APPENDIX D

EXPERIMENTAL TRAWLING OPERATIONS ON LAKE VICTORIA

By J. M. GEE & M. P. GILBERT

A programme has been started to investigate the feasibility of operating a trawl fishery for *Haplochromis* in connection with development of a proposed cannery by the Uganda Government. Because of the lack of gear much time has been spent on the development of boats and nets for this type of fishing. An account of these developments and an analysis of preliminary trawling results is given below.

GEAR DEVELOPMENT

The only boat available was an old 45 ft. seaplane harbour tender, powered by two Perkins S6 diesed engines with straight through drive to 16/14 propellers. Stern gallows and a 33.1 reduction gear niggerhead winch driven off the starboard engine were designed and fitted. The boat is basically unsuitable for trawling and will not take any rough weather. Despite two engines, manoeuvring the trawl during towing is difficult because the stern gallows take-off had to be mounted aft of the propellers. However, this craft has been used in all the trawling operations attempted so far.

At present work is proceeding on the conversion of a 48 ft Fairmile fish carrier, powered by a Perkins S6 diesel engine with 2:1 reduction gear box. All the superstructure is being redesigned, a 4 gear Fiffer drum winch driven off the main engine installed, aft decks cleared and trawl gallows erected. A mast and boom is also being added for the easier handling of larger quantities of fish. This vessel should make an admirable trawler for Lake Victoria and will be ready for operation in early 1967.

The only bottom trawl available was a Vigneron Dahl trawl with an overall length of 36ft, a headrope length of 45ft and a footrope length of 46½ ft. The mesh sizes are 2½ in in the wings and the square, 2 in in the belly and lengtheners and 1 in in the codend. The performance of the trawl was improve'd by the addition of bobbin line, the bobbins being 6 in diameter wooden rollers spaced along a steel wire with 1 in diameter wooden spacers and The weights were added in sufficient quantity to make the whole bobbin line just negatively buoyant. Otter doors were made and fitted up in the correct manner for easy disconnection from the trawl warps. These latter were 3 in circumference manilla ropes marked off in 50 ft intervals. The relationship between speed of boat, length of warp and depth of trawl were calculated and tested for this set of gear.

No midwater trawls were available so the authors designed and made a small experimental trawl to their own specifications (Figure DI). This is on the lines of the Larson-Phantom trawl with a square of approximately 12 ft each side. The wings are 3 in mesh of 48 ply nylon, the square 2½ in mesh, the belly 2 in mesh of 24 ply nylon, the lengthener 1½ in and the codend 1 in 48 ply nylon. Originally lined with mosquito netting this net had recently had a ½ in codend put inside. About 14 pbnet-kites and three flying-kites are used on the headrope and

2 torpedo-shaped lead weights are inserted between the lower wings and the tow legs. The tow legs are 42 ft warps attached to depth regulating rings attached to the boards. These arc scaled down replicas of the wing boards used on the Larson Phantom trawl.

Surface trawling was tried before either midwater or bottom trawling. The net now used for bottom trawling was first tried on the surface. The headline was fitted with corks and five flying-kites and the foorline with weights and one steel depressor attached to the footrope by two lines. 30 ft tow legs attached the net to floating otter boards. These were made by attaching 20 in by 38 in doors to the underside of floating submarine paravanes. When the Vigneron Dahl net was reconverted to a bottom trawl an old Danish Seine was adopted as the surface trawl.

BOTTOM TRAWLING

Trials have been carried out in the Jinja area (Ramafuta, Maundu and Namone) and in the Entebbe area (Tavu, Bugalo and Kame). So far however only a total of 14.2 trawling hours has been completed. A general analysis by weight of all catches on the various bottom types is given in Table D1.

The figures for catch/trawling hour are most important and these show an overall catch of 311.8 lbs/hour; the catches on sand being about 40 lbs/hour higher than on mud. The catch rate recorded when both types of bottom were crossed on the same haul (usually at the same depth) are similar to those from sand bottoms but have a species composition more characteristic of the mud bottom fauna.

