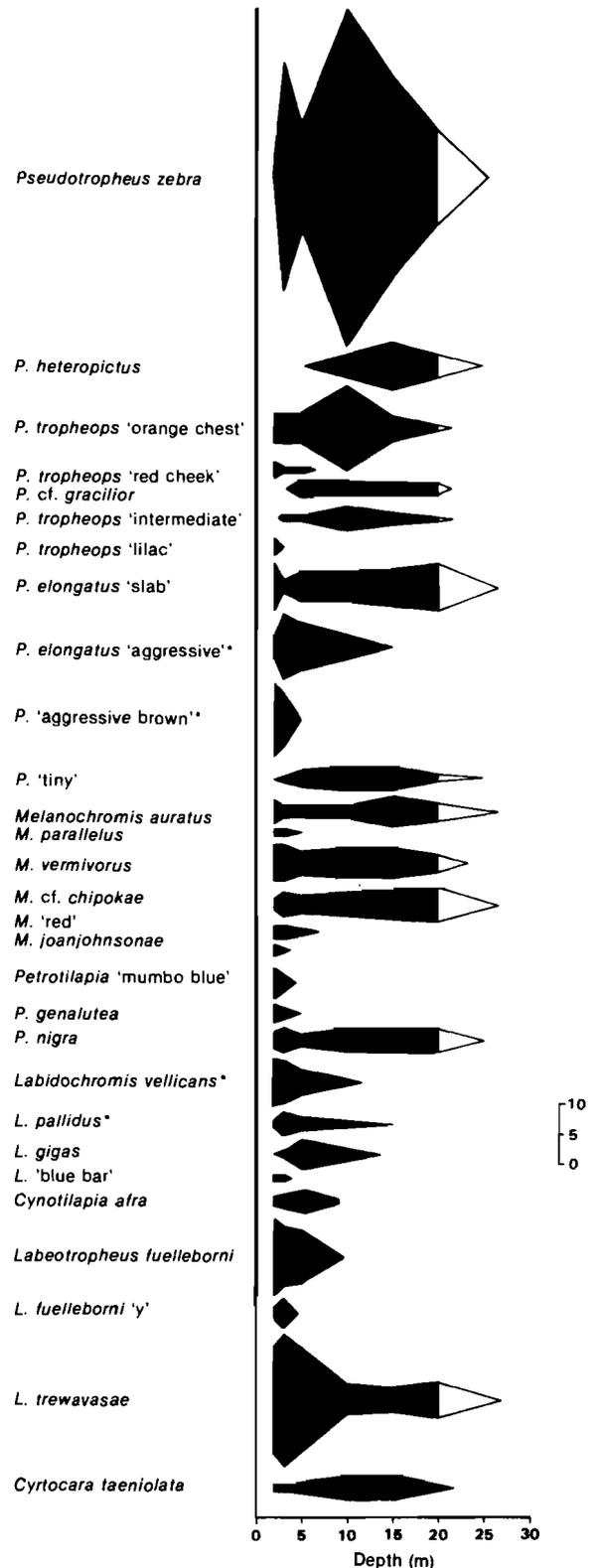


Figure 42 Transect F at Thumbi West Island, giving the depth distribution and numerical abundance of the Mbuna species and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

'labrosa', *C. taeniolata*, *C. intermedia*, *C. euchila*, *C. rostrata*, *C. 'pink dorsal'*, *C. kirkii*, *C. johnstonii*, *Hemitilapia oxyrhynchus*, *Trematocranus jacobfreibergi*, *Aulonocara 'yellow collar'*, *A. 'blue collar'*. All of these species are of importance to the aquarium trade, but *Trematocranus jacobfreibergi* is particularly important in this region as almost 90% of individuals caught for export

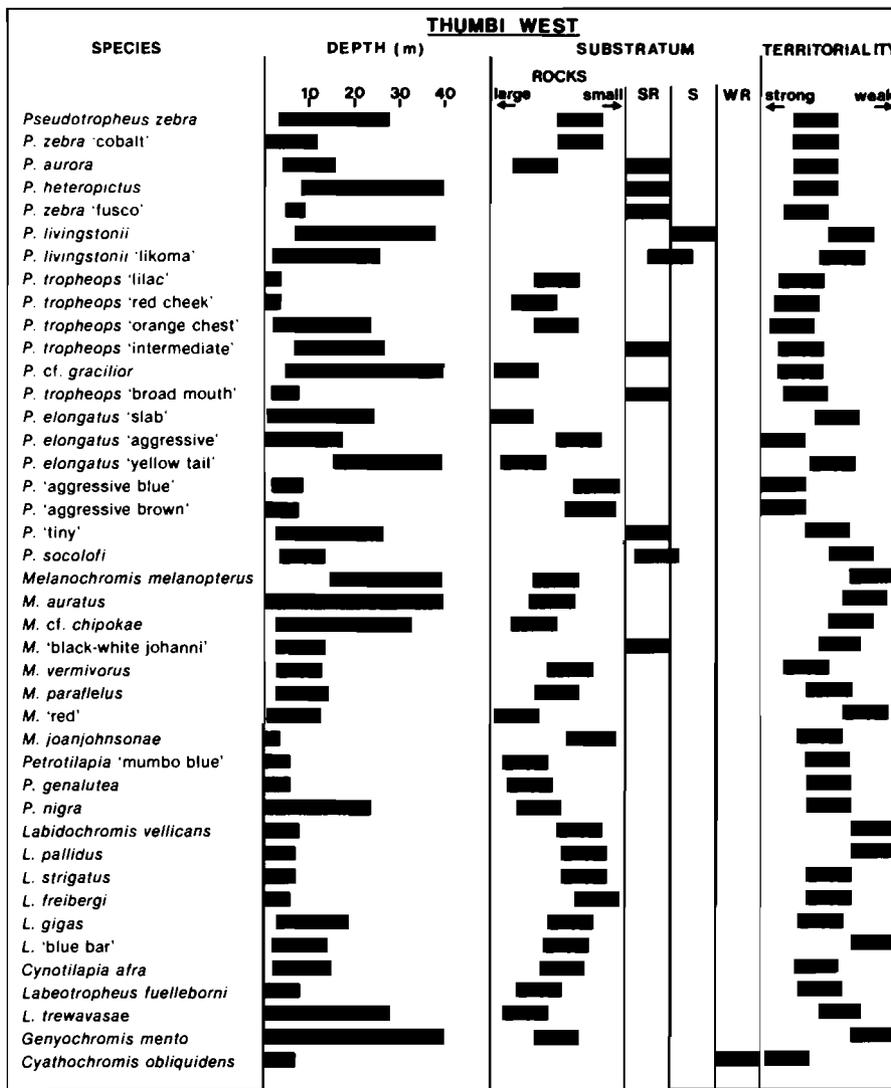


Figure 43 A summary of resource utilization of the Mbuna community at Thumbi West Island. For rest of legend see Figure 28 (p.254).

come from the intermediate habitats of Otter Point. *Cyrtocara* 'pink-dorsal' is common along the sand-rock interface of Thumbi West; it is apparently endemic to the island and is sold in large numbers. The most common non-Mbuna of the rocky shores is *Cyrtocara taeniolata*, the numerical abundance of which is depicted in Figures 36 & 38 – 42.

Piscivorous species found in this study area are *Aristochromis christyi*, *Cyrtocara compressiceps*, *C. fuscotaeniata*, *C. kiwinge*, *C. linni*, *C. livingstonii*, *C. macrostoma*, *C. polystigma*, *C. spilorrhyncha*, *C. woodi*, *Docimodus evelynae*, *Serranochromis robustus* and at least three species of *Rhamphochromis*. *C. linni* and *D. evelynae* are more numerous at Thumbi West than at any other area studied. The most northerly record of *C. fuscotaeniata* is at Otter Point where this species is uncommon.

Several species of Utaka also frequent the rocky shores. Those identified are *Cyrtocara chrysonota*, *C. quadrimaculata* and, at Otter Point, *C. inornata* and *C. eucinostomus*.

Area 5: Mumbo Island

Mumbo Island is a wooded forest reserve within the Lake Malawi National Park. It lies between the Maleri Islands and Thumbi West Island (Figure 44). The water which separates Mumbo Island from other islands is at least 100 m deep. The island itself is little more than 600 m long and

about 400 m wide. Its shore is entirely rocky except for a small beach at the southerly inlet and another in North Bay. Within the shallows of these small bays are beds of *Vallisneria aethiopica*. The rocks are of rough granite which weathers to form a coarse gravel which lies at the sand-rock interface. Large rocks characterize Mumbo Island, though smaller rocks do occur. The shore shelves steeply into deep water except in the vicinity of the beaches.

Diving stations

The fishes at Mumbo Island were studied at four diving stations (sites A – D; Figure 44). Point transects were conducted at stations A and B.

Station A. At the mouth of the southerly inlet the rocks shelf very rapidly, sometimes almost vertically, to 35 m. The area is dominated by boulders and slabs, some of which are so large that they form walls of rock many metres in area. A point transect was conducted on the western arm of the inlet.

Station B. A second point transect was conducted at site B which shelves gradually to about 5 m and then descends steeply to the sandy plain at 25 m. This site is composed of large rocks and boulders.

Station C. At the entrance to the northern bay, boulders

descend steeply to about 12 m. Within the bay, however, the sandy bottom becomes progressively shallower, eventually forming an exposed beach within the inlet.

Station D. The shore at this site shelves steeply to 35 m and has a higher proportion of medium-sized rocks than at other sites.

The community

Twenty species of Mbuna occur at Mumbo Island, 16 of which were found at all four diving stations. Four species are endemic to the island (Table 23). Those species which are not endemic differ in coloration from their nearest conspecific neighbours although three species (*Melanochromis auratus*, *M. vermivorus* and *Cyathochromis obliquidens*) have identical coloration to their nearest conspecific neighbours.

A comparison of the fauna of different rocky shores (Table 23) shows that Mumbo Island shares more species of Mbuna with the Thumbi West, Monkey Bay, Domwe Island and Zimbabwe Island region than with the more distant rocky shores of the Maleri Islands. Indeed, all nine species which occur at Zimbabwe also occur at Mumbo Island. All species common to both Mumbo and Maleri Islands are widespread in the southern lake and four of these species (*Labeotropheus fuelleborni*, *L. trewavasae*, *Genyochromis mento* and *Cyathochromis obliquidens*) have an almost lake-wide distribution. Thus the fishes shared by Mumbo and the Maleri Islands are those most likely to be found widely on rocky shores of the southern lake. At Nakantenga Island, which is the closest of the three Maleri Islands to Mumbo Island (Figure 44), and at Mumbo Island

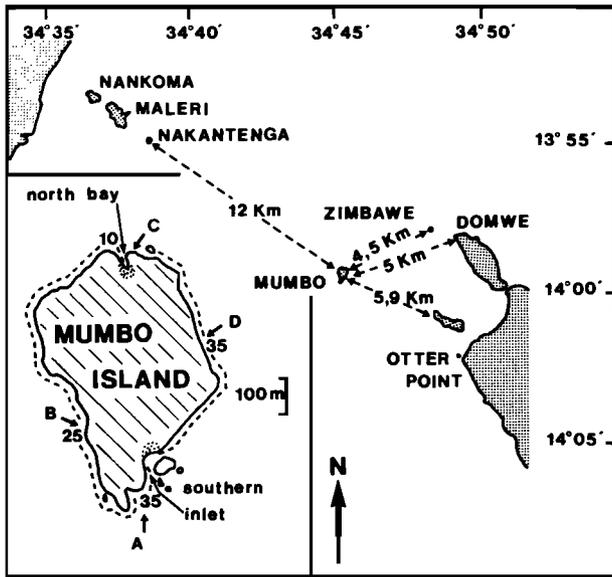


Figure 44 Mumbo Island and its relation to the nearest rocky shores. In the inset of Mumbo Island the positions of the diving stations A – D are indicated by arrows. The dotted lines indicate the extent of the rocky shore and the numerals within these lines give the depth at which rocks meet the sandy plains. Sandy beaches are stippled.

Table 23 The distribution of Mbuna species at diving stations A – D around Mumbo Island and at neighbour rocky shores. Present (+), absent (–), endemic to Mumbo Island (*)

Species	Mumbo Island diving stations				Other areas			
	A	B	C	D	Thumbi West I.	Zimbabwe I.	Domwe I. Nankumba	Maleri Islands
1. <i>Pseudotropheus zebra</i>	+	+	+	+	+	+	+	–
2. <i>P. zebra</i> 'mumbo' *	–	+	+	–	–	–	–	–
3. <i>P. tropheops</i> 'lilac mumbo' *	+	+	+	+	–	–	–	–
4. <i>P. elongatus</i> 'aggressive'	+	+	+	+	+	+	+	–
5. <i>P. elongatus</i> 'yellow tail'	+	+	+	+	+	+	+	–
6. <i>P. elongatus</i> 'slab'	+	+	+	+	+	–	–	–
7. <i>Melanochromis melanopterus</i>	+	+	+	+	+	+	+	–
8. <i>M. cf. chipokae</i>	–	+	–	–	+	–	–	–
9. <i>M. vermivorus</i>	+	+	+	+	+	+	+	+
10. <i>M. auratus</i>	+	+	+	+	+	–	+	+
11. <i>M. cf. brevis</i>	+	+	–	–	–	–	+	+
12. <i>Petrotilapia</i> 'mumbo blue'	+	+	+	+	+	–	–	–
13. <i>P.</i> 'mumbo yellow' *	+	+	+	+	–	–	–	–
14. <i>P. genalutea</i>	+	+	+	+	+	–	+	+
15. <i>Labidochromis mylodon</i> *	+	+	+	+	–	–	–	–
16. <i>L. vellicans</i>	+	+	+	+	+	+	+	+
17. <i>Labeotropheus fuelleborni</i>	+	+	+	+	+	+	+	+
18. <i>L. trewavasae</i>	+	+	+	+	+	+	–	+
19. <i>Genyochromis mento</i>	+	+	+	+	+	+	+	+
20. <i>Cyathochromis obliquidens</i>	+	–	+	–	+	–	+	+
Totals	18	19	18	16	15	9	12	8

the populations of male *Labeotropheus trewavasae* have blue dorsal fins. This could indicate an affinity between the two populations.

The point transects (Figures 45 & 46) show that the greatest number of species inhabit the shallows. They also indicate that the most numerous species are *Pseudotropheus zebra*, *P. tropheops* 'lilac mumbo' and *Melanochromis vermicivorus*. All species, however, are common in their preferred habitats with the exception of *Melanochromis* cf. *chipokae* and *M.* cf. *brevis* which are rare and uncommon respectively.

There are no important aquarium fishes among the non-Mbuna of Mumbo Island, though the piscivorous species *Cyrtocara kiwinge*, *C. linni*, *C. livingstonii*, *C. macrostoma* and *C. polystigma* are sometimes collected. Other species which occur at Mumbo Island are *Cyrtocara compressiceps*, *C. euchila*, *C. fenestrata*, *C.* 'labrosa', *C. picta* and several Utaka species. In the beds of *Vallisneria aethiopica*, *Astatotilapia calliptera* is common. Over sand *Lethrinops praeorbitalis* was frequently seen, usually being followed by *Cyrtocara moori* and *C. annectens* which foraged in the feeding excavations made by *L. praeorbitalis*. Several species of *Rhamphochromis* were also seen.

No *Trematocranus* spp. nor *Aulonocara* spp. were recorded from Mumbo Island.

Area 6: The Maleri Islands

A cluster of three islands situated in the north-western part of the south-west arm of Lake Malawi are referred to col-

lectively as the Maleri Islands, but only the central, largest island actually bears this name. The island north-west of it is Nankoma and that to the south is Nakantenga (Figure 47). Nankoma is separated from Maleri Island by a channel approximately 520 m wide and no deeper than 18 m. Nakantenga is about 1 820 m from Maleri Island and the water between them is slightly deeper than 60 m.

All three islands are small. Maleri Island is 1 923 m in length and between 780 and 1 300 m wide. Nankoma is 1 090 m by 570 m and Nakantenga is approximately 415 m long and 155 m wide.

These islands are thickly covered by trees, shrubs and creepers. The vegetation extends to the water's edge and a number of trees and shrubs on the edge of the islands were drowned when the lake reached high levels during the wet seasons in 1978, 1979 and 1980. The rocky shore around the Maleri Islands meets the sandy bottom at depths ranging from 3 to 30 m. Most of the shore shelves steeply. An unusual feature of the Maleri Islands is that rocky areas deeper than 12 m are covered by a thin layer of firm mud on which Aufwuchs grows. When the Linthipe River on the nearby (5,5 km) mainland is in flood the Maleri Islands may be surrounded by muddy water and it is likely that the mud on the rocks comes from this source.

The Maleri Islands are well separated from the other rocky islands of Mumbo, Thumbi West, Zimbabwe and Domwe (Figure 44) as well as from Namalenje Island. Virtually all of the adjacent mainland coastline is sandy with very few, small, scattered rocky regions at Kambiri Point

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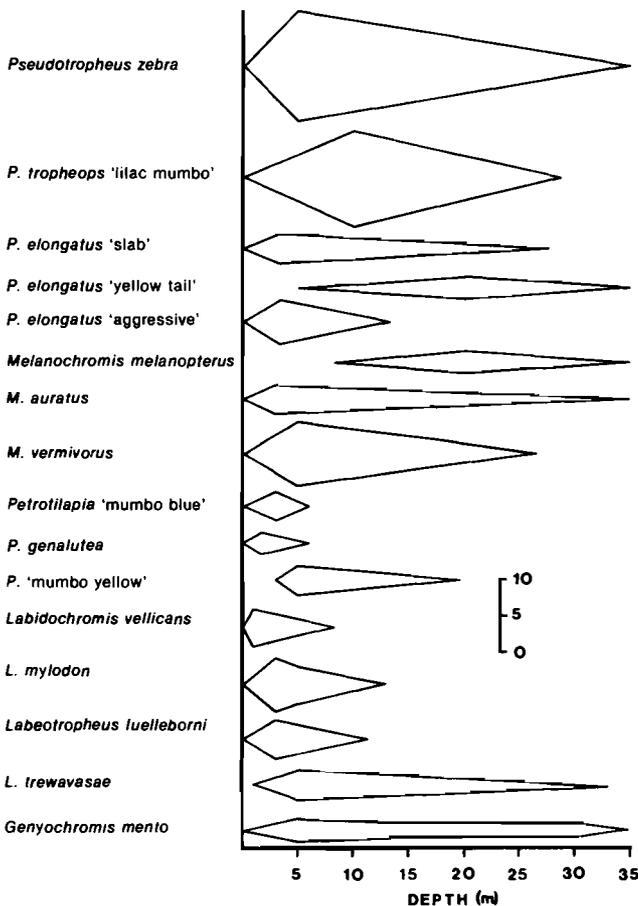


Figure 45 The point transect at station A, Mumbo Island, giving the depth distribution and an estimate of numerical abundance of Mbuna species. Estimated numerical abundance is expressed as the number of individual fishes in 50 m².

