ON THE IDENTIFICATION OF THE SUB-POPULATIONS OF *HILSA ILISHA* (HAM.) IN THE GANGETIC SYSTEM WITH A NOTE ON THEIR DISTRIBUTION

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Though heterogeneity in the Hilsa stock of the Gangetic System was doubted by earlier workers, an efficient method to distinguish them at a particular moment of time within a centre was lacking. In the present paper the authors had been able to identify three different varieties of Hilsa, denoted here as sub-populations, which were discriminated with the aid of a set of morphometric characters. The discriminant scores for the three sub-populations, viz. broader, broad and slender, were ascertained by using the formulae:

$$L_1 = -0{\cdot}01647A+0{\cdot}24026B-8{\cdot}92010$$
$$L_2 = 0{\cdot}08053A-0{\cdot}12299B-9{\cdot}42156$$
$$L_3 = 0{\cdot}15927A-0{\cdot}44187B-9{\cdot}88599$$

following the method described by Rao (1952). A and B in the formulae indicate the total length and maximum body height at the origin of the dorsal fin respectively.

Applying these formulae to the samples drawn from different areas of the Gangetic System for the purpose of this investigation, it was observed that all the three sub-populations are widely distributed over the entire system though the rate of intermingling between the centres is different warranting that a correct knowledge of the sub-population distribution at a centre and between the centres at a moment of time has to be properly understood for the successful management of the fishery.

Introduction

The occurrence of different races of Hilsa in the Gangetic System had drawn the attention of many earlier workers (Jenkins 1938, 1940; Naidu 1939; Mojumdar 1939; Hora and Nair 1940; Hora 1941; Pillay 1952). In the recent past, Pillay *et al.* (1962) have pointed out with some clarity that at least two populations of *Hilsa ilisha* are existent in the Ganga River which were represented by the samples drawn from Allahabad and Buxar respectively and that these are distinguishable from the population in the Padma represented by samples from Lalgola. On the basis of the results of tagging experiments conducted in these rivers, reported by Pillay *et al.* (1962), the possibility of small-scale intermingling of the populations between Buxar and Lalgola was also doubted. Their contention was mainly based on the premises that the population at a centre is homogeneous in nature and that the comparison of the samples between the centres will indicate the nature of heterogeneity. They further suggested that examination of samples from places between Allahabad, Buxar and Lalgola will help in understanding the distribution of individual populations inhabiting the river system. In the absence of any clear-cut hydrological barrier between Allahabad, Buxar and Lalgola, all of which conform to typical riverine environment, the possibility of intermingling of the stocks between Buxar and Lalgola, as doubted by them, also indicate the possibility of intermingling between the stocks represented by Buxar and Allahabad which might have been masked due to low rate of intermingling at these two centres at the time the samples were drawn. This poses the question: whether or not samples drawn from a centre can be taken as representative of a homogeneous population? Ghosh (*in press*) had suggested that the stocks of Hilsa at Allahabad are heterogeneous in nature and in their further studies on the juvenile Hilsa collected from the Jamuna and the Ganga at Allahabad, Ghosh *et al.* (*unpublished work*) have observed that the juvenile Hilsa belongs to two different stocks. This further lends support to the view that the stock of Hilsa at a centre cannot be considered as homogeneous and warrants that a suitable method be evolved to separate the stocks at a centre by careful examination of the population of the system in respect to season. After establishing the identity of the Hilsa populations of the source, this can then be extended to individual centres on the Ganga System and compared between the centres to find out the distribution of each population in space and also the nature of intermingling between the populations at a centre and between centres in respect to seasons. Since the Hilsa stocks of the Ganga System are, in all probability, endemic in nature with limited migration within the river system (Pillay and Rosa Jr. 1963) which is further substantiated by their distinctness from the stock at Lalgola on the Padma (Pillay *et al.* 1962) and that of the Hooghly (Pillay 1952; Pillay *et al.* 1962), such an approach will not only enable the understanding of the nature of distribution of the Hilsa populations in the Ganga System, but will also serve as a base for the estimation of different parameters of the population dynamics on a 'unit population' basis in an attempt to formulate judicious management policy.

