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MOLLUSCAN RESOURCES OF KALI RIVER ESTUARINE SYSTEM IN KARNATAKA

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Introduction

The Kali river in Karnataka is well known for edible molluscan resources but there have been no detailed studies on the resources of the river except for the works of Rai *(J. Bomb. nat. Hist. Soc.,* 35 (4): 826-47, 1932) and Alagarswami and Narasimham (*Proc. Symp. Living Resources of the seas around India,* CMFRI: 648-58, 1973) who have made some observations on the resources in the river and their exploitation. Available information on the clam and oyster resources of the Kali river is of a generalised nature and it has been felt that there is need for a detailed survey of the river which supports a regular molluscan fishery. A survey of the Kali river was considered by the Central Marine Fisheries Research Institute on account of a dispute arising between the clam fishermen of the Kali river and the industry exploiting shell deposits. It was felt that first hand assessment of the conditions would help to evaluate the status of the live clam resources from the river bed. During the survey conducted in November–December, 1978 observations were made on the environmental conditions, species composition of the molluscan resources, their distribution pattern, exploitation and marketing and the findings are presented in this paper.

Physiography of Kali river

The Kali river is an important perennial river of Karnataka which joins the sea at the northern border of Karwar at lat. 14°48′ N and long. 74°8′ E (Fig. 1). Some islets are present in different parts of the river from a distance of 2 km from its mouth. There are also submerged rocks upstream beyond a distance of 7 km from the mouth. The water depth varied from less than 1 m to 7.75 m and at a number of places near the banks of the river it was ankle deep enabling fishermen to collect clams found there easily. Strong currents occur in the river especially at low tide.

Method of survey

The river was surveyed from the river mouth upstream up to Mallapur, the limit up to which molluscan resources are available in the river bed. The survey was planned in such a way that a certain spot on the southern bank of the river was taken as the base and the river bed was extensively sampled breadthwise along a straight line towards the northern bank. Samples were collected at a distance of every 200 m between the banks. The width of the river varies much. It is 0.4 km at the mouth and a maximum of 1 km at other places, for example at Nandangadda. A quadrat frame of 0.5 x 0.5 m was made use of for sampling the river bed (Fig. 2). To prevent the frame from moving due to water current, it was provided with sharp, pointed wooden pegs at the four corners so that it could be placed over the sampling area by driving the wooden pegs into the sand. After fixing the quadrat repeated skin divings were made quickly to scoop out the sand and mud up to a depth of 25 cm from the sampling area. Later the molluscan species found in the samples were separated. At each sampling station particular attention was paid to observe the nature of bottom, depth of water in the sampling area, species composition, density of population per m^2, size range of the species and percentage of live and dead shellfish.

From the river mouth to Mallapur, totally 12 bases viz., river mouth, Kodibag, Nandangadda, Sunkeri, Kadwad, Ambeju, Bhairebag, Kinnar, Botjug, Kerwad, Irpagae and Mallapur extending over a distance of 18 km were selected along the southern bank of the river for observations. The data collected from different parts

