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# Characteristics of the Fish's Body Affecting Gillnet Selectivity

by

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## ABSTRACT

Experimental fishing with a fleet of gill nets of various mesh sizes was carried out on seven occasions during 18 months in order to understand the main factors related to the characteristics of the fish' body which affect the selectivity of gill nets. Data were analyzed for 4 species: sciaenids *Micropogonias furnieri* and *Menticirrhus americanus*, mugilid *Mugil platanus* and clupeid *Brevoortia pectinata*. The relations between girths at each position along the body and distance from the snout can be used to represent the body shape of each species in an attempt to explain the reasons for the catch. This knowledge of girth and fish profile helps to indicate the best mesh size to catch a certain length range and probably produces more reliable results than fish lengths. Catch is most efficient when fish girth slightly exceeds mesh perimeter, i.e., when the ratio "girth at the position where the fish was caught/mesh perimeter" ranges from 1 to 1.1. The relationship between the size of fish and the mesh is through girth and not through length. Thus, the girth frequency distribution of all the species should be the same for a particular mesh size, but because the relations between girth and length differ, there are differences between species' length distributions.

Gear Selectivity/Technical Interactions Symposium

## INTRODUCTION

Apart from fish size, there are other body dimensions which also influence selectivity: the length-girth-weight relationships (Kipling, 1957; Regier, 1969; Kawamura, 1972).

Farran (1936) found that the maximum girth of herring varied with the condition factor, which in turn determined whether fish of a given length would be captured in a mesh of a given size. McCombie and Fry (1960) considered that the maximum girth provided the best estimate of the size of fish caught, but Regier and Robson (1966) raised the objection that girths are often estimated from lengths, and Regier (1969) concluded that unless precise measurements of girths could be taken at the position of meshing, it was better to continue to use length as the basis for establishing selectivity.

The aims of this study were to investigate the adequacy of using girth in preference to length when estimating selectivity curves, and the effects of interspecific differences in body shape and anatomical projections on gill net selectivity. These effects should be taken into account when estimating selectivity through analytical methods.

## MATERIAL AND METHODS

### 1. Fishing Gear

A fleet of anchored gill nets was set in each of 5 stations along the estuary of Patos Lagoon (Brazil), in the area between Barra do Rio Grande and Sao Lourenço do Sul, a town located 93 km north up the estuary (Fig.1). This area was divided in 5 zones, selected according to the effect of marine waters in the estuary, in such a way that the innermost station corresponded to the least saline waters. A total of seven 7-day cruises were made between March 1988 and August 1989.

Nets were made of monofilament white polyester, with floats attached every 0.5 m along the headline. The footrope was weighted by individual lead weights, attached about 1.5 m apart. Each net, one of each mesh size, consisted of a single section 50 m long and 3 m deep, rigged with a hanging coefficient of 0.5, with stretched meshes of 50, 60, 70, 80, 90, 100, 110 and 120 mm. The nets of each mesh size were identified by the colour of the floats.

Nets were set at least 50 m apart to in order to avoid the effect of one net's catch on that of another net; the linear order of the nets (one of each mesh size) was varied randomly each time they were set. The end of each net was attached to an anchor on the lagoon bed and each anchor was marked with a buoy.

Nets were set along the direction of the water currents to reduce the risk of them being lost or pushed towards the bottom (thus liable to act as tangle nets) in a strong flow of water, and were fished in waters up to 3 m deep so that they would hang from surface to bottom. Nets were left to fish for a period of 12 to 15 hours (from dusk to dawn). A total of 236 lifts were made during the period of the study (Table 1).

The position of enmeshing along the fish's body was recorded before removing fish from the net. Fish that fell out the nets as they were being hauled and that showed the position where they were enmeshed, were included in the total catch.

Catch by unit effort was estimated for each species and mesh size as weight (g) per hour of net setting and as number per hour of net setting. Fishing effort was determined as total fishing hours for all cruises. On the occasions when the nets were set but catch was nil, the values were included.

2. Sampling

All fish caught were measured for total/fork length by species, mesh size and station. For those species caught in large numbers, subsamples of 2 individuals by 1-cm length class per station were taken, up to a total of 10 fish by length class by mesh size for each cruise to comprise the morphological subsamples.

Girths and distances from the snout were measured at seven or eight positions on the fish's body (Fig.2). To represent the positions in which fish can most easily be wedged, the body shape was described by plotting the girth at each predetermined position against the distance from the snout to the respective position (McCombie and Berst, 1969). Girths and distances measured from the snout were expressed as proportions of total or fork length for each specimen and averages for each position were determined.

## RESULTS

The fleet of nets was set for a total of 3,431 h during 7 cruises, catching 30 species belonging to 19 families (Table 2). Of these, 4 species were caught throughout the whole period: *M.furnieri* and *M.americanus* (Sciaenidae), *M.platanus* (Mugilidae) and *B.pectinata* (Clupeidae). *M.furnieri* was the most frequently captured species, comprising up to 26.5% of the total, and *M.platanus* was the most abundant by weight (31.2%). These four species are analysed in this study.

1. Catch per Unit of Effort

When CPUE by mesh size for all cruises and species is examined, the 50 mm net appears to be the most efficient in terms of numbers of fish, and the 70 mm net the most efficient in terms of weight (Fig. 3).

*M.furnieri* gave the highest value of CPUE in numbers and *M.platanus* in weight (Fig.4), and *M.americanus* and *B. pectinata* showed similar values of CPUE in both numbers and weight.

*M.furnieri* and *M.americanus* showed similar CPUE trends with mesh size (Fig.5): those caught by small mesh size nets were more abundant and catches decreased with larger mesh sizes. Catches of *M.americanus* by nets larger than 70 mm were negligible. Because of the high values of CPUE of *M.furnieri* and *M. americanus* for the 50 mm net, it appears that the largest numbers of the population of these species were of a size that were sampled most effectively by 50 mm mesh size or less.

*M.platanus* showed different tendencies for CPUE with mesh sizes in terms of weight and numbers (Fig.6). CPUE in weight increased with larger mesh sizes, reaching a peak in the 90 mm net at values which were similar to the ones recorded in the nets of 100, 110 and 120 mm. CPUE in numbers increased from small mesh sizes to reach a peak in the 70 mm net and then decreased for nets of larger mesh sizes. *B.pectinata* was caught most frequently by the 70 mm net, catches decreasing for smaller and larger mesh nets.

2. Body Shape

The maximum girth of *M.furnieri* and *M.americanus* is located next to the anterior end of the base of the first dorsal fin (Fig.2). This position, and the base of pectoral fin and the posterior end of opercula, are close to the same imaginary transverse line. Catches at these positions for *M.furnieri* accounted for more than 73% of the total, and for *M.americanus* for about 55% of the total. Catches at the pre-opercula were also numerous in the latter species (28.4%). When girths and distances were related, the position of pectoral and first dorsal girths were about the same for *M.furnieri* (Fig.7). For *M. americanus*, girths on these positions and opercula girth gradually increased.

First dorsal, pectoral and opercula girths were linearly related to total length and an analysis of covariance did not show any significant difference between the slopes of the relationships whilst the elevations were not equal, for both species (Table 3).

Maximum girth ($G_{max}$), at the base of first dorsal fin, is linearly related to total length (TL) for both species according to the following equations:

*M.furnieri*

$G_{max}$ (mm)=-9.28+0.642 TL(mm) $r^2$=0.93 n=280

*M.americanus*

$G_{max}$ (mm)=-38.20+0.693 TL(mm) $r^2$=0.89 n=170

Table 3- Analysis of covariance between the regressions of girth at opercula (Op), girth at pectoral fin (Pect) and girth at first dorsal (D1) and total length.(ns- not significant; *- significant at P=0.05).

| Source | df | SS | MS | F |
|---|---|---|---|---|
| *M.furnieri* | | | | |
| Pooled | 835 | 33910 | 40 | |
| Between slopes | 2 | 172 | 86 | 2.12ns |
| Total | 837 | 38736 | | |
| Between means | 2 | 4826 | 2413 | 59.4* |
| *M.americanus* | | | | |
| Pooled | 500 | 24104 | 48 | |
| Between slopes | 502 | 24172 | 48 | 0.7ns |
| Total | 504 | 30430 | | |
| Between means | 2 | 6258 | 3129 | 64* |

*M.platanus* was mostly caught by being enmeshed around the posterior end of the opercula and the base of pectoral fin, which accounted for 73% of the total catch; these positions are located on the same region of the body (Fig.2). This species has a large part of the body which has approximately the same girth, from the opercula to the base of the anal fin. However, proportions of girth on fork length showed that the region of maximum girth is near to the position of the first dorsal fin (Fig.8), in spite of the fact that opercula and pectoral girths are similar and even though these locations are considerably far apart. In contrast to the other species, the anal girth of *M.platanus* is bigger than that at the second dorsal girth.

Maximum girth, measured at the base of the first dorsal fin, is linearly related to length by:

$G_{max}$ (mm)=-8.54+0.584 FL(mm) $r^2$=0.95 n=208

In *B.pectinata*, the maximum girth is next to the position of the base of the first dorsal fin (Fig.2). Girths at opercula and pectoral fin are about the same and 51.8% of the fish were caught in this region. About 25% of fish were enmeshed in the region located between the opercula and pectoral fin and the first dorsal fin. The relationship between girths and distances along the body showed that girth is maximum at the first dorsal fin and that pectoral and opercula girths can be considered to be the same (Fig.8). About 36% of the total catch of this species was composed of fish which fell from the nets because in these occasions this species was held in the net by entanglement of its ventral spines.

Maximum girth, measured at the base of the first dorsal fin, is linearly related to length by:

$G_{max}$ (mm)=-2.10+0.790 FL(mm) $r^2$=0.95 n=238

Opercula and pectoral girths of *M.platanus* and *B.pectinata* were linearly related to fork length and the analysis of covariance did not show any significant difference between the slopes of the relationships although the elevations differed (Table 4).

