A STUDY OF THE VARIABILITY IN THE FISH CATCHES TAKEN BY SUCCESSIVE HAULS IN THE INSHORE WATERS OFF CALICUT

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Introduction

One of the problems undertaken for investigations at the Calicut Sub-Station of the Central Marine Fisheries Research Station when it was established in May 1948, was a study of the fish populations of the inshore area near Calicut with a view to ascertaining the species of fishes caught from the area, their fluctuations and behaviour. This study necessitated periodical sampling of the populations. The fact that most of the fishes occurring in the inshore waters would be pelagic in nature introducing mobility and mixture was anticipated. The idea of this study was to find out whether a limited number of sample hauls from such a mobile population would help to know the composition of such a population with a specified degree of accuracy. This needed the study of the variability obtained in the species composition obtained in the catch of successive sample hauls. With this view, four series of sampling trials were conducted over a period of one month and the result of analyses of these trials is given in this communication.

Adequacy of sampling is an important prerequisite in any population study. Thompson (1928) considered the proportion of size-groups of haddock population by taking two series of sample catches by Otter-trawl, and concluded that the samples gave a reasonable representation of the proportions of size-groups. Gardiner and Graham (1925) calculated the variability in ten replicate hauls taken by Petersen's Young fish-trawl based on the number of each species of fish caught. Barnes and Bagenal (1951) have studied the variability in catch obtained in short repeated trawls taken over an inshore ground. According to their finding, the coefficient of variation of a single haul for all the species of fish taken together varied from 50 to 85%.

Material and Methods

One of the important problems of a sampling design is the selection of sample unit. To study the composition of fish population, the sample unit generally chosen

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is the catch taken in unit time by a certain gear. Selection of a suitable gear, however, to sample the fish population of any area of the sea, especially of all the species therein, is beset with many difficulties as one has to contend with factors like the varied sizes and behaviour of different species and different sizes of the same species. A series of trial fishing with different types of nets used along this coast revealed that every net was selective in some way or other. It was finally observed that the composite catches obtained by two nets, a boat-seine (*Paithu vala*) and a gill-net (*Chala vala*), very nearly represented the total commercial catch landed along this coast by various nets. Hence for the purpose of this study, the catch obtained by simultaneous operations of these two nets for 15 minutes, was taken as the sampling unit. A description of these nets and an account of the mode of their operation have been given by Bhimachar and Venkataraman (1952). It must, however, be emphasised that the conclusions arrived at in this communication have been restricted to the sampling trials made by the joint operations of these two nets.

It was observed during experimental fishing that the populations, both in respect of composition and numerical abundance, differed even within the inshore area, according to the depths. For purposes of taking samples, the inshore area near Calicut along the Malabar Coast was, therefore, divided into three zones, *viz.*, 2 fathom, 4 fathom and 6 fathom-zones. Three replicate samples of 15 minutes' duration were taken in each zone. A series of 9 samples, 3 in each zone, were taken once a week. Four such series of samples were taken, two in April and two in May 1951. Each sample was analysed in fresh condition for the total weight and weight, number and sizes of various species. The time being summer, the weather and ecological conditions in the inshore sea were steady. The sample catches were made in the morning on all the four days between 6 a.m. to 9 a.m. at almost the same places as far as possible with the same set of boat and nets operated by the same crew.

Fifty-six species of fish were caught during these experimental sampling, in addition to 4 species of prawns and 3 species of crabs. About a dozen species were commonly represented in all the hauls. Except for *Dasyatis* (*Pastinachus*) *sephen*, *Platycephalus punctatus*, *Solea ovata*, *Trypauchen vagina* and 3 species of *Cynoglossus*, which are demersal fish, all other species may be regarded as, more or less, " pelagic " fish.

Analysis of the Data

Table I gives the total number of specimens obtained in different hauls in different zones in the four series.

The analysis of variance of the above hauls is given in Table II.

None of the first order interactions are significant. The variation between hauls and dates is also not significant. As expected, the variation between zones is highly significant. In fact, this was evident from the total of all

TABLE I

Total weight (in lb.)