Various morphological and other characters were considered useful by different workers in discriminating the races of Hilsa in Indian waters (Day 1873; Jenkins 1938, 1940; Mojumdar 1939; Naidu 1939; Hora and Nair 1940; Hora 1941; Pillay 1952, 1954, 1957; Pillay *et al.* 1962; Ghosh, *in press*). Many of the characters considered useful by these workers were not tested as to their efficiency and those tested involve heavy computational need making it difficult to employ them in wide-scale field application in connection with population studies. Therefore, the main purpose of this investigation was to identify the Hilsa stocks of the Ganga System with the help of a minimum number of morphometric characters so that this can be extensively carried out in the field by different workers as would be required for detailed population studies. The present paper embodies the results of investigation carried out in this line.

Collection of Material

The material for this study was obtained from the commercial catches of *Hilsa ilisha* at Allahabad in 1962, at Varanasi and Buxar in 1963, at Bhagalpur in 1963, 1964 and 1965, at Rajmehal and Lalgola in 1964, all during the monsoon seasons of the respective years, caught by non-selective gears ranging in mesh size from ½ inch to 3 inches when stretched. Exorbitant cost of the fish has limited the size of the sample to 163 specimens collectively obtained from the stations mentioned above. The distribution of samples taken up for this study according to centres from Allahabad downstream is:

Allahabad	..	35
Varanasi	..	11
Buxar	..	35
Bhagalpur	..	36
Rajmehal	..	11
Lalgola	..	35

Morphometric measurements were made of only fresh specimens immediately on their being landed at the respective assembly centres. Specimens showing first sign of putrefaction or those preserved in ice were rejected. Same set of tools were used for the purpose of measurements at individual centres of observation.

Method of Analysis

Based on the contention of Pillay *et al.* (1962) that the populations at Allahabad, Buxar and Lalgola of the river system are different, the samples containing equal number of observations at each of these centres were pooled together so that the reliable estimate of relative frequencies of individual populations can be determined. In addition, samples from in between Allahabad and Buxar represented by Varanasi and between Buxar and Lalgola represented by Bhagalpur and Rajmehal were also combined since these should conform to either of the populations existing in the Ganga River System and their inclusion will in all likelihood make the sample better representative in nature.

It was observed that some of the specimens landed at the assembly centres appeared robust in stature as compared to some others of identical size. A preliminary examination of the data indicated that for fish of identical total length, in some specimens the head length was equal to, or a little less than, the maximum body height taken at the origin of the dorsal fin giving the fish a slender appearance, while in others the maximum body height was greater than the head length and the fish looked robust in stature. The utility of the body height and the head length in distinguishing races had been pointed out by earlier workers (Hora and Nair 1940; Hora 1941; Pillay 1952; Pillay *et al.* 1962). Therefore, these two characters were chosen to be studied in relation to the total length as they were found to be responsible for the robust or slender appearance of the fish. An examination of the data also revealed that the height at the origin of the anal fin was greater in slender variety as compared to that of the robust variety of identical size. This character was, therefore, selected for the study to find out its relative merit as compared to the other characters.