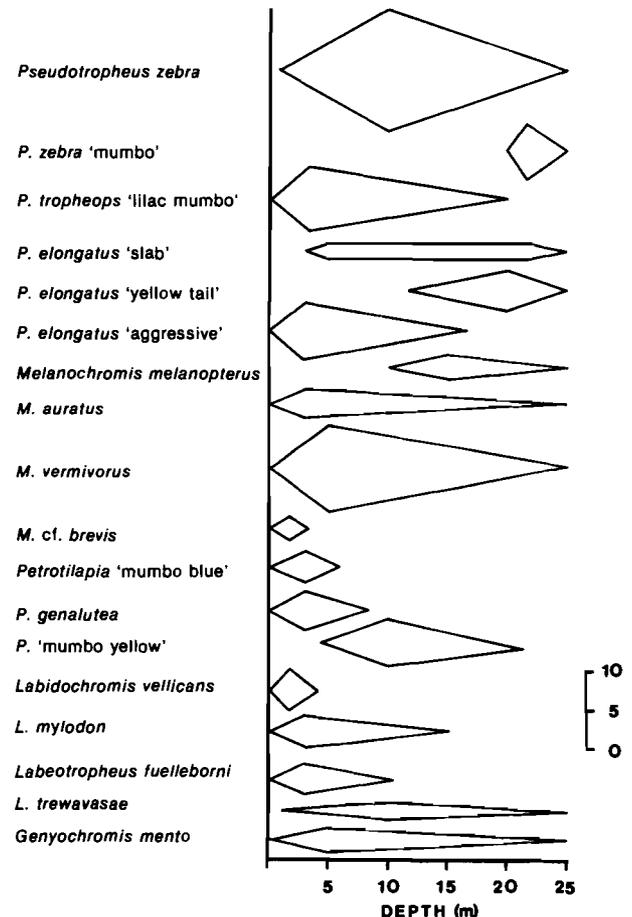


Figure 46 The point transect at station B, Mumbo Island, giving the depth distribution and an estimate of numerical abundance of Mbuna species. Estimated numerical abundance is expressed as the number of individual fishes in 50 m².

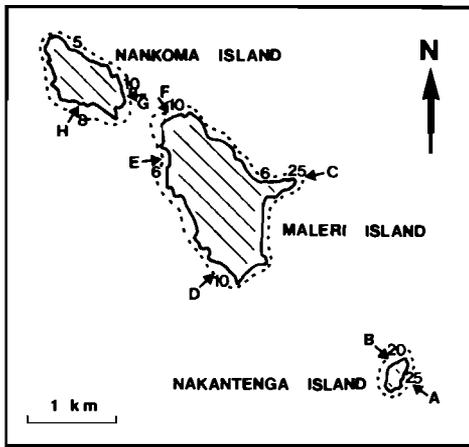


Figure 47 Diving stations (A – H) at the three Maleri Islands. The dotted lines indicate the extent of the rocky shore and the numerals within the lines give the depth at which rocks meet the sandy plain. The position of the Maleri Islands relative to other shores is given by Figures 1 and 44.

and Senga Point (Figure 52). Thus, the Maleri Islands are isolated from other rocky shores by large tracts of sand and open water.

Diving stations

The fishes of the Maleri Islands were studied at eight stations; two were at Nakantenga (A & B), four were at Maleri (C–F) and two were at Nankoma (G & H; Figure 47). At sites A to D medium-sized and medium-large rocks occur along the water's edge down to a depth of 2–3 m. Below this medium-sized and small rocks predominate, though at sites A & C groups of larger rocks occur between 4 and 8 m. At site B an intermediate zone of small rocks in sand occurs between 8 and 12 m. Stations E to F are in shallow, sheltered, sediment-rich areas. These sites are rocky to about 5 m, then of an intermediate nature until the sandy bottom is reached. The rocks at these stations are mainly small and medium-sized though scattered boulders and slabs are present. An unusual feature at site H is that smooth, rounded light-coloured pebbles cover the bottom of the extreme shallows to a depth of about 2 m. Line transects were laid at sites B, C and D.

The communities

There are 35 species of Mbuna at the Maleri Islands of which 34 occur at Maleri Island, 30 at Nankoma Island and 28 at Nakantenga Island (Table 24). Nankoma and Maleri Islands are close to one another and have the same species except that deep-water species such as *Pseudotropheus 'dumpy'*, *Melanochromis crabro* and *Cynotilapia 'maleri'* do not occur at Nankoma where the maximum depth of the rocky shore is 12 m. Seven species present at Maleri and Nankoma Islands are absent from Nakantenga Island which has one species which is not at the other two islands (*P. zebra 'red dorsal'* was probably introduced to Maleri Island see p.162).

Thirteen Mbuna species are endemic to the Maleri Islands (Table 24) and most of the species which also occur in other areas are uniquely coloured at the Maleri Islands. Indeed, even between Maleri Island and Nakantenga Island there are marked colour differences between certain populations. For example, male *Labeotropheus fuelleborni* at Maleri and

Nankoma Islands are powder-blue, but at Nakantenga they have a golden flush on their flanks; male *Labeotropheus trewavasae* are pale blue with orange dorsal fins at Maleri and Nankoma Islands, but they have blue dorsal fins at Nakantenga Island; male *Pseudotropheus zebra* 'black dorsal' have rusty-red cheeks at Maleri and Nankoma Islands, but blue cheeks at Nakantenga Island. Fifteen species recorded at the Maleri Islands also occur naturally at Thumbi West Island, though there is some doubt that *Labidochromis vellicans* of the Maleri Islands is conspecific with the Thumbi West population (Lewis pers. comm.). The Maleri Islands have 14 species in common with Mbenji Island and nine species in common with Mumbo Island. Some of these shared species, however, may not be conspecific as interpopulational differences in colour occur. Eleven species at the Maleri Islands have been described (Table 24).

Twenty-four of the 28 Mbuna species which occur at Nakantenga Island were recorded in the transect (Figure 48). Those species not included in the transect (*Pseudotropheus livingstonii*, *P. 'dumpy'*, *Melanochromis crabro* and *Genyochromis mento*) were uncommon at or absent from the transect site.

Twenty-two Mbuna species are recorded in the transect at station C (Figure 49). Although this is the only site at which we found *Cynotilapia 'maleri'*, this uncommon species was not sufficiently well represented in the transect (only two individuals were seen) to be depicted in the figure.

At station D, 21 Mbuna species are recorded in the transect (Figure 50). Those species not recorded in the transects are either absent from sites (Table 24), or occur in habitats not included in the transects, or they were so uncommon at the time that they were not included in the sample.

Sites E–H are shallow and lack the deep-water species (*Pseudotropheus 'dumpy'* and *Cynotilapia 'maleri'*), but have numerous fishes of the intermediate and sediment-rich habitats, including species such as *Pseudotropheus tropheops* 'broad mouth' and *Cyathochromis obliquidens*.

The majority of species and the greatest number of individuals occur in the shallows, though the extreme shallows have fewer species and individuals than found at 3 m (Table 25).

A summary of the preferred habitats and degree of territoriality is given by Figure 51. Ten species of Mbuna at the Maleri Islands inhabit intermediate or sandy zones, but *P. livingstonii* is the only species consistently found away from the rocks. *P. livingstonii* is also the only species associated with sand and intermediate zones which does not build sand-scrape nests. The summary indicates that, as a consequence of zonation and species-specific habitat preferences, partitioning of resources takes place. None of the sympatric members of the *Pseudotropheus zebra* species-complex have identical habitat requirements, but those of the allopatric *P. zebra* 'red dorsal' and *P. zebra* 'blue' do appear identical.

At the Maleri Islands no single Mbuna species has an overall numerical dominance. However, certain habitats are dominated by particular species: small rocks in the shallows are dominated by members of the *Pseudotropheus* 'aggressive' species-group; medium-sized rocks are dominated by the lithophilous members of the *P. zebra* species-complex and the *P. tropheops* species-complex; medium-large rocks contain numerous members of *Petrotilapia* spp. and

Table 24 The distribution of Mbuna at the Maleri Islands indicating endemicity (*) and also those species which the Maleri islands have in common with Mumbo Island, Thumbi West Island and Mbenje Island. Present (+); absent (-); introduced (i); *L. fuelleborni* blue form (b); *L. fuelleborni* yellow-flanked form (y); *L. trewavasae* orange dorsal (od); *L. trewavasae* blue dorsal (bd)

Species	Maleri Islands diving stations								Neighbouring areas				
	Nakantenga		Maleri				Nankoma		Mumbo	Thumbi			
	A	B	C	D	E	F	G	H		West	Mbenji		
1. <i>Pseudotropheus zebra</i> 'blue'	*	-	-	+	+	+	+	+	+	-	-	-	
2. <i>P. zebra</i> 'red dorsal'	*	+	+	-	i	-	-	-	-	-	-	-	
3. <i>P. zebra</i> 'yellow throat'	*	+	+	+	+	+	+	+	+	-	-	-	
4. <i>P. zebra</i> 'black dorsal'	*	+	+	+	+	+	+	+	+	-	-	-	
5. <i>P. zebra</i> 'fusco'		+	+	+	+	+	+	+	+	-	+	+	
6. <i>P. zebra</i> 'patricki'		-	-	-	-	+	+	+	-	-	-	+	
7. <i>P. livingstonii</i>		-	-	-	-	+	+	+	-	-	+	-	
8. <i>P. tropheops</i> 'lilac maleri'	*	+	+	+	+	+	+	+	+	-	-	-	
9. <i>P. tropheops</i> 'maleri blue'	*	+	+	+	-	+	-	+	-	-	-	-	
10. <i>P. tropheops</i> 'maleri yellow'	*	+	+	+	+	+	+	+	+	-	-	-	
11. <i>P. tropheops</i> 'orange chest'		+	+	+	+	+	+	+	+	-	+	-	
12. <i>P. tropheops</i> 'broad mouth'		-	-	-	-	+	+	+	-	-	+	-	
13. <i>P. williamsi</i> 'maleri'	*	+	+	-	+	-	-	-	+	-	-	-	
14. <i>P. elongatus</i> 'slab'		+	+	-	-	-	-	-	-	+	+	-	
15. <i>P. elongatus</i> 'bar'		+	+	+	+	-	-	-	+	-	-	+	
16. <i>P.</i> 'aggressive yellow head'	*	+	+	+	+	+	-	-	+	-	-	-	
17. <i>P.</i> 'aggressive grey head'	*	+	+	+	+	+	-	-	+	-	-	-	
18. <i>P.</i> 'aggressive zebra'		+	+	+	+	+	+	+	+	-	-	+	
19. <i>P.</i> 'aggressive blue'		-	-	-	-	+	-	-	+	-	+	-	
20. <i>P.</i> 'dumpy'	*	-	+	+	-	-	-	-	-	-	-	-	
21. <i>P.</i> 'burrower'	*	+	+	+	+	+	+	+	+	-	-	-	
22. <i>Melanochromis auratus</i>		+	+	+	+	+	+	+	+	+	+	+	
23. <i>M. vermivorus</i>		+	+	+	+	+	+	+	+	+	+	+	
24. <i>M.</i> 'slab'		+	+	+	+	+	+	-	+	-	-	+	
25. <i>M. crabro</i>		+	+	+	-	-	-	-	-	-	-	+	
26. <i>Petrotilapia</i> 'yellow chin'		+	+	+	+	+	-	+	-	-	-	+	
27. <i>P. genalutea</i>		+	+	+	+	+	+	+	-	+	+	+	
28. <i>P.</i> 'fuscous'		+	+	+	+	-	-	+	+	-	-	+	
29. <i>Labidochromis vellicans</i>		+	+	+	+	+	+	+	+	+	+	-	
30. <i>L. pallidus</i>		+	+	+	+	+	+	+	+	-	+	-	
31. <i>Cynotilapia</i> 'maleri'	*	-	-	+	-	-	-	-	-	-	-	-	
32. <i>Labeotropheus fuelleborni</i>		y	y	b	b	b	b	b	b	b	b+y	b	
33. <i>L. trewavasae</i>		bd	bd	od	od	od	od	od	od	bd	od	-	
34. <i>Genyochromis mento</i>		+	+	+	+	+	+	+	+	+	+	+	
35. <i>Cyathochromis obliquidens</i>		-	-	+	+	+	+	+	+	+	+	+	
Totals		13	27	28	28	26	27	22	24	24	9	15	14

Labeotropheus spp. and in the intermediate habitats *Pseudotropheus zebra* 'fusco' is extremely numerous, particularly at sites E, F, G and H, and *P.* 'burrower' is common. Members of the *P. elongatus* species-group and of the genus *Melanochromis* are well represented (Figures 48–50).

Several of the non-Mbuna which contribute to the cichlid communities of the Maleri Islands are important aquarium fishes particularly *Aulonocara* 'maleri gold' which is common in intermediate habitats in depths of 3–25 m (Figures 48–50). The most numerous non-Mbuna is *Cyrtocara taeniolata* which is included in the transects (Figures

48–50). *C. euchila*, *C. fenestrata*, *C.* 'labrosa', *C.* 'maleri thick lip' and a number of other undescribed species which feed from the rocky and intermediate habitats were also found.

Piscivores are represented by *Aristochromis christyi*, *Cyrtocara kiwinge*, *C. linni*, *C. livingstonii*, *C. polystigma*, *C. macrostoma*, *C. spilorhyncha*, several species of *Rhamphochromis* and by *Serranochromis robustus*.

In addition several species of Utaka were found.

Area 7: Namalenje Island, Senga Point and Rifu
The three rocky regions considered here are in the south-

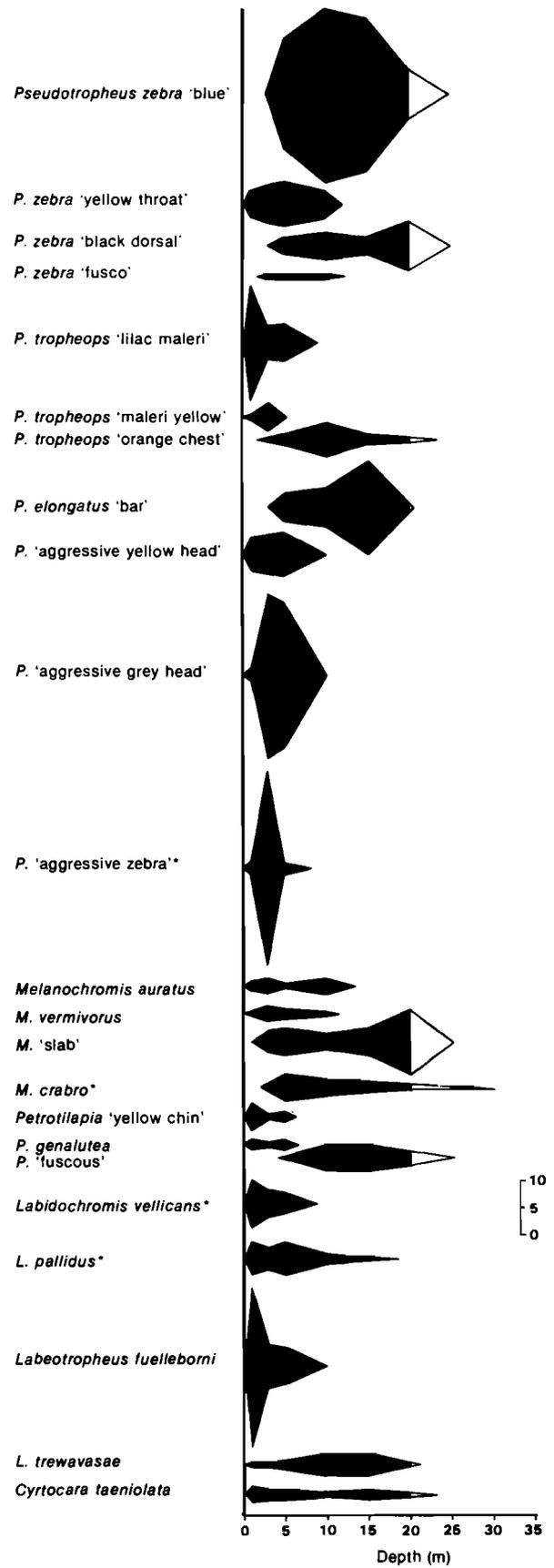
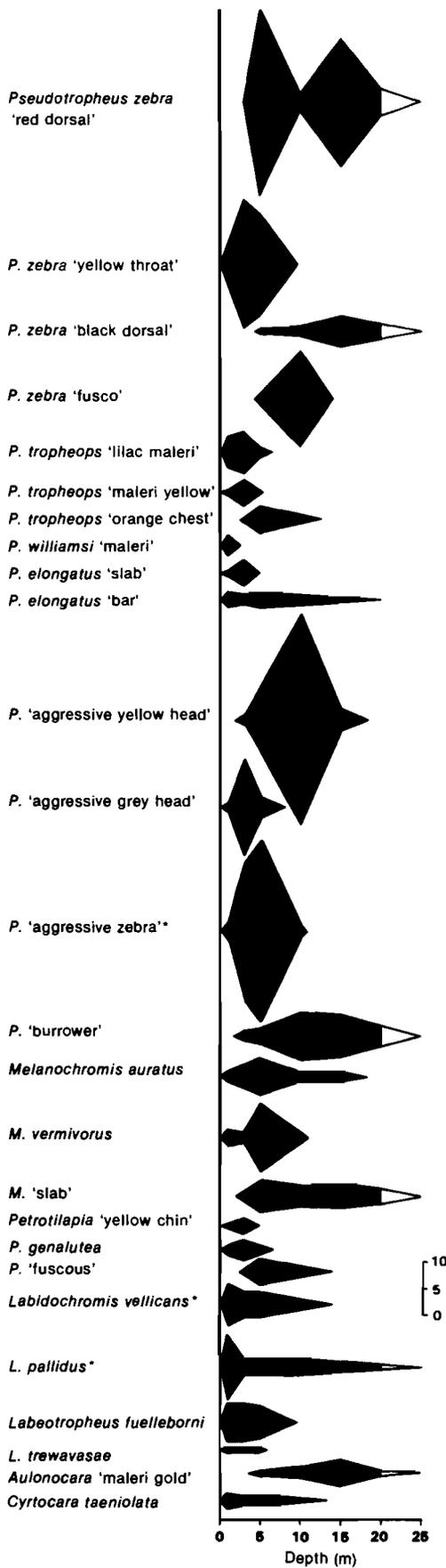