Haplochromis is by far the most common genus caught in all habitats and localities sampled. In two hauls, one over sand and one over mud, *Haplochromis spp.* were the only fish caught. Over a sand bottom they form, on average, 90 percent of the catch (292.7 lbs/trawling hour). On mud bottoms other genera are more prominent and *Haplochromis* only form 72.5 percent of the catch (208 lbs/trawling hour). These percentages are influenced by two large catches of *Tilapia* (one in 45 ft and the other in 60 ft of water) and two fair catches of *Bagrus* over a mud bottom. Although most of the hauls on sand were not as deep as those on mud, depth does not seem to affect the percentage composition of the catches, but it may affect their magnitude (i.e. catch/hour figures). Areas of mud bottom in deeper water have not yet been sampled. The overall proportion of *Haplochromis* in all catches is 83 percent (259 lbs/trawling hour.)

Tilapia were caught in both habitats but the species caught on sand were almost entirely *T. zillii* and *T. variabilis*. The latter species formed the bulk of the catch and individuals were nearly all in breeding condition. The *T. zillii* were generally small but in good condition (with a very convex belly line). Small numbers of *Tilapia* came in regularly with each haul. The only *Tilapia* species found over the mud bottom was *T. esculenta;* their breeding condition was not determined but their distribution was much more irregular. 30 percent of the hauls on mud contained no *Tilapia* and 35 percent contained only one or two specimens. Two large catches were obtained in the Entebbe area (one of 137 and another of 211 individuals) when a particular type of echo-trace was fished - (see below) and 28 were caught in a haul off Namone over a simibr trace.

Bagr1is dOC1nac is the other species which formed a significant percentage of the catches on both sand and muJ. Again its appearance on sand was very regular but in small numbers, whereas on mud its distribution was sporadic, two heavy catches making up both the percentage and catch/hour contribution. *Bagrus* were most abundant however in hauls over both mud, and sand when good catches were obtained in two out of the three hauls made.

Table D2 is an attempt to compare catches in different areas of similar bottom types. The fishing effort however was not proportionate which makes comparison dubious. The sand bottom at Ramafuta, near Jinja, produced similar catches of *Haplochromis* to the comparable environment at Tavu near Entebbe, although *Tilapia* and to some extent *Bagru.s* formed less significant parts of the catch. The catches at Nsadzi (off Entebbe) were much lower than in the other two areas and two poor catches of *HajJlochromis* were obtained. *Bagrus* was the only other species caught here. The catch rates and species composition of *Haplochromis* over mud bottoms in the Jinja and Entebbe areas were very similar. The differences in total catchltrawling hour are accounted for mainly by the variation in catches of *Tilapia* and *Bagrus.*

To summarize the data on distribution and catches therefore, it may be said that *Haplochromis* are abundant in all areas and form the bulk of all catches. *Bagrus, Protopterus* and small *Barbus* spp. are also found in all environments Trawl hauls over sand bottoms are characterized by the presence of *T. zillii, T. variabilis* (and *Barbus altianalis)* while trawl hauls over mud are characterized by the presence of *T. esculenta, Synodontis, Clarias* and *Xenoclarias.*

The total length to the nearest 0.5 cm was measured for a sample of each haul made and percentage frequency curves constructed. Figure D2 shows the length frequency curves for catches over sand and mud bottoms in the Entebbe area.

MIDWATER TRAWLING

SO far this gear has been relatively unsuccessful in terms of catching fish. A number of hauls were made in the Entebbe area but the behaviour of the trawl was not completely satisfactory and the depth of fishing very uncertain. The boards, when given a steep diving angle, appeared to be fishing at approximately the correct depth (as shown when the echo sounder was used to locate the trawl under water) but this made them very unstable. Recently the diving angles have been reduced again and extra torpedo-sluped lead weights fitted to the net.

Small catches were obtained on a number of occasions, the main genus caught being *Engraulicypris.* This is a pebgic shoaling fish and thought to occur in large quantities in the lake, but little is known of its biology. The length frequencies of the catches varied considerably, sometimes a large number of extremely small individuals were caught and at other times a smaller number of large individuals. It is hoped that as the trawl is made to work more efficiently and when a much larger trawl is employed these fish may be caught in sufficient quantities to make their exploitation an economic proposition.

Haplochromis were the other main constituent of the catch but on the whole were very few in number and their total weight amounted to only a few ounces. On one occasion a fair number of vcry small, immature specimens were caught, otherwise only two or three individuals came up with each haul.

No correlation with echo as yet be made because of the uncertainty as to both the fishing depth and the eftlciency of the net as well as the very poor catches obtained.