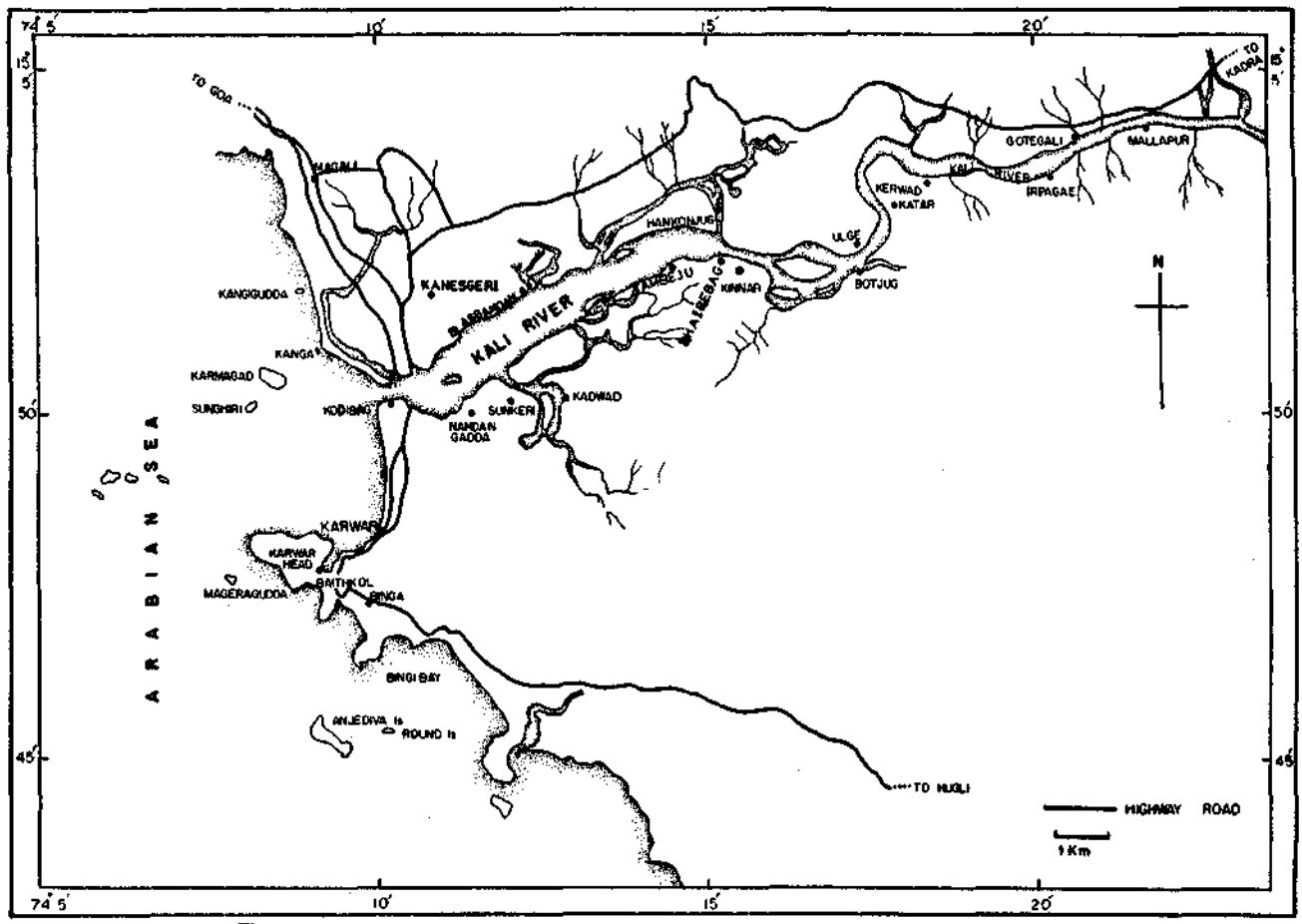


Fig. 1. Map showing important clam and oyster fishing villages along Kali river.

of each base were pooled together and the average was worked out for the density of population. The size range of individual species was also noted. The average depth was determined, water samples were collected and salinity, dissolved oxygen and pH were determined at each base.

Observations and results

Hydrographic conditions in Kali River

Generally the salinity of the Kali river fluctuates in different areas with the tides. At Kodibag which is near the mouth of the river, the salinity was high, 33.44‰ at high tide and decreased to 21.65‰ at low tide (Table 1). The salinity values at Sunkeri and Kadwad further upstream in the river were comparatively less than at Kodibag being 30.82‰ and 28.85‰ respectively. At Sunkeri a decline in salinity to 18.15‰ was noticeable at low tide. At Kinnar which is 8 km from the river mouth salinity was very low, 8.76‰ and the values in the bases further up showed progressive reduction and at Mallapur it was 0.24‰. In the bases in the upper reaches there was further fall in salinity at low tides.

The dissolved oxygen varied over a limited range of 3.18–3.73 ml/l at the various bases at high tide and the values were slightly higher at low tide. The pH fluctuated between 8.2 and 8.4 in Kodibag–Kadwad area at high tide and it was 7.0–7.4 in Kinnar-Mallapur area. A fall in pH was evident in the Kodibag–Nandangadda area at the time of low tide.