Series	Dates		Zone 1	Zone 2	Zone 3
I	19–4–1951	Haul 1	190	502	431
		Haul 2	283	773	540
		Haul 3	346	301	572
II	26–4–1951	Haul 1	193	396	623
		Haul 2	93	466	622
		Haul 3	221	492	533
III	10–5–1951	Haul 1	209	571	300
		Haul 2	350	506	435
		Haul 3	379	466	420
IV	17–5–1951	Haul 1	125	316	1,180
		Haul 2	218	488	333
		Haul 3	213	727	538
		TOTAL ..	2,820	6,004	6,527

TABLE II

Analysis of variance of the total number of specimens caught

Source of variation	Degrees of freedom	Sum of squares	Mean square
Between hauls (H) ..	2	1,244·66	622·33
Between zones (Z) ..	2	670,922·66	335,461·33
Between dates (D) ..	3	20,044·46	6,681·49
Interaction HZ ..	4	98,720·17	24,680·04
Interaction ZD	6	176,927·12	29,487·85
Interaction DH ..	6	111,281·12	18,546·85
Residual	12	457,858·05	38,154·84
TOTAL ..	35	1,536,998·24	

the hauls in the different zones, as shown at the bottom of Table I. While only 2,820 fishes were taken in zone 1 in the 12 hauls, the numbers taken in the zones 2 and 3 were 6,004 and 6,527. It may be pointed out here that the high numerical value in haul 1 in zone 3 of series IV was due to the concentration of prawns in the area at the time of sampling. The number of prawns in the three replicate hauls in zone 3 were 1,010, 150 and 377 respectively.

In addition to the factor of number of specimens caught in the different hauls, which is the main basis for analysis of variance in this paper, it was considered worthwhile to analyse the variation in respect of the total weights of the individual hauls also.

Table III gives the total weights of different hauls in pounds in the 3 zones on different dates.

The analysis of variance of the above is shown in Table IV.

As in the analysis of variance of the total number of specimens caught, the analysis also shows that the variation " between zones " is significant.

Variability in the Size Ranges of the Different Fishes Caught in the Three Zones

The present work is primarily directed to the study of sample hauls to ascertain the composition of different species in the fish population in the sea. Sufficient numbers of single species were not taken in all the hauls so as to permit an analysis of the variability in the size-composition of different species in the various hauls. However, the mean lengths of a few of the common species in the different hauls are shown separately for each zone in the Tables XV to XVII. The sizes of prawns and crabs were approximately the same in all the hauls. It would be seen from these tables that approximately the same sizes of various species were being caught in the different hauls.

Detailed Analysis of the Data Zone by Zone

The total yield in the 3 zones being different, it is reasonable to pursue the analysis further, separately for each zone.

In the 4 series of operations carried out in over 4 weeks, although the number of species obtained in the catches was large, the number of specimens of each species was small. Hence, for the purpose of analysis, only those species which were obtained in fair numbers and in all the hauls could be considered. The extent of variation of these common species from haul to haul, separately for each zone, is indicated in Table V.

TABLE III

Total weight (in lb.)

Series	Dates		Zone 1	Zone 2	Zone 3
I	19–4–1951	Haul 1	2·09	3·62	3·52
		Haul 2	1·77	6·42	4·19
		Haul 3	2·54	3·41	3·52
II	26–4–1951	Haul 1	3·13	4·48	5·00
		Haul 2	3·09	3·44	5·75
		Haul 3	2·86	3·60	4·86
III	10–5–1951	Haul 1	2·77	5·45	2·64
		Haul 2	3·10	3·51	3·31
		Haul 3	3·16	3·07	3·58
IV	17–5–1951	Haul 1	2·34	4·45	7·56
		Haul 2	2·60	4·30	3·75
		Haul 3	2·88	4·51	5·83
		TOTAL ..	32·33	50·26	53·51

TABLE IV

Analysis of variance of the total weight in lb. of individual hauls

Source of variation	Degrees of freedom	Sum of squares	Mean square
Between Hauls (H) ..	2	0·4309	0·2154
Between zones (Z) ..	2	21·6783	10·8392
Between dates (D) ..	3	4·7544	1·5848
Interaction HZ ..	4	1·8800	0·4700
Interaction ZD ..	6	11·7224	1·9537
Interaction DH ..	6	4·5372	0·7562
Residual	12	10·5919	0·8826
TOTAL ..	35	55·5951	