SURFACE TRAWLING

This method, the first to be used, has only been tried in the Jinja area. A number of trawl hauls were made in different localities and have been grouped as in Table D3. The range of species caught is much smaller than with bottom trawling and *HajJ!ocbrolllis* \vere again the most important genus, forming over-all 90 percent of the catch. Surface trawling however was by no means as productive as bottom tra\vling (see above); producing an overall catch/ trawling hour of only 21.3 lbs of *HajJ!ochrolllis,* and an overall t'otal catch/trawling hour of 24.3 Ibs. *Alestes jacksoni, A. sadleri* and *El1graulicypris* were the only other species which occurred regularly. *A. sadleri* was absent from all hauls made in water over 30 ft, i.e. Buvuma Channel and Lufu. The total weight contribution of these species in terms of catchltrawling hour is negligible. The\ odd specimen of *C!arias* was caught in some trawl hauls, but again they formed an insignificant item from the commercial point of view.

The length frequencies of *Haplochromis* from the surface trawls are shown in Figure D3. The inshore fishings in shallow water in Napoleon Gulf and Grant Bay have been lumped together as have the fishings in deeper water in Buvuma Channel and at Lufu Island. These length frequencies show a completely different pattern to those for bottom trawling, with a slightly .ske\\Ted distribution about a single peak.

There are certain advantages of surface trawling over bottom trawling. The size range of *HajJ!ocbro1llis* caught is much smaller and therefore easier to handle from the cannery point of view. Surface trawling gear could be expected to be cheaper and last longer than bottom trawling gear. In our opinion however, these advantages are far outweighed by the disadvantages involved. All surface trawling has to be done at night; trawl hauls made during the day were usually negative. The method of fishing is haphazard, and little or no help can be gained from the use of an echo 'sounder because of the phenomenon of 'shoal' dispersion at dusk already described (Gee, 1966). The catches of *HajJ!ochromis* are very small compared with bottOm trawling, too small in fact to be commercially worthwhile accord;ng to the present data.

OTHER TRAWLING RESULTS

Trawling has been attempted previously on Lake Victoria, but not for the specific purposes at utilizing the *Haplochromis* in the catches. S. H. Deathe using the m.v. NINGU trawled extensively off South Dagusi in waters over 60 ft deep. No detailed results are available but the following are his total catch figures for all species in 1954 (District Commissioner, Busoga. Personal communication).

January	50	hours	11,375	lbs
February	54	hours	11,240	lbs
March	46	hours	8,241	lbs
April	17	hours	2,268	lbs
May	58.5	hours	11,943	lbs
TOTAL:	225.5	hours	45,068	lbs

These results produce a mean total catch/hour of 199.8 lbs. He reponed that *Haplochromis* formed approximately 66 percent of the catch which would give a catch/hour of approximately 133 lbs.

The trawling results of EAFFRO in 1950-51 and the Lake Viccoria Fisheries Service (LVFS) are much better documented (EAFFRO 1951; 1952; LVFS 1957,1958). A summary of the *Haplochromis* catches are given in Table D4. Most of the trawling by EAFFRO was done in the region of Buvuma Island and the more offshore islands in the Jinja area while the LVFS trawling results are mainly from the offshore islands, in the vicinity of Entebbe and the open lake. Unfortunately no information is available on the size of trawl used but it was probably of similar proportions to the one used in the present survey. Some high mean catch/hour figures were obtained by EAFFRO and although the LVFS figures are lower they both show that large catches of *HajJlochromis* can be obtained in waters of intermediate depth, i.e., between 30 ft and 120 ft. Below this depth there appears to be a rapid decrease in catch down to 200 ft.

Both organizations are of the opinion that these results confirm the susplClOn that very few fish are likely to be found in the deeper waters of the lake. A few *Synodontis* were caught in water over 200 ft deep, but not in sufficient quantity to be commercially important. The trawling results of the LVFS did however indicate that large shoals of *EngraulicyjJYis* were often encountered in the surface waters of the open lake down to a depth of 60-70 ft, particularly at dawn and dusk. For the harvesting of these however they recommended the use of a 900-1,500 ftpurse seine of ¼ in mesh about 90 ft deep.

Most of the EAFFRO trawling was done over a mud bottom and the genera other than *Haplochromis* in the catches were very similar to those given in the present trawling results; *Tilapia*, *Bagrus* and *Clarias* were the three most important genera, but *Mormyrus* which we have not had so far in a trawl, featured fairly prominently in about 10 percent of the catches.

TRAWL CATCHES AND ECHO SOUNDER RESULTS

An echo sounder was used on all occasions in conjunction with the bonem trawling operations. It was hoped that some correlation could be obtained between catches and echo-traces and then echo soundings could be used as a means of estimating quantities of fish present in the area and the amount of fish which could be obtained for the cannery.