On the basis of the relation between head length and the maximum body height, the sample was then separated into two groups as 'slender' and 'robust'. In the robust group it was observed that the difference of the maximum body height and the head length varied widely. Pillay *et al.* (1962) had surmised that though the stocks represented by the Buxar sample and the Lalgola sample do not come under the same cluster but generally they are nearer to each other and one of the characters that distinguishes these at 5 per cent significant level was observed by them to be the body height. An examination of the samples from Lalgola and Buxar revealed that the samples are mainly composed of robust variety. The ratio of the maximum height to the head length for robust variety was calculated and the limit $\bar{x} \pm 2\sigma\bar{x}$ was constructed from the resulting series of ratios. Specimens falling within this confidence limit were tentatively grouped as 'broad' and those beyond the upper limit were taken to be 'broader'. After separating the sample into three groups as 'slender', 'broad' and 'broader', the method of regression analysis was employed to test the heterogeneity between the groups. On being satisfied on the heterogeneity between the groups, the ratio of the maximum body height to the head length was applied to individual specimens arbitrarily drawn from the pooled data. It was observed that, in some specimens, the ratio of the maximum body height to the head length was below the limit of the broad variety, though, in all appearance, they looked broad. In some other specimens, the ratio of the maximum body height to the head length coincided with the upper confidence limit of the broad variety making it difficult to correctly assign these fish to broad or broader variety. Therefore, it was considered necessary to apply some statistical method to properly assign such specimens to any individual sub-population. Since the relative frequencies of individual group for a known sample size pooled for different sectors of the Ganga System were available, the method of discriminant score (Rao 1952) was applied.

The discriminant scores, thus ascertained, were then applied on another set of 102 specimens drawn from different parts of the river system to find out the efficiency of the method in measuring the akinness for any individual to a particular sub-population, by studying the magnitude of the score obtained for individual fish (Appendix).

Since the discriminant score ascertained pertained to the existing populations of the river system, as a whole, these were then applied to the available observations at each of the centres taken up for the study separately irrespective of the season to find out the over-all pattern of intermingling at a centre which will also reflect the distribution of different sub-populations in space when compared between them.

Results of Analysis

Considering the total length of the fish as an independent variate on which the body height, head length and the height at the origin of the first anal fin ray are dependent, the regression analysis was employed independently for each of the dependent variate on the total length.

The following Tables (I–VIII) represent the results of regression analysis on the body heights of the three groups separated on the basis as discussed in the foregoing chapter.

TABLE I

Analysis of covariance of the body heights of broader and broad types

	D.F.	$S(X_i-\overline{X})^2$	$S(X_i-\overline{X})(Y_i-\overline{Y})$	$S(Y_i-\overline{Y})^2$	b_{YX}	$b_{YX}\,S(X_i-\overline{X})(Y_i-\overline{Y})$	S.S. corrected for regression	D.F.
Broad ..	42	320266	83443	22058	0·26054	21740	318	41
Broader ..	42	417773	121474	36269	0·29077	35321	948	41
								82
Total ..	84	738039	204917	58327	0·27765	56895	1432	83

TABLE II

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	M.S.	Obs. F.
Deviation from total average regression ..	83	1432		
Deviation from individual regressions within samples	82	1266	15·44	
Difference ..	1	166	166	10·75

highly significant

TABLE III

Analysis of covariance of the body heights of broad and slender types

	D.F.	$S(X_i-\overline{X})^2$	$S(X_i-\overline{X})(Y_i-\overline{Y})$	$S(Y_i-\overline{Y})^2$	b_{YX}	$b_{YX} S(X_i-\overline{X})(Y_i-\overline{Y})$	S.S. corrected for regression	D.F.
Broad ..	42	320266	83443	22058	0·26054	21740	318	41
Slender ..	42	314493	73897	17604	0·23497	17364	240	41
								82
Total ..	84	634759	157340	39662	0·24787	39000	662	83

TABLE IV

Test of heterogeneity of regressions within samples

Source of variation	D.F.	S.S.	M.S.	Obs. F.
Deviation from total average regression ..	83	662		
Deviation from individual regressions within samples	82	558	6·80	
Difference ..	1	104	104	15·29 highly significant

The above analysis clearly indicated highly significant heterogeneity between the groups. The results of regression analysis of the head length of these groups, as represented in the following tables, fail to discriminate the stocks and the difference between the groups is found to be non-significant.