TABLE V

Variation in common species

	Zone 1		
	Mean	S.D.	Ratio
Prawns	109·42	55·86	0·51
Crabs	13·33	7·06	0·53
Thrissocles	13·25	7·19	0·54
Carcharius	3·17	2·30	0·72
	Zone 2		
Prawns	279·68	159·06	0·57
Crabs	12·93	6·34	0·49
Cynoglossus	32·93	16·00	0·49
Thrissocles	12·65	8·17	0·64
	Zone 3		
Prawns	277·00	174·79	0·63
Crabs	25·22	12·38	0·49
Cynoglossus	50·10	24·95	0·50
Sciæna	47·92	25·06	0·52
Johnius	30·50	17·20	0·56

It may be seen that for each zone, the standard deviation is approximately proportional to the mean catch of different species taken over a series. The following table also shows separately for each zone the mean, SD and the ratio between SD and means, for the species with which the analyses of variance have been worked out in each zone.

In view of the almost constant ratio between the mean and the standard deviation of different species, the logarithmic values of the original numbers have been used for the purpose of analyses.

Zone 1.—The mean number of the common specimens caught in zone 1 in the 4 series of operations is given in Table VI.

The species of *Scoliodon* and *Thrissocles* and prawns and crabs which constitute about 60 per cent. of the catch in this zone have been taken into consideration for the purpose of analysis of variance, which is given in Table VII.

The mean squares for dates and hauls are not significant. The first order interaction DS is just beyond the 5 per cent. level but below 2·5 per cent. level. Hence taken in conjunction with the other first order

TABLE VI

Mean number of common species in series I to IV in zone 1

Species	Series			
	I	II	III	IV
Scoliodon spp. ..	1·7	3·3	3·0	4·7
Thrissocles spp. ..	21·7	8·3	17·7	5·3
Opisthopterus tardoore ..	30·3	5·3	15·3	0·7
Leiognathus spp.	15·3	2·0	27·3	1·0
Anodontostoma chacunda	1·0	23·3	6·7	2·7
Pseudosciæna spp. ..	3·7	3·0	4·0	14·0
Johnius belengeri ..	..	..	2·3	1·3
Ambassis gymnocephalus	37·0	12·7	12·3	..
Otolithes spp.	0·7	..	3·3	3·0
Cynoglossus spp. ..	1·3	3·3	0·7	8·7
Prawns	100·0	67·3	148·3	122·0
Crabs	18·3	19·7	10·0	5·3

TABLE VII

Analysis of variance for the catch of four forms in Zone 1

Source of variation	Degrees of freedom	Sums of square	Mean square
Between dates (D) ..	3	0·1302	0·0434
Between hauls (H) ..	2	0·0582	0·0291
Between species (S) ..	3	15·0538	5·0179
Interaction DH ..	6	0·2761	0·0460
Interaction DS	9	1·8817	0·2091
Interaction HS	6	0·7141	0·1190
Residual	18	1·2963	0·0720
TOTAL ..	47	19·4104	

