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HYDROGRAPHY OF THE WADGE BANK – PREMONSOON AND MONSOON SEASONS

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ABSTRACT

The hydrography of the Wadge Bank during premonsoon and monsoon seasons is presented. The thermocline slopes downward towards the central region. Upwelling is prominent in the entire region during monsoon and is observed only in the western and central parts of the region during premonsoon. The low saline Bay of Bengal waters are present in the southeastern part of the Wadge Bank and high saline waters of the Arabian Sea intrude from northwest indicating the withdrawal of the North Equatorial Current (NEC) during premonsoon. During monsoon, high saline (35.2×10^{-3}) waters of the western equatorial Indian Ocean are present in the western part of the region and low saline (34.8×10^{-3}) Bay of Bengal water is present in the eastern part.

Key-words: Wadge Bank, upwelling, temperature, salinity, hydrography.

INTRODUCTION

The Wadge Bank, situated off the southern tip of the Indian peninsula covering an area of about 13,500 sq.km. is the meeting place of the waters from the Arabian Sea and the Bay of Bengal and is also one of the most fertile regions of the North Indian Ocean. The surveys of Fishery Survey of India during October 1981 to April 1983 revealed high demersal fishing grounds in the Wadge Bank. The monthwise catch per hour for all fish has been found to vary from 60 kg in March to 444 kg in June. Realising the fishing potential of the area, systematic oceanographic surveys were carried out on board R V *Gaveshani* during the premonsoon and monsoon seasons in 1981 and the results are presented in this paper.

MATERIAL AND METHODS

Twenty seven stations (2153 to 2179) were occupied during 19-26 May, 1981 and the same stations were repeated during 19-26 September, 1981 covering four meridional sections I-IV (Fig.1). Salinity was estimated using a salinometer (Autosal) with an accuracy $\pm 0.003 \times 10^{-3}$, while the temperature was measured at standard depths using reversing thermometers. Figs.2 and 3 show the distribution of temperature and salinity at surface,

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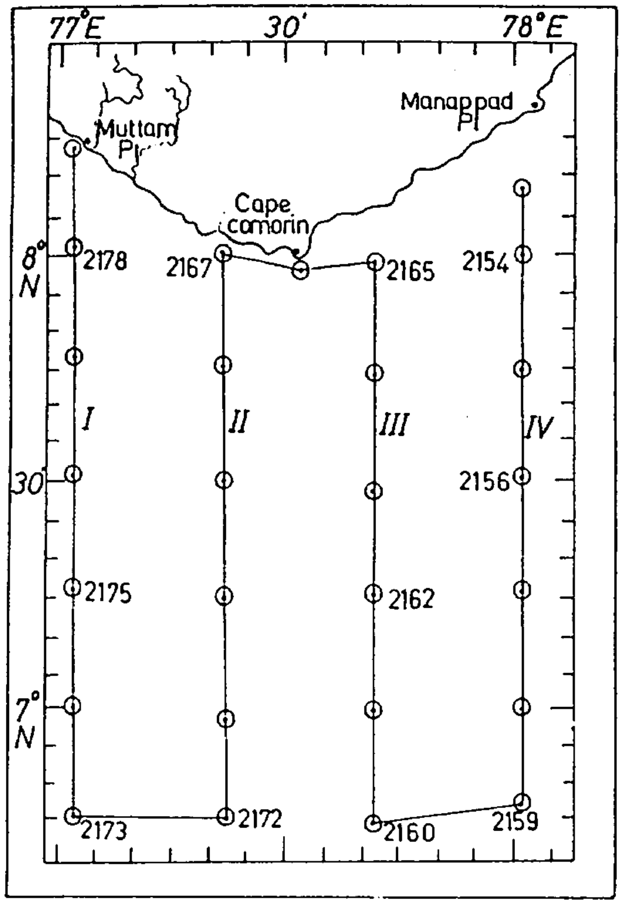

Fig.1. Location of hydrographic stations (2153-2179)

50, 100 and 500 m depths. The vertical distribution of temperature and salinity along the sections I-IV are presented in Figs.4 to 7.

