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**THE PHYSICOCHEMICAL AND NUTRIENT CONDITIONS  
IN THE SEA AROUND SURIN ISLANDS, WESTERN PENINSULAR  
THAILAND**

by

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# THE PHYSICOCHEMICAL AND NUTRIENT CONDITIONS IN THE SEA AROUND SURIN ISLANDS, WESTERN PENINSULAR THAILAND

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## ABSTRACT

Physicochemical parameters of offshore and inshore waters were measured at Surin Islands, off the west coast of peninsular Thailand, during April 1976. Results showed that salinity, dissolved oxygen and temperature were relatively stable within the surface waters but were variable at lower depths, whereas the pH was relatively stable at all depths. Turbidity was very low.

Nutrient conditions were measured in the offshore and inshore waters, and also in a freshwater stream on an island. Results of these findings are discussed.

## I. INTRODUCTION

The present study was made during a joint expedition involving the Fisheries Department, Forestry Department, Applied Scientific Research Corporation of Thailand, universities and other governmental agencies, to Surin Islands, located off the west coast of peninsular Thailand in the Andaman Sea (97° 50' E, 9° 25' N), during April 1976 (Northeast Monsoon Period). The aims of the expedition were to collect basic ecological information about the islands with a view to establishing them as a protected area and a marine park, as the islands are still relatively undisturbed and the surrounding rich and diverse coral reefs relatively unexploited (Brockelman, 1977). It was noted, during the expedition that in some areas, particularly off the west coast, trawling activities were heavy and some parts of the coral reefs had been damaged by trawling and dynamite activities.

The aim of this study was to investigate the vertical variations of salinity, temperature, dissolved oxygen, turbidity, pH, inorganic nitrite, nitrate and phosphate in the offshore and inshore waters and to determine which nutrients were drained into the sea from the land by a freshwater stream on an island.

The results presented here represent a preliminary analysis of the physicochemical and nutrient conditions in the offshore and inshore waters about the islands and the nutrient conditions in a fresh water stream on an island. Very few investigations of this kind (Anonymous, 1965-67) have been made in this region of the Indo-West Pacific.

As shown by Weyl (1970), Hettler (1976) and Williams (1972) measurements of this kind are important factors in determining the growth-rate and diversity of organisms in the sea and thus are valuable as they provide some indication of the fertility of the sea water.

## II. DESCRIPTION OF THE STUDY AREA

Surin Islands are situated about 50 km. off the west coast of Takua Pa, Thailand, and consist of two main islands, namely Surin Nua and Surin Tai (see Fig. 1). These two islands cover an area of about 32 square kilometers and are mostly covered by primary forest. The largest bay is located on the southeast side of Surin Nua and fringed by a narrow belt of mangrove forest. About 2 km. offshore, the water depth drops from about 6 m. to more than 20 m. Descriptions of the sampling stations follow:-

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<sup>1</sup> Formerly Prawin WOOTISTIRAPHINYOE.