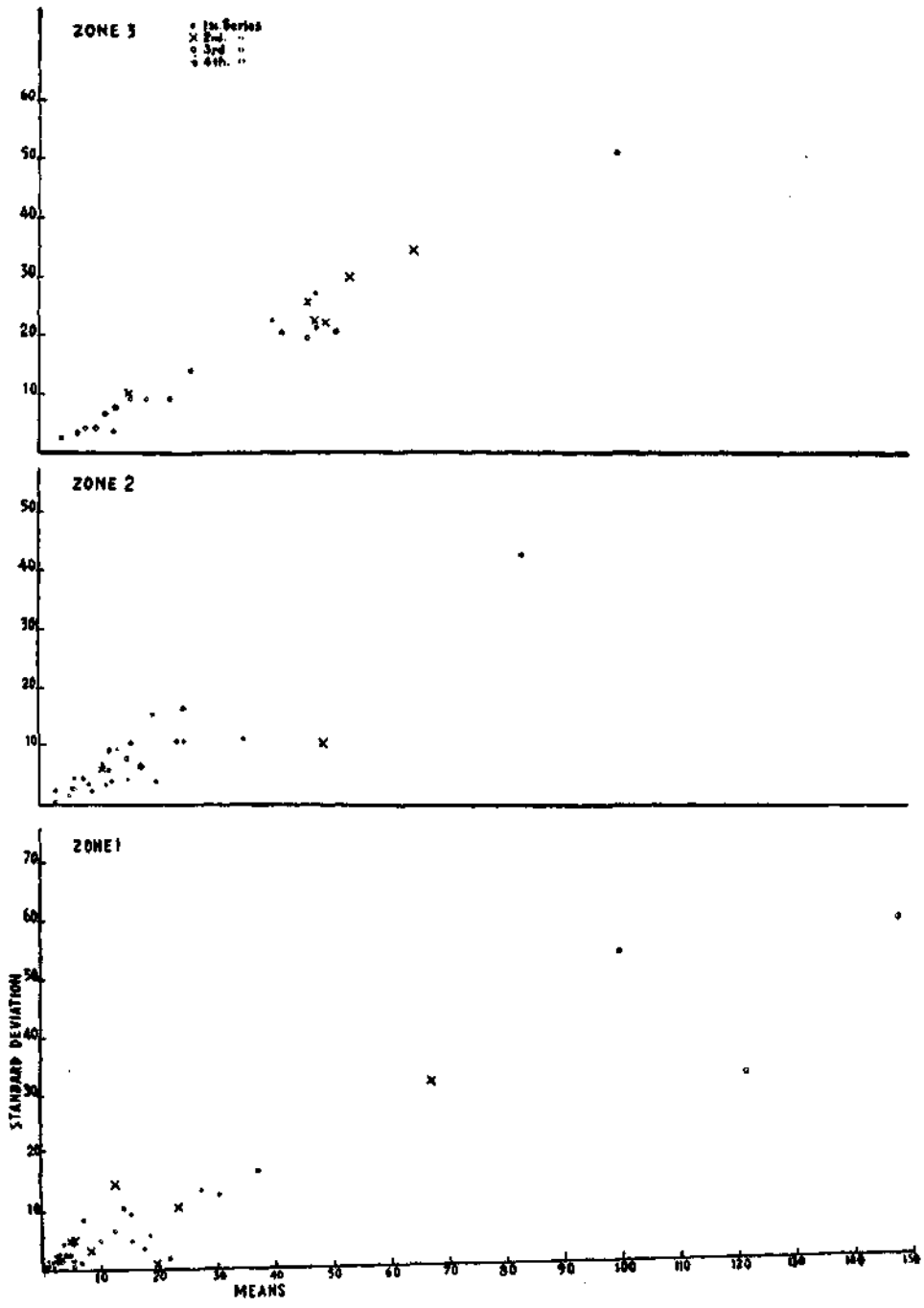

Fig. 1

interaction terms and the mean squares for dates and hauls, this may also be considered non-significant. This means that all sample hauls throughout the period of sampling were being taken from the same fish population. The small mean square value for hauls indicates that no significant changes took place as a result of successive hauls over the same ground. Amalgamating all the interaction terms, the error of variance of a single observation is ·1068 or a log standard deviation of ·3268 corresponding to a coefficient of variation of 112 per cent.

Zone 2.—In Zone 2 the mean number of common species obtained in the four series of hauls is given below:—

TABLE VIII

Mean number of common species in series I to IV in zone 2

Species	Series			
	I	II	III	IV
Scoliodon spp. ..	0·7	1·3	1·0	2·7
Thrissocles spp. ..	11·3	10·7	13·3	15·3
Opisthopterus tardoore ..	184·3	17·0	3·0	6·7
Leiognathus spp. ..	12·3	5·3	24·7	7·3
Anodontostoma chacunda	..	6·7	1·3	2·7
Pseudosciæna spp. ..	55·7	9·0	20·0	15·0
Johnius belengeri ..	11·7	19·3	5·7	9·0
Ambassis gymnocephalus	4·3	2·3	2·3	4·0
Otolithes spp. ..	12·0	2·7	5·3	2·7
Cynoglossus spp. ..	24·7	48·7	35·0	23·3
Prawns	83·0	288·0	357·0	390·0
Crabs	10·7	15·0	17·3	8·7

The analysis of variance of the species of *Cynoglossus* and *Thrissocles* and prawns and crabs, which constitute about 70 per cent. of the catch in this zone, is given below:—

TABLE IX

Analysis of variance of the four main forms in zone 2

Source of variation	Degrees of freedom	Sums of squares	Mean square
Between dates (D) ..	3	0·5938	0·1979
Between hauls (H) ..	2	0·1056	0·0528
Between species (S) ..	3	13·6180	4·5393
Interaction DH ..	6	0·2794	0·0466
Interaction DS	9	0·9035	0·1004
Interaction SH	6	0·9211	0·1535
Residual	18	0·7533	0·0418
TOTAL ..	47	17·1747	