Figure 48 Transect at station B, Nakantenga Island, giving the depth distribution and numerical abundance of the Mbuna species and of *Aulonocara* 'maleri gold' and *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

Figure 49 Transect at station C, Maleri Island, giving the depth distribution and numerical abundance of the Mbuna species and *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

western portion of the central lake (Figure 52). The rocks at Senga Point and at Rifu are rounded, medium-large,

shelve steeply and in May 1980 they had a maximum depth of 4 and 6 m respectively. The narrow strip of rocks is about 500 m long at Rifu and approximately 300 m long at Senga

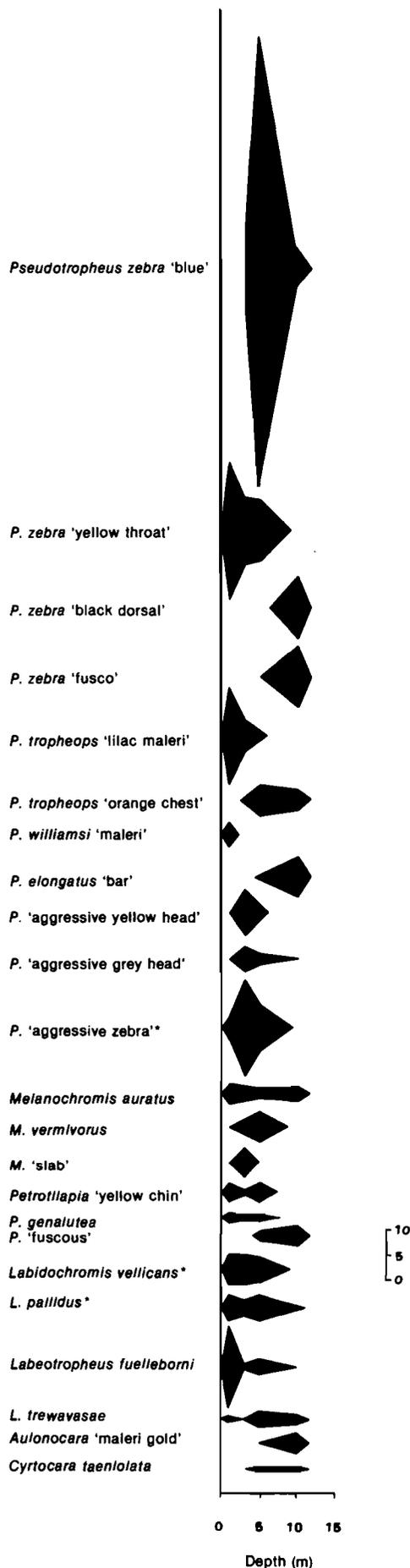


Figure 50 Transect at station D, Maleri Island, giving the depth distribution and numerical abundance of the Mbuna species and of *Aulonocara* 'maleri gold' and *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

Table 25 The number of Mbuna species and the number of individual cichlids of all species recorded at different depths in the transects at the Maleri Islands. Dashes indicate the depths at which the number of individuals was not counted

	Depth (m)							
	1	3	5	10	15	20	25	30
Transect B								
No. Mbuna species	17	21	22	19	11	8		
No. individuals all cichlids	340	290	315	180	86	35		
No. individuals m ⁻²	6,8	5,8	6,3	3,6	1,7	0,7		
Transect C								
No. Mbuna species	16	21	22	16	11	12	5	
No. individuals all cichlids	305	275	305	170	165	110	-	
No. individuals m ⁻²	6,1	5,5	6,1	3,4	3,3	2,2	-	
Transect D								
No. Mbuna species	12	17	19	10				
No. individuals all cichlids	260	580	315	150				
No. individuals m ⁻²	5,2	11,6	6,3	3,0				

Point. Both areas are exposed to winds and to waves.

Namalenje is a small island about 200 m long and 100 m wide. It comprises medium-large and large rocks as well as boulders and slabs. The shore shelves steeply to the sandy plain at 6–11 m depth.

At these three diving stations we swam along the rocky shores to establish which fishes were present and to collect specimens.

The communities

All 17 species which occur in this study site are found at Namalenje Island, but only four species are found at Senga Point and three species at Rifu (Table 26). Only two species are endemic to the area. The five *Pseudotropheus zebra* 'cobalt' and 14 *P. lombardoi* occurring at Namalenje Island were almost certainly introduced to the island by an exporter of aquarium fishes who has his base at the nearby Kambiri Point.

The ichthyofauna of Namalenje Island has greater affinities with that of the Maleri Islands, with which it shares 11 species, than with Mbenji Island with which it shares seven species, including the introduced *P. lombardoi*. The greater similarity with the Mbuna of the Maleri Islands may be attributed to the fact that these islands are closer (18 km) to Namalenje than is Mbenji Island (41 km).

Both the species richness (Table 26) and the numerical density of Mbuna at Senga Point and Rifu are extremely low. The most common species at both sites are *P. tropheops* 'broad mouth' and *Labeotropheus fuelleborni*; *Petrotilapia* spp. are uncommon and only one *Melanochromis auratus* was seen at each site.

Area 8: Mbenji Island

Mbenji Island is a collective name for a number of small islands (Figure 52) which together provide the largest rocky area on the western side of the lake between the Maleri Islands and the north-western shores. Unlike the thickly forested islands occurring elsewhere, Mbenji has been denuded of trees and shrubs by itinerant fishermen who used this vegetation as fuel. The rocks of Mbenji Island are varied, and large, vertical pillars and walls of rock which

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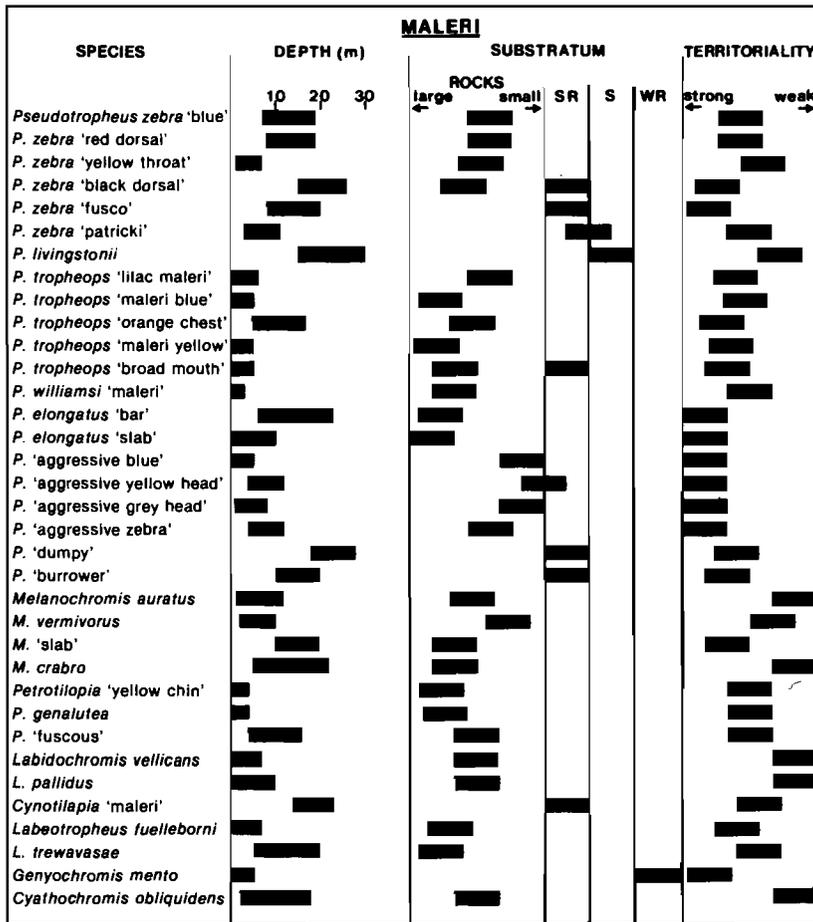


Figure 51 A summary of resource utilization of the Mbuna community at the Maleri Islands. For rest of legend see Figure 28 (p.254).

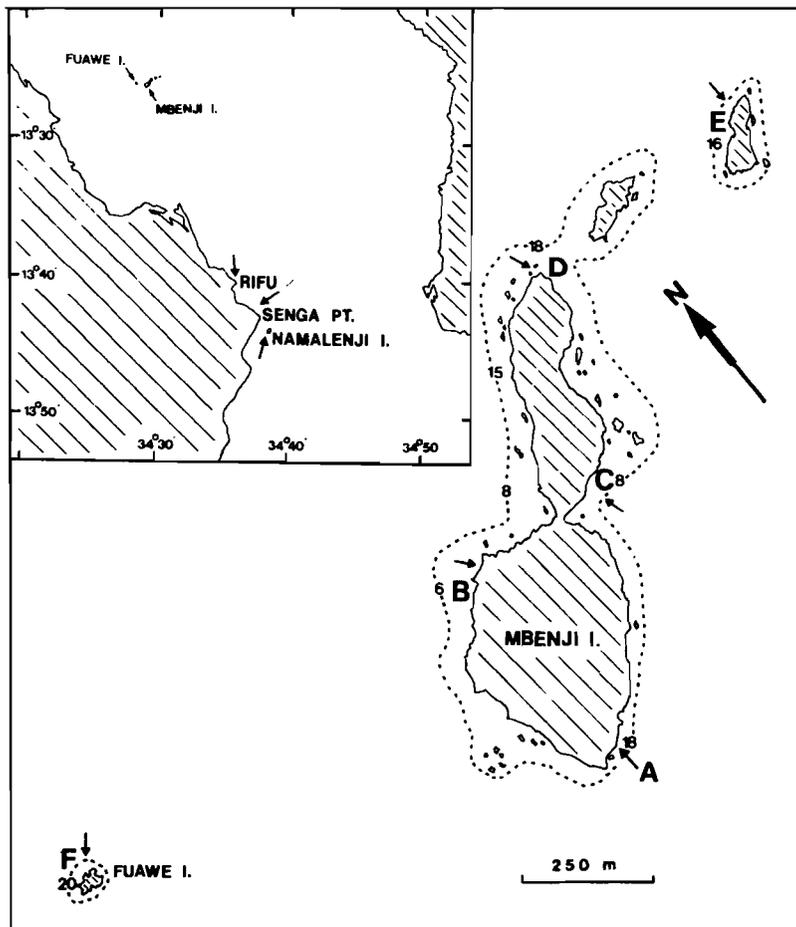


Figure 52 A map of study areas 7 (inset) and 8. The arrows and letters (A – F) show the positions of the diving stations. The dotted lines around the Mbenji Islands indicate the extent of the rocky shore and the numerals within these lines give the depth at which rocks meet the sandy plains. At Rifu, Senga Point and Namalenje Island the rocky shores are in shallow waters (see text: p.272 & 273).

Table 26 The Mbuna of Namalenje, Senga Point and Rifu. The species common to Namalenje Island, the Maleri Islands and Mbenji Island are shown. Present (+), absent (–), introduced (i), endemic (*)

Species	Diving stations			Neighbouring areas	
	Namalenje Island	Senga Point	Rifu	Maleri Islands	Mbenji Island
1. <i>Pseudotropheus zebra</i>	+	–	–	–	–
2. <i>P. lombardoi</i>	i	–	–	–	+
3. <i>P. zebra</i> 'cobalt'	i	–	–	–	–
4. <i>P. zebra</i> 'patricki'	+	–	–	+	+
5. <i>P. tropheops</i> 'lilac maleri'	+	–	–	+	–
6. <i>P. tropheops</i> 'maleri yellow'	+	–	–	+	–
7. <i>P. tropheops</i> 'broad mouth'	+	+	+	+	–
8. <i>P. williamsi</i> 'namalenje' *	+	–	–	–	–
9. <i>P. elongatus</i> 'namalenje' *	+	–	–	–	–
10. <i>Melanochromis auratus</i>	+	+	+	+	+
11. <i>Petrotilapia</i> 'yellow chin'	+	–	–	+	+
12. <i>P. genalutea</i>	+	+	–	+	+
13. <i>Labidochromis</i> 'blue bar'	+	–	–	–	–
14. <i>L. vellicans</i>	+	–	–	+	–
15. <i>Labeotropheus fuelleborni</i>	+	+	+	+	+
16. <i>L. trewasasae</i>	+	–	–	+	–
17. <i>Genyochromis mento</i>	+	–	–	+	+
Totals	17	4	3	11	7

rise from the bottom are a feature of these islands. Beds of small and medium-sized rocks surround the pillars. The rocky shores nearest to Mbenji are those at Rifu which are 28 km away.

Diving stations

The fishes were studied at six diving stations A–F (Figure 52).

Station A. This site is exposed and comprises medium-sized and large rocks in the extreme shallows, but from 3–18 m small and medium-sized rocks predominate. Sand appears among the rocks from 15 m and at 18 m depth the bottom is sandy. A line transect was laid at this site and in doing so we avoided the massive pillars of rock which rise above the bed of broken rocks.

Station B. This is a shallow station where small and medium-sized rocks dominate the shallows to a depth of 4–6 m; thereafter an extensive, gradually shelving intermediate zone continues to 12 m.

Stations C, D and E. These stations are composed of rocks of all sizes, but large rocks and boulders predominate with many vertical pillars rising from the lake floor. Site C shelves gradually, but stations D and E descend steeply in a step-wise manner.

Station F. The islet of Fuawe, station F, is a pinnacle of large rocks which descends steeply to 20 m. A sand patch occurs at 6 m depth in a valley between two rocky peaks. At the time of our visit the rocks at 9–17 m depth were completely covered by a dense mat of brown slimy alga (unidentified) which could be peeled in strips from the rocks. This alga is not eaten by the fishes and it blocked the gaps

between the rocks preventing access to refuge and spawning sites. Mbuna were almost entirely absent from this algal-covered zone, though they were numerous in shallower and deeper water.

The communities

There are 29 Mbuna species at Mbenji Island of which 14 (48%) are endemic (Table 27). Of the other species only *Melanochromis labrosus*, *M. crabro* and the four *Petrotilapia* species appear identical to conspecifics which occur elsewhere. This high degree of endemism and the unique coloration of most of those species which have populations in other regions is probably a consequence of the isolation of the Mbenji Island Mbuna.

Mbenji Island has 13 species in common with the Maleri Islands, six in common with Likoma Island and seven in common with Namalenje Island (Table 27). The closest affinities of the Mbenji community are, therefore, with the Maleri Islands. Eleven species of Mbuna at Mbenji Island have been described.

At diving station A there are 26 Mbuna, 19 of which were recorded in the transect (Figure 53). The discrepancy between the number of species occurring at the station and the number recorded in the transect is accounted for as follows. The two species belonging to the *Pseudotropheus elongatus* species-group did not occur in the transect, probably because they frequent boulders and large rocks which were avoided when the transect lines were laid. *P. zebra* 'patricki', *Melanochromis labrosus*, *M. crabro*, *Petrotilapia* 'fuscous' and *Genyochromis mento* were too sparsely distributed in the transect area to feature in the figure.

Diving station B is a mixture of rocky and intermediate habitats which accommodates all 29 species. Station C is

Table 27 The Mbuna species at diving stations A – F at Mbenji Island. Mbuna species common to Mbenji, Likoma and Maleri Islands are shown. Present (+), absent (–), endemic to Mbenji Island (*)

Species	Mbenji diving stations						Maleri Island	Likoma Island
	A	B	C	D	E	F		
1. <i>Pseudotropheus zebra</i> 'mbenji'	*	+	+	+	+	+	–	–
2. <i>P. lombardoi</i>	*	+	+	+	+	+	–	–
3. <i>P. zebra</i> 'fusco'		+	+	+	+	+	+	–
4. <i>P. zebra</i> 'patricki'		+	+	+	–	+	+	–
5. <i>P. tropheops</i> 'mbenji blue'	*	+	+	+	+	+	–	–
6. <i>P. tropheops</i> 'mbenji yellow'	*	+	+	+	+	+	–	–
7. <i>P. williamsi</i> 'mbenji'	*	–	+	–	+	–	–	–
8. <i>P. elongatus</i> 'mbenji blue'	*	+	+	+	+	+	–	–
9. <i>P. elongatus</i> 'mbenji brown'	*	+	+	+	+	+	–	–
10. <i>P.</i> 'aggressive zebra'		+	+	+	+	+	+	+
11. <i>P. tursiops</i> 'mbenji'	*	+	+	+	+	+	–	–
12. <i>P.</i> 'red-dorsal'	*	+	+	+	+	+	–	–
13. <i>P. lucerna</i> 'mbenji'	*	–	+	–	–	–	–	–
14. <i>Melanochromis auratus</i>		+	+	+	+	+	+	–
15. <i>M. vermivorus</i>		+	+	+	+	+	+	–
16. <i>M.</i> 'slab'		+	+	+	+	+	+	–
17. <i>M. labrosus</i>		+	+	–	–	+	–	+
18. <i>M. crabro</i>		+	+	–	+	–	+	+
19. <i>Petrotilapia</i> 'yellow chin'		+	+	+	+	+	+	–
20. <i>P.</i> 'mumbo blue'		+	+	+	+	+	–	–
21. <i>P. genalutea</i>		+	+	+	+	+	+	–
22. <i>P.</i> 'fuscous'		+	+	+	+	+	+	–
23. <i>Labidochromis mbenji</i>	*	+	+	+	+	+	–	–
24. <i>L. ianthinus</i>	*	+	+	+	+	+	–	–
25. <i>Cynotilapia</i> 'yellow dorsal'	*	+	+	+	–	+	–	–
26. <i>C.</i> 'black dorsal'	*	+	+	–	+	+	–	–
27. <i>Labeotropheus fuelleborni</i>		+	+	+	+	+	+	+
28. <i>Genyochromis mento</i>		+	+	+	+	+	+	+
29. <i>Cyathochromis obliquidens</i>		–	+	–	–	–	+	+
Totals		14	26	29	23	23	13	6

mainly rocky and does not have several of the fishes which frequent intermediate habitats; it also lacks some of the rarer species such as *Pseudotropheus williamsi* 'mbenji', *Melanochromis labrosus* and *M. crabro* (Table 27). Site D lacks only two fishes of the shallow intermediate habitats (*Pseudotropheus lucerna* 'mbenji' and *Cyathochromis obliquidens*) and the rare *Melanochromis labrosus* (Table 27). Similarly, sites E and F are represented by all but the rare and intermediate zone species.