Distribution of clams and oysters

The survey has brought to light a vast clam bed which extends from the river mouth to a distance of 18 km upstream up to Mallapur. The clam resources comprise of three species *Meretrix meretrix, Paphia malabarica* and *Villorita cyprinoides*. Locally the large clams *M. meretrix* and *P. malabarica* are called *Kube* and *Tisra* respectively. *V. cyprinoides* is also known as *Kube*. Two species of oysters *Crassostrea madrasen-*

Table 1. *Hydrographic conditions during November-December 1978 at different bases of survey in Kali river, Karnataka*

Area		Nature of bottom	Average depth in m	Salinity (‰)		Dissolved oxygen (ml/l)		pH	
				At high tide	At low tide	At high tide	At low tide	At high tide	At low tide
River mouth		Sandy	4.5						
	N	Muddy, rocky							
Kodibag	M	Muddy							
	S	Coarse sand	3.0	33.44	21.65	3.18	3.73	8.4	7.2
	N	Hard substratum, sandy, rocky							
Nandangadda	M	Sandy	2.0						
	S	Muddy							
	N	Sand with mud, rocky							
Sunkeri	M	Sandy	2.0	30.82	18.15	3.18	3.73	8.2	7.4
	S	Sandy, rocky							
Kadwad	N	Muddy, rocky							
	M	Sandy	1.75	28.85		3.59		8.4	
	S	Muddy, rocky							
	N	Sandy							
Ambeju	M	Sandy, rocky	1.50						
	S	Sandy, muddy							
	N	Sandy, rocky							
Bhairebag	M	Coarse sand	1.50						
	S	Sandy							
	N	Sandy							
Kinnar	M	Coarse sand	1.60	8.76	7.45	3.59	3.73	7.4	7.2
	S	Black clay, muddy							
	N	muddy							
Botjug	M	Sandy	1.50	5.70	4.83	3.73	4.01	7.2	7.2
	S	Sandy							
	N	Sandy							
Kerwad	M	Coarse sand	7.75	2.43		3.73		7.2	
	S	Muddy							
	N	Sandy							
Irpagae	M	Muddy	1.50	0.46		3.46		7.0	
	S	Muddy							
	N	Sandy							
Mallapur	M	Sandy	1.50	0.24	0.24	3.73	3.73	7.0	7.0
	S	Rocky							

N-North, M-middle and S-South portions of transects.

sis and *Saccostrea cucullata* have veen recorded from the river. The oysters are known locally as *Kaloo*.

M. meretrix is the dominant species and occurs at a depth of 1 m or less from Nandangadda to Kinnar with clams in densities of 4–160/m² from Nandangadda to Kinnar (Table 2). In this area the substratum is predominantly sandy with a little mud which appears to be most ideal for this species to settle and grow. The size range of the clams found at Bhairebag and Kinnar which are 7-8 km from the mouth of the river is 7–17 mm On the other hand the size of clams in the downstream areas Nandangadda to Ambeju varied from 19 mm to 48 mm. This suggests that the clams of smaller

Table 2. *Density and size range of bivalves occurring in different bases in Kali river*

Area	*Meretrix meretrix*			*Paphia malabarica*			*Villorita cyprinoides*			Edible oysters		
	Average density per m²			Average density per m²			Average density per m²			Average density per m²		
	Live	Dead	Size range (mm)	Live	Dead	Size range (mm)	Live	Dead	Size range (mm)	Live	Dead	Size range (mm)
River mouth		10		4		20–31					20	80–120
Kodibag		20		10		22–33				2	15	80–120
Nandangadda	4	80	30–38	120	20	25–34				10	10	70–100
Sunkeri	130	2	33–36							15	20	80–150
Kadwad	140	16	31–48							3	25	80–150
Ambeju	150	15	19–27							4	42	90–120
Bhairebag	160	20	14–17							2	35	90–120
Kinnar	120	25	7–14							2	40	90–120
Botjug							120		22–36			
Kerwad							80		16–34			
Irpagae							52	8	18–35			
Mallapur							4		20–28			

sizes prefer the upstream areas. Dead shells of this species occurred in densities of 2–80/m² from river mouth up to Kinnar.

P. malabarica is found from river mouth up to Nandangadda only and it is common in the latter area with an average density of 120/m². This species is distributed in the deeper parts of the river where the depth is 2–3 m and ranges in size from 20 to 34 mm.

From Kinnar onwards at different places like Botjug, Kerwad and Irpagae up to Mallapur the black clam *V. cyprinoides* is the only clam species met with. This species occurs over a wide depth range of less than 1 m to 7.5 m at Kerwad. The average density of this species is 120/m², at Botjug and it progressively decreases in the upstream areas reaching a density of 4/m² at Mallapur. *V. cyprinoides* is distributed in the upper parts of the river only between Kinnar and Mallapur where the salinity is very low being 0.24‰-8.76‰ even at high tides. Beyond Mallapur upstream the river bed is predominantly rocky and no clams are encountered.

