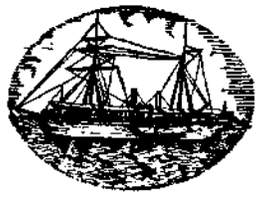
SYMPOSIUM ON CRUSTACEA

PART IV



MARINE BIOLOGICAL ASSOCIATION OF INDIA

MARINE FISHERIES P.O., MANDAPAM CAMP

INDIA

PROCEEDINGS

OF THE

SYMPOSIUM ON CRUSTACEA

HELD AT

ERNAKULAM

FROM JANUARY 12 TO 15, 1965

PART IV

SYMPOSIUM SERIES 2

MARINE BIOLOGICAL ASSOCIATION OF INDIA

MARINE FISHERIES P.O., MANDAPAM CAMP

INDIA

OBSERVATIONS ON THE PRAWN FISHERY OF MAHARASHTRA COAST*

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ABSTRACT

About 80% of the total prawn production of the country comes from the Ratnagiri-Broach region, which practically makes up the entire output of the Maharashtra coast. Based on observations carried out from October 1959 to December 1963 from three representative sampling centres, *viz.*, Arnala, Versova and Sassoon Dock, the magnitude of the fishery, species and size composition, and relative abundance of the various species are given in the paper. Unlike any other part of the country the prawn fishery of Maharashtra is supported by a number of species occurring throughout the year, of which at least ten are of commercial value, being caught in large quantities. More than half the total catch is made up of small shrimps such as *Palaemon tenuipes*, *Hippolysmata ensirostris* and *Acetes indicus* and the larger prawns, *viz.*, *Metapenaeus affinis* and *Parapenaeopsis* spp. have only a limited fishery. *Solenocera indicus*, *Hippolysmata ensirostris* and *Atypopenaeus compressipes* are landed in marketable quantities only along this coast.

INTRODUCTION

THE average annual catch of prawns and other crustaceans† along the Indian coast is 94,911 metric tons constituting 14·60% of the total marine fisheries of India (Table I, Jones, 1963). The magnitude of the catches of the Maharashtra coast can be assessed from the available statistics for the coastline from Ratnagiri to Broach, which excludes the Goa Ratnagiri region of Maharashtra in the south and includes the Daman-Broach region of Gujarat in the north. The crustacean fishery of the Maharashtra coast south of Ratnagiri is so very poor that it can be equated with the equally poor crustacean fishery north of Daman, facilitating the consideration of the available statistics from Ratnagiri to Broach as representing the fishery of Maharashtra State. The average annual crustacean landings from Ratnagiri to Broach is 81,672 metric tons constituting about 80% of the total fishery in India (Table I).

A critical qualitative appraisal of the prawn fishery of the State has not been made so far. The only available information is from Rai (1933) and Shiakhmahmud and Tembe (1960), the former being a limited account of the fishery of the then Bombay Presidency and the latter a numerical assessment of species of prawns based on samples selected from Sassoon Dock alone.

MATERIAL AND METHODS

A preliminary survey of the main prawn fishing centres of the Maharashtra coast was undertaken in 1959, with a view to finding out the magnitude of the fishery at the different centres, on the basis of which three approximately equidistant centres, namely, Sassoon Dock, Versova and Arnala representing different levels of fishing along the coast, were selected for regular periodic observations.

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† Other crustaceans form a very negligible percentage in the catches,

The main fishing gear employed for catching prawns in the region are fixed bag nets, locally known as *dol* and *bokshi*. The *dol* is more or less similar to the *Behundi jal* of Bengal (Naidu, 1942), except for the absence of wings. Setna (1949) gave a detailed account of the design and operational techniques of the *dol* along the Maharashtra coast. The *bokshi* is only a smaller version of the *dol* and is invariably operated very close to the shore in shallow waters. The *dol* is the chief gear used for obtaining the bulk of the prawn catch. Its length varies from place to place along the coast, ranging from 40–50 metres at Sassoon Dock and 50–60 metres at Versova and Arnala.

Regular observations were started in October, 1959 at Sassoon Dock and Versova and in November 1959 at Arnala. After obtaining the requisite information to understand the prawn resources at Arnala, observations were discontinued there since July 1962 while they were continued at the other two centres upto December, 1963.

The centres were visited once in a week to make sample studies of the prawn catches obtained in the different fishing units. Each boat-net combination was considered as a fishing unit in the present study. On each observation day about 10–15% of the total number of fishing units recorded to be in operation were examined. The species composition by weight of the total prawn catch in each observed unit was noted down.

The average catch per fishing unit was calculated on the basis of the sample observations and the total catch on the day of observation was estimated by multiplying the average value with the total number of fishing units in operation. The average weight per day of the total catch of prawns and that of each of the component species were worked out by dividing the summed up total catch for the observed days with the number of days of observation. The total prawn catch as well as the catch of each species in the different months was estimated by multiplying the average values per day with the number of fishing days in the month at each centre.

