ATLAS OF CLAM RESOURCES OF KARNATAKA

G. Syda Rao, P. S. Kuriakose, N. Ramachandran,
M. M. Meiyappan, G. P. Kumaraswamy Achary,
D. Nagaraja, H. S. Shivanna

CMFRI Special Publication
Number 46

Central Marine Fisheries Research Institute
COCHIN
(Indian Council of Agricultural Research)
P. B. No. 2704, E. R. G. Road, Cochin 682031, India

JUNE 1989

Restricted circulation

Published by

Dr. P. S. B. R. JAMES
Director
Central Marine Fisheries
Research Institute
P. B. No. 2704
E. R. G. Road
Cochin-682 031
India

Edited by

Dr. N. RAMACHANDRAN
and
Dr. E JOHNSON
Central Marine Fisheries
Research Institute
Cochin-682 031

Printed at
S. K. Enterprises, Cochin-18

PREFACE

Clams have been a source of protein from ancient times for those living on the banks of estuaries and backwaters. The clam shells, being an excellent raw material for the production of lime, formed an important source of income for the fishermen families in Kerala and Karnataka. With the increasing demand for the fine quality lime obtained from the shells for the manufacture of paper chemicals, poultry feed, polyfibre and cement, the exploitation of both clams as well as shell deposits has become intense. Simultaneously, as the demand for frozen clam meat from foreign countries increased, even baby clams were not spared in recent years. Besides, construction of dams and destruction of forests have led to physical and chemical changes in the environment in estuaries. All these recent developments have adverse effect on this resource and the need for conservation and management assumes paramount importance.

Therefore, it became necessary to consolidate the information on clam resources of Karnataka and Kerala and project it in an appropriate manner as to be useful for the planners, developmental agencies and conservationists. This atlas on the clam resources of the estuaries of Karnataka is an outcome of the work done by the Central Marine Fisheries Research Institute during the years 1983 to 1985. It is hoped that this document

will be useful to those involved in the development of clam resources for taking appropriate measures of conservation and management. I wish to record my appreciation to Dr. G. Syda Rao, Dr. P. S. Kuriakose, Dr. N. Ramachandran, Shri M. M. Meiyappan, Shri G. P. K. Achary, Shri D. Nagaraj and Shri H. S. Shivanna of the Molluscan Fisheries Division and Dr. E. Johnson of the Library and Documentation Division for the hard and sincere work put in by all of them to bring out this useful atlas.

Sd/-
P. S. B. R. JAMES
Director
Central Marine Fisheries
Research Institute
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INTRODUCTION

Among the renewable molluscan resources in India, the clams of the estuarine and backwater regions provide livelihood for the poor who exploit them for their meat and shells. The clam meat is rich in protein and is also cheap when compared to prawns and fishes. It is relished by the rich and the poor alike in Karnataka. The clam shells, made up of mostly calcium carbonate, are used for industrial purposes. The export of frozen clam meat started recently during the eighties enhanced the rate of exploitation considerably in states like Kerala causing concern. Therefore the study of this resource has gained importance in recent years.

Literature on the taxonomy of clams include Preston (1915), Hornell (1917), Prashad (1921) and Satyamurti (1956). Biological aspects were dealt with by Rao (1951), Abraham (1953), Joshi (1963), Ranade (1964), Durve (1963, 1964, 1970), Durve and Dharmaraja (1965), Seshappa (1967), Deshmukh (1972), Mane (1974), Nair (1975), Nair and Shynamma (1975), Krishna Kumari et. al. (1977) and Salih (1973, 1978 a, 1978 b). Information on the distribution and exploitation of clams from India was provided by Rao (1963), Jones (1968), Alagarswami and Narasimham (1973), Nair and Mahadevan (1974), Rasalam and Sebastian (1976), Narasimham (1986), and Narasimham et al (1984, 1986) and on depuration by Balachandran and Surendran (1984). The chemical composition of clams was studied by Venkataraman and Chari (1951), Nagabhushanam and Deshmukh (1974) and Krishnakumari et al (1977). Studies on resource characteristics, exploitation and biology of clams from Karnataka were made by Rai (1932), Harkantra (1975), Rao (1984, 1987), Nayar et al (1984), Rao and Rao (1985) and Narasimham et al (1986). The distribution of shell deposits in the estuaries of Karnataka was documented by Gopal et al (1976) and Venkatkumaran and Bhat (1978). Silas et al (1982) felt that the existing potential for bivalve culture was immense and stressed the need for organising culture programme to augment production.

Taking into consideration the demand for clam meat in both India and abroad and for shells by the industries within the country and the existing potential for exploitation and culture, the following areas require careful investigation.

1. The current status of exploitation of different species of clams, marketing and utilization of clam meat and shells.

2. Distribution and abundance of clams and their ecology and

3. Identification of suitable areas for clam culture.

Keeping the above objectives in view, the Central Marine Fisheries Research Institute undertook a detailed survey of the clam resources of Karnataka and Kerala in 1984. The results presented here pertain to Karnataka and it is hoped that this report would provide the basic information essential for planning future developmental programmes on clams in the State.

METHODS OF STUDY

The survey of the estuaries of Karnataka was carried out during February-May 1984. A fibreglass dinghy with an out board motor/canoe was used for transport in the estuaries.

Data on salinity, dissolved oxygen, temperature, and pH of the water were collected from bar-mouth till the end of clam beds in the upper reaches of estuaries at frequent intervals, reflecting the prevailing environmental conditions of the respective estuaries. Sediment samples were collected from all clam beds. They were passed through a set of sieves ranging from 2000 μ to 63 μ following wet process. The sediments were graded as granules and larger grades (over 2000μ) coarse sand (1000-500μ) medium sand (500-250μ) fine sand (250-125μ) very fine sand (125-63μ) and silt and clay (under 63μ) following Wentworth scale (Buchanamn and Kain 1971). The clam beds were located by frequent sampling and their contours marked on a map. Based on approximate area of the bed, clam samples were collected as follows.

Area of bed	No. of samples
Under 5 ha	5
5-20 ha	10
20-50 ha	20
50-100 ha	30
Over 100 ha	50

In shallow stations sampling was carried with a G. I. frame of 0.25 sq m area with a height of 10 cm. In deeper areas a hand operated dredge was used. All the clams below 10 mm were considered as seeds From each sample, the number and weight of different species of clams were noted, for estimating the species-wise standing stock for each bed. From the pooled

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samples a random sub-sample of 200 clams for each species were drawn for biological studies like length, weight, condition, maturiry, sex etc. Catch, effort, utilisation and other relevant data were collected from the fishing centres. Besides the above, enquiries were made with the fishermen, merchants and local people to assess the magnitude of the clam fishery in each estuary. Frequent visits were made prior to the survey to collect information on aspects of exploitation.

ESTUARIES OF KARNATAKA: GENERAL FEATURES

All the rivers of Karnataka necessarily flow from east to west. None of them takes its rise as much as 35 km. beyond the peaks of tha western ghats and since these ghats are now here more than 80 km. from the sea, the course of these rivers nowhere exceeds 150 km. (Anon 1973) All these small rivers join Arabian Sea·, forming extensive estuaries along the coastal Karnataka. (Fig. 1) The rainfall increases from coast towards the western ghats on the eastern boarder of the districts, North Kanara (N. K.) and South Kanara (S. K.). South Kanara receives about 3900 mm annual average rainfall (1970-82), of which about 87% is contributed by South West monsoon (June to September). Consequently there is fresh water flow in all the rivers, almost throughout the year. During monsoon period the salinity in the estuaries undergoes wide fluctuations and touches even fresh water conditions. The salinity is generally low from June to Novembar (20 ‰). Stable conditions prevail during December-May period when salinity will gradually rise beyond 20 ‰ to sea water conditions. The water temperature is generally low during monsoon and high during summer. The day temperature ranges from 27.4 to 32° C. Most of the estuaries are shallow and predominantly sandy. The bar mouths of all the estuaries are open throughout the year. The mixing of saline water to the upper reaches of the estuaries is noticed and based on this a regular pattern of zonation of different species of clams is observed from barmouth, (Fig 2)

Out of the 14 estuaries (Fig.1) surveyed, 8, estuaries were found to have stock of live clams. It was reported by local fishermen that other estuaries also yielded clams during earlier years. Seasonally some of the species disappear due to unfavourable conditions but repopulate in the subsequent years. Kalinadi, Aghnashini and Mulky estuaries had high production potential of clams.

CLAM SPECIES OF KARNATAKA

Meretrix meretrix, M. casta, Katelysia opima, Paphia malabarica and *Villorita cyprinoides* were the species encountered during the study of Karnataka

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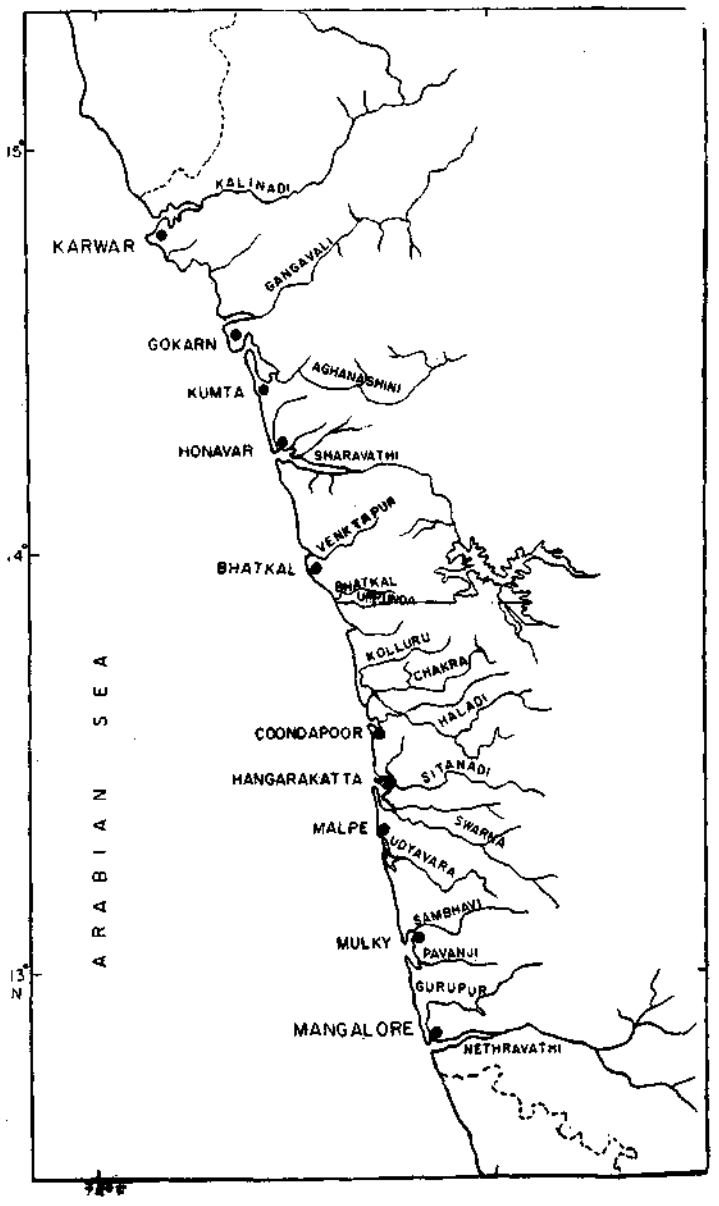

Fig. 1 Estuaries of Karnataka

estuaries. *M. casta, P. malabarica* and *V. cyprinoides* were found to be the prominent clam contributing to the fishery.

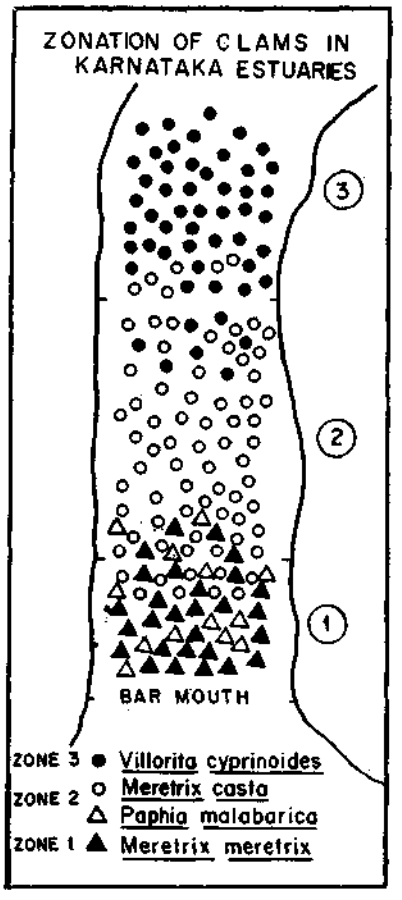

Fig. 2 Zonation of clams in Karnataka Estuary.

Meretrix meretrix (Linnaeus)

Local name: Dadda/Ane maruvai (S. K.)
Khube/Bele belchi (N. K.)

