

Short Communications

Swarming of a Pteropod *Cavolinia uncinata pulsata* (Rang, 1829; Spoel, 1969) in the Inshore Waters off Cochin

M. SAKTHIVEL

National Institute of Oceanography, Cochin 18

Manuscript received 12 October 1972

A swarm of *C. u. pulsata* is observed in the inshore waters off Cochin (9°58'N, 76°10'E). As this is an oceanic species the possibility of it being carried close to the coast because of mixing of oceanic water with coastal water is suggested. The morphology of the species is described.

OF the several groups of zooplankton, the swarming of a few groups such as cladocerans, amphipods and pteropods has been reported along the east and west coasts of India¹⁻⁵. The area off Cochin along the south-west coast of India shows special significance with regard to a few species of zooplankton. A monotypical swarm of an hyperiid amphipod, *Hyperia sibaginis* Stebbing, is noticed by Nair³ in the area off Cochin. Of all the areas explored in the Indian Ocean, the pseudothecosome pteropod *Desmopterus papilio* Chun reaches its maximum abundance in the area off Cochin⁶.

The species *Cavolinia uncinata* (S. or. Euthecosomata, Gastropoda) has three sub-species, viz. *C. u. uncinata*, *C. u. roperi* and *C. u. pulsata*. Of these the former two are found in the Atlantic and the latter in the Indian Ocean. Tesch⁷ reports that *C. uncinata* is generally found in the equatorial zone with more common occurrence in the Indo-Malayan waters. Study of the International Indian Ocean Expedition material reveals that the major centre of the population of *C. uncinata pulsata* is found around Andaman Sea and often gets transported to the west by the North Equatorial Current⁸. As a branch of this current flows into the eastern Arabian Sea, this species is also found there, but absent in other parts of the Arabian Sea. Therefore *C. u. pulsata* is considered as an indicator of the Bay of Bengal water mass.

The present report is based on the examination of the zooplankton collections of the Arabian Sea 'Pelagic Fishery Project'. The plankton samples have been collected by 'Bongo Net'⁹ along the Malabar and Mysore coasts during November 1971. In one of the samples, from the inshore waters off Cochin (9°58'N, 76°10'E) a swarm of *C. u. pulsata* was observed. About 95% of the volume of the sample was dominated by this species. This species which normally occurs in few numbers with less than 10/haul in the IIOE standard net collections made from 200 m to surface was found with 105 individuals in an oblique haul from 10 m to 0 m. The size of the swarm appears to be small as the neighbouring stations contained very few numbers. As this

is an oceanic species, the occurrence in such shallow inshore waters is reported for the first time. As November is the transition period and reversal of monsoon currents takes place, it is possible that this species could have been carried close to the coast because of mixing of oceanic water with coastal water. The mixing of cold water mass with the warmer coastal waters off Japan produces conditions for swarming in the *Euphausia pacifica*¹⁰.

The shell is dark brown in colour with a length to breadth ratio of 9:7. The maximum breadth is found at 1/2 of the total length or 2/5 of the body length of the shell. The caudal spine is distinctly curved like a hook. The upper lip of the dorsal valve is semicircular and bends like a hood over the ventral valve. The dorsal valve has five prominent ribs. The lateral fins are bilobed and the ventral fin is semicircular.

The author is indebted to Dr N. K. Panikkar for the encouragement and Dr T. S. S. Rao for going through the manuscript. Sincere thanks are due to the scientists and crews of *Sardinella* for collecting the material.

References

1. SELVAKUMAR, R. A., *Curr. Sci.*, **39** (1970), 481.
2. RAJAGOPAL, P. K., *Curr. Sci.*, **31** (1962), 467.
3. NAIR, K. K. C., *Curr. Sci.*, **41** (1972), 185.
4. AIYAR, R. G., MENON, K. S. & MENON, M. G. K., *J. Madras Univ.*, **8** (1936), 97.
5. CHACKO, P. I., *Proc. Indian Acad. Sci.*, **31** (1950), 162.
6. SAKTHIVEL, M., *Meteor. Forsch. Ergebnisse*, **10** (1972), 46.
7. TESCH, J. J., *Dana Rep.*, **5** (1948), 1.
8. SAKTHIVEL, M., *Studies on Euthecosomata of the Indian Ocean*, Ph.D. thesis, Cochin University, Cochin, 1972.
9. MCGOWAN, J. A. & BROWN, D. M., *Univ. California*, 1966, SIO, Ref. 63-23, 1-56.
10. MAUCLINE, J. & FISHER, L. R., *Adv. Mar. Biol.*, **7** (1969), 454.