The mean squares for hauls and the two first order interactions DH and DS are not significant. The mean squares for dates and SH are just beyond the 5 per cent. level but are below 1 per cent. level. It is seen from a careful scrutiny of the catch figures of different hauls that on the first day of sampling, the catches of most of the fishes are slightly lower than those on other days. The reason for this is not clear, but it is likely that the sample hauls were not taken from the specific place or for the specific duration. Another peculiarity noted is that the catch of *Thrissocles* in the first haul every day was slightly greater than those of the other hauls. This might have occurred purely by chance and may account for the interaction SH noted above. The analysis of variance of the sample hauls excluding the data for the first day and those for *Thrissocles* is given in Table X.

None of the interaction terms in the above table are significant. Hence amalgamating them with the residual mean square, the log standard deviation of a single haul would be ·1988 corresponding to a coefficient of variation of 58 per cent.

Zone 3.—The mean number of the common species obtained in zone 3 is given in Table XI.

TABLE X

Analysis of variance of three main forms in zone 2 excluding the data for first day

Source of variation	Degrees of freedom	Sum of squares	Mean square
Between dates (D) ..	2	0·1896	0·0948
Between hauls (H) ..	2	0·1093	0·0546
Between species (S) ..	2	9·6535	4·8267
Interaction DH ..	4	0·1218	0·0304
Interaction DS	4	0·1846	0·0461
Interaction HS	4	0·2794	0·0698
Residual	8	0·2052	0·0256
TOTAL ..	26	10·7434	

TABLE XI

Mean number of common species in series I to IV in zone 3

Species	Series			
	I	II	III	IV
Scoliodon spp. ..	0·3	0·7	0·7	1·7
Thrissocles spp. ..	6·7	15·0	3·7	7·7
Opisthopterus tardoore ..	99·3	46·0	12·7	9·7
Leiognathus spp. ..	20·7	3·0	6·0	0·3
Anodontostoma chacunda	0·3	4·3	0·3	4·0
Pseudosciæna spp. ..	47·7	47·3	25·7	51·0
Johnius belengeri ..	40·0	53·7	15·3	13·0
Ambassis gymnocephalus	3·0	0·3	8·3	2·3
Otolithes spp. ..	5·0	2·3	2·0	2·3
Cynoglosses spp. ..	47·7	64·7	46·3	41·7
Prawns	138·3	244·7	212·7	512·3
Crabs	22·3	49·0	18·3	11·3

TABLE XIV

Zonal variation in the total number of common species of fish during the period of sampling

Species	Zone 1	Zone 2	Zone 3
Scoliodon sorrakawah	36	17	10
Pellona ditchoa	43	9	5
Anodontostoma chacunda ..	101	32	27
Ambassis gymnocephalus ..	186	39	42
Lactarius lactarius	20	107	26
Leiognathus splendens	90	132	62
Sardinella longiceps	4	32	5
Otolithes ruber	21	64	35
Opisthopterus tardoore	155	641	503
Pseudosciæna sina	68	272	486
Cynoglossus semifasciatus ..	40	393	576
Johnius belengeri	11	137	366
Thrissocles mystax	133	134	96
Kowala coval	..	4	74
Caranx djedaba	..	1	32
Prawns	1,166	3,356	3,324
Crabs	155	155	303

was observed between the hauls taken in different zones. The species like *Scoliodon sorrakowah, Pellona ditchoa, Anodontostoma chacunda* and *Ambassis gymnocephalus* always occurred more abundantly in zone 1 than in zones 2 and 3. *Pseudosciæna sina, Johnius belengeri, Opisthopterus tardoore* and *Cynoglossus semifasciatus,* which were conspicuously poor in zone 1, occurred abundantly in zones 2 and 3. In case of some species like *Lactarius lactarius, Sardinella longiceps, Kowala coval* and *Caranx djedaba,* their abundance was confined to one of the 3 zones. *Thrissocles mystax* and *Leiognathus splendens* were obtained in fair numbers in all the 3 zones. Prawns and crabs contributed a good fishery in all the 3 zones, though they were generally more abundant in zones 2 and 3. As has been noted in reference 2, this mode of distribution of the various species between zones is applicable only to the summer months. During other seasons of the year there is considerable change both in species composition and their numerical abundance in the inshore sea. Zone 1 which is seen to be poor, has been observed to be very rich on other occasions.