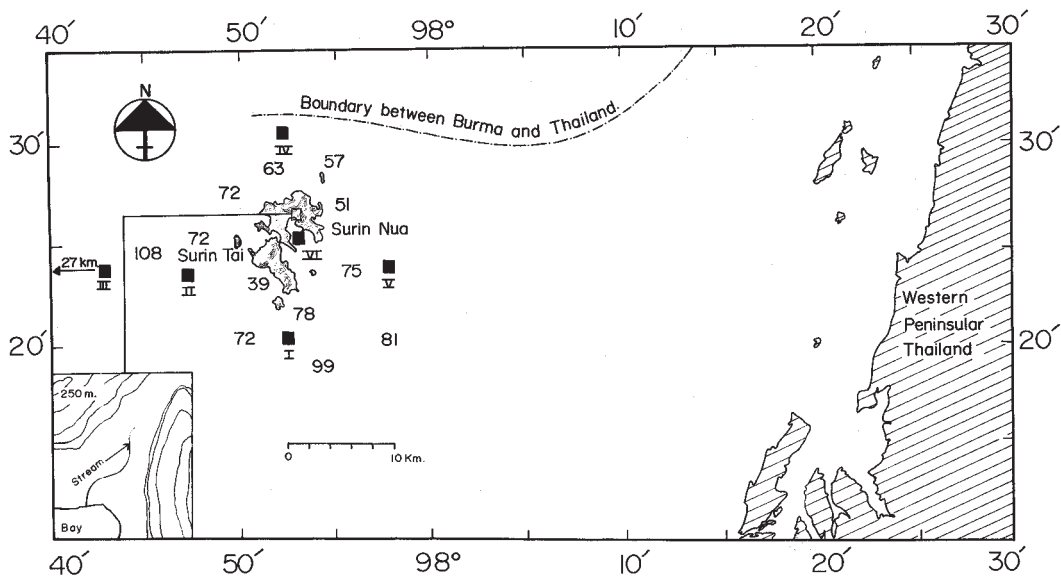


Fig. 1—The Surin Islands (Surin Nua and Surin Tai) in the Andaman Sea. The stream catchment area is enlarged in the lower left-hand corner of the Figure. ■ = Hydrographic stations; Numbers given = Water depth in meters.

#### OFFSHORE WATERS

Five sampling stations: Station I, 9 km. south; Stations II and III, 9 and 27 km. west respectively; Station IV, 9 km. north; Station V, 9 km. east (Fig. 1). Waters of Stations 1, 2, 4 and 5 reached a depth of about 60 m. and in Station 3 were about 90 m. in depth.

#### INSHORE WATERS

One sampling station, Station VI is located in the southeast bay of Surin Nua (2 km. from the land), with a water depth of about 30 m.

#### FRESHWATER STREAM

On Surin Nua, approximately 650 m. long, originating in a mountain area approximately 250 m. above sea level; its catchment area is in the southeastern part of Surin Nua (see Fig. 1). Three sampling stations are situated along the 100 m. from the stream mouth, where the tidal range was about 3 m. The stream in the area where measurements were taken was about 1 m. wide and about 5 cm. deep. The results from these 3 sampling stations are presented collectively.

### III. MATERIALS AND METHODS

#### a) FIELD TECHNIQUES

Water samples were collected from the surface and at varying depths down to the bottom. The number of sampling points and the depth of each is shown for stations 1 to 6 in Figs. 2a to 2f respectively.

Water samples were collected from each station by reversing water bottles for analysis of the chemical parameters: salinity, temperature, dissolved oxygen, turbidity, pH, inorganic nitrite, nitrate and phosphate. Temperature was read on a pressure protected thermometer with auxiliary thermometer.

The vertical cross section area of the fresh water stream was estimated from its width and depth at 3 sampling stations. The water flow speed (cm./sec.) of this stream was measured with a digital rotor type flowmeter (model 2030, General Oceanic Company, U.S.A.).

#### b) LABORATORY TECHNIQUES

Salinity was determined using a Goldberg T/C temperature compensated refractometer, model

10491, American Optical Corporation. Oxygen was determined using a Delta Scientific Oxygen Analyzer model 2110. Turbidity as Formazin Turbidity Units (FTU) and the pH were determined using the Hach DR-EL chemical kit with colour filter number 4445 and 4084 respectively. The inorganic nitrite, nitrate and phosphate as  $\mu\text{g-at/L}$  were analyzed according to Strickland and Parson (1972) by using the Hach colorimeter with green and red colour filters respectively.

#### IV. RESULTS

The vertical profiles for each physicochemical and nutrient measurement taken at the offshore (Stations 1–5) and inshore (Station 6) sampling areas are given in Figs. 2a to 2f respectively.

The temperature and dissolved oxygen in the surface waters were around  $29.5^{\circ}\text{C}$  (range  $29.2^{\circ}\text{C}$ – $29.7^{\circ}\text{C}$ ) and around 88% saturation (range 85%–92% saturation) respectively. At lower depths the temperature and dissolved oxygen decreased, reaching their lowest values around  $23.3^{\circ}\text{C}$  (range  $23.1^{\circ}\text{C}$ – $23.4^{\circ}\text{C}$ ) and around 45% saturation (range 40%–50% saturation) respectively, notably in the deeper waters (90 m.) of Station 3 (see Fig. 2c). The salinity in the surface waters was around  $32.0\text{‰}$  (range  $31.5\text{‰}$ – $32.5\text{‰}$ ). At lower depths, however, this value increased to around  $34\text{‰}$