TABLE V

Analysis of covariance of the head lengths of broader and broad types

	D.F.	$S(X_i-\overline{X})^2$	$S(X_i-\overline{X})(Y_i-\overline{Y})$	$S(Y_i-\overline{Y})^2$	b_{YX}	$b_{YX} S(X_i-\overline{X})(Y_i-\overline{Y})$	S.S. corrected for regression	D.F.
Broad ..	42	320266	73251	16907	0·22872	16754	153	41
Broader ..	42	417773	94492	21570	0·22618	21372	198	41
								82
Total ..	84	738039	167743	38477	0·22728	38125	352	83

TABLE VI

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	M.S.	Obs. F.
Deviation from total average regressions ..	83	352		
Deviation from individual regression within sample	82	351	4·28	
Difference ..	1	1	1	4·28

not significant

TABLE VII

Analysis of covariance of the head lengths of broad and slender types

	D.F.	$S(X_i-\overline{X})^2$	$S(X_i-\overline{X})(Y_i-\overline{Y})$	$S(Y_i-\overline{Y})^2$	b_{YX}	$b_{YX}\,S(X_i-\overline{X})(Y_i-\overline{Y})$	S.S. corrected for regression	D.F.
Broad ..	42	320266	73251	16907	0·22872	16754	153	41
Slender ..	42	314493	71647	16519	0·22782	16323	196	41
								82
Total ..	84	634759	144898	33426	0·22827	33076	350	83

TABLE VIII

Test of heterogeneity of regression within the samples

Source of variation	D.F.	S.S.	M.S.	Obs. F.
Deviation from total average regression ..	83	350		
Deviation from individual regression within sample	82	349	4·26	
Difference ..	1	1	1	4·26

not significant

Similar analysis of the data for the body height at the origin of the anal fin indicated a non-significant difference between the broad and broader varieties, but significant at 5 per cent level between the broad and slender variety as will be discerned from Tables IX–XII.

TABLE IX

Analysis of covariance of the heights at the origin of the anal fin of broader and broad types

	D.F.	$S(X_i-\overline{X})^2$	$S(X_i-\overline{X})(Y_i-\overline{Y})$	$S(Y_i-\overline{Y})^2$	b_{YX}	$b_{YX} S(X_i-\overline{X})(Y_i-\overline{Y})$	S.S. corrected for regression	D.F.
Broader ..	42	417773	77295	15134	0·18502	14301	833	41
Broad ..	42	320266	56816	10401	0·17740	10079	322	41
								82
Total ..	84	738039	134111	25535	0·18171	24369	1166	83

TABLE X

Test of heterogeneity of regression within the samples

Source of variation	D.F.	S.S.	M.S.	Obs. F.
Deviation from total average regression ..	83	1166		
Deviation from individual regression within sample	82	1155	14·08	
Difference ..	1	11	11	1·28

not significant

TABLE XI

Analysis of covariance of the heights at the origin of the anal fin of broad and slender types

	D.F.	$S(X_i-\overline{X})^2$	$S(X_i-\overline{X})(Y_i-\overline{Y})$	$S(Y_i-\overline{Y})^2$	b_{YX}	$b_{YX} S(X_i-\overline{X})(Y_i-\overline{Y})$	S.S. corrected for regression	D.F.
Broad ..	42	320266	56816	10401	0·17740	10079	322	41
Slender ..	42	314493	50019	8292	0·15905	7956	336	41
								82
Total ..	84	634759	106835	18693	0·16831	17981	712	83

TABLE XII

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	M.S.	Obs. F.
Deviation from total average regression ..	83	712		
Deviation from individual regression within sample	82	658	8·02	
Difference ..	1	54	54	6·73

significant at 5 per cent level

Therefore, the analysis of the data indicated that, of the three characters taken up for this study, the body height in relation to the total length appears to be the best character to separate individual sub-populations. While the head length completely fails to differentiate between the sub-populations, the height at the origin of the anal fin distinguishes between the slender and the broad variety at 5 per cent significant level but fails to discriminate the broad and the broader varieties.