DISCUSSION

In a study of variability of replicate hauls, it is necessary that the hauls are taken from the same population of different species of fish. From an

TABLE XV

The mean length (cm.) for some of the common species in the separate hauls taken in zone 1

	Series I			Series II			Series III			Series IV		
	19–4–1951			26–4–1951			10–5–1951			17–5–1951		
	Haul 1	Haul 2	Haul 3	Haul 1	Haul 2	Haul 3	Haul 1	Haul 2	Haul 3	Haul 1	Haul 2	Haul 3
Thrissocles mystax	17·04	15·90	17·78	..	17·29	16·58	15·82	14·00	10·80	..	16·83	17·15
	5·19	2·69	5·14	3·90	..	6·52	6·17	6·93	6·97	7·90	7·58	9·60
Cynoglossus semi-fasciatus	..	..	5·40	6·45	..	..	5·23	..	..	7·30	..	6·59	6·77
Leiognathus splendens	..	5·03	6·70	5·63	..	4·55	5·82	5·65	5·72	..	5·50	6·20
Johnius belengeri	..	..	..	..	..	..	..	8·67	8·25	..	7·80	8·80
Pseudosciæna sina	..	5·57	5·70	5·73	6·04	6·40	..	7·80	7·10	..	6·67	6·56
Anodontostoma chacunda	..	..	8·87	9·55	9·47	9·35	10·19	9·68	9·76	9·76	10·07	8·80
Opisthopterus tardoore	6·06	5·07	7·55	11·98	..	8·68	8·97	9·84	8·24	17·20	15·20	..
Ambassis gymnocephalus	4·99	4·89	4·86	7·26	6·60	6·36	6·04	5·87	5·75	..	..	..
Ambassis gymnocephalus	3·03	6·20	..	7·95	6·34	..	8·56	7·96	..	..	5·87	..

TABLE XVI

The mean length (cm.) for some of the common species in the separate hauls taken in zone 2

	Series I			Series II			Series III			Series IV		
	19–4–1951			26–4–1951			10–5–1951			17–5–1951		
	Haul 1	Haul 2	Haul 3	Haul 1	Haul 2	Haul 3	Haul 1	Haul 2	Haul 3	Haul 1	Haul 2	Haul 3
Thrissocles mystax ..	15·85 4·86	16·80 6·83	15·67 5·52	17·07 5·39	16·00 7·77	16·30 7·16	15·44 7·29	.. 6·72	16·70 8·24	17·13 6·31	15·75 7·00	16·65 7·60
Cynoglossus semifasciatus	8·20	7·10	8·14	6·79	6·24	7·33	7·47	8·47	7·44	6·92	7·62	8·03
Leiognathus splendens	5·46	6·63	6·63	6·16	5·75	6·70	5·98	4·08	6·13	6·26	6·26	5·90
Johnius belengeri ..	4·91	6·51	7·48	7·72	6·58	6·81	8·70	7·14	6·70	7·92	7·11	7·65
Pseudosciæna sina	5·54	5·18	5·74	6·48	6·91	6·86	6·72	6·20	6·73	8·15	6·56	7·26
Anodontostoma chacunda ..	..	..	..	9·60	9·50	9·58	9·40	10·90	9·90	10·06	10·02	..
Opisthopterus tardoore ..	5·76	6·29	6·05	9·49	9·22	7·83	13·00	8·60	9·50	7·61	8·04	..
Ambassis gymnocephalus ..	8·02	7·96	8·10	6·00	6·10	..	5·75	5·00	..	7·40	..	..