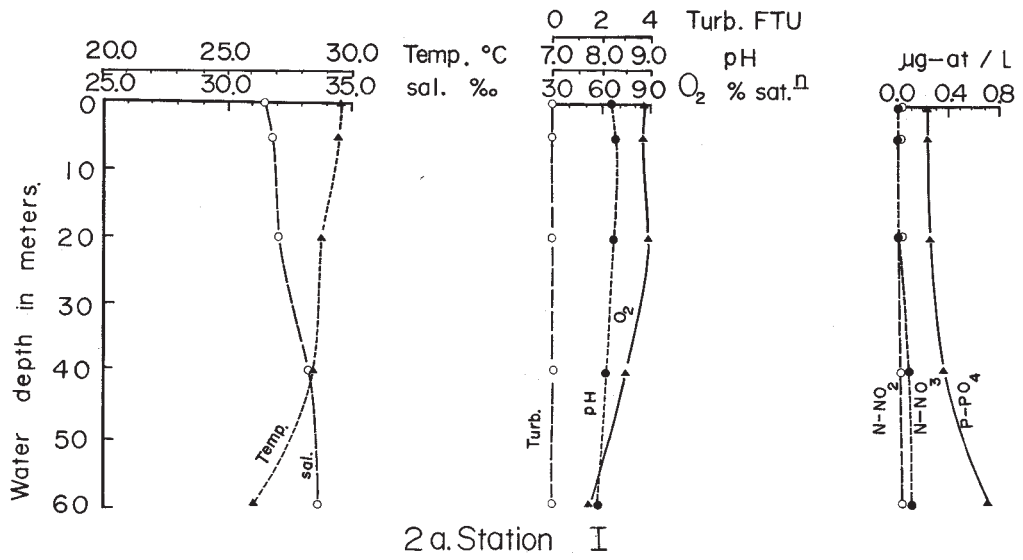
(range  $33.5\text{‰}$ – $35.0\text{‰}$ ). Thus, the results of the temperature and salinity measurements at both offshore and inshore stations showed that there was relatively little stratification in the water column investigated. It should be pointed out, however, that these variables were less marked at the inshore station (see Discussion).

At all stations, turbidity was generally low (around zero FTU). Although the pH was at all depths around 8, it was slightly higher in the surface waters (see Figs. 2a–2f). At the offshore stations (Figs. 2a–2e) the nutrient content i.e. phosphate, nitrate, nitrite was relatively low in the upper surface waters (0–40 m.) but increased at the lower depths. The concentration of nitrate and nitrite in these offshore waters was relatively lower than that of phosphate (Figs. 2a–2e), but at the inshore station, nutrient content was similar and found to be about the same at all depths (Fig. 2f).

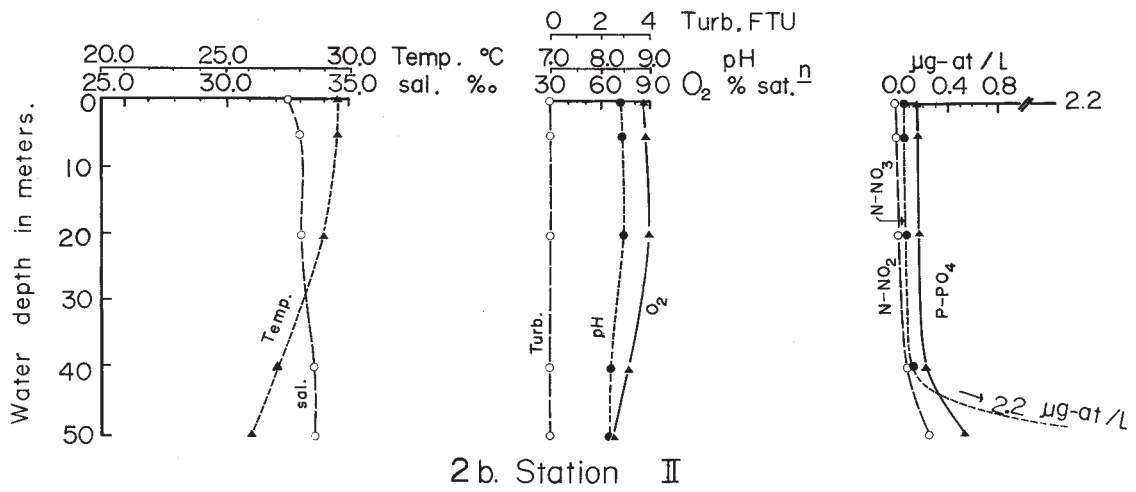
The results of the measurement taken in the freshwater stream are given in Table 1. The mean speed of the run-off flow into the bay was 37 cm./sec. (range 33 cm./sec.–41 cm./sec.). The mean inorganic nitrate content of the stream water was  $2.1 \mu\text{g-at N-NO}_3/\text{L}$  (range  $2.0$ – $2.2 \mu\text{g-at N-NO}_3/\text{L}$ ) and the phosphate content was  $0.7 \mu\text{g-at P-PO}_4/\text{L}$  (range  $0.6$ – $0.8 \mu\text{g-at P-PO}_4/\text{L}$ ). No nitrite was detected (see Discussion).