Table 4- Analysis of covariance between the regressions of girth at opercula (Op) and girth at pectoral fin (Pect) and total length.(ns- not significant; *- significant at P=0.05).

| Source | df | Sb ($x10^{-3}$) | SS | t |
|---|---|---|---|---|
| *M. platanus* | | | | |
| Op | 205 | 5.84 | | |
| Pect | 204 | 6.19 | | 1.19ns |
| Elevation | 413 | | 21616 | 7.35* |
| *B.pectinata* | | | | |
| Op | 236 | 7.98 | | |
| Pect | 236 | 8.47 | | 0.24ns |
| Elevation | 473 | | 29684 | 2.74* |

Although fork length is a more accurate measure than total length for *M. platanus* and *B.pectinata* because the caudal fin can be easily eroded, linear regressions of total length against maximum girth were also plotted for these two species to investigate any difference between the species, since the area around the first dorsal fin corresponds to the region of maximum girth for all 4 species (Fig.9). The length-girth relations, except for *M.platanus*, showed similar slopes. An analysis of covariance revealed that all regressions differed significantly from each other (Table 5). Girths of *M.platanus* increased at a smaller rate for each unit of length when compared to the other species, an evidence of its elongated body shape, which is typical of members of the family Mugilidae.

Table 5- Analysis of covariance between the regressions of maximum girth and total length for *M.furnieri*, *M.americanus*, *M.platanus* and *B.pectinata*.(*- significant at P=0.05).

| Source | df | SS | MS | F |
|---|---|---|---|---|
| Pooled | 859 | 73664 | 85.7 | |
| Between slopes | 3 | 14767 | 4922 | 71.5* |
| Total | 862 | 219072 | | |
| Between means | 3 | 145408 | 48469 | 565* |

3. Position of Capture

To examine the effect of capture at different body positions on the total catch, the methodology described by McCombie and Berst (1969) was used. The relative frequencies of the fish caught were plotted against the ratio "maximum girth/mesh perimeter" (Gmax/P) and against the ratio "girth at the position where the fish was caught/mesh perimeter" (Gc/P), discriminated by points of enmeshing (Figs.10 and 11).

For *M.furnieri*, the modal values of Gmax/P for fish caught at opercula, pectoral fin and first dorsal fin were identical to that of the total catch, at 1.1 (Fig.10, left upper panel). The curve of fish caught by the pre-opercula contributed a positive skew.

For *M.americanus* there was also a positive skew, produced by fish caught by the orbital region and pre-opercula (Fig.10, left lower panel). The modal value of Gmax/P for fish caught either by the pectoral fin or first dorsal fin was 1.1 and was identical to the value for the total catch. For fish caught by the opercula the modal value was 1.2.

For *M.platanus* a slight positive skew was introduced by fish caught at opercula (Fig.11, left upper panel). Modal values were 1.2 for fish caught at the opercula and 1.1 for those caught near the pectoral and first dorsal fins.

For *B.pectinata* there was little influence of the component curves to any skewness; fish caught at opercula showed a wide range of Gmax/P ratios, from 1.0 to 1.2. The modal value for total catch and pectoral fin were at 1.1 (Fig.11, left lower panel).

When considering the girth where fish were actually caught (Gc/P) (Fig.11, right panel), curves of *M.furnieri* and *M.americanus* showed opposite trends when compared with Gmax/P curves. For *M.furnieri*, a negative skew was produced by fish caught at opercula, and modal values were all 1.0 for captures at the pre-opercula, opercula and pectoral fin and 1.1 for the first dorsal fin.

For *M.americanus*, a negative skew was introduced by fish caught by the orbital region, where the mode was 0.8, whilst the remaining mode was 1.1 (Fig.11, right panel).

Modal values of Gc/P for *M.platanus* were 1.0 for fish caught at the position of the opercula and pectoral fin and 1.1 at the first dorsal fin (Fig.11, right panel).

Modal values for *B.pectinata* varied between 1.0 for pectoral fin and 1.1 for opercula and dorsal fin positions (Fig.7, right panel).

4. Length Frequency Distributions

As expected, caught fish lengths increased with larger mesh sizes. For the species considered here, the distributions fitted normal curves, showed obvious modes and included few fish for smaller and larger lengths.

For *M.furnieri*, mean lengths varied from 18.5 cm for a 50 mm net, through 21.3 cm for a 60 mm net to 24.4 cm for a 70 mm net (Fig.12). *M.americanus* had larger mean lengths than *M.furnieri* for the same mesh sizes (23.4 cm, 25.4 cm and 26.7 cm, respectively) (Fig.12). *M.platanus* had unimodal distributions for all mesh sizes, in spite of the small numbers of fish caught by each mesh size (Fig.13). Mean fork lengths varied from 19.6 cm for 50 mm mesh to 45.0 cm for 120 mm mesh. *B.pectinata* was the smallest species caught, at lengths for all mesh sizes ranging from 10 to 32 cm. Mean fork lengths varied from 16.4 cm for a 50 mm net, 18.4 cm for a 60 mm net, to 20.9 cm for a 70 mm net (Fig.13).

5.Girth and Mesh Size

Because fish are caught by enmeshing, girth of capture and mesh size seem to be more closely related than fish length and mesh size. To demonstrate the validity of this assumption, the variances of the relationships of fish length and maximum girth vs. mesh size by species were compared. The variances of the first relationship are significantly smaller than those of the latter for all species (Table 6). Maximum girths varied less in relation to the same fish length than fish lengths on maximum girths for all species (Table 6). These results imply that the range of values that girths can assume is smaller than those showed by lengths for the same girth and that girth measurements are more directly related to mesh size than fish lengths.

Table 6- Variances, expressed as mean squared error (MSE) of the relationships between maximum girth vs fish length and fish length vs maximum girths, and of maximum girths and fish lengths vs mesh size. ((*- significant at P=0.05).

| | n | MSE | MSE | F | n | MSE | MSE | F |
|---|---|---|---|---|---|---|---|---|
| *M.furnieri* | 278 | 51.5 | 116.5 | 0.44* | 169 | 316.8 | 718.8 | 0.44* |
| *M.americanus* | 167 | 47.2 | 88.3 | 0.53* | 158 | 304.9 | 549.6 | 0.55* |
| *M.platanus* | 206 | 133.5 | 370.1 | 0.36* | 192 | 278.1 | 570.4 | 0.49* |
| *B.pectinata* | 235 | 51.7 | 78.9 | 0.65* | 214 | 588.2 | 899.6 | 0.65* |

**DISCUSSION**

1. Body Shape

The relations between the girth at each position along the body and distance from the snout (Figs.7 and 8) can be used to represent the body shape of each species in an attempt to explain the reasons for them being caught. This knowledge, of girth and fish profile, helps to indicate the best mesh size required to catch a certain length range and probably produces more reliable results than do fish lengths.

For *M.furnieri* and *M.americanus*, the girths at opercula, pectoral and first dorsal fins can be considered to be the same. This means that girths similar to the maximum girth determine the probability of wedging, and that the exact position of the maximum girth is not important.

For *M.platanus* there is a small difference between opercula, pectoral and maximum girths, and this seemed to be the reason why fish were mostly caught by the anterior region, despite the species not possessing body appendages which would enable it to be tangled.

Compared to the other species considered here, the body of *B.pectinata* is stouter (Fig.14). A single curve can be fitted for the anterior region of the body of both *M.americanus* and *M.platanus*, independent of the relative position of the various girth measurements (the second dorsal fin of *M.americanus* is at the same relative position as the first dorsal fin of *M.platanus*). However, this does not mean that the same mesh will catch the same size of fish of these two species, just that their girths are related in the same way to length. For *M.furnieri*, the curve (Fig.14) tends to be the opposite of that of *M.platanus*, when compared to *M.americanus*. The difference is due to the higher anterior profile of *M.furnieri*, and its interaction with the net meshes. The curves differ for the posterior region, with *M.americanus* being slimmer than *M.platanus*, and similar to *M.furnieri*. However, this region does not contribute significantly to enmeshing.

2. Position of Capture

The fact that fish can be caught at different body positions may contribute to the skew in selectivity curves based on maximum girth (Figs.10 and 11).

*M.americanus* does not possess protruding appendages which could explain why fish can be frequently found which are caught by the orbital region. However, the pre-opercula of *M.americanus* are not closely aligned with the skull and can, therefore, be responsible for some part of the catch, 28% in this study.

The small differences in modal values of Gmax/P and Gc/P between opercula, and pectoral and first dorsal fin for *M.furnieri* and *M.americanus* (Fig.10) demonstrate that the region of maximum girth can be considered at any of those three positions as seen above.

The modal values of Gmax/P are the same for pectoral and first dorsal fins for *M.platanus*, in spite of the large distance between them, because of the shape of the body of this species, which remains the same along the region between opercula and the second dorsal fin.

For all species, the modes of Gc/P are smaller than the Gmax/P. Averages of Gmax/P for all positions of capture varied between 1.13 and 1.22 and for Gc/P ranged from 1.03 to 1.07. It is evident that for most of the fish caught, the girth at the position of capture is slightly greater than the mesh perimeter. For all species, except for *M.platanus*, the range of Gmax/P was wider than that for Gc/P. For *M.platanus*, the ranges for both distributions were identical.

Very few fish were caught when Gmax/P was less than 1.0, because when the mesh is larger than fish girth, fish can usually swim through the net. Small and large values of this parameters for *M.americanus*, caught by the orbital region, indicate that these fish should not be considered as enmeshed but are entangled by this region of the body.

For the species considered in this study, when Gc/P exceeds 1.2, the efficiency of catch declines sharply. No *M.furnieri* or *B.pectinata* were caught at Gc/P ratios greater than 1.2. Only 4.6% of *M.americanus* were caught at a ratio above 1.3, and only 0.6% of *M.platanus* were taken at a ratio above 1.4.

