On the Optimum Mesh size for the Capture of *Barbus tor* (Hamilton)

A. A. KHAN, N. A. GEORGE,* T. JOSEPH MATHAI** AND A. K. KESAVAN NAIR*

Burla Research Centre of Central Institute of Fisheries Technology, Burla - 768 017

Results of mesh selectivity experiments on *B. tor* are presented in this paper. Selectivity curve on the basis of maximum girth of fish in relation to perimeter of mesh was worked out. The optimum girth/mesh perimeter ratio was found to be 1.31. A linear regression of G + 0.445L = 12.8 was fitted for conversion of length to girth.

Mesh selectivity curve is important from management point of view of fisheries and also to obtain accurate information concerning fish population from catch data, to protect the immature fishes and to improve the exploitation of exploitable stock. Mesh selectivity of gill nets have been discussed by Olsen (1959), Regier & Robson (1966), McCombie & Fry (1960), Ishida (1962), Kitahara (1971) and Hamley & Regier (1973). These workers have made use of either the length frequency distribution of fishes to fit the selectivity curve or the maximum girth of fish in relation to perimeter of mesh. An attempt is made here to suggest the optimum mesh sizes.

Materials and Methods

The fishing experiments were carried out in Gobindsagar reservoir from October, 1969 to November, 1970 and a total of 561 valid observations were made. Mesh sizes experimented at a depth range 7 m to 40 m in the fishing experiments are 40 mm, 47.5 mm, 50 mm, 52.5 mm and 55, mm and 60 mm bar. The design details and specification of the gear are as given by Khan *et al.* (1975).

A surf boat OAL 18' was used for conducting the fishing experiments. Two hundred and sixtyfive *B. tor* were caught among the other fishes, predominantly *L. diplostoma, L. bata* and *Mystus seenghala*. Details of data on length, gill girth, maximum girth and weight of each fish caught by the different mesh sizes were recorded.

Results and Discussion

The catches in numbers for the total number of nets operated for all mesh sizes are presented in Table 1. Only net of mesh sizes 50 mm bar were taken to estimate the optimum girth/mesh perimeter ratio, as sufficient number representing all size groups were available only with this net. Linear relationships of 'girth on length' and 'length on girth' were worked out by the method of least squares.

McCombie & Berst (1969) have chosen girth in preference to length, to investigate the relation between selectivity and the fit of the fish to the mesh. According to them a ratio based on the relation between fish girth and mesh perimeter would seem to be the most direct measure of fit. McCombie & Fry (1960) plotted the frequency of capture against the ratio of maximum girth of fish to mesh perimeter. McCombie & Berst (1969) fitted the gill net selectivity curves, on the basis of maximum girth of fish in relation to perimeter of mesh, by the method of moments. Following these authors maximum girth/mesh perimeter ratios were worked out for each individual fish for the mesh size 50 mm. The frequency distribution of these are shown in Table 2. The mean worked out to 1.31 and the standard deviation to 0.147. The skewness as measured by the

* Central Institute of Fisheries Technology, Cochin-682 029.

** Research Centre of Central Institute of Fisheries Technology, Panaji - 403 001, Goa.

Table 1. *No. of Barbus tor caught in different size groups*

Length group	40 mm	47.5 mm	50 mm	52.5 mm	55 mm	60 mm
330	1	—	—	—	—	—
350	—	1	—	—	—	—
370	—	1	—	—	—	—
390	4	2	—	—	—	—
410	21	4	—	—	—	—
430	8	2	4	2	—	—
450	6	6	3	1	—	—
470	6	5	5	3	1	—
490	1	3	8	14	—	—
510	3	2	11	4	—	—
530	2	1	25	6	—	—
550	1	—	16	—	3	—
570	2	—	22	4	2	—
590	—	—	12	1	—	—
610	—	—	6	—	—	1
630	—	—	4	—	3	4
650	—	—	3	2	1	—
670	—	—	4	—	—	1
690	—	—	—	—	—	—
710	—	—	1	—	1	2
730	—	—	—	—	1	1
750	—	—	1	—	—	—
Total	55	27	125	37	12	9

Table 2. *Frequency distribution of maximum girth/mesh perimeter ratios*

Maximum girth/ mesh perimeter	No. of fishes	Theoretical frequency
1.0	5	4.8
1.1	7	12.4
1.2	30	25.4
1.3	39	33.4
1.4	23	27.8
1.5	13	14.9
1.6	5	5.1
1.7	3	1.2

third moment worked out to 0.00098. The theoretical frequencies obtained on fitting the normal frequency function (Hoel, 1957),

$$f(x) = \frac{e^{-\frac{1}{2}\left(\frac{x - 1.31)}{0.147}\right)^2}}{0.147 \sqrt{2\pi}}$$

where 'x' is the girth/perimeter ratio and are given in column (3) of Table 2. The goodness of fit was tested x^2. The frequencies in the first and last classes were pooled with the adjacent classes as the expected frequency in these classes were less than 5 (Table 2). The x^2 now worked out to 5.01 which is not significant for 3 degrees of freedom. Thus the normal approximation was found satisfactory. The fitted normal curve corresponding to the percentage frequencies along with the observed percent frequencies are shown in Fig. 1. The model girth-perimeter