This species shows different colour patterns and attains over 60 mm length in the anterio-posterior axis. Anterior cardinal tooth of left valve distinctly notched. Valves trigono suborbicular. Pallial sinus very shallow. Shell is more inflated than *M. casta* and not as thick as *M. casta*. Hinge is delicate and weaker when compared with *M. casta*.

Meretrix casta (Chemnitz)

Local name: Maruvai (S. K.)
Khube/Belebelchi (N. K.)

Meretrix casta does not show colour patterns.Shell ovate to oblong with or without two obscure and often imperfect radial bands. Anterior cardinal tooth in left valve entire. Length of shell is usually less than 50 mm. Hinge elongate and strong. Pallial sinus shallow. Posterior margin of the shell when more angular and pointed are considered as a varietal form as *M. casta* var. *ovum* (Hanley) (Hornell 1917), which is common in the estuaries of Karnataka.

Katelysia opima (Gmelin)

Local name: Moli (S. K)

Shell is inflated solid and thick with smooth surface and slightly longer than high, margins evenly rounded. Hinge has three strong cardinal teeth; the tooth in the left valve in front of the cardinal and the corresponding depression in the right is absent. The pallial sinus deep and the apex of the sinus bluntly angular. Shell pale yellowish brown or creamy, sometimes with purplish, or grey markings forming concentric undulating lines with three or four radial bands radiating from the umbo.

Paphia malabarica (Chemnitz)

Local Name: Kesha maruvai (S.K)
Tisre (N.K)

Shell concentrically grooved throughout the entire surface with deep impressions. Length of the shell about one and one third times as long as high. Pallial sinus is 'U' shaped and very deep. Three short thick cardinal teeth. The tooth in front of the cardinals in the left valve and the hollow in the right is rudimentary.

Villorita cyprinoides (Gray)

Local name : Kappu maruvai (S.K)
Kala Khube, Kari belchi } (N.K)

Shell trigonal, cordate and very oblique, inflated in the umbonal as well as in the middle regions and greatly compressed ventrally. Umbones lying near the anterior margin being recurved anteriorly and slightly inwards, hollow, separated from the hinge and one another by a narrow chink only. Shell thick with concentric ridges prominent with anterior portion, umbones striated. Periostracum greenish brown, dark brown or black.

BIOLOGY OF THE ESTUARINE CLAMS

The clams distributed in the estuarine system show definite settlement pattern and breeding cycle based on changes in the environment. Substratum plays a prominent role in the formation of beds of these clams. However there are different breeding seasons showing peak spawning activity for *Meretrix meretrix, M. casta, Villorita cyprinoides, Katalysia opima* and *Paphia malabarica* in the estuaries of Karnataka and in other regions. Based on these factors these clams are distributed along the estuary from the bar-mouth to the interior, showing characteristic zonation pattern as shown in figure 2. *M. meretrix, Paphia malabarica* and *M. casta* occur near the bar-mouth forming multispecies beds whereas towards the interior *M. casta* forms separate beds without mixing with other species. *Villorita cyprinoides* starts at the upper reaches of the estuaries forming multispecies beds in combination with *M. casta*. They form seperate beds in areas where fresh water conditions exist.

The general pattern of life cycle of clams in the estuarine environment is also more or less the same (Fig. 3) for all the species, except in the characteristic preference of the free living larvae in selecting proper substrata for forming their beds. All these clams attain sexual maturity when they are about 15-20 mm in length, Sexes are separate. The gametes are released in water and fertilization is external. The fertilised eggs which are planktonic, metamorphoses to trochophore and the veliger stage within 24 hours and these free living larvae take 12-15 days to show signs of selecting the substratum and further the free movement in water is continued to 25 to 30 days to settle permanently in the estuarine beds. The velum completely disappears and the foot is well developed by this time and these spat are capable of crawling and burrowing in the substratum with the help of the foot. The distribution, the breeding season and biological features in brief of the clams involved in this study are as follows.

Meretrix meretrix: Commonly known as the 'great clam', occuring in large quantity in Kalbadevi and Bhatea creek in Maharashtra; Chapora, Sal, Mandovi and Zuari estuaries in Goa, Kalinadi, Aghanasini and Coondapur estuaries in Karnataka and in the Ashtamudi like in Kerala. In the east coast this species was found in majority of the estuaries. especially at Adyar, Courtalayar, Vellar and Cooum in Tamil Nadu. It is found in Pulicat lake and in Chilka lake on the seaward side (Nayar and Mahadevan 1974).

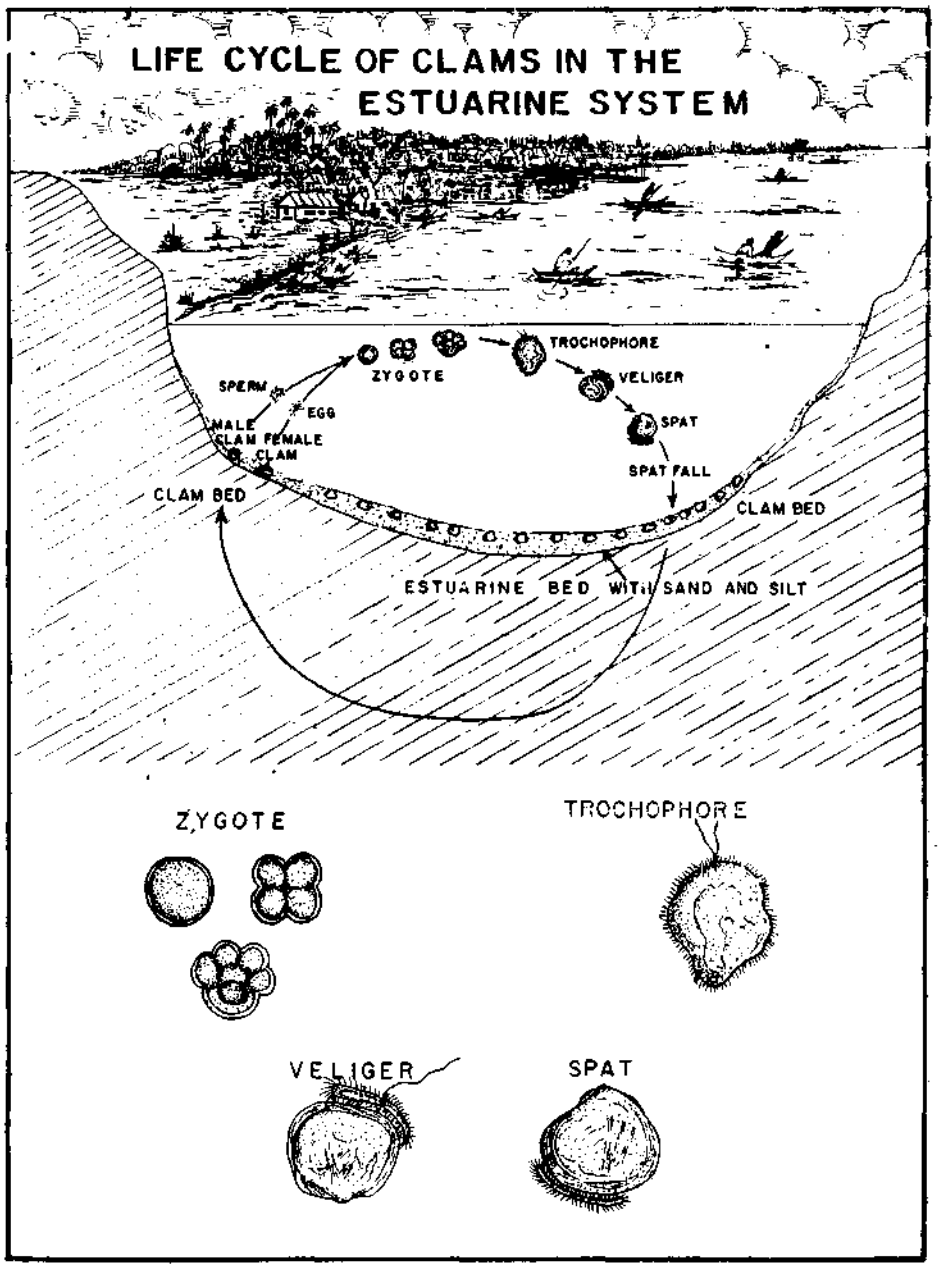

Fig. 3 General pattern of life cycle of clams in the estuary

In Bombay coast, breeding season extends from March to June and if conditions are favourable, they may continue to breed throughout the year except during monsoon months (Rai, 1932). Spawning in the east coast is found to occur about the middle of September and again in May (Hornell 1922).

Indiscriminate fishing in some regions has affected the production of this species, since it has distributional limitations of occurring only in the higher saline regions of the estuary. Periodic floods also affect the population if fresh water condition exists for a longer duration in the bar-mouth area.

Meretrix casta: Occurs in almost all the estuaries of Karnataka, along with all other species of estuarine clams in beds as well as forming single species beds of *M. casta*. The more compressed and pointed outline of the posterior angle of the shell and small sized forms of this species is considered to be *M. casta* var, *ovum* (Hornell 1917). This variety (plate 2) forms major beds in this area. The major spawning season is from September to March. Minor variations in the spawning season are common. This species attains first maturity at a length of 17 mm. Major spat settlement occurs during September December and April–May periods. The spat that settle during September-December period contribute to the fishery, whereas those that settle during April-May are subjected to heavy mortalities during south-west monsoon. The condition index (% edibility) ranged from 8.4 in May to 16 in September. High condition index coincide with peak spawning period. Studies on age and growth indicated that *M. casta* attains 36.5 mm in six months, 42.6 mm in nine months and 46.6 mm in one year. Most of the clams do not survive to the second year (Rao G. S. 1987). This species tolerates wide salinity ranges. The largest recorded specimen measured 43 mm in length

Villorita cyprinoides : The northern-most region where it is reported is at Siridavo, Savoi, Amonen and Naibag in Goa. In Karnataka majority of the estuaries have *Villorita* stock and the Kalinadi, Aghnashini and Gurupur estuaries have rich stocks.

In Cochin backwaters peaks of breeding activities are recorded twice a year i. e, late May to August or September and January to late March and attain sexual maturity at a length of 11 to 15 mm (Nair, 1975). Under natural condition it grows to 30 mm in length during the first year. Growth during the second year is only 11 cm. In the Nethravathi estuary this species attains

a length of 27 mm at the end of one year and 30 mm at 16 months. The spawning season is from October to May, (Rao, K. S. 1987).

The varietal form of this species grows in higher salinity ranges and clams of 15 to 20 mm size range tolerate a salinity of 0.87‰ to 29.85‰ and larger clams having 40 to 50 mm length tolerate salinity range of 4.73 to 27.11‰ (Nair & Shynamma 1975). However *V. cyprinoides* survives even in freshwater condition in Kerala and Karnataka estuaries.

Katelysia opima : Found in the barmouth regions of estuaries along with *M. meretrix* and *M casta* beds in Bombay, North and South Kanara, Kerala and Tamil Nadu coast. Extensive beds occur in Batya creek and Kalbadevi creek in Ratnagiri, in Tarkarli creek near Malwan, in Ashtamudi lake Kerala and in Adyar river mouth Tamil nadu. In Mahim bay *K. marmorata* occurs in thick beds spread over an area of 25000 sq. m. and K. *opima* is also available in few numbers in this bed.

Sexual maturity is seen in three months old clams when they are 11-12 mm in length. Spawning starts in December when the estuary is in communication with the sea and lasts about a month (Rao 1951) and found to spawn thrice in life span. Clams of 26-33.8 mm length are over one year old and not completed second year. The 38 8 to 43.5 mm size represents the two year old clams and the life span is about three years. The meat has high commercial value and hence this species can be used for adopting culture operations.

Paphia malabarica : This species occurs along with *M. casta*, *M. meretrix* and *K. opima*, in the estuaries of Karnataka near the bar-mouth area.

P. malabarica attains first maturity at a length of about 20 mm. The peak spawning period is from October to February. During some years mature specimens were observed in other months like March, June and August. Thus the spawning season of *P. malabarica* is short when compared to that of *M. casta*. The condition index in *P. malabarica* is high and ranged from 11 8 in May to 14 3 in February. This species attains a length of 36.3 mm in six months. 43.1 mm in 9 months and 48 1 mm in one year. The largest specimen of *P. malabarica* recorded in this area is 51 mm (Rao. G. S. 1987). In estuaries like Gurpur, this species has appeared and formed thick bed after a gap of ten years, suggesting that they might have repopulated from the neighbouring Mulky estuary.

CLAM RESOURCES

Kalinadi

Kalinadi originates from Western Ghats and joins the Arabian Sea near Karwar. The annual production of clam resources is estimated to be 545 tonnes. *Meretrix meretrix, Meretrix casta* and *Villorita cyprincides* are the clams occurring at present and *Paphia malabarica* was noticed till 1982. During the investigation, four beds were found to be highly productive (Fig.4).