It seems that catch is most efficient when fish girth slightly exceeds mesh perimeter, i.e., Gc/P ranges from 1 to 1.1. Treschev (1963) considered that capture was maximal when the girth of the fish was 1.0-1.2 times greater than the mesh perimeter. However, the fish girth-depth relationship can be influenced by its degree of fatness, fullness of stomach and sexual maturity. The species examined here showed variations in their degree of sexual maturation and stomach fullness, but catches were not large enough to examine these effects statistically. In addition, Regier and Robson (1966) considered that the swimming thrust exerted by a fish might have more influence on its capture than its girth which can explain in part why fish of such different profiles as *B.pectinata* and *M.platanus*, for example, are gilled by nets with the same mesh size.

3. Length Frequency Distributions

It can be seen that there is an increase in body length of captured fish as mesh sizes increases, which makes it possible to estimate the specific mesh size in which a particular size of fish is most likely to be caught. The mean length of each species caught by a particular mesh size can be regarded as that with the highest probability of capture in that mesh size.

Although entanglement was not the most important way of being caught for any of the species considered here. 12% of *M.americanus* were caught by the mouth and orbital regions rather than at the region of maximum girth. This part of the catch should not be related to mesh size when considering enmeshing to be responsible for capture, and the length distribution for the species was corrected by eliminating the specimens that were not gilled or wedged (Fig.12). For *B.pectinata*, only those fish which were clearly marked by the mesh were included in the length distribution.

## CONCLUSION

When length distributions by mesh size for all species are superimposed, some of the curves seem to be displaced. This is because the relation between the size of the fish and the mesh is through girth and not through length, regardless of the species. According to this reasoning, the girth frequency distribution of all the species should be the same for a particular mesh size. but because the relations between girth and length differ, there are differences between species' length distributions. On the other hand, the analysis of several measurements of girth related to their location on fishes' body (Fig.14) showed that *M.platanus* and *M.americanus* can be considered to be the same in terms of the region that determines the catch, *B.pectinata* can be considered a tall-bodied species and the shape of *M.furnieri*'s body lies between these two. However, catch by enmeshing always occurs when fish girth and mesh perimeter ratio ranges from 1 to 1.1, regardless of the exact site on the fish body. What it probably happens is that for fish as stout as *B.pectinata* catch will occur at a more precise location on its body than for fish with a large region of the body with similar girth, as *M.platanus*; in this case, enmeshing may occur along any site of this region.

The "selectivity factor" K (of the relation $m=Kl_O$ where m=mesh size and $l_O$=modal length) provides another description of the body's shapes of these species. The values are 0.12, 0.14, 0.18 and 0.19 for *M.platanus*, *M.americanus*, *M.furnieri* and *B.pectinata*, respectively. These values agree with the ranges determined for slim and tall-bodied fish by Baranov (1948).

Regier (1969) suggested that the use of a measure of girth as the primary parameter in gillnet selectivity, should not be accepted as a well-founded tradition. Moreover, this author suggested that if girths could not be routinely measured, lengths should then be used. It is been also mentioned that, although girths may have a stronger relationship with mesh size than fish length, it is better to continue to measure fish length in case that girth cannot be measured routinely. Observed and estimated girths of *M.furnieri*, *M.americanus*, *M.platanus* and *B.pectinata* were compared and no significant difference was found between them (Table 7), which implies that the use of observed and estimated girths should be analised for each species under investigation, and may be considered, up to the moment, a matter of choice in the case of the species examined in this study .

Table 7- Comparison between estimated girths and observed girths of *M.furnieri*, *M.americanus*, *M.platanus* and *B.pectinata* - Kolmogorov-Smirnoff two-samples test.

| | *M.furnieri* | *M.americanus* | *M.platanus* | *B.pectinata* |
|---|---|---|---|---|
| n | 12 | 12 | 18 | 20 |
| D | 0.166ns | 0.153ns | 0.104ns | 0.05ns |

It is been mentioned that the nature of gillnet selection is not yet sufficiently well defined to indicate conclusively which parameter or parameters will eventually be established as the conventional choice. From the results presented here, however, girth seems to be a more precise parameter to describe and determine the selectivity curve, and it is suggested that along with length, measurements of maximum girth or girth at the position of capture (depending on the species) should be routinely recorded. Moreover, a ratio based on the relationship between fish girth and mesh perimeter is the most direct measure of how fish fit in the mesh and represent the effect of the net on the capture of fish.

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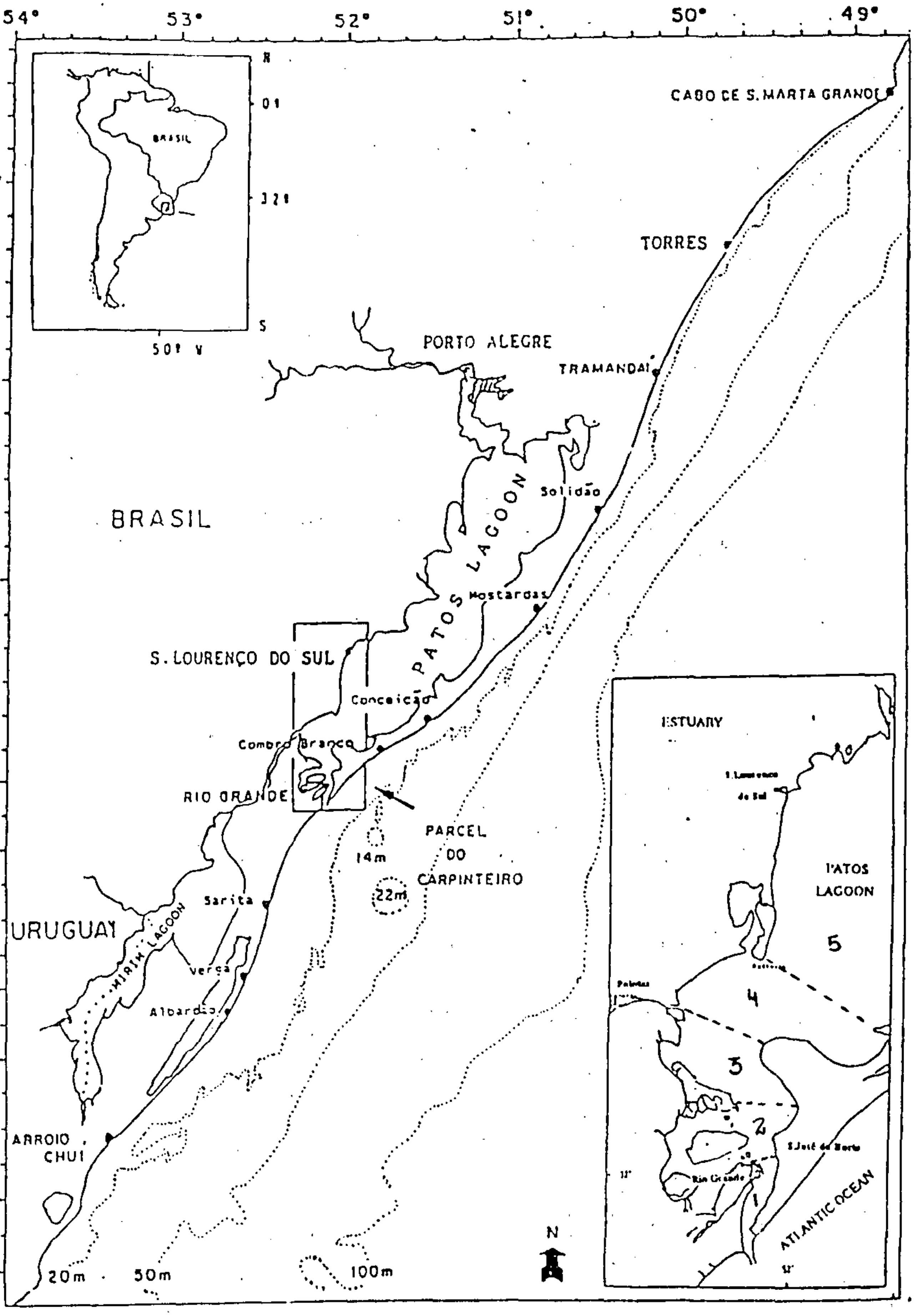
Table 1. Number of lifts, time of setting (hr), number (N) and weight (W, g) of the more frequently caught species with experimental gill nets with mesh size ranging from 50 mm to 120 mm. by cruise in the estuary of Patos Lagoon. One set of each mesh size was used in each cruise, each net was 50 long and 3 m height.

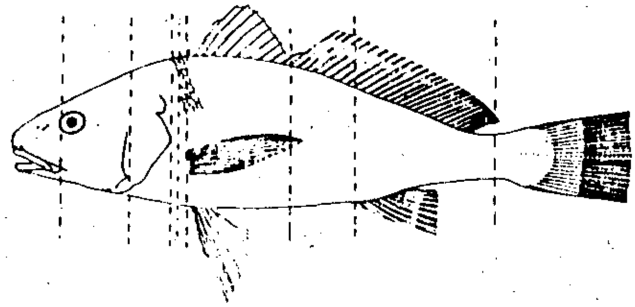
| Cruise | No.of | Time of | *M.furnieri* | | *M.americanus* | | *M.platanus* | | *B.pectinata* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lifts | Setting | N | W | N | W | N | W | N | W |
| Mar/88 | 37 | 14.55 | 86 | 6795 | 11 | 1221 | 8 | 5271 | 25 | 6625 |
| Apr/88 | 38 | 14.31 | 150 | 15061 | 9 | 2045 | 36 | 30671 | 59 | 9525 |
| May/88 | 28 | 14.08 | 17 | 3016 | 1 | 371 | 24 | 10751 | 26 | 4147 |
| Aug/88 | 28 | 15.13 | 17 | 2951 | 5 | 1831 | 9 | 805 | 2 | 494 |
| June/89 | 35 | 15.08 | 72 | 5682 | 46 | 8893 | 14 | 4108 | 145 | 11681 |
| July/89 | 35 | 13.29 | 42 | 6629 | 79 | 14701 | 72 | 31401 | 68 | 9361 |
| Aug/89 | 35 | 14.35 | 111 | 7165 | 66 | 13171 | 47 | 14411 | 38 | 9815 |
| TOTAL | 236 | | 495 | 47299 | 217 | 42233 | 210 | 97418 | 363 | 51648 |

Table 2. Marine, estuarine and freshwater fish collected in the estuary of Patos Lagoon with experimental gill nets.