TABLE I

Total annual production of marine fish and crustaceans in metric tons

Year	Total fish production for India	Total crustacean catch for India	Percentage of crustacean catch to total fish catch	Total crustacean catch for zone 11 (Ratnagiri to Broach)	Percentage of zone 11 crustacean catch to total crustacean catch for India	Source
1950	5,70,860	73,694	12·91	57,558	78·10	C.S.I.R.*
1951	5,25,482	75,584	14·38	57,256	75·75	,,
1952	5,20,002	75,785	14·57	61,015	80·51	,,
1953	5,72,278	89,254	15·66	76,550	85·77	,,
1954	5,78,966	1,51,789	26·22	1,40,972	92·87	,,
1955	5,86,315	1,04,942	17·90	89,528	85·31	,,
1956	7,07,349	1,57,024	22·19	1,23,714	78·79	,,
1957	8,61,634	1,34,357	15·59	1,06,167	79·02	,,
1958	7,43,799	85,334	11·47	61,228	71·75	,,
1959	5,74,993	66,426	11·55	42,730	64·33	,,
1960	8,79,681	70,600	8·76	..	..	F.A.O.†
1961	6,83,569	64,806	9·48	..	..	,,
1962	6,44,244	84,248	13·08	..	..	,,
Average	6,49,936	94,911	14·60	81,672	80·53	

* *Fish and Fisheries of India, Wealth of India Ser.*, C.S.I.R., 1962.

† *Year-book of Fishery Statistics*, F.A.O., 1960–62, 13–15.

Species Occurring in the Fishery

Thirty species of prawns were found to occur along the Maharashtra coast, a classified list of which is given below:

Section **PENAEIDEA**

Family PENAEIDAE

Subfamily PENAEINAE

Genus *Miyadiella*

1. *M. pedunculata* Kubo

Genus *Penaeus*

2. *P. canaliculatus* Olivier
3. *P. monodon* Fabricius
4. *P. penicillatus* Alcock
5. *P. semisulcatus* de Haan

Genus *Metapenaeus*

6. *M. affinis* (Milne Edw.)
7. *M. monoceros* (Fabr.)
8. *M. brevicornis* (Milne Edw.)
9. *M. dobsoni* (Miers)

Genus *Parapenaeopsis*

10. *P. stylifera* (Milne Edw.)
11. *P. sculptilis* (Heller)
12. *P. hardwickii* (Miers)
13. *P. cornutus* (Kishinouye)
14. *P. acclivirostris* (Alcock)

Genus *Trachypenaeus*

15. *T. curvirostris* (Stimpson)

Genus *Metapenaeopsis*

16. *M. novae-guineae* (Haswell)
17. *M. mogiensis* (Rathbun)

Genus *Atypopenaeus*

18. *A. compressipes* (Henderson)

Subfamily SOLENOCERINAE

Genus *Solenocera*

19. *S. indicus* Nataraj

Family SERGESTIDAE

Genus *Acetes*

20. *A. indicus* Milne Edw.

Section **CARIDEA**

Family PALAEMONIDAE

Genus *Palaemon*

Sub-genus *Nematopalaemon*

21. *P. tenuipes* Henderson

Sub-genus *Exopalaemon*

22. *P. styliferus* Milne Edw.

Genus *Macrobrachium*

23. *M. rosenbergii* (de Man)

24. *M. idae* (Heller)

Family HIPPOLYTIDAE

Genus *Hippolysmata*

25. *H. ensirostris* Kemp

26. *H. vittata* Stimpson

Genus *Tozeuma*

27. *Tozeuma* sp.

Genus *Latreutes*

28. *Latreutes* sp.

Family CRANGONIDAE

Genus *Pontocaris*

29. *P. lacazei* (Gourret)

Family ALPHEIDAE

Genus *Alpheus*

30. *Alpheus* spp.

Rai (*loc. cit.*), Chopra (1939, 1943) and Panikkar and Menon (1955) have mentioned that *Palaemon styliferus* forms a major component of the prawn catches of Bombay. During the present investigations, however, it was observed that by far the most abundant species was *Palaemon tenuipes* and not *P. styliferus* which occurred only to a limited extent.

Among the penaeids, *Penaeus indicus*, which is of great commercial value along the Malabar and Madras coasts has bean found to be scarce along the Maharashtra coast, though Shaikhmahmud and Tembe (*loc. cit.*) have reported that it constituted about 12% (numerically) in their samples from Sassoon Dock. In this connection, it is of interest to note that the three varieties of *P. indicus* decribed by Alcock (1906) have subsequently been raised to the status of separate species, *i.e.*, *P. indicus*, *P. penicillatus* and *P. merguiensis*, according to which the species available along the Maharashtra coast has been identified as *P. penicillatus*. Of the other penaeid prawns, two species belonging to the genus *Parapenaeopsis*, namely, *P. cornutus* and *P.maxillipedo*, were recorded from Bombay by Mehendale and Tambe (1958) and Shaikhmahmud and Tembe (*loc. cit.*) respectively, of which the latter was reported to be a species of commercial value. These two species closely resemble each other. During the present study only *P. cornutus* was found occasionally. *Para-*