For the purposes of correlating echo-traces with catch on a sand botcom only *Haplochromis* was considered as it forms 85 percent of all catches, the numbers and weights of other genera being insignificant. The catches of *HajJlochromis* were calculated as lbs/30-min haul and the traces arranged in order according to the catch weight. When this was done it was very apparent that there was no correlation between density of bottom traces and catch. The five heaviest catches of *Haplocbr01nis* were made on traces with very few fish marks near the bottom. An intermediate size catch and the smallest catch of all were also made on similar traces. The two heaviest traces in the series came at the top of the intermediate catch range. The sixth heaviest catch and all others were made on medium density traces. It is fairly apparent therefore that the traces produced were not principally of *Haplochromis* and there are therefore three main alternatives.

1. That the visible traces were from shoals of fish too small to be retained in a 1 in mesh codend.

2. That they were made by some organism other than fish, plankton being the most likely.

3. If however, the echo sounder would pick up either of the above items it should also pick up the *Haplochromis* caught in the trawl. Most of these *Haplochromis* however are bottom feeding forms (mollusc eaters, insectivores and bottom detritus feeders) and will presumably be in close contact with the bottom. If this is so they will be very difficult to distinguish (if at all possible) from the bottom echo itself. This hypothesis is borne out by observations made by the authors over a sand bottom using an aqualung. L'arge numbers of *Haplochromis* are often seen within 6 in to 12 in of the bottom or actually resting on the bottom, but if the diver paused for any length of time in midwater, very few if any *Haplochromis* were ever encountered.

Little or no correlation between density of echo-trace and catches of *Haplochromis* was obtained over a mud bottom. In these hauls however, other genera particularly *Tilapia* sometimes featured prominently and some correlation between type of echo and genera caught was obtained. A very fine diffuse trace was often present over the mud bottom up to about 15 ft. from the bottom. Sometimes nothing else was superimposed on this, sometimes it was patchy and on two occasions fairly heavy comet-shaped strikes were found in the background feather. On these two occasions large catches of *Tilapia esculenta* were obtained, whereas the occasional one or two specimens only were caught on the other diffuse traces. Here the hypothesis is that these large diffuse traces are dense concentrations of *Melosira* - a silicaceous, filamentous diatom, and that sometimes large shoals of *T. esculenta* can be found feeding on them. *T. esculenta* is a phytoplankton filter-feeder in which *Melosira* forms a significant quantity of the stomach contents, usually around 20 percent by weight (Welcomme -pers. comm.). One trawl haul in the Jinja area through a fine feather trace produced similar results; a higher catch than normal of *T. esculenta* 'was obtained, the guts of these fish were very full and analysis showed that *M('lnsira* formed 80 percent of the total contents (Welcomme-pers. comm.). Other evidence that many of these traces may in fact be aggregations of pbnkton was obtained while diving off Ramafuta Island in an attempt to identify some traces seen on the echo sounder. They were very similar to those described above but rather patchy. On two successive dives no fish were seen but dense masses of suspended matter — mostly plankton (where the light intensity was drastically decreased) were passed through at the same depth as the traces produced on the sounder. These facts are strong corroborating evidence for the above hypothesis and it is hoped that plankton analysis of water samples taken in and above these types of traces will give more direct evidence.

A Kelvin Hughes M.S. 24 echo sounder was used abroad the m.v. **NINGU** by the LVFS. Although this is a low frequency sounder (15-30 Kc/s) compared with the Furono (50 Kc/s) used at present, their results were just as difficult to interpret. They could find no correlation between echo-trace and trawling result and found that trawl catches varied tremendously in different areas of similar habitat. Because of the little discernable pattern in their results they doubted whether a mechanised trawl fishery could be made to work economically.

REFERENCES

GEE, J. M. (1966) - Some preliminary observations on the distribution and behaviour of fish in Lake Victoria as shown by an echo-sounder. *EAFFRO Ann. Rep. for* 1965: 68.

EAFRO (1951) - *EAFRO Ann. Rep. for 1950:* 15, 24-25.
EAFRO (1952) - *EAFRO Ann. Rep. for* 1951: 19-20,48.
LVFS (1957) - *LVFS Ann. Rep. for* 1956/57: 12-13.
LVFS (1958) - *LVFS Ann. Rep. for* 1957/58: 11-24.