RESULTS AND DISCUSSION

Temperature: The sea surface temperature, in general, decreases from offshore towards the coast from 29.5 to 26.4°C during premonsoon and from 27 to 24.5°C during the monsoon (Fig.2) with the lowest temperature occurring in the region near Cape Comorin. The usual summer maximum temperatures are not observed in the monsoon season. Meridional temperature gradients are prominent only in the region east of section II and zonal gradients in the west during premonsoon; whereas in the monsoon season they are prominent in the entire region. At 50 m, the temperature distribution in the south-central part of the study area during premonsoon (Fig.2b) is more or less the same (29°C) as that of surface, whereas towards the eastern and western sides of this region the temperature decreases to 23 to 25°C respectively. This implies that the thermocline is sloping down towards the south-central part zonally. The temperature in the central

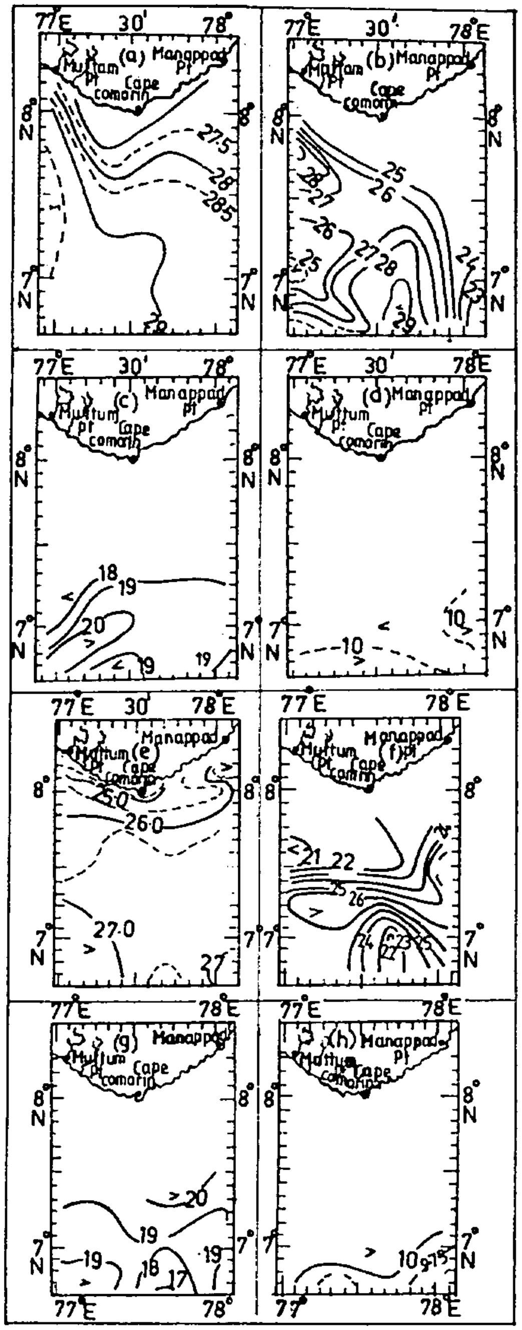

Fig.2. Temperature (°C) distribution at (a) surface, (b) 50, (c) 100 and (d) 500 m depths during May, and at (e) surface, (f) 50, (g) 100 and (h) 500 m depths during September.

part of the study area during monsoon (Fig.2f) is nearly the same (26°C) as that of surface while towards the northern and southern sides of the central region, it decreases to 22°C. Thus in the monsoon, the thermocline is sloping down towards the central part meridionally. The large variation of temperature between surface and 50 m during the monsoon season clearly indicates upwelling in the northern and south-central part of the Wadge Bank.

At greater depths (Fig.2c & d) an offshore increasing tendency in temperature is noticed during premonsoon season and a reverse trend in the monsoon season (Fig.2g & h).