TABLE II

Prawn species occurring in the fishery of Maharashtra coast

\+ Rare; ++ Present; +++ Abundant; ++++ Very abundant

Species	Harnai	Murud	Alibag	Sassoon Dock	Worli	Versova	Arnala	Satpati	Dahan
Miyadiella pedunculata	..	..	..	+	..	+	..	..	..
Penaeus canaliculatus	..	..	..	+	..	+	+	..	..
P. monodon	+	+	+	+	+	+	+	+	+
P. penicillatus	+	+	+	++	+	+	++	+	+
P. semisulcatus	..	..	..	+	..	..	..	..	..
Metapenaeus affinis	++	++	+++	+++	+++	+++	++	++	++
M. monoceros	++	+	++	++	++	++	+	+	+
M. brevicornis	+	..	+	+++	+	++	++	+	++
M. dobsoni	..	..	..	+	..	+	+	..	..
Parapenaeopsis stylifera	+++	+++	+++	+++	++	+++	++	+	+
P. cornutus	..	..	..	+	..	+	..	..	..
P. sculptilis	..	+	++	+++	+	++	+++	+	+++
P. hardwickii	++	+++	+++	+++	+++	+++	++	++	++
P. acclivirostris	..	..	..	++	..	+	..	..	..
Atypopenaeus compressipes	..	..	+	++	+	+++	+	..	..
Trachypenaeus curvirostris	..	..	..	+	..	+	..	..	..
Metapenaeopsis novae-guineae	..	..	..	+	++	..	..	..	..
M. mogiensis	..	..	..	..	..	+	..	..	..
Solenocera indicus	++	+	+++	+++	++	+++	++	++	+
Acetes indicus	+++	+++	++++	++++	+++	++++	++	++	++
Palaemon tenuipes	++++	++++	++++	++++	++++	++++	+++++	++++	+++
P. styliferus	+	..	+	++	+	+	++	..	++
Macrobrachium rosenbergii	..	..	+	..	..	+	...	..	..
M. idae	..	..	..	..	..	+	-	..	..
Hippolysmata ensirostris	++	++	+++	+++	+++	+++	++	++	++
H. vittata	..	..	..	+	..	+	...	..	..
Tozeuma sp.	..	..	..	++	..	+	..	..	..
Latreutes sp.	..	..	+	+	..	+	..	..	..
Pontocaris lacazei	...	..	..	+	..	..	..	...	..
Alpheus sp.	...	+	+	++	..	+	+	...	+

penaeopsis hardwickii and *Atypopenaeus compressipes* occurring along the west coast of India and their commercial importance were first pointed out by Kunju (1962).

Miyadiella pedunculata, a new penaeid genus and species, described by Kubo (1949),is recorded for the first time in Indian waters. It was found always along with juvenile *Atypopenaeus compressipes*.

The extent of occurrence of the various species at important prawn fishing centres covered in the preliminary survey along the Maharashtra coast is shown in Table II.

Trends in the Fishery

Fishing activities were practically suspended during the S.W. monsoon all along the coast of Maharashtra. However at Sassoon Dock the *dol* fishery was found to continue during this period though on a reduced scale. *Bokshi* operations were usually more at Arnala than at the other two centres and during the monsoon months a still larger number of units were used.

The estimated average monthly prawn landings and their species composition, at the three centres is given in Table III. It may be seen that the best catches were obtained at Versova followed by Sassoon Dock and Arnala in that order. Based on the preliminary survey it has been observed that the magnitude of the prawn fishery decreases southward and northward of Bombay.

During the period April-May the prawn landings were comparatively high at all the centres, while during October-November they were high only at Sassoon Dock and Versova. The prawn catches were generally higher at Versova than at Sassoon Dock, but during the monsoon months, when *dol* net operations were suspended at the former centre, they were continued to some extent at the latter. The period from February to May was found to be the best season at Arnala.

Of the thirty species occurring in the catches only ten contributed to one per cent. or more of the total fishery at the three centres taken together and hence considered commercially important; the rest were grouped together under miscellaneous prawns. *Atyopenaeus compressipes*, however, constituted over 3% only at Versova. The annual averages of species contributing to the prawn fishery at the three centres in the different months are shown in Fig. 1.

Seasonal Variation in Abundance of the Different Species

Metapenaeus affinis

It was abundant at Versova and Sassoon Dock from September to November, when it contributed to about 90% of its average annual catch at these two centres. The species was observed to occur in considerable quantities only sporadically at Arnala without being restricted to a particular season.

In certain periods it formed the mainstay of the prawn fishery; *e.g.*, in the month of October 1961 it was recorded to constitute 86·2% of the total catch at Versova.

It is interesting to note that the period of abundance commences immediately after the S.-W. monsoon and declines suddenly by the middle of November every year.

M. brevicornis

About 60% of the total catch of *M. brevicornis* for all the three centres was found at Sassoon Dock alone. It constituted 2·08%, 1·60% and 0·46% of the average annual prawn fishery at Sassoon Dock, Arnala and Versova, respectively, indicating its scarcity at Versova.