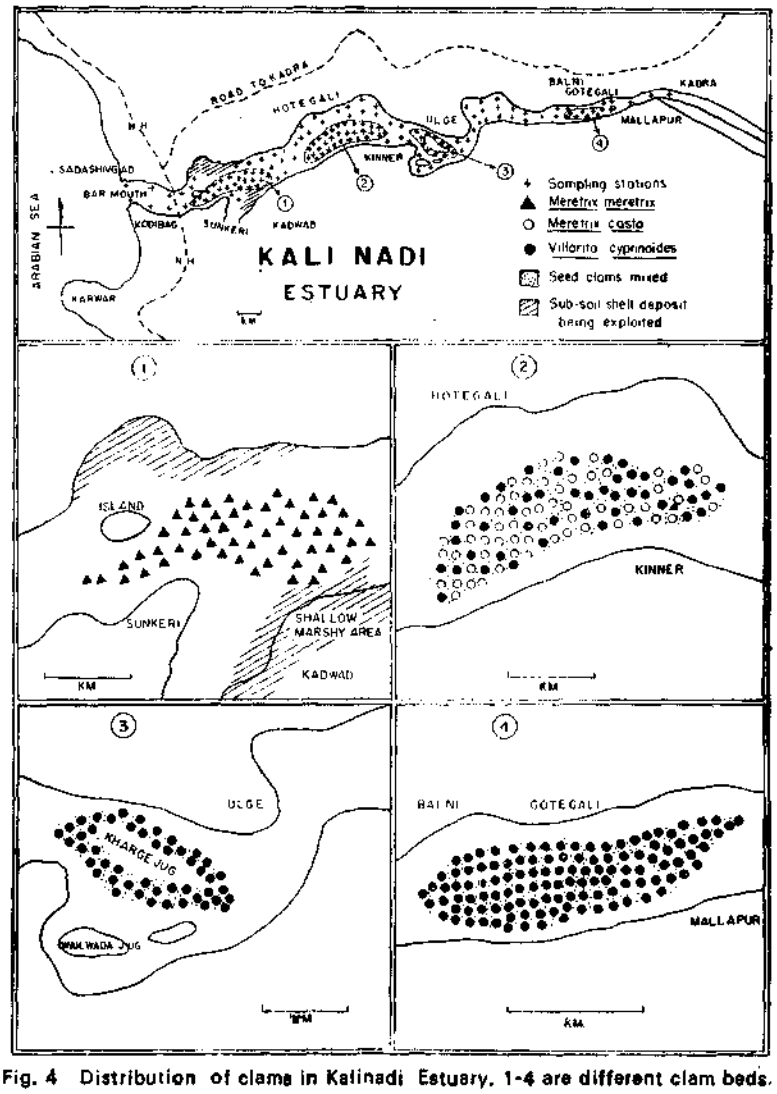

Fig. 4 Distribution of clams in Kalinadi Estuary. 1-4 are different clam beds.

Bed 1 extends from Kodibag to opp. Kadwad and has an area of 175 ha. Most of the bed area exposes during low tide. Only *M. meretrix* is contributing to the fishery from this bed.

Bed 2 extends from opp. Hotegali to eastern side of Kinner on the southern bank and covers an area of 180 ha. *M. casta* and *V. cyprinoides* occur in this bed along with seed clams of both species.

Bed 3 is around Kharge jug, an island about 11 km from the barmouth, having an area of 60 ha. Only *V. cyprinoides* is available here.

Bed 4 is located in the Balni-Gotegali area covering 40 ha. and is about 18 kms from the barmouth. Here also, only *V. cyprinoides* is present.

Major clam fishery in this estuary is by *V. cyprinoides* (525 t). The estimated annual effort in mandays is 18500. Handpicking is the method adopted and 95% of the catch is transported to Goa for edible purposes.

The department of Mines and Geology, Govt. of Karnataka, has estimated the shell deposit reserve of this estuary to be about 1,16,090 tonnes (Venkatkumaran and Bhat 1978). The west coast paper mill, Dandeli, consumes about 6000 t of shells (Gopal *et al*: 1976). The present rate of shell deposit exploitation from this estuary is about 24,500 t.

NATURE OF BOTTOM OF CLAM BEDS

Bed No.	Nature of bottom	Coarse sand	Medium sand	Fine sand	Silt & clay
		(%)	(%)	(%)	(%)
1	Sandy	23.52	46.00	30.40	0.08
2	Sandy	40.40	45.60	14.00	0
3	Sandy	55.60	37.40	7.00	0
4	Sandy	52.80	23.20	23.20	0.80

FISHERY AND PRODUCTION

Method of collection	:	Handpicking
No. of canoes	:	15
Annual effort in mandays	:	18,500
Men	:	60%
Women	:	32%

Kalinadi

Area of the Estuary : 1700 ha

Period of observation : February, 1984

Clam resources

Bed No.	Area of clam bed (ha)	Standing stock									Total estimated standing stock (t)
		Meretrix casta			*Meretrix meretrix*			*Villoria cyprinoides*			
		Quantity (t)	Size range (mm)	Density (nos/ sq. m)	Quantity (t)	Size range (mm)	Density (nos/ sq. m)	Quantity (t)	Size range (mm)	Density (nos/ sq. m)	
1.	175	—	—	—	252	14-46	20	—	—	—	252
2.	180	159	11-31	125	—	—	—	98	6-29	23	257
3.	60	—	—	—	—	—	—	111	7-29	89	111
4.	40	—	—	—	—	—	—	91	7-30	86	91
Tot.	455	159	—	—	252	—	—	300	—	—	711

Total number of samples from beds : 150

Children	:	8%
General season	:	October-May
Peak season	:	January-May
Important centres of production	:	Kodibag-Sunkeri, Kinner Balni-Gotegali
Annual production (catch) Species		
Meretrix meretrix	:	20 t
Villorita cyprinoides	:	525 t
Total	:	545 t
Shell deposits	:	24500 t
Utilization		
Live clams	:	Gastronomic
Shell deposits	:	Industrial

MARKETING

Local	:	5%
Distant market	:	95%
Destination market	:	Karwar (2-10 km), Goa (85 km)
Method of transportation	:	Packed in gunny bags in fresh condition without ice by van for distant market

Price: Production Centre-Consumer level

Meretrix meretrix: — Rs. 1-2/100 nos (1 kg shell-on)

Villorita cyprinoides: Rs. 12-14 per 50 kg. Rs. 0.5/100 nos (1 kg shell-on)

Shell deposits: Rs. 1 per basket (25 kg)

EXPORT

Nil

SEED RESOURCE

Meretrix casta	:	Bed 2 — 35 t
Villorita cyprinoides	:	Bed 2 — 2 t
		Bed 3 — 6 t
		Bed 4 — 2 t
		Total — 45 t

ADDITIONAL INFORMATION

In Kinnar area meat of *Villorita* is extracted and preserved in dried form for use during off season. *Paphia malabarica* occurred in the estuary till 1982 (Bed 1) *Meretrix casta* is not found in Bed 1 since 1983.

SIZE COMPOSITION (%)

Size group (mm)	*M. meretrix*	*M. casta*	*V. cyprinoides*
6-10	—	—	4
11-15	4	70	17
16-20	11	16.5	23
21-25	37	8.5	28
26-30	18	4.5	28
31-35	7	0.5	—
36-40	9	—	—
Above 40	14	—	—

SIZE COMPOSITION IN FISHERY SAMPLE (%)

Size group (mm)	*M. meretrix*	*Villorita cyprinoides*
16—20	4	24
21—25	24	76
26—30	4	—
31—35	44	—
36—40	12	—
Above 40	12	—

OTHER DATA

Estimated shell reserve : 116090 t
Estimated annual production : 24,500 t

Aghnashini

Aghnashini originates from Western Ghats and joins the Arabian sea at Tadri, about 65 kms south of Karwar. The clam bed which is located in the centre of the estuary at Tadri has an area of 200 ha (Fig 5.) This bed contains *Meretrix meretrix* and *Meretrix casta*. The adjacent bed is about 5 kms from the barmouth and extends from opp. Betkuli to near Mirjan and covers an area of 225 ha. *Meretrix casta* and *Villorita cyprinoides* occur in this bed. A third bed is located in the centre of the estuary in Mirjan-Hegde area and it contains only *V. cyprinoides*. The total annual production is 755 t and *M. casta* constitutes more than 60%. The production of *V. cyprinoides* is only 5 t. The estimated annual effort in mandays is 23000 and fishing is by handpicking. Good seed resources were also observed from Bed No. 2 in

case of *M. casta* (64 t) as well as for *V. cyprinoides* (19 t). *Paphia malabarica* was noticed before 1983 from Tadri area and during the period of investigation it was not recorded.

Shell deposits are exploited to the tune of about 7600 t annually from Tadri area and is utilized in industry. The estimated shell reserve for this estuary is 9,27,500 tonnes (Venkat Kumaran and Bhat, 1978).

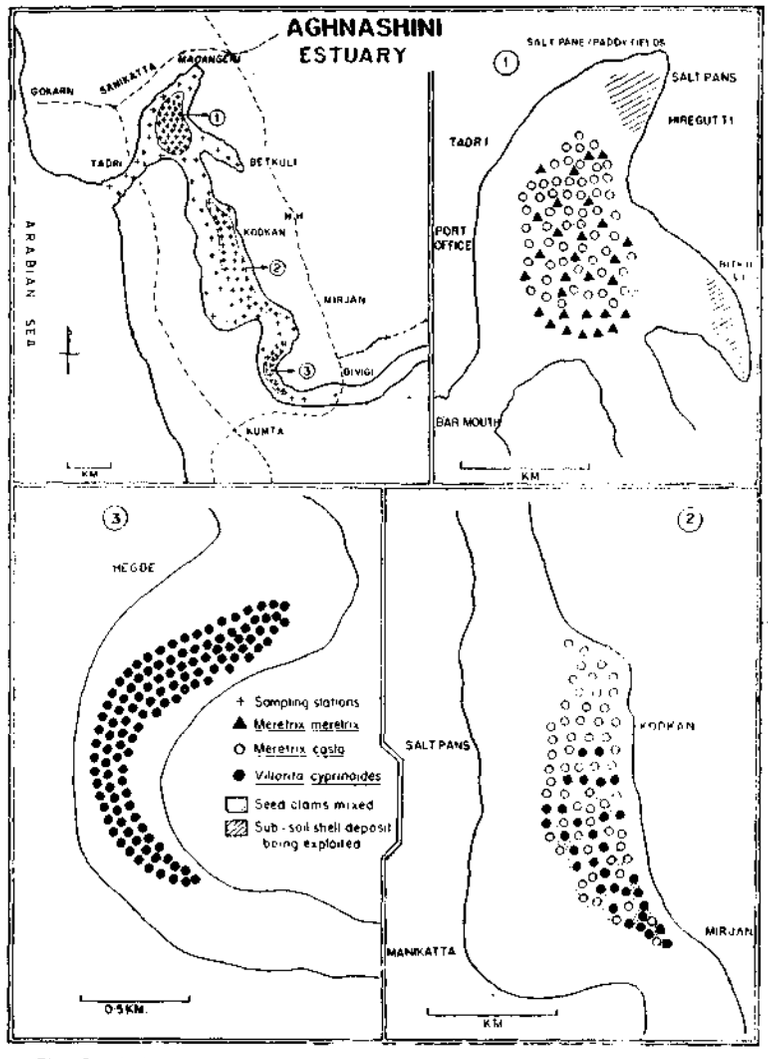

Fig 5 Aghnashini Estuary - distribution of clams in different stations.

Area of the estuary : 1200 ha

Period of observation : February 1984

CLAM RESOURCES

Bed No.	Area of clam bed (ha)	Standing stock									Total estimated standing stock (t)
		Meretrix casta			*Meretix meretix*			*Villorita cyprinoides*			
		Quantity (t)	Size range (mm)	Density (Nos/ sq. m)	Quantity (t)	Size range (mm)	Density (Nos/ sq m)	Quantity (t)	Size range (mm)	Density (Nos/ sq m)	
1	200	273	18-35	12	189	18-51	5	—	—	—	462
2	225	1448	8-22	492	—	—	—	304	8-31	87	1752
3	100	—	—	—	—	—	—	257	11-32	49	257
Tot.	525	1721	—	—	189	—	—	561	—	—	2471

Total number of samples from beds : 130

NATURE OF BOTTOM OF CLAM BEDS

Bed No.	Nature of bottom	Coarse sand (%)	Medium sand (%)	Fine sand (%)	Silt& clay (%)
1	Sandy	13.8	39 0	46.6	0.6
2	Sandy	53 2	40.8	6.0	0
3	Sandy	75.0	21.8	3 0	0.2

FISHERY AND PRODUCTION

Method of collection : Handpicking
No. of canoes : 40
Annual effort in mandays : 23000
Men : 13%
Women : 74%
Children : 13%
General season : October-May
Peak season : January-May
Important centres of production : Tadri, Mirjan
Annual production (catch)
Species
Meretrix casta : 500 t
Meretrix meretrix : 250 t
Villorita cyprinoides : 5 t
Total : 755 t
Shell deposits : 7600 t

UTILIZATION

Live clams : Gastronomic
Shell deposits : Industrial

MARKETING

Local : 5%
Distant markets : 95%
Destination market : Honavar (25 km)

Price:

	Production centre	Consumer level
Meretrix casta	(30 kg) Rs. 6/-bag	Rs. 0.25-0.50/kg shell-on

Meretrix meretrix: —Rs. 0.50—1.00/kg shell-on
Shell deposits: Rs. 0.50 per basket (25 kg)

EXPORT

Nil

SEED RESOURCE

Meretrix casta	:	Bed No. 2	:	64 t
Villorita cyprinoides	:	Bed No. 2	:	19 t

ADDITIONAL INFORMATION

Occurrence of *Paphia malabarica* was noticed only during certain years.