ESTIMATION OF DISCRIMINANT SCORES

Based on the findings of regression analysis presented earlier, the discriminant scores for individual sub-populations were estimated on the relation between the total length and the maximum body height following the method described by Rao (1952).

Rao stated that 'A constant likelihood ratio (L) corresponds to a constant difference in the discriminant scores. If the *a priori* probabilities are Π_1, Π_2 and Π_3 for the three groups, then the rule of procedure is to assign an observed individual to that group for which

$$L_r + \log_e \Pi_r \text{ is maximum,} \quad r = 1, 2, 3.\text{'}$$

Applying this principle in the present study the mean scores of total length and maximum body height for the three sub-populations of Hilsa were ascertained to be as follows:

Group	Sample size	Mean score (in mm.) Total length (A)	Max. body ht. (B)
Broader	43	360·70	98·98
Broad	43	381·14	96·35
Slender	77	348·78	80·97

The dispersion matrix within the groups and its reciprocal were found to be:

within dispersion matrix (W_{ij})	A	B	reciprocal (W^{ij})	A	B
A ..	7866	2044	A ..	0·003216	−0·011886
B ..	2044	553	B ..	−0·011886	0·045742

The discriminant scores were then calculated for broader, broad and slender types respectively and can be expressed as:

$$L_1 = -0{\cdot}01647A+0{\cdot}24026B-8{\cdot}92010$$
$$L_2 = 0{\cdot}08053A-0{\cdot}12299B-9{\cdot}42156$$
$$\text{and } L_3 = 0{\cdot}15927A-0{\cdot}44187B-9{\cdot}88599$$

For the purposes of classification, the expression to be calculated is

$$L+\log_e \Pi,$$

where Π denotes the relative frequency of a particular class.

Applying this formula, the discriminant scores involving the relative frequencies are given in Table XIII.

TABLE XIII

The linear discriminant scores for various groups

Group	Coefficients of measurements		Constant term	
	A	B	(a) in terms of general proportion	(b) for proportion from present data
Broader ..	−0·01647	0·24026	$-8{\cdot}92010+\log_e \Pi_1$	−10·25268
Broad ..	0·08053	−0·12299	$-9{\cdot}42156+\log_e \Pi_2$	−10·75414
Slender ..	0·15927	−0·44187	$-9{\cdot}88599+\log_e \Pi_3$	−10·63597

$\Pi_1 = 0{\cdot}26380$, $\Pi_2 = 0{\cdot}26380$, $\Pi_3 = 0{\cdot}47239$.

Thus, ascertaining the discriminant score, it is now possible to assign any individual to its appropriate group by calculating the linear discriminant score with the help of the characters, total length and maximum height, corrected for *a priori* probabilities, for which its score is highest.

DISTRIBUTION OF THE SUB-POPULATIONS IN THE GANGA SYSTEM

Having ascertained the identity of individual sub-population, attempt was made to find out their distribution in space. For this purpose data collected from different centres on the river Ganga, namely Allahabad, Varanasi, Buxar, Bhagalpur, Rajmehal and Lalgola, were examined. Samples of each centre were separated into its respective sub-populations by calculating the discriminant scores and the result is presented in Table XIV.

TABLE XIV

Distribution of individual sub-populations of Hilsa ilisha *in the Ganga System*

Place	Number examined	Variety (No.)		
		Slender	Broad	Broader
Allahabad ..	110	22	60	28
Varanasi ..	76	11	23	42
Buxar ..	76	21	23	32
Bhagalpur ..	163	77	51	35
Rajmehal ..	32	4	25	3
Lalgola ..	96	20	36	40

It will be seen that all the three sub-populations are widely distributed in the entire stretch from Allahabad in the upstream to Lalgola on R. Padma in the downstream. However, the limited number of observations at some of the centres do not permit the understanding of the pattern and the rate of intermingling of the sub-populations between different centres. All the same, this investigation indicates a wide-scale intermingling between the sub-populations and warrants that samples at regular intervals be examined for all these centres to properly understand the pattern and the rate of intermingling of the sub-populations of Hilsa in the Ganga System as a whole which will then enable an understanding of the nature of distribution of individual sub-population and will help in the construction of analytical type of population models for individual sub-population.