TABLE III

Average species composition of the prawn fishery in kg. at different centres

Months	Centres	*M. affinis*		*M. brevicornis*		*P. stylifera*		*P. hardwickii*		*P. sculptilis*		*S. indicus*	
		Average catch	%	Average catch	%	Average catch	%	Average catch	%	Average catch	%	Average catch	%
1	2	3	4	5	6	7	8	9	10	11	12	13	14
January	Versova	7,317	2·55	4,158	1·45	5,025	1·75	16,818	5·86	18,063	6·29	49,432	17·22
	S. Dock	2,288	1·20	2,273	1·19	5,072	2·66	9,742	5·11	24,333	12·75	10,142	5·32
	Arnala	2,899	3·01	733	0·76	1,102	1·14	1,043	1·08	13,413	13·93	5,298	5·57
February	Versova	2,512	0·88	941	0·33	4,156	1·46	26,675	9·38	8,616	3·03	55,950	19·60
	S. Dock	619	0·57	1,403	1·29	1,103	1·01	4,343	4·00	9,228	8·50	9,417	8·67
	Arnala	302	0·14	1,125	0·53	1,808	0·85	2,448	1·15	18,138	8·54	11,203	5·27
March	Versova	9,434	2·89	2,019	0·62	5,417	1·66	27,269	8·34	7,956	2·43	65,938	20·17
	S. Dock	2,420	1·63	1,425	0·96	3,307	2·22	6,509	4·38	6,713	4·51	27,856	18·73
	Arnala	633	0·42	4,000	2·66	187	0·12	11,097	7·37	5,317	3·53	10,867	7·22
April	Versova	7,724	1·59	669	0·14	1,618	0·33	10,845	2·24	2,032	0·42	65,110	13·42
	S. Dock	4,275	2·13	1,846	0·92	919	0·46	3,361	1·68	7,735	3·86	13,999	6·99
	Arnala	2,433	1·15	2,467	1·17	167	0·08	8,500	4·02	9,600	4·53	12,250	5·79
May	Versova	11,409	2·45	1,140	0·25	164	0·04	16,481	3·54	5,872	1·26	58,184	12·50
	S. Dock	3,619	1·41	1,993	0·77	1,179	0·46	4,259	1·65	14,930	5·80	14,799	5·75
	Arnala	3,883	2·43	375	0·23	150	0·09	9,192	5·74	10,233	6·39	9,467	5·91
June	Versova	335	2·79	..	..	..	..	133	1·11	495	4·13	2,063	17·20
	S. Dock	637	0·33	2,983	1·54	175	0·09	1,243	0·64	7,505	3·88	3,006	1·56
	Arnala	17	0·10	200	1·18	..	..	150	0·88	7,517	44·30	..	..
July	Versova	..	..	..	..	..	..	..	..	..	..	..	..
	S. Dock	3,576	3·28	3,148	2·89	13,166	12·07	2,772	2·54	12,369	11·34	442	0·41
	Arnala	75	0·51	413	2·82	75	0·51	..	..	6,600	45·12	..	..

August	Versova	2,456	14·37	130	0·76	308	1·80	..	..	462	2·70	..	..
	S. Dock	3,431	2·54	4,572	3·38	6,911	5·15	1,209	0·89	12,112	8·97	..	..
	Arnala	..	..	810	7·15	315	2·78	..	..	5,963	52·65	..	..
September	Versova	60,414	48·26	330	0·26	25,556	20·41	206	0·16	1,179	0·94	112	0·09
	S. Dock	53,380	29·50	4,552	2·52	26,301	14·54	1,443	0·80	5,170	2·86	15	..
	Arnala	2,540	13·87	2,278	12·44	825	4·50	..	..	2,570	14·03	..	..
October	Versova	2,41,783	52·47	162	0·04	70,075	15·21	5,827	1·26	1,012	0·22	8,232	1·79
	S. Dock	1,55,500	52·39	12,290	4·14	46,085	15·53	10,645	3·59	10,740	3·62	2,302	0·78
	Arnala	585	1·66	1,425	4·05	1,125	3·20	1,350	3·84	8,250	23·47	1,950	5·55
November	Versova	1,17,783	24·51	4,273	0·89	42,167	8·77	72,733	15·14	14,843	3·09	89,608	18·65
	S. Dock	1,09,683	46·72	7,300	3·12	28,317	12·06	12,417	5·29	11,317	4·82	11,467	4·88
	Arnala	4,866	15·82	1,420	4·62	3,628	11·80	2,642	8·59	6,118	19·89	2,233	7·26
December	Versova	9,450	4·14	712	0·32	7,171	3·12	44,256	19·40	10,446	4·58	48,234	21·14
	S. Dock	2,270	2·34	937	0·96	3,240	3·34	1,275	1·31	4,900	5·04	14,520	14·95
	Arnala	823	3·03	503	1·85	303	1·12	2,347	8·64	8,868	32·65	2,654	9·77
Average	Versova	4,70,621	14·83	14,564	0·46	1,61,732	6·10	2,21,243	6·97	71,171	2·24	4,42,863	13·96
annual	S. Dock	3,41,698	15·87	44,722	2·08	1,35,775	6·31	59,218	2·75	1,27,052	5·90	1,07,965	5·01
catch	Arnala	19,056	1·93	15,749	1·60	9,685	0·98	38,769	3·93	1,02,587	10·41	55,922	5·68

