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BIOMETRIC STUDIES ON *ANCHOVIELLA COMMERSONII*[1] (LACEPEDE) (ENGRAULIDAE : PISCES) FROM ANDHRA COAST

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INTRODUCTION

IT is a well established fact that in many species of fishes discrete populations can be distinguished by morphological and/or physiological differences between them. Racial studies in fishes, as pointed out by Prasad (1958 p. 465), are 'important both in the field of systematics and that of fishery biology. In systematics racial differences blend into specific differences, while in fishery biology they are indicative of the segregation of populations and occupy an important place in the determination of separate fish stocks in relation to a given fishery.' Tester and Hiatt (1952) have drawn attention to the practical importance of such studies in the solution of the problem of overfishing. When there is the danger of a particular species of fish being overfished in a particular locality, it is essential to find out whether overfishing affects only the particular stock or population or the entire species. Schaefer and Walford (1950) and others made biometric comparisons of yellowfin tuna and albacore from different parts of the Pacific from this angle.

Hjort (1930) dealt with the arguments in regard to the origin of races. He states that a 'somewhat sharp division of opinion exists between those who regard the formation of races as the result of fortuitous hereditary combinations of characteristics, and those who regard it as due to an interplay of the power of adaptation shown by the animals concerned and the physicochemical conditions predominating in particular areas of the sea.'

A considerable amount of work on populations and races in economically important fishes has been carried out.[3]

Whitebait (species of *Anchoviella* Fowler) are widely distributed in inshore waters of India and are caught in large numbers, both for food and as bait. *A. commersonii* (Lacépède) is one of the most common species. Along the Andhra Coast *A. commersonii* occurs both in inshore waters away from the influence of any nearby river, as at Waltair, and also in an estuarine environment (Godavari estuary). The present investigation was undertaken to find out if these two stocks, living under different environmental conditions, belong to a homogeneous population or to two different populations which could be biometrically differentiated.

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[1] The present day valid name of *Anchoviella commersonii* (Lacépède) is *Stolephorus commersonii* Lacépède.

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[3] Such a large amount of literature has accumulated in the course of the last few years that it is beyond the scope of the present paper to refer to all the work.

In the Godavari estuary, *A. commersonii* was found to occur in considerable numbers from February to June. It was practically absent during the flood season from July to September and occurred only in very small numbers from October to January. In the February-June period, the range of salinity in the estuary was from 19.6‰ to 32.0‰ (D. V. Rama Sarma, personal communication). Along Waltair coast, samples of *A. commersonii* were collected from February to September when they formed a good fishery (Babu Rao, 1958). During this period (i.e. February to September) the salinity range at Waltair was from 28‰ to 35‰ (Ganapati & Rama Sarma, 1958). Thus it can be seen that during the *A. commersonii* fishery, the salinity in general was higher at Waltair than in the Godavari estuary, while the range was wider in the estuary than at Waltair.

Material and Methods

Random samples of *A. commersonii* were collected from fishermen's catches at Waltair, and at Yanam in the Godavari estuary. The samples were preserved in 5% formalin and the body measurements and counts of meristic characters were made in preserved specimens. Counts of meristic characters in small fish were made according to the method described by Taning (1944).

For the comparison of meristic characters the Chi-square test (Bailey, 1959) was used. When the distance between two populations in many characters (body measurements) was to be simultaneously tested for significance, the method of multiple regression analysis as described by Rao (1952) was applied.

Observations

The meristic data selected for comparison of the stocks from Waltair and Godavari estuary (Table I) were :

1. Number of vertebrae (total number).
2. Gill rakers (of the lower arm of the first gill arch on the left side).
3. Anal fin rays.
4. Pectoral fin rays (on the left side).

The following measurements were taken for the multiple regression analysis study.

1. Standard length (dependent variable)
2. Head length (independent variable)
3. Height of the body (,, ,,)
4. Anal fin length (,, ,,)
5. Eye diameter (,, ,,)

The ranges and means of these measurements for the two populations are presented in Table II.