Table 1. The run-off flow from the freshwater stream on the southeast bay catchment area of Surin Nua and the amount of nutrients drained therefrom into the bay per day.

Average stream flow (cm./sec.)	=	$37 \pm 5$
Average stream cross section (cm. <sup>2</sup> )	=	265
Stream catchment area (km. <sup>2</sup> )	=	0.8
The nitrate content ( $\mu\text{g-at N-NO}_3/\text{L}$ )	=	$2.10 \pm 0.05$
The nitrite content ( $\mu\text{g-at N-NO}_2/\text{L}$ )	=	0.00
The phosphate content ( $\mu\text{g-at P-PO}_4/\text{L}$ )	=	$0.70 \pm 0.03$
Calculated nitrate (mg. $\text{NO}_3\text{-N}$ ) drained into the bay per day	=	$24 \pm 2$
Calculated phosphate (mg. $\text{PO}_4\text{-P}$ ) drained into the bay per day	=	$19 \pm 1$

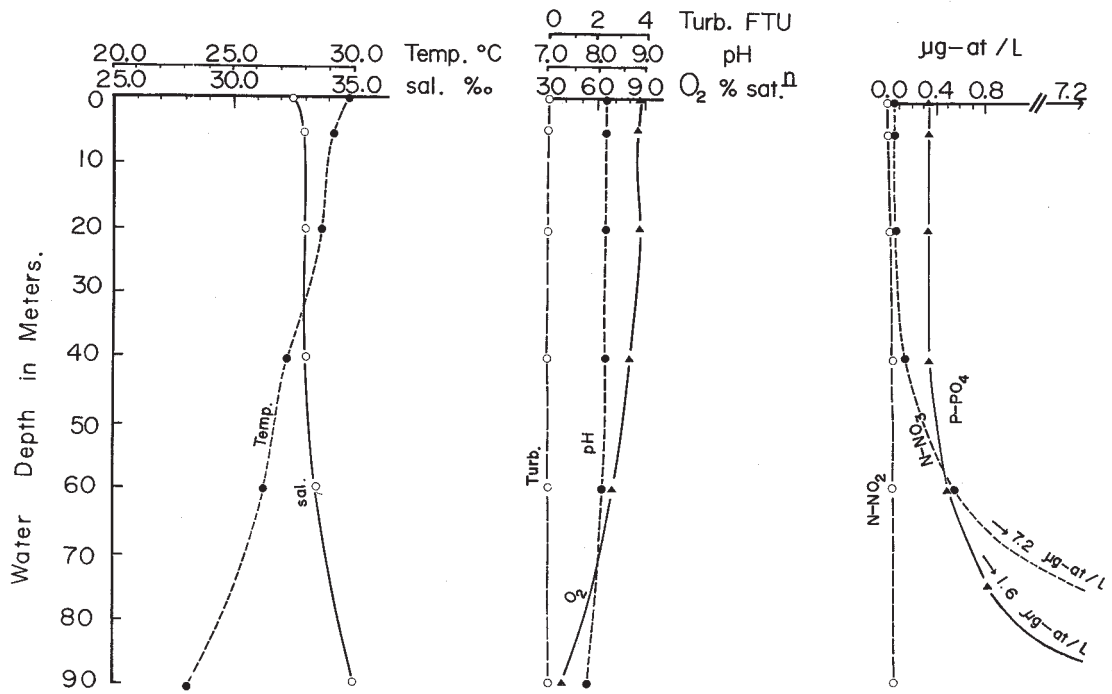