The majority of Mbuna species and most individuals of the cichlids of rocky shores live at less than 10 m depth (Table 28). The high number of individuals in water less than 5 m depth at station A is due to the numerous resident species and also to schools of *Pseudotropheus* 'red dorsal' and shoals of feeding *Labeotropheus fuelleborni*.

Mbenji Island is the most northerly point in the distribution of *Pseudotropheus zebra* 'fusco', *P. zebra* 'patricki', *Melanochromis auratus*, *M. vermivorus*, *Petrotilapia* 'yellow chin', *P.* 'mumbo blue' and *P.* 'fuscous'. Most of these species are relatively widely distributed in the southern regions of Lake Malawi.

Mbenji Island is the only area of the lake which has four

Table 28 The number of Mbuna species and the number of individual cichlids of all species counted at different depths in the transect at Mbenji Island

	Depth (m)					
	1	3	5	10	15	18
No. Mbuna species	14	22	24	18	14	9
No. individuals all cichlids	445	382	295	210	260	180
No. individuals m ⁻²	8,9	7,6	5,9	4,2	5,2	3,6

species of *Petrotilapia* (*P.* 'yellow chin', *P.* 'mumbo blue', *P. genalutea* and *P.* 'fuscous'); at all other stations fewer species were found. All four species are most numerous on exposed, sediment-free rocky shores where they favour medium-sized and large rocks. At most sites the four species co-exist in the shallows, though a separation with depth occurs in so far as *P.* 'yellow chin' and *P.* 'mumbo blue' are rare beyond 5 m, but *P. genalutea* occurs to 11 m (Figure 53) and *P.* 'fuscous' penetrates to 20 m.

The Mbuna which dominate the rocky shores numerically

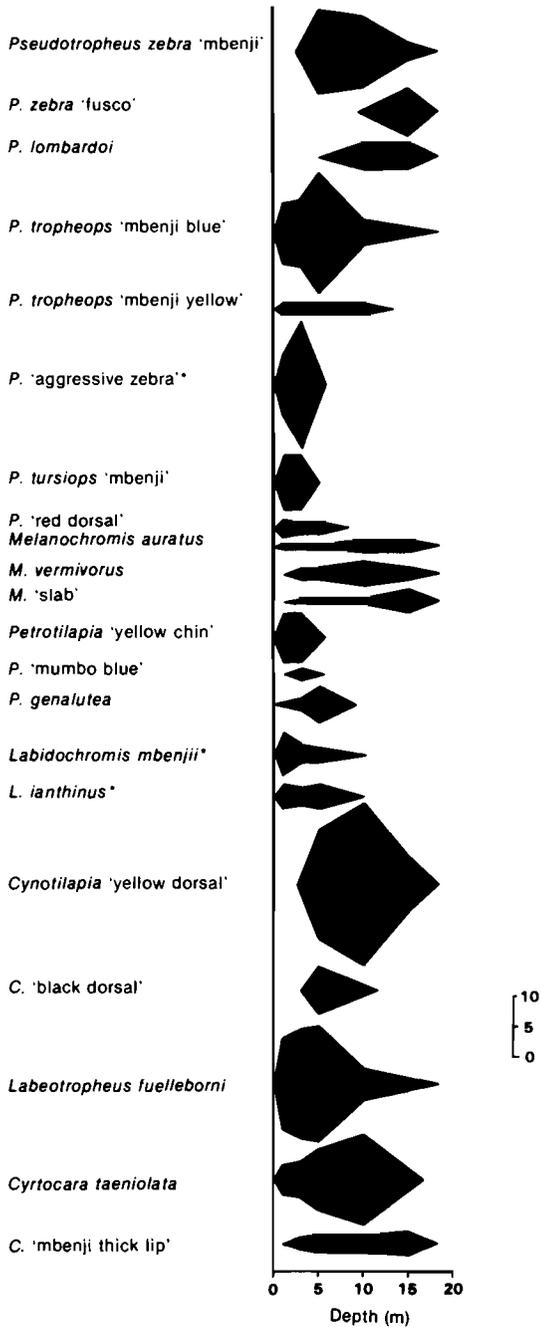


Figure 53 Transect A, Mbenji Island, giving the depth distribution and numerical abundance of the Mbuna and two species of *Cyrtocara*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

are *Pseudotropheus zebra* 'mbenji', *P. tropheops* 'mbenji blue', *Labeotropheus fuelleborni* and *Cynotilapia* 'yellow dorsal' with *Pseudotropheus* 'aggressive zebra' and *P. tursiops* 'mbenji' being numerous among small and medium-sized rocks in shallow water (Figure 53). *Melanochromis* 'slab' is more common among large rocks than it is in the transect area.

The summary of preferred habitats shows that six species inhabit the intermediate zones (Figure 54). Of these, *Pseudotropheus zebra* 'fuscus' and *P. lombardoi* dominate the sand-rock interface in deepish water, though *P. lombardoi* favours the more rocky aspects and *P. zebra* 'fuscus' extends further onto the sand. *P. zebra* 'patricki' is the dominant Mbuna of shallow, intermediate habitats, being particularly common at the extensive intermediate zone at

station B. *Cyathochromis obliquidens* and *Pseudotropheus lucerna* 'mbenji' are uncommon species.

Cyrtocara taeniolata is the most common of the non-Mbuna (Figure 53) and appeared more numerous at Mbenji Island than at any other site studied. Other species present which feed from the Aufwuchs mat are *C. fenestrata*, *C. picta* and several species with hypertrophied lips: *C. euchila*, *C. 'labrosa'* and a common species (Figure 53) which is apparently endemic to Mbenji Island, *C. 'mbenji thick lips'* (Plate 12f). *Aulonocara* 'mbenji blue' is an attractive fish (Plate 12d) of the intermediate habitat which is popular with aquarists.

The ambush predators *Cyrtocara livingstonii*, *C. polystigma*, *C. linni* and the pursuit piscivores *C. kiwinge*, *C. macrostoma*, *C. spilorhyncha*, *Aristochromis chrystyi*, *Serranochromis robustus* and several *Rhamphochromis* species were well represented. Particularly common around Mbenji Island are a number of the planktivorous Utaka species which were heavily fished by itinerant fishermen at the time of the survey (May 1980).

Area 9: The islands of Likoma and Chisumulu

Likoma and Chisumulu are the biggest islands in Lake Malawi. They are also the only islands which are permanently inhabited, each supporting several thousand people who are largely dependent upon fish for their livelihood. These islands are rich in ornamental fish and together provide a greater variety of species for export than any other area of comparable size in the lake.

Likoma, the larger island, comprises a main island, about 7,4 km at its longest and 3,9 km at its widest, and several islets close to its shore (Figure 55). The rocky shores of Likoma Island are punctuated by a series of beaches which are particularly extensive along the southern half of the island. The continuity of the rocky shores is also broken by two reeded areas: one is at Ngani and the other in the northern inlet of Madimba Bay. All the islets associated with Likoma Island are rocky though there is a shallow sandy patch between the two Mbamba islets. Likoma Island is 4,4 km from the Mozambique coast and 10,4 km from Chisumulu Island (Figures 1 & 4).

Chisumulu Island comprises a main island about 4 km long and 1,8 km wide, two islets and numerous small rocky outcrops and submerged reefs close to its shores (Figure 56). The rocky shores of Chisumulu Island are punctuated by beaches which occur within the bays. The two islets are rocky.

Diving stations at Likoma Island

The fishes were studied at 25 diving stations around Likoma and line transects were laid at six (A – F; Figure 55). At most sites the rocks of Likoma Island are small to medium in size, but at Ndumbi Rocks, Ndomo Point and Masimbwe islet, rocks are medium-large and large. Rocky shores in predominantly sandy areas are seldom more than 8 m in depth (e.g. at Ulisa, Khuyu, Mlonga, Ponyemba and White Rock); elsewhere the rocky shores extend into deep water (Figure 55).

Membe Point. Transect A was laid at Membe Point where the rocks are predominantly small and medium-sized with a few scattered groups of large rocks. A littoral shelf descends gradually to 8–10 m. The edge of the shelf is marked by medium-large rocks and from this point the bot-

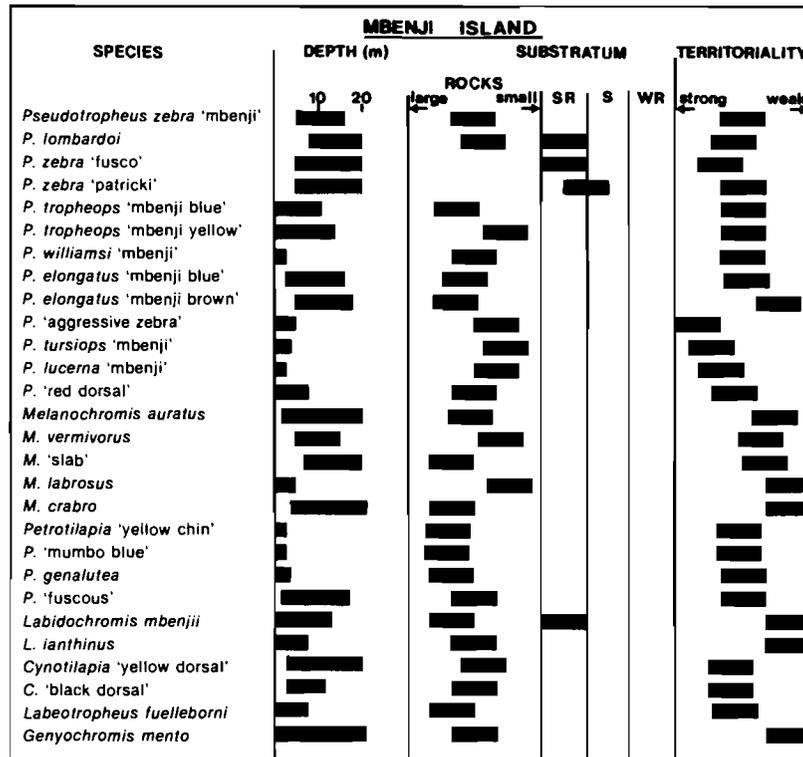


Figure 54 A summary of resource utilization of the Mbuna community at Mbenji Island. For rest of legend see Figure 28 (p.254).

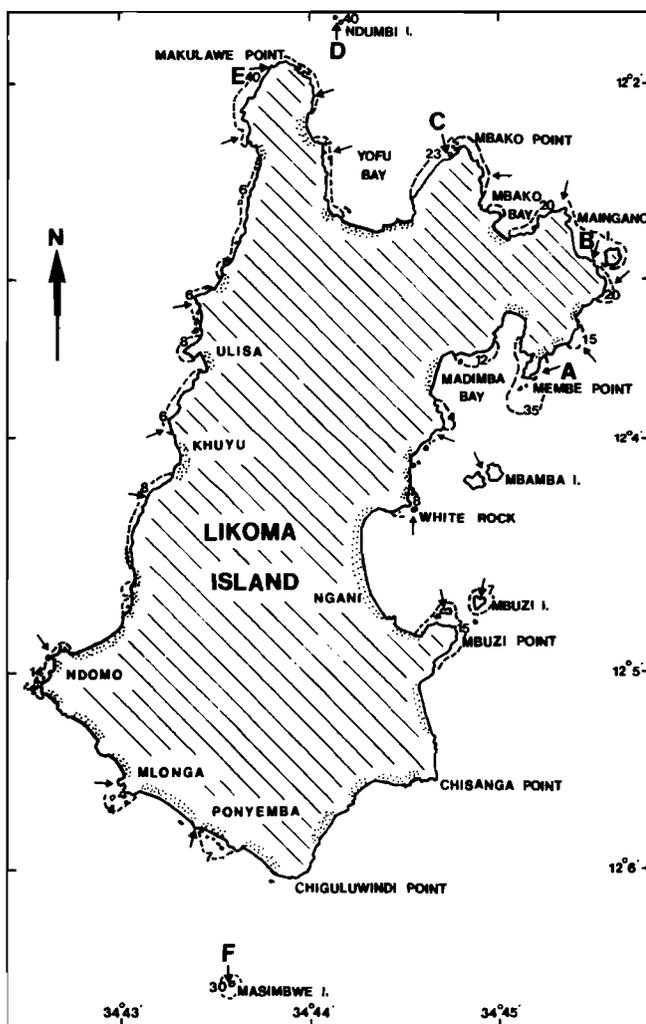


Figure 55 The diving stations at Likoma Island are indicated by arrows. Letters A – F show the position of transect sites. The dotted lines indicate the extent of the rocky shores and the numerals within these lines give the depth at which rocks meet the sandy plain. Sandy beaches are stippled. The position of Likoma Island relative to other shores is given by Figures 1 and 4.

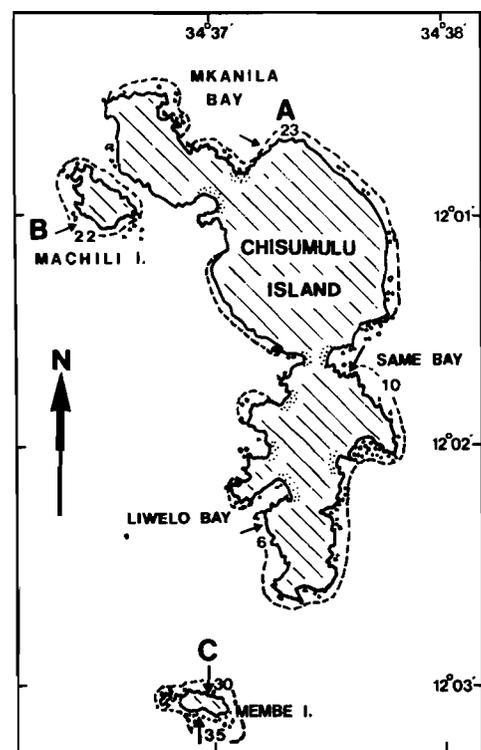


Figure 56 The diving stations at Chisumulu Island are indicated by arrows. Letters A – C show the positions of transect sites. The dotted lines indicate the extent of the rocky shores and the numerals within these lines give the depth at which rocks meet the sandy plain. Sandy beaches are stippled. The position of Chisumulu Island relative to other shores is given by Figures 1 and 4.

tom slopes steeply to 25 m where it then shelves more gradually again. From 25 m to 35 m the bottom becomes intermediate in nature with small rocks set in sand.

Maingano. Transect B, at Maingano, was set over small and medium-sized rocks. The bottom in this area shelves very gradually to 10 m, then steeply to sand at 35 m. An unusual

feature of rocks at this site is that many in the 2–8 m depth range are cemented together sometimes forming peculiar shapes. In places the rocky bed is pitted with pot-holes some of which are at least 1 m deep and 1 m in diameter. The rocks comprising the walls of these holes also appear cemented together. A strip of intermediate habitat 5–15 m wide runs from the main island shore past Maingano Islet through the transect station. This strip has the appearance of an ancient stream bed, which it might be.

Mbako Point. Transect C was conducted on the Yofu Bay side of Mbako Point where the bottom slopes gradually to a depth of 6 m about 50 m off-shore, then more steeply to sand at 25 m depth. The rocks at this site are predominantly small and medium-sized.

Ndumbi. Transect D was laid westwards from the apex of Ndumbi Rocks, a submerged reef situated about 0,8 km north of Makulawe Point. Medium-large and large rocks shelf steeply to at least 40 m depth from about 1 m below the surface (August 1980).

Makulawe Point. Makulawe Point (site E) has a bed of small rocks in the shallows which is set among large and medium-sized rocks, but from 3–5 m depth medium-sized and large rocks predominate and descend rapidly to at least 40 m depth.

Masimbwe Islet. The islet of Masimbwe (site F) rises from a sandy plain in 30–35 m of water and comprises mainly medium-sized and large rocks. The transect was laid on the northern side of the islet.

Diving stations at Chisumulu Island

The fishes were studied at five stations at Chisumulu Island and transects were laid at three (A–C; Figure 56).

Mkanila Bay. At site A the bottom comprises mainly rounded, medium-small rocks which descend to sand at 23 m depth, approximately 60 m from the shoreline.

Machili Islet. At site B the rocks between 0–5 m depth are medium-sized and medium large, but from 5–18 m the rocks are angular, of variable size ranging from huge boulders and pillars of rock to pebble-sized broken rock. From 18–22 m the bottom comprises small flat rocks on a sandy bottom. The slope is so gradual that the 20 m depth contour is estimated to be more than 200 m from the shoreline.

Membe Islet. The northern shore of Membe Islet (site C) comprises small rounded rocks and pebbles in the extreme shallows, but from about 3 m depth angular rocks of variable size, from pebbles to boulders, cover the bottom. Ridges of slab-like rock run east-west along the bottom and may have sandy patches between them. The line transect was laid northwards from this shore, but because of strong northerly winds when we returned to complete the transect, the deep dives were conducted on the southern shore. The rocks of this shore are also variable in size, but are more rounded and close packed.

Same Bay and Liwelo Bay. We also dived at Liwelo Bay and Same Bay (Figure 56). The diving station at Liwelo was over a littoral shelf in shallow water which is dominated by small rocks. At Same Bay the bottom is composed of beds of pebbles and small rocks on sand, but flanking these beds are slabs and boulders.

The communities

Sixty-two Mbuna taxa were found at Likoma and Chisumulu Islands (Table 29). Forty-nine occur at Likoma Island, 32 occur at Chisumulu Island and there are 19 common to both islands. Forty-seven of these Mbuna taxa were not found anywhere else in the study area, though several might occur on the nearby Mozambique coast. Twenty species have been described. Three species are believed to have been introduced to Likoma Island from Chisumulu and one species from Nkhata Bay.