Meristic Characters : The Chi-square test applied to the number of (1) vertebrae, (2) gill rakers, (3) anal fin rays and (4) pectoral fin rays of the samples from the two localities, did not show significant differences in the first two characters. With regard to the anal and pectoral fin rays, the two stocks were found to show

significant differences, the probability of the differences between the stocks arising from errors in sampling being less than five in a thousand trials (Table III ; Fig. 1).

TABLE I

Frequency distribution of the meristic characters of A. commersonii *from Godavari estuary and Waltair*

(A) *Vertebrae*

Locality	38	39	40	41	n
Godavari	2	120	39	1	162
Waltair	1	119	27	—	147

(B) *Gill Rakers*

Locality	22	23	24	25	26	n
Godavari	—	38	84	38	2	162
Waltair	4	37	69	25	1	136

(C) *Anal Fin Rays*

Locality	20	21	22	23	24	n
Godavari	7	71	65	17	2	162
Waltair	15	63	55	3	—	136

(D) *Pectoral Fin Rays*

Locality	12	13	14	15	16	n
Godavari	—	10	91	59	2	162
Waltair	2	29	101	36	—	168

TABLE II

Ranges and means of the morphometric characters of the two localities

Morphometric Character	Waltair Coast n=47		Godavari estuary n=48	
	Range	Mean	Range	Mean
1. Standard length ..	5.10 cm.-7.95 cm.	6.4489	5.05 cm.-7.90 cm.	6.4333
2. Head length ..	1.28 cm.-1.90 cm.	1.5987	1.20 cm.-1.92 cm.	1.5923
3. Height of the body ..	1.00 cm.-1.75 cm.	1.3426	0.92 cm.-1.80 cm.	1.3235
4. Anal fin length ..	0.95 cm.-1.65 cm.	1.2738	1.10 cm.-1.65 cm.	1.3327
5. Eye diameter ..	0.40 cm.-0.64 cm.	0.4772	0.38 cm.-0.60 cm.	0.4700

TABLE III

Chi-square test applied to the meristic data of samples from the two localities

S. No.	Character	obs X^2	d.f.	P.	Significance	Remarks
1.	Vertebrae	1.4402	1	>0.05	Not significant	Classes 38 and 39, and 40 and 41 are bracketed.
2.	Gill rakers	2.3035	2	>0.05	Not significant	Classes 22 and 23 and 25 and 26 are bracketed.
3.	Anal fin rays	13.6955	3	<0.005	Significant	Classes 23 and 24 are bracketed.
4.	Pectoral fin rays	17.6220	2	<0.005	Significant	Classes 12 and 13 and 15 and 16 are bracketed.

Morphometric Characters : Multiple regression analysis was applied to the morphometric data to test the significance of the difference between the two populations. The various statistics required for the test were calculated and the results tabulated (Table IV A-F). The mean square due to deviation from the hypothesis of equality of regression coefficients in the two groups is found to be less than the mean square due to deviation from separate regressions (Table IV F). Hence the hypothesis of equality of regressions cannot be rejected. As far as the morphometric characters taken into consideration, concerned, the two populations do not significantly differ.

DISCUSSION

Various statistical methods were employed in biometric studies, particularly with regard to meristic characters (Dice & Leraas 1936, Ginsburg 1938, 1954, Simpson & Roe 1939, Hubbs & Perlmutter 1942, Hubbs & Hubbs 1953). Hitherto in the study of meristic characters, the mean was given prime importance. But when different samples are being compared in the meristic characters, the mean has no significance since the frequencies of the countable characters are discontinuously distributed, unlike those of measurable characters which are continuously distributed. The correct way of comparing the frequencies of discontinuously distributed characters is to compare the proportions directly. Ginsburg (*loc. cit.*) was partially successful in achieving this but the method described by him was outdated, in the sense that it lacks mathematical precision. For the comparison of meristic characters the Chi-square test, in which the proportions are directly compared, is preferable. Roedel (1952) was among the first to compare meristic data by the Chi-square test, for his studies on the Pacific mackerel, and it was the method employed in the present study also.