DISCUSSION

The identification of the Hilsa stocks in the Ganga System has been posing a serious problem for the investigators. For the first time Pillay *et al.* (1962) indicated with certain amount of clarity that two stocks of Hilsa represented by Allahabad and Buxar samples can be distinguished from one another by the length of head, height and thickness of caudal peduncle and the diameter of eye at 1 per cent significant level and by height and thickness of the body at 5 per cent significant level. The distinguishing characters differentiating the stock of Buxar from that of the Padma were recorded by them to be thickness and height of caudal peduncle and diameter of eye at 1 per cent level of significance and the height and thickness of body at 5 per cent significant level. Their findings were mainly based on the contention that the stock of Hilsa at a centre is homogeneous in nature and comparison between the centres will indicate the pattern of heterogeneity. That the population of a centre is not homogeneous has been brought to light by this investigation as also some earlier investigations (Annual Report of Central Inland Fisheries Research Institute for 1963-64; Ghosh, *in press*; Ghosh *et al. unpublished*). Therefore, though their work had pointed out the distance of populations as represented by Allahabad, Buxar and Lalgola samples respectively, the heterogeneity of Hilsa population at a centre was overlooked. Due to this grouping together of heterogeneous population at a centre, the possibility that some characters which would have otherwise been significant but were masked cannot be overruled. Furthermore, some of the characters found to be efficient, viz. thickness of the caudal peduncle and thickness of the body, are likely to have high percentage of personal error when taken by different workers as this will depend on how the fish is handled by the individual worker. These limitations, coupled with heavy computational need when a large number of characters are involved, restrict its utility in large-scale field application in connection with the studies on population dynamics. In the present study only those characters were considered which had least possibility of personal bias from worker to worker and chosen characters can be measured by keeping the fish on the measuring board without shifting its position.

The analysis of the morphometric data covering the vertical body gradients, viz. the maximum body height and the height at the origin of the anal fin, and horizontal body gradient, viz. length of the head in relation to the total length, of the Hilsa stocks present in the Ganga System during the monsoon season had shown that they can be efficiently identified to its respective sub-population by the body height of the fish in relation to its total length. While the head length completely fails to differentiate the stocks, the height at the origin of the anal fin differentiates the slender and the broad variety at 5 per cent level of significance and fails to differentiate between the broad and broader varieties. The efficiency of the body height as a racial discriminant for Hilsa of the Gangetic System was earlier pointed out by various workers (Hora and Nair 1940; Pillay 1952; Pillay *et al.* 1962). The present study lends support to their contention as to the efficiency of the body height in relation to the total length as a suitable racial discriminant. Unless this is further examined by discriminant scores, the akinness of a fish to its respective sub-population cannot be truly understood. This was attempted in the present investigation and was found to be very satisfactory in identifying the fish to its appropriate sub-population.

However, individual sub-population is supposed to maintain a characteristic physiological entity manifested in growth rate, reproduction, size at first maturity, etc., and the authenticity of such classification on the basis of morphometric data can only be adjudged when this is corroborated by the physiological activity. Growth being one of the manifestations of physiological activity, the comparative size-specific length-weight relationship of the sub-populations was attempted. It was observed that the length-weight relationship for the identical size of fish belonging to different sub-populations differed significantly from one another (Ghosh and Rao *unpublished work*). Being satisfied that there is difference in the physiological activity as manifested by the growth pattern, it may be inferred that body height in relation to the total length of the fish can be taken as a suitable criterion to identify the sub-populations of Hilsa inhabiting the Ganga System and the method can be recommended for wide-scale field application in connection with population studies.

