DISCUSSION

The common feature of the June and September trips is that good catches were obtained near the boundary between the nearshore warm water and the cold water from deeper layers. It is presumed that cold water could be observed at other places such as the canyon off Kuching in which the boundary of cold and warm water masses could be formed. However, such boundary surfaces are considered as unstable. Near the Gulf of Thailand, the intense intrusion of deep-layer water, as observed in June, 1972, is considered to occur only in certain specific seasons.

CONCLUSION

There is a possibility that good fishing grounds along the canyon off Kuching can be formed throughout all seasons. However, the locations of good fishing grounds may be changed according to the change in oceanographic conditions. Near the Gulf of Thailand, good fishing grounds may be formed only in some seasons.

Reference

Robinson, M.K., 1963. physical Oceanography in the Gulf of Thailand.
Ecology of the Gulf of Thailand and the South China Sea. A report on the results of the Naga Expedition,1959–1961: 34–50.

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Behaviour of the Warm-Water Mass Along the East Coast of the Malay Peninsula

by
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Abstract

A preliminary study was made on oceanographic conditions in the South China Sea, using the data collected over two monsoon seasons. In the northeast monsoon and the subsequent stagnant season, a narrow belt-like water mass of high temperature and low salinity was observed along the east coast of the Malay Peninsula. While in the southwest monsoon season, the existence of this water mass was not clear.

The presence of this narrow belt of water mass suggest the existence of a southward-flowing current which may play a role in transporting the water from the Gulf of Thailand to the coastal area of the Peninsula.

INTRODUCTION

Along the east coast of the Malay Peninsula a narrow belt-like water mass of high temperature and low salinity, extending from the Gulf of Thailand to the vicinity of Singapore, was observed by the research vessel CHANGI in April, 1971. On the other hand, during a joint trawl survey by Thailand, Malaysia and Germany conducted in this area between March and April, 1967, a southward-flowing current of about one knot was observed in the nearshore area. The above two facts seem to suggest that the southward-flowing current in this season plays a role in transporting the water from the Gulf of Thailand to the coastal area of the Peninsula.

Using the data from CHANGI together with some other data, analysis was made to clarify the behaviour of this water mass in more detail. When considering the geostrophic balance of water masses, the above belt of water is concluded to flow in a southerly direcition. The results are described here.

OBSERVATIONS

Between October, 1970 and June, 1971, four research trips were made by CHANGI to the area off the east coast of the Malay Peninsula. These are as follows:

Period	Number of Stations
17 – 22, Oct., 1970	6
17 – 23, Nov., 1970	7
13 – 26, Apr., 1971	21
31 May – 12 June 1971	16

The first two cruises were carried out during the northeast monsoon season, and observation stations were arranged at irregular intervals of 40 to 100 nautical miles along the coast. The third cruise was made in the spring intermonsoon season. The stations were arranged to form meshes at relatively regular intervals of about 60 nautical miles off the east coast of the Peninsula and this cruise covered the widest area among the four cruises. The fourth cruise was carried out at the beginning of the southwest monsoon, and stations were arranged at regular intervals of 60 nautical miles.

At each station serial observation was made, and in addition BT observation was made during the last two trips.

OCEANOGRAPHIC CONDITION OFF EAST COAST OF MALAY PENINSULA

Analysis of the data was made three-dimensionally to get synoptic information. Fig. 1 shows the composite surface and vertical sections of temperature in the spring intermonsoon season, 1971. The interesting feature is a narrow belt of warm water mass along the east coast of