TABLE III (*Contd.*)

Months	Centres	*A. compressipes*		*A. indicus*		*P. tenuipes*		*H. enstrostris*		Miscellaneous		Total
		Average catch	%	Average catch	%	Average catch	%	Average catch	%	Average catch	%	
1	2	15	16	17	18	19	20	21	22	23	24	25
January	Versova	8,382	2·92	1,10,165	38·39	49,073	17·10	18,505	6·45	58	0·02	2,86,996
	S. Dock	..	..	77,400	40·57	30,590	16·03	25,087	13·15	3,875	2·03	1,90,802
	Arnala	..	..	6,537	6·79	56,423	58·59	4,962	5·15	3,899	4·05	96,309
February	Versova	11,974	4·21	1,10,756	38·95	55,533	19·53	6,300	2·22	974	0·34	2,84,387
	S. Dock	..	..	53,664	49·43	26,070	24·01	1,374	1·27	1,353	1·25	1,08,574
	Arnala	..	..	15,418	7·26	1,45,079	68·29	13,904	6·54	3,029	1·43	2,12,454
March	Versova	20,728	6·34	89,650	27·42	94,158	28·80	4,288	1·31	69	0·02	3,26,926
	S. Dock	..	..	75,006	50·44	20,682	13·91	3,528	2·37	1,268	0·85	1,48,714
	Arnala	..	..	9,233	6·13	1,04,067	69·11	3,320	2·20	1,854	1·23	1,50,575
April	Versova	9,131	1·88	1,29,653	26·73	2,52,830	52·13	4,930	1·02	496	0·10	4,85,038
	S. Dock	..	..	52,155	26·04	1,04,524	52·18	10,441	5·21	1,064	0·53	2,00,319
	Arnala	..	..	4,300	2·03	1,65,700	78·27	5,283	2·50	1,000	0·47	2,11,700
May	Versova	5,635	1·21	64,074	13·77	2,93,261	63·02	8,668	1·86	462	0·10	4,65,350
	S. Dock	..	..	54,238	21·06	1,46,868	57·03	12,210	4·74	3,451	1·34	2,57,546
	Arnala	..	..	1,133	0·71	1,19,592	74·72	3,558	2·22	2,475	1·55	1,60,058
June	Versova	18	0·15	888	7·40	7,590	63·29	450	3·75	20	0·18	11,992
	S. Dock	..	..	41,581	21·52	1,09,909	56·89	24,856	12·86	1,314	0·68	1,93,209
	Arnala	..	..	433	2·55	6,717	39·59	483	2·85	1,450	8·55	16,967
July	Versova	..	..	..	..	..	..	..	..	..	..	..
	S. Dock	..	..	20,764	19·03	26,683	24·46	24,418	22·38	1,757	1·61	1,09,095
	Arnala	..	..	75	0·51	3,338	22·82	563	3·85	3,488	23·85	14,627

August	Versova	..	..	3,519	20·59	7,344	42·98	2,500	14·63	369	2·16	17,088
	S. Dock	..	..	12,630	9·35	72,925	53·98	20,273	15·00	1,040	0·77	1,35,103
	Arnala	..	..	375	3·31	2,400	21·19	300	2·65	1,163	10·27	11,326
September	Versova	..	..	11,809	9·43	14,713	11·75	9,806	7·83	1,072	0·86	1,25,197
	S. Dock	..	..	16,478	9·10	43,185	23·87	28,845	15·94	1,519	0·84	1,80,888
	Arnala	..	..	170	0·93	6,050	33·03	2,238	12·22	1,643	8·97	18,314
October	Versova	70	..	61,187	13·28	12,925	2·80	52,758	11·45	6,812	1·48	4,60,843
	S. Dock	..	..	13,128	4·42	19,627	6·61	19,967	6·73	6,520	2·20	2,96,804
	Arnala	..	..	1,350	3·84	2,815	8·01	14,725	41·89	1,575	4·48	35,150
November	Versova	33,208	6·91	32,525	6·77	2,192	0·46	25,408	5·29	45,821	9·53	4,80,561
	S. Dock	..	..	22,800	9·71	10,277	4·38	11,392	4·85	9,791	4·17	2,34,761
	Arnala	..	..	133	0·43	528	1·72	8,484	27·59	701	2·28	30,753
December	Versova	15,931	6·98	61,324	26·88	20,772	9·10	8,010	3·51	1,859	0·82	2,28,165
	S. Dock	..	..	49,075	50·52	14,175	14·59	4,885	5·03	1,860	1·91	97,157
	Arnala	..	..	17	..	6,138	23·26	3,809	14·03	1,515	5·58	27,157
Average	Versova	1,05,077	3·31	6,75,565	21·29	8,10,579	25·55	1,41,623	4·46	58,031	1·83	31,73,069
annual	S. Dock	..	..	4,88,919	22·70	6,25,515	29·05	1,87,276	8·70	34,812	1·62	21,52,952
catch	Arnala	..	..	39,174	3·98	6,19,027	62·82	61,629	6·25	23,792	2·41	9,85,390