During the premonsoon and monsoon the depth of the thermocline, in general, is less than 50 m in the region under study. The orientation of the isotherms across the shelf region indicates upwelling near the coast in the western and central parts (Fig.4 a-c) during premonsoon and in all the sections (Fig.5 a-d) during the monsoon season. The upwelled waters after mixing with the surface water attain temperature varying between 26 and 28°C during premonsoon and as low as 24-27°C during monsoon. Thus a drop of 1 to 2°C in the surface temperature in the premonsoon and 2 to 3°C in the monsoon season are noticed in the upwelling areas as compared to those on offshore areas. No remarkable variation in the temperature distribution is noticed below 200 m during premonsoon and monsoon seasons.

Salinity: At surface, a clear distribution between the two types of waters viz. high saline waters (35.5×10^{-3}) of the Arabian Sea in the shelf region and low saline waters (34.9×10^{-3}) of the Bay of Bengal in the slope region are seen during premonsoon (Fig.3a). A zone of separation (salinity front) between these two water masses is seen to extend upto a depth of 100 m during this season (Fig.3b and 3c). High saline waters (35.2×10^{-3}) of the Western Equatorial Indian Ocean in the slope region and low saline waters (34.8×10^{-3}) of the Bay of Bengal in the shelf region are noticed at surface during the monsoon season (Fig.3e). Western Equatorial Indian Ocean water was observed in the central region at 50 m (Fig.3f) and an admixture of this and Bay of Bengal water is observed towards north and south which may be due to upwelling and mixing. The admixture of Bay of Bengal and Western Equatorial Indian Ocean water is noticed at 100 m depth (Fig.3g). Fig.3d & h indicate the presence of high saline waters (35.2×10^{-3}) with temperature of 10°C (Fig.2d and 2h) in the south-western region during premonsoon and monsoon at 500 m.

As seen from sections I & IV (Fig.6) the high saline waters reach the surface at the shelf edge and spread towards the coast during the premonsoon season. But in the monsoon season, high saline waters (35.2×10^{-3}) observed in the shelf region of section I have spread towards sections II, III and IV (Fig.7).

High saline waters (35.4×10^{-3}) above 50 m depth intrude towards the coast along section I during premonsoon season and extrude from the coast along section II (Fig.6). During the premonsoon season a low salinity

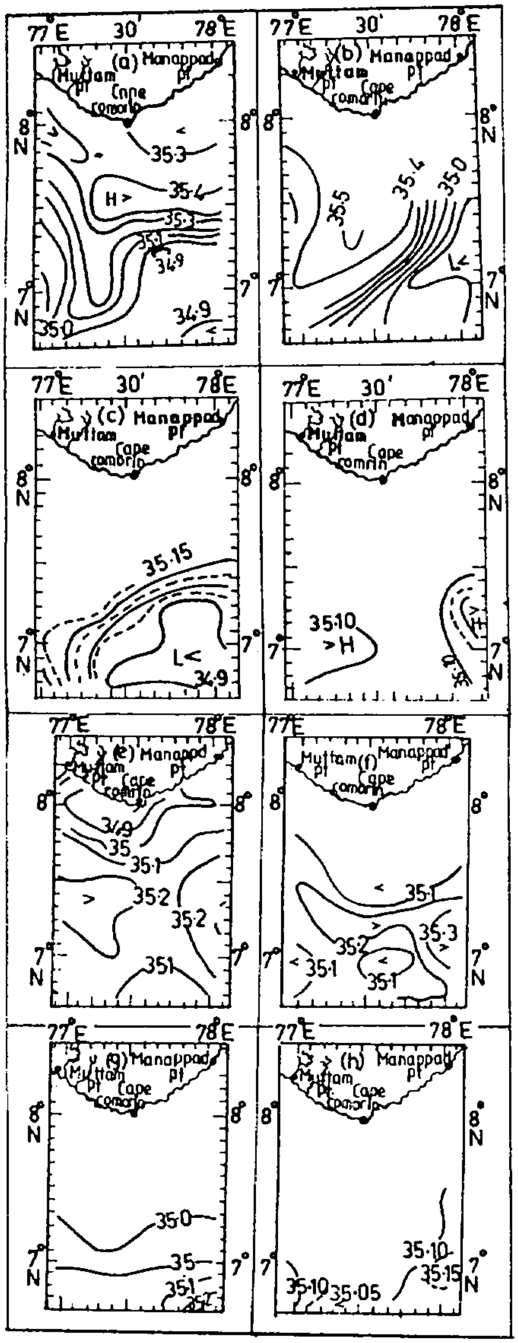

Fig.5. Salinity ($\times 10^{-3}$) distribution at (a) surface, (b) 50, (c) 100 and (d) 500 m depths during May and at (e) surface, (f) 50, (g) 100 and (h) 500 m depths during September.