The rock oyster *S. cucullata* is found in small numbers of 10–20/m², on the surface of rocks in intertidal zone at Sunkeri (Fig. 3), Kadwad and Ambeju. In these areas *C. madrasensis* is also found in clusters in densities of 3–15/m², attached to discarded oyster shells at a depth of 1–2 m. Dead oysters were noticed from the river mouth up to Kinnar. In and around Kodibag which is about 2 km from the mouth of the river live oysters are very few, but further upstream they are comparatively more common as at Nandangadda and Sunkeri (Table 2). The oysters are found attached to rocks at Nandangadda while at Sunkeri they settle on oyster shells thrown into the river by fishermen after scooping out oyster meat. Beyond Sunkeri up to Kinnar, oysters occur in very low densities on rocky or firm sandy muddy substratum.

Clam and oyster fisheries

Both clam and oyster resources of the Kali river are exploited. The clam fishery of the river is a very important one and a large number of fisherfolk are engaged in the fishery while the oyster fishery is a localised one and restricted to Sunkeri. The fisherfolk of the villages on both the northern and southern banks of the river are engaged in clam fishing. The main clam fishing centres are Kodibag, Nandangadda, Sunkeri, Kinnar and Kadwad on the southern bank and Sadasivagad, and Kanesgiri on the northern bank. The fisherfolk belong to Harkantra, Gabbit, Konkanagarvi, Ambitta, Dlathi, Bhovi and Bandari communities. Of these, persons of the Gabbit community are exclusively engaged in clam fishing. Although more than 25,000 fisherfolk in total are living in these villages

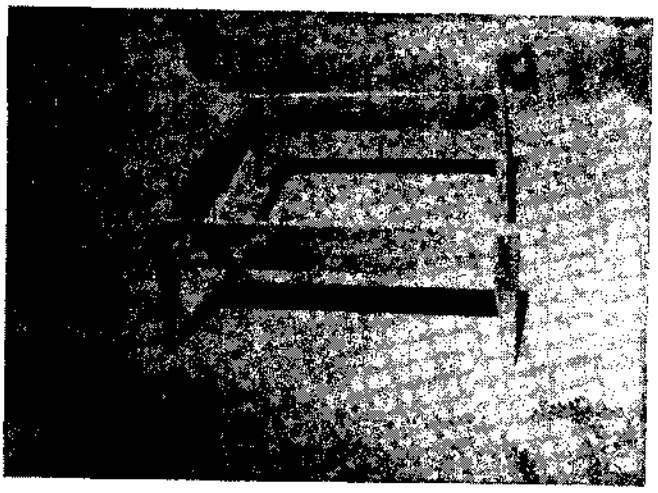


Fig. 2. Wooden quadrat used for sampling bivalves.

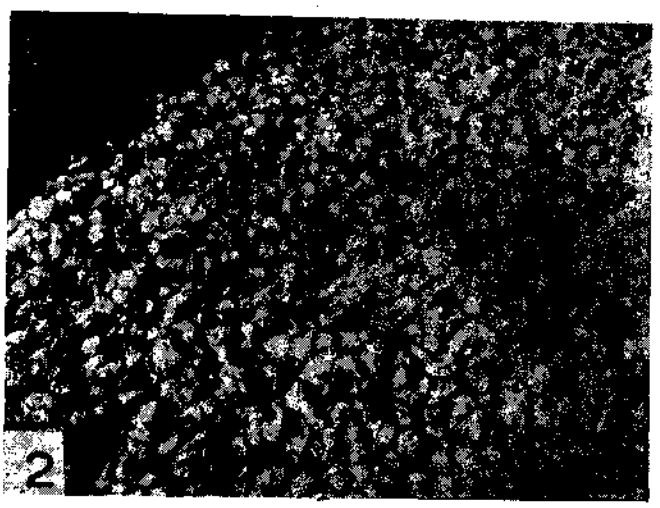
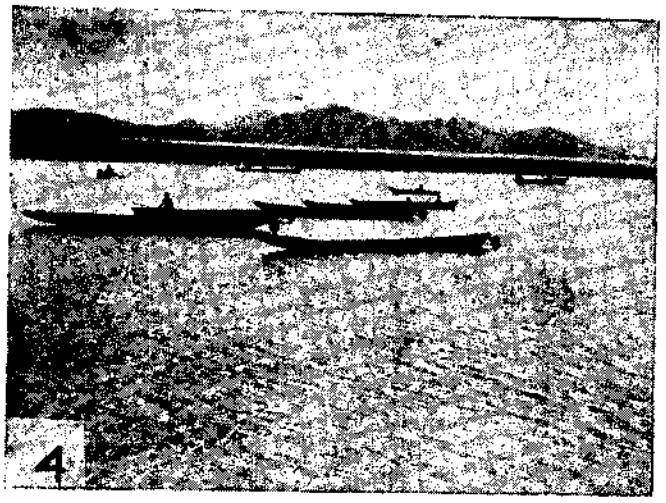