SIZE COMPOSITION (%)

Range in mm.	*M. casta*	*M. meretrix*	*V. cyprinoides*
6-10	1.7	—	4.3
11-15	16.3	—	19.7
16-20	43.3	22	20.0
21-25	11.3	30	25.0
26-30	12.0	8	27.5
31-35	15.4	4	3.5
36-40	—	14	—
Above 40	—	22	—

SIZE COMPOSITION OF *M. CASTA* IN FISHERY SAMPLE (%)

11-15-20%
16-20-40%
21-25-40%

Bed No. 1 with larger sized population has only low density of population and hence not exploited during the period of survey. In case of *M. meretrix* and *V. cyprinoides* the same size composition is exploited by the fishery also.

OTHER DATA

Estimated shell reserve : 927500 t

Estimated annual
Production : 7600 t

Gangavali

Joins the Arabian Sea at Manjuguni near Ankola. The area of the estuary is 640 ha. During the period of observation (February, 1984), 45 samples were collected from the bar mouth to 9 kms. upstream (Fig. 6) Live

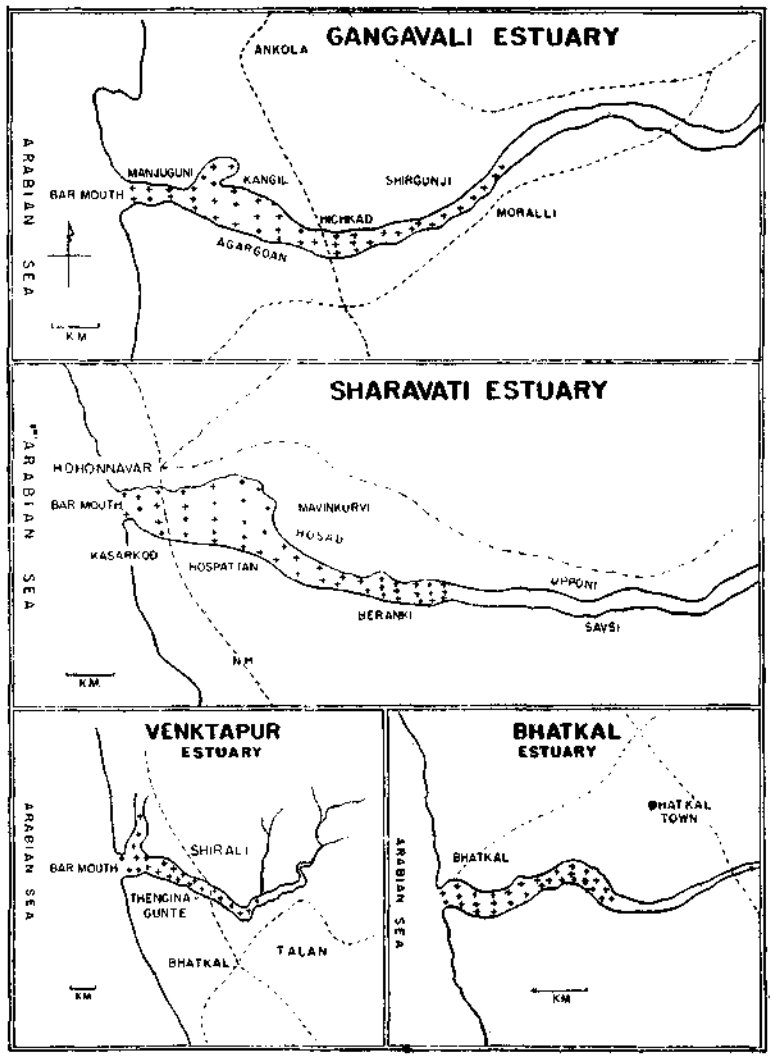

Fig. 6 Gangavali, Sharavati, Venktapur and Bhatkal Estuaries showing sampling stations.

clams were not found in this estuary. Local enquiries revealed that there existed a minor fishery for *Meretrix casta* and *Paphia malabarica* before 1980 and subsequently the fishery had declined considerably. The fishery was not noticed during 1982-1984. Alagarswami and Narasimham (1973) reported that *Paphia malabarica* was dominant in the fising of this estuary with a peak season during March-June. Commercial exploitation of shells either from the estuary or from the adjoining areas were not noticed.

Sharavati

Sharavati joins the Arabian sea near Honavar. The total area of the estuary is 1600 ha. A total of 50 samples were collected during February, 1984 (Fig. 6). Live clams were not found in this estuary and clam fishery was also noticed. Local enquires revealed that there was no clam fishery during the last 10 years. However, Alagarswami and Narasimham (1973) reported that clams were collected regularly by about 100 persons and M. *meretrix* was the predominent species.

Commercial exploitation of shells from the estuary was not noticed during the period of study. Venkat Kumaran and Bhat (1978) reported that the annual production of shells was 75 to 100 tonnes and the estimated reserve was 116090 tonnes.

A hydroelectric project exists in this river in the upstream area at Linganamakki. About 2 kms from the barmouth, the salinity of the water was less than 1‰ during February 1984.

Venkatapur

Originates in the Western Ghats and joins the Arabian sea near Venktapur. The area of the estuary is about 200 ha. Twenty five samples were collected from the barmouth to a distance of 6 kms (Fig. 6). Live clams were not present in the estuary. However Rao and Rao (1985) observed about 138 t of clams comprising *P. malabarica, M. casta* and *M. meretrix* distributed over an area of 33 ha. Commercial exploitation of shells from the estuary is not noticed during the period of investigation.

According to Venkat Kumaran and Bhat (1978) the estimated shell reserve of the estuary is 464400 tonnes and the annual production was estimated to 100 tonnes.

Bhatkal

Joins the Arabian sea at Bhatkal. The total area of the estuary is 130 ha. Thirty samples were collected from the barmouth to a distance of 4 kms (Fig. 6). Live clams were not present in the estuary. Commercial exploitation of shell deposits was not noticed during the period of study. Local enquires revealed that there were no shell deposits in the estuary.

UPPUNDA ESTUARY

This is the smallest estuary in the south Kanara, near Byndoor. Area of estuary : 170 ha (Fig. 7). Period of observation : May, 1984

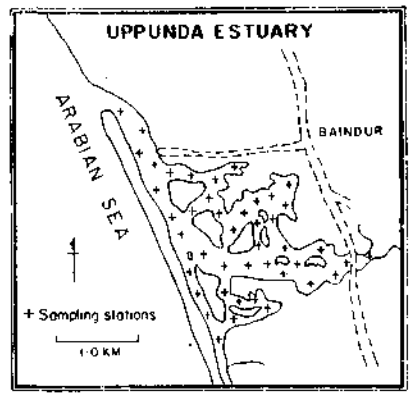

Fig. 7 Uppunda Estuary showing sampling stations

CLAM RESOURCES

No clam resource at present. Occurrence of *P. malabarica*, *K. opima*, *M. casta* and *M. meretrix* in few numbers was recorded.

NATURE OF BOTTOM OF CLAM BEDS : Sandy

FISHERY AND PRODUCTION*

Method of collection	:	Hand picking
No. of canoes	:	5
Total effort (man days)	:	5500
Men	:	8%
Women	:	66%
Children	:	26%

General season : November - June
Peak season : March - June
Fishing Centres : Paduvaru
Annual production
Species :

P. malabarica : 80 t
K. opima : 65 t
M. casta : 10 t

* Data pertains to 1983

UTILIZATION

Live clams : Gastronomic 100%

MARKETING

Local : 100%
Destination markets : Byndoor

	Production Centre	Price : (Consumer level)
P. malabarica	—	Rs. 2.50/100 clams
K. opima	—	Rs. 2.50/100 clams
M. casta	—	Rs. 0.60/measure (750 gm)

EXPORT

Nil

SEED RESOURCE

Nil

Coondapoor estuary

The estuary formed by several smaller streams and rivers (Haladi, Kollur and Chakra) to the north of Coondapoor town joins the Arabian Sea at Gangolli. This is the largest estuary in south Kanara. (Fig 8)

Area of estuary : 2550 ha Period of observation : May, 1984

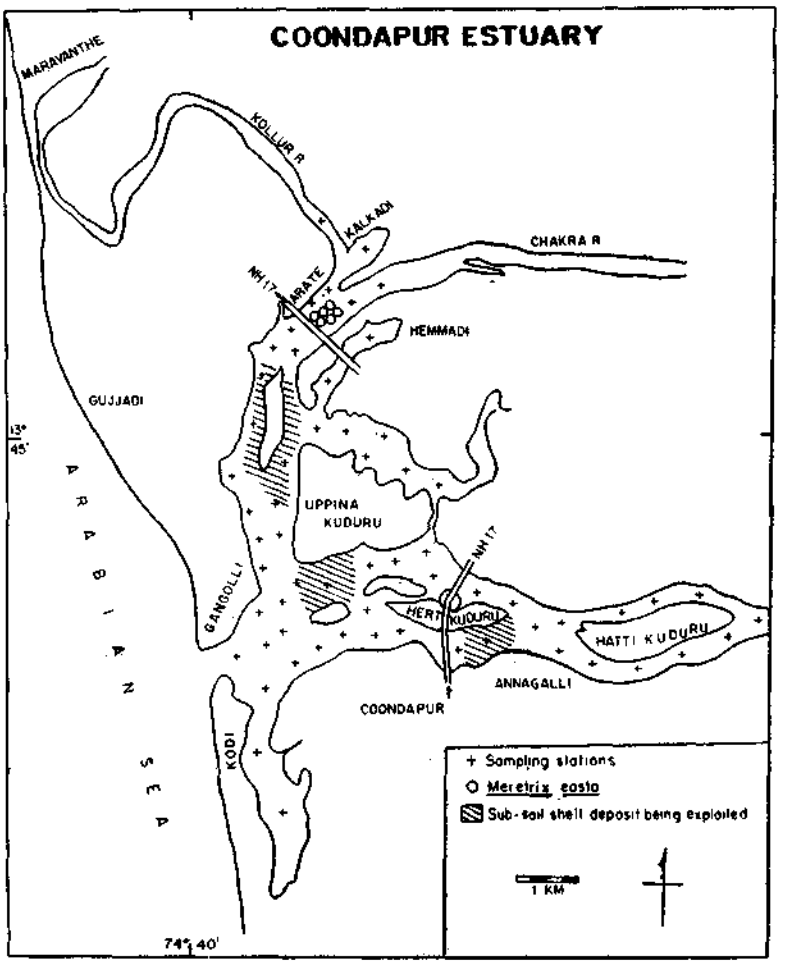

Fig. 8 Coondapur Estuary showing Clam beds.

CLAM RESOURCES

Bed No.	Area of Clam bed (ha)	Standing stock			Total estimated Standing stock (t)
		M. casta Quantity (t)	Size range (mm)	Density (No/m²)	
1	11	19	11–21	208	(19)

Total number of samples from bed : 10

PLATE 1. Picking clams from exposed beds by local women.

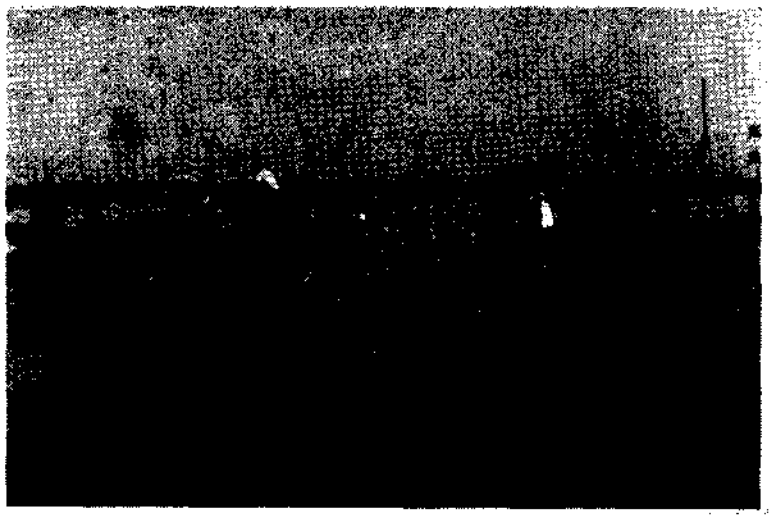

PLATE 2. Lime shell exploitation in Coondapur estuary.