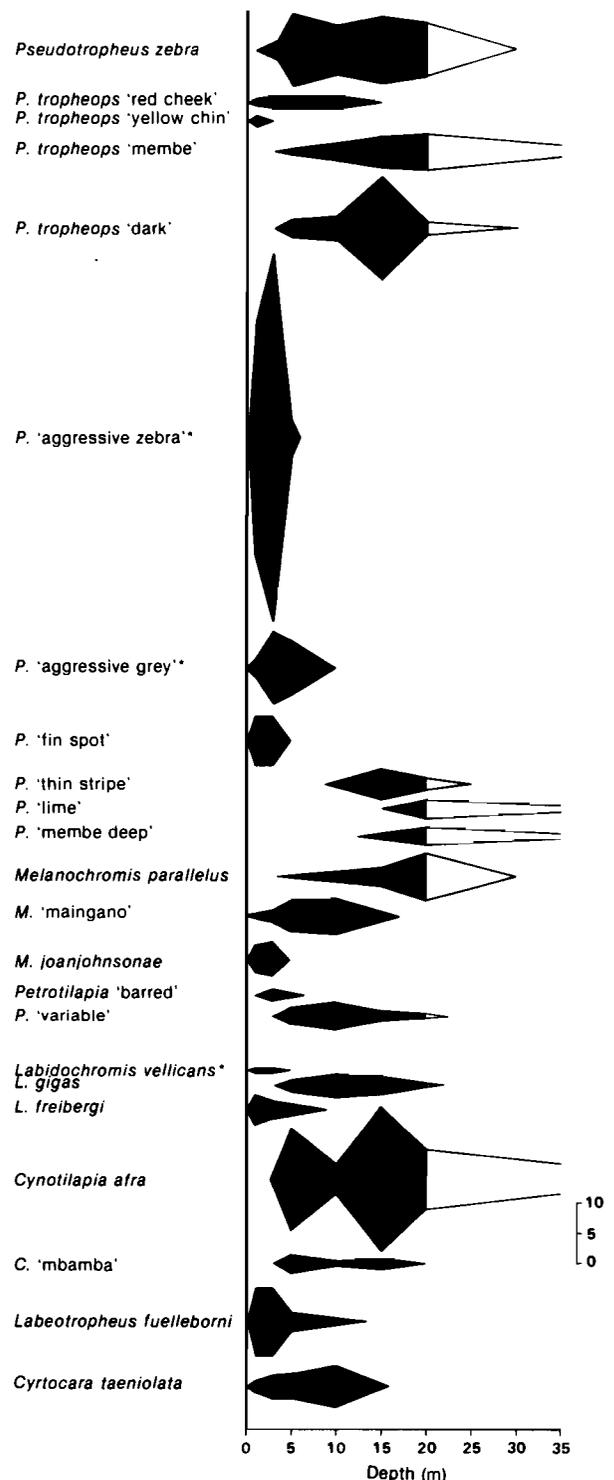


Figure 57 Transect A at Membe Point, Likoma Island, giving the depth distribution and numerical abundance of the Mbuna and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

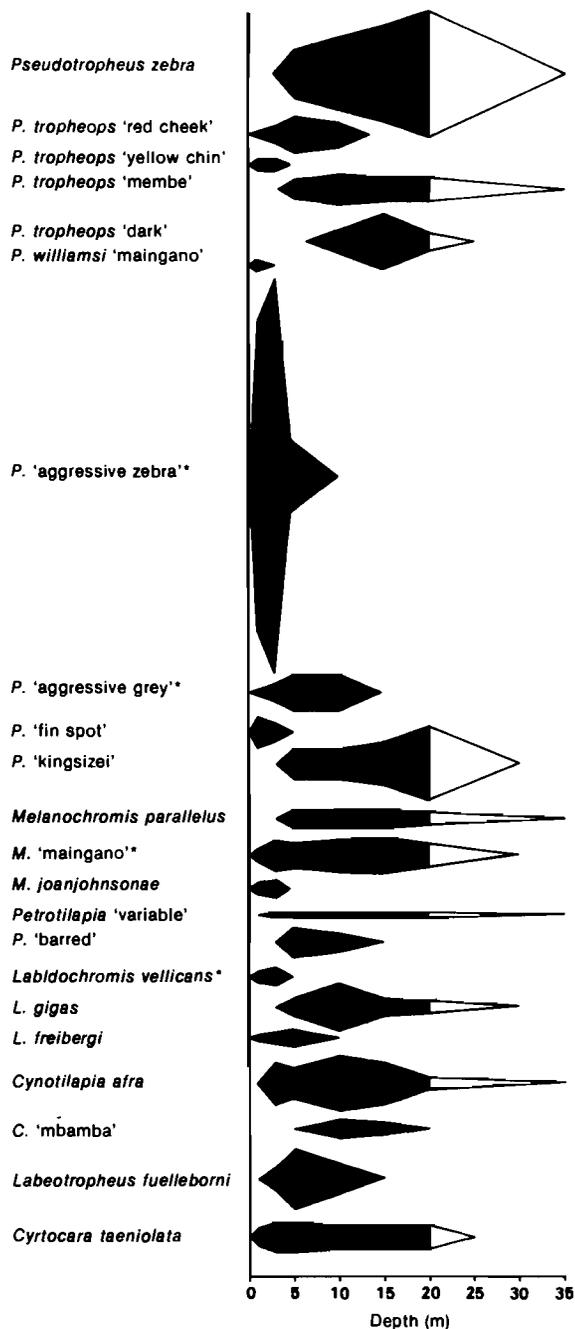


Figure 58 Transect B at Maingano, Likoma Island, giving the depth distribution and numerical abundance of the Mbuna and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

A notable feature of the Mbuna of both islands is that many are limited in their distribution to small geographic areas. Consequently, no diving station at Likoma has more than 57% (28 species) of the island's full complement and at Chisumulu Island no station has more than 80% (25 species) of its complement (Table 29). Furthermore, no two diving stations have exactly the same species assemblage (Table 29). The closer stations are to one another and the more similar their habitats, the greater the number of species they have in common. But even species common to two sites may have different abundances being rare at one station and common at a neighbouring site (Figures 57 – 65).

The transect Figures (57 – 65) give the numerical abundance and the depth distribution of the Mbuna at diving stations A – F at Likoma Island. Not all species which occur at the diving stations are included in the transects. The

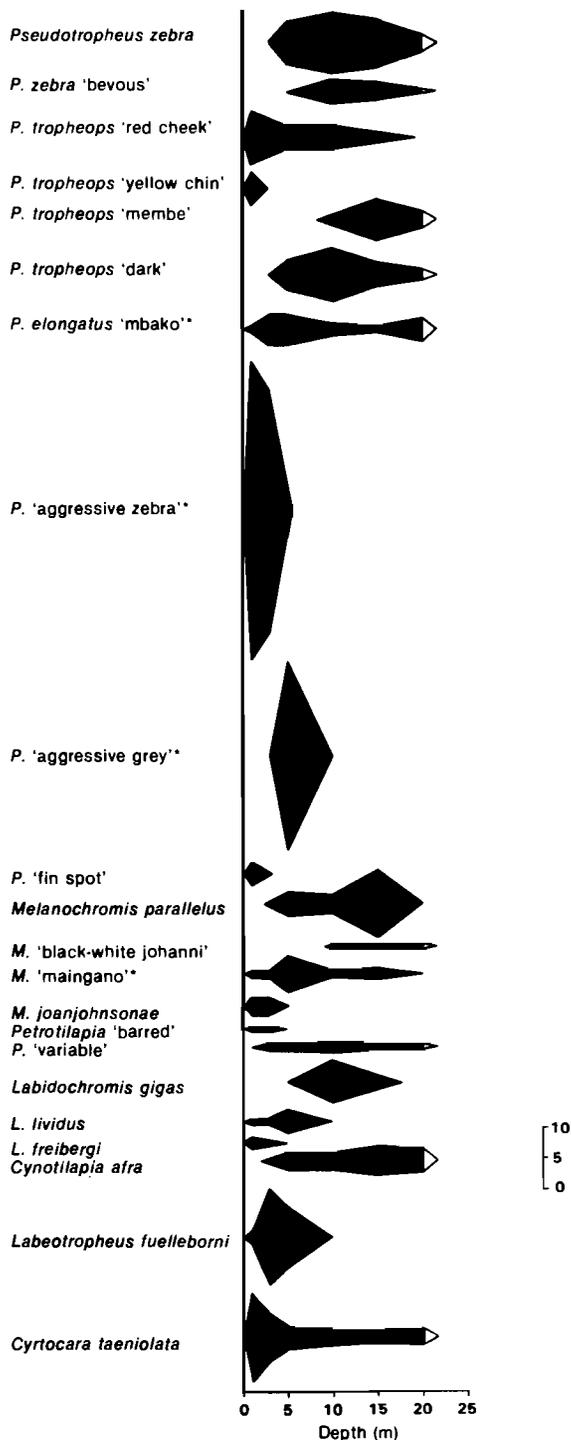


Figure 59 Transect C at Mbako Point, Likoma Island, giving the depth distribution and numerical abundance of the Mbuna and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

discrepancy is accounted for by the fact that the area studied at each diving station is larger than the area sampled by the transect and so fishes in microhabitats not traversed by the transects would have been omitted. Similarly, rare and uncommon species may not have been represented in the transect during the study period or, if they were present, they may have been too scarce to feature in the transect figures. Fishes which are generally rare or uncommon at Likoma Island, and therefore occurred in few transects are *Melanochromis melanopterus*, *M. 'blue'*, *M. labrosus*, *M. crabro*, *Cynotilapia 'ndumbi'* and *Genyochromis mento*,

Table 29 The Mbuna at the principal diving stations of Likoma and Chisumulu Islands. Present (+); absent (-); uncertain (?); introduced (i); found at Likoma and/or Chisumulu Islands only (*)

Species	Likoma Island stations													Chisumulu stations						
	Membe	Maingano	Mbako	Makulawe	Ndumbi	Ulisa	Khuyu	Ndomo	Mlonga	Ponyemba	Masimbwe I.	Mbuzi	White Rock	Madimba	Mbamba	Membe I.	Liwelo	Machili I.	Mkanila	Same
1. <i>Pseudotropheus zebra</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2. <i>P. zebra</i> 'cobalt'	-	-	-	-	-	-	-	-	-	-	-	i	i	i	-	-	-	-	-	-
3. <i>P. zebra</i> 'bevous'	*	-	+	+	-	-	-	-	-	-	-	-	+	-	-	+	-	-	+	-
4. <i>P. aurora</i>	*	-	-	-	-	+	+	+	+	+	-	+	+	-	-	-	-	-	-	-
5. <i>P. livingstonii</i> 'likoma'	*	-	-	-	-	+	+	+	+	+	-	+	+	-	-	-	-	-	-	-
6. <i>P. zebra</i> 'greberi'	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+	+
7. <i>P. tropheops</i> 'red cheek'	*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
8. <i>P. tropheops</i> 'yellow chin'	*	+	+	+	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+	+
9. <i>P. tropheops</i> 'membe'	*	+	+	+	+	-	-	+	-	-	+	+	+	+	+	-	-	-	-	-
10. <i>P. tropheops</i> 'dark'	*	+	+	+	+	-	-	+	-	-	+	+	+	+	+	-	-	-	-	-
11. <i>P. tropheops</i> 'gold'	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
12. <i>P. williamsi</i> 'maingano'	*	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13. <i>P. williamsi</i> 'khuyu'	*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
14. <i>P. williamsi</i> 'chisumulu'	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	+
15. <i>P. elongatus</i> 'mbako'	*	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16. <i>P. elongatus</i> 'ndumbi'	*	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-
17. <i>P. elongatus</i> 'ornatus'	*	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18. <i>P. elongatus</i> 'gold bar'	*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-
19. <i>P. elongatus</i> 'chisumulu'	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
20. <i>P.</i> 'aggressive zebra'	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-
21. <i>P.</i> 'aggressive grey'	*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-
22. <i>P. tursiops</i>	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
23. <i>P.</i> 'aggressive yellow fin'	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
24. <i>P.</i> 'yellow tail'	*	-	-	-	+	-	+	+	+	-	+	-	-	-	-	-	-	-	-	-
25. <i>P.</i> 'ndumbi gold'	*	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26. <i>P.</i> 'fin spot'	*	+	+	+	-	-	+	+	+	-	-	+	+	+	-	-	-	-	-	-
27. <i>P.</i> 'cobalt'	*	-	-	-	-	-	+	+	+	-	-	-	-	-	-	+	-	-	+	+
28. <i>P.</i> 'lime'	*	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29. <i>P.</i> 'membe deep'	*	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30. <i>P.</i> 'kingsize'	*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31. <i>P.</i> 'thin stripe'	*	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32. <i>P.</i> 'jacksoni'	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
33. <i>P.</i> 'newsi'	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+	+
34. <i>Melanochromis melanopterus</i>	+	+	+	+	+	-	-	-	-	-	+	-	-	-	+	+	+	+	+	+
35. <i>M. parallelus</i>	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+
36. <i>M.</i> 'maingano'	*	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37. <i>M.</i> 'black-white johanni'	*	+	-	+	-	-	+	+	+	+	+	+	+	+	+	-	-	-	-	-
38. <i>M.</i> 'blue'	+	-	+	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
39. <i>M.</i> 'red'	*	-	-	-	-	-	-	-	-	-	-	i	-	i	-	+	+	+	-	-
40. <i>M.</i> 'blotch'	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
41. <i>M. joanjohnsonae</i>	*	+	+	+	+	-	+	+	+	-	-	+	+	+	+	-	-	-	-	-
42. <i>M. labrosus</i>	+	+	+	-	-	-	+	+	-	-	-	-	-	+	-	-	-	-	-	-
43. <i>M. crabro</i>	-	-	-	-	-	-	+	+	-	+	-	+	-	-	-	-	-	+	+	+
44. <i>Petrotilapia</i> 'likoma variable'	*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-
45. <i>P.</i> 'likoma barred'	*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-
46. <i>P.</i> 'orange pelvic'	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
47. <i>P.</i> 'retrognathus'	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
48. <i>P.</i> 'yellow ventral'	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-
49. <i>Labidochromis gigas</i>	*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
50. <i>L. freibergi</i>	*	+	+	+	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
51. <i>L. lividus</i>	*	-	-	+	+	-	+	+	-	-	?	-	-	-	-	-	-	-	-	-
52. <i>L. vellicans</i>	+	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
53. <i>L. zebroides</i>	*	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
54. <i>L. strigatus</i>	*	-	-	-	-	-	-	-	-	-	-	-	i	i	-	+	+	+	+	+
55. <i>L. flavigulus</i>	*	-	-	-	-	-	-	-	-	-	-	-	i	i	-	+	+	+	+	+
56. <i>L. chisumulae</i>	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+

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Table 29 continued

Species	Likoma Island stations															Chisumulu stations					
	Membe	Maingano	Mbako	Makulawe	Ndumbi	Ulisa	Khuyu	Ndomo	Mlonga	Ponyemba	Masimbwe I.	Mbuzi	White Rock	Madimba	M b a m b a	Membe I.	Liwelo	Machili I.	Mkanila	Same	
57. <i>Cynotilapia afra</i>	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	
58. <i>C. 'mbamba'</i>	+	+	+	+	+	-	-	+	-	-	+	-	-	-	+	+	-	+	+	-	
59. <i>C. 'ndumbi'</i>	*	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
60. <i>Labeotropheus fuelleborni</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
61. <i>Genyochromis mento</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	
62. <i>Cyathochromis obliquidens</i>	-	-	-	-	-	+	+	+	-	-	-	-	+	+	-	-	-	-	-	-	
Totals	47	28	28	27	23	19	21	25	26	13	13	20	21	28	25	17	25	19	24	25	24

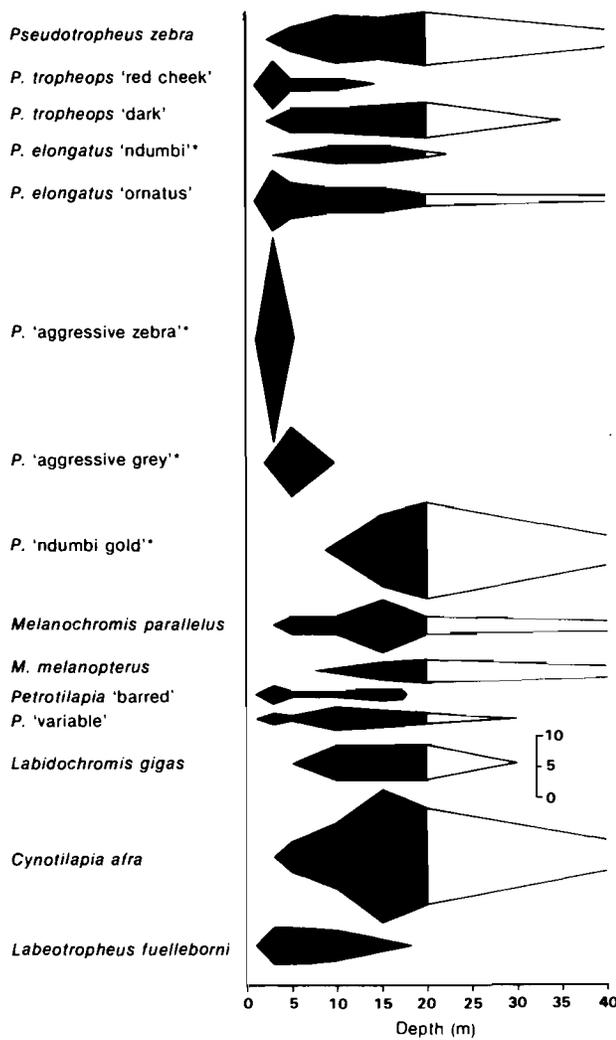


Figure 60 Transect D at Ndumbi Rocks, Likoma Island, giving the depth distribution and numerical abundance of the Mbuna and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

though *G. mento* was well represented at Masimbwe Islet (Figure 62).

Ten species found at Likoma Island did not occur in any transect. Six of these (*Pseudotropheus aurora*, *P. livingstonii* 'likoma', *P. williamsi* 'khuyu', *P. elongatus* 'gold bar', *P.*

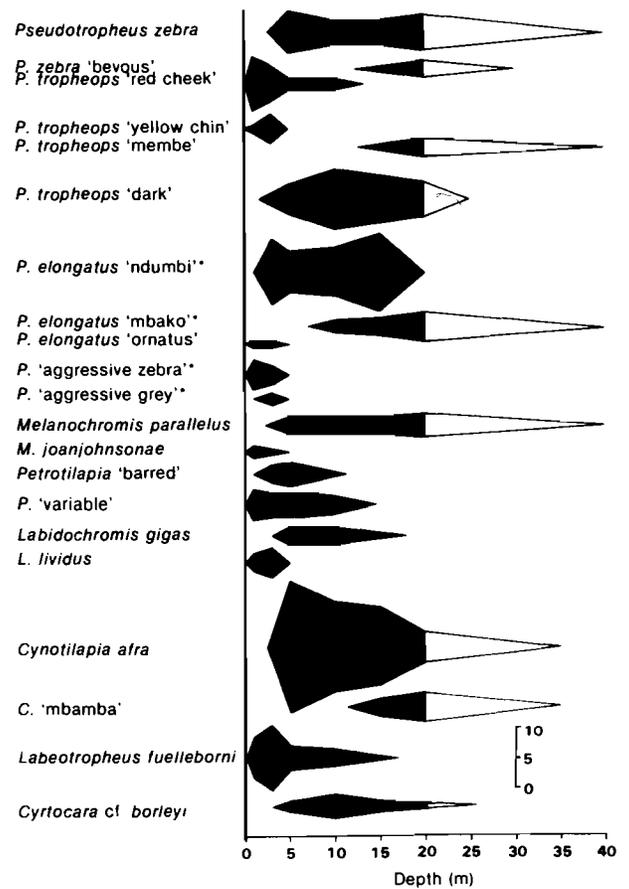


Figure 61 Transect E at Makulawe Point, Likoma Island, giving the depth distribution and numerical abundance of the Mbuna and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

'cobalt' and *Cyathochromis obliquidens*) live in shallow intermediate or in sandy habitats, principally around the southern half of the island, where transects were not laid. The four introduced species *Pseudotropheus zebra* 'cobalt', *Melanochromis* 'red', *Labidochromis strigatus* and *L. flavigulus* all live in the shallows of Madimba Bay, White Rock and Mbuzi where transects were not laid.