On establishing the identity of individual sub-population of Hilsa, it requires that attempts be made to understand the pattern and rate of intermingling at a centre and between the centres in respect to time since all the sub-populations were found to occur simultaneously at a centre and are widely distributed in the system. To maintain their separate entity it is very likely that each one of them will occupy separate spawning ground and, therefore, at the spawning season, the intermingling at such places will be negligible or, perhaps, nil. Ricker (1950) has observed such instances in case of Sockeye Salmon of the Fraser River System. Some work in this line has been initiated and the pattern and the size at which the intermingling takes place in the lower stretch of the Ganga System has been worked out and are being reported separately (Ghosh and Bhattacharya *unpublished work*).

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Appendix

Application of the discriminant scores to identify the stocks of Hilsa ilisha (*Ham.*) *of the Ganga System* (*pooled for entire area under investigation*)

Sl. No.	Morphometric characters		Class to which it is assigned	Sl. No.	Morphometric characters		Class to which it is assigned
	Total length in mm	Max. height in mm			Total length in mm	Max. height in mm	
1	454	133	Broader	41	364	100	Broader
2	458	120	Broad	42	307	81	Broader
3	440	120	Broader	43	315	82	Broad
4	443	104	Slender	44	275	72	Broad
5	379	91	Slender	45	378	101	Broader
6	416	111	Broader	46	368	100	Broader
7	344	89	Broad	47	341	99	Broader
8	335	86	Broad	48	420	125	Broader
9	448	120	Broader	49	470	114	Slender
10	493	117	Slender	50	340	83	Slender
11	285	68	Slender	51	335	84	Broad
12	416	111	Broader	52	435	114	Broad
13	451	127	Broader	53	371	87	Slender
14	426	126	Broader	54	311	77	Slender
15	474	135	Broader	55	396	105	Broader
16	306	84	Broader	56	444	115	Broad
17	477	132	Broader	57	415	106	Broad
18	447	120	Broader	58	388	102	Broad
19	222	57	Broad	59	359	93	Broad
20	307	84	Broader	60	466	117	Broad
21	446	122	Broader	61	452	114	Broad
22	355	94	Broader	62	400	102	Broad
23	383	111	Broader	63	374	94	Broad
24	218	57	Broader	64	499	127	Broad
25	213	56	Broader	65	354	86	Slender
26	114	31	Broader	66	427	113	Broader
27	229	60	Broader	67	441	110	Broad
28	197	53	Broader	68	424	111	Broad
29	134	37	Broader	69	221	54	Slender
30	419	113	Broader	70	443	111	Broad
31	362	96	Broader	71	217	54	Broad
32	260	74	Broader	72	221	54	Slender
33	465	141	Broader	73	219	54	Slender
34	497	151	Broader	74	122	31	Broad
35	490	134	Broader	75	359	85	Slender
36	452	118	Broader	76	343	89	Slender
37	477	127	Broader	77	375	85	Slender
38	415	115	Broader	78	378	88	Slender
39	367	97	Broader	79	486	114	Slender
40	417	113	Broader	80	450	110	Slender

APPENDIX—*contd.*

Sl. No.	Morphometric characters		Class to which it is assigned	Sl. No.	Morphometric characters		Class to which it is assigned
	Total length in mm	Max. height in mm			Total length in mm	Max. height in mm	
81	404	97	Slender	92	283	68	Slender
82	285	68	Slender	93	279	65	Slender
83	493	117	Slender	94	263	64	Slender
84	238	57	Slender	95	377	91	Slender
85	200	49	Slender	96	349	83	Slender
86	287	68	Slender	97	478	106	Slender
87	214	50	Slender	98	497	119	Slender
88	187	45	Slender	99	234	63	Broader
89	191	47	Slender	100	211	55	Broader
90	474	111	Slender	101	492	129	Broader
91	356	83	Slender	102	428	109	Slender