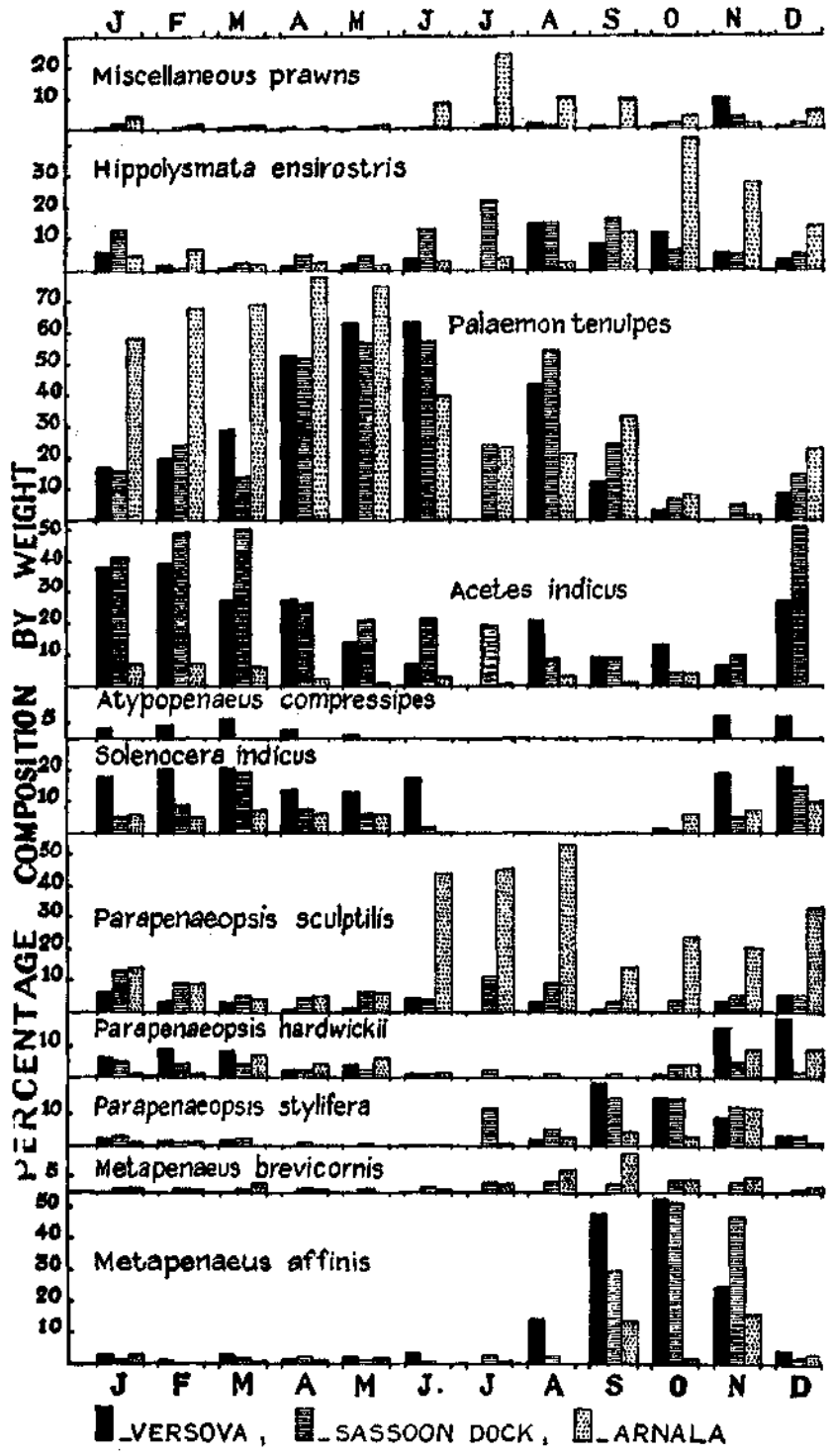

FIG. 1. Average species composition of the prawn fishery in different months at the three centres of observation.

Its season at Sassoon Dock started in June with a gradual rise in catch which reached a peak in October when it constituted 4·14% of the total prawn catch in that month, and declined suddenly from December onwards. At Arnala, the season for the fishery was during March-April, but it was also found to be relatively more abundant than the other species in September.

Parapenaeopsis stylifera

The season for the fishery of this species coincides with that of *M. affinis* (September to November), comprising 79% of its average annual yield from the three centres together. In July and August the species was observed to make up 12·07% and 5·15% respectively of the total catch at Sassoon Dock.

P. hardwickii

The season for this fishery at Versova was found to start suddenly in November coinciding with the decline of *M. affinis* and continued on a lesser scale upto May, with a gradual decrease. At Sassoon Dock its peak of abundance was in October-November when 39% of its total annual catch was obtained. The seasonal occurrence of this species at Arnala was observed to be different from the other two centres, being more abundant from March to May.