Fig. 3. Rock oysters, *Saccostrea cucullata* at Sunkeri.



Figs. 4 and 5. Clam fishing using boats and nets at Sunkeri.

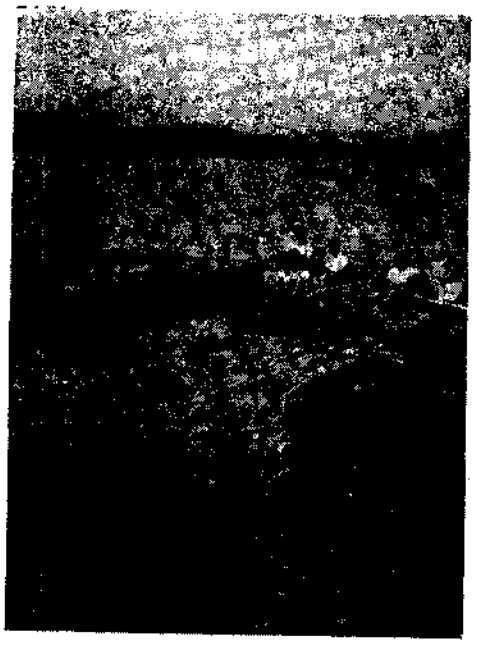


Fig. 6. Fisherwomen gathering clams by hand-picking at Sunkeri.

Fig. 7. Clam fishing net.

Fig. 8. Dredge used for collecting bivalve shells from the subfossil deposits of Kali river.

Fig. 9. A fisherwoman with clams ready for sale.

Fig. 10. Dredging operation for empty shells.

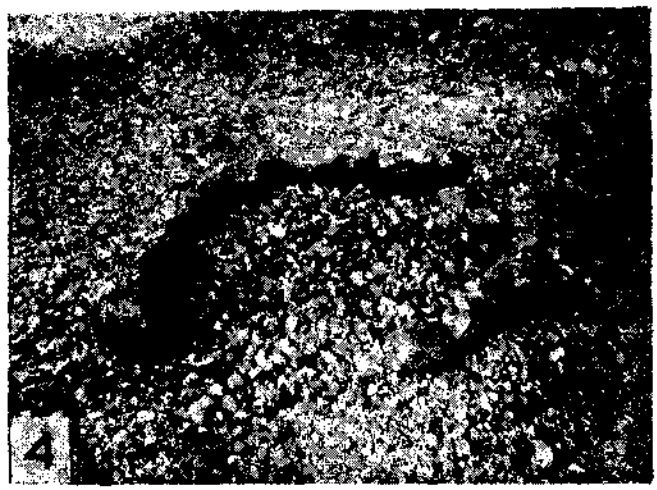


Fig. 11. Clams kept in sheltered tidal area.

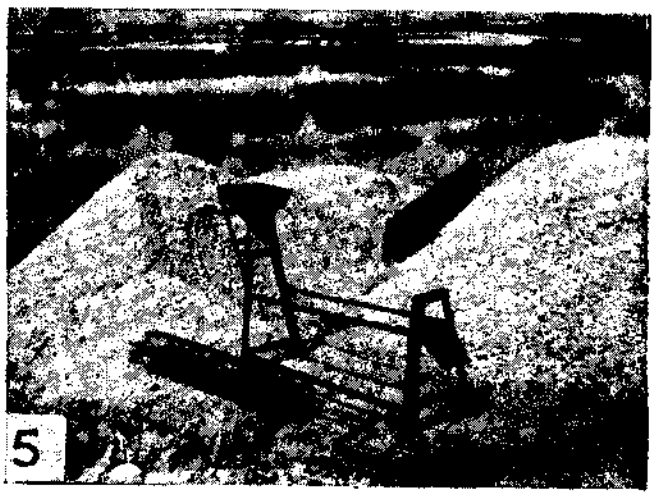


Fig. 12. Heaps of shells with sieving device.