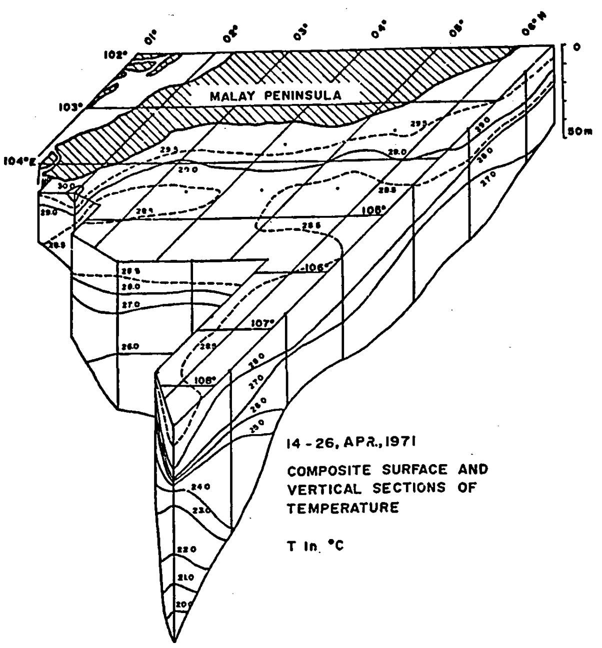

Fig. 1 Composite surface and vertical sections of temperature. April, 1971.

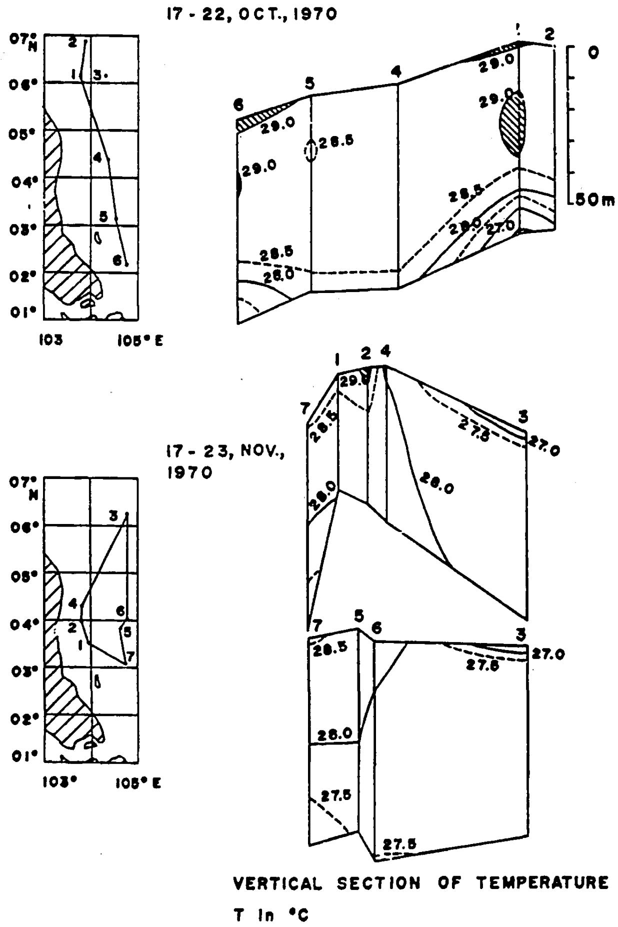

Fig. 2 Vertical sections of temperature. October and November, 1970.

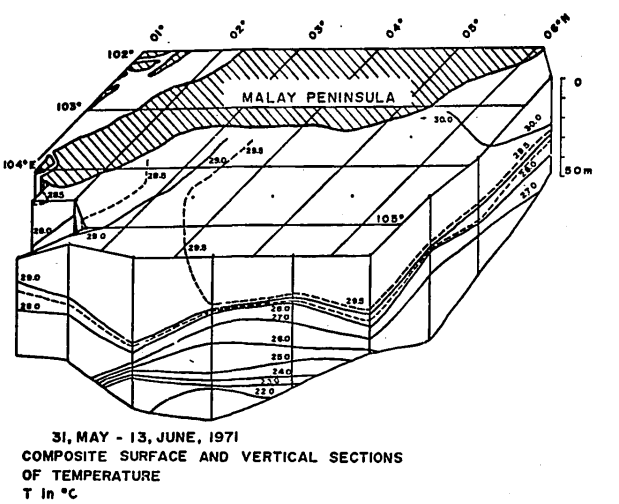

Fig. 3 Composite surface and vertical sections of temperature. May to June, 1971.

the Malay Peninsula, which is over 29°C in temperature. This was between 10 and 20 m. in depth and extended from the mouth of the Gulf of Thailand to the vicinity of Singapore. This water mass was low in salinity, and this fact will be discussed later in more detail.