Figures 63 – 65 give the numerical abundance and depth distribution of the Mbuna at diving stations A – C at Chisumulu Island. The two yellow-chinned species of

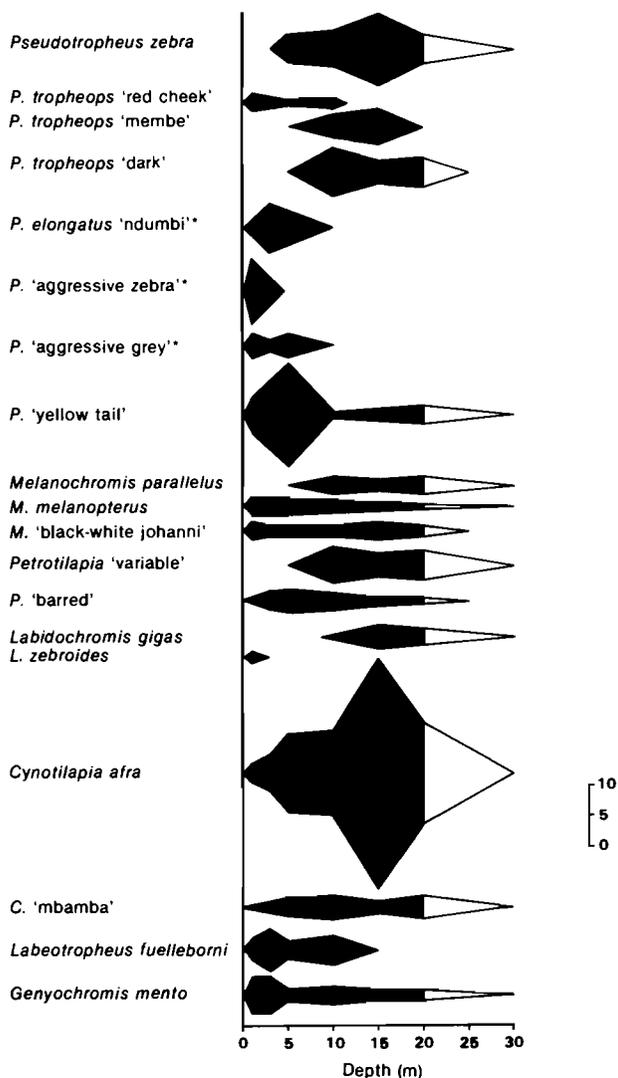


Figure 62 Transect F at Masimbwe Islet, Likoma Island, giving the depth distribution and numerical abundance of the Mbuna and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

Petrotilapia, *P. 'retrognathous'* and *P. 'yellow ventral'*, were not recognized as being distinct until after the completion of the transects and so both species are recorded together as *P. 'yc, mix'* in the figures. The shallow-water species is *P. 'retrognathous'* which normally does not venture beyond 10 m depth, and the deeper water species is *P. 'yellow ventral'* which has a depth range extending to at least 33 m. The bidomal distribution of *P. 'yc, mix'* suggests that the two species do not overlap much in their depth distribution.

Pseudotropheus elongatus 'gold bar' and *P. 'jacksoni'* do not feature in any transect as they live in Liwelo Bay and Same Bay, respectively, where transects were not laid. The rarity of *P. 'aggressive yellow fin'* at Machili Islet, site B, and its consequent absence from the transect is probably due to the presence of medium-sized and medium-large rocks in the shallows. Rocks of this size appear unsuitable to this species which normally lives among small rocks. In contrast, territorial and particularly non-territorial adult and juvenile *P. tropheops 'red cheek'*, *P. tropheops 'yellow chin'* and *Labeotropheus fuelleborni* are more numerous at this site than at any other station.

In general, the greatest species richness was found at

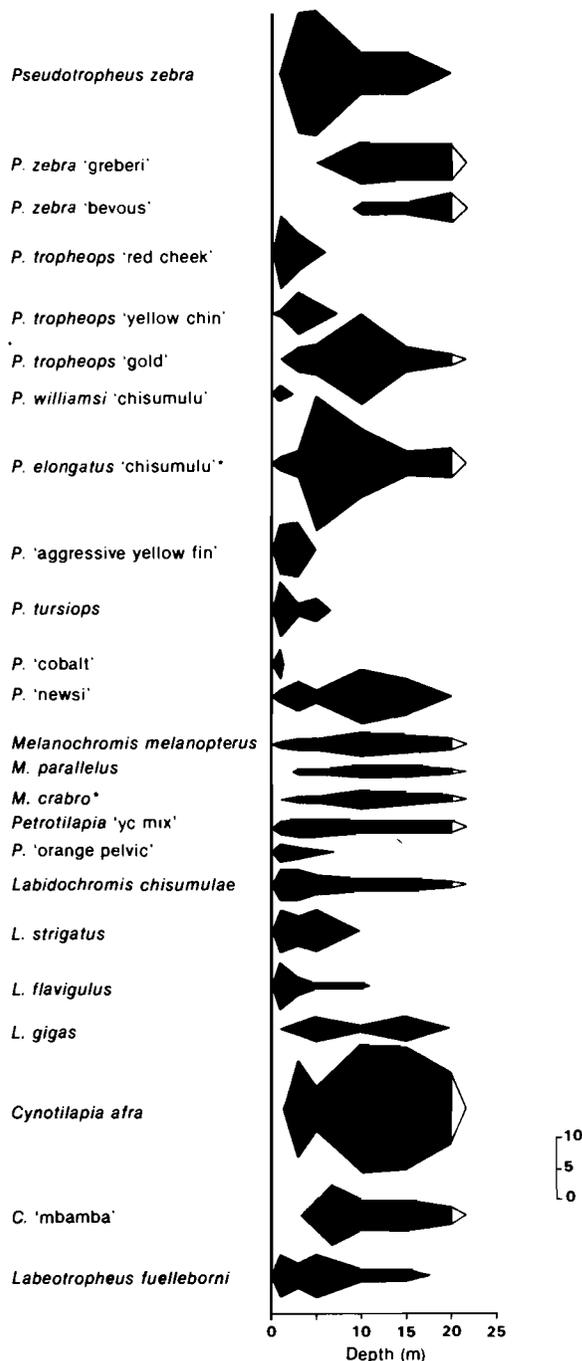


Figure 63 Transect A at Mkanila Bay, Chisumulu Island, giving the depth distribution and numerical abundance of the Mbuna and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

3 – 10 m and the greatest number of individual cichlids occurred in the shallows at both Likoma and Chisumulu Islands (Table 30–31). *Labeotropheus fuelleborni* and *Pseudotropheus tropheops* species-complex subadults feed in large numbers in the extreme shallows and this accounts, in part, for the high numerical abundance of cichlids at these depths at all transect stations. The only exception is the submerged reef, Ndumbi Rocks (site D) Likoma Island. The reasons for the relatively low numbers of fishes in the shallows of the reef are that (i) the apex at which the transect was laid was submerged to a depth of 1–2 m and (ii) it consists of medium-large rocks with few refuge sites. From 5–15 m depth schools of non-territorial *Cynotilapia afra* and *Pseudotropheus zebra* contributed to the high numbers

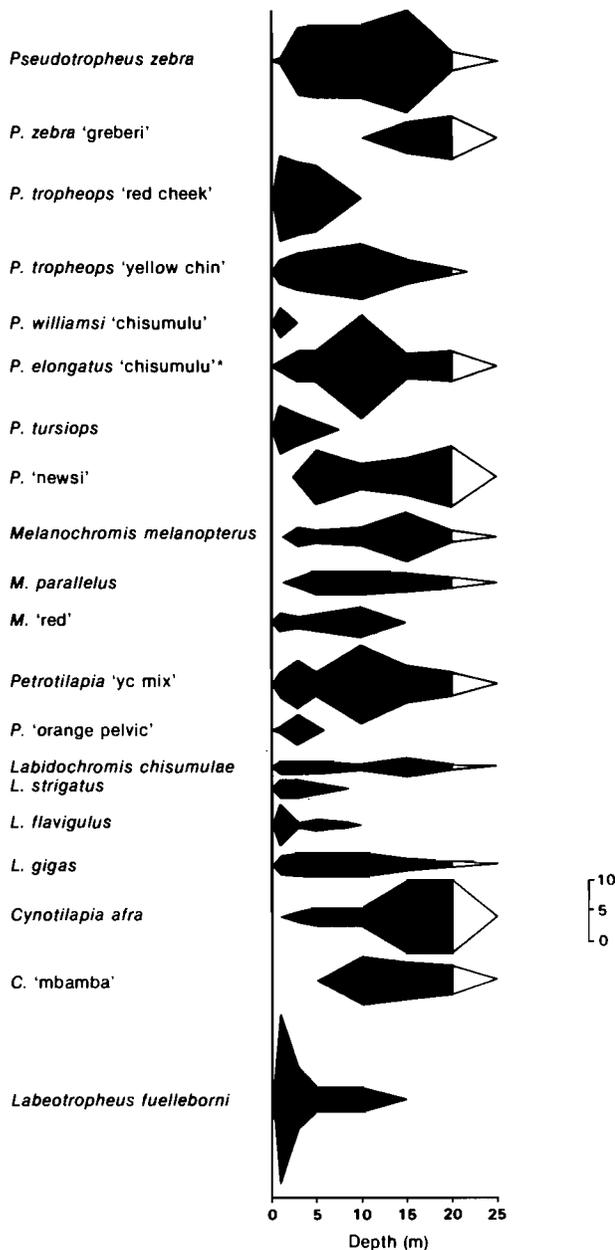


Figure 64 Transect B at Machili Islet, Chisumulu Island, giving the depth distribution and numerical abundance of the Mbuna and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m^{-2} .

of cichlids within the transect.

Figures 66 and 67 summarize the preferences for particular depth zones and microhabitats of Mbuna of Likoma and Chisumulu, giving a general indication of how these resources are partitioned. It should be noted that several species with apparently identical requirements occur allopatrically (Table 29).

Within the littoral rocky environments of Likoma Island the areas of large rocks are dominated numerically by the *Petrotilapia* spp. and by territorial and particularly non-territorial *Labeotropheus fuelleborni*, *Pseudotropheus tropheops* 'red cheek' and *P. tropheops* 'dark'. At Ndumbi Rocks schools of *P. elongatus* 'ornatus' are common over large rocks and boulders. Territorial *P. elongatus* 'ndumbi' are also common in these areas at Ndumbi Rocks and Makulawe Point. At Chisumulu Island areas of large rocks are dominated by *Petrotilapia* spp., *Labeotropheus*

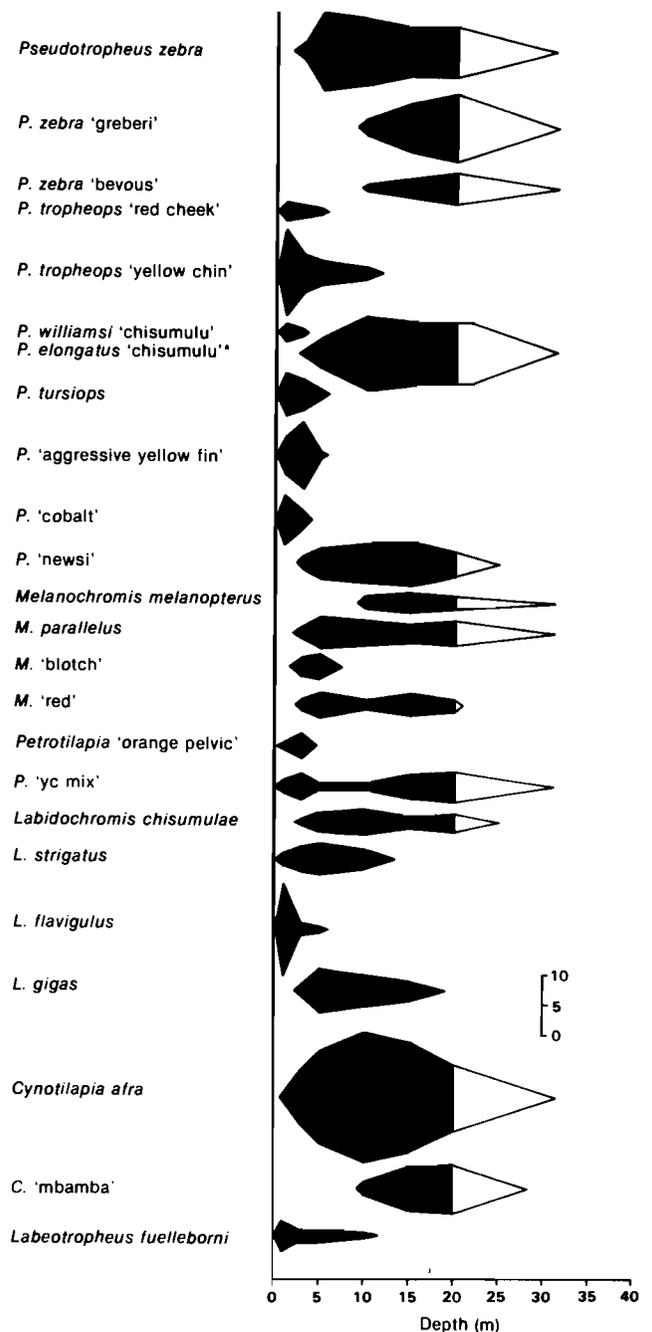


Figure 65 Transect C at Membe Islet, Chisumulu Island, giving the depth distribution and numerical abundance of the Mbuna and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m^{-2} .

fuelleborni and members of the *Pseudotropheus tropheops* species-complex. Upper surfaces of slabs and boulders are frequented by schools of *Melanochromis* 'red', while *Pseudotropheus elongatus* 'chisumulu' is common on vertical rock faces.

At both islands, *Cynotilapia afra* and *Pseudotropheus zebra* are the most numerous fishes in habitats of medium-sized and small rocks. However, in the shallows of Likoma Island these habitats, particularly those where small rocks predominate, are inhabited by many *Pseudotropheus* 'aggressive zebra' and *P. 'aggressive grey'* (Figures 57–62). These species are absent from Chisumulu Island where *P. 'aggressive yellow fin'* and *P. tursiops* occupy similar ecological niches. All species of *Labidochromis* are com-

Table 30 The number of Mbuna species and the number of individual cichlids of all species counted at different depths in transects A – F at Likoma Island. A = Membe Point, B = Maingano, C = Mbako Point, D = Ndumbi Rocks, E = Makulawe Point, F = Masimbwe. Dashes indicate that individual fishes were not counted below 20 m depth

	Depth (m)									
	1	3	5	10	15	20	25	30	35	40
Transect A										
No. Mbuna species	14	18	22	15	13	11	9	8	4	
No. individuals all cichlids	430	382	305	290	285	170	–	–	–	
No. individuals m ⁻²	8,6	7,6	6,1	5,8	5,7	3,4	–	–	–	
Transect B										
No. Mbuna species	15	19	19	18	16	11	10	9	6	
No. individuals all cichlids	256	239	241	332	293	180	–	–	–	
No. individuals m ⁻²	5,1	4,8	4,8	6,6	5,9	3,6	–	–	–	
Transect C										
No. Mbuna species	13	17	17	14	13	10				
No. individuals all cichlids	310	280	250	240	210	155				
No. individuals m ⁻²	6,2	5,6	5,0	4,8	4,2	3,1				
Transect D										
No. Mbuna species	8	12	15	14	13	13	10	8	7	7
No. individuals all cichlids	215	320	290	295	280	275	–	–	–	–
No. individuals m ⁻²	4,3	6,4	5,8	5,9	5,6	5,5	–	–	–	–
Transect E										
No. Mbuna species	12	17	16	13	13	11	10	9	7	
No. individuals all cichlids	442	263	324	231	173	233	–	–	–	
No. individuals m ⁻²	8,8	5,3	6,5	4,6	3,5	4,7	–	–	–	
Transect F										
No. Mbuna species	13	15	16	15	14	13	10	9		
No. individuals all cichlids	440	400	370	252	234	155	–	–		
No. individuals m ⁻²	8,8	8,0	7,4	5,0	4,7	3,1	–	–		

Table 31 The number of Mbuna species and the number of individual cichlids of all species counted at different depths in transects A – C at Chisumulu Island. A = Mkanila Bay, B = Machili Islet, C = Membe Islet. Dashes indicate that individual fishes were not counted below 20 m depth

	Depth (m)							
	1	3	5	10	15	20	25	30
Transect A								
No. Mbuna species	18	19	21	18	16	13	–	–
No. individuals all cichlids	305	270	260	183	192	174		
No. individuals m ⁻²	6,1	5,4	5,2	3,7	3,8	3,5		
Transect B								
No. Mbuna species	17	19	17	16	14	13	12	
No. individuals all cichlids	285	345	280	290	150	200	–	
No. individuals m ⁻²	5,7	6,9	5,6	5,8	3,0	4,0	–	
Transect C								
No. Mbuna species	14	21	18	17	14	13	11	9
No. individuals all cichlids	430	325	315	315	140	210	–	–
No. individuals m ⁻²	8,6	6,5	6,3	6,3	2,8	4,2	–	–