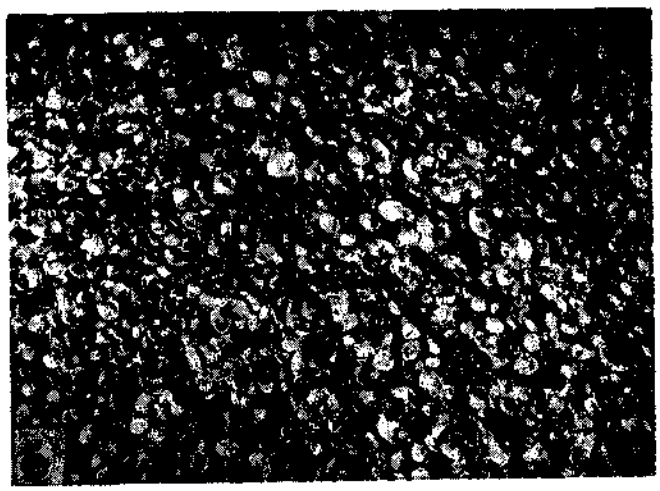


Fig. 13. A close-up view of shells gathered for industrial uses.

along Kali river, on an average only about 500 individuals including men, women and children fish for clams in the river every day. Fishing is carried out throughout the year unless there is a heavy flood in the river as during the southwest monsoon months.

Clam fishing is done during low tides irrespective of the time of the day. Hand-picking (Fig. 6) is the common method of fishing for the large clam *Meretrix meretrix* although nets are used sometimes in areas where the clams are found in large numbers. In deeper zones of the river the bottom is ploughed with leg and individual clams are collected as in Sunkeri area. When a large number of clams are encountered, a clam fishing net called *Kambalai* (Fig. 7) is used (Figs. 4 & 5). The net is held in position with one leg over the river bed while the clams along with sand and debris are pushed into the net with the other leg. After repeated operations for sometime, the net is lifted, the sand allowed to pass through the meshes and clams are collected and stored in boat. In some areas in and around Sunkeri and Kadwad during low tide, the bed is completely exposed and clams are handpicked from such areas. Intensive fishing for *Meretrix meretrix* is done in areas from Sunkeri to Kinnar.

In the case of fishing for *Paphia malabarica* the boat is kept in position with the help of a bamboo pole since the clams have to be collected from deeper areas with depths of 2–3 m. (Figs. 4 & 5) Due to the occurrence of clams together in large numbers, a net is frequently used. On an average about 75 boats are employed per day for *Paphia* fishing. Empty shells of *Paphia* are also collected in the net. When compared to other molluscan species, empty shells of *Paphia* are encountered in more numbers and form almost half of the quantity of the live clams. Irrespective of the species, the empty shells are invariably left on the river bed.

Clams are kept in the intertidal areas in small enclosures made with stones (Fig. 11) and are thus safely stocked for two or even three days before marketing. Usually the clams collected are stocked for at least one day before they are marketed. Rough estimates made of clam landings of Kali river indicate an annual clam production of about 2,000 t. *Crassostrea madrasensis* occurring in the river bed at a depth of 1–2 m at Sunkeri are collected by fishermen by diving at low tides. The oysters gathered are either sold or consumed by the fishermen.

In addition to the fishing of live clams and oysters, sub-soil molluscan shell deposits mostly clams present in the river bed are exploited on a large scale by agents of companies manufacturing calcium carbonate, caustic soda and fertilizers. (Table 3). The State Department of Geology leases out the right of collection of empty shells from the Kali river bed on a long term basis. The particulars of the companies etc. who acquired the rights of lease are given in Table 3. The clam shells are collected by the lessees from the river bed by operating a kind of a dredge consisting of an iron frame, with a net and provided with a long iron handle. The dredge could be operated at a depth of 2–4 m (Figs. 8 & 10).