The behaviour of this coastal water during the previous northeast monsoon is suggested in Fig. 2. The fgure shows the vertical sections of temperature during October and November, 1970. As seen in the figure, there are fewer stations, and they were not arranged to form meshes. Consequently, we cannot clearly map out the pattern of the coastal water. However, water of high temperature is shown at stations nearer to the coastline. This water of high temperature was also low in salinity.

The composite surface and vertical sections of temperature in the early stages of the southwest monsoon season are shown in Fig. 3. The locations of stations along the coastline were almost identical to those of the April expedition. The water layers are thermally well stratified, as seen in the figure, and the surface temperature increases with increasing latitude. It should be noted in particular that the narrow belt of warm water along the coastline which was seen in the northeast monsoon and its subsequent stagnant seasons is not present in the figure. Although most of the shallow layers are covered by water over 29°C, this water mass seems to be different from that which covered the coastal area in the two previous seasons, since the salinity of this water mass was considerably higher.

Our attention has been focussed on the coastal water of high temperature and low salinity, which is likely to appear only in the northeast monsoon and its subsequent stagnant seasons. The fact that this water mass extended from the Gulf of Thailand suggests that it might have originated from the Gulf.

Before discussing this point, the temperature and salinity characteristics of the water in the southern part of the South China Sea and that in the Gulf of Thailand must first be considered.

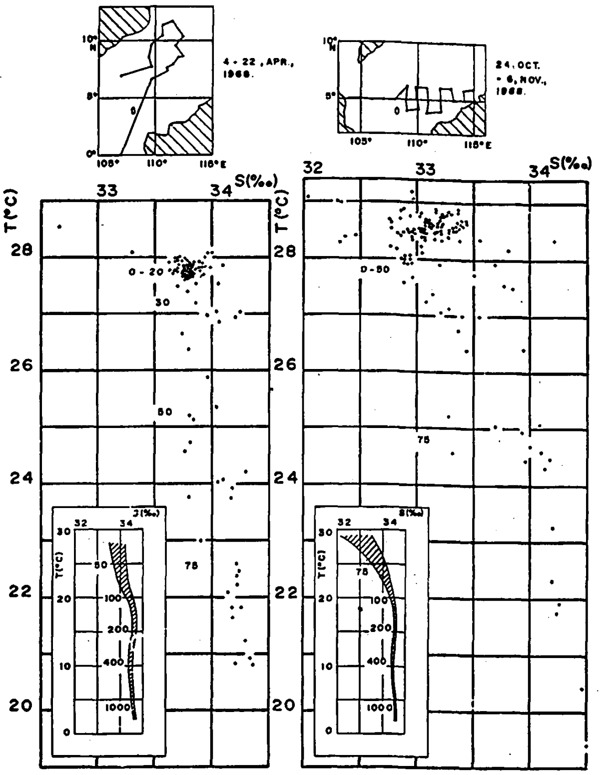

Fig. 4 T-S diagrams in southern part of South China Sea, April and October to November, 1968.

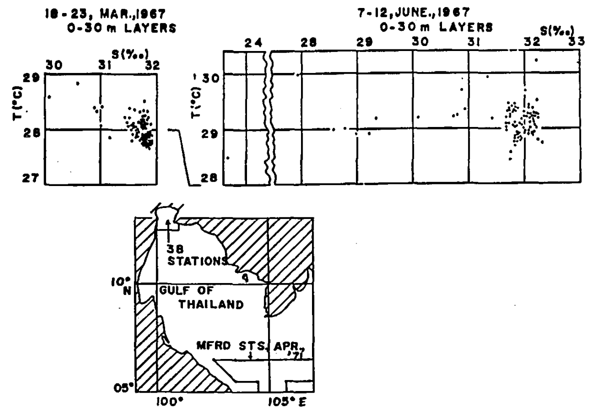

Fig. 5 T-S diagrams in bay head of Gulf of Thailand, March and June, 1967.