PLATE 3. Shell dredger used for the exploitation of shell deposits in the Coondapur estuary.

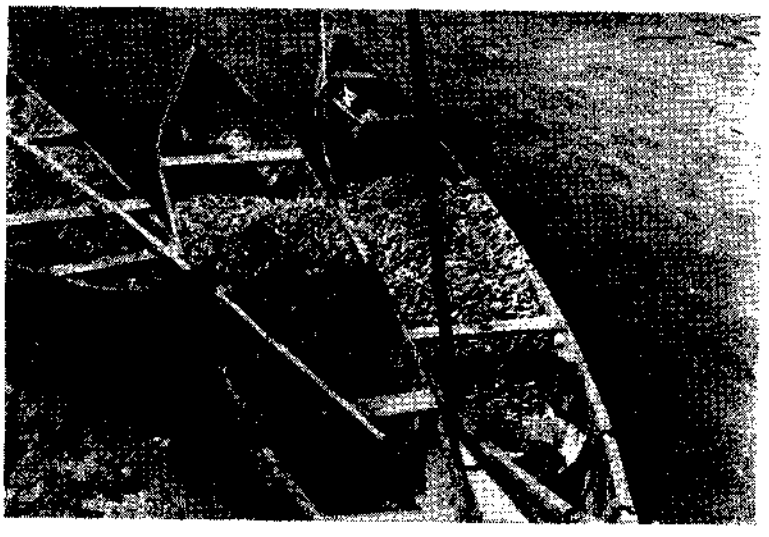

PLATE 4. The live clams in the canoe.

NATURE OF BOTTOM OF CLAM BEDS

Bed No.	Nature of bottom	Coarse sand (%)	Medium sand (%)	Fine sand (%)	Silt & clay (%)
1	Sandy	50.6	32.5	10.6	6.3

FISHERY AND PRODUCTION*

Method of collection : Hand picking, shell dredge
No. of canoes : 50
Total effort (Mandays) : 10000
Men : 47%
Women : 29%
Children : 24%
General season : November-June
Peak Season : April-June
Fishing Centres : Coondapoor, Gangulli

Annual Production

Species

P. malabarica : 500 t
M. meretrix : 40 t
M. casta : 50 t
V. cyprinodes : 8 t
K. opima : 5 t

* Data pertains to 1983
Shell deposit exploited - (Average for 1975-76 to 1981-82) = 20,436 t/year

UTILIZATION

Live clams : Gastronomic 100%
Shell deposit : Industrial (Poly fibre, chemicals)

MARKETING

Local : 50%
Distant markets : 50%
Destination markets : Gangulli, Coondapoor, Hemmadi, Byndur, Navunda

Price:	Production Centre	Consumer level
P. malabarica	Rs. 25/1000 clams	Rs. 3/100 clams
M. meretrix	—	Rs. 2.50 to 4.00/100 clams
M. casta	—	Rs. 1.00/100 clams
V. cyprinoides	—	Rs. 1.25/100 clams
K. opima	—	Rs. 2.50/100 clams
Shell deposit	Rs. 85–100/t	

EXPORT

Nil

SEED RESOURCE

Nil

ADDITIONAL INFORMATION

At present there is no fishery due to lack of resources. In 1983 (April-June) shell dredges were used to collect *P. malabarica* for the first time. Occurrence of *P. malabarica, M. meretrix, K. opima* and *V. cyprinoides* in very few numbers was noticed during the present survey.

SIZE COMPOSITION (%)

Size group (mm)	*M. casta*
10–15	76
15–20	22
20–25	2

SITA ESTUARY

The Sita river rises in the western ghats beyond Someshwar to the north-east of Udupi taluk and joins the Arabian Sea near Hangarakatta.

Area of estuary : 980 ha. Period of observation : May, 1984

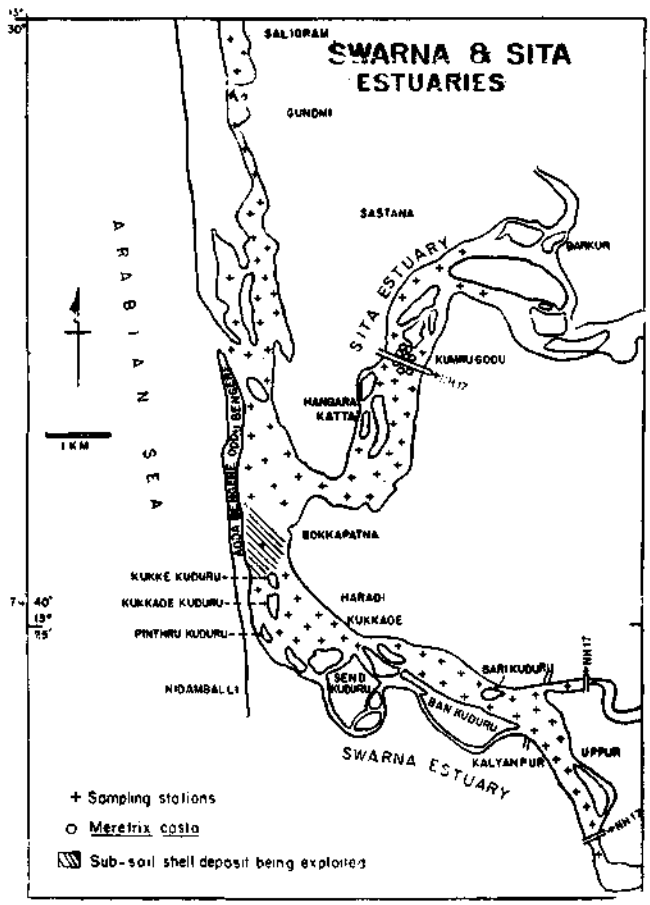

Fig. 9 Swarna and sita Estuaries showing sampling stations and distribution of clams

CAM RESOURCES (Fig. 9)

Bed No.	Area of clam bed (ha)	Standing stock			Total estimated standing Stock
		Quantity (t)	*M. casta* Size range (mm)	Density (No/m²)	
1	9	3	16-26	14	3

Total number of samples from bed : 10

NATURE OF BOTTOM OF CLAM BED

Bed No.	Nature of bottom	Coarse sand (%)	Medium sand (%)	Fine Sand (%)	Silt & clay (%)
1	Sandy	44.6	42.8	12.3	0.3

FISHERY AND PRODUCTION*

Method of collection	:	Hand picking
No. of canoes	:	Nil
Total effort (mandays)	:	14400
Men	:	—
Women	:	75%
Children	:	25%
General season	:	November-June
Peak season	:	February-June
Fishing Centres	:	Sasthan, Hangarakatta, Mabakala
Annual Production		
Species		
M. caste	:	230 t
V. cyprinoides	:	5 t
K. opima	:	5 t
M. meretrix	:	5 t

* Data pertaing to 1983

UTILIZATION

Live clams	:	Gastronomic 100%

MARKETING

Local	:	30%
Distant markets	:	70%
Destination markets		Hangarakatta, Koteswar, Coondapoor

Price :	Production Centre	Consumer level
M. meretrix	—	Rs. 2.50/100 clams
M. casta	Rs. 20/30 kg	Rs. 0.60/measure (750 gms)
K. opima	—	Rs. 2.00/100 clams
V. cyprinoides	—	Not sold

EXPORT

Nil

SEED RESOURCE

Nil

ADDITIONAL INFORMATION:

SIZE COMPOSITION (%)

Size group (mm)	*M. casta*
20–25	41.5
25-30	57.5
30-35	1.0

SWAKNA ESTUARY

The Swarna river flows from the hills situated to the south-eastern boundary of the Udupi taluk. This river joins the Sita estuary before joining the Arabian Sea near Hangarakatta. Area of estuary : 800 ha (Fig. 9) Period of observation : May, 1984

CLAM RESOURCES

No clam resource at present. Presence of *V. cyprinoides* and *M. casta* in very negligible numbers were observed

NATURE OF BOTTOM OF CLAM BEDS

Sanday

FISHERY AND PRODUCTION*

Method of collection	:	Hand picking
No. of canoes	:	Nil
Total effort (mandays)	:	4000
Women		25%
Children	:	75%

General season : November-May
Peak season : February-May
Fishing Centres : Kalyanpur
Annual production
Species
V. cyprinoides : 15 t
* Data pertains to 1983

UTILIZATION

Live clams : Gastronomic 100%
Shell deposit : Industrial (paper, poly fibre, chemicals)

MARKETING

Local : 100%
Destination market : Kalyanpur

Price :	Production centre	Consumer level
V. cyprinoides	Not sold	Not sold

EXPORT

Nil

SEED RESOURCE

Nil

ADDITIONAL INFORMATION :

Shell deposits are exploited at the rate of 9000 t per annum with shell dredge ("machine").

Udyavara Estuary

Area of the estuary : 800 ha Period of observation : May, 1984

CLAM RESOURCES (Fig.10)

Bed No.	Area of Clam bed (ha)	Standing stock *Metric caste*			Total estimated Standing stock (t)
		Quantity (t)	Size range (mm)	Density (No/m²)	
1	10	34	23–32	54	34

Total number of samples from bed : 10

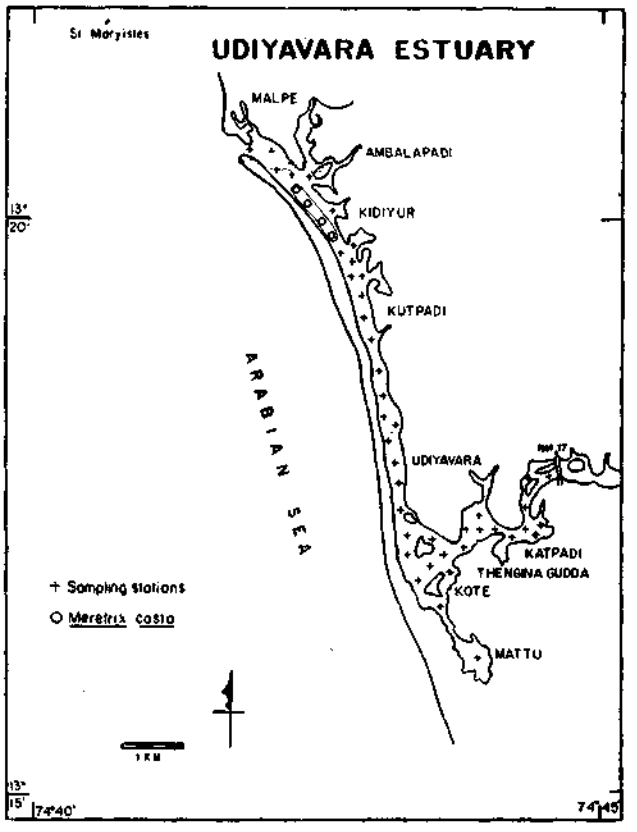

Fig. 10 Distribution of clams in Udaya vara Estuary.

NATURE OF BOTTOM OF CLAM BEDS

Bed No.	Nature of bottom	Coarse sand (%)	Medium sand (%)	Fine sand (%)	Silt & clay (%)
1	Sandy	16.2	45.1	31.0	7.7

FISHERY AND PRODUCTION*

Method of collection : Handpicking

No. of canoes : Nil

Annual effort in mandays	:	12000
Men	:	11%
Women	:	56%
Children	:	33%
General season	:	November-May
Peak season	:	February–May
Fishing Centres	:	Malpe, Katapadi

Species :

M. casta	:	215 t
P. malabarica	:	5 t
V. cyprinoides	:	5 t

* Data pertains to 1983

UTILIZATION

Live clam :	*M. casta*	:	Gastronomic 100%
	P. malabarica	:	Gastronomic 100%
	V. cyprinoides	:	Gastronomic 100%

MARKETING

Local	:	100%
Destination markets	:	Malpe, Udupi, Kalyanpur

Price:	Production centre	Consumer level
M. casta	—	Rs. 1/100 clams
P. malabarica	—	Rs. 3/100 clams
V. cyprinoides	—	Not sold
Lime shells	Nil	

EXPORT

Nil

SEED RESOURCE

Nil

PLATE 5. Clams filled in gunny bags.

PLATE 6. Clams are being loaded into van, at Mulky, for distribution to markets at different places. The people who are engaged in clam picking can also be seen.