When it is dragged on the bottom of the river where shell deposits are present, the shells are collected along with sand and debris. After washing the shells in the water the dredge is lifted and shells taken into the boat. On making trial operations of the dredge to assess the effect of dredging on live clams, it was found that near the banks of the river clam shells alone were collected

Table 3. *Details of leases for exploiting sub-fossil shell deposits in Kali river, Karnataka*

Name of lessee	Area and extent sanctioned		Date of sanction	Period
M/s. Mineral Enterprises (P) Ltd., Karwar	Kodibag	403.23 ha	11–7–1972	21 years
–do–	Chittakula	110.50 ha	3–1–1976	–do–
Shri M. Mohammed Ismail	Kadwad & Kinnar	132.52 ha	28–6–1976	–do–
M/s. Mangala Minerals	–do–	–do–	20–10–1976	–do–
M/s. West Coast Paper Mills Ltd.	Sunkeri	151.71 ha	14–12–1976	–do–
M/s. Mangala Minerals	Kali river creek		1–6–1978	10 years

in it whereas in deeper areas good numbers of live clams were got along with dead ones. The dredged shells are allowed to dry, sieved and accumulated in large quantities for the use of industries (Figs. 12 & 13.)

Marketing of clams

Clams are regularly sold in the local markets. They are taken to the markets by womenfolk in headloads and sold throughout the day. The clams are marketed with shells intact (Fig. 9) while the oysters are shucked and meat sold. The market price of the large clam *M. meretrix* depending on the size varies from 30 paise to 65 paise per 100 numbers whereas *Paphia malabarica* is sold at the rate of 30 paise per 100 numbers. The prices of shucked oysters is higher and they are sold at Rs. 4–6 per 100 numbers. Normally the marketable size of *M. meretrix* varies from 30 to 48 mm, that of *P. malabarica* from 20 to 34 mm and oysters from 90 to 120 mm in size. Both clams and oysters are packed in wet gunny bags and sent in vans to distant places like Goa and Bombay where they find a ready market. People living in and around the villages situated on the banks of the river in upper reaches, who are mainly agriculturists barter clams for paddy. One measure of clams irrespective of size fetches equal quantity of paddy. At times, clam and oyster meat is also sun-dried and marketed.

Discussion

The present work has shown that there is an organised clam fishery for *Meretrix meretrix, Paphia malabarica* and *Villorita cyprinoides* in Kali river. The three species of clams show differential distribution. *Paphia malabarica* is confined to lower reaches of river from the river mouth to Nandangadda where salinity is 33.44‰ suggesting that this species has distinct preference for areas where salinity is high. In a study of benthos of Kali river, Harkantra *(Mahasagar* 8 (1 & 2): 53-58, 1975) has also made similar observations on this species. *Meretrix meretrix* occurs over a distance of 6.25 km from Nandangadda where the salinity is 30.82‰ to Kinnar where the salinity is 8.76‰. *Villorita cyprinoides* is distributed only in low salinity areas in the upper parts of the river from Botjug to Mallapur where salinity is uniformly low fluctuating between 5.7‰ and 0.24‰ indicating that this species thrives well in low salinity conditions.

Although large quantities of clams are caught from the river, there is no information on the annual production, seasonal variations in landings and biological characteristics of the species exploited. Studies on these aspects will be helpful for proper management of the fishery. There are many large shallow stretches in the Kali river where it may be possible to transplant seed clams and carry out clam farming. The possibilities for conducting clam farming in the river could be explored as production from clam farming operations could augment that from capture fishery in the river. There is a very large demand for clam meat in several countries. India has exported as much as 510 t of clam meat during 1982–83. By stepping up clam production from Kali river, there are very good possibilities to meet the demands of export industry.

In the exploitation of the subfossil shell deposits in the Kali river, there appears to have been indiscriminate capture of live clams, belonging to the species *Meretrix meretrix* and *Paphia malabarica* in large numbers, which is detrimental to the resources. According to the local clam fishermen, dredging operations have been carried out by the agents of industries over wide areas in the river bed.

Due to the intensive quarrying carried out in these areas the topography of the river bed has changed much rendering survival of clam populations difficult. Therefore it is suggested that areas where subfossil deposits are distributed should be clearly demarcated through detailed geological investigations and the State Government has to prevent indiscriminate capture of the live clams by regular inspection of the quarrying of shell deposits.

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