It was found that the numbers of anal and pectoral fin rays were higher in the samples from Godavari estuary (where the salinity was lower but temperature more or less similar to that at Waltair) than in the samples from Waltair. In an analogous case, Cox (1923) observed that in the stickleback, *Apletes quadraeus* Mitchell, the

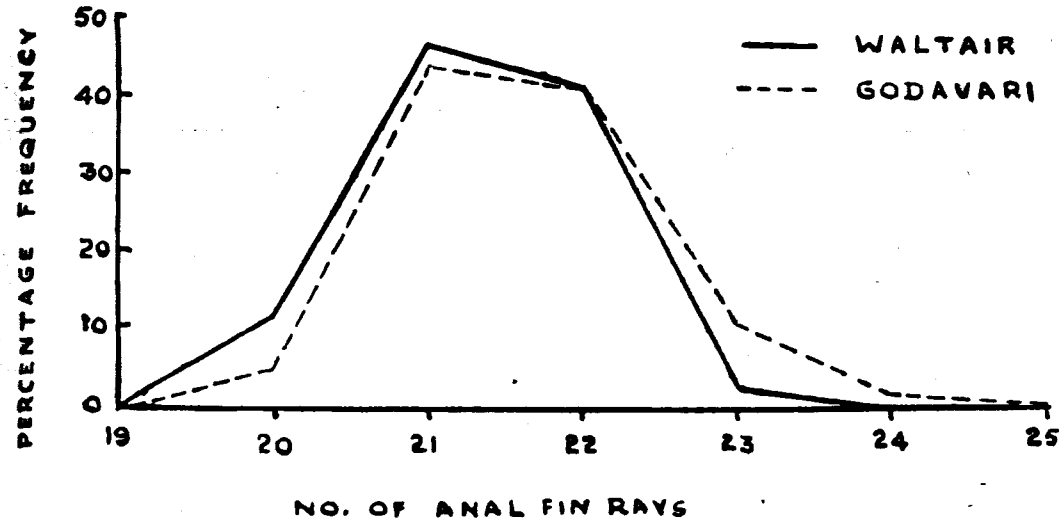

FIG. 1 (a) Percentage frequency polygons of anal fin rays

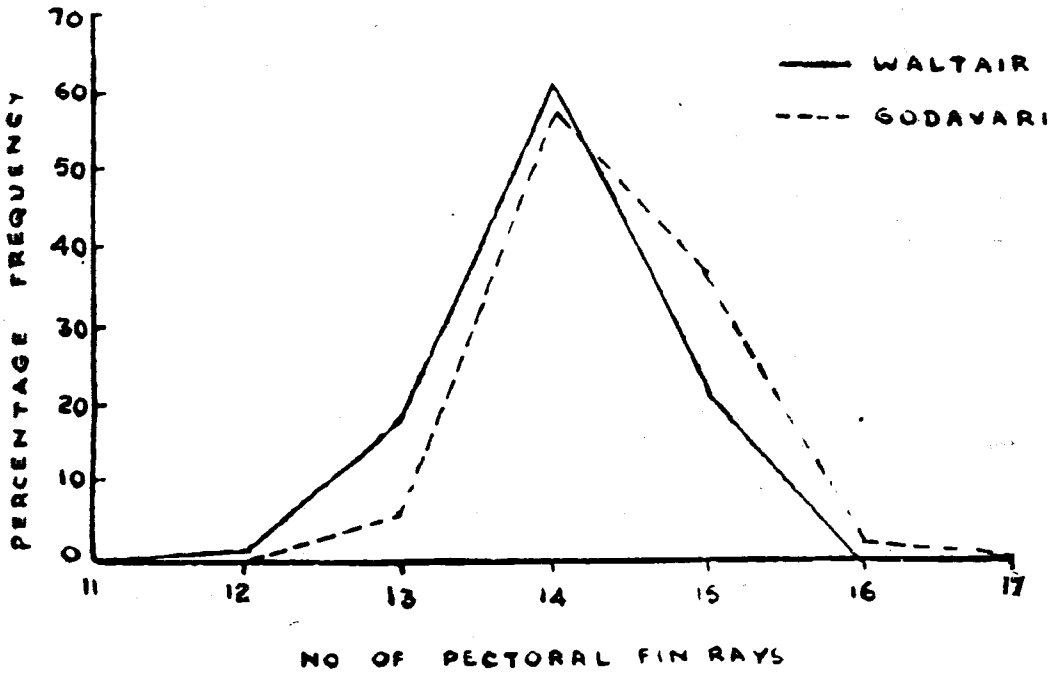

FIG. 1 (b) Percentage frequency polygons of pectoral fin rays

TABLE IV

Multiple regression analysis :

(A) *Corrected sums of products matrix of Waltair coast samples*

	X_1	X_2	X_3	X_4
X_1	1.4765	1.6561	1.4373	0.3915
X_2	1.6561	2.0343	1.6778	0.4445
X_3	1.4373	1.6778	1.5967	0.3931
X_4	0.3915	0.4445	0.3931	0.1419

(B) *Corrected sums of products matrix of Godavari estuary samples*

	X_1	X_2	X_3	X_4
X_1	1.7664	1.5357	1.1075	0.3598
X_2	1.5357	1.6647	1.1026	0.3433
X_3	1.1075	1.1026	0.8825	0.2401
X_4	0.3598	0.3433	0.2401	0.1266

(C) *Corrected sums of products matrix of the pooled samples*

	X_1	X_2	X_3	X_4
X_1	3.2439	3.1947	2.5358	0.7524
X_2	3.1947	3.7077	2.7537	0.7911
X_3	2.5358	2.7537	2.5616	0.6231
X_4	0.7524	0.7911	0.6231	0.2697

(D) *Corrected sums of products of 'Xi's with 'Y' for Waltair coast, Godavari estuary and pooled samples*

	Waltair	Godavari	Pooled
X_1	6.4989	6.6373	13.1387
X_2	7.5707	6.3339	13.9115
X_3	6.5002	4.5047	10.9830
X_4	1.7409	1.4320	3.1755

In the above four tables (A-D) the notation is as follows :

Y=Standard length ; X_1=Head length ; X_2=Height of the body ; X_3=Anal fin length ; X_4=Diameter of eye ; Xi=X_1, X_2, X_3, or X_4.

(E) *Estimates of regression coefficient for Waltair coast, Godavari estuary and pooled samples*