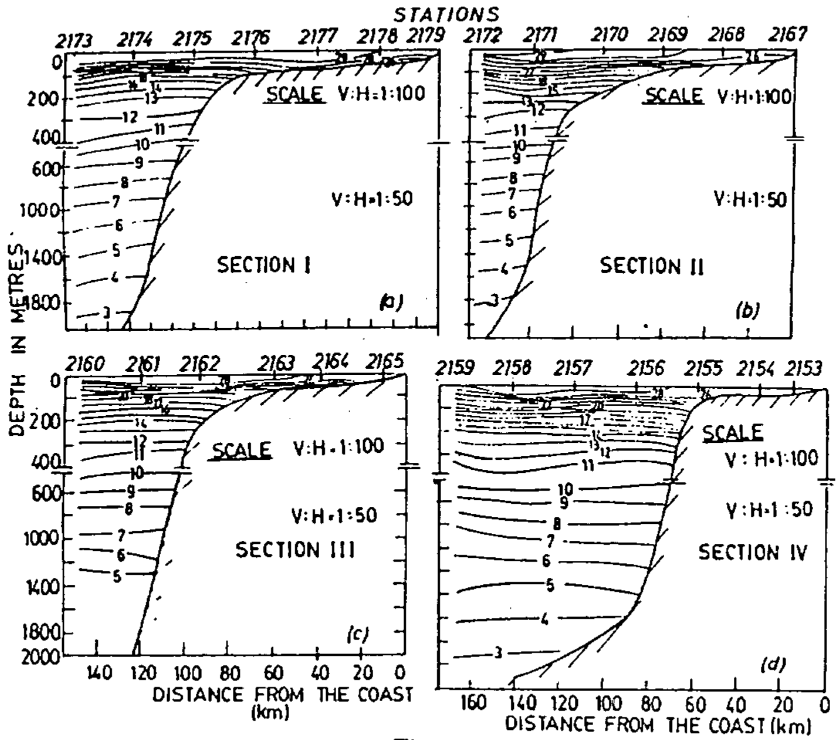

Fig. 4

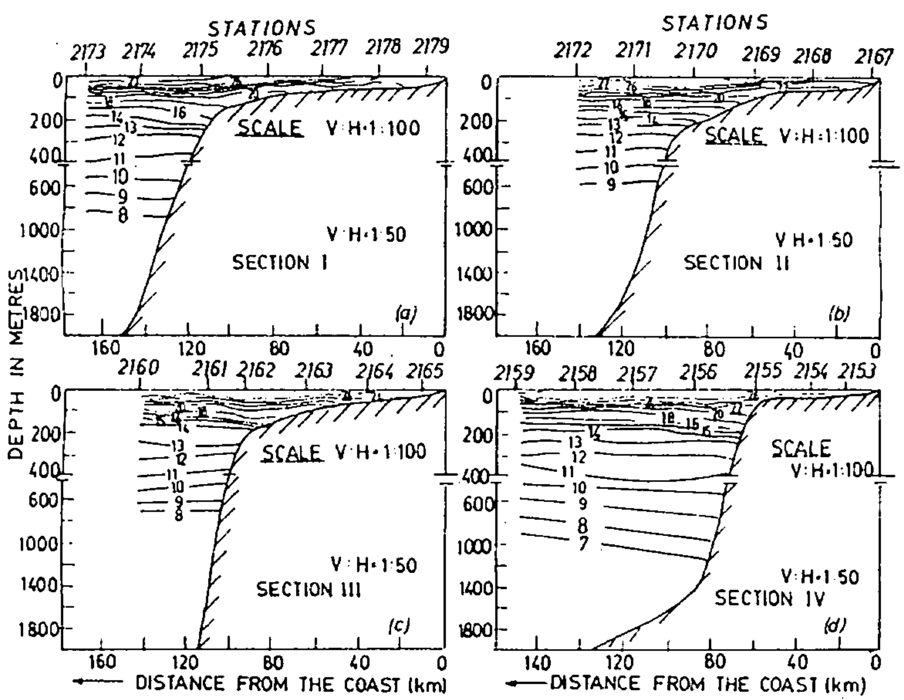

Fig. 5

Figs.4 & 5. Vertical distribution of temperature (°C) along sections I-IV during May and September respectively