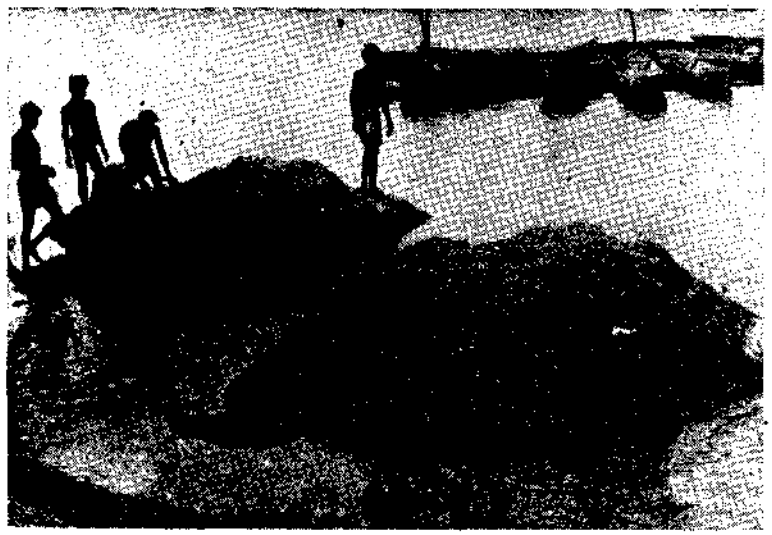

PLATE 7. Heap of clam shells, Kalinadi

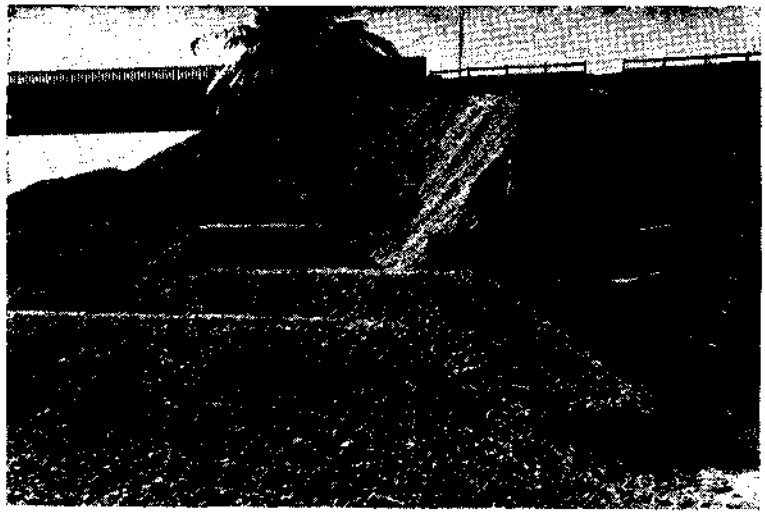

PLATE 8. Lime shells near a lime factory at Coondapoor

ADDITIONAL INFORMATION :

At present there is no clam fishery due to the poor resource position. Occurrence of clams *P. malabarica*, *K. opima* and *V. cyprinoides* in very few numbers was noticed. *Geloina bengalensis* (local name, "Anaigoyyalu"), a large sized clam was observed in very few numbers.

SIZE COMPOSITION OF CLAM (%)

Size group (mm)	*M. casta*
20–25	12
25–30	77
30–35	11

MULKY ESTUARY

This estuary is formed by the confluence of two rivers, the Sambhavi and Pavanje. They flow from opposite directions on both the sides of Mulky town and join the Arabian Sea near Chitra up. This is one of the most important clam fishing centres of Karnataka.

Area of the estuary : 750 ha Period of observation : May, 1984

CLAM RESOURCES (Fig. 11 & 12)

Bed No	Area of clam bed (ha)	Standing stock						Total estimated standing stock (t)
		Meretrix casta			*Paphia malabarica*			
		Quantity (t)	Size range (mm)	Density (Nos/ sq. m)	Quantity (t)	Size range (mm)	Density (Nos/ sq m)	
1	27	271	19–31	234	—	—	—	271
2	91	1758	18–35	243	631	27–36	85	2389
3	1	31	24–32	452	—	—	—	31
4	89	1409	18–37	245	113	27–35	10	1522
5	5	38	6–9	7262	—	—	—	38
6	19	156	22–34	157	—	—	—	156
Tot.	232	3625	—	—	744	—	—	4407

Total number of samplesfrom beds : 100

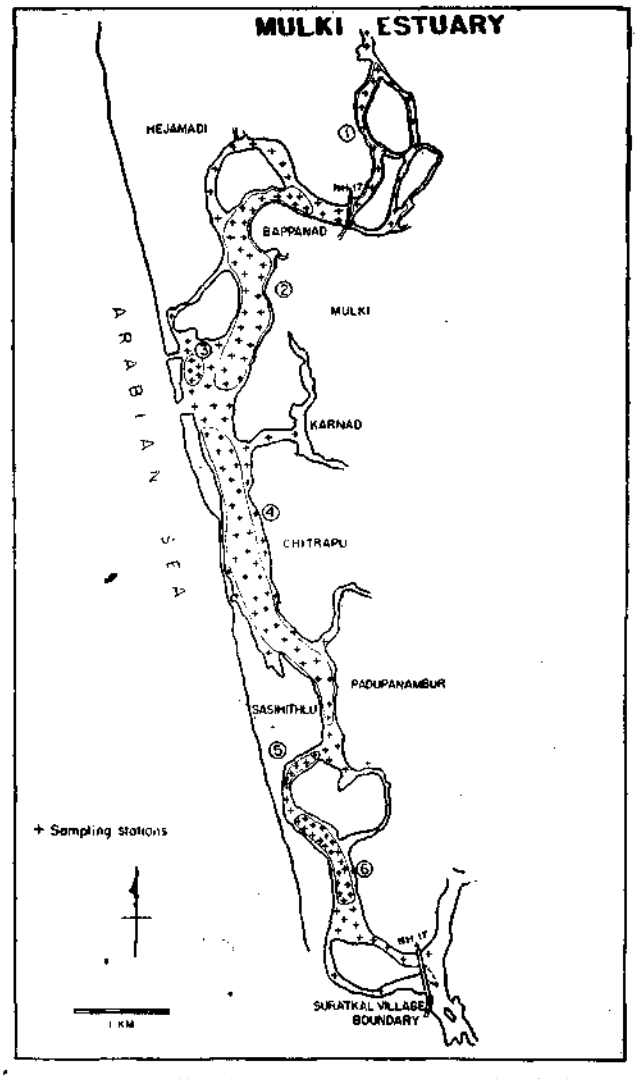

Fig 11 Mulkey Estuary showing different clam bads.

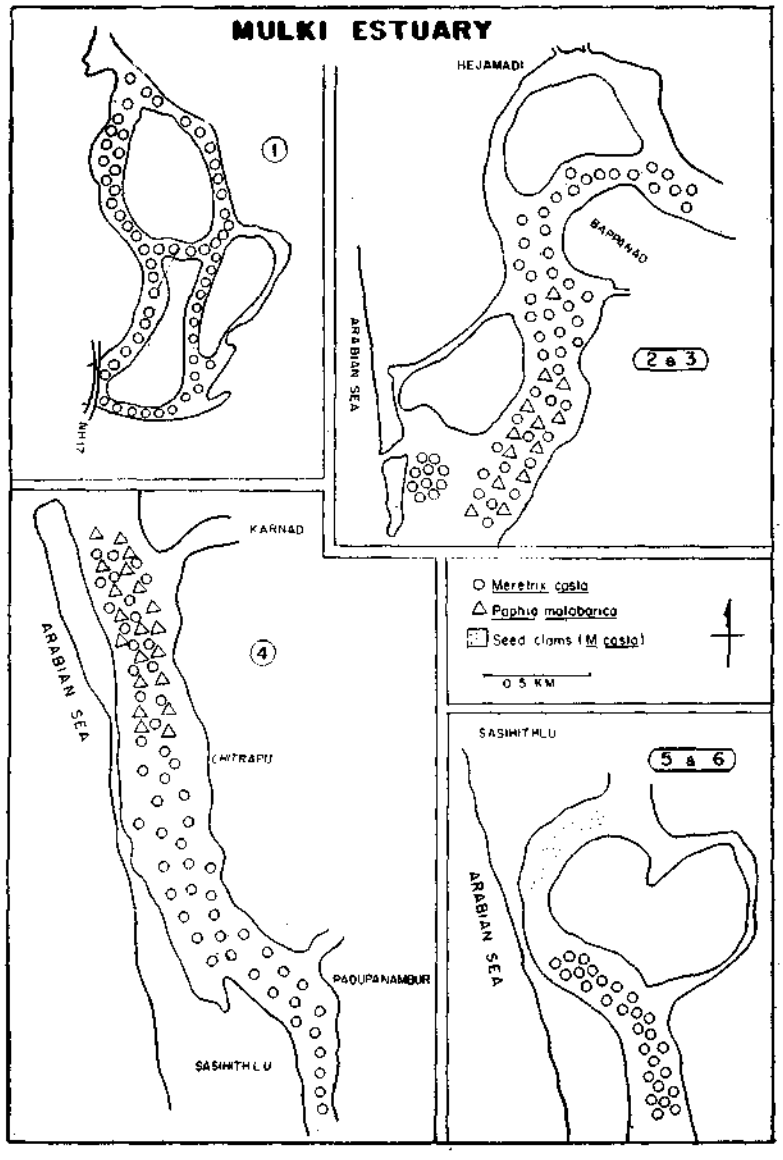

Fig. 12 Clam distribution in different beds of Mulky Estuary.

NATURE OF BOTTOM OF CLAM BEDS

Bed No.	Nature of bottom	Coarse sand (%)	Medium sand (%)	Fine sand (%)	Silt& clay (%)
1	Sandy	61.3	28.8	5.3	4.6
2	Sandy	23.3	18.8	53.5	4.4
3	Sandy	4.1	26.3	59 4	10.0
4	Sandy	0.7	0.6	95.6	3.1
5	Sandy	20.0	51.2	21.2	7.6
6	Sandy	31.9	49.3	14.8	4.0

FISHERY AND PRODUCTION*

Method of collection : Hand picking, Clam nets
No. of canoes : 15
Total effort (man days) : 24000
Men : 25%
Women : 65%
Children : 10%
General season : Throughout the year
Peak season : February-May
Fishing Centres : Bappanadu, Nadi kuduru, Chitraup, Sasihitlu
Annual production
Species
M. casta : 1814 t
P. malabarica, : 578 t

* Data pertains to 1983

UTILIZATION

Live clams *M. casta* : Gastronomic 25%, Lime 75%
P. malabarica : Gastronomic 100%

MARKETING

Local	:	10%
Distant markets	:	90%
Destination market	:	Mangalore, Udupi, Malpe, Hangarakatta, Coondapoor, Gangulii and other Ghat areas

Price :	Production Centre	Consumar level
M. casta	Rs. 8-10/30 kg	Rs. 0.75/100 clams
P. malabarica	Rs. 20-35/30 kg	Rs. 3-3.50/100 clams
Lime shells	Rs. 80/t	

EXPORT

Nil

SEED RESOURCE

M. casta	Bed No. 5	38 t

ADDITIONAL INFORMATION

During 1979 the standing stock was 1500 t

SIZE COMPOSITION (%)

Size group (mm)	*P. malabarica* Sample from bed	*P. malabarica* sample from fishery	*M. casta* Sample from bed	*M. casta* Sample from fishery
5-10	—		16.6	
10-15	—		—	
15-20	—		3.7	6.0
20-25	—	52.0	36.2	85.0
25-30	26.0		28.6	
30-35	73.0	48.0	13.9	
35-40	1.0		1.0	9.0
Above 40	—		—	

OTHER DATA

The estimated shell deposit reserve is 5,00,000 t. (Gopal *et al* 1976).

GURPUR ESTUARY

Gurpur river flows from the northern boarder of Mangalore city and joins the Arabian sea near Bengere.

Area of the Estuary : 840 ha

Period of observation : April, 1984

CLAM RESOURCES (Fig. 13)

Bed No.	Area of clam bed (ha)	Standing stock									Total estimated standing stock (t)
		P. malabarica			*Meretrix casta*			*Villoria cyprinoides*			
		Quantity (t)	Size range (mm)	Density (nos/ sq. m)	Quantity (t)	Size range (mm)	Density (nos/ sq. m)	Quantity (t)	Size range (mm)	Density (nos/ sq. m)	
1.	15	165	28-42	122	25	19-30	21	—	—	—	190
2.	37	—	—	—	60	5-9	821	—	—	—	90
3.	20	—	—	—	—	—	—	95	21-31	89	95
Tot.	72	165	—	—	85	—	—	95	—	—	345

Total number of samples from beds : 40

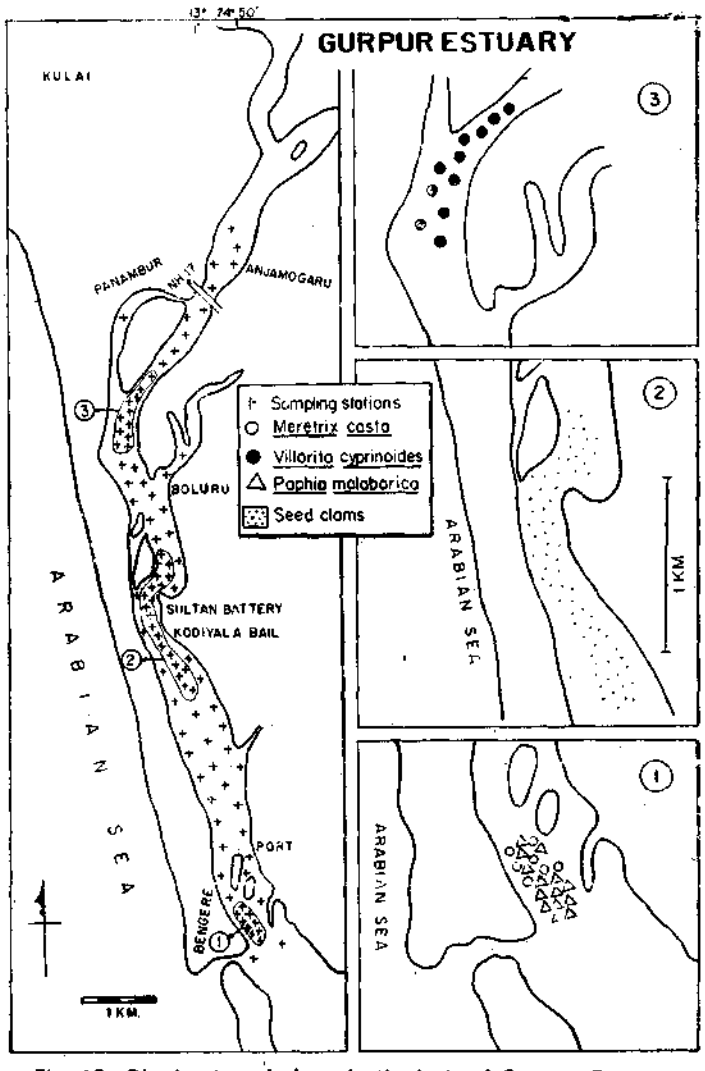

Fig. 13 Distribution of clams in the beds of Gurupur Estuary.