P. sculptilis

As in the case of *M. brevicornis* its yield at Sassoon Dock and Arnala was quite considerable, contributing 42·23% and 34·10% respectively of the total annual landings of the prawn. It was found to be the second most important fishery at Arnala constituting 10·41% of the total prawn fishery at the centre. Though the fishery was observed to be relatively less important at Versova, the maximum landings at the centre were comparable with those at Sassoon Dock in the month of January. At Arnala, the species was most abundant in the month of February. The prominence of this fishery at Sassoon Dock and Arnala was partly due to its relative abundance during the monsoon months of June to August, during which period at Arnala the species comprised 44·30% to 52·65% of the total fishery while at Sassoon Dock only 3·88% to 11·34%.

Solenocera indicus

It supported a very important fishery at Versova, where the yield was 73% of its total landings at the three centres. At Versova and Sassoon Dock, synchronising with the appearance of *P. hardwickii*, maximum catches of this species were obtained in November, though the period of abundance extended upto May. The peak period of its abundance at Arnala was from February to April. Its virtual disappearance from the coastal waters during the monsoon months is of interest.

Atypopenaeus compressipes

As mentioned earlier this small penaeid prawn was observed to have commercial importance only at Versova. It appears suddenly in November along with *P. hardwickii* and *S. indicus*. The fishery continued at a steady level upto May with a minor peak in Ma rch.

Acetes indicus

This small shrimp was observed to be the second important species in magnitude only to *P. tenuipes* at Versova and Sassoon Dock, where it constituted about 97% of its fishery at the three centres taken together. The best landings were obtained from January to April at these two centres. Its abundance at Sassoon Dock was comparatively high even in May to July. The maximum catches at Arnala were recorded during the period January to March.

A. indicus formed the bulk of the prawn fishery at Versova in the months of October, 1960 (60%) and December 1963 (60%) and at Sassoon Dock in December 1959 (70%) and April 1963 (60%).

Palemon tenuipes

It was found to be the most important species from the point of view of its abundance. Its fishery extended from January to June at all the three cantres. At Arnala the importance of this fishery was far higher than at the other two centres. The maximum landings were observed in April-May in all the three centres, when about half of its annual catch was obtained. A minor period of abundance was also observed at Sassoon Dock (July to September). The period of October–November was the poorest for the fishery in all the centres.

In certain months (April and May, 1960 and May 1961) *P. tenuipes* was found to dominate the catches to the extent of more than 80% of the total prawn fishery.

Hippolysmata ensirostris

The periods of maximum abundance of the species were January, October and November at Versova, January and June to September (monsoon months) at Sassoon Dock, and February and October at Arnala. Thus it could be seen that the periods of seasonal abundance varied from centre to centre, the causes of which are not yet known.

Miscellaneous Prawns

The species grouped under miscellaneous prawns are shown in Table II. Of these, *Penaeus penicillatus* and *P. monodon* were observed to be of more frequent occurrence than the others, at all the three centres. In the months of October and November large mature individuals of *Metapenaeus monoceros* and *Metapenaeopsis novae-guineae* were obtained at Versova and Sassoon Dock in appreciable numbers, coinciding with the peak period of abundance of *M. affinis* and *P. stylifera*, which resulted in a higher percentage composition of miscellaneous prawns during these months at the two centres. The high percentage composition of miscellaneous prawns at Arnala from June to September was due to the incidence of *Palaemon styliferus* in large numbers, caught mainly in the *bokshi* nets.

General Considerations

The foregoing account shows that the prawn fishery of the Maharashtra coast is mainly supported by the small prawns and shrimps, such as *Palaemon tenuipes*, *Acetes indicus* and *Hippolysmata ensirostris*, the three together contributing to about 58% of the total prawn fishery in the region, of which 33% of the total fishery is made up of *Palaemon tenuipes* alone (Table IV). *Solenocera indicus* belonging to the subfamily *Solenocerinae*, members of which usually inhabit deep waters (Alcock, 1901) is found to support a fishery of commercial magnitude along the Maharashtra coast only, constituting about 10% of the total prawn fishery in the region. In their account of the prawn fishery of Bombay Shaikhmahmud and Tembe (*loc. cit.*) regarded the above four species as unimportant prawns of no commercial value.

Of the species bigger in size *M. affinis* is the most important, making up 13% of the total prawn fishery. The three species of *Parapenaeopsis*, namely, *P. stylifera*, *P. hardwickii* and *P. sculptilis* together form about 14% of the fishery (Table IV).

On the basis of seasonal abundance, the prawn fishery of Maharashtra coast is found to follow an annual cycle of species predominance during different periods. The prawn catches were found to be particularly rich in respect of *P. tenuipes* from April to May, of *M. affinis* and *P. stylifera* from September to November and of *A. indicus*, *S. indicus* and *P. hardwickii* from December to March.

The prawn fishery of Maharashtra coast is remarkable for the occurrence of *S. indicus*, *H. ensirostris* and *A. compressipes* in adequate proportions to support fishery of commercial importance. The species are not known so far to occur in abundance in other parts of the Indian coast. *A. compressipes* and *Solenocera* sp. are however, reported to form a small percentage of the fishery in the Seto Inland Sea of Japan (Yasuda, 1955).