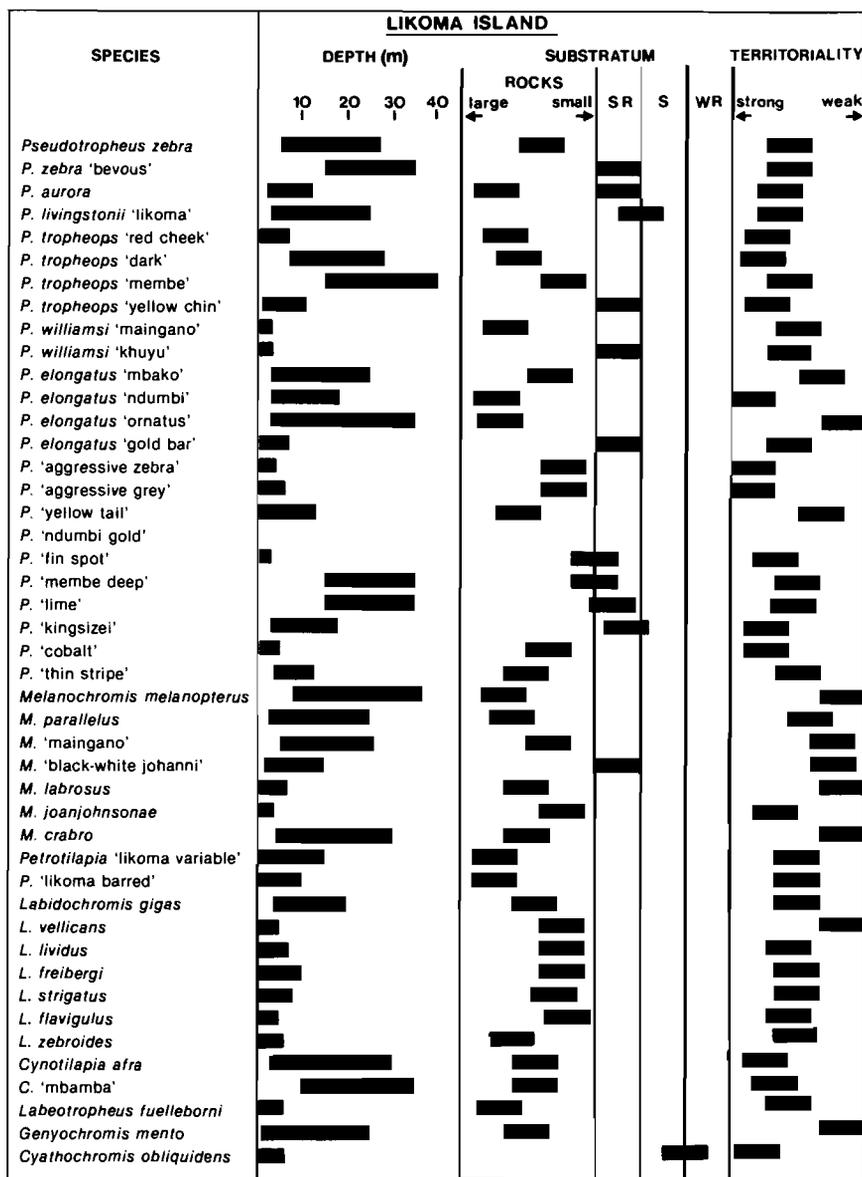


Figure 66 A summary of resource utilization of the Mbuna community at Likoma Island. For rest of legend see Figure 28 (p.254).

mon among small-medium and medium-sized rocks at both islands, and at Likoma Island *Melanochromis joanjohnsonae* is a common inhabitant of these zones in the shallow water.

There are 14 species which inhabit the intermediate zones at Likoma, though only *Pseudotropheus livingstonii* 'likoma' is common over sand (Figure 66). At Chisumulu there are five species which frequent the intermediate zones (Figure 67), but none of these ventures far from rocks. The *Melanochromis* species of these two islands are weakly territorial, the only exception is *M. joanjohnsonae* which is comparatively aggressive (Figure 66).

A behavioural characteristic of *Labidochromis* species occurring elsewhere in the lake is that they are not territorial; but of the eight species found at Likoma and Chisumulu all but *L. chisumulae* and *L. vellicans* are territorial (Figures 66 & 67). An intriguing, but unanswered question is whether the territoriality of *Labidochromis* species found at these islands is related to the fact that there are so many members of the genus at these islands.

In addition to Mbuna, a great variety of other fishes occur at Likoma and Chisumulu. Many species (e.g. Utaka species) are numerically abundant and are harvested for

food to support local fisheries (Iles 1960; Fryer & Iles 1972). Several of these fishes are also of value to the ornamental fish trade, including Utaka species such as *Cyrtocara chrysonota* and a bottom-dwelling species which builds sand-scrape nests at the sand-rock interface from 8–35 m depth. This species is sold as *Cyrtocara mloto*, but is black with contrasting light markings and does not resemble the species described as *C. mloto* by Iles (1960).

Also exploited for export to aquarists are *Aristochromis christyi*, *Cyrtocara euchila* (which is more common at Liwelo Bay, Chisumulu, than at any other site visited in Lake Malawi), *C. rostrata*, *C. moori*, *C. linni*, *C. polystigma*, *C. livingstonii*, *C. annectens* and a fish tentatively identified as *Lethrinops macrophthalmus* which builds turret nests on most of the beaches around Likoma Island. A popular aquarium fish, *Cyrtocara electra* Burgess, 1979 occurs along the rock-sand interface from 5 to at least 35 m depth. Both *Aulonocara* 'yellow collar' and *A. 'blue collar'*, of the sand-rock interface, are caught for export.

Area 10: The north-western shores

The first comprehensive study of Mbuna ecology was conducted by Fryer (1959a) at Nkhata Bay on the western shores

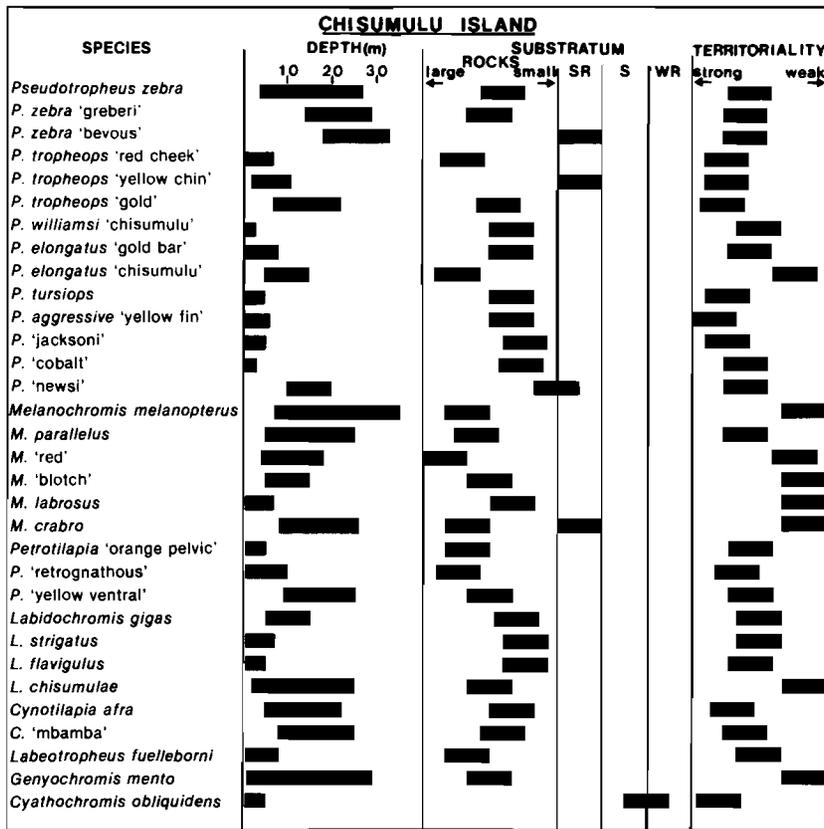


Figure 67 A summary of resource utilization of the Mbuna community at Chisumulu Island. For rest of legend see Figure 28 (p.254).

of Lake Malawi. This work was followed by an eco-behavioural programme which concentrated on the *Pseudotropheus zebra* species-complex of the same region (Holzberg 1978). Both of these studies provided an invaluable foundation for our survey of the north-western shores which extended northwards from Chirombo Point to include stations at Nkhata Bay, Lion's Cove, Mara Rocks, Dankanya Bay, Mpandi Point, Ruarwe and Chilumba (Figure 68).

The shores of this region are a little more than 150 km in length and are predominantly rocky though sandy beaches occur in most bays. A major division of the rocky shores occurs at Dankanya Bay and at Usisya Bay where long beaches (7 and 14,8 km respectively) occur on both sides of Mpandi Point (Figure 68). Sandy shores dominate the mainland coast of Chirombo Point to the Nankumba Peninsula, but a rocky zone occurs at Bandawe Point and at Bandakusha Island.

The diving stations

The fishes were studied at nine stations between Chirombo Point and the sandy beach at Dankanya Bay (area 10a, Figure 4), at Mpandi Point, Mara Rocks and the northernmost point in Usisya Bay (area 10b, Figure 4) and at Ruarwe and Chilumba (area 10c, Figure 4). In addition, a brief visit was made to Bandawe Point, south of Chirombo Point.

Bandawe Point. Bandakusha Island off Bandawe Point is a rocky outcrop in 6–8 m depth. A single 2-h visit was made to Bandawe Point and Bandakusha Island. The species found there are recorded in Table 32. A fish very like *Petrotilapia genalutea* occurs there but its coloration is not identical and the affinities are obscure at present. The uncertainty regarding the identification of this species is in-

dicated in Table 32.

Chirombo Point to Nkhata Bay. The rocky shores between Chirombo Point and Nkhata Bay are dominated by large, steeply shelving rocks. Only one small sandy bay (about 100 m wide) breaks this rocky shore.

Nkhata Bay. At Nkhata Bay (Figure 68) two transects were conducted: (A) at the point of the peninsula which divides Nkhata Bay and (B) on the southern shore of the same peninsula (Figure 68). The rocky shore of this peninsula was described in detail by Fryer (1959a) and also by Holzberg (1978). It comprises small and medium-sized rocks on the littoral shelf, with large rocks, boulders and slabs dominating the steeply shelving region at the edge of the shelf where the rocky shore plunges steeply into deep water. At the point of the peninsula (site A) the littoral shelf extends about 110 m from the shore, where it reaches a depth of 8–10 m, and then descends rapidly to a depth in excess of 40 m. Several sandy patches occur among the rocks of the littoral shelf. On the southern shore, at site B, the littoral shelf reaches a depth of 6–9 m about 50 m from the shoreline. The bottom then descends steeply to the sandy plain at 30 m.

Lion's Cove. This is a small bay about 20 km north of Nkhata Bay (Figure 68). It has a sandy beach, flanked by rocky shores that shelf very steeply into deep water. The majority of rocks at Lion's Cove are medium-sized.

Dankanya Bay and Usisya Bay. The five stations visited in this area are:

- (i) Cape Manulo, where medium-sized and large rocks descend rapidly to 30 m.
- (ii) The southern shore of Dankanya Bay, where a gradual-

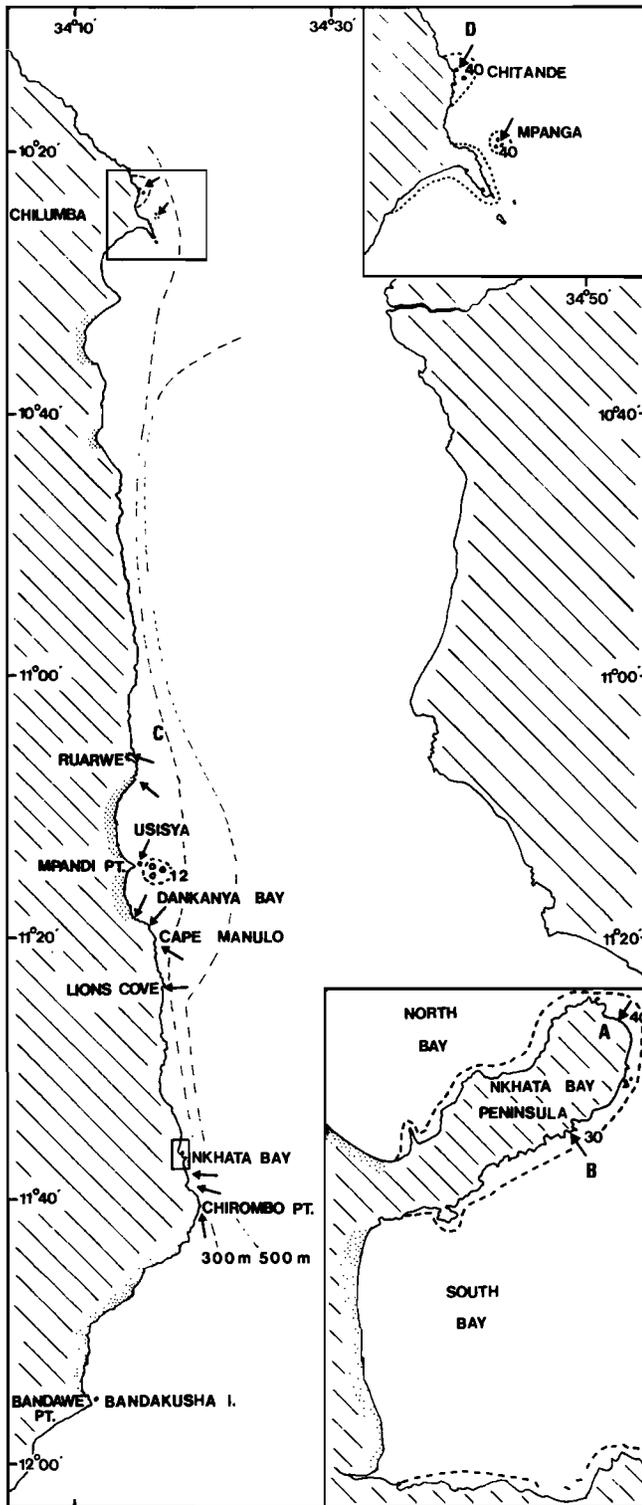


Figure 68 The diving stations along the north-western coast of Lake Malawi are indicated by arrows. Insets show the positions of transect stations A and B on the Nkhata Bay Peninsula, and transect D at Chitande. The position of the Ruarwe transect is indicated by the letter C. The dotted lines within the insets indicate the extent of the rocky shores and the numerals within these lines give the depth at which rocks meet the sandy bottom. The shores shelf steeply, as indicated by the inshore positions of the 300 m and 500 m depth contours. Sandy beaches are stippled.

ly shelving shore of medium-sized and small rocks meets the sandy plain at 7 m.

- (iii) Mpandi Point, a small rocky outcrop on the end of a sandy peninsula between the two bays. It comprises large rocks in 3–5 m of water.
- (iv) Usisya Bay which is mainly sandy, but fishes were

studied at the site on its northern shore where small rocks predominated though scattered groups of medium-sized and large rocks rose above the general level of the bottom.

- (v) Mara Rocks, a group of rocks off Usisya which rise from the bottom at 15–25 m of water. These rocks are mainly medium-sized and large, and subject to wave action; at the time we dived a strong southerly current was prevalent.

Ruarwe. A transect was laid at Ruarwe on the northern arm of the bay where medium-sized rocks shelf gradually to 12 m depth and then more steeply to at least 40 m. From 30 to 40 m depth sand patches appeared among the rocks.

Chilumba. Two sites were studied at Chilumba; Mpanga Rocks and Chitande Point (Figure 68). Mpanga Rocks form part of a rocky reef that runs out from the mainland and comprises huge boulders and large rocks. Isolated patches of small and medium-sized rocks were found between the boulders and at one site a little sand had gathered in a rocky valley. At the diving station the rocks descended to at least 40 m. A transect was laid on the north-easterly shore of Chitande Point where medium-sized rocks descended gradually to 11 m and then more steeply to 40 m. At the time of the survey (Oct. 1980) Chitande Point was cut off from the mainland by a 10 m stretch of water which was no more than 1,5 m deep.

The communities

There are at least 54 Mbuna species along the rocky shores of the north-western regions (Table 32). The species assemblage at each diving station is unique and the differences between the assemblages become progressively greater as the distance between stations increases. Thirty-seven species of Mbuna occur along the southern rocky shore from Chirombo Point to Dankanya Bay, 17 occur in the central region, including Mara Rocks and Mpandi Point and 35 were found in the northern region from Usisya to Chitande. The northern and southern regions have 19 species in common, but there are 30 species which do not occur in both regions; 16 of these occur in the southern region only and 14 are confined to the northern region. Of the 17 species found in the central region one is endemic, two are shared with the northern region and 14 occur in both the northern and southern regions. These differences in the species assemblages along this coast may be attributed to the sedentary nature of Mbuna (see p.301), the considerable distance between stations and, as most Mbuna have a reluctance to cross sandy areas (Fryer 1959a), it is likely that the various beaches, particularly those at Dankanya Bay and Usisya Bay, constitute major physical barriers to the distribution of at least some species.

Forty of the species occurring along the north-western shores were found nowhere else in the lake and several species are apparently restricted in their distribution to small parts of the coast. The number of previously described species in the area is 20 (Table 32).

This study area has more members of the *Pseudotropheus zebra* species-complex, the *P. tropheops* species-complex, the *P. elongatus* species-group, and more species in the genera *Petrotilapia* and *Cynotilapia* than any other area. In contrast, the *Pseudotropheus* 'aggressive' species-group and the *P.* 'miscellaneous' species-group are poorly represented, each having only three members (Table 32).