NATURE OF BOTTOM OF CLAM BEDS

Bed No.	Nature of bottom	Coarse sand	Medium sand	Fine sand	Silt & clay
		(%)	(%)	(%)	(%)
1	Sandy	14.1	30.9	52.5	2.5
2	Sandy	57.7	30.1	10.5	1.7
3	Sandy	30.7	42.4	17.1	9.8

FISHERY AND PRODUCTION *

Method of collection	:	Hand picking, clam net, shall dredge
No. of canoes	:	10
Total efforn (Mandays)	:	13000
Men	:	74%
Women	:	22%
Children	:	4%
General season	:	November–May
Peak season	:	February–May
Important centres of Production	:	Bunder, Sultan Battery, Kulur
Annual production		
Species		
P. malabarica	:	600 t
M. casta	:	300 t
V. cyprinoides	:	375 t

* Data pertains to 1983

UTILIZATION

Live clam :	*P. malabarica*	Gastronomic	70%
		Lime	30%
	M. casta	Gastronomic	17%
		Lime	83%
	V. cyprinoides	Gastronomic	53%
		Lime	47%

MARKETING

Local	:	100%
Destination markets	:	Mangalore and suburbs

Price :	Production centre	Consumer level
P. malarbarica	Rs. 30/30 kg	Rs. 2/100 clams
M casta	Rs. 8/30 kg	Rs. 0.50/100 clams
V. cyprinoides	—	Rs. 0.75/100 clams

Lime shells : Rs. 80/tonne

PLATE 9. Clam shells loading in truck.

PLATE 10. Selling clams in the local market.

EXPORT

Nil

SEED RESOURCE :

M. casta Bed No.2 60 t

ADDITIONAL INFORMATION

During 1979 survey *P. malabarica* was not observed and it was observed in 1983 for the first time. Enquiries revealed that this clam was present almost at the same area about ten years back. In 1983 it was commercially exploited. During the monsoon period of 1984 (June-July) fishermen from Coondapur came with their "machines" (boat and shell-dredge) and exploited almost completely, the available resource of this clam (about 150 t). 90% of the catch was sent to Coondapur where it fetched about Rs 80/30 kg. The price at production centre was Rs. 40/30kg. It is to be noted that for the first time there was clam fishery during monsoon period in this estuary.

SIZE COMPOSITION (%)

Size group (mm)	*P. malabarica*		*M. casta*		*V. cyprinoides*	
	Sample from bed	Sample from fishery	Sample from bed	Sample from fishery	Sample from bed	Sample from fishery
5-10	—	—	50.0	—	—	--
10-15	—	—	—	—	—	—
15-20	—	—	0.5	—	—	--
20-25	—	2.5	36.5	99.0	74.0	98 0
25-30	2.5		12.5		24.0	
30-35	35.0	91.0	0.5	1.0	2.0	
35-40	56.0		0.5		—	2.0
Above 40	6.5	6.5	—	—	—	

OTHER DATA

Shell deposits absent (Gopal *et al* 1976)

NETHRAVATHI ESTUARY

Nethravathi is one of the biggest and sacred rivers of coastal Karnataka. It rises in the ghats to the east of Kudremukh and flows down the Bangades valley past Belthangady. It is joined at Uppinangady by another river called Kumanadhara, which originates from Kumara parvata near Subramanya. At Mangalore Nethravathi joins the Gurpur river and form a common estuary.

Area of estuary: 1920 ha Period of observation: April, 1984

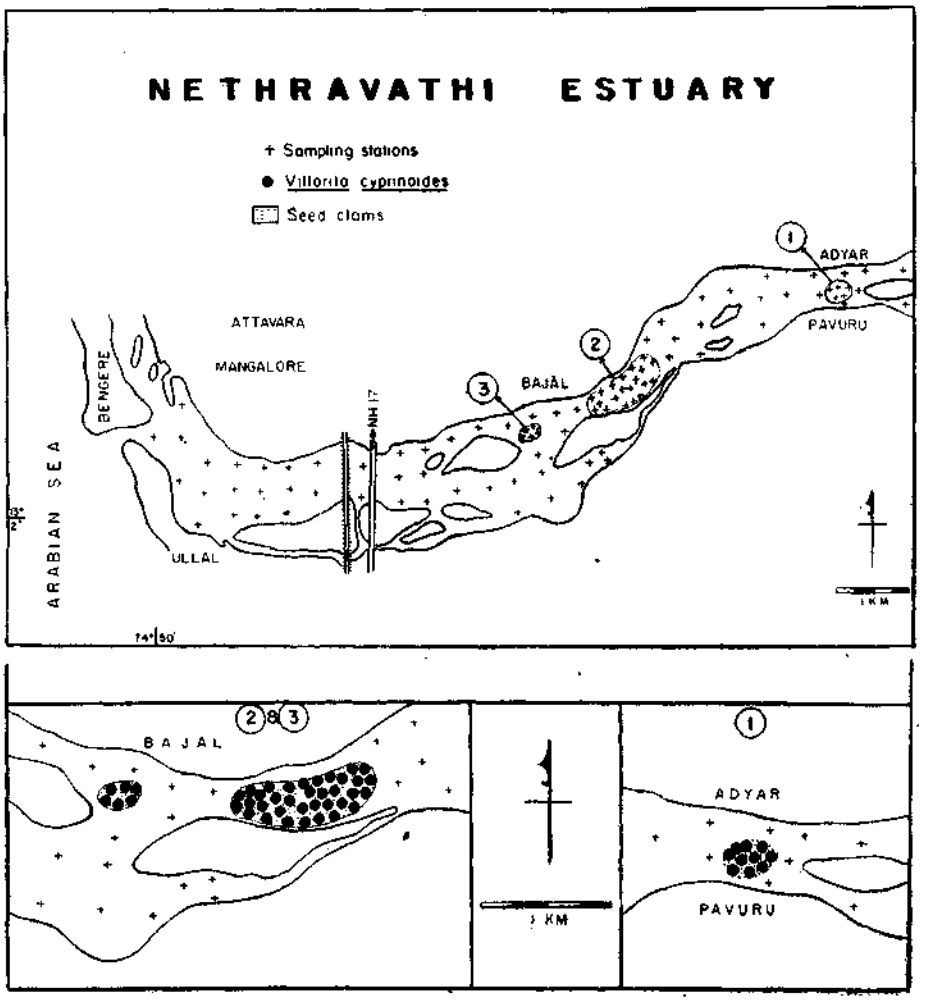

Fig. 14 Nethravathi Estuarry showing clams beds and distribution of clams.

CLAM RESOURCES (Fig. 14)

Bed N.o	Area of clam bed (ha)	Standing stock			Total estimated standing stock
		Villorita cyprinoides			
		Quantity (t)	Size range (mm)	Density (No/m²)	
1	1	4	20-29	53	4
2	45	69	6-29	1526	69
3	2	2	6-25	9	2
Tot.	48	75	—	—	75

Total number of samples from beds: 30

NATURE OF BOTTOM OF CLAM BEDS

Bed No.	Nature of bottom	Coarse sand (%)	Medium sand (%)	Fine sand (%)	Silt & clay (%)
1	Sandy	82·2	7.5	5.6	4.7
2	Sandy	42.6	45.6	6.5	5.3
3	Sandy	87.6	6.3	1.2	4.9

FISHERY AND PRODUCTION*

Method of collection : Hand picking
No of canoes : 3
Total effort (man days) : 16000
Men : 12%
Women : 54%
Children : 34%
General season : October-May
Peak season : February-May
Fishing Centres : Adyar, Bajal, Jeppu, Ullal Parangipetta

Annual production
Species
V. cyprinoides : 149 t
M. casta : 233 t

* Data pertains to 1983

UTILIZATION

Live clams : Gastronomic 100%

MARKETING

Local : 100%

Destination markets : Mangalore and suburbs

Price:	Production centre	Consumer level
M. casta	Rs. 7/30 kg	Rs. 0.60/100 clams
V. cyprinoides	—	Rs. 1/100 clam

EXPORT

Nil

SEED RESOURCE:

V. cyprinoides : Bed No.2 53 t
Bed No.3 0.1 t

ADDITIONAL INFORMATION:

M. casta's presence was noticed along Ullal area.
At present there is no commercial exploitation in Nethravathi estuary.

SIZE COMPOSITION OF CLAMS (%)

Size group (mm)	*V. cyprinoides*
5-10	37.5
10-15	—
15-20	—
20-25	52.8
25-30	9.7

OTHER DATA

Shell deposits absent (Gopal *et. al.* 1976)

STANDING CROP AND YIELD

The species-wise standing stock and yield is presented in table for all the estuaries surveyed. The total standing stock of eight estuaries having calm population is estimated to be 8027 tonnes. *Meretrix casta, V. cyprinoides. P. malabarica* and *Meretrix meretrix* have a standing stock of 5646, 1031, 909 and 441 tonnes respectively in the order of abundance, whereas *K. opima* is present in stray numbers.

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Live clams : Gastronomic 100%

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Local : 100%

Destination markets : Mangalore and suburbs

Price:	Production centre	Consumer level
M. casta	Rs. 7/30 kg	Rs. 0.60/100 clams
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EXPORT

Nil

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Bed No.3 0.1 t

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5-10	37.5
10-15	—
15-20	—
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OTHER DATA

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STANDING CROP AND YIELD

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TABLE 1 *Standing stock and annual exploitation of clams from the Karnataka estuaries* (in tonnes)

Name of the estuary	*M. casta*		*M. meretrix*		*K. opima*		*P. malabarica*		*V. cyprinoides*		Total	Total
	Standing stock	Annual exploitation	Standing stock	Annual exploitation	Standing stock	Annual exploitation	Standing stock	Annual exploitation	Standing sfock	Annual exploitation	standing stock	exploitation
	(t)	(t)	(t)	(t)	(t)	(t)	(t)	(t)	(t)	(t)		
Kali Nadi	159	—	252	20	—	—	—	—	300	525	711	545
Gangavali	—	—	—	—	—	—	—	—	—	—	—	—
Aghnasini	1721	500	189	250	—	—	—	—	561	5	2471	755
Sharavathi	—	—	—	—	—	—	—	—	—	—	—	—
Venktapur	—	—	—	—	—	—	—	—	—	—	—	—
Bhatkal	—	...	—	—	—	—	—	—	—	—	—	—
Uppunda	—	10	—	—	—	65	—	80	—	—	—	155*
Coondapoor	19	50	—	40	—	5	—	500	—	8	19	603*
Sita	3	230	—	5	—	5	—	—	—	5	3	245*
Swarna	—	—	—	—	—	—	—	—	—	15	—	15*
Udyavara	34	215	—	—	—	—	—	5	—	5	34	2251*
Mulky	3625	1814	—	—	—	—	744	587	—	—	4369	2392*
Gurpur	85	300	—	—	—	—	165	600	95	375	345	1275*
Netravathi	—	233	—	—	—	—	—	—	75	149	75	382*
Total	5646	3352	441	315	—	75	909	1763	1031	1087	8027	6592

* Data pertains to 1983.

The seed potentiai, during this study, is also presented for each estuary. Only Kalinadi, Aghnashini, Mulki, Gurpur and Nethravathi had seed resources at the time of survey. The total seed resource is estimated as 197 tonnes and 82.1 tonnes for *M, casta* and *V. cyprinoides* respectively. Seed of *M. meretrix, K. opima* and *P. malabarica* were not recorded from any of the beds during the study.