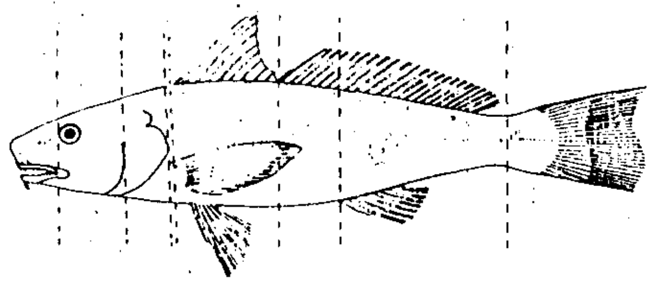
| | SCIENTIFIC NAME | TOTAL NUMBER | TOTAL WEIGHT (g) |
|---|---|---|---|
| CLUPEIDAE | *Brevoortia pectinata* | 392 | 51648 |
| | *Optisthonema oglinum* | 1 | 86 |
| ENGRAULIDAE | *Lycengraulis sp.* | 103 | 7475 |
| CHARACIDAE | *Oligosarcus jenynsii* | 7 | 1700 |
| | *Oligosarcus robustus* | 30 | 3210 |
| | *Astianax sp.* | 18 | 2220 |
| CURIMATIDAE | *Pseudocurimata gilberti* | 28 | 3385 |
| ARIIDAE | *Genidens genidens* | 27 | 5472 |
| | *Netuma barba* | 34 | 10895 |
| | *Netuma planifrons* | 3 | 501 |
| PIMELODIDAE | *Pimelodus maculatus* | 7 | 965 |
| | *Rhamdia sp.* | 4 | 735 |
| LORICARIIDAE | *Loricariichthys anus* | 46 | 4470 |
| ATHERINIDAE | *Odontesthes sp.* | 29 | 3824 |
| TRIGLIDAE | *Prionotus punctatus* | 1 | 65 |
| POMATIDAE | *Pomatomus saltatrix* | 90 | 13028 |
| CARANGIDAE | *Selene vomer* | 1 | 13 |
| | *Trachinotus marginatus* | 8 | 328 |
| SCIAENIDAE | *Macrodon ancylodon* | 2 | 530 |
| | *Menticirrhus americanus* | 217 | 42233 |
| | *Micropogonias furnieri* | 495 | 47299 |
| | *Paralonchurus brasiliensis* | 4 | 281 |
| | *Pogonia cromis* | 4 | 385 |
| CICHLIDAE | *Geophagus brasiliensis* | 1 | 70 |
| MUGILIDADE | *Mugil platanus* | 245 | 97418 |
| GEMPYLIDAE | *Thyrsitops lepidopodea* | 18 | 2730 |
| TRICHIURIDAE | *Trichiurus lepturus* | 5 | 2770 |
| STROMATEIDAE | *Peprilus paru* | 1 | 18 |
| BOTHIDAE | *Paralichthys sp.* | 34 | 8060 |
| SOLEIDAE | *Achirus garmani* | 12 | 315 |
| | TOTAL | 1867 | 312129 |



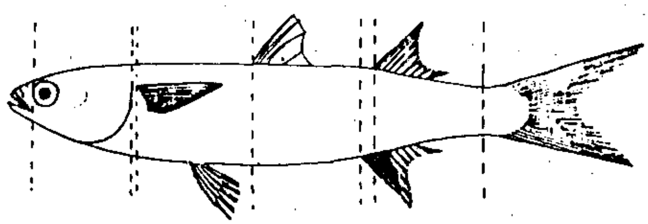

1- The southern coast of Brazil and the lagoon system; the estuary of Patos Lagoon is shown in the inset; 1-5 represent the sub-areas of the fishing trials.