TABLE D1. BOTTOM TRAWLING - GENERAL ANALYSIS OF ALL CATCHES BY HABITATS (EXPRESSED IN lbs LANDED)

\+ = present in very small quantities

absent

BOTTOM	DEPTH (FT)	TIME (MIN)	*T. zillii*	*T. variabilis*	*T. esculenta*	*Haplochromis*	*Bagrus*	*Clarias*	*Synodontis*	*Protopterus*	*Barbus*	*Labeo*	*Xenoclarias*	*Engraulicypris*	*Lates*	TOTAL
TOTAL CATCH																
Sand	20-60	462	7.9	51.7	8.0	2,254.0	112.5	9.5	+	44.0	2.5	-	-	+	-	2,500.1
Mud	30-66	31 5	-	-	226.4	1,092.2	105.5	40.8	18.5	19.8	+	-	'0.20	+	-	1,503.4
Sand/Mud	12-60	72	+	-	3.0	305.0	51.4	8.4	5.9	16.7	+	0.9	-	+	1.5	392.8
TOTAL		849	7.9	51.7	237.4	3,651.2	279.4	58.7	24.4	80.5	2.5	0.9	0.20	+	1.5	4,396.3
PERCENTAGES																
Sand	20-60	462	0.31	2.5	0.32	90.0	4.80	0.37	+	1.70	0.10	-	-	+	-	100
Mud	30-66	31 5	-	-	15.06	72.67	7.02	2.71	1.23	1.32	+	-	0.2	+	-	100
Sand/Mud	12-60	72	-	-	0.76	77.60	13.08	2.14	1.50	4.25	+	0.20	-	+	0.38	100
TOTAL		849	0.18	1.18	5.40	83.06	6.36	1.34	0.56	1.83	+	+	+	+	0.04	100
CATCH/HOUR																
Sand	20-60	60	1.03	6.71	1.04	292.73	15.91	1.23	+	5.71	0.32	-	-	-	-	324.68
Mud	30-66	60	-	-	43.12	208.04	20.10	7.77	3.22	3.77	+	-	+	+	- -	286.32
Sand/Mud	12-60	60	-	-	2.50	254.17	42.83	7.00	4.92	13.92	+	0.75	-	+	1.25	327.34
TOTAL		60	0.56	3.66	16.84	259.00	19.81	4.16	1.73	5.71	+	+	+	+	+	311.80

TABLE D2. BOTTOM TRAWLING — [illegible]

DIFFERENT AREAS OF SAME HABITAT (EXPRESSED AS LBS LANDED)

+ = present in very small quantities

— = absent

Locality	Number of Hauls	Time (Min)	Depth (ft)	*T. zillii*	*T. variabilis*	*T. esculenta*	*Haplochromis*	*Bagrus*	*Clarias*	*Synodontis*	*Protopterus*	*Barbus*	*Xenoclarias*	*Engraulicypris*	TOTAL
TOTAL CATCH															
SAND															
Ramafuta	3	47	24–45	—	—	0.2	224.2	10.0	9.5	—	—	+	—	—	243.9
Tavu	15	355	20–45	7.9	51.7	7.8	1,924.1	109.6	—	+	44.0	2.5	—	—	2,135.8
Nsadzi	2	60	40–60	—	—	—	117.5	2.9	—	—	—	+	—	—	120.4
MUD															
Namone	1	20	30	—	—	9.9	57.2	—	—	0.4	—	+	0.2	+	67.7
Kome	2	60	35–45	—	—	115.5	215.6	9.9	6.7	0.7	4.4	—	—	—	353.2
Bugalo-N	4	95	45–65	—	—	97.5	293.4	48.2	16.5	4.0	4.4	+	+	—	464.0
Bugalo-S	5	140	65	—	—	3.1	526.0	47.4	17.5	1.3	11.0	+	—	—	618.5
CATCH/HOUR															
SAND															
Ramafuta	3	60	24–45	—	—	0.26	286.97	12.8	12.16	—	—	+	—	—	312.19
Tavu	15	60	20–45	1.33	8.73	1.30	325.00	18.51	—	+	7.43	0.42	—	—	362.72
Nsadzi	2	60	40–60	—	—	—	117.5	2.9	—	—	—	+	—	—	120.4
MUD															
Namone	1	60	30	—	—	29.7	171.6	—	—	1.2	—	+	0.6	+	203.1
Kome	2	60	35–45	—	—	115.5	215.6	9.9	6.7	0.7	4.4	—	—	—	353.2
Bugalo-N	4	60	45–65	—	—	61.71	185.70	30.5	10.44	2.53	2.78	+	+	—	293.66
Bugalo-S	5	60	65	—	—	1.33	225.75	20.34	7.51	0.56	4.72	+	—	—	260.21