Premonsoon Tidal Flow Characteristics of Mandovi Estuary

C. S. MURTY & P. K. DAS

National Institute of Oceanography, Panaji

Manuscript received 12 October 1972

Current and salinity changes over a complete tidal cycle (during spring tide) in Mandovi river estuary during 20-21 March 1970 are reported. Higher current speeds are observed during the flood compared to those of ebb, the maximum speed for flood and ebb currents being 160 and 108 cm/sec respectively. Salinity varies in accordance with the tide and also with depth with higher salinities found near the bottom. The salinity at Mandovi river mouth has an annual range of 25‰.

THIS note reports the results of the studies on the currents and salinities over a complete tidal cycle (during spring tide) made in the Mandovi river

estuary during 20-21 March 1970. These studies form part of a project oriented towards an understanding of the processes of sedimentation in the estuary and the formation and maintenance of the Aguada and Reis Margos bars near the mouth of the estuary. The river Mandovi has a slight meander before joining the sea (Fig. 1) and the navigation channel which is open almost throughout the year and closed only during the south-west monsoon (June-September) follows this by grazing the northern shore first and the southern shore next (near Aguada bar) immediately before entering the sea (Fig. 1). Keeping this deeper channel in view, the observations were made at Station A, which yielded interesting results by way of differential ebb and flood flow patterns, and relatively more salinity intrusion through one and freshwater discharges through the other side of this part of the estuary. Another set of similar observations was made at Station B on 16-17 March 1970, on similar lines for finding out the horizontal salinity gradient¹. Practically no information is available on the currents in this area, particularly over complete tidal

cycles. Some studies on the salinity changes in the area, however, during February and August were reported by Dehadrai².

The Mandovi estuary may be classified as a stratified estuary in the south-west monsoon which gradually evolves towards a well mixed one during the premonsoon period through a partially mixed one during the postmonsoon period according to the definition given by Pritchard³. The present study shows typical premonsoon (well mixed) conditions.

Station A is situated about 2.5 miles from the mouth of the estuary and about half a mile from the constriction near the mouth. At this station the boat was anchored and observations on currents were made at the surface and near the bottom every hour over a complete tidal cycle using an Ekman type current meter. Water samples were collected simultaneously with the help of a Hytech water sampler for salinity measurements. A few surface water samples were also collected in one-litre bottles for measuring suspended sediment loads.

As is evident from Fig. 2, the observations at this station indicated higher current speeds during the