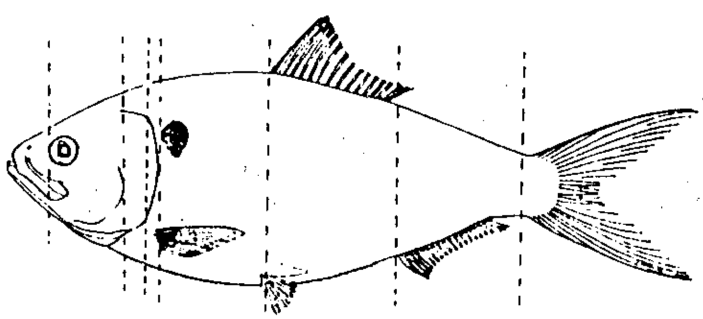
M. furnieri



M. americanus

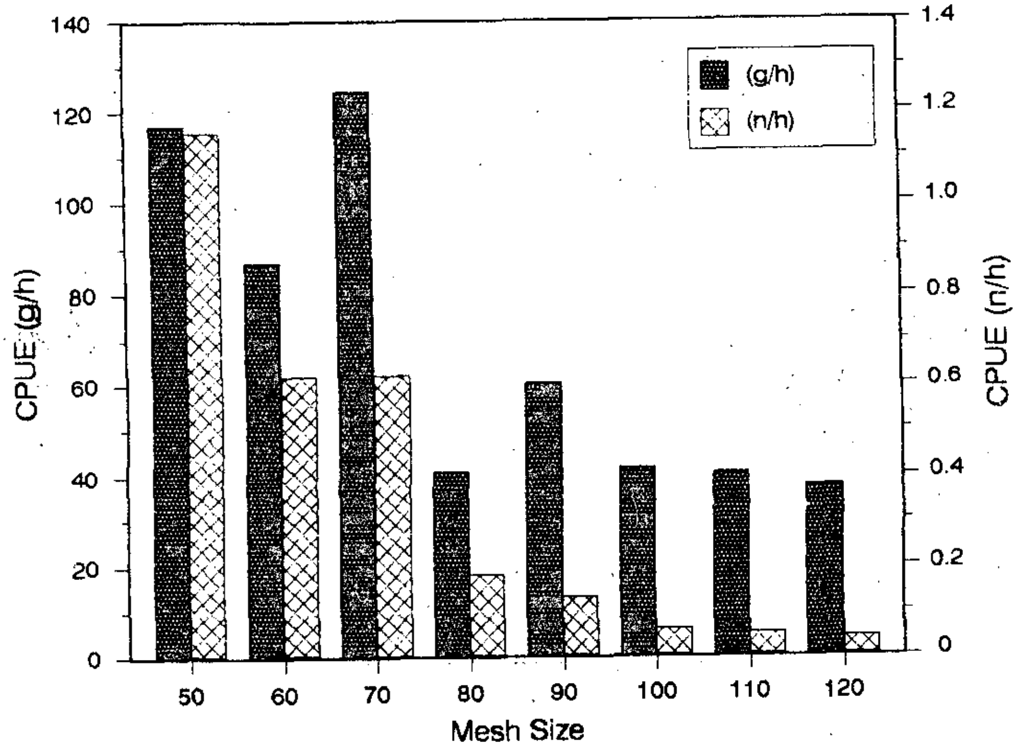


M. platanus

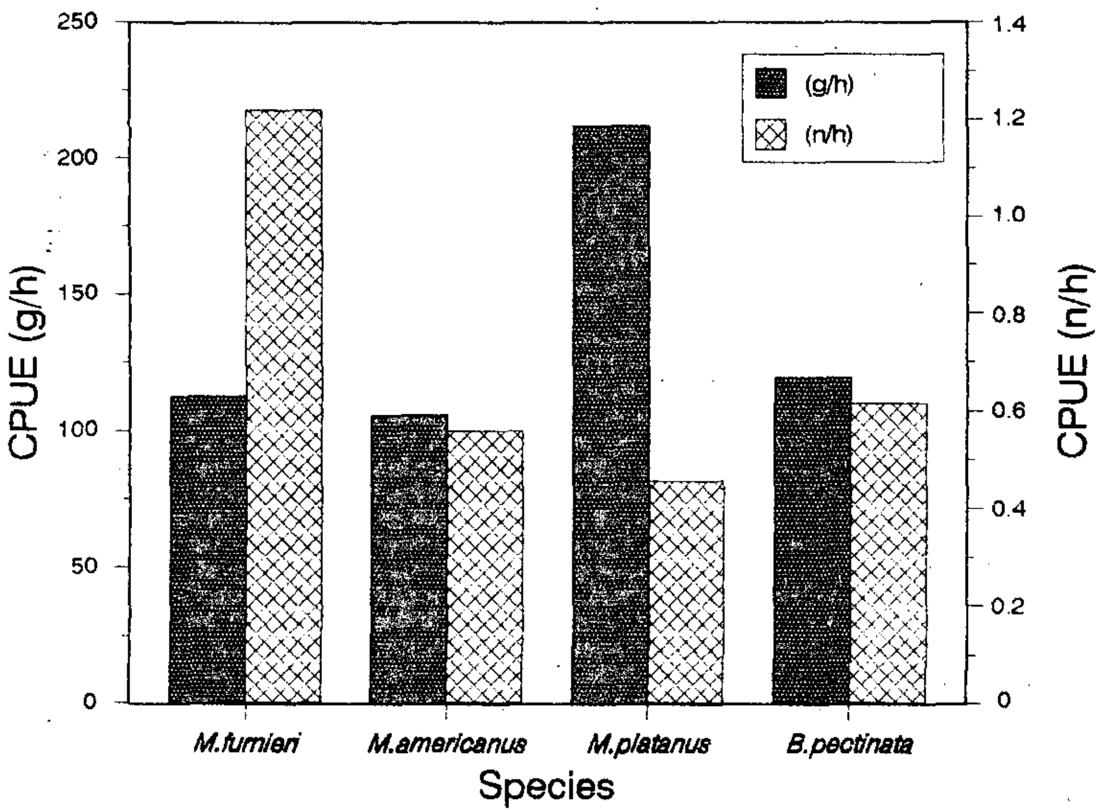


B. pectinata

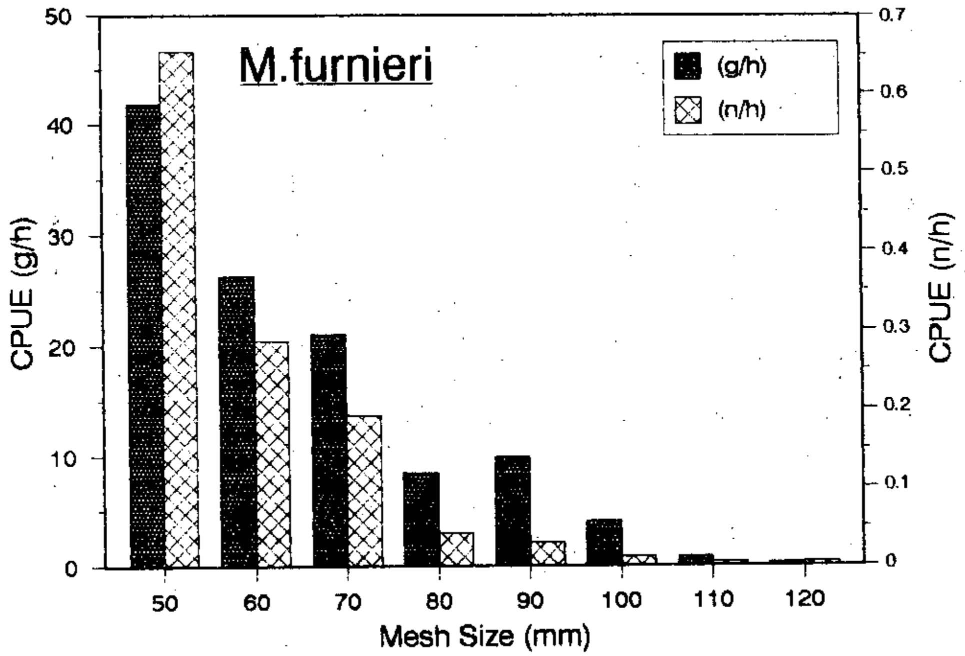
2- Positions (indicated by broken lines) at which girths and distances from the snout were measured.

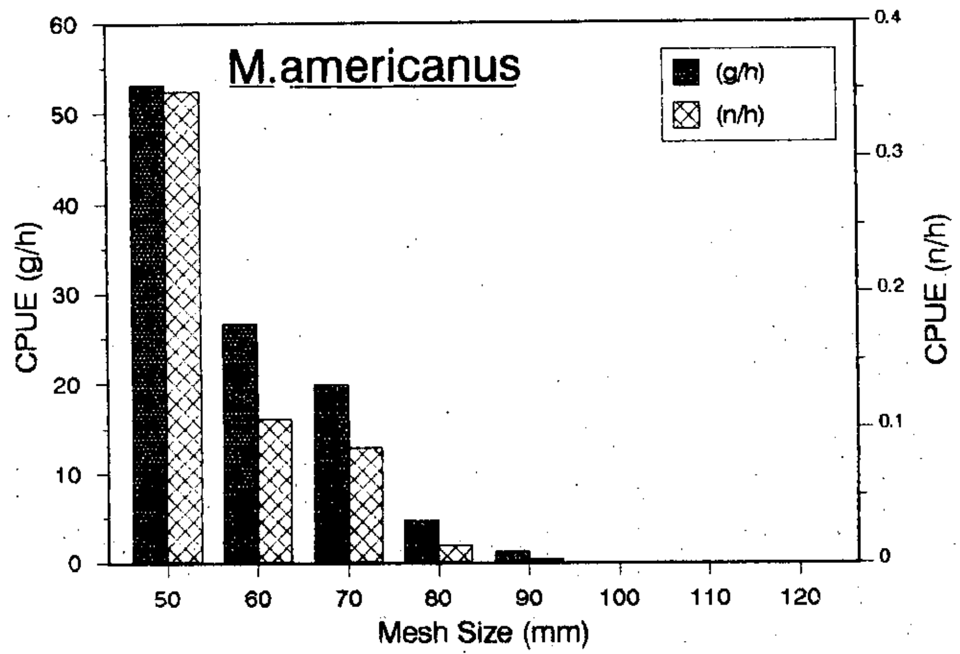



3- CPUE, in weight and numbers, for all species by mesh size.

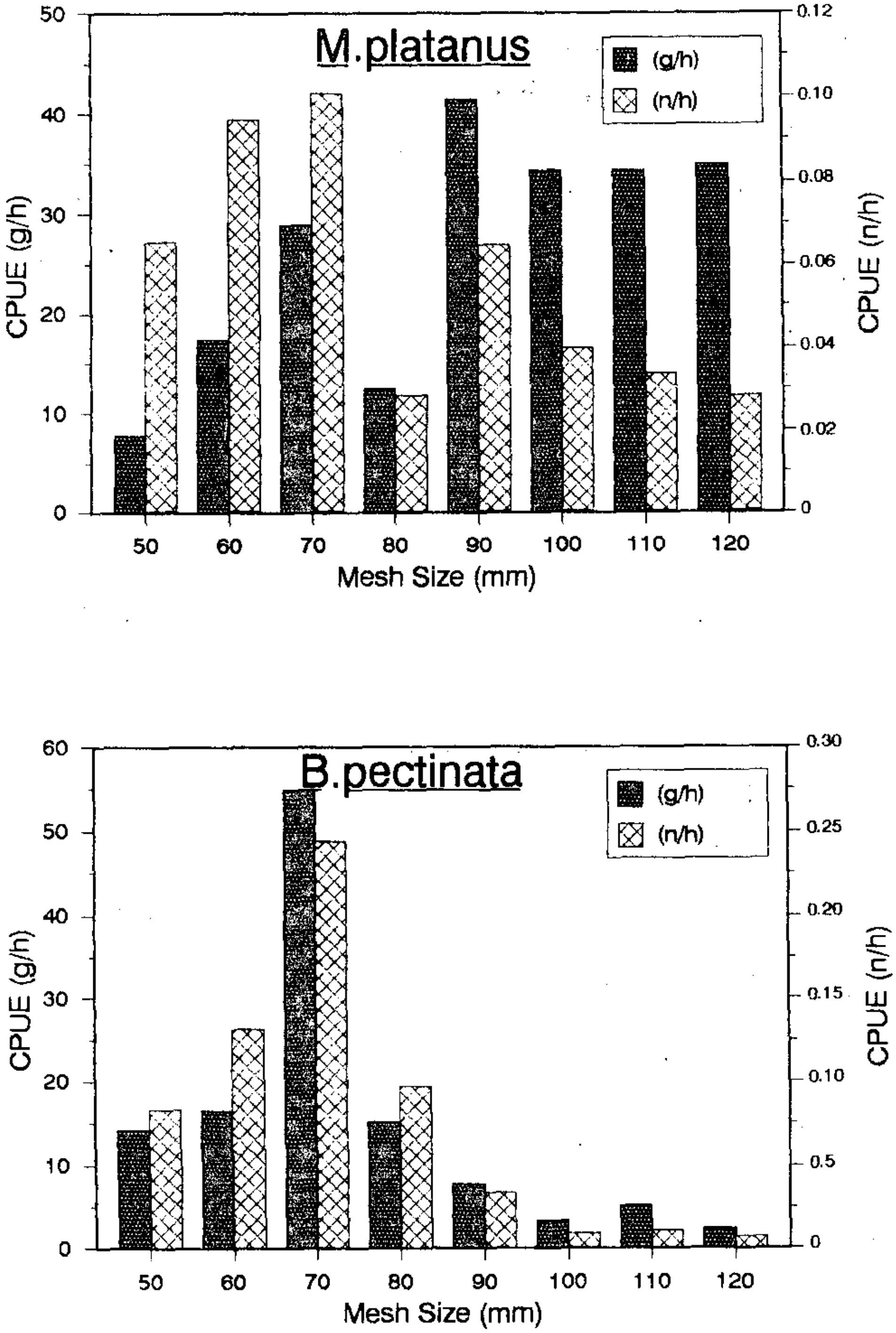



4- CPUE, in weight and numbers, for all mesh sizes by species.