The total exploitation of live clams from these estuaries was 6592 tonnes annually. *Meretrix casta* was the dominent species contributing to the fishery. The catch was taken to distant markets like Goa, Honavar and other markets by road whenever the production in those estuaries are very low.

UTILISATION

The annual exploitation of live clams from the Karnataka estuaries was 6592 tonnes and *Meretrix casta* was the dominent species (3352 tonnes) contributing to the fishery. The live clam fishery in this state is mainly for extraction of meat for local consumption unlike other areas and the shells are also utilised in the lime industry *Paphia malabarica* which yields higher rate of meat also had a good fishery in Mulky and Gurpur estuaries.

The total reserve of subsoil shell deposits in the Karnataka estuaries is 21,35.700 tonnes (Gopal et al 1976 and Venkat Kumaran and Bhat 1978). The annual exploitation from these beds is 52,500 tonnes from Kali, Aghnasini and Coondapoor estuaries The average annual exploitation of shells from Coondapoor is found to be 20,436 tonnes for the years 1975-76 to 1981-82 (Rao, 1983). The shells are used in paper, rayon, leather, carbide, cement, fertiliser industries, besides as shell grit for poultry.

EXPORT

India has entered the export market of clams only during the recent years and the meat of *Villorita cyprinoides, Meretrix meretrix, Meretrix casta, Paphia malabarica* and *Katelysia opima* is being exported. Based on the figures of the Marine Products Export Development Authority the following are the various clam products exported from India during 1981 and 1982.

Product		1981	AUV	1982	AUV	Major market in 1982
Canned	Q	10,070				
clam	V	1,85,794	18 45	—	—	
Clam meat	Q	1,600		9,192		
Pickle	V	28,212	17.63	61,416	6.68	
Frozen clams	Q	16,000		3,98,000		
	V	1,11,000	—	84,79,000	—	Japan (396 tonnes)

Q. Quantity in Kg
V. Value in Rs.
AUV. Average Unit Value Rs/kg

The export trend during the last few years show that there is immense potential to develop the export of clam meat in the coming years. At present the major collection centres for clam meat are from the Kerala estuaries and the meat is extracted from the shell at these centres which function as collection points by the industrialists. The exporters are collecting clam meat from the Karnataka region also.

The Central Institute of Fisheries Technology has developed the processing methods for clam meat (Balachandran and Unnikrishnan Nair 1975) and the methodology for purification of clam meat (Balachandran and Surendran, 1984)

SHELL FISH POISONING

Even though clams, mussels and oysters are regularly consumed by local people of the coastal areas of India paralytic shellfish poisoning by consumption of bivalve meat was very rare. During April, 1983 a case has been reported from Mangalore area A 14 year old boy had died and several people were hospitalised following the consumption of clams from Kumble estuary near Mangalore. The cause of death was reported to be due to respiratory paralysis after consuming *Meretrix casta*. Further analysis of the samples revealed paralytic shellfish poison (PSP) at a level of 18,740 mu/100g in clams obtained from house of affected people and 18,936 mu/100g in clams from natural bed (Indrani *et al* 1984). Another fatal incident took place at Vayalur in Tamil Nadu by consuming *M. casta* which contained toxins of dinoflagelletes (Silas et al, 1982).

However the exporters adopted a procedure of keeping clams in chlorinated water overnight in large containers and the method is found to be successful for purification of clams before processing.

CLAM CULTURE POTENTIAL

The resource potential of bivalve molluscs of India and the culture possibilities are discussed by Silas *et al* (1982). Our country having numerous estuaries and backwaters has immense potential to increase clam production by adopting scientific farming. Considering this the Central Marine Fisheries Research Institute has established a hatchery at Tuticorin and developed the know-how, for the mass scale production of seed.

Culture of *Meretrix casta* was attempted in the Mulky estuary near Mangalore. During the culture period February to June, *M. casta* had grown from an initial mean length of 17 9 mm to 31.5 mm in four months and the survival rate was 48.2% (Rao and Rao 1980, 1983). Experimental transplantation of *M. casta* in Vellar estuary (Tamil Nadu) indicated a mean growth of 7.5 mm (0.25 gm) to 41.5 mm (31.34 gm) during September 1976 to October 1977 (Sreenivasan, 1983).

The present study has shown good seed resources of *M. casta* and *V. cyprinoides* in Kalinadi, Aghnasini, Mulky and Gurpur estuaries. There are possibilities for transplanting and culturing them in areas where clams are not abundant Species like *Paphia malabarica, Katelysia opima* and *Meretrix meretrix* which command high market potential in India as well as in the export market are found in limited quantities over restricted areas. Sufficient biological and ecological information from all the estuaries is essential for culturing these clams. However the experiments conducted at Mulky revealed that the destructive potential of the estuarine crab *Scylla serrata* on the transplanted clams appear to be very high. Hence this aspect should be taken into consideration while planning the clam culture.

CONSERVATION AND MANAGEMENT

The details of the total standing stock and the annual exploitation of clams in each estuary is separately given in the section of standing crop and yield. The explaitation of seed clams before attaining maturity is an important factor affecting the repopulation of clam beds and the fishery during subsequent years. Being an annual crop and having high variations in settlement pattern, proper monitoring of the crop and judicious exploitation of this resource is necessary to maintain the production of clams and yield during the future years.

The annual live clam production of the estuaries of Karnataka is found to be 6592 tonnes and the proportionate meat yield is 53,344,11,256 and 141 tonnes for *M. meretrix, M. casta, Katelysia opima, P. malabarica* and *V. cyprinoides* respectively totalling 805 tonnes. At the average cost of Rs. 8/kg the estimated revenue from meat amount to Rs. 64,40,000 and this is inclusive of the meat from seed clams and all the species combined together. But when it is computed at the sale price of 100 clams in the local market for each species separately, it comes to Rs. 1,08,10,660.

It has been observed that the exploitation of clams bel ow 20 mm is very high in quantity and consequently the numbers. The yield of meat for different size groups of M. *meretrix, M. casta* and *V. cyprinoipes* (table 2, figure 15) indicates that the number of clams below 20mm size required to yield one Kg

TABLE 2: YIELD OF MEAT IN CLAMS OF KARNATAKA ESTUARIES

Meretrix meretrix

Size (mm)	Average total weight	Average meat weight	Meat index	Number of clams per 1 kg	Meat weight/ 1 kg clam	Number of clams/kg of meat
10-15	1.20	0.30	25.0	833	250	3333
15-20	1.85	0.43	23.3	541	233	2326
20-25	4.93	0.74	14.9	203	150	1351
25-30	7.10	0.95	13.4	141	134	1053
30-35	14.03	2.01	14.3	71	143	497
35-40	21.14	2.76	13.1	47	133	362
> 40	33.52	4.93	14.7	30	148	203

Meretrix casta

Size (mm)	Averege total weight	Average meat weight	Meat index	Number of clams per 1 kg	Meat weight/ 1 kg clam	Number of clams/kg of meat
5-10	0.16	0.01	6.6	6250	63	100000
10-15	0.78	0 11	14.6	1282	141	9091
15-20	1.85	0.24	13.0	541	130	4167
20-25	3.84	0.36	9.4	260	94	2778
25-30	6.81	0.64	9 4	147	94	1562
30-35	12.67	1.18	9.3	79	93	847
35-40	19 80	1.88	9.5	50	84	532

V cyprinoides

Size (mm)	Average total weight	Average meat weight	Meat index	Number of clams per kg	Meat weight kg of clams	Number of clams/kg of meat
5-10	0.14	0.02	14.3	7143	143	50000
10-15	0.97	0.16	16.5	1031	165	6250
15-20	3.14	0.41	13.1	318	130	2439
20-25	5.28	0.58	10.9	189	110	1724
25-30	8.92	1.01	11.4	112	113	990
30-35	10.69	1.23	11.5	94	116	813

Paphia malabarica

Size (mm)	Average total weight	Average meat weight	Meat index	Number of clams per kg	Meat weight/kg of clams	Number of clams/kg of meat
25-30	7.48	0.99	13.2	134	133	1010
30-35	9.75	1.40	14.4	103	144	714
35-40	14.25	2.16	15.1	70	151	463
> 40	18.32	2.82	15.4	55	155	355

of meat is very high, when compared to the sizes above 20 mm. In the case of *P. malabarica* 1010 clams of 25-30 mm are required to yield one Kg of meat. This clearly suggests that the exploitation of clams below 20 mm adversely affects the production and yield of meat.

Conservation measures to protect the smaller size groups from being indiscriminately exploited will increase the production three to four times by a simple process of allowing these clams to grow to a harvestable size at the economical level. While adopting this measure the seasonal variations of the estuaries' ecological conditions like fluctuation in salinity or exposure of the clam beds, which may lead to large scale morality is to be taken into consideration and accordingly harvest also should be arranged.

In, Mulky and Gurpur estuaries clams are collected in large quantities fot utilising the shells alone. Similar is the case with the estuaries in other states. Proper technology for large scale processing of clam meat to have products of longer shelf life needs to be evolved.

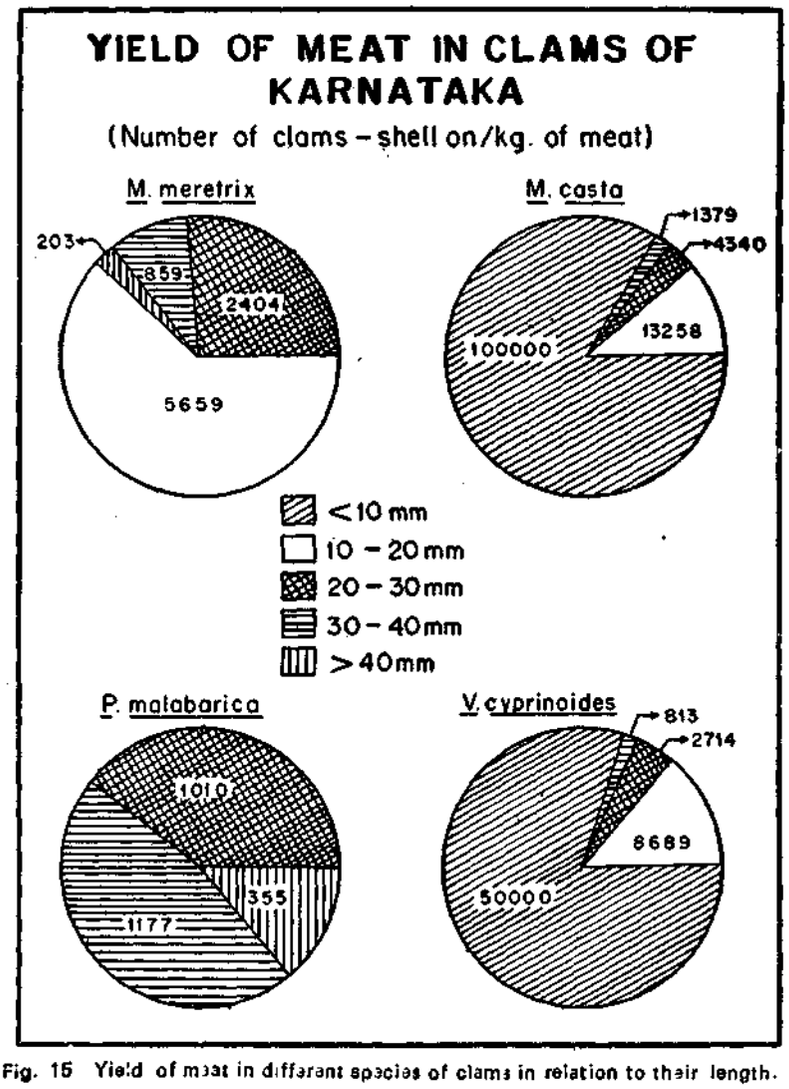

Fig. 15 Yield of meat in different species of clams in relation to their length.

There are no reliable estimates of exploitation of clams during different seasons from all the estuaries of Karnataka, as they are essential for formulating management policies. It is also felt that frequent surveys of all the estuaries should be conducted in different seasons over the years to find out changes in stock sizes in-relation to other environmental and biological factors. A clear picture on the biology of *M. meretrix* and *K. opima* from Karnataka estuaries is yet to emerge. With the experience of Coondapoor and

Kali estuaries (Rao 1983, Nayar et al 1984) it is suggested that the areas of live clam beds may be excluded from the perview of sub-soil shell deposit mining. The present study may be considered as a beginning towards focussing the attention of different agencies with regard to the importance of clams and the direction for further studies.

ACKNOWLEDGEMENTS

We thank Dr. P.S.B.R. James, Director, CMFRI and Shri S. Mahadevn, Head, Molluscan Fisheries Division for taking keen interest in bringing out this publication. We are grateful to Dr. K. Alagarswami, former Head of Division for his guidance from planning the work to the preparation of this atlas. The help provided by the Officers-in-Charge of Karwar and Mangalore Research Centres aregratefully acknowledged.

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