Jurnal Pen. Perikanan Laut No. 51 Th. 1989 Hal. 79–100.

STUDY ON THE BIG PURSE SEINERS FISHERY IN THE JAVA SEA

VII. Environment of the Java Sea. *
(Lingkungan Perairan Laut Jawa)

*M. Portier **, T. Boely. **, and Subhat Nurhakim ****

RESUME

Les phénomènes hydroliques sont essentiels dans la répartition des espèces pélagiques et leur abondance en certains secteurs. L'hydrologie de la mer de Java est mal connue, car nous ne possédons pas de données recouvrant plusieurs cycles annuels. La synthèse des travaux réalisés depuis 1910 nous permet d'affirmer que malgré son caractère relativement fermé la mer de Java est le siège d'importants mouvements d'eaux, dépendants du régime des moussons, qui modifient profondément son hydrologie. Les fluctuations de salinité sont élevées alors que celles de la température sont faibles. La richesse en sels nutritifs y semble moyenne.

ABSTRACT : Oceanographic phenomena are essential determining factors in the distribution of pelagic species and their abundance in certain sectors. The hydrology of the Java Sea is not well known, for no data covering several annual cycles ia available. A review of the studies made since 1910 has proved that, despite virtually a closed sea, the Java Sea is a centre of important water movements depending on the monsoon regime which has a great effect on its hydrological system. Salinity rates fluctuate considerably, whereas thos of temperatures very little. There is an average abudance of nutrient salts.

ABSTRAK : Fenomena Oseanografi merupakan faktor esensial untuk mengetahui distribusi dan kelimpahan jenis-jenis ikan pelagis. Keadaan hidrologi Laut Jawa masih belum banyak diketahui karena kurangnya sumber data pendukung tahunan yang teratur yang dapat digunakan. Telaah dari studi lingkungan sudah ada mulai dari tahun 1910-an walaupun masih serba terbatas. Laut Jawa termasuk perairan penting karena gerakkan airnya tergantung dari keadaan musim (monsoon) yang dampaknya berpengaruh pada sistem hidrologinya. Fluktuasi kadar garamnya berbeda nyata, sedangkan perbedaan suhu perairan di sepanjang tahun tidak begitu menyolok.

INTRODUCTION

Coastal pelagic species are particularly sensitive to seasonal changes in the marine environment (hydroclimate). These changes can explain the migratory movements of the fish and the location of the zones where they concentrate.

Data available on the hydroclimate of the Java Sea are very fragmental and none cover several annual cycles, excepting in a few restributed areas such as the Seribu Isladns. The results observed here cannot however be extended to the whole of the Java Sea are. Very few ocenographic surveys have been carried out there, but those undertaken by the Dutch in 1916 and 1918 (VAN VEEL,

---

*) This note is part of a series of papers analysing in greater detail the global problem of "big" purse seiners fishing in the Central Java Province, and is based on all the fundamental data available since 1976 on the activity of the ships based there.

** ORSTOM. 213, rue La Fayette–75480 Paris cedex 10, FRANCE
*** BPPL. 12, Jalan Krapu – Jakarta Utara, INDONESIA.

1923), by the R/V CHAIN I (EMERY and *al.*, 1972), by MUTIARA IV (LOSSE and DWI-PONGGO, 1976) and R/V CORIOLIS (BOELY and *al.*, 1985) must be mentioned. Attempts at a systematic overall study of the hydrology of the Java Sea (particularly salinity) per 1°*1° squares, were carried out, based on data obtained by merchant ships (VEEN, 1951 and 1953).

After briefly recalling the physical and climatic features of the Java Sea, this paper attempts to review all the studies made so far and present the main resutls obtained.

THE ENVIRONMENT

1. Physical Features

The Java Sea, with a surface of 467.000 km^2, is the southeastern part of the great Sunda shelf which stretches from the Gulf of Thailand to southeast of Kalimantan. It is a relatively closed sea connected by the straits of Karimata to the China Sea, and to the Indian Ocean via the Sunda and Bali straits. Eastwards, it opens wide into the Flores Sea and through the straits of Makassar to the Celebes Sea (Fig. 1). Its mean depth is 40 metres with a maximum 90 metres north of Madura Island. In fact it is a vast submerged plain, which emerged several times during the Pleistocene (EMERY and *al.*, 1972), linking Sumatra and Java to Kalimantan. It presents a slope slightly inclined towards east (1/2 minute gradient).

According to EMERY 1972, 80% of the bottom is covered with a thick layer of dense mud (Fig. 2). During the PECHINDON campaign (BOELY and *al.*, 1988), large muddy beds mixed with shell and coral debris were detected in the central part and south of Kalimantan. Near the coast, rocky outcrops associated with coral formations are observed.

2. Climatology.

The prevailing climate in the Java Sea is a typical monsoon climate marked by a complete reversal of the wind regime. This phenomenon is caused by differences in temperature between the continental and oceanic areas. The rainy monsoon occurs between mid December and March and is characterised by very windy periods with frequent rainfall lasting for days. The dry monsoon occurs from June to September and is more regular. The climate varies considerably throughout this zone.

a. Winds

These are the essential feature of the climate. From November to February they blow from the northwest with a mean intensity of 3 Beaufort. From May to September they blow in a south to southeast direction and are more regular, their force sometimes exceeding 4 Beaufort. During the transitional months they are light and very changeable (Fig. 3 and 4) and land-breezes can then upset the general pattern.

b. Rainfall at sea

Rainfall at sea follows a very marked seasonal rhythm (Fig. 5). The rainy season lasts from December to March with a maximum in January to February. The dry season takes place from July to October with a pronounced minimum in September, sometimes less than 50 mm. There is a clearly marked west to east gradient (WYRTKI, 1955), the most abundant rainfall being observed off the coasts of Sumatra and Kalimantan. The mean annual rate is 1880 mm. The relative humidity decreases from February to November. Due to the heavy rainfall during the first two months of the year, it decreases during the transitional months, becoming light when the southeast monsoon sets in.

c. Tempreature of the air.

The intensity of the monsoon is indicated by the monthly means. In general, the temperature is lower when the monsoon is more regular and lasts longer. During the northwest monsoon this particularly is accompagnied by increased rainfall. The mean monthly temperature is 27°C and the daily amplitude is much higher in the transitional months. Maximums are recorded between 12h and 16h, except during the northwest monsoon when the extent of the cloud layer and the abundance of the rain provoke many daily variations in temperature. Following a semi-annual rhythm, maximums are reached in the intermonsoon periods., whereas the minimums correspond to the monsoon periods (Fig. 6).

HYDROLOGY OF THE JAVA SEA

The hydroclimate of the Java Sea is dominated by the monsoon regime. It is characterised in particular by the rapid and complete reversal of the current regime (WYRTKI, 1957; DUING, 1970).

1. Currents

The system of currents depends entirely on the winds except along the coasts of Sumatra and Java where local geographic phenomena can alter the patterns. During the southeast monsoon (June to September) the currents flow westwards (Fig. 7a). They generally move at a slow speed around 0.5 knots in the whole of this zone, reaching 1 knot at the level of Belitung Island. During the northwest monsoon (December to March) the patterns reverses completely, the currents then bearing eastwards (Fig. 7b). They are generally much stronger than during the southeast monsoon (1–2 knots). The intermonsoon periods (April to May and October to November) have exactly the same structure with a residual westward current along the coasts of Kalimantan, the rest of the Java sea being occupied by current usually flowing eastwards (Fig. 7c and 7d). These are slight variable currents. At this time of the year the sea and land breezes have the greaetest impact.

These movement affect the whole volume of water; at 40 m the directions of the currents resemble those found at the surface with an identical maximum speed. The tidal currents have little effect except near the coasts and at the river mouths where tidal waves may occur.

2. Water masses

According to the season, four types of water masses are clearly detectable (WHYTKI, 1956):

- oceanic waters with a salinities over 34‰ occupying 20% of the area;
- mixed waters with a salinities between 32‰ and 24‰ representing approximately 60% of the region;
- coastal waters with salinities less than 32‰ extending over 15 to 20% of the zone;
- river waters with a low very salinity less than 30‰ covering no more than 3% of the area.

At the start of the southeast monsoon (May-June) the oceanic masses of the Indian Ocean penetrate the Indonesian archipelago through the Flores Sea and those of the Pacific via the Celebes Sea. They rejoin at the level of the Makkasar straits in August. This water mass continues to progress westwards in the Java Sea where it reaches a maximal expansion in September-October (Fig. 8a) at the end of the southeast monsoon. During the rainy season, the waters flow back and are found at a great distance from the Java sea in April-May. In certain years these water masses do not enter the Java Sea at all.

The coastal waters govern the regime of the western part of the Java Sea. These waters come from the Malacca straits and the river mouths of the west and south coasts of Kalimantan. At the beginning of the rainy season, these coastal waters borne by the general circulation of the currents arrive in the Java Sea from the China Sea and advance eastwards in February-April. At the end of the rainy season they cover the whole of the Java Sea and the Makassar straits. In the course of the dry season they flow back to reach their maximum retreat in September-October (Fig. 8b et 8c).

The mixed waters present throughout the year occupy different sectors depending on the season. From January to April, following behind the coastal waters from the China Sea, they enter the Java Sea, occupying the western part. With the onset of the southeast monsoon, under the pressure of the oceanic waters, they invade the eastern part and by October they cover practically the whole of the Java Sea.

The river waters are locally significant. Arriving from Kalimantan (Fig. 8d), the 30‰ isohaline can be found more than 100 milles from the coasts. The maximum advance of this isohaline varies according to the rainfall in the catchment basins of each river and is generally reached a month after the end of the rainy season. The most inportant hydrographic basins are those of the Barito, Mendawai and Mentubar rivers. In Java Island where the hydrographic system is much less developed, these rivers waters are very localised.

3. Temperatures

The annual fluctuations of the surface temperature are relatively slight and the Java Sea has a great thermal stability. The annual mean is 28°C with a gradient situated between 2 and 3°C (Fig. 6). Usually during the northwest monsoon the highest temperatures are found in the east (VAN VEEL, 1923) and the lowest in the west along the coasts of Sumatra (influence of rainfall). During the southeast monsoon this gradient is reversed and the highest temperatures are then found in the west. The minimums are observed in June-August and December-January (27°C), the maximums being recorded in April, May and November (30°C) in the intermonsoon periods. The water mass itself is very homogeneous with slight thermal gradients from 1°C, recorded in May 1985 during the PECHINDON survey, to 0.4°C during MUTIARA IV campaigns (LOSSE and DWIPONGGO, 1977) in July-September. The horizontal temperature stratification is not always respected but no reverse phenomenon is observed. In the extreme eastern part of the region where the depth exceeds 90 metres a slight thermocline appears between 30 and 70 metres at certains periods of the year (June-July). A study of the data provided by the Gosscompt charts, covering a period from June 1981 to December 1984 confirms these results. The data regrouped per 1°15 * 1°15 squares show a remarkable homogeneity in latitude and longitude (Fig. 9).

4. Salinities.

This is one of the main factors determining the distribution of fish species in the Java Sea. The distribution of isohalines reflects the movement of the water masses exactly (annex I). They are generally characterised by a low salinity and present an importan annual fluctuation due to the considerable amount of water brought down by the rivers, to differences between evaporation and rainfall and to changes in the current system.

This factor varies considerably from one year to the next, causing great variations in the annual mean of the surface salinity. The minimum salinity is found from January to June (mean 31.8‰) and the maximum in September (34‰) (Fig. 10). In the western part of the Java Sea where the effect of runoffs from the rivers is important, salinity varies between 30 and 32‰. Large surfaces with salinities below 30‰ can be found at the river mouths along the coasts of Sumatra and Kalimantan (Fig. 11). At depth, few changes are recorded in the first 40 metres, below wich salinity increases with depth. In the coastal regions under the influence of outflows from the rivers and rainfall the water stratifies and a marked positive gradient forms which, although localised, can be considerable (BOELY and *al.*, 1988).

5. Other characteristics.

The only data available were provided by the campaign undertaken by the R/V CORIOLIS in May 1985. At this time, the oxygen rate in the centre of the Java Sea was fairly high 4.2 ml/1 at the surface, with maximum values found at a depth of 20 metres. There is no oxycline.

At the surface, the chlorophyll a level is low except in two sectors, the first to north towards Kalimantan, the other close to the Karimunjava Islands. At depth, values higher than 0.5 μatg/1 are noted at the 30 m isobath or towards the shore. They can exceed 1.0μatg/1 near the bottom. The coastal enrichments are associated with the outflow of terrigenous deposits, whereas concentrations recorded near the bottom are due to the remineralization of organic matter. In May 1985, the zone prospected proved poor in nutrients salts. In the northwest (111°E) values of NO_3 and NO_2 rise somewhat near the bottom (0.9μatg/1). Likewise the phosphate values are higher near the bottom (0.7μatg/1).

CONCLUSION

The lack of data covering several annual cycles prevents us from obtaining an overall view of the hydrological phenomena occurring in the Java Sea. The setting up of regular surveys in this region and the analysis of satellite data available and of SHIP messages will further improve our understanding of this system.

The hydrological conditions prevalent in this region depend on the monsoon regime, wind and rainfall being the determining factors. Influenced by the winds the currents move eastwards during the northwest monsoon and the unsalted water masses flowing from the great rivers of Sumatra and Kalimantan invade the whole of the Java Sea; with the southeast monsoon the direction of the currents reverse and the oceanic water masses from the Indian and Pacific Oceans enter in their turn. Despite the Java Sea being virtually closed, its waters undergo great renewal.

This movement of the waters, together with the resulting consequences (fluction of salinity) is the determining factor in the distribution of species. This temperature remains homogeneous throughout the year.

The Java Sea seems to be fairly rich in ressources. The great terrigenous deposits occuring at certain times of the year can however add to these riches on a local scale. The primary production would be relatively important (phytoplankton 250–500 mgC/M^2/d, zooplancton 200–500 mg/m^3) (DOTY and *al.*, 1963).

BIBLIOGRAPHIE

Anonymous, 1968. Underwater handbook, South China Seas. The Hydrographer of the Navy. London.

Berlage (H.P.) 1927. Monsoon currents in the Java Sea and its entrances. Konin. Magnet. Met. Observat. te Batavia Verhandelengen 19:1 – 28.

Berlage (H.P.). 1949. Regensval in Indonesie (Rainfall in Indonesia). Konik. Magnetisch. en Meteor. Observatorium te Batavia. Verdl. 37.

Boely (T.), Potier (M.), Subhat Nurhakim, Suherman Banon, Suwarso and Tuti Hariati. 1987. Compilation of the data on the big purse seiners fishery in the Java Sea. 1976—1985. Mar. Res. Fish. Inst. 114p.

Boely (T.), Potier (M.) and Subhat Nurhakim. 1987. Study on the big purse seiners fishery in the Java Sea. I. The main pelagic species caught. Mar. Res. Fish. Inst., 11p.

Boely (T.). Martin Linting, Petit (D.), Potier (M.), Subhat Nurhakim and Sujianto. 1988. Estimation of the abundance of pelagic fish in the central part of the Java Sea (Indonesia). Etudes et Theses. ORSTOM. In press.

Boely (T.), Potier (M.) and Subhat Nurhakim. 1988. Study on the big purse seiners fishery in the Java Sea. VI. Sampling procedure. In prep.

Doty (M.S.), Soeriaatmadja (R.E.) and Soegiarto (A.). 1963. Observations on the primary marine productivity of Northwestern Indonesian waters. Mar. Res. in Indonesia. Vol. 5:1—25.

Duing (W.). 1970. The monsoon regime of current in the Indian Ocean. Honolulu East — West Center Press. 68p.

Emery (K.O.), Uchupi (E.), Sunderland (J.), Uktolseja (H.L.) and Young (E.M.). 1972. Geological structure and some water characteristics of the Java Sea and adjacent continental shelf. United Nations ECAFE, CCOP Tech. Bull. Vol. 6:197—223.

Groves (G.W.) and Niemeyer (G.). 1975. A numerical simulation of wind driven water circulation on the Sunda shelf. Mar. Res. in Indonesia. Vol. 14:31—47.

Hardenberg (J.D.F.) and Soeriatmadja (R.E.). 1955. Monthly mean salinities in the Indonesian Archipelago and adjacent water for the months March 1950—February 1953. Org. Sci. Res. Indonesia, Bull. 21:1 — 68.

Ilahude (A.G.). 1978. On the factors affecting the productivity of the southern Makassar strait. Mar. Res. Indonesia. 21:81 — 107.

Ilahude (A.G.). 1979. On the hydrology to the Natuna Sea. (Southern China Sea). The Kuroshio IV. Proc. Yth. CSK symposium, Tokyo: 332—352.

Potier (M.), Boely (T.), Subhat Nurhakim and Suherman Banon. 1987. Study on the big purse seiners fishery in the Java Se. II. Evolution and structure of the Javanese purse seiners fleet. Mar. Res. Fish. Inst. 16p.

Potier (M.), Boely (T.), Subhat Nurhakim and Suherman Banon. 1988. Study on the big purse seiners fishery in the Java Sea. IV. The Catches. Mar. Res. Fish. Inst. In press.

Potier (M.), Boely (T.) and Subhat Nurhakim. 1988. Study on the big purse seiners fishery in the Java Sea. V. Estimation of the effort. Mar. Res. Fish. Inst. In press.

Sjarif (S.), 1959. Seasonal fluctuation in the surface salinity of the southern part of Kalimantan (Borneo). Mar. res. in Indonesia. Vol. 4:1—25.

Soeriatmdja (R.E.) 1956. Seasonal fluctuation in the surface salinity off the north coast of Java. Marine Reasearch in Indonesia. Vol. 1:1 — 19.

Suhbat Nurhakim, Potier (M.) and Boely (T.). 1988. Study on the big purse seiners fishery in the Java Sea. III. The Fishing method. Mar. Res. Fish. Inst. In press.

Van Veel (K.M.). 1923. Meteorological and hydrographical observations made in the western part of the Netherlands East Indian Archipelago. Treubia 4, Mai 1923:1 — 559.

Veen (P.CH). 1951. Surface salinities in the Indonesian archipelago and adjacent waters. Organiz. Sci. Res. Indonesia. Publ. 33.

Veen (P.CH). 1953. Preliminary charts of the mean salinity of the Indonesian archipelago and adjacent waters. Organiz. Sci. Res. Indonesia. Bull. 17.

Wyrtki (K.). 1955. Surface salinities in Indonesian and surrounding waters January 1955—September 1955. Lembaga Penyelidikan Laut di Indonesia.

Wyrtki (K.), 1956. Monthly charts of surface salinity in Indonesian and adjacent waters. J. Cons. CIEM 21 (3):268–279.

Wyrtki (K.). 1956. The rainfall over the Indonesian waters. Lemb. Meteorologi dan Geofisika. Verhandl. 49:1 – 24.

Wyrtki (K.). 1957. Precipitation, evaporation and energy exchange at the surface of southeast Asian waters. Mar. Res. Indonesia 3:7 – 40.

Wyrtki (K.). 1957. Die zirkulation an der oberflache der sudostasiatischen gewasser. Deut; Hydrof. Zeitschrift, 10 (1)

Wyrtki (K.) 1961. Physical ocenography of the South – East Asian waters. Naga Report. Scripp. Inst. Oceanogr. Univ. Calif. Vol. 2:1 – 195.

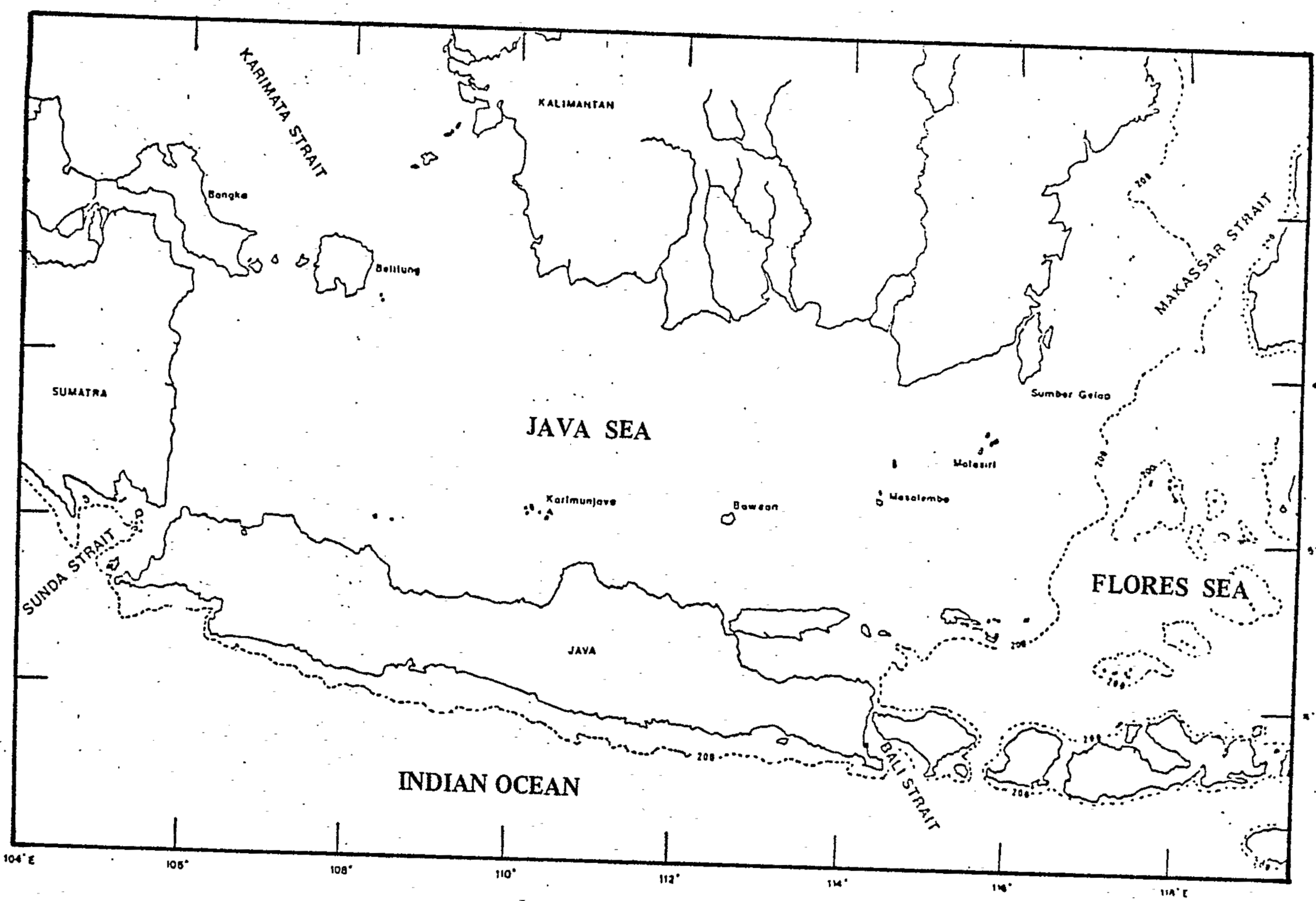


Fig. 1 – Situation géographique de la mer de Java.
– Location chart of of the Java Sea.
Gambar 1. – Peta Lokasi Laut Jawa.

Jurnal Pen. Perikanan Laut No. 51 Th. 1989 Hal. 79–100.

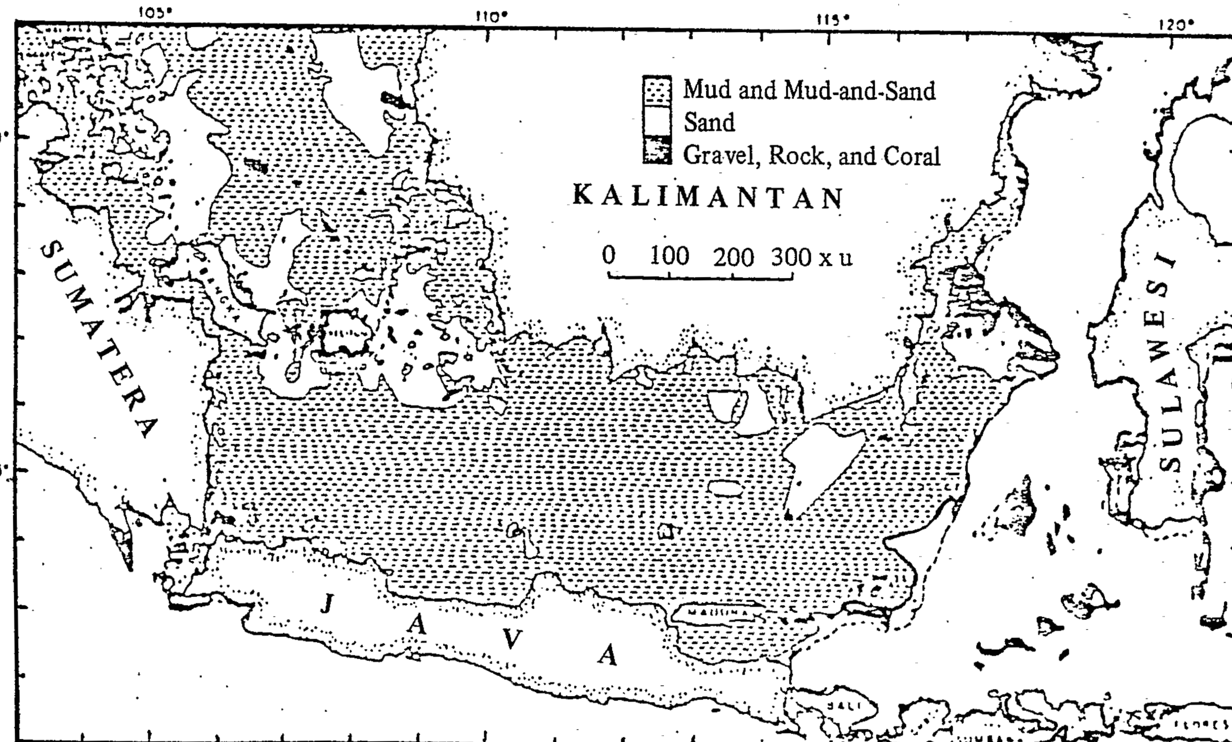


Fig. 2. – Carte sédimentaire de la mer de Java (D'apres Emery et al., 1972).
– Sediment chart of the Java Sea (from Emery and al. 1972).

Gambar 2. – Peta sedimen (keadaan dasar) Laut Jawa (Emery and al. 1972)

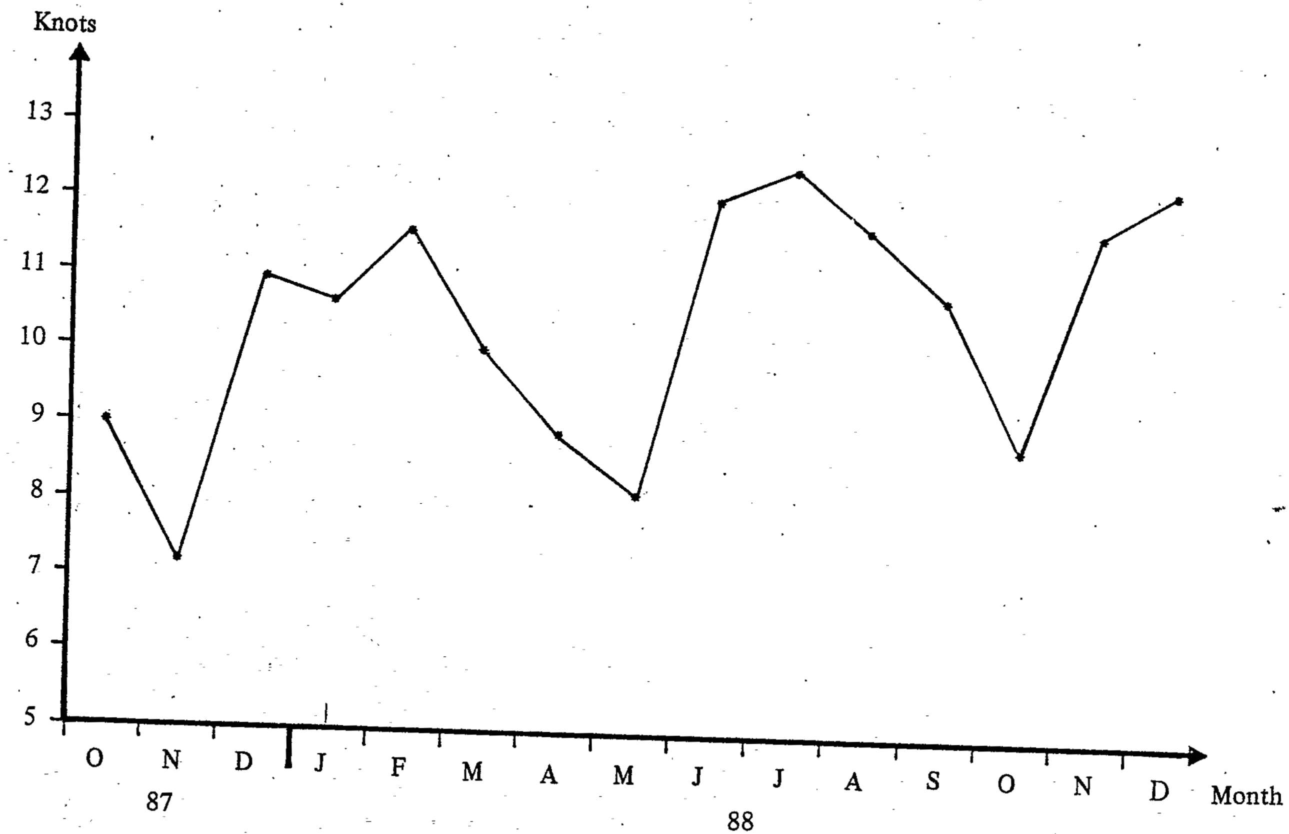


Fig. 3. – Intensité moyenne des vents en mer de Java d'octobre 1987 à décembre 1988 (Données SHIP).
– Mean velocity of the winds in the Java Sea from October 1987 to December 1988 (SHIP data).
Gambar 3. – Rata-rata kecepatan angin di Laut Jawa dari Oktober 1987–Desember 1988 (data kapal)

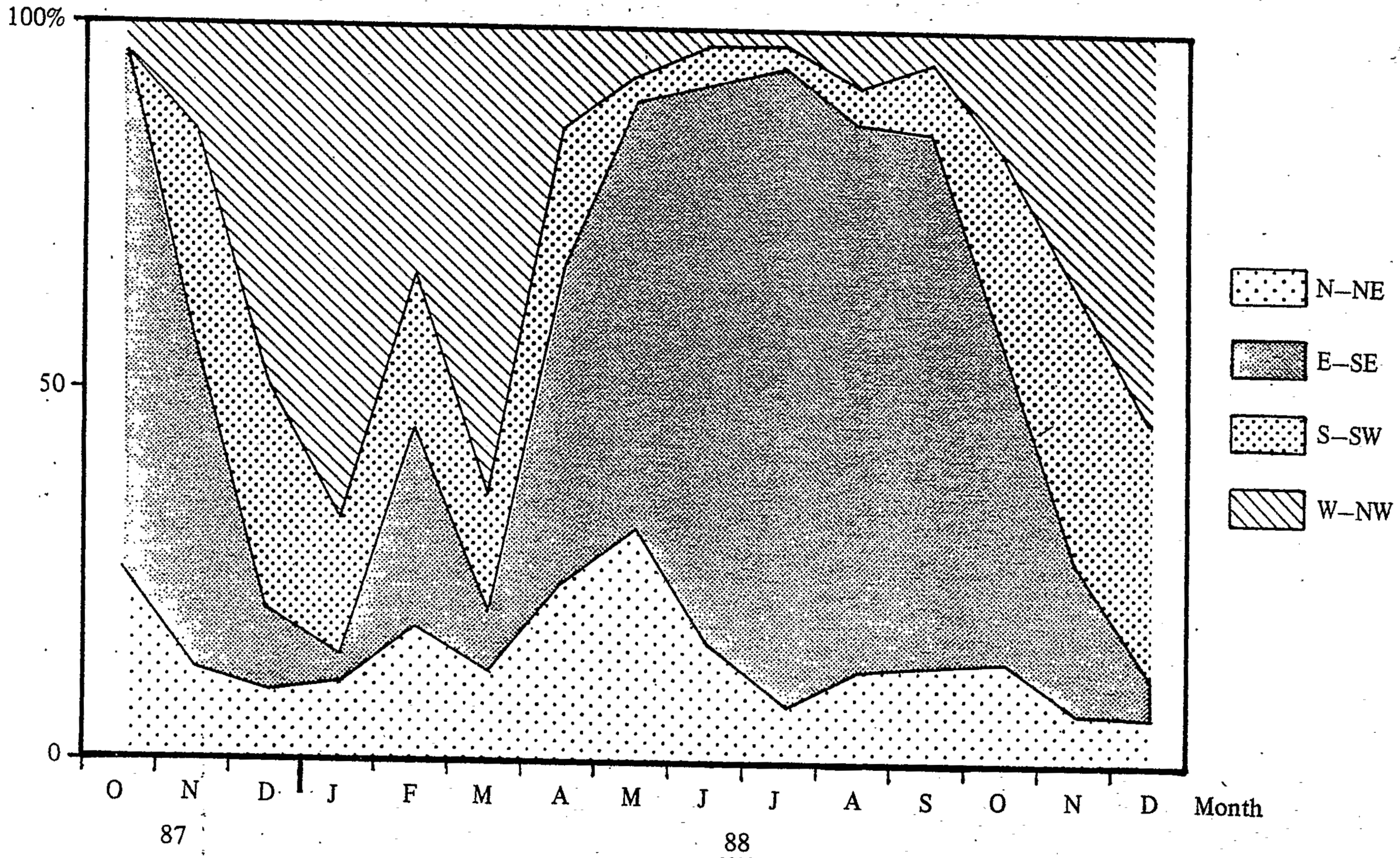


Fig. 4. – Répartition mensuelle de la direction des vents an mer de Java d'octobre 1987 à décembre 1988 (Donnees SHIP).
– Monthly distribution of the winds direction in the Java Sea from October 1987 to December 1988 (SHIP data).

Gambar 4. – Distribusi bulanan arah angin di Laut Jawa dari Oktober 1987–Desember 1988 (data kapal).

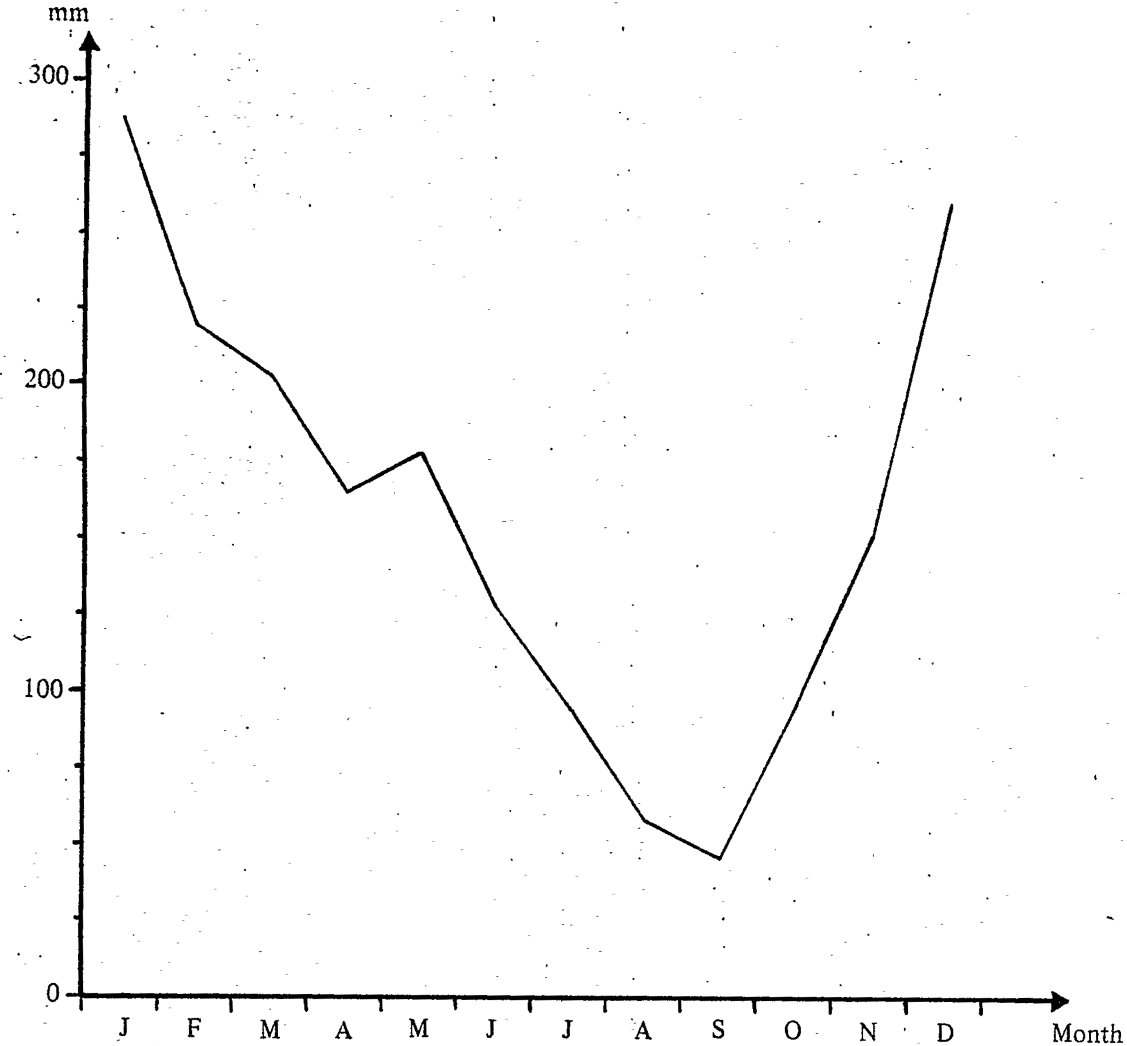


Fig. 5 – Pluviométrie moyenne mensuelle en mer de Java (D'après Wyrtki, 1956).
– Monthly mean rainfall in the Javaya Sea (from Wyrtki, 1956).

Gambar 5. – Rata-rata curah hujan bulanan di Laut Jawa (Wyrtki, 1956).

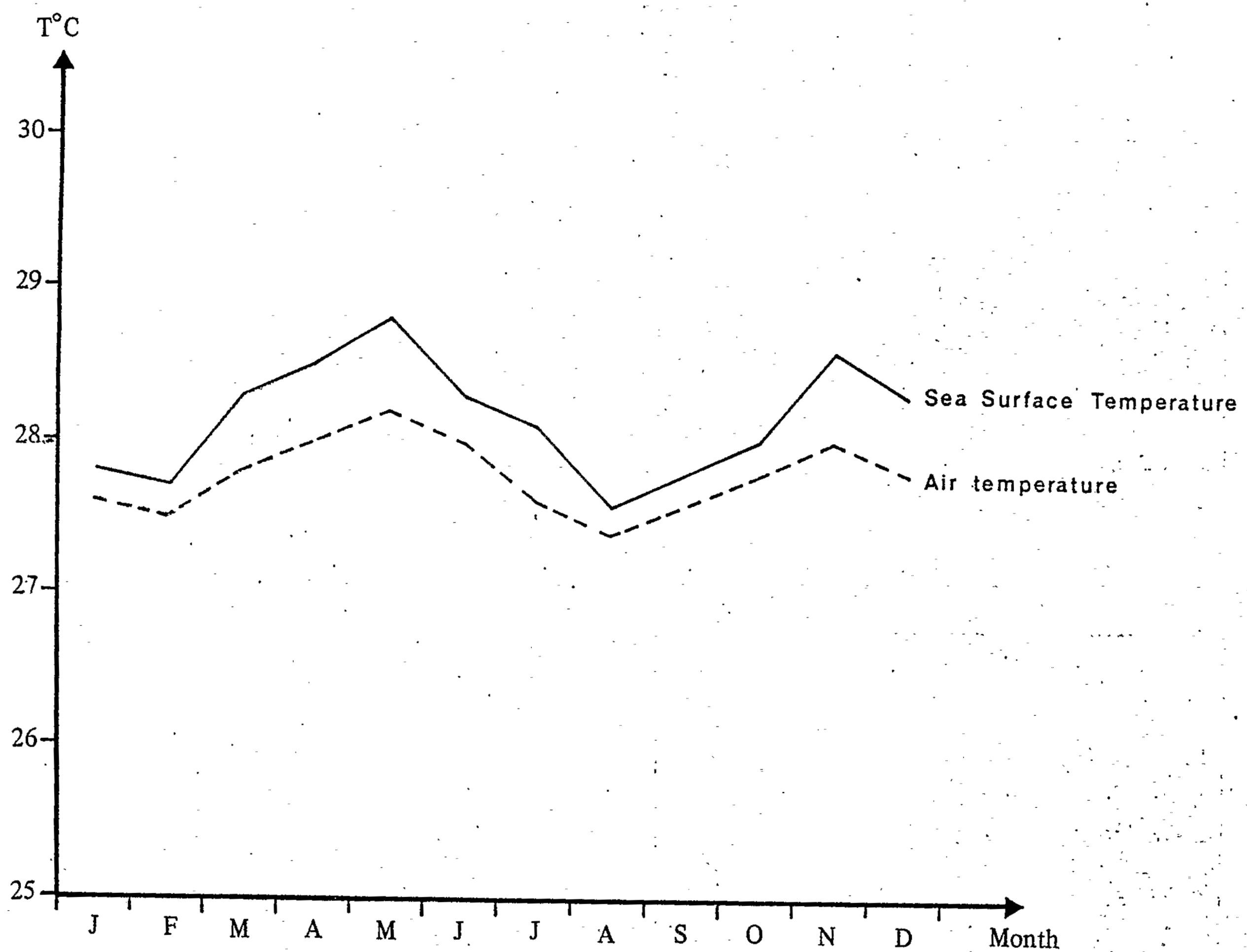
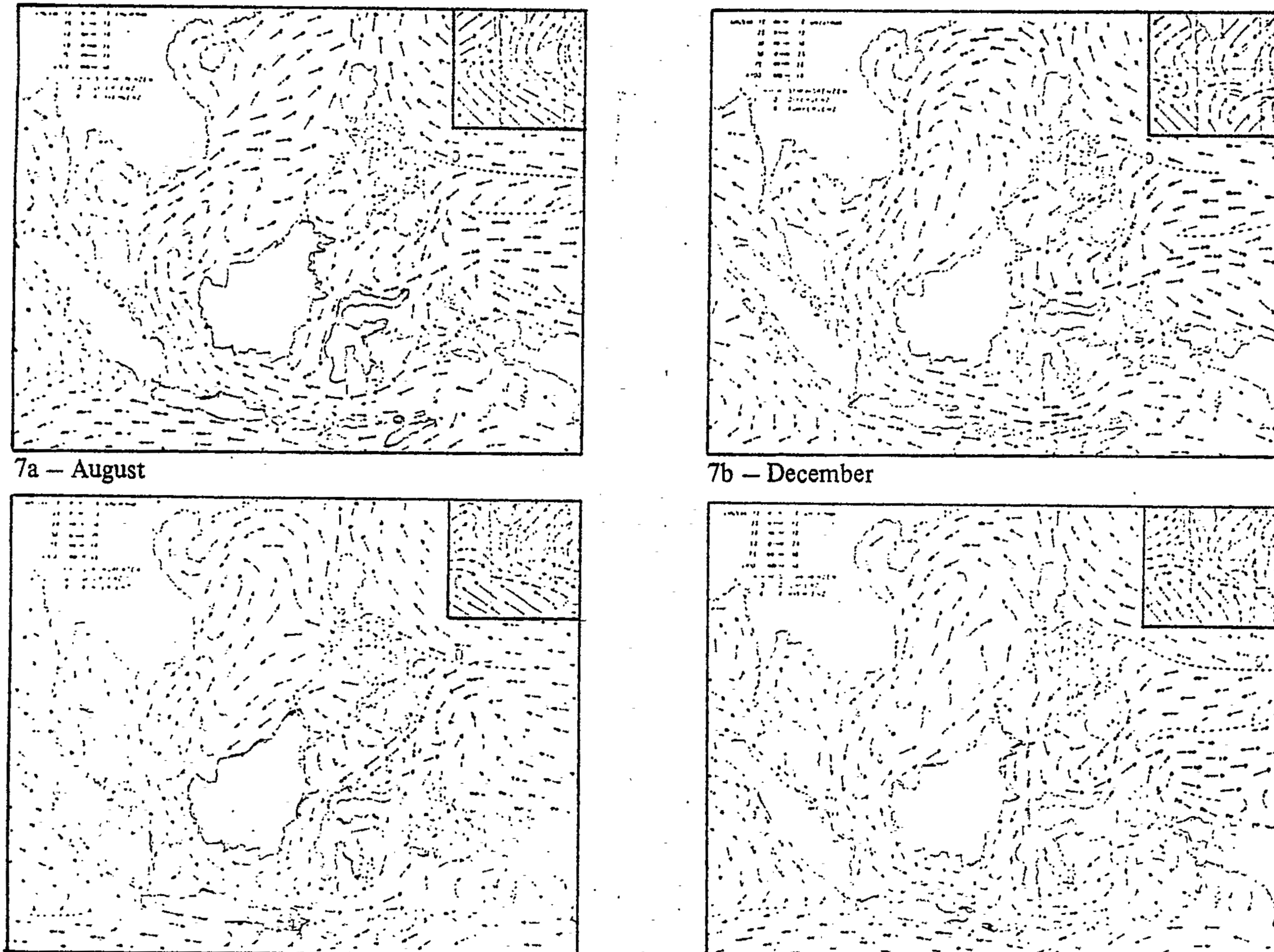


Fig. 6. – Températures moyennes mensualles de l'air et de la mer en mer de Java (Données SHIP et d'après Wyrtki, 1956).
– Monthly mean air and sea surface temperatures in the Java Sea (SHIP data and from Wyrtki, 1956).

Gambar 6. – Rata-rata bulanan suhu permukaan air dan udara Laut Jawa (data kapal. dan Wyrtki, 1956).



7a – August

7b – December

7c – April

7d – October

Fig. 7 – Système des courants de surface en mer de Java (D'apres Wyrtki, 1957).
– Surface current system in the Java Sea (From Wyrtki, 1957).
Gambar 7. – Sistem peredaran arus air permukaan Laut Jawa (Wyrtki, 1957).

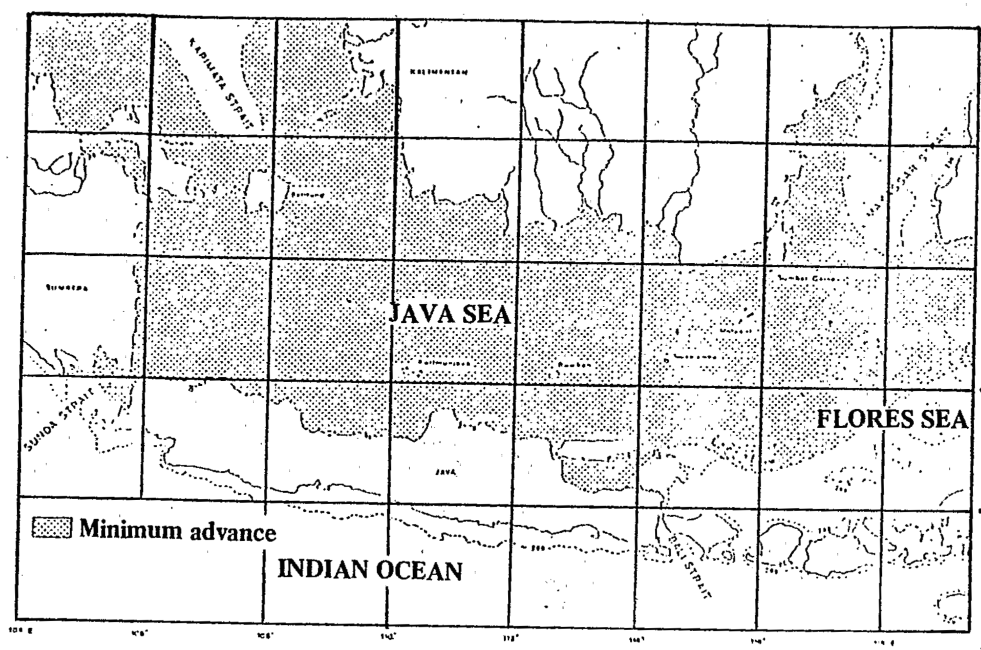


Fig. 8a – Avancée minimale de l'isohaline 32‰ en mer de Java.
– Minimal advance of the 32‰ isohaline in the Java Sea.
Gambar 8a – Peredaran isohaline minimal 32‰ di Laut Jawa

