EAFFRO OCCASIONAL PAPER 11

The Establishment of a commercial fishery for Haplochromis in the Uganda waters of Lake Victoria, Part III - 1968

by

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GENERAL CONCLUSIONS

1. On good or moderately good bottoms, trawling speeds over 2.4 - 2.8 knots do not increase catch rates but on very soft bottoms catch and trawling speed are proportional.

2. Mesh size has a profound effect on catches of Haplochromis obtained. A 1" and 2" mesh codend appear to produce about equal quantities over a good bottom but catches drop off drastically in mesh sizes over 2".

3. The catches of species other than Haplochromis are very little affected by codend mesh sizes of 2" and over but are very markedly reduced in a 1" codend.

4. From a cannery point of view, although a $2\frac{1}{2}$" codend gives the best percentage return of the sizes of Haplochromis required, a 2" codend produces larger quantities of the required size due to a much higher catch rate in this mesh size.

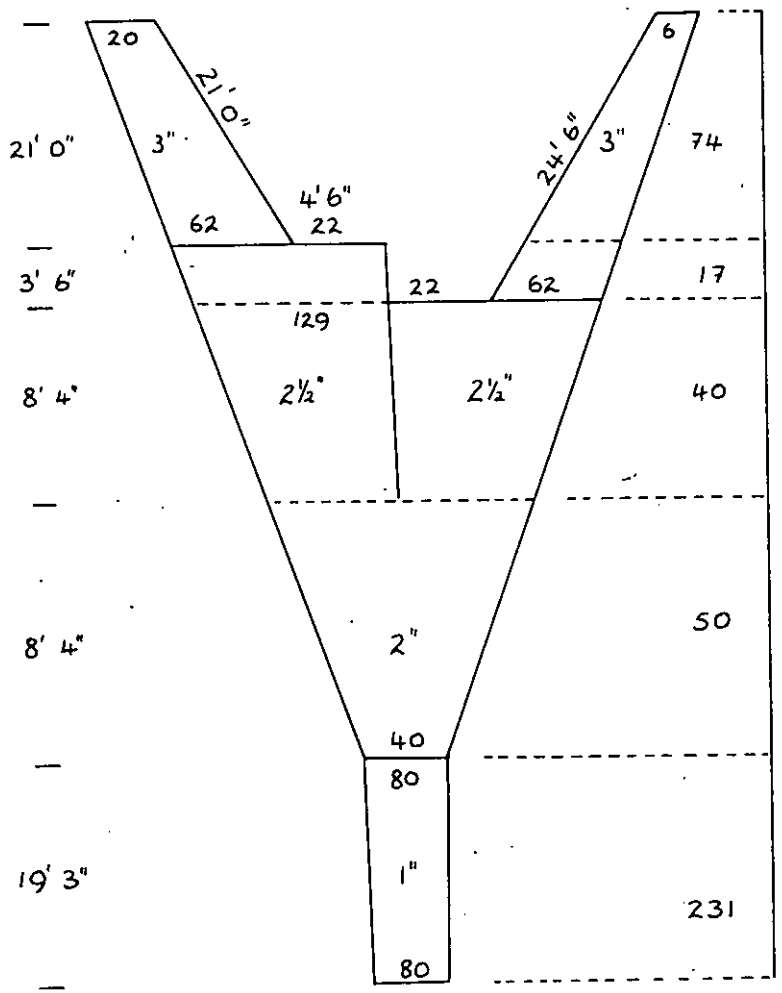
5. Mesh size and locality significantly affect the types of Haplochromis caught and it is suggested that a 2" codend fishes a better cross section of the species present in the population than does a $2\frac{1}{2}$" codend.

6. Sand areas and good mud bottoms between 45' and 75' appear to produce the highest quantities of Haplochromis but the catches of most other commercial species is approximately proportional to the depth (except Synodontis which is inversely proportional to depth).

INTRODUCTION

In a previous report (Gee and Gilbert 1968) an attempt was made to estimate stock densities in the Entebbe area of Lake Victoria based on catch figures obtained in EAFFRO No. 1 trawl fitted with a 1" codend and towed at an estimated 1.7 knots (probably an underestimate). The results were rather discouraging in that the figures obtained for stock densities were definitely very low. It was felt that the major weakness of the operations was the trawl net but as it was the only net available

FIG. 1. EAFFRO No. 1 TRAWL - TWO SEAM, 46' 6" ON HEADROPE.



MATERIAL.

WINGS - COTTON 20^s/60
SQUARE - COTTON 20^s/45
BELLY - COTTON 20^s/45
CODEND - NYLON 210/18

HEADROPE - 1½" CIRC. KURALON LINE

GROUND ROPE - 2" CIRC. MANILA FASTENED TO 3/16" DIAM. CHAIN.
3/8" DIAM. WIRE ROVE THROUGH ENDS OF CHAIN.
4 BOSOM BOBBINS 9" X 6" ATTACHED.

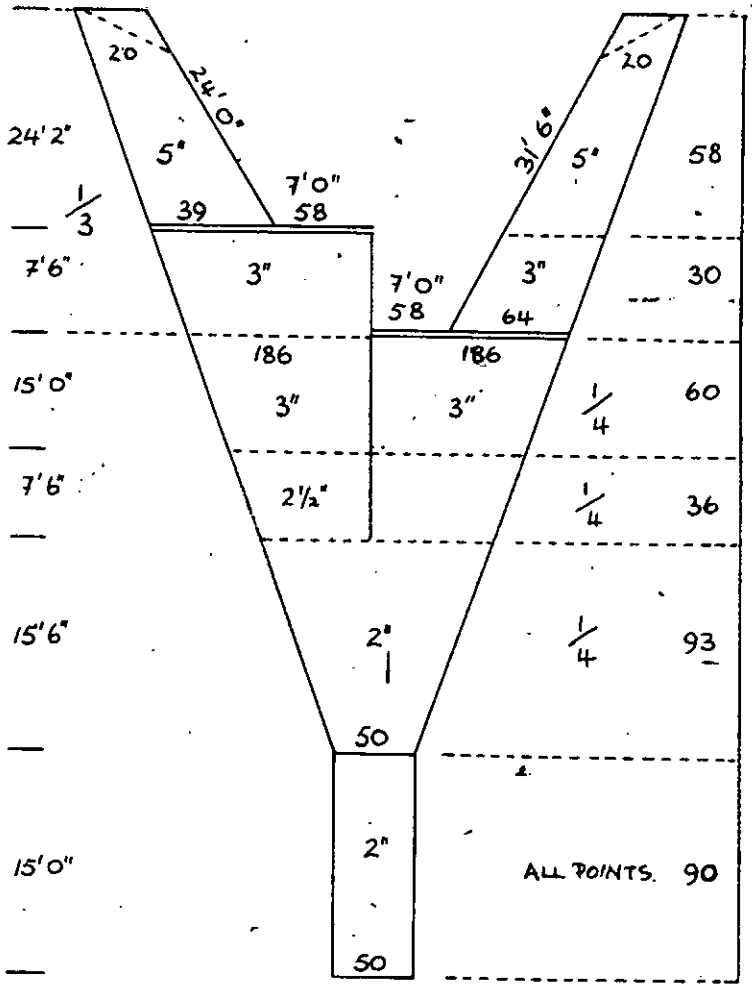
BREAST LINE - 1½" CIRCUMFERENCE MANILA.

WEIGHT.

GROUND ROPE - 46 LBS.
TOTAL DRY WEIGHT OF TRAWL - 170 LBS.
BUOYANCY ATTACHED - 45 LBS.

ORIGINAL DRAWING BY. G. ILLUGASON.

FIG. 2. UNDP No. 1 TRAWL - TWO SEAM, 55 FEET ON HEADROPE.



MATERIAL.

WINGS	-	210/24 NYLON TREATED WITH TAR.
SQUARE	-	210/24 " " " "
BELLY	-	210/24 " " " "
CODEND & LENGTHENER	-	210/36 " " " "
HEAD ROPE	-	2" CIRCUMFERENCE COMBINATION ROPE
GROUNDROPE	-	2" CIRCUMFERENCE COMBINATION ROPE
BREASTLINE	-	2" CIRCUMFERENCE COMBINATION ROPE

WEIGHT.

GROUNDROPE - 63LBS.

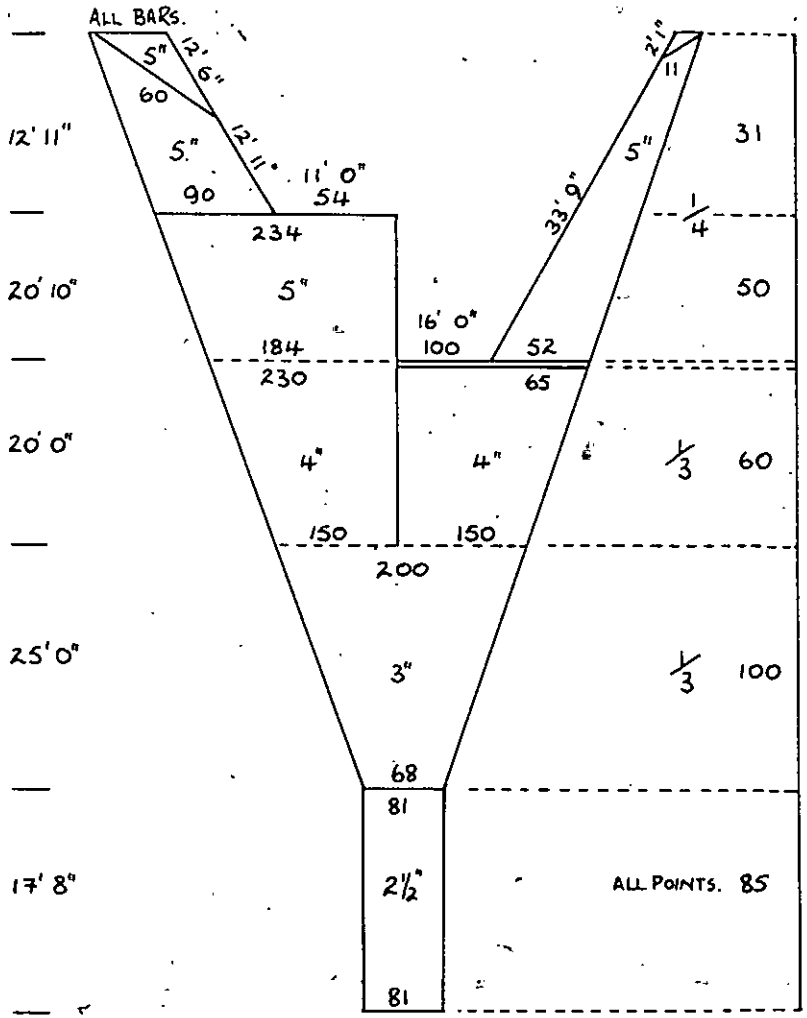
TOTAL DRY WEIGHT OF TRAWL = 150 LBS.

BUOYANCY ATTACHED = 63LBS.

1/4 = No. of BATTINGS. / No. of ROWS.

DESIGNED BY G. ILLUGASON.

FIG. 3. UNDP No 2 TRAWL – TWO SEAM, 61' 10" ON HEADROPE.



MATERIALS.

UPPER WINGS	No 24 COURLENE
LOWER WINGS	No 30 COURLENE
UPPER BELLY	No 24 COURLENE
LOWER BELLY	No 30 COURLENE
CODEND.	No 39 COURLENE

HEADROPE 1½" CIRCUMFERENCE COMBINATION ROPE

GROUNDROPE ⅜" DIAMETER WIRE ROPE SERVED WITH 2½" MANILA ROPE

BREASTLINE . 1½" CIRCUMFERENCE COMBINATION ROPE

WEIGHT.

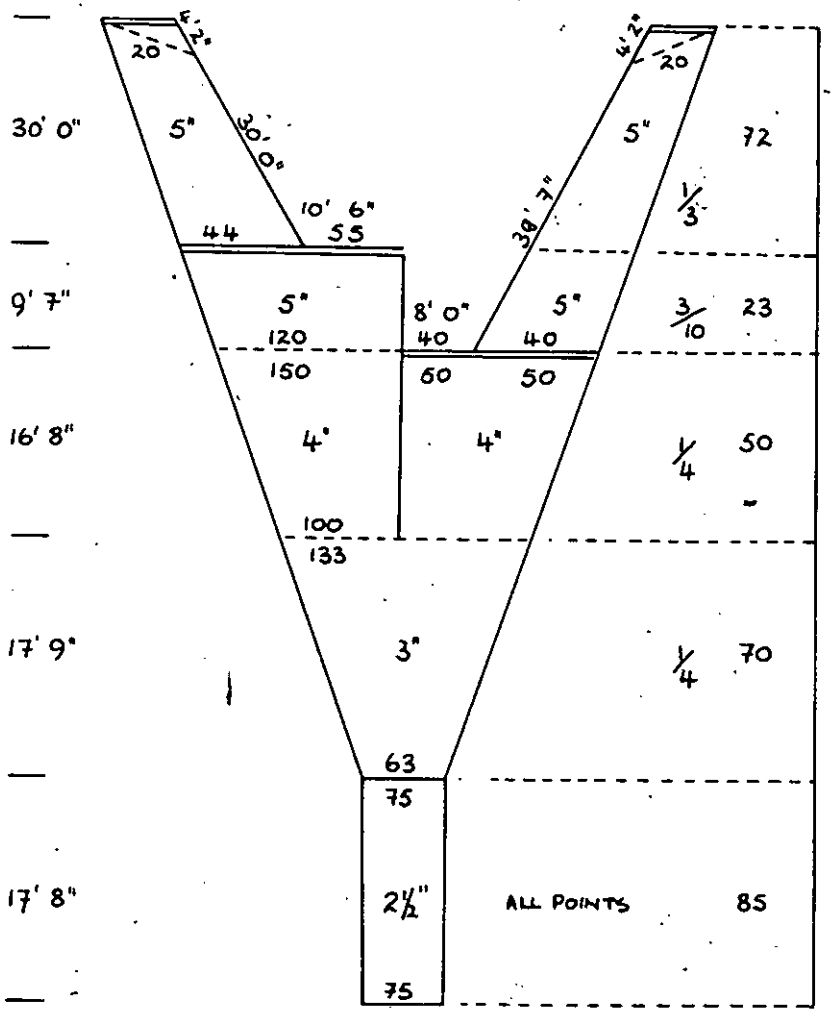
GROUND ROPE 150LBS (DRY WEIGHT)

BUOYANCY 140LBS.

1/3 = No. OF BAITINGS. / No. OF. ROWS.

DESIGNED BY G. ILLUGASON.

FIG. 4. UNDP No. 3 TRAWL - TWO SEAM, 78' 10" ON HEADROPE.



MATERIALS.

UPPER WINGS	No 24 COURLENE
LOWER WINGS	No. 30 COURLENE
UPPER BELLY	No. 24 COURLENE
LOWER BELLY	No. 30 COURLENE
CODEND.	No. 39 COURLENE

HEADROPE 1½" CIRCUMFERENCE COMBINATION ROPE.

GROUNDROPE 5/8" DIAMETER WIRE ROPE SERVED WITH 2½" MANILLA ROPE.

BREASTLINE 1½" CIRCUMFERENCE COMBINATION ROPE.

WEIGHT.

WEIGHT OF GROUNDROPE DRY = 130 LBS.

BUOYANCY ATTACHED = 98 LBS.

$\frac{3}{10} = \frac{\text{No. of BAITINGS.}}{\text{No. of ROWS.}}$

DESIGNED BY G. ILLUGASON.

and neither of the authors were expert on the design and construction of more suitable nets, this particular net had to be used.

With the advent at the beginning of 1968 of the UNDP Masterfisherman and later in the year of the UNDP research vessel IBIS, this gear weakness was remedied during the year. Although trawling operations were extended to cover most of the northern part of the Lake, the main emphasis of the investigations was on the improvement in design and performance of the trawling gear both for the UFD vessel DARTER and the UNDP vessel IBIS. The Masterfisherman designed and made a new net (with 2" and $2\frac{1}{2}$" codends) for use from the DARTER (denoted UNDP No. 1 trawl) and 2 nets for use from the IBIS (denoted UNDP No. 2 and 3 nets) - these are shown in Figures 1-4. This report contains the results obtained with this new gear.

Relative catching power of the new nets and the old EAFFRO No. 1 net was determined, work was done to determine the effect of various mesh sizes and trawling speeds on catches, and data have been analysed both quantitatively and qualitatively to provide some idea of the magnitude of catches which might be expected in various areas of the northern lake region. Recommendations are made with respect to mesh sizes and towing speeds which are regarded as most suitable for Haplochromis trawling operations.

COMPARISON OF NETS AND VESSELS

During January and February, while the author was on leave, the UNDP No. 1 trawl and the EAFFRO No. 1 trawl were fished for a total of 31.4 hours in the region of Bukakata. The results of this trawling have been used to try and assess the relative efficiency of the two nets with the object of enabling comparisons to be made between results obtained in the past with the EAFFRO trawl and those to be obtained with the UNDP trawls in the future. The results are not strictly comparable in that the fishing of the two nets was rather haphazard, no effort being made to try and equalize the fishing times of the nets nor the precise localities in which they were operated. The general localities however were similar and are as follows:- Sango Bay: the area south of

Table 1 : Comparison of UNDP No. 1 net and EAFFRO No. 1 net

Bukakata area - January-February 1968

Net	Time	Total	Haploch.	Tilapia	Protop.	Siluroidea
Total Catch - weight in Kg.						
All nets	31.4	7,223	5,399	257	916	651
UNDP No. 1	19.7	5,103	3,360	229	911	603
EAFFRO No. 1	11.7	2,120	2,039	28	5	48
Catch/hour - weight in Kg.						
All nets	1	230.3	171.9	8.2	29.2	20.7
UNDP No. 1	1	259.1	170.6	11.6	46.3	30.6
EAFFRO No. 1	1	181.2	174.3	2.4	0.4	4.1
% Composition						
All nets		100.0	74.7	3.6	12.7	9.0
UNDP No. 1		100.0	65.8	4.5	17.9	11.8
EAFFRO No. 1		100.0	96.2	1.3	0.2	2.3

the Luamba Pennisular; Bukakata Channel; Salisbury Channel. The UNDP No. 1 net, with a theoretical opening of 22' by 4', had a 2" codend and was towed at approximately 2.7 knots, while the EAFFRO No. 1 net with a theoretical opening of 15' by 3', had a 1" codend and was towed at approximately 2.4 knots. A brief summary of the results is given in Table 1.

The average total catch/hour in the UNDP net is 1½ times greater than in the EAFFRO net (259 kg/hour of 181 kg/hour) but the average catch/hour of Haplochromis is the same in both nets (about 170 kg/hour). When the higher towing speeds, greater spread and greater fishing height of the UNDP net are taken into account the catches of this net might be expected to be more than double those of the EAFFRO net. This is true for all species, including Haplochromis in the Sango Bay area and as far as total catch is concerned in the Salisbury Channel area. The other two areas are difficult to compare because of the greater discrepancies in trawling times for the two nets. It will be noted that much larger quantities of Protopterus, Bagrus and Clarias were taken in the UNDP net than in the EAFFRO net. This may be due to the slightly higher trawling speed of the former but is more likely to be a result of the greater pressure wave set up by the smaller codend meshes of the EAFFRO net allowing a much greater escapment rate, by these larger species, from the mouth of the trawl. A similar kind of comparison can be made between the UNDP No. 1 trawl worked from DARTER and the UNDP No. 2 and 3 trawls worked from IBIS in the Dagusi/Sigulu area of the Lake. In this case however, the comparisons are probably even less valid as DARTER worked the area in May-August and the IBIS worked the area in September and October. Thus the difference in times at which the nets were operated could be quite significant for, as has been commented upon elsewhere (Appendix A EAFFRO Annual Report 1968) the size and composition of a population in a given area changes radically over a short space of time. While the average speed at which all the nets were towed is approximately the same (2.8 - 3.0 knots), as is the fishing height, the theoretical spread of the UNDP No. 2 and No. 3 net is 27 ft. and 33.5 ft. respectively, compared with 22 ft. for the UNDP No. 1 net.

Table 2 : Comparison of UNDP No. 1, 2 and 3 nets in Dagusi area

May-October, 1968

Nets	Time	Total	Hapl.	Tilap.	Protop.	Bagrus	Clarias	Barbus	Lates
Total Catch - weight in Kg.									
No. 1	21.5	5,116	2,245	1,009	914	543	332	-	73
No. 2	6.0	1,928	1,028	26	165	207	497	5	-
No. 3	9.0	1,363	475	13	339	171	364	1	-
Catch/hour - weight in Kg.									
No. 1	1	238	105	47	43	25	15	-	3
No. 2	1	321.2	171.3	4.3	27.5	34.5	82.8	0.8	-
No. 3	1	151.4	52.8	1.4	37.7	19.8	40.4	0.1	-
% Composition									
No. 1	-	100.0	44.0	19.8	18.1	10.5	6.3	-	1.3
No. 2	-	100.0	53.3	1.3	8.6	10.7	25.8	0.3	-
No. 3	-	100.0	34.9	1.0	24.9	12.5	26.6	0.1	-

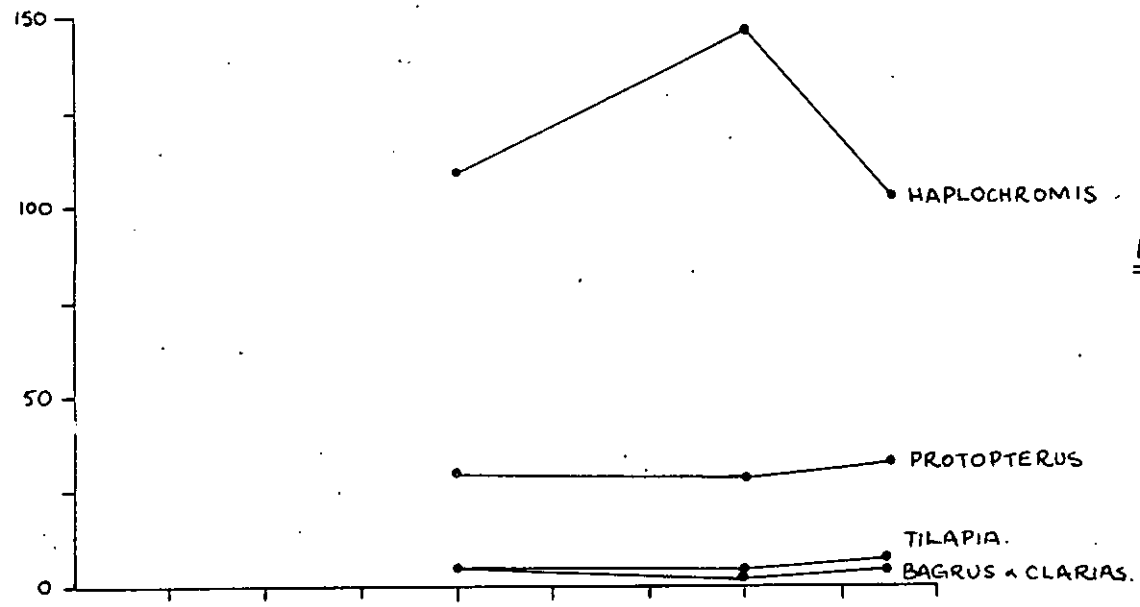
In the light of the results given in Table 2, it would appear that the UNDP No. 2 net is the best but the high catch figure obtained here is biased by two exceptionally heavy catches on the west side of Sigulu in October. If these two catches are excluded the total catch and Haplochromis catch figures for this net are very similar to those obtained over a much larger fishing time in the UNDP No. 1 net. The catches of other species vary considerably in the different nets but is more a reflection of the varying abundance of different species at different times than of the catching qualities of the nets. A more carefully executed fishing programme is necessary before these three nets can be adequately compared.

RELATIONSHIP OF TRAWLING SPEED AND CATCHES

In March and April, 1968 an attempt was made to determine the effect of towing speed and mesh size of the codend on the catches obtained in the trawl. The UNDP No. 1 trawl, operated from DARTER, was used for the trials which were conducted in two localities having different bottom types - soft mud on the north side of Buvu Island in the Salisbury Channel and hard mud (clay) and sand in an area just south of the Luamba Pennisular (Bukakata). At the Buvu Island site the trawl, fitted with the various mesh size codends, was towed at a speed of 1.7 knots and then at the maximum speed which could be obtained with that size of codend. Instead of each haul being made over a set distance it was made for the duration of one hour so that, in order to be comparable, the results had to be adjusted to a standard distance of 2.4 nautical miles. The procedure was the same in the Luamba Pennisular area except that the minimum speed was set at 2.4 knots instead of 1.7 knots. Unfortunately, it was only possible to make one, and sometimes two hauls with each mesh size at each speed.

Later in the year, when DARTER and the UNDP No. 1 trawl was operating in the Dagusi area with 2" and 2½" codends, various trawling speeds were tried. These were not necessarily in exactly the same spot but in the same general locality at the mouth of Macdonald Bay where the depth and bottom type is fairly uniform.

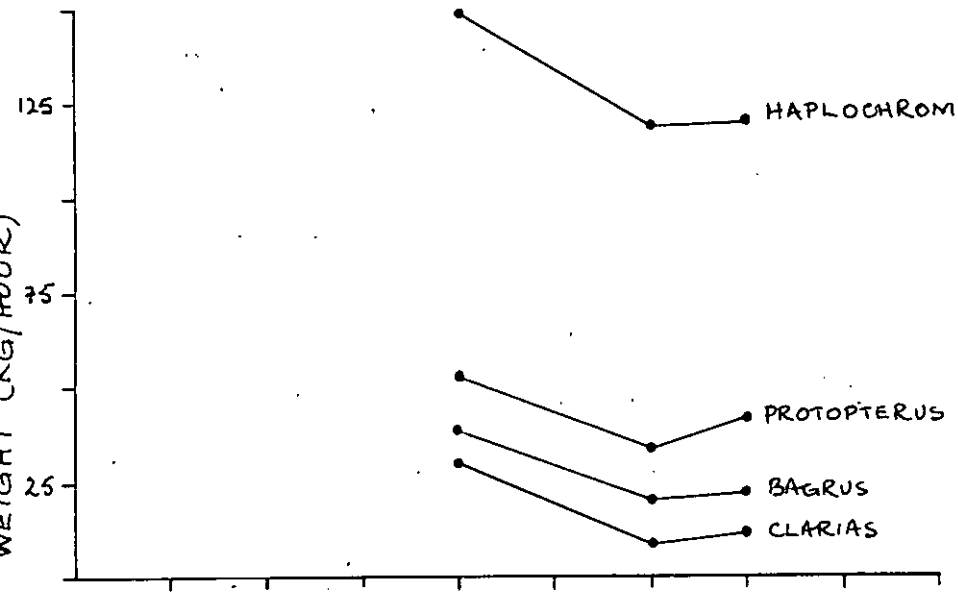
FIG. 5 RELATIONSHIP OF CATCH TO TRAWLING SPEED OVER THREE DIFFERENT BOTTOM TYPES - LAKE VICTORIA 1968.



LUAMBA.

HARD MUD.

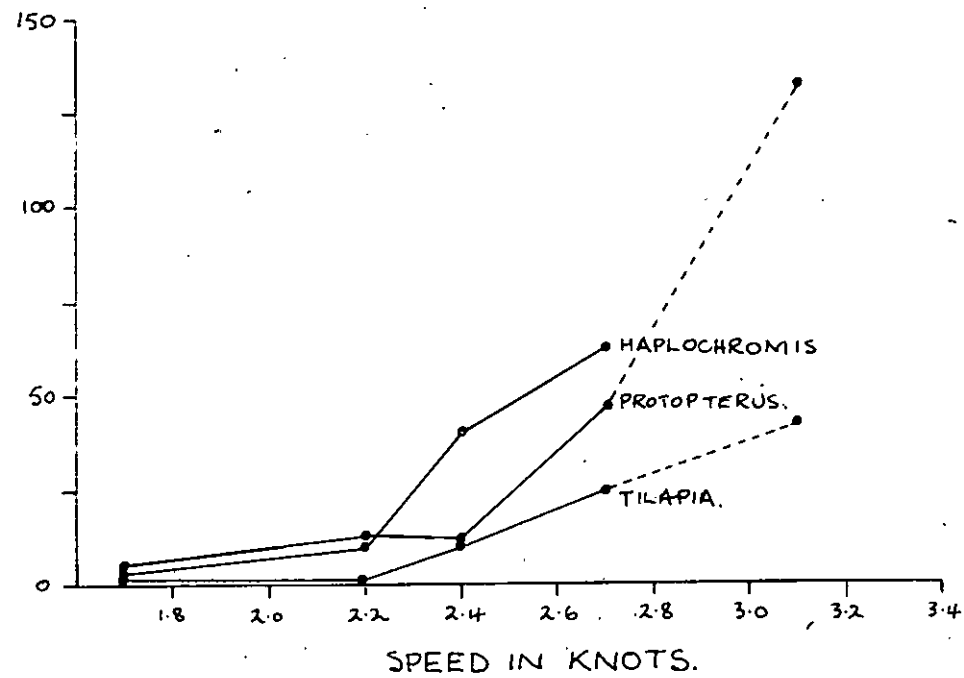
1" - 3" CODENDS.



MACDONALD BAY

MUD.

2" - 2½" CODENDS.



BUVU ISLAND.

SOFT MUD.

1" - 2½" CODENDS.

BROKEN LINE IS 3" CODE

The results showing the effect of speed on catches of the main species taken are given in Figure 5. Here, the average catch of each species for all mesh sizes used is plotted against towing speed. The Buvu Island graph shows that there is a marked increase in catch of all species with speed, particularly in excess of 2.2 knots. No figures are shown for Haplochromis over 2.7 knots as speeds in excess of this could only be obtained with a 3 inch mesh codend, and as will be shown later, this mesh size is too large to catch anything but very small quantities of large Haplochromis. The dotted line represents catches of Tilapia and Protopterus in the 3 inch codend only and both species show a steady increase in catch rate with speed. Catches of Bagrus and Clarias are not shown as these species formed an insignificant proportion of the catch in this area. The graphs for the other two areas show a very slight decrease in catch with speed in the case of Haplochromis and either no increase or only a very slight increase at speeds in excess of 3.0 knots for the other species. Thus it would appear that at speeds in excess of 2.4 knots, trawling speed has little effect on catches at the present time.

The conflicting picture presented by the Buvu Island graph and those from the other two areas is most probably due to the different qualities of the substrates over which the trawl must pass. In areas of very soft mud the trawl has a tendency to sink into the mud at slow speeds and the great pressure exerted by the mud on the net prevents the net from opening. At high trawling speeds the net and doors rise to the surface of the mud and only then is the proper opening and full fishing efficiency obtained. Over harder substrates, which exert little or no drag on the net and doors, the trawl will open to its proper width at much slower speeds. It is therefore probable that the graphs shown for Luamba and Macdonald Bay give a better indication of the effects of speed on catches than the Buvu Island graph.

THE EFFECT OF CODEND MESH SIZE ON CATCHES

A number of different mesh size codends have been used on the UNDP No. 1 trawl in the Luamba Pennisular, Buvu Island and Dagusi Island areas. In the former area 1", 2", 2½" and 3" nets were fished over the

FIG. 6 CATCH PER HOUR OF VARIOUS GENERA IN DIFFERENT MESH SIZED CODENDS AT LUAMBA (•) AND DAGUSI (○) USING UNDP No 1. NET.

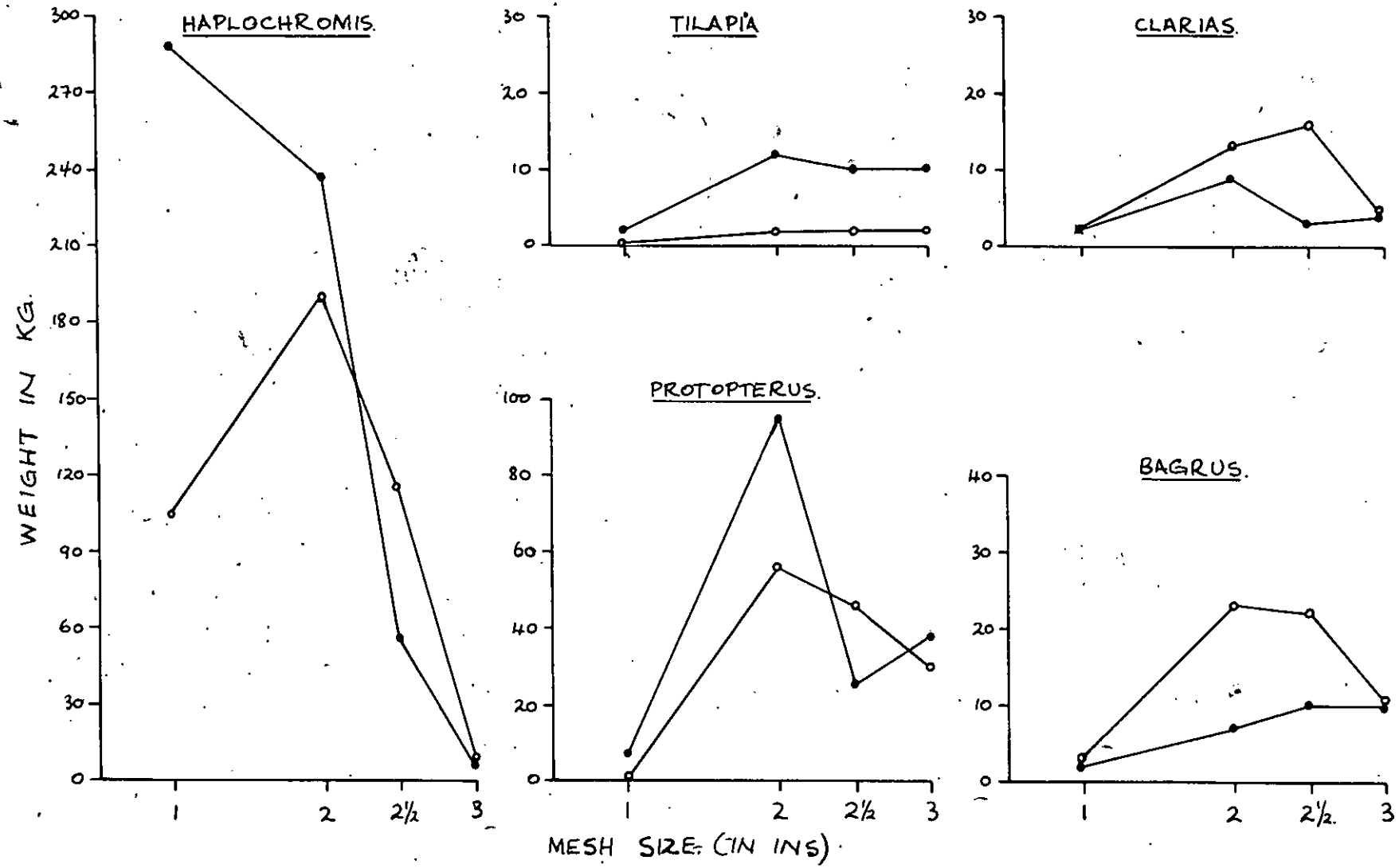
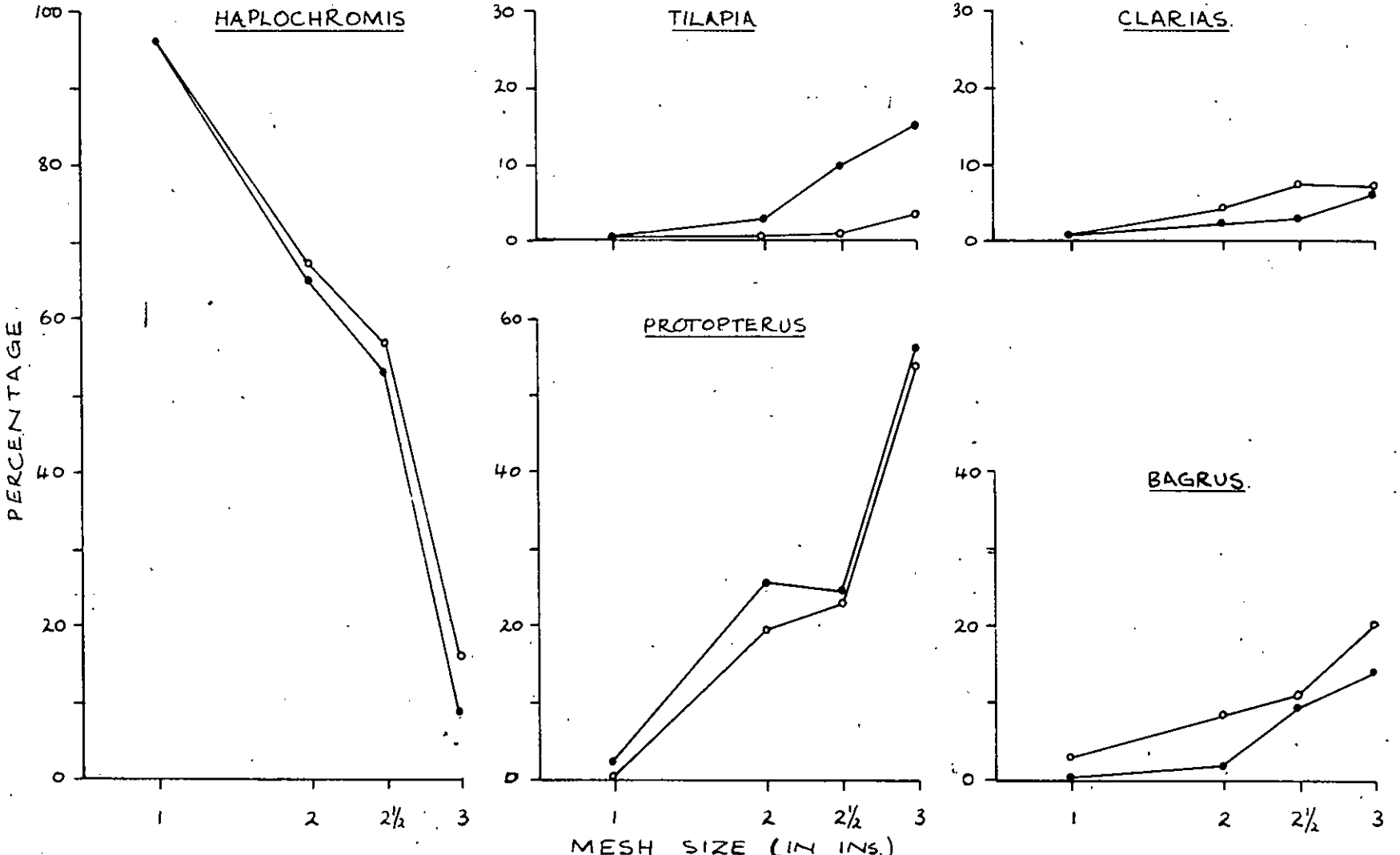


FIG. 7. PERCENTAGE OF VARIOUS GENERA IN CATCHES FROM DIFFERENT MESH SIZED CODENDS AT LUAMBA (•) AND DAGUSI (○) USING UNDP No 1. NET. - LAKE VICTORIA 1968.

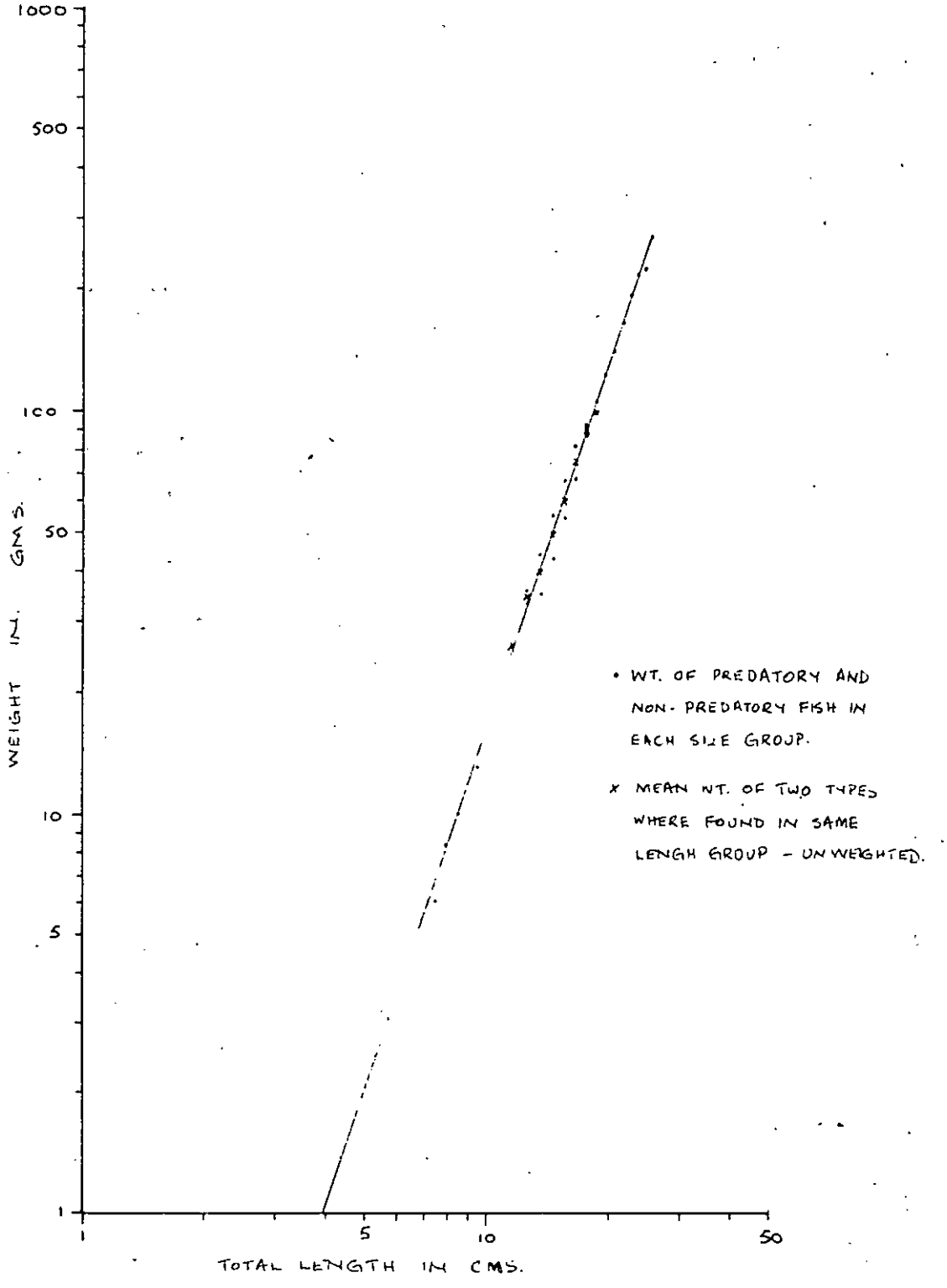


same ground during the experiment described in the previous section. The Buvu Island results are not taken into consideration here as it has been shown that towing speed played a dominant role in the fishing efficiency of the trawl. In the Dagusi area 2" and 2½" codends were used fairly extensively but not under controlled conditions as at Luamba. In this area only one haul at 2.8 knots was made with a 1" codend and two hauls at 3.1 knots with a 3" codend. In the results given in Figures 6 and 7 the factor of varying ground coverage caused by variations in the trawling speed has not been taken into account and the plots represent the actual catch/hour of the particular codend mesh size.

Figure 6 in which catch/hour is plotted against mesh size, shows that catches of Haplochromis fall off very markedly in codends with mesh sizes larger than 2". In fact, in a 3" codend the catch/hour of Haplochromis is so low as to be almost negligible (6-9 kg per hour). The Haplochromis catches in a 1" codend appear to vary greatly in their magnitude from higher than the 2" codend in the Luamba area to very much lower than 2" codend in the Dagusi area. In the latter case however only one haul was made with the 1" codend so the comparison is probably unrealistic. It would appear that the catch/hour of the 1" codend, at least in inshore regions, is probably approximately the same, or slightly higher than in the 2" codend (cf also Table 1).

The effect of mesh size on catches of species other than Haplochromis is not so clear cut. In all areas however the catches in a 1" codend are almost negligible, hardly ever being more than 2-8 kg/hour for any one species and the total not usually forming 4-5% of the catch (Figure 7). In general terms it might be said that in mesh sizes of 2" and over the quantities caught are approximately the same or increase very slightly at least up to 3". In a number of cases, notably Protopterus, Bagrus and Clarias the catches in the Dagusi area are higher in 2" and 2½" codends than in a 3" codend but as only two hauls were made with a 3" codend the comparison is probably unrealistic. In the case of Protopterus, the catches in a 2" codend in all areas sampled, but particularly the North-west region of the lake, were higher than in the

FIG. 8. TOTAL LENGTH WEIGHT RELATIONSHIP OF HAPLOCHROMIS FROM 7 HAULS LISTED IN THE TEXT.



other mesh sizes. This is probably due to the disproportionate number of hauls that were made in March with a 2" codend in the Zinga Bay area of the Salisbury Channel where Protopterus, appeared to be particularly abundant.

HAPLOCHROMIS LENGTH FREQUENCY DISTRIBUTION AND CATCH COMPOSITION IN RELATION TO MESH SIZE OF CODEND

During the year, although Haplochromis length measurements were taken from a fairly large number of hauls, it was only possible to make a detailed analysis of the species, their lengths, weights, sexes and gonad states from a total of 7 catches taken in various localities. These localities are as follows:-

Luamba Pennisular - 3 hauls over hard mud at 30 ft. with 2", $2\frac{1}{2}$" and 3" codend

Macdonald Bay - 1 haul over mud at 55' with a $2\frac{1}{2}$" codend

Musene Island - Dagusi - 1 haul over mud at 90' with a 2" codend

Luvia Island - Dagusi - 1 haul over mud at 130' with a 2" codend

Hunters Rock - 1 haul over mud at 200' with a $2\frac{1}{2}$" codend

From all the length data collected, frequency distribution curves of the Haplochromis caught in various mesh size codends have been constructed. However in some instances, for example when trying to assess both fishing effort required and trawl codend mesh sizes which should be employed to supply a commercial cannery with Haplochromis, it is more desirable to represent each length class of fish by a percentage weight than by a percentage number. This has been done by constructing an overall length/weight curve (Figure 8) for all Haplochromis weighed and measured from the above listed hauls and so determined a weight value of each class mark. The product of this standard class weight and the class frequency converted into a percentage represent the precentage weight frequency of each length class. These figures can only be approximate as the standard class weight should be expected to vary with locality in accordance with the species composition of the Haplochromis stocks. As an example, the standard class weight for the 13.5 cm class mark in the Luamba area was 38 gms compared with 41 gms in the Dagusi area. This is due to the fact

FIG. 9. "LESS THAN" OGIVES FOR HAPLOCHROMIS CATCHES IN VARIOUS MESH SIZES OF CODEND - DAGUSI

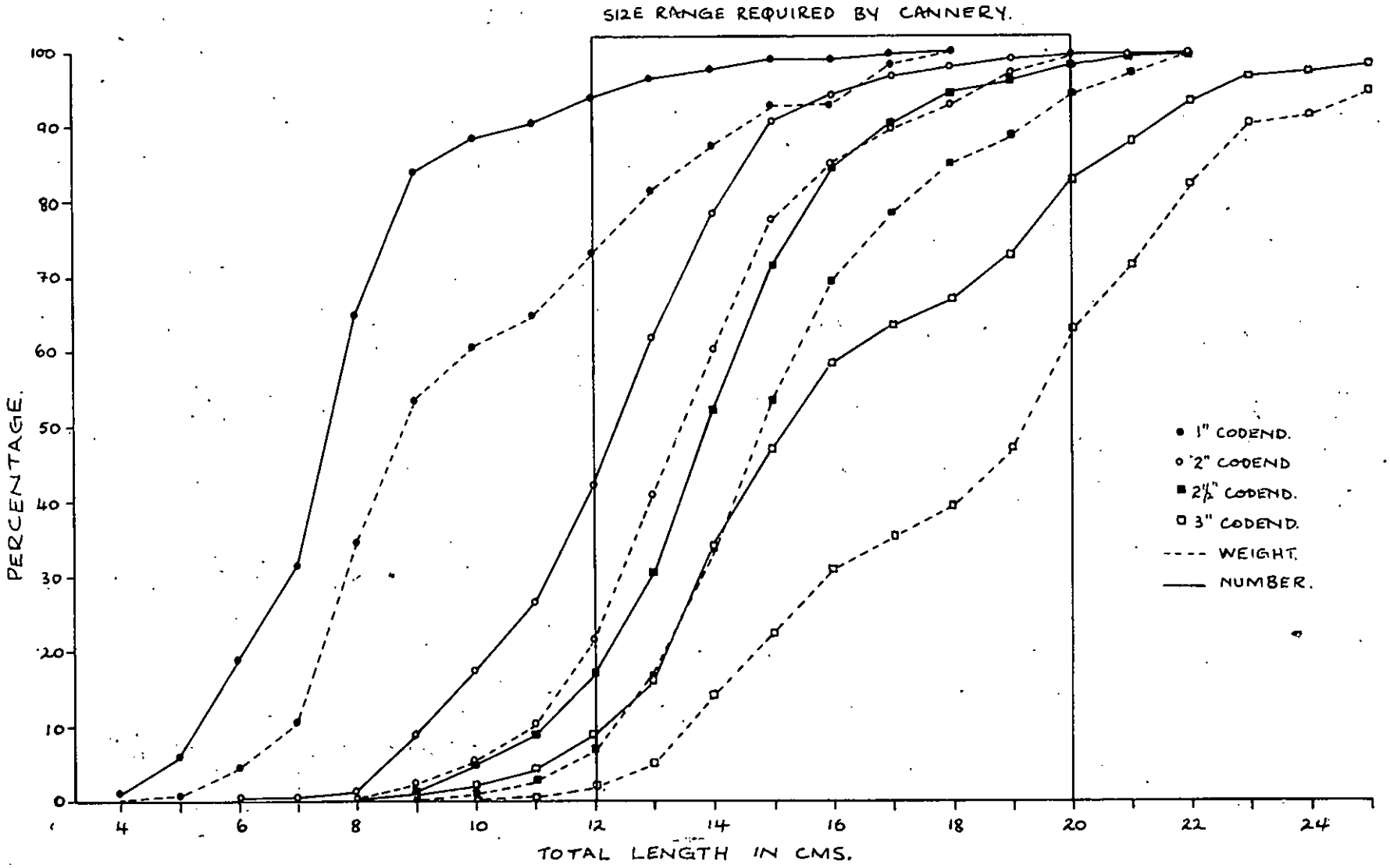


FIG. 10. "LESS THAN" OGIVES OF HAPLOCHROMIS CATCHES IN VARIOUS MESH SIZES OF CODEND - LUAMBA PENINSULAR 1968.

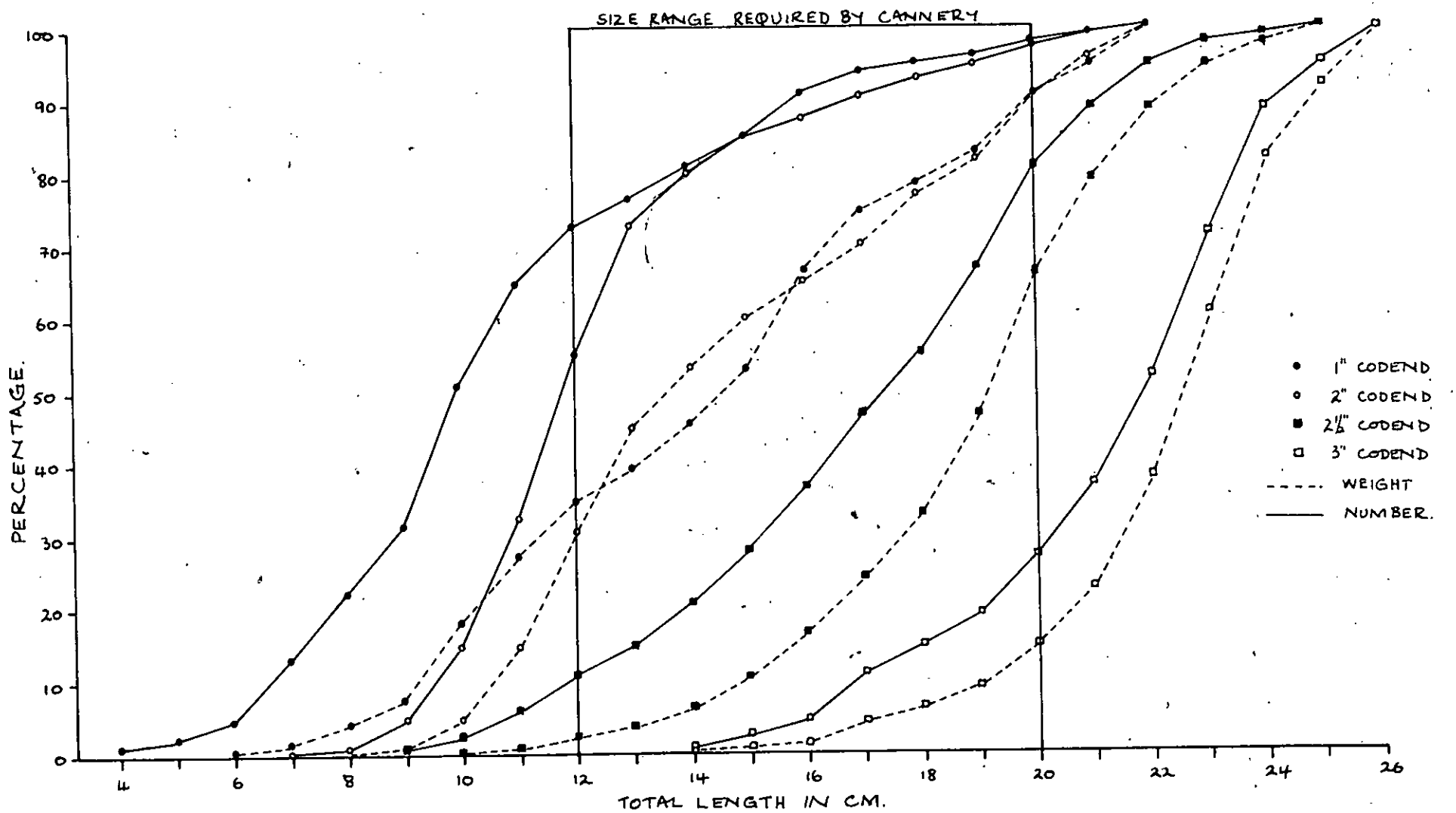


Table 3 : Haplochromis catch characteristics of different mesh size codends on the UNDP No.1 trawl

	NET	RANGE (cms. T.L.)	MEAN (cms.T.L.)	SD	SD RANGE (cms.T.L.)	WITHIN 12-20 cms. % number	% wt.
Luamba	1"	2.0-21.9	10.6	3.6	7.0-14.2	25	56
	2"	6.0-21.9	12.4	2.8	9.6-15.2	42	61
	2½"	8.0-24.9	16.9	3.5	13.4-20.4	70	64
	3"	13.0-25.9	21.3	2.6	18.7-23.9	28	15
Dagusi	1"	3.0-17.9	7.7	2.2	5.5- 9.9	6	27
	2"	5.0-21.9	12.3	2.3	10.0-14.6	58	77
	2½"	7.0-21.9	14.0	2.6	11.4-16.6	81	88
	3"	7.0-26.9	16.1	3.7	12.4-19.8	74	61

Table 4: Catches of 12-20 cm. T.L. Haplochromis from 2" and 2½" codends

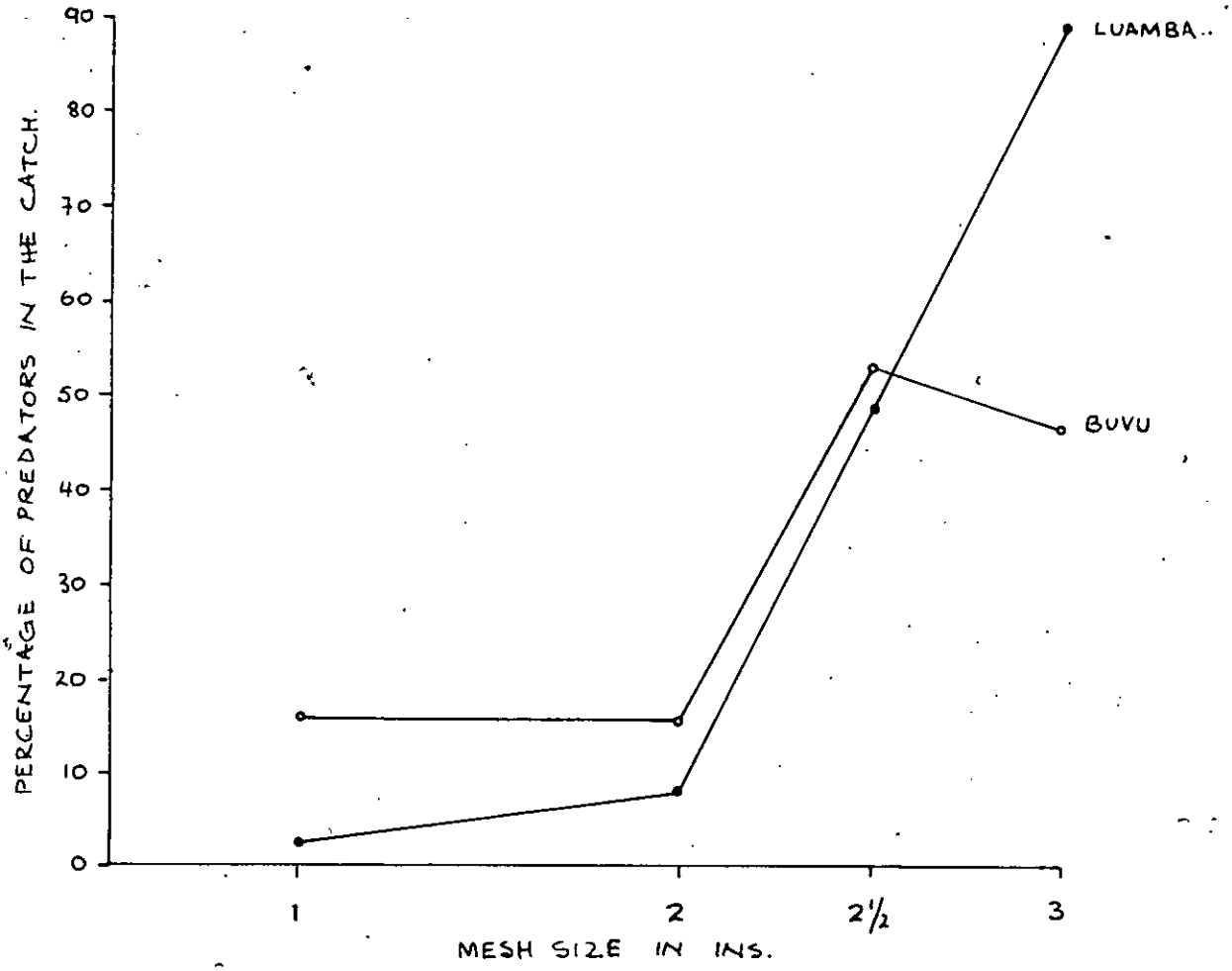
	NET	CATCH/HOUR	% USEABLE	USEABLE CATCH/HOUR
Luamba	2"	237	61	145
	2½"	55	64	35
Dagusi	2"	190	77	146
	2½"	116	88	102

that in the latter area H. empodisma is the dominant species in this size group whereas at Luamba the species was not present in the catches and its place was taken by H. ishmaeli and H. obtusidens.

Length and weight frequencies for the Dagusi and Luamba populations are plotted as cummulative percentage ogives in Figures 9 and 10 and some of the more relevant data set out in Table 3. It can be seen that the frequency distributions of the various mesh sizes are strikingly different for the two areas. This is not due to a change in the characteristics of the net or codends but is solely a reflection of the different species composition of the two populations. The Dagusi population is largely dominated by one species, H. empodisma. This species has a maximum adult size of about 16 cms. T.L. and an average size of around 14 cms. The length selection curves for 2", 2½" and 3" codends in the Dagusi area up to the 90%, 80% and 60% levels respectively reflect, almost entirely, codend selection characteristics for this one species. Little can be said about the 1" curve as only one haul was made and not analysed for species composition. The Luamba population, on the other hand, is not dominated by any one species to the same extent and appears to be a population in which a number of large predatory species, caught mostly in the 2½" and 3" codends, are supported by a diversity of small, non-predatory species which are present in large numbers and caught mainly in 1" and 2" codends. This is shown most clearly in Figure 11 in which the percentage of predatory Haplochromis in the catch is plotted against mesh size. While the 1" codends have almost no predatory forms in the catch the 3" net is almost entirely predators. The majority of the non-predators in the 2½" codend were the species H. ishmaeli which grows to a larger size than most of the other non-predators in the region but does not dominate the population in the same way that H. empodisma does in the Dagusi area. Thus from these two examples it can be seen that when assessing the likely returns to a cannery from a particular area, the species composition of the population becomes important and may call for different mesh sizes of codend to be operated in different areas.

From a study of the canning process by Dr. Beatty and Dr. Hesse of U.F.D., it has been shown that only those Haplochromis of total length

FIG 11. HAPLOCHROMIS CATCH COMPOSITION WITH MESH SIZE.



between 12.0 and 20.0 cms are of a suitable and economic size. Therefore, the precentages (by weight and number) of the catches which fall within the range have been calculated from Figures 9 and 10 and are shown in Table 3.

It can be seen that the returns from a 3" codend (15% by weight) at Luamba and a 1" codend (27% by weight) at Dagusi are far too low. In both areas the returns from a $2\frac{1}{2}$" codend are highest (64% and 88% respectively) but the return from a 2" codend, although slightly lower, are still acceptable. However, in Table 4 these estimated useable percentages are expressed as a catch per hour for the two sizes of codend and it can be seen that the 2" net will still produce a higher quantity of useable fish than the $2\frac{1}{2}$" codend. Although it would appear that the 2" codend is the most economic size to be used in a commercial fishery for Haplochromis, it is felt that some preliminary fishing should be carried out using a $2\frac{1}{4}$" codend with a view to possibly increasing the useable percehtage of the catch without significantly reducing the quantities caught.

When considering the use of a particular mesh size codend, say 2" or $2\frac{1}{2}$", in a Haplochromis fishery, account should be taken of the likely effect this will have on the natural balance between species in the population. Very little is known about this at the present time, even if only the relationships between predators and non-predators as a whole are considered; i.e., in a natural population how many predatory forms can be supported by the smaller prey species present in the population? Figure 11 shows that if a 2" codend is fished in the Luamba population (April, 1968), the ratio of non-predators to predators in the catch is approximately 12 - 1 whereas the ratio in a $2\frac{1}{2}$" codend is nearer 1 - 1. This latter ratio is certainly not similar to the ratios which are likely to be found in the natural population and thus by fishing a $2\frac{1}{2}$" codend in this area the natural balance of the population will be upset by removing a much greater proportion of the predatory forms, thus possibly relieving the predation pressure on the smaller forms which may then be expected to increase in number. The ratios obtained in a 2" codend are probably nearer the proportion present in the natural population and so the use of a codend

Table 5 : Summary of bottom trawling in the Entebbe area of Lake Victoria - 1968

Habitat	Date	Depth (ft)	Bottom	Time (hrs)	Mesh (ms)	Speed (km)	Catch per hour in Kg. Total	Hapl.	Til.	Proto.	Bagr.	Clar.	Synod.	Barb.	Trawl used
Sango Bay area	Jan-Feb.68	30-65	Clay	13.6	1-2	2.4-2.7	177.7	119.2	8.3	27.7	22.5		-	-	EA1 & UN 1
	Oct. 68	30	"	2.0	2½	3.0	132.0	64.0	5.0	30.0	5.0	28.0	-	-	UN 3
Luamba Pennisular	Nov. 67	20-40	Clay, Sand	15.3	1	2.4	208.2	196.1	7.1	-	3.4	5.0	-	1.1	EA 1
	Jan-Feb.68	30-35	Clay, Sand	6.3	1-2	2.4-2.7	316.5	271.1	6.0	31.3	8.1		-	-	EA 1 & UN 1
	Mar-Apr.68	35	Clay	6.0	1-2½	2.4-3.2	253.5	198.9	6.5	39.5	5.0	3.3	-	0.3	UN 1
Bukakata Channel	Jan-Feb.68	32-45	Mud, Sand	7.0	1-2	2.4-2.7	282.6	223.0	7.7	27.0	24.9		-	-	EA 1 & UN 1
Salisbury Channel	Jan-Feb.68	35-70	Sand, Mud	4.5	1-2	2.4-2.7	186.9	113.1	11.4	35.6	26.8		-	-	EA 1 & UN 1
	Mar-Apr.68	25-60	Mud	19.0	1-2½	2.1-3.5	294.1	165.9	18.2	92.6	7.7	9.7	-	-	UN 1
	October 68	30-65	Mud	4.0	2½	3.0	171.0	72.0	10.5	33.2	19.0	32.0	3.8	0.5	UN 3
Damba Channel	October 68	65-85	Mud	3.8	2½	3.0	267.9	150.8	3.2	23.4	37.4	34.7	18.4	-	UN 3

of this mesh size is more likely to maintain an equilibrium in the population which remains after heavy fishing. The non-predators in a natural Haplochromis population usually represent a fairly wide variety of trophic groups, the proportions present presumably depending on the relative availability of the particular food source. In the Luamba area the non-predatory catch in the 2½" codend was formed almost entirely of one species, a molluscivore, whereas a much wider range of species from different trophic groups were present in the 2" codend catches. Thus among the non-predators alone the catch from a 2" codedn would again be likely to maintain a more satisfactory balance in this part of the population.

Thus from observations (relatively few in number) made in two different habitats, it may be concluded that from both a biological and economic point of view, a 2" codend is a much more suitable size to be employed in a trawl fishery for Haplochromis than a 2½" codend, the 1" and 3" codends being apparently uneconomic on the whole. The biproducts, in terms of other species caught, of such a fishery would appear to be of the same order of magnitude whether a 2" or a 2½" codend were used.

GENERAL TRAWLING RESULTS AND DISTRIBUTION OF GENERA

A general summary of the trawling results which have been obtained in 1968 is given in Tables 5 and 6. Due to the variety of nets and codend mesh sizes used, emphasis cannot be placed on the actual figures for total catch/hour and Haplochromis catch/hour as it has been shown that these vary greatly with the type of codend used. Generally, however, it would appear that, in the North West part of the lake, the Bukakata Channel and the sand area south of this along the shore to Dumu Point are the most productive grounds from the point of view of Haplochromis, the catches being in the order of 200-250 kg/hour. Good returns were also obtained from the Salisbury Channel area (north side) and the Damba Channel with catches in the order of 150-200 kg/hour.

In the Jinja area the trawling operations covered a much wider depth range but the bottom type was generally mud of varying consistency.

Table 6: Summary of bottom trawling in Jinja area of Lake Victoria - 1968

Habitat	Date	Depth (ft)	Bottom	Time (hrs)	Mesh (ms)	Speed (km)	Catch/hour in Kg. Total	Hap.	Til.	Proto.	Bagr.	Clar.	Synod.	Lates	Barb.	U.N. Trawl used
Ingira Bay	Sept.68	48-50	Mud	3	2½	2.4-3.0	158.7	30.0	-	26.7	5.0	69.7	-	27.3	-	2,3
	Oct. 68	30-50	"	11	2½-4	2.4-3.0	248.0	18.2	7.0	33.8	0.2	183.8	-	5.0	-	2,3
	Nove.68	24-33	"	7	2½	2.8-3.0	355.7	39.7	52.2	77.1	0.9	169.9	-	16.9	-	3
						MEAN	267.3	26.7	20.8	46.6	1.1	160.2	-	11.9	-	
Pilkington Bay	Sept-Oct.68	24	Mud	1.5	2½	2.8	178.7	28.7	28.7	46.0	-	65.3	-	10.0	-	2,3
Hannington Bay	Sept-Nov.68	24	"	4.2	2½	2.4-3.0	90.0	9.5	5.2	10.5	6.7	22.1	-	36.0	-	2,3
East of Dagusi	May 68	54-66	Mud	6.5	1-2½	2.7-3.2	321.3	149.0	124.8	19.6	14.5	3.7	+	9.7	-	1
	July 68	45-75	"	14.75	2-2½	2.4-3.1	213.8	134.3	0.8	45.0	22.4	10.6	+	0.7	-	1
	Aug. 68	48-60	"	8.75	2½	2.8-3.0	221.3	87.9	22.3	52.9	34.4	23.8	-	-	-	1
	Sept.68	48-66	"	6.5	2-2½	2.4-3.6	199.0	70.9	2.9	71.2	17.4	35.8	-	-	0.8	1,2,3
	Oct. 68	45-75	"	9.5	2½	2.7-3.0	259.4	135.9	2.6	18.6	30.1	72.1	-	-	0.1	2,3
Itome Bay	Aug-Sept.68	60-90	Mud	3.6	2½	2.8-3.1	140.0	52.2	1.0	30.3	15.3	38.1	3.1	-	-	1,3
Buvuma Channel	Aug-Oct. 68	65-105	"	9.0	2½-4	2.7-3.2	127.4	58.8	-	13.1	4.3	39.8	11.4	-	-	1,2,3
South Buvuma	July 68	75-135	Mud	5.0	2	2.4-2.8	146.9	113.6	-	14.4	11.8	6.5	0.6	-	-	1
	Oct. 68	75-115	"	2.0	2½	3.0	51.5	27.5	0.5	2.0	5.5	14.0	2.0	-	-	2,3
Hunters Rock	Sept-Oct.68	195-220	"	12.0	2½	2.7-3.0	68.4	39.6	0.1	-	11.9	7.3	9.5	-	-	2,3

The total and Haplochromis catches in the area show the same general pattern as previous trawling operations in the area. This is a definite tendency for optimum catches (at least of Haplochromis) to be made in water approximately 45-75' deep; and with an increase in depth over 75' there is a corresponding decrease in catches. A decrease in catches in shallow bays is also evident but as the substrate in these sheltered areas is usually very soft, the decrease in catches may be merely a reflection of the decrease in the efficiency of the trawl over this type of bottom.

Reviewing the whole situation therefore, it would appear that maximum catches of Haplochromis are made over hard or sandy bottoms and that on mud the optimum depth appears to be about 45-75 ft. These results re-affirm the conclusions drawn from previous trawling operations.

As codend mesh sizes of 2" to 3" have very little effect on the quantities of other species caught, i.e. Protopterus, Bagrus, Clarias, Tilapia and Lates, the catch figures and distribution data for these are likely to be more reliable. Detailed comments on the distribution of these species are contained in Appendix A of EAFFRO Annual Report for 1968.

REFERENCES

GEF, J.M. & GILBERT, M.P. (1968) The Establishment of a Commercial Fishery for Haplochromis in the Uganda Waters of Lake Victoria - Part II 1967. EAFFRO Occasional Paper No. 8.