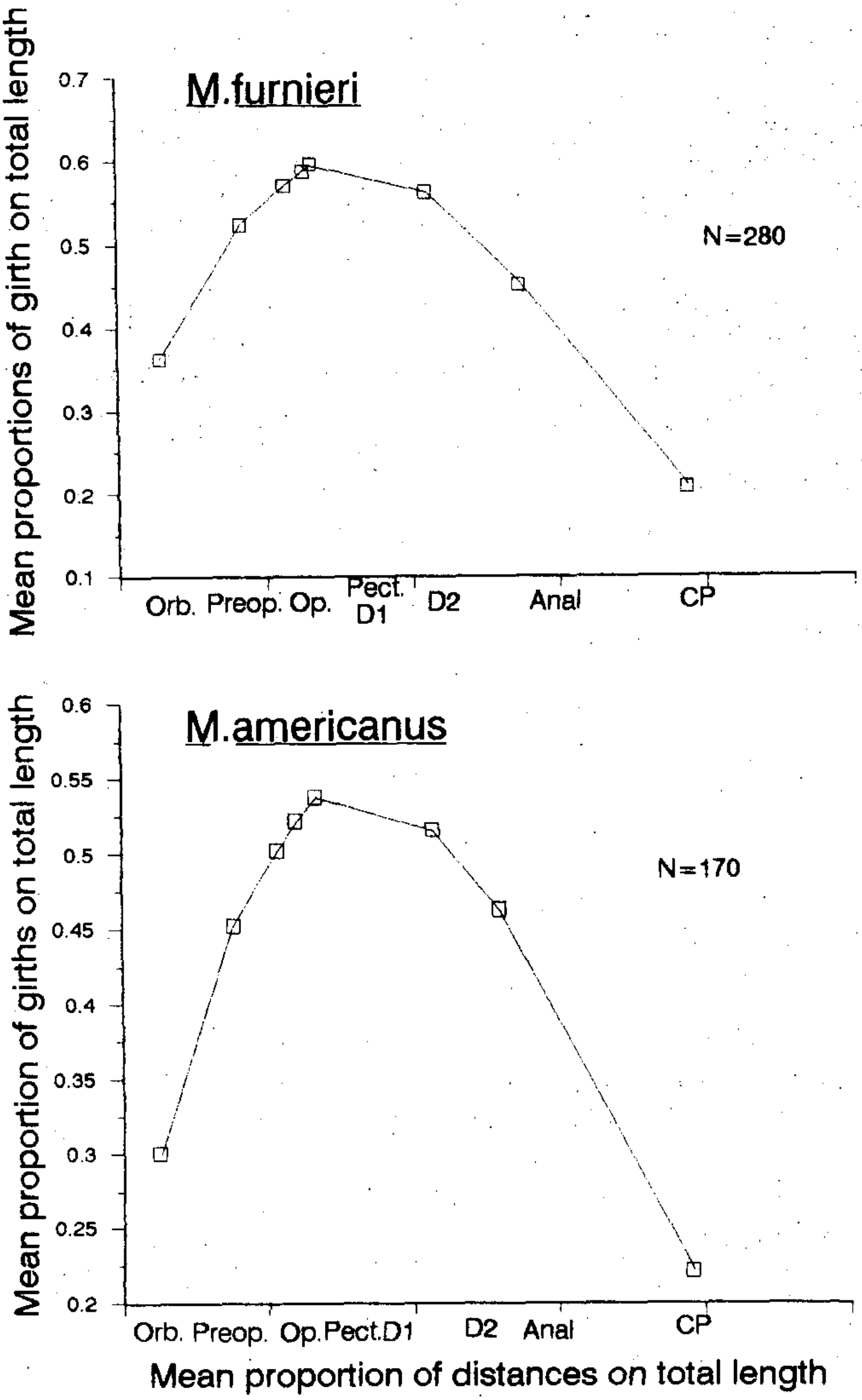


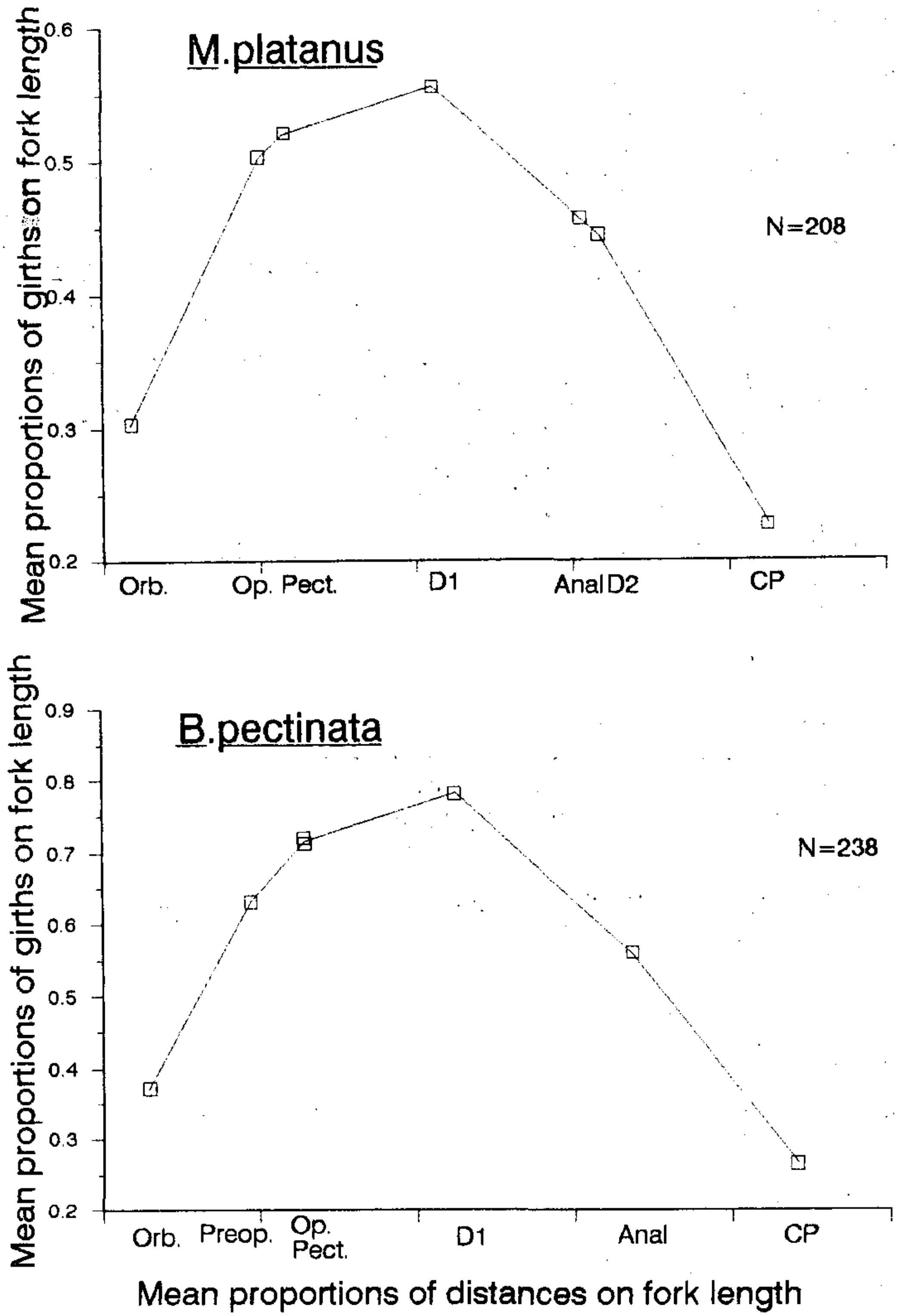

5- CPUE, in weight and numbers, of *M.furnieri* and *M.americanus* by mesh size.



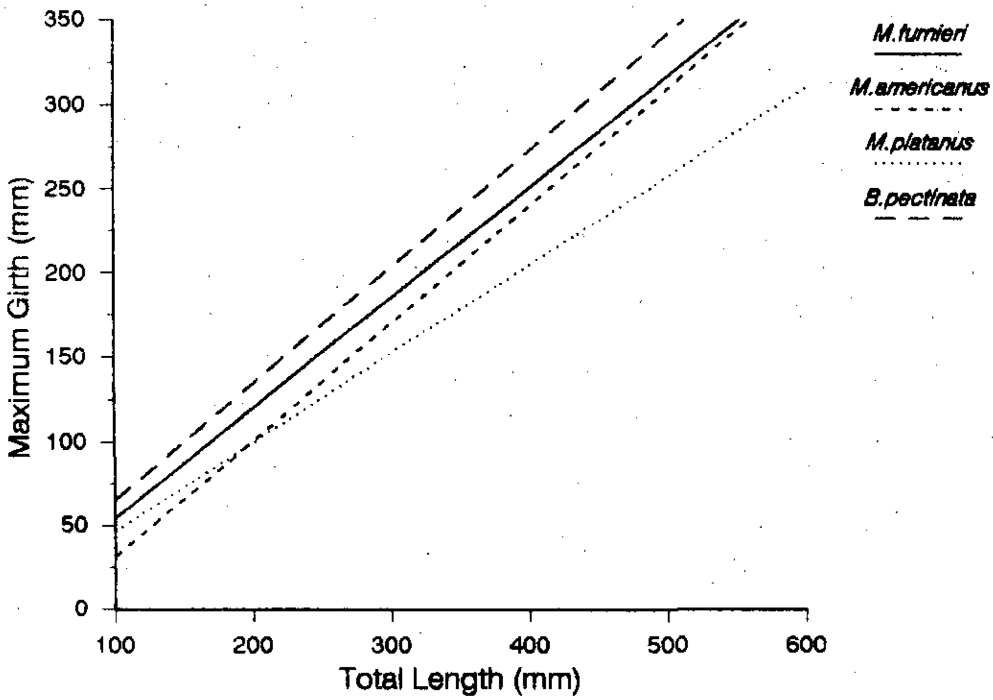

6- CPUE, in weight and numbers, of *M.platanus* and *B.pectinata* by mesh size.




7-Relative measurements of girths in relation to the position on the body of *M.furnieri* and *M.americanus*.

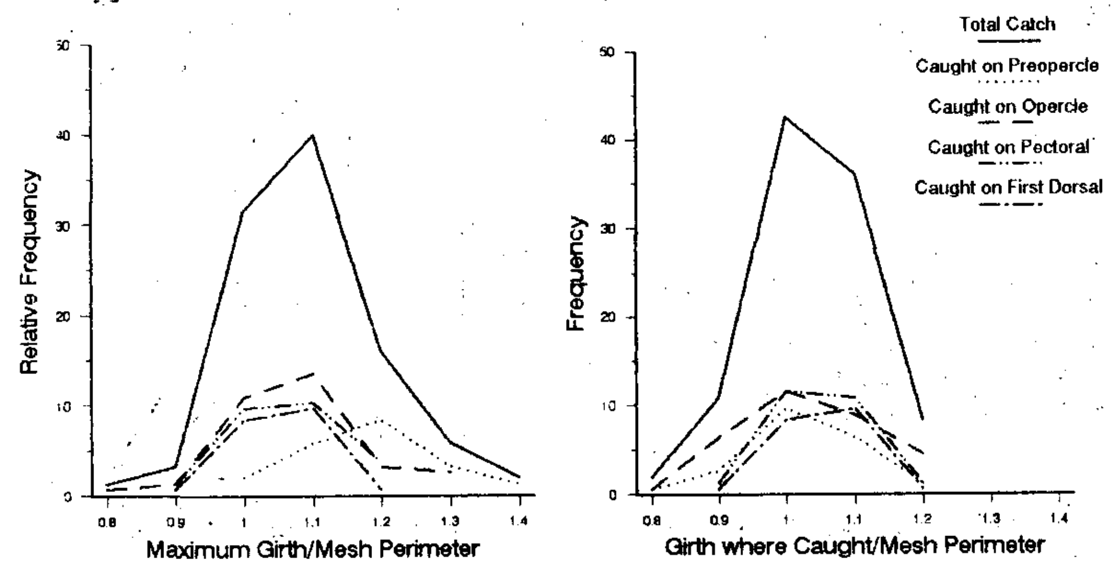



8- Relative measurements of girths in relation to the position on the body of *M.platanus* and *B.pectinata.*