2a. Station I

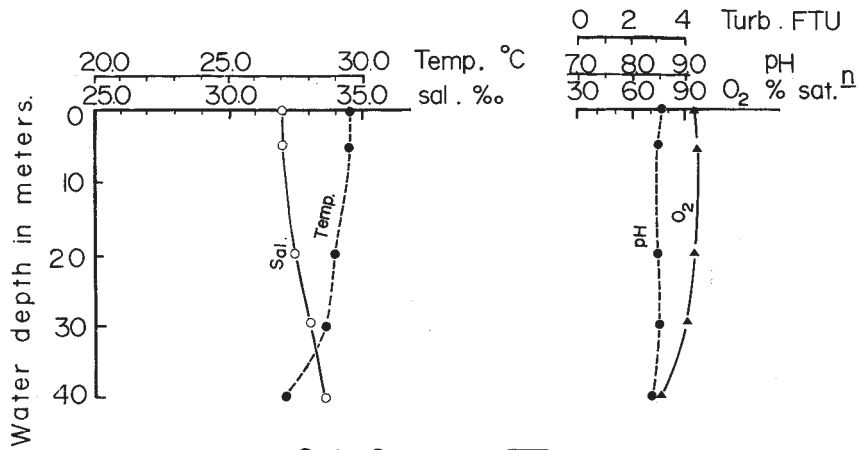


2b. Station II

Figs. 2a, b—The measurements of temperature (°C), salinity (‰), pH, turbidity (FTU), and dissolved O<sub>2</sub> (% saturation), N-NO<sub>2</sub>, N-NO<sub>3</sub> and P-PO<sub>4</sub> (µg-at/L) at Stations I and II around the Surin Islands.

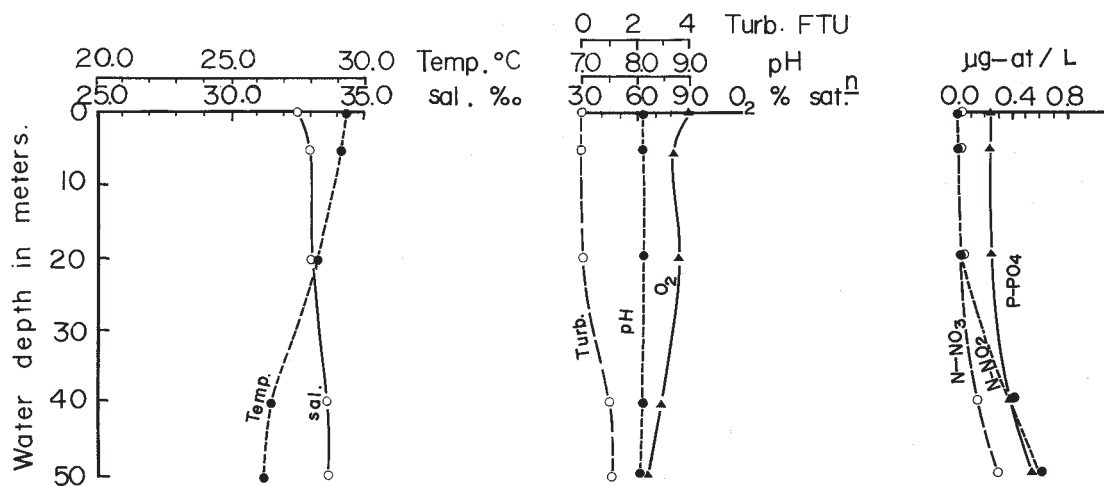


2c. Station III

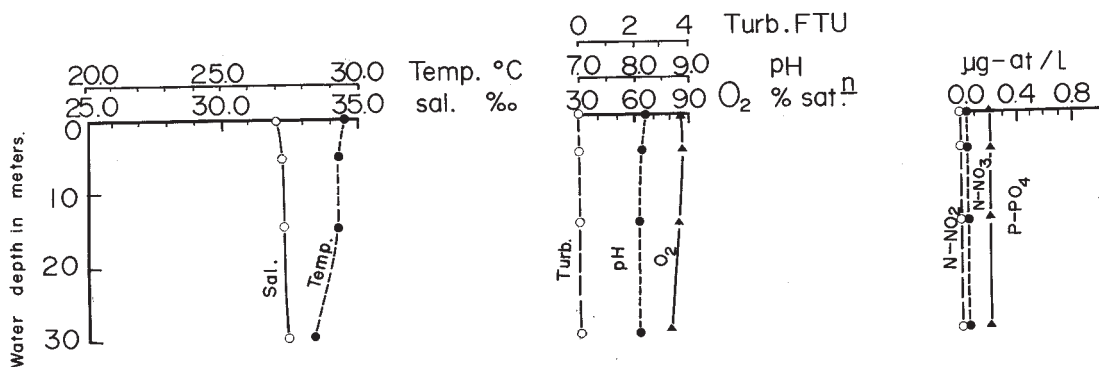


2d. Station IV

Figs. 2c, d—The measurements of temperature ( $^{\circ}\text{C}$ ), salinity ( $\text{‰}$ ), pH, turbidity (FTU), and dissolved  $\text{O}_2$  (% saturation),  $\text{N-NO}_2$ ,  $\text{N-NO}_3$  and  $\text{P-PO}_4$  ( $\mu\text{g-at/L}$ ) at Stations III and IV around the Surin Islands.