TABLE IV

Percentage composition of the prawn species at different centres

Species	All the three centres	Versova	Sassoon Dock	Arnala
Palaemon tenuipes ..	32·56	25·55	29·05	62·82
Acetes indicus ..	19·07	21·29	22·70	3·98
Metapenaeus affinis ..	13·17	14·83	15·87	1·93
Solenocera indicus ..	9·61	13·96	5·01	5·68
Hippolysmata ensirostris ..	6·19	4·46	8·70	6·25
Parapenaeopsis hardwickii ..	5·06	6·97	2·75	3·93
P. stylifera ..	4·87	6·10	6·31	0·98
P. sculptilis ..	4·77	2·24	5·90	10·41
Atypopenaeus compressipes ..	1·66	3·31	..	..
Metapenaeus brevicornis ..	1·19	0·46	2·08	1·60
Miscellaneous prawns ..	1·85	1·83	1·62	2·41

Several factors, namely the force and duration of the tidal current, the extent of rainfall over the adjoining land mass, the annual cycle of upwelling of coastal waters and the depth and location of fishing grounds, seem to influence the success or failure of the prawn fishery of Maharashtra coast as well as its species composition.

Since the prawn fishery of this coast is based mainly on fixed bag nets entrapping the prawns and fish that move in with the tidal current, its success depends on the strength of the flow of the prevailing tide. During the present study it was noticed that the extremes of tidal currents, *i.e.*, neap and spring tides of certain months, had an adverse effect on the prawn fishery. When *dol* nets were operated in strong currents, the usual close-meshed cod end was replaced by another cod end with a wider mesh resulting in the elimination of *Acetes indicus*, *Palaemon tenuipes* and other small prawns. The magnitude of the tidal influence on the content and composition of the prawn fishery along the Maharashtra coast is being studied, the results of which will be published elsewhere.

Some prawns like the penaeids are migratory in habit with an obligatory period of life in waters of low salinity. An analysis of the annual rainfall data of the Konkan coast for the past fifteen years *vis-a-vis* the prawn catches revealed a diect relationship, as found in other parts of the world by Gunter and Hildebrand (1954) and Thomson (1955). Details of these findings are being published elsewhere.

Carruthers *et al.* (1959) indicated the effect of annual upwelling of the coastal waters of Bombay on the fisheries in general. The shoreward migration and consequent abundance of the penaeid prawns such as *M. affinis*, *M. monoceros*, *P. stylifera* and *M. novae-guineae* in the post-monsoon period of October-November along the Bombay coast, may probably be attributed, along with other

possible factors, to this momentous upwelling taking place at this time every year resulting in the shoreward slope of the oxygen minimum layer on the continental shelf.

The incidence of *Metapenaeus brevicornis*, *Parapenaeopsis sculptilis* and *Palaemon styliferus* in comparatively large numbers in the *bokshi* nets of Arnala and the *dol* nets of Sassoon Dock may be due to the location of the fishing sites at these centres close to the shore within a depth range of five to fourteen metres. These prawns are known to be estuarine penetrating species prefering a shallow water habitat (Kunju, 1955; Rajyalakshmi, 1961).

Knowledge of the extent and the periods of availability of the different species of prawns useful for freezing, canning, curing by sundrying, etc., and marketing them in fresh condition according to consumer preferences is important for the concerned industries to plan and execute their operational activities. The present studies have revealed that the small-sized species like *Palaemon tenuipes* and *Acetes indicus* and the large-sized ones like *Metapenaeus affinis*, *Parapenaeopsis stylifera*, *P. hardwickii* and *Solenocera indicus* were regular in their periodicity of abundance to meet the demands of the different industries for continuous supplies.

Summary

The magnitude of the prawn fishery of the Maharashtra coast and its very high place in the crustacean fisheries of India have been stated.

The seasonal abundance of different species constituting the prawn catches has been studied from regular samples collected at three centres representing different levels of the fishery.

Thirty species of prawns and shrimps have been found in the fishery, of which those comprising one or more per cent. of the total fishery in their order of abdunance are *Palaemon tenuipes*, *Acetes indicus*, *Metapenaeus affinis*, *Solenocera indicus*, *Hippolysmata ensirostris*, *Parapenaeopsis hardwickii*, *P. stylifera*, *P. sculptilis*, *Atypopenaeus compressipes* and *Metapenaeus brevicornis*.

Palaemon tenuipes, *Acetes indicus* and *Hippolysmata ensirostris* among the smaller species contitute the major portion of the catches. Among the larger species, *Metapenaeus affinis*, *Parapenaeopsis hardwickii*, *Parapenaeopsis stylifera*, and *Parapenaeopsis sculptilis* are of considerable commercial importance.

That *Solenocera indicus*, *Hippolysmata ensirostris* and *Atypopenaeus compressipes* occurring in quantities to support fisheries to some extent has been pointed out for the first time.

Palaemon tenuipes in April and May, *Metapenaeus affinis* and *Parapenaeopsis stylifera* in September to November and *Acetes indicus*, *Parapenaeopsis hardwickii* and *Solenocera indicus* in December to March have been found to be particularly abundant.

The influence of tidal current, rainfall, and upwelling in deeper waters of the continental shelf on the fishery has been indicated.

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