N.B. results from mixed sand/mud bottoms not included

TABLE D3. SURFACE TRAWLING - GENERAL ANALYSIS OF CATCHES

(expressed as lbs landed)

- = absent,

+ = present in very small quantities

LOCALITY	DEPTH (FT)	TIME (MIN)	*Haplochromis*	*A. jacksoni*	*A. sadleri*	*Engraulicypris*	*Clarias*	*Tilapia*	*Barbus*	TOTAL
Napoleon Gulf	15-20	250	123.9	5.9	4.85	4.25	3.5	+	+	142.4
Grant Bay	15-45	120	37.5	-	0.5	0.7	-	-	-	38.7
Buvuma Channel	50-90	120	32.75	-	-	-	-	-	-	32.7
Lufu Island	75	90	18.0	0.3	-	0.25	3.0	-	+	21.5
TOTAL	-	580	212.15	6.2	5.35	5.20	6.5	+	+	235.4
Total Catch/hour	-	60	21.3	0.6	0.55	0.54	0.72	-	+	23.7
Total percentage	-	-	90	2.6	2.3	2.3	2.2	2.8	+	100

TABLE D4. SUMMARY OF TRAWL CATCHES MADE BY LVFS (a) AND EAFFRO (1950-51) (b) FROM ALL LOCALITIES FISHED

Depth ft	Mean time (min)		Mean catch (lbs)		Mean catch/hour (lbs)	
	a	b	a	b	a	b
10-19	-	40		0.75		1
20-29	45	29	59	83	80	166
30-39	36	26	196	16	336	38
40-49	60	30	45	164	45	328
50-59	37	29	39	106	62	212
60-69	60	26	42	130	42	300
70-79	-	33		218		396
80-89	60	32	14	147	14	280
90-99	-	37		87		140
100-119	-	50		86		101
120-139	50	60	32	80	38	80
140-159	47					
160-179	60		2		2	
180-199	30		3		6	