TABLE XVII

The mean length (cm.) for some of the common species in the separate hauls taken in zone 3

	Series I			Series II			Series III			Series IV		
	19–4–1951			26–4–1951			10–5–1951			17–5–1951		
	Haul 1	Haul 2	Haul 3	Haul 1	Haul 2	Haul 3	Haul 1	Haul 2	Haul 3	Haul 1	Haul 2	Haul 3
Thrissocles mystax	..	15·80	..	16·87	17·20	15·00	..	..	..	..	..	13·6
	4·70	5·24	5·70	5·31	6·72	6·24	6·22	7·60	5·80	..	6·87	6·08
Cynoglossus semifasciatus ..	7·03	5·99	6·80	7·25	7·42	6·99	7·22	7·27	7·46	9·05	7·23	8·44
Leiognathus splendens	6·99	6·53	6·27	6·06	6·01	5·70	6·15	6·20	..	..	..	..
Johnius belengeri ..	5·13	6·15	6·09	7·33	6·64	7·44	6·82	6·52	7·32	6·92	7·31	9·17
Pseudosciæna sina ..	5·33	6·29	5·99	7·17	6·65	6·59	6·97	6·17	7·35	6·74	6·57	6·93
Anodontostoma chacunda	..	..	9·80	10·31	10·40	9·90	..	10·40	..	10·48	10·05	10·65
Opisthopterus tardoore ..	5·69	5·50	8·50	8·12	7·42	5·81	6·60	7·01	7·07	8·09	7·43	7·23
Ambassis gymnocephalus ..	8·40	7·70	7·50	5·90	..	..	6·98	6·91	5·84	..	7·00	6·53

examination of the data collected during this study it is observed that the numerical abundance of various species of fish differs in the three different zones of the inshore sea. The analysis of variance for each zone shows that the major portion of the population remained unchanged in all the 3 zones during the period of sampling. This was as expected, for the fishery during the summer months of May and June, when the sample hauls were taken, remains very steady. That the different hauls were being sampled from the same population is further confirmed by the fact that the mean sizes of the common species of fishes were more or less the same over the period of sampling.

Now, the question of the degree of precision of such a single haul has to be considered. It has been shown that the coefficient of variation of a single haul in the 3 zones varied from 58 to 112 per cent. Taking the coefficient of variation as 85 per cent., which is roughly the mean of three coefficients, and converting the logarithmic catches to actual catches and taking $\pm 2\sigma$ as fiducial limits, for a catch of 100, the range of variation is 29 to 344. Thus in successive hauls, a catch which is about $\frac{1}{3}$ or 3 times another catch cannot be regarded as significantly different. The source of this variability is attributed to the variability existing in the population itself. This is further supported by the fact that in any series of successive hauls, the mean number of catch of any particular species and the standard deviation of the catches of this species were roughly proportional, which suggests that the different species are segregated into groups. When the variability of the population becomes larger, as is the case in winter months when the sudden incursion or excursion of the pelagic fisheries takes place, the coefficient of variation of a single haul may be larger than at present. This, of course, requires confirmation.

Hence it is evident that if we want to get a clear idea of the average abundance of different species in such a variable fish population consisting of various mobile species, we have necessarily to take a very large number of sample hauls. If, for example, we desire that the difference between the sample estimate and the population should not be more than 10 per cent. at the 5 per cent. probability level, then the size of the sample would be $n = t^2c^2/p^2\,(1\cdot96)^2 \cdot 85^2/100 = 277$ sample hauls approximately, where c is the coefficient of variation and p the percentages of allowable error and t is the value of 5 at the specified probability level. It appears to us that this is too large a number of samples to handle from the practical point of view. If, however, we want to have a rough estimate of the fish population with an error up to the extent of 20 per cent., then the sample size at the same probability level would be about 69. If the fishery is stable over a period of a few months,

and the sample hauls are spread over the weeks, 3 to 4 hauls per week may then be adequate for the purpose. But for a more accurate study, a larger number of sample hauls per week would be necessary.

Summary

This study relates to the analysis of variance in four series of replicate fish hauls in respect of number of specimens of each species of fish, total weights of hauls and the sizes of the common species of fishes in the catches. In taking the fish catches, controlled working conditions were maintained as far as possible. The variation between hauls was non-significant while that between zones was significant indicating that while the population was, more or less, constant in any particular area of the sea, it was different from zone to zone. The variation between dates was also non-significant, reflecting that the fishery was steady during the period of sampling. The mean size of the common species of fishes was also almost constant in all the hauls.

The coefficient of variation for a single haul is found to vary between 58 to 112 per cent. The real source of this variability is due to the inherent characteristics of the fish population which consists of various pelagic and demersal species. This is supported by the fact that the standard deviation and the mean catch of any species in the replicate hauls of any series are found to be roughly proportional, suggesting that the different species are segregated into groups in the sea.

It is shown that, for a preliminary study of the fish population, 3–4 samples hauls per week may be adequate under certain circumstances.

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