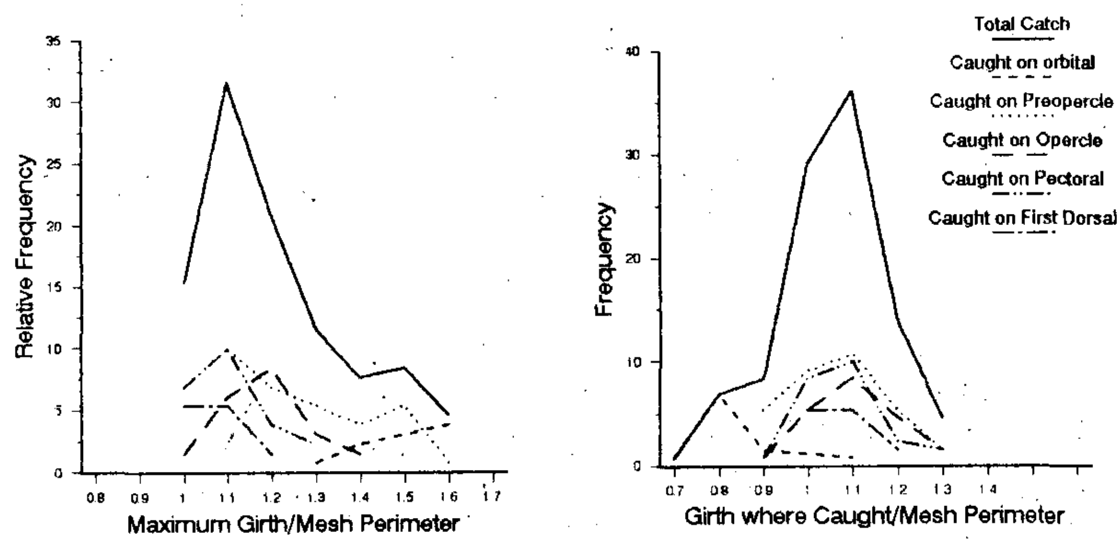



9- Relationship between maximum girth and total length by species.