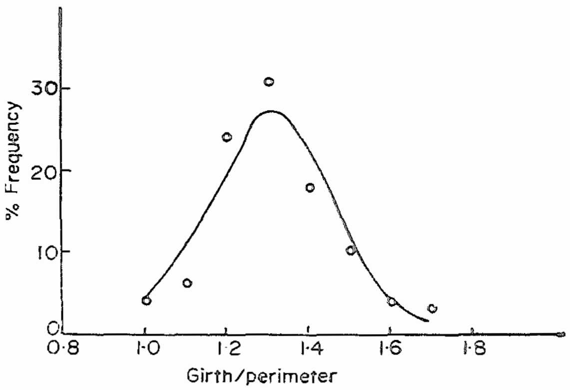

Fig. 1. Gillnet selectivity curve on the basis of maximum girth of fish in relation to perimeter of mesh.

ratio is found to be 1.31. Using this ratio, it is possible to determine mesh sizes to exploit any desired size of fish. If a specified length is perferred, the length-girth relationship can be used to fix the mesh size. This relationship for *B. tor* was found to be

$$L = 1.85\ G + 67.6$$

where L is the estimated mean length for a girth measurement, G. Standard error of the regression coefficient was 0.052 (2.8% of the regression coefficient) with 95% confidence interval for the regression coefficient ranging from 1.75 to 1.95. Hamley & Regier (1973) used a linear relationship G = al + b to estimate girths (G) from length (L) by regression of girth samples of Walleye. They obtained a relationship of the form,

$$G = 0.56\ L - 1.7$$

From a regression of maximum girth on total length, this relationship for *B. tor* was obtained as

$$G = 0.445\ L + 12.8 \text{ (Fig. 2)}$$

The regression coefficient was found to be highly significant (r = 0.908 being highly significant for 265 degress of freedom). The 95% confidence interval for the regression coefficient is 0.420 to 0.470. The standard error of the regression coefficient was only 2.8% of the same. Since the normal fit was found adequate in the present case, the optimum girth to perimeter ratio can be taken to be 1.31. This optimum ratio can be used to fix the mesh size to catch a fish of a specified girth. If only length measurements are available the regression equation

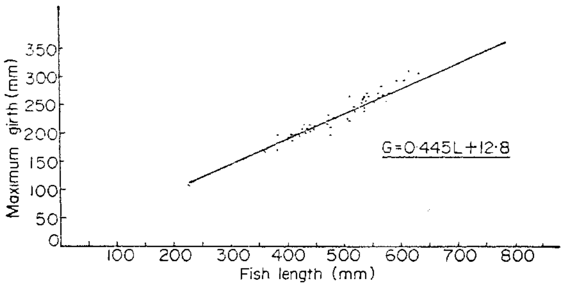

Fig. 2. Regression between maximum girth and length

$G = 0.445\ L + 12.8$ can be applied to get the corresponding girth measurement and the optimum mesh size worked out. Using the regression relationship $L = 1.85\ G + 67.6$ and the optimum maximum girth to mesh perimeter ratio of 1.31, the optimum maximum girths and lengths of fish caught by nets of the mesh size considered is presented in Table 3.

Table 3. *Optimum maximum girths and lengths of Barbus tor caught by different mesh sizes*

Mesh size	Optimum maximum girth mm	Estimated optimum length mm
40	209.6	455.4
47.5	248.9	528.1
50	262.0	552.3
52.5	275.1	576.5
55	288.1	600.8
60	314.4	649.2

No fish was caught for girth/perimeter ratio greater than 1.7. The optimum ratio of 1.31 compares well with the girth/perimeter ratio of yellow perch of Senth Bay, estimated by McCombie & Berst (1969).

In conclusion, selectivity curve on the basis of maximum girth of fish in relation to perimeter of mesh for the species *B. tor* was worked out. The optimum girth/mesh perimeter ratio was found to be 1.31. For conversion of length to girth, a linear regression of $G = 0.445\ L + 12.8$ was found useful for *B. tor*. The optimum maximum girths and the corresponding lengths (total) of *B. tor* caught by the experimental mesh sizes have been presented on this basis.

The authors are thankful to Shri M.Rajendranathan Nair, Director, Central Institute of Fisheries Technology, Cochin for permission to publish the paper.

References

Hamley, J.M. & Reigier, H.A. (1973) *J. Fish. Res. Bd Canada* **30**, 817

Hoel, P.G. (1957) *Introduction to Mathematical Statistics*, Asia Publishing House, Bombay

Ishida, T. (1962) *Bull. Hokkaido Reg. Fish. Res. Lab.* **25**, 20

Kitahara, T. (1971) *Bull. Jap. Soc. Sci. Fish.* **37**, 4

Khan, A.A., George, N.A. & Pandey, O.P. (1975) *Fish. Technol.* **12**, 64

McCombie, A.M. & Berst, A.H. (1969) *J. Fish. Res. Bd Can.* **26**, 2681

McCombie, A.M. & Fry, F.E.J. (1960) *Trans. Am. Fish. Soc.* **90**, 337

Olsen, S. (1959) *J. Fish. Res. Bd Can.* **16**, 339

Regier, H.A. & Robson, D.S. (1966) *J. Fish. Res. Bd. Can.* **23**, 423