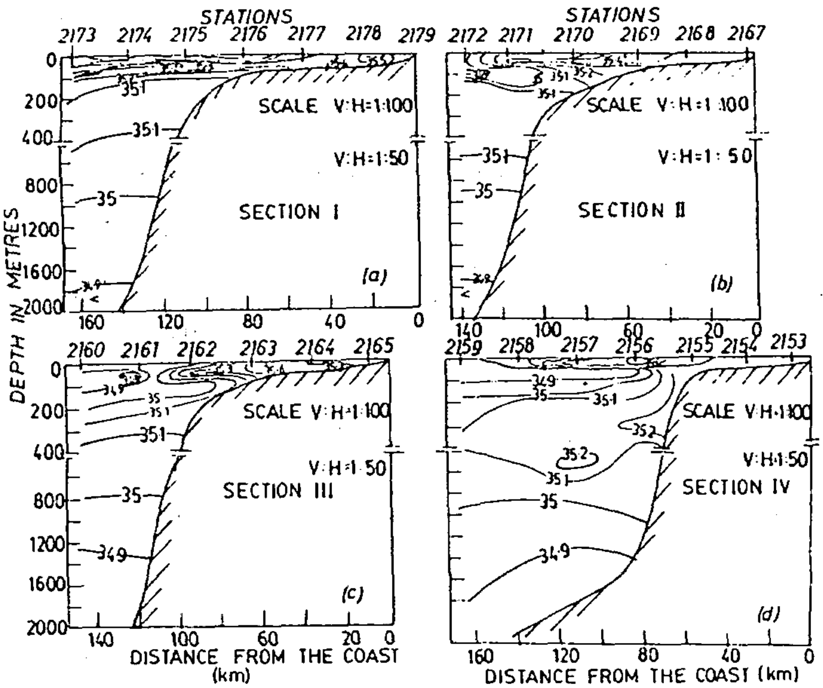

Fig. 6

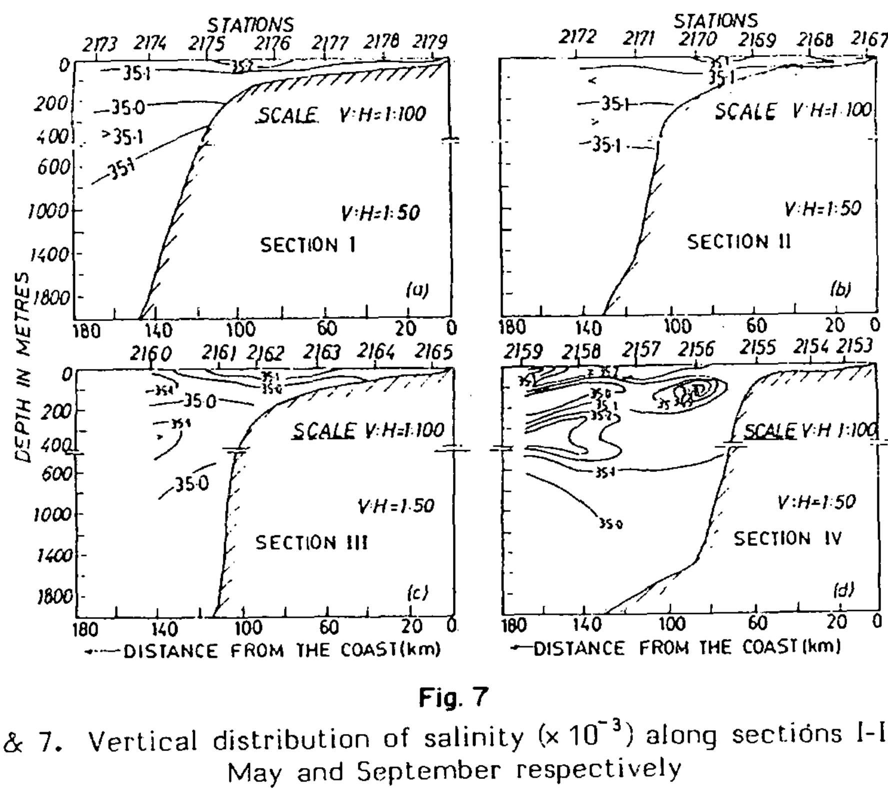

Fig. 7

Figs.6 & 7. Vertical distribution of salinity ($\times 10^{-3}$) along sections I-IV during May and September respectively cell (34.9×10^{-3}) is observed at 100 m in sections I-III (Fig.6) whereas during monsoon season this cell is observed only in section IV on the eastern part of the Wadge Bank at the same depth. The cell is gradually reduced in size from east to west during premonsoon. This indicates that the cell is apparently due to an earlier intrusion of low saline waters of the Bay of Bengal under the influence of North Equatorial Current (NEC).

Thus in the Wadge Bank, during premonsoon, at about 100 m depth the low saline Bay of Bengal water occupies the south western part (Fig.3) and at the surface, off Muttam, a tongue of high saline water (35.5×10^{-3}) spreads parallel to the coast towards Cape Comorin. Observations on currents in the north-western part of Wadge Bank during premonsoon season also indicated that the resultant current off Muttam was approximately parallel to coast line and directed south-eastward (Rama Raju, Ramesh Babu and Anto, 1986).

Table I — Percentage composition of water masses in the Wadge Bank region

Water Mass	Percentage content									
	Premonsoon					Monsoon				
(Stations)	2174	2171	2161	2158	Average	2174	2171	2161	2158	Average
Arabian Sea	29	17	12	12	17	19	19	18	17	18
Bay of Bengal	26	40	45	52	41	36	36	37	38	37
Equatorial Indian Ocean	45	43	43	36	42	45	45	45	45	45

During the monsoon season except for the low salinity (34.8×10^{-3}) cell at about 100 m depth, the entire Wadge Bank shows salinity ranging from 35 to 35.2×10^{-3} indicating the presence of Equatorial Indian Ocean water.