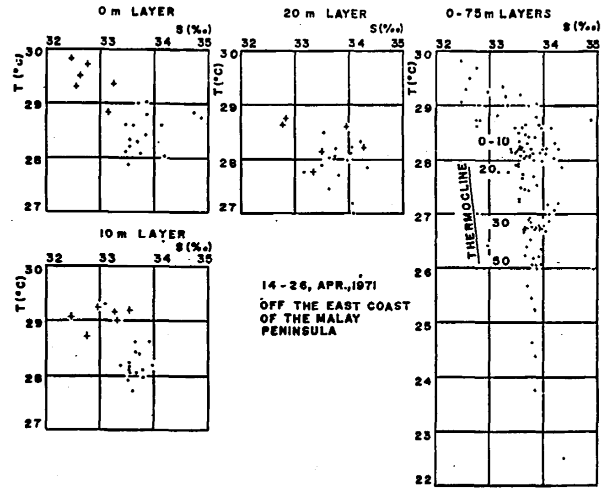

Fig. 6 T-S diagrams off east coast of Malay Peninsula, April, 1971.

T-S CHARACTERISTICS OF WARM-WATER MASS AND THOSE IN NEIGHBOURING WATERS

Using the CSK data collected in April and November, 1968, the temperature-salinity diagrams of the southern part of the South China Sea were constructed as illustrate in Fig. 4. In layers shallower than 100 m. in depth, some signs of seasonal changes are noticeable. During the northeast monsoon the salinities of the upper layers were rather widely distributed, as seen at the upper part of the T-S diagram for November, 1968. This is probably due to the locations of the observation stations, which stretched from the Malay Peninsula to waters off Borneo. In fact, those plots below 33 $^{0}/_{00}$ in salinity are for the stations near the two coasts. Taking this fact into consideration, we may conclude that during the northeast monsoon and its subsequent stagnant season, the off-shore water in the South China Sea seldom exceeds 29°C and is seldom below 33 $^{0}/_{00}$.

Fig. 5 shows the T-S diagrams in the bay head area of the Gulf of Thailand around April, 1967. The data for this figure were also obtained from CSK. It is seen from the two T-S diagrams that the salinity in the bay head area was about 32 $^{0}/_{00}$ or less.

On the results of the NAGA Expedition, Robinson (1963) reported that between April and May, 1960 the surface temperature throughout the Gulf of Thailand exceeded 30°C while the surface salinity and that of the shallower parts of the Gulf were below 33 $^{0}/_{00}$.

Fig. 6 shows the T-S diagrams, plotted from the CHANGI data collected in April, 1971. In this figure are shown the T-S plots for 0, 10 and 20 m. layers separatedly as well as plots for 0 to 75 m. together. In the T-S diagrams for 0 and 10 m. there are clearly two distinct groups of plots. The plots with cross are from stations within the narrow belt of warm water. At 20 m. depth, however, it is hard to distinguish clearly the water masses.

From the above findings, it could be inferred that during the northeast monsoon and its subsequent stagnant period, the warm water of low salinity of the Gulf of Thailand flows out as a narrow belt along the east coast of the Malay Peninsula.

DISCUSSION

In Fig. 1 the warm water mass is almost parallel to the coastline and is between 10 to 20 m. in depth. In the area to the north of the Malay Peninsula, we estimate the velocity of this water mass by using an idealized model and some simplification of our data. In this model the isothermal surface of 29°C is assumed to be a boundary which separates the coastal and offshore waters.