2 e. Station V



2 f. Station VI

Figs. 2e, f—The measurements of temperature (°C), salinity (‰), pH, turbidity (FTU), and dissolved O<sub>2</sub> (% saturation), N-NO<sub>2</sub>, N-NO<sub>3</sub> and P-PO<sub>4</sub> (µg-at/L) at Stations V and VI around the Surin Islands.

## V. DISCUSSION

The waters about Surin Islands come from the Indian Ocean Current which moves into the Andaman Sea in a clockwise manner during the Northeast Monsoon period (Neuman and Pierson, 1966). The results of the present study clearly indicated little stratification in temperature and salinity from the surface waters to the lowest depths in the offshore waters about these islands. Thus, these findings are interesting inasmuch as they indicate that the watermass is relatively stable (Neuman and Pierson, 1966).

Wium-Anderson (1977) found the primary production of the surface waters at Surin Islands to be notably high (0.90–1.45 mgC/m<sup>2</sup>/day). During the present investigation a notably greater saturation of oxygen, and lower concentration of nutrient i.e. nitrate and phosphate were found in the surface waters at offshore stations. In view of Wium-Anderson's (1977) findings, these results were apparently correlated to the intensive photosynthetic activities of the phytoplankton in these surface waters. Furthermore, the pH was slightly higher in the surface waters which is due to the release of CO<sub>2</sub> into the water by photosynthetic activities (Riley and Chester, 1971). Results of this investigation indicated a relatively lower concentration of nitrate than phosphate in the surface waters, suggesting a faster uptake of nitrate by phytoplankton. It is noteworthy in this respect that Thayer (1974) reported similar results in surface waters about organisms exhausting the available supply of nitrate faster than phosphate due to physiological requirements. It should be noted that the nitrite concentration was notably less than that of nitrate in the surface waters due to its chemical and biological oxidation to nitrate (Riley and Chester, 1971).

The concentration of nutrients, including nitrite, in the bottom offshore waters was much higher than that at the surface, as would be expected in view of the fact that nutrients accumulate at the deeper levels and are regenerated there (Tait, 1972). Moreover, it is noteworthy that the nitrate/phosphate ratio at the 90 m. depth (see

Fig. 2a) was relatively close to 7/1 respectively, as is characteristic of most deep oceanic waters (Tait, 1972).

An upwelling is known to occur in the eastern part of the Andaman Sea (Wyrski, 1973). No turbidity was found in the surface waters during this study, but some turbidity was apparent at lower depths, thus suggesting some upwelling in these deeper waters. Such an upwelling undoubtedly ensures a continuous recycling of nutrients from the deeper depths to the surface waters (Tait, 1972). Thus, a rich, continuous supply of nutrients, as a result of the upwelling, would be available to the phytoplankton in the surface waters, and promote a high rate of primary production (Krey, 1973).

The southeast bay of Surin Nua is relatively shallow with a maximum depth of 30 m. The physicochemical conditions were relatively constant in this area, presumably due to the tidal activities. The primary production of these inshore waters was relatively high (Wium-Andersen, 1977), and therefore, the oxygen saturation and nutrient content, as shown by the results of the present study, correspondingly high and low respectively. While some nutrients are undoubtedly recycled within the shallow waters of this bay, some of these nutrients come from the land as an analysis of the stream water showed it contained a relatively high amount of nitrate and phosphate (24 mg. NO<sub>3</sub>-N/day and 19 mg. PO<sub>4</sub>-P/day). Moreover, some nutrients probably come from the fringing mangrove forest which lined this bay.

The presence of a rich source of nutrients in the waters about Surin Islands, and the correspondingly high photosynthetic activities found there (Wium-Andersen, 1977), possibly accounts for and/or supports the rich and diverse coral fauna of the Surin Islands.

## VI. CONCLUSION

The results of the present study show:—

1. A notably greater saturation of oxygen and



lower concentration of nutrients were found in the surface waters due to intensive photosynthetic activities found there, whereas the opposite was found in the bottom waters.

2. The physicochemical conditions were stable

at both offshore and inshore waters indicating very little stratification of the watermass.

3. The freshwater stream provided a considerable amount per day of nutrients from land (south-east bay catchment area) into the inshore waters.

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