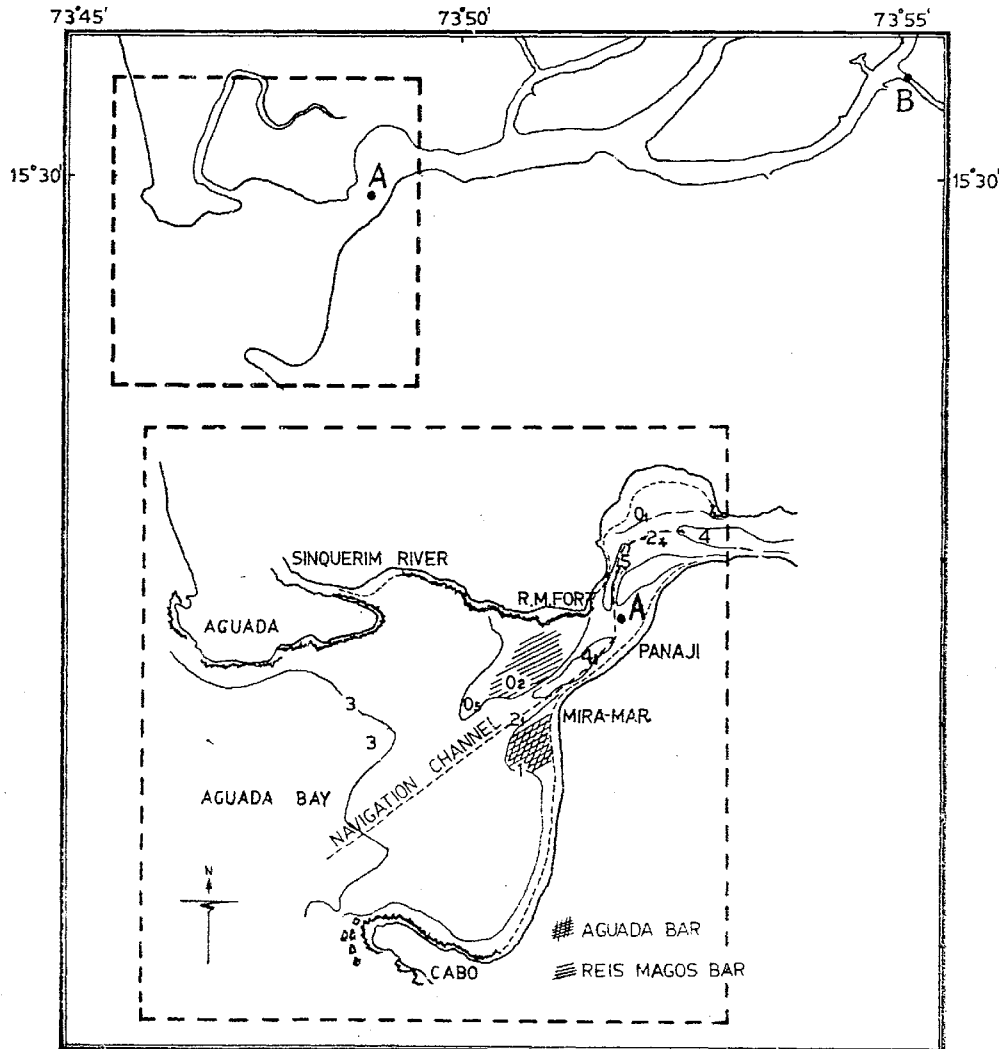


Fig. 1 — Station location and the bathymetry of the area in fathoms and feet (in subscript)

flood compared to those of the ebb, the maximum speed for the flood and ebb currents being 160 and 108 cm/sec respectively near the surface and 128 and 98 cm/sec 1 m above the bottom. Peak velocities during the flood and ebb precede the high and low water (predicted for Mormugao harbour) by 3 hr while the zero velocities lag by 1 hr. Observations on the current velocities over complete tidal cycle revealed a counterclockwise change in the direction of flow from flood to ebb, indicating a predominance of ebb current over the flood on the northern side of the channel. This is understandable from the fact that since there is a net transport upstream at Station A which is on the southern side of the channel, over a complete tidal cycle (as revealed by the current curve in Fig. 2 and the velocity-salinity diagram in Fig. 3), there must be a net transport downstream on the northern side of the channel.

The salinity variation is found to be in accordance with the tide. The salinity maxima and minima are found to be lagging behind the high and low waters by about 1 hr, i.e. the times of their occurrence synchronize with those of zero velocities. The

salinities vary depthwise with higher salinities being found near the bottom. The salinities near the surface and near the bottom vary from 33.35 to 36.5‰ and 33.5 to 36.7‰ respectively. The maximum range of salinity at this station during this period is 3.2‰ over a tidal cycle. A comparison of salinities at Station A with those at Station B indicates a gradient of 5.5 to 6.0‰ over a distance of about 8 miles. This suggests the presence of internal circulation in the estuary by way of currents due to density gradients. Fig. 3 shows a plot of the mean velocity-the mean salinity for Station A. Comparing the areas bounded by the ebb and flood sections of the curve which is a plot based on the averages of surface and bottom values of current and salinity, it can be seen that there is a salinity influx upstream to the tune of 20% over a full tidal cycle at Station A (southern side of the channel). The estimate was arrived at using the relationship

$$\text{Per cent net flow over a tidal cycle} = \left\{ \frac{\text{Area (flood)} - \text{Area (ebb)}}{\text{Total area}} \right\} \times 100$$

where the sign (−) indicates the flood/ebb predominance. This is on the same lines as given by Simmons⁴ for per cent of total flow upstream or downstream. In the absence of any appreciable amount of freshwater discharge, it can be deduced from reasons of continuity that the excess flood flow through the southern part of the channel is compensated by equivalent (or slightly more in case of any freshwater discharge) excess ebb flow through the northern part of the channel near Station A over a complete tidal cycle.