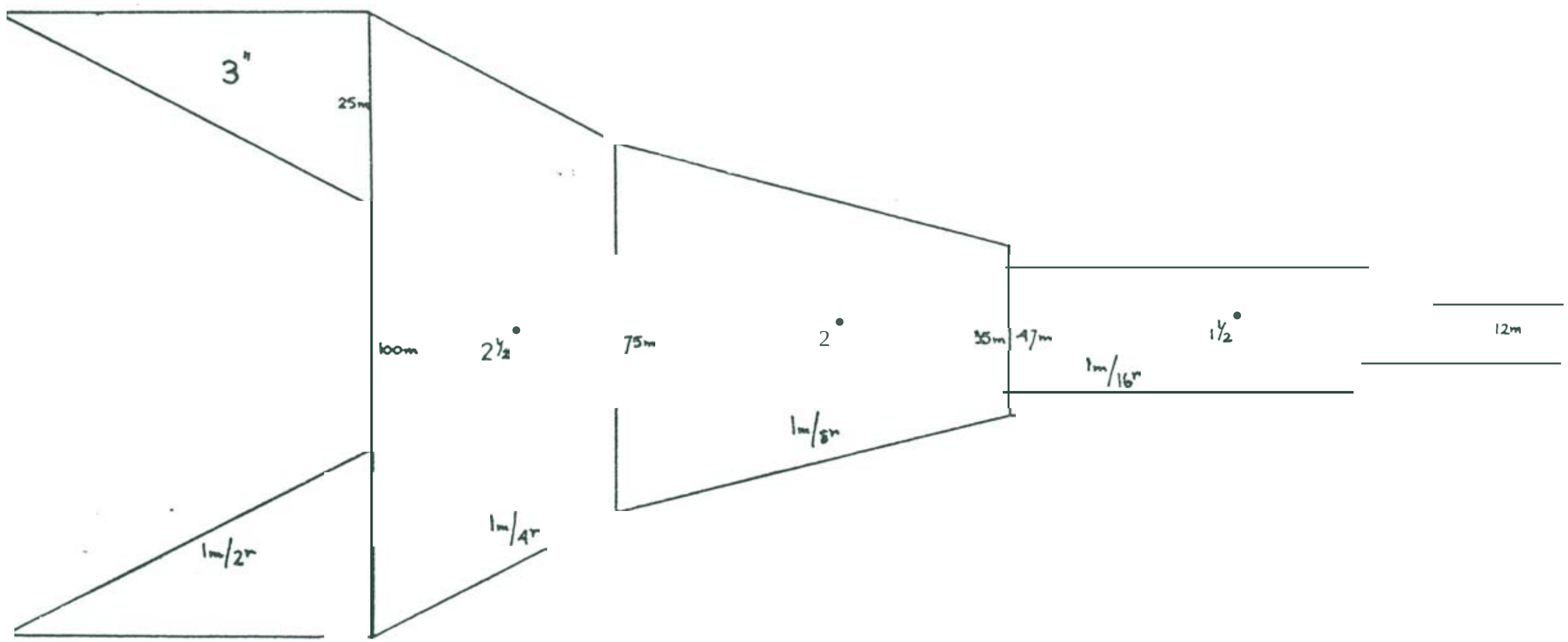

FIGURE D1. Representational drawing of an experimental mid-water trawl designed by the authors.

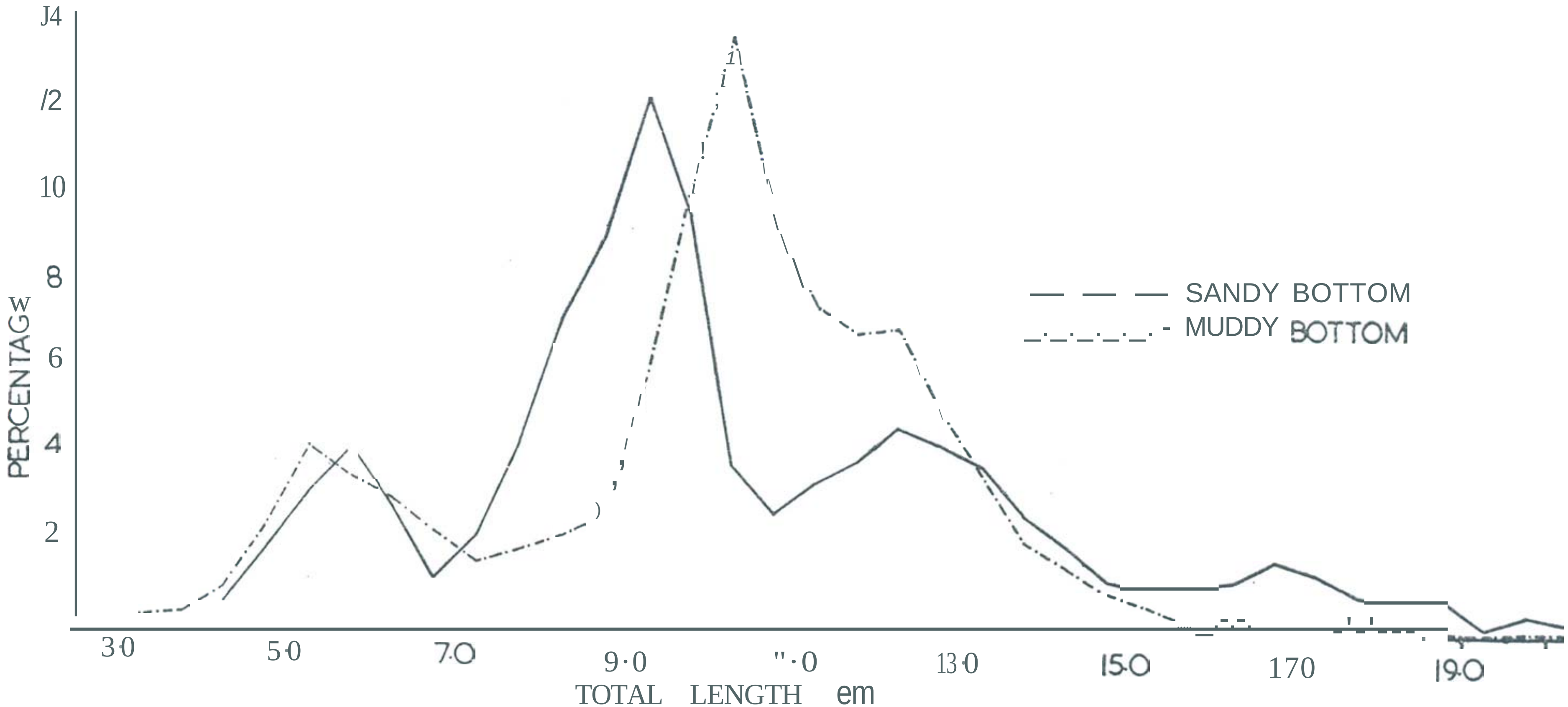

FIGURE D2. Length frequencies of *Haplocbromis* from bottom trawl hauls over sand and mud in the Entebbe region