Table 32 The Mbuna at the principal diving stations of the north-western shores of Lake Malawi. Present (+); absent (-); uncertain (?); present but identification uncertain (+ ?); found at sites along the north-western shores only (*)

Species	Diving stations of north-western shores										
	Southern				Central		Northern				
	Bandawe	Nkhata Bay	Lion's Cove	Dankanya Bay	Mara Rocks	Mpandi Point	Usisya	Ruarwe	Mpanga Rocks	Chitande	
1. <i>Pseudotropheus zebra</i>	-	+	+	+	-	-	-	-	-	-	
2. <i>P. zebra</i> 'cobalt'	*	-	+	+	+	-	-	-	-	-	
3. <i>P. zebra</i> 'gold'	*	-	+	+	+	-	-	+	-	-	
4. <i>P. zebra</i> 'ruarwe'	*	-	-	-	-	-	-	+	-	-	
5. <i>P. zebra</i> 'chilumba'	*	-	-	-	-	+	+	+	+	+	
6. <i>P. zebra</i> 'mpanga'	*	-	-	-	-	-	-	+	-	-	
7. <i>P. zebra</i> 'pearly'	*	-	-	-	-	-	-	+	+	-	
8. <i>P. zebra</i> 'ianth'	*	-	-	-	-	-	-	-	+	-	
9. <i>P. zebra</i> 'chitande'	*	-	-	-	-	-	-	-	-	+	
10. <i>P. tropheops</i> 'mauve'	*	+	+	+	+	+	+	+	+	+	
11. <i>P. tropheops</i> 'olive'	*	-	+	+	+	+	+	+	+	+	
12. <i>P. tropheops</i> 'black'	*	+	+	+	+	+	+	+	+	+	
13. <i>P. tropheops</i> 'rust'	*	+ ?	+	+	-	-	-	-	-	-	
14. <i>P. tropheops</i> 'deep'	*	-	+	-	-	-	-	-	-	-	
15. <i>P. tropheops</i> 'band'	*	-	+	-	-	-	-	-	-	-	
16. <i>P. tropheops</i> 'no band'	*	-	+	-	-	-	-	-	-	-	
17. <i>P. tropheops</i> 'red fin'	*	-	-	-	-	?	-	-	+	+	
18. <i>P. tropheops</i> 'weed'	*	-	-	+	+	-	+	-	?	-	
19. <i>P. tropheops</i> 'chitande yellow'	*	-	-	-	-	-	-	-	-	+	
20. <i>P. williamsi</i> 'nkudzi'	*	-	+ ?	-	-	-	-	-	-	-	
21. <i>P. elongatus</i>	*	+ ?	+	-	-	-	-	-	-	-	
22. <i>P. elongatus</i> 'nkhata brown'	*	-	+	-	-	-	-	-	-	-	
23. <i>P. elongatus</i> 'mara'	*	-	-	-	-	+	-	-	-	-	
24. <i>P. elongatus</i> 'ruarwe'	*	-	-	-	-	-	-	+	-	-	
25. <i>P. elongatus</i> 'bee'	*	-	-	-	-	+	-	-	-	+	
26. <i>P. elongatus</i> 'mpanga'	*	-	-	-	-	-	-	-	+	-	
27. <i>P. fuscus</i>	*	+	+	+	-	-	-	-	-	-	
28. <i>P. fuscoides</i>	*	-	+	+	-	-	-	-	-	-	
29. <i>P. cf. M. perspicex</i>	*	-	-	-	-	-	-	+	-	+	
30. <i>P. lucerna</i>	*	+	+	+	-	-	+	+	-	-	
31. <i>P. minutus</i>	*	-	+	+	-	-	-	+	-	+	
32. <i>P. 'polit'</i>	*	-	-	+	-	-	-	-	-	-	
33. <i>Melanochromis melanopterus</i>	*	-	+	+	-	+	-	-	+	+	
34. <i>M. parallelus</i>	*	-	+	+	+	+	-	-	+	+	
35. <i>M. 'blue'</i>	*	-	+	-	-	-	-	+	+	+	
36. <i>M. crabro</i>	*	-	+	-	-	-	-	-	-	-	
37. <i>Petrotilapia tridentiger</i>	*	-	+	+	+	+	+	+	+	+	
38. <i>P. genalutea</i>	*	+ ?	+	+	+	-	+	+	-	-	
39. <i>P. 'small blue'</i>	*	-	+	+	+	-	-	-	-	-	
40. <i>P. 'ruarwe'</i>	*	-	-	-	-	-	-	+	-	+	
41. <i>P. 'chitande'</i>	*	-	-	-	-	-	-	+	+	+	
42. <i>P. 'black flank'</i>	*	-	-	-	-	-	-	-	+	-	
43. <i>Labidochromis maculicauda</i>	*	-	+	+	+	+	+	+	+	+	
44. <i>L. caeruleus</i>	*	-	+	+	-	-	-	+	?	?	
45. <i>Cynotilapia afra</i>	*	-	+	+	+	+	+	+	+	+	
46. <i>C. axelrodi</i>	*	-	+	+	-	-	-	-	-	-	
47. <i>C. 'mbamba'</i>	*	-	+	+	+	-	-	+	+	+	
48. <i>C. 'lion'</i>	*	-	-	+	-	-	-	-	-	-	
49. <i>C. 'mpanga'</i>	*	-	-	-	-	-	-	-	+	-	
50. <i>Labeotropheus fuelleborni</i>	*	+	+	+	+	+	+	+	+	+	
51. <i>L. trewavasae</i>	*	-	+	+	+	+	+	+	+	+	
52. <i>Gephyrochromis lawsi</i>	*	-	+	+	-	-	-	-	-	-	
53. <i>Genyochromis mento</i>	*	+	+	+	+	+	+	+	+	+	
54. <i>Cyathochromis obliquidens</i>	*	-	+	+	-	-	+	?	-	+	
Totals	40	9	34	29	17	14	13	12	26	22	24

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Similarly, the genus *Melanochromis* is poorly represented, having only four species of which three are uncommon or rare.

Figures 69 – 72 give the numerical abundance and depth distribution of the more common Mbuna at the two diving stations at Nkhata Bay and at the stations at Ruarwe and Chitande. Twenty-seven of the 34 Mbuna of Nkhata Bay were recorded in the transects (Figures 69 – 70). Four of those not recorded (*Pseudotropheus williamsi* 'nkudzi', *Melanochromis* 'blue', *Melanochromis crabro* and *Gephyrochromis lawsi*) are rare or uncommon. *Cyathochromis obliquidens* did not occur in either transect as it inhabits intermediate, weeded areas. *Genyochromis mento* which occurs sparsely over all rocky areas is also not included.

At the time the transects were laid we did not recognize the differences between *Pseudotropheus tropheops* 'band' and *P. tropheops* 'no band' and so these two fishes are recorded together as *P. tropheops* 'band' (Figures 69 & 70).

At Ruarwe, *Pseudotropheus lucerna*, *Melanochromis melanopterus*, *Petrotilapia genalutea*, *Labidochromis*

caeruleus, *Cynotilapia axelrodi* and *Genyochromis mento* were too sparsely distributed to be recorded in the transect.

Eighteen of the 23 species occurring at Chitande were recorded in the transect; those not recorded are the inhabitants of the intermediate zone (*Pseudotropheus tropheops* 'weed', *P. elongatus* 'bee', *P. cf. Melanochromis perspicax*, *Cyathochromis obliquidens*) and *Genyochromis mento*.

At all sites members of the genus *Cynotilapia*, particularly *C. afra*, and of the *Pseudotropheus zebra* species-complex dominate the rocky shores numerically (Figures 69 – 72). These habitats also teem with numerous individuals, especially non-territorial individuals, of a variety of species of the *Pseudotropheus tropheops* species-complex. Furthermore, the *Petrotilapia* spp. and the *Labeotropheus* spp. are well represented among medium-large and large rocks. The areas of small rock at Nkhata Bay are dominated by *Pseudotropheus fuscus*, *P. fuscooides* and *P. minutus*. Similar habitats at Ruarwe and Chilumba are dominated

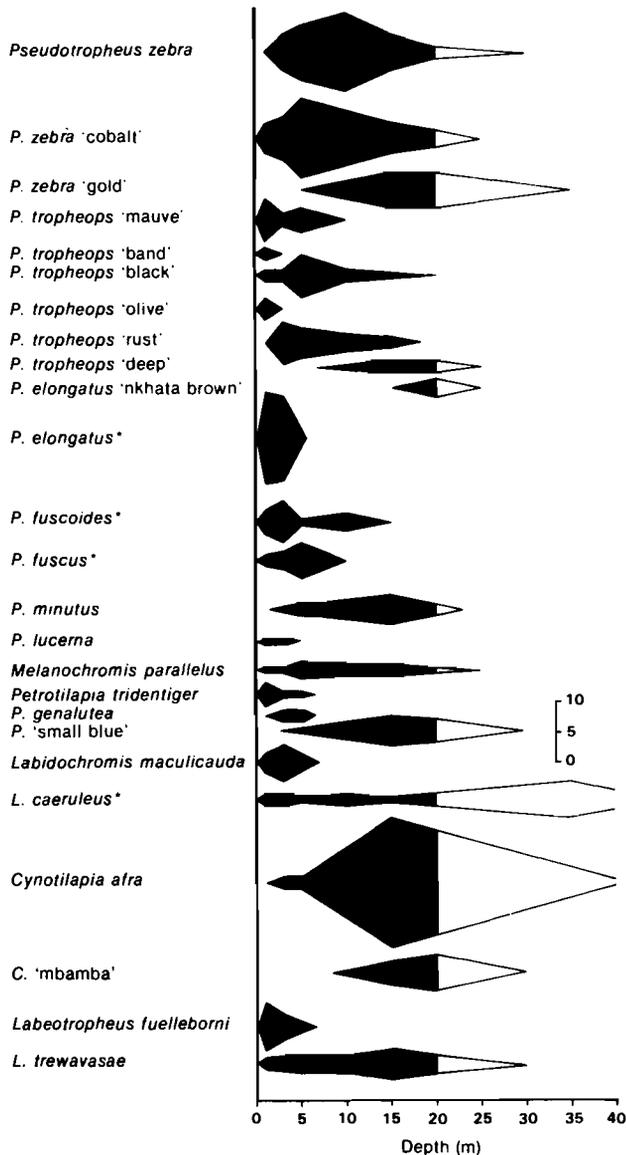


Figure 69 Transect A, Nkhata Bay, giving the depth distribution and numerical abundance of the Mbuna species. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

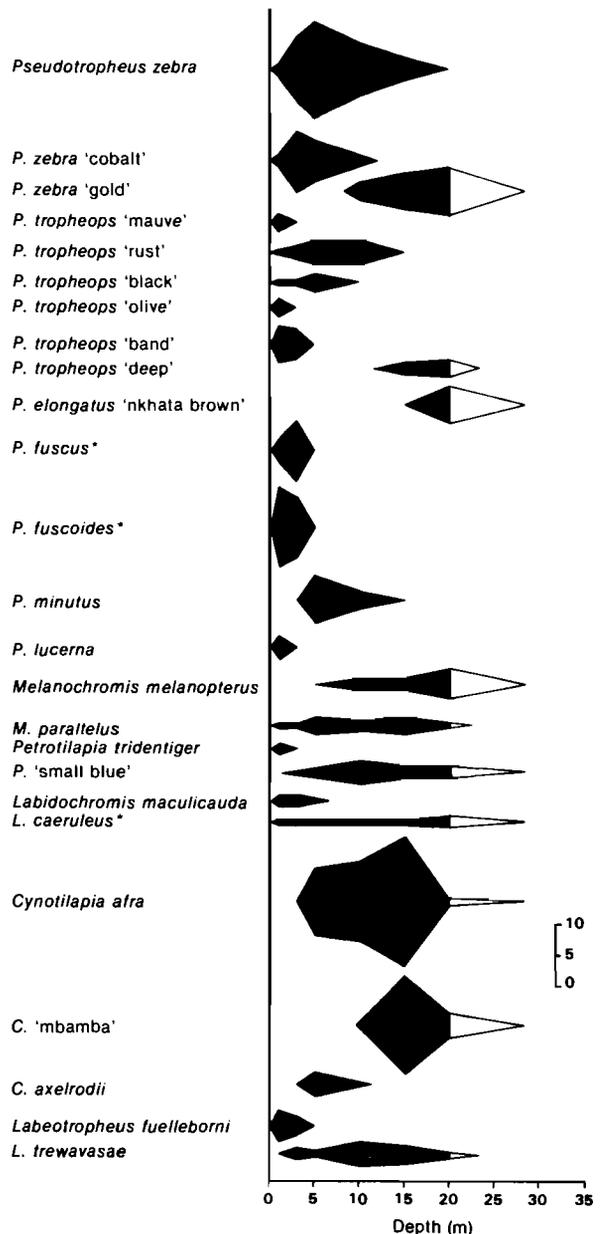


Figure 70 Transect B, Nkhata Bay, giving the depth distribution and numerical abundance of the Mbuna species. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

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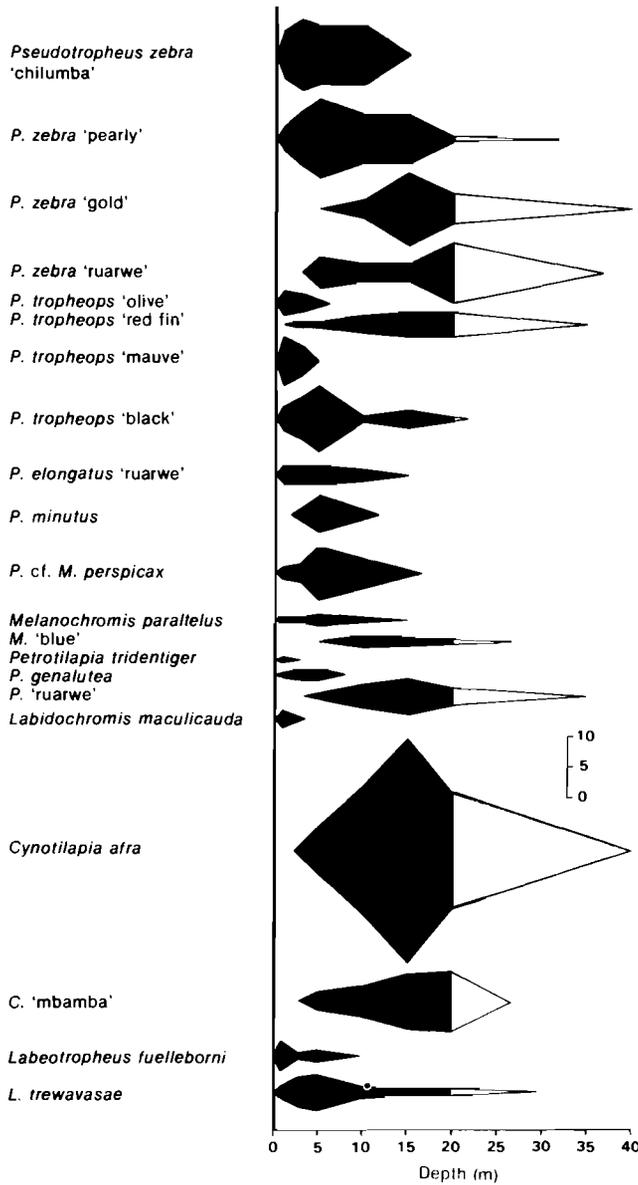


Figure 71 Transect C at Ruarwe, giving the depth distribution and numerical abundance of the Mbuna species. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

by *P. minutus* and *P. cf. Melanochromis perspicax*.

At all sites most Mbuna species occupy the shallows (Table 33). In almost all other areas studied the greatest number of individuals occur at 3–10 m, but on the north-western shores the number of individual cichlids is greatest at 8–15 m. The greater number of Mbuna individuals in deeper water is due to the large number of non-territorial individuals of the genus *Cynotilapia* and of the *Pseudotropheus zebra* species-complex which inhabit these depths.

Figures 73–75 show that there are 14 Mbuna which live mainly in the intermediate habitats of this study area. Only *Cynotilapia axelrodii* ventures any distance away from rocks; the other species hold territories over sand, near to rocks. *Labidochromis caeruleus* is a non-territorial species which has not demonstrated any clear preference for rocky or intermediate habitats.

Time available for the survey of the north-western shores was so limited that only the Mbuna were studied. Fryer (1959a) gives a comprehensive account of the non-Mbuna in

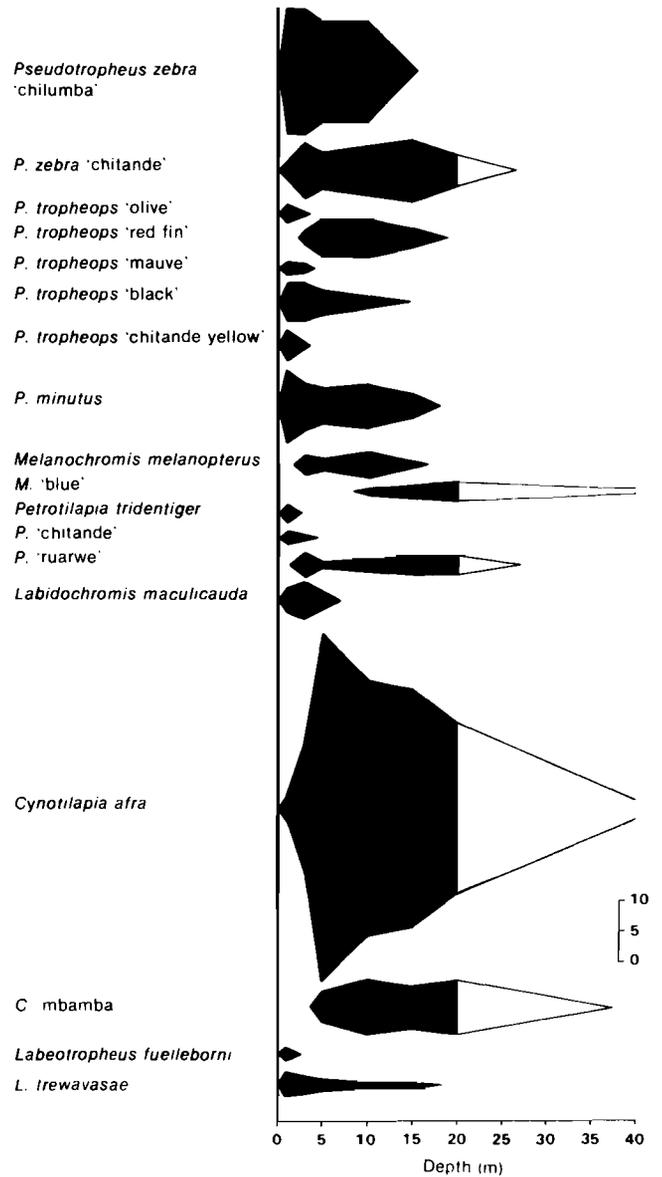


Figure 72 Transect D at Chitande, giving the depth distribution and numerical abundance of the Mbuna species and of *Cyrtocara taeniolata*. Territorial males of each species were counted except for those species marked (*) where both sexes were counted. Numerical abundance = fishes 50 m⁻².

Nkhata Bay and all we can usefully add is that *Cyrtocara linni*, which was not recorded by Fryer, is present on all shores.

DISCUSSION Aquarium fish resource

The principal objectives of this survey were to determine the variety and depth of the ornamental fish resources, particularly the Mbuna, to develop a numerical baseline against which the effects of exploitation might be measured in the future, to provide an aid to the identification of Mbuna and to identify those heavily exploited species which were in need of protective legislation.

The results indicate that the variety of ornamental fishes is far greater than originally realized; 196 Mbuna species/taxa were found and we have been informed that exporters of these fishes are continuing to discover additional species during their exploration of submerged reefs and previously unexploited coastlines (N.J. Edwards pers. comm.). It is