The average salinity at the Mandovi river mouth has an annual range of about 25‰. This range is spread over a period of 8 months (about 500 tidal cycles). The increase in the average salinity in the postmonsoon period is obviously exponential as the postmonsoon river discharge is negligible and the tidal cycles mainly flush out the freshwater stored during the monsoon in the Mandovi river system. This implies that a velocity-salinity curve would spiral upwards along the salinity axis while at the same time the area covered by the ebb part of it would gradually decrease giving rise to a proportionate increase in the area covered by the flood part of the velocity-salinity diagram.

Water samples collected during this study showed that even in the premonsoon season an average of 30 mg/litre of suspended sediment load occurs in the surface waters. The seasonal changes in the hydrographic features of the river Mandovi suggests that while during the monsoon period when there is a maximum of suspended load, the sedimentation takes place through the process of current speeds falling below the critical speed (for different particle sizes) during various stages of the tide; in the postmonsoon period the sedimentation will be dominated by the process of flocculation due to the differences in salinities. Moreover, by the same reasoning, coarser sediments can be expected during monsoon and finer ones during the postmonsoon periods.

The ebb current which brings considerable amount of sediments in the form of suspended load during the monsoon period decreases considerably in speed as it passes the constriction in the river near Station A, and approaches the divergent region at the

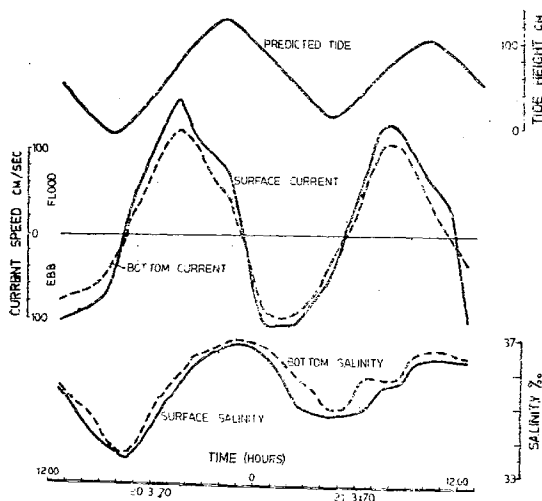


Fig. 2 — Variation of current and salinity with tide at Station A during March 1970

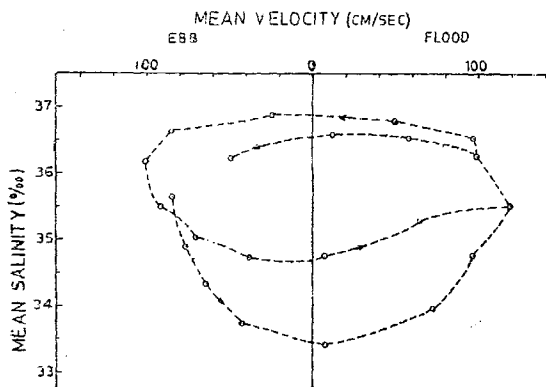


Fig. 3 — Velocity-salinity diagram for March 1970 for Station A

mouth of the river (Aguada Bay). The speed of the current is also partly reduced by the opposing wave action in this region. This may lead to considerable deposition of sediment closer to the constriction resulting in the formation of the Aguada and Reis Magos bars. During the flood current similar deposition may take place (although to a lesser degree) upstream of the constriction near Station A due to the divergence of flood current.

The authors express their gratitude to Dr N. K. Panikkar, Director, for his keen interest and encouragement and to Dr V. V. R. Varadachari for suggestions of improvements in the manuscript. They thank the Captain of Ports, Panaji, for providing boat facilities. The help of Shri V. Hariharan during the collection of data is acknowledged.

References

1. DAS, P. K., MURTY, C. S. & VARADACHARI, V. V. R., *Indian J. mar. Sci.*, **1** (1972), 95.
2. DEHADRAI, P. V., *Proc. Indian Acad. Sci.*, **72B** (1970), 68.
3. PRITCHARD, D. W., *Estuarine hydrography, Adv. in geo-physics*, Vol. 1 (Academic Press, New York), 1952, 243.
4. SIMMONS, H. B., *Estuary and coastline hydrodynamics*, by A. T. Ippen (Engg Soc. Monographs, McGraw-Hill, London), 1966, 673.