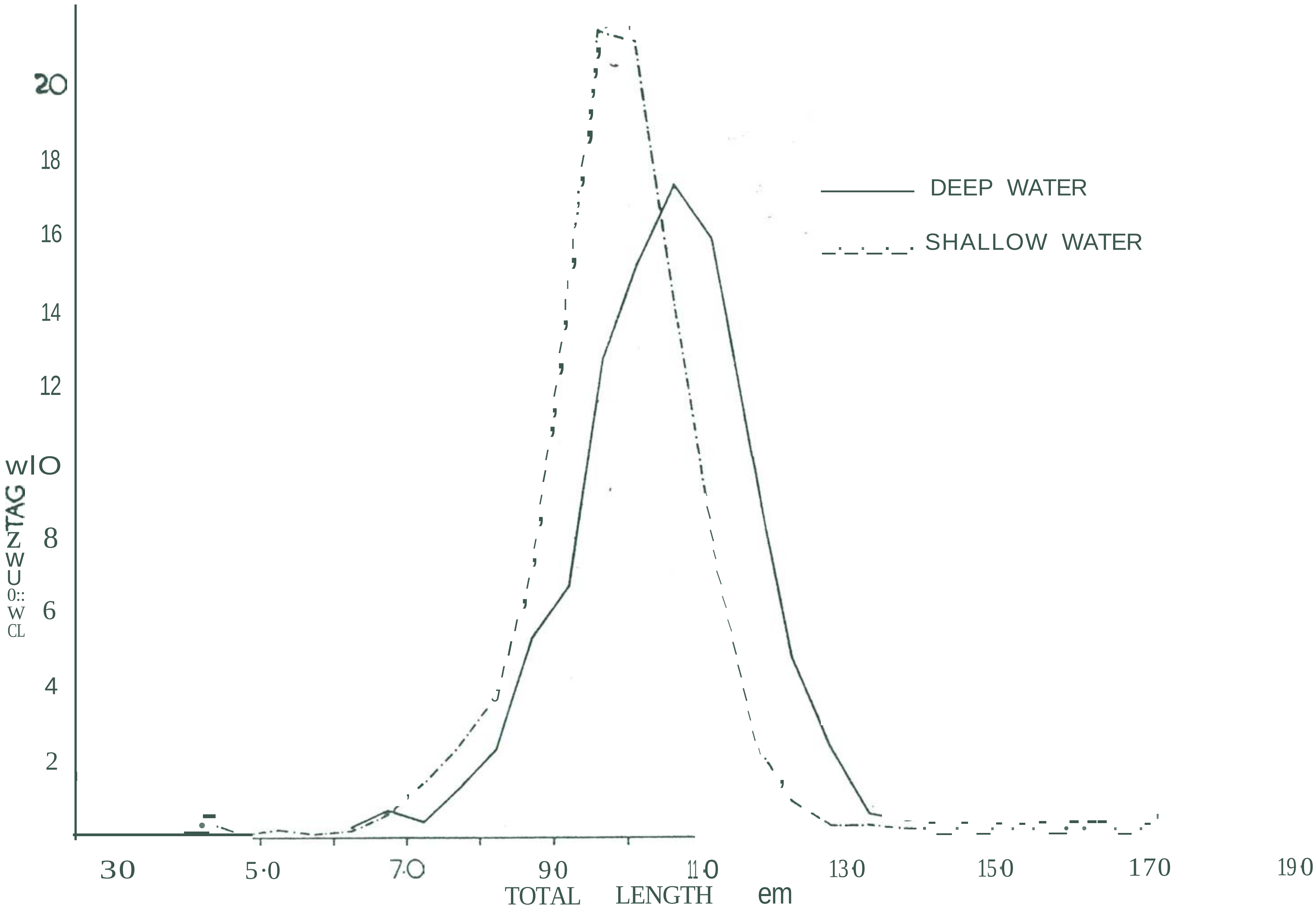

FIGURE D3. Length frequencies of *Haplochromis* from surface trawl hauls in deep and shallow waters