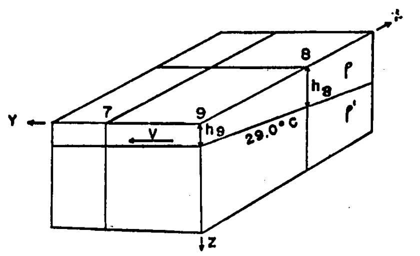

Fig. 7 Ideally simple model of two homogenous layers.

Imagine that the sea consists of two homogeneous layers, and the lower layer is at rest. The current v in the upper layer is assumed to be parallel to the y-axis of the coordinate system in Fig. 7. Then, from the consideration of the geostrophic balance, we can get the following relation:

$$f.v = (1 - \rho/\rho')\, g \frac{dh}{dx} \qquad (1)$$

where f is the Coriolis' factor and is expressed as $2\,\omega \sin \varphi$. h is the thickness of the upper layer, and ρ and ρ' are the densities of the upper and lower layers respectively. On substitution of

$\rho = 1.0207\ g.cm^{-3}$, $\rho' = 1.0218\ g.cm^{-3}$,
$\Delta h = 8\ m$, $\Delta x = 110\ km$, $g = 980\ cm.sec^{-2}$,
$\omega = 7.292 \times 10^{-5}\ rad.sec^{-1}$, $\varphi = 6^{\circ}30'N$,

into the above equation and calculating, we have

$v = 47.6\ cm.\ sec^{-1}$

In other words, there may be a southward-flowing current of about one knot along the east coast of the Malay Peninsula.

As mentioned before, this southward-flowing current was actually observed during a joint survey by Thailand, Malaysia and Germany (Anon., 1967). observation agrees with our results.

CONCLUSION

A narrow belt of southward-flowing current is considered to appear along the east coast of the Malay Peninsula during the northeast monsoon and its subsequent stagnant season. By this current the water of the Gulf of Thailand seems to be transported to the area off the east coast of the Peninsula.

References

Robinson, M. K. 1963. Physical oceanography in the Gulf of Thailand. Ecology of the Gulf of Thailand and the South China Sea, A report on the results of the Naga Expedition, 1959–1961: 34–50.

Anonymous 1967. Results of the joint Thai-Malaysian-German trawling survey off the east coast of the Malay Peninsula, 1967. Marine Fisheries Laboratory, Department of Fisheries, Ministry of Agriculture and Cooperatives, Thailand and Fisheries Research Institute, Fisheries Division, Ministry of Agriculture and Cooperaitves, Malaysia. 18 p. 1967.

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Preliminary Report on the Distribution of Chaetognaths in the Southern Part of the South China Sea

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Abstract

This paper reports the distribution of chaetognaths in the southern part of the South China Sea, based on the plankton samples collected by the research vessel CHANGI from April 1970 to April 1972.

The chaetognath specimens collected in April, 1972 were identified. Altogether 22 species belonging to 5 genera were discerned. *Sagitta enflata* was the dominant species and was widely distributed in the areas surveyed. While the common species in the neritic waters are *S. bedfordii*, S. bedoti, *and S. oceania*, the common species in the oceanic province are *Krohnitta pacifica, K. subtilis, Pterosagitta draco, S. bipunctata, S. hexaptera, S. lyra, S. minima, S. pacifica* and *S. regularis. S. enflata* and *S. ferox* are common in both neritic and oceanic provinces.

The individual numbers of chaetognaths varies from 400 to 13,000 per 100 m^3 of water. In general, the chaetognaths are abundant in coastal waters but decline towards the open sea.

Based on the occurrence of the various species, the importance of chaetognaths as biological indicators of water masses are discussed. *P. draco, S. hexaptera, S. minima* and *S. pacifica* are useful indicators of the presence of oceanic water in the neritic province. The presence of these species in some neritic waters adjacent to the oceanic province suggests the mixing of oceanic water and neritic water in the respective areas during the survey.