	Waltair	Godavari	Pooled
1.	2.36697	1.99857	2.09144
2.	1.44104	1.32039	1.43209
3.	0.39245	0.80330	0.56845
4.	0.13678	0.52673	0.44824

(F) *Analysis of variance for testing equality of regression coefficients*

Residual due to	D.F.	S.S.	Mean Square
Deviation from hypothesis ..	(p) 5	$(R_1^2-R_0^2)$ 0.0208	0.00416
Separate regressions ..	$(n+n'-2p)$ 85	(R_0^2) 1.6361	0.01925
	$(n+n'-p)$ 90	(R_1^2) 1.6569	

The notations used in this table are from Rao (1952 : Table 3f. 3∠. page 113;) p=no. of variables.

number of dorsal spines is higher in those parts of St. Lawrence characterized by lower salinity and higher temperature.

Summary and Conclusions

The stock of *Anchoviella commersonii* Lacépède from Waltair (where the salinity was higher and the range less) was found to differ significantly from that in the Godavari estuary (where the salinity was lower and the range greater), in the number of anal fin rays and in the number of pectoral fin rays. The stock of the Godavari estuary was having a significantly higher number of anal and pectoral fin rays, when compared with that of Waltair.

However, when a multiple regression analysis was applied to morphometric data (viz., standard length, head length, height of the body, anal fin length and eye diameter), there were no significant differences between the two stocks, indicating that heterogeneity is not evident in measurable characters.

It may be considered that *A. commersonii* of Godavari estuary and of Waltair constitute two different populations, distinguishable only in meristic characters, i.e., anal fin rays and pectoral fin rays.

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