Concentration of Gold in Seawater

N. N. SHARMA

Central Salt & Marine Chemicals Research Institute
Bhavnagar

Manuscript received 8 March 1972; revised manuscript
received 25 August 1972

Gold in seawater concentrate (20°Bé) was concentrated by reduction with Cr(II) salt solution. Spectrographic analysis of the reduced mass showed 1.0×10^{-6} g gold/litre seawater.

GOLD and the other trace elements are present¹ in seawater in so small quantities that their direct precipitation is not possible. They are required to be concentrated before analysis. Many techniques, viz. adsorption, co-crystallization², solvent extraction, chelate resins³, etc., have been suggested for the concentration of trace elements; adsorption being the most widely employed for the concentration of gold. The most commonly used adsorbing agents for gold concentration are iron slag³, coal⁴, kieselguhr⁵, cellulose and hydrocellulose⁶, pyrites⁷, colloidal ferric hydroxide, etc. Co-precipitation of gold with metallic sulphides⁸ has also been suggested. However, these two techniques allow the gold to be associated with large quantities of adsorbing or precipitating agent without in any way affecting the state of gold present in the seawater. Another very effective method of recent origin for the estimation of gold is the neutron activation analysis which requires elaborate equipment.

The only direct approach for the concentration of gold in seawater is by Bardt⁹ who reduced the seawater successively or simultaneously with sulphur dioxide and sulphite lye. Tandon and Mehrotra¹⁰ have precipitated the gold quantitatively from a solution of its salt by reducing it with Cr(II) salt solution. This principle has been extended to

TABLE 1 — GOLD PRECIPITATION FROM SEAWATER

Vol. of seawater* litres	Place of sample collection	Cr ²⁺ solution added ml	Ppt. obtained mg	Au found g/litre $\times 10^{-6}$
2	Bhavnagar†	200	—	—
2	Bhavnagar	200	120.0	1.00
2	do	150	110.4	0.92
2	Ghoga	200	128.2	1.07
2	Veraval	200	132.0	1.10
2	Okha	200	130.8	1.09
3	Bhavnagar	300	191.2	1.06
4	do	350	260.8	1.08

*Density of seawater sample 20°Bé.

†Density of sample 4°Bé.

seawater and gold has been concentrated directly in the metallic form. The reduced mass was subsequently analysed spectrographically.

Cr(II) solution (0.1N) was prepared¹¹ from potassium dichromate (AnalaR). Jones reductor was modified by using a separating funnel connected to the burette with a long tube for discharge at the bottom. Chromium salt solution was kept overnight in the reductor (separating funnel) containing amalgamated zinc (AnalaR). Hydrogen atmosphere was maintained in the assembly throughout. Efficient reduction to Cr(II) was indicated by the appearance of a light blue colour for the solution in the reductor.

Seawater samples were collected from the salt works and were used without any further purification. Known volumes of seawater were acidified with hydrochloric acid (pH 0.1) to avoid the formation of basic double salt of chromium by hydrolysis. Dissolved oxygen was then removed from the brine by adding, carefully, 25 ml of 5% solution of sodium sulphite, to avoid the loss of Cr(II) reductant. Reduction was carried out by adding measured volumes of the reducing agent through the burette whose long tip discharged the reductant at least 10-12 cm below the surface of the brine. Slow but continuous stirring was carried out throughout the addition of the reductant since brisk stirring produces bubbles. Haziness appeared almost immediately on the addition of the reducing agent, but with more concentrated brines (20°Bé) fairly good turbidities were obtained. The developed turbidity showed Brownian movements but did not settle even after a week. After keeping overnight the colloidal mass was digested on a water-bath till the salt begins to just crystallize. Settling salt scavenged the turbidity. It was then filtered through sintered glass crucible under low suction. The precipitate was washed with minimum amount of hot water till all the crystals of salt were washed out. The precipitate was then dried in an oven at 105°C.

The reduced mass thus collected was analysed spectrographically. Amongst the various unidentified and unconfirmed lines in the spectrum, the lines corresponding to gold could clearly be identified. From the intensity of characteristic gold lines, the gold was estimated at 0.01% in the reduced mass. The gold content in seawater was calculated (Table 1).