Wind: Observed surface wind on board R V *Gaveshani* in May indicates that the wind speed varies from 5 to 10 m sec^{-1} and direction from 310° on the western part to 225° on the eastern part of the Wadge Bank. In September, the wind speed varies from 2 to 9 m sec^{-1} and direction from 300° on the western part to 235° on the eastern part. The alongshore component of the surface wind ranges from 4.4 to 11.9 m sec^{-1} in May and from 1.9 to 7.5 m sec^{-1} in September. Thus in both the months the surface winds have a major component parallel to the coastline and direction favourable for upwelling.

Mixing of watermasses: Mixing in the Wadge Bank has been studied by the method of 'triangle of mixing' (Mamayev, 1975) based on the T-S diagrams prepared using hydrographic data collected during the premonsoon and monsoon seasons at stations 2174, 2171, 2161 and 2158 and from the values of thermohaline indices of the watermasses in the Bay of Bengal, Arabian Sea and Equatorial Indian Ocean (Wyrtki, 1971). The percentage composition of each of these waters during the premonsoon and monsoon seasons are shown in the Table I. It is evident that, during the monsoon season the percentage composition of the three watermasses is uniform over the entire region due to increased mixing. However, in the premonsoon season, even though the average percentage composition of the water masses appears to be the same as in the monsoon season, the Arabian Sea and Bay of Bengal waters have unequal composition from western part to eastern part.

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