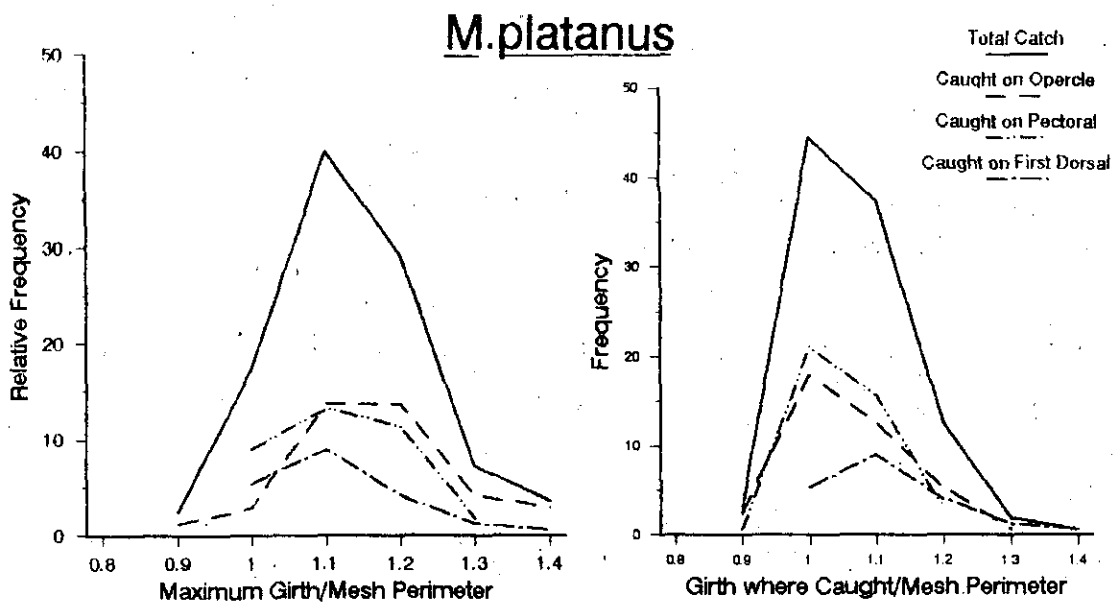
## M.furnieri

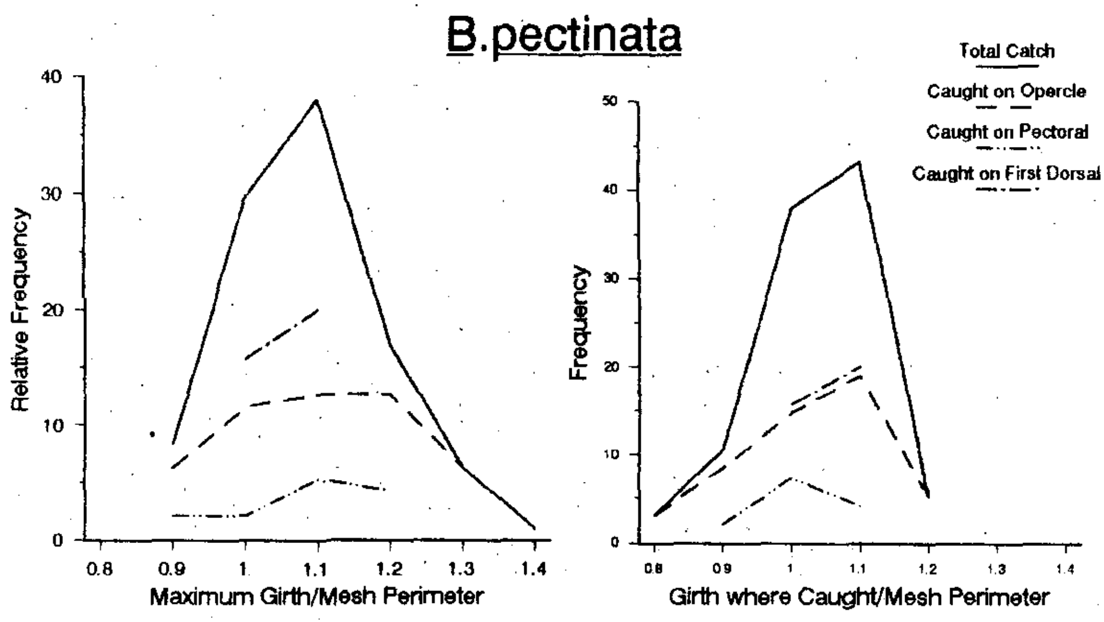



## M.americanus

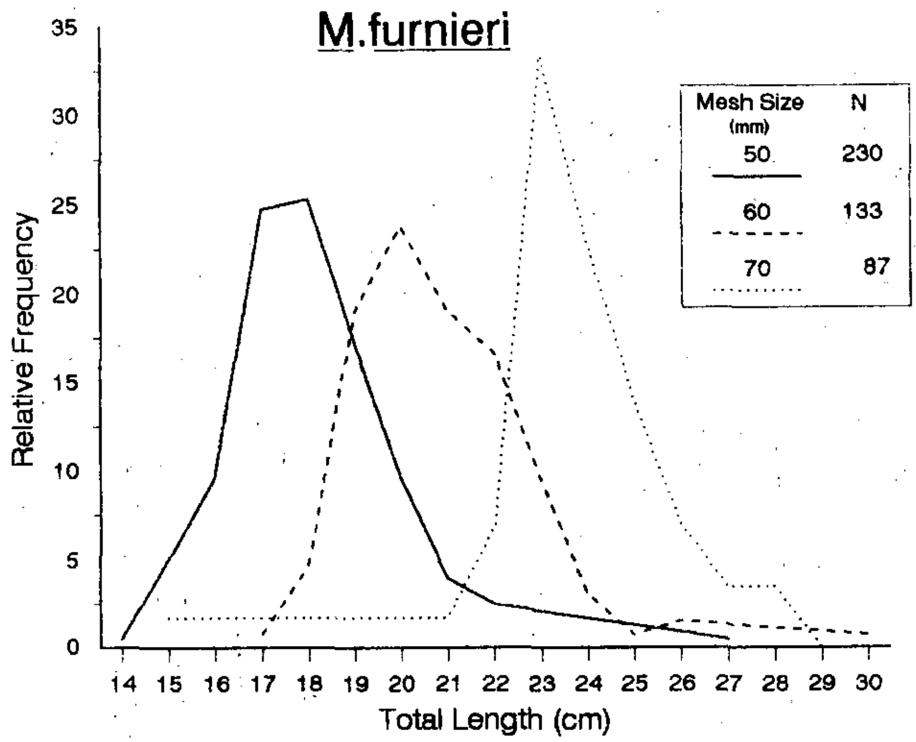


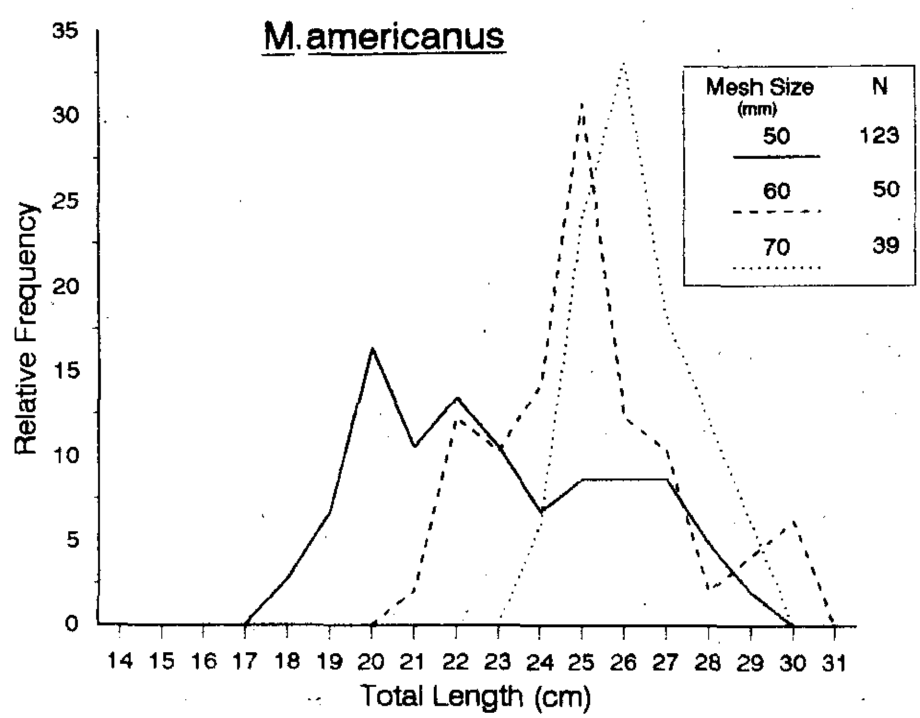

10- Position of girth and girth at the point of enmeshing for *M.furnieri* and *M.americanus.*



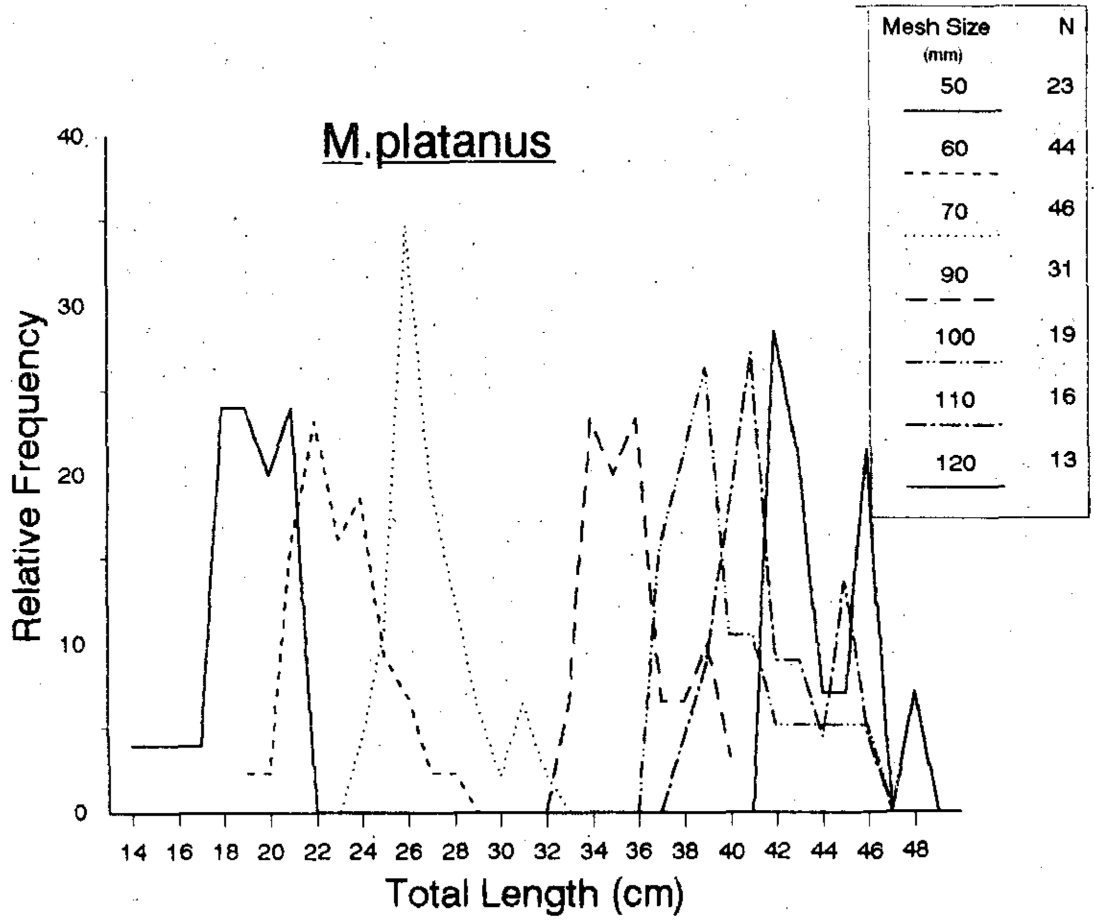



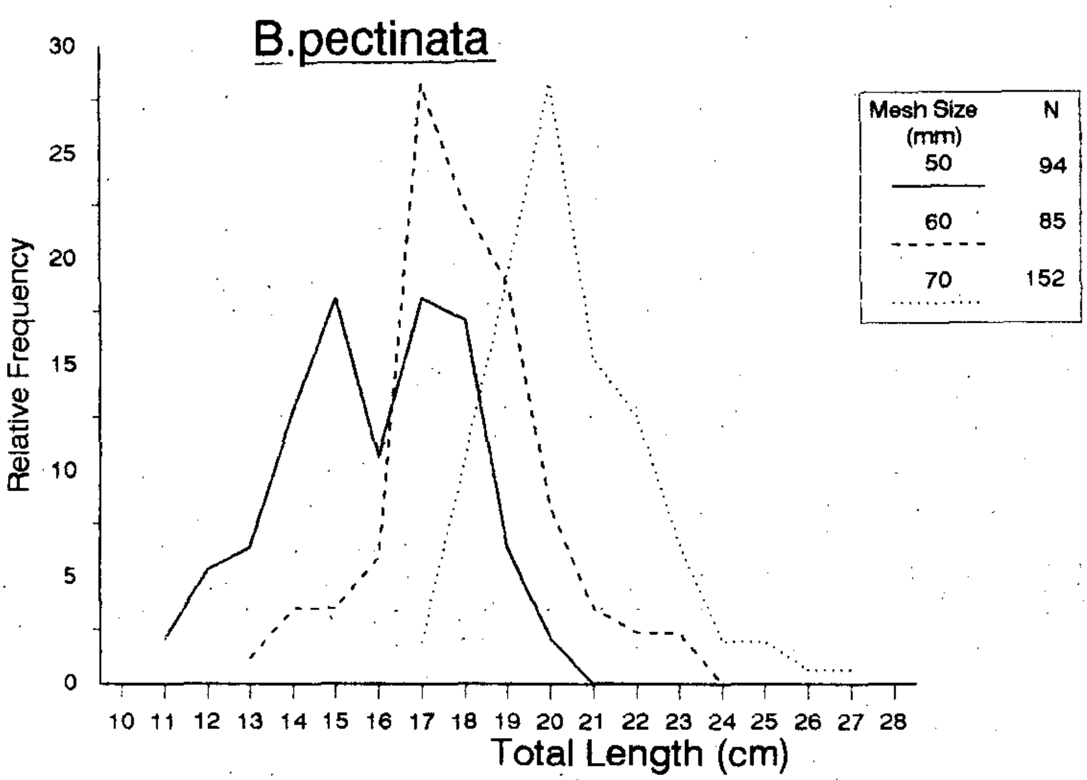

11- Position of girth and girth at the point of enmeshing for *M.platanus* and *B.pectinata.*



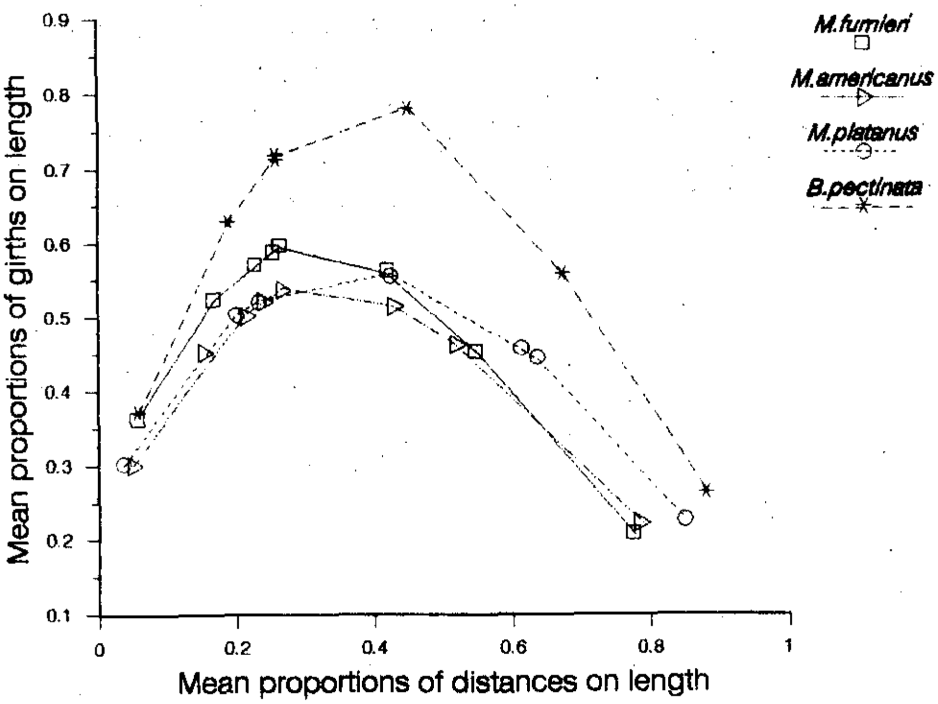




12- Length distributions of *M.furnieri* and *M.americanus* by mesh size.




13- Length distributions of *M.platanus* and *B.pectinata* by mesh size.




14- Relative measurements of girths in relation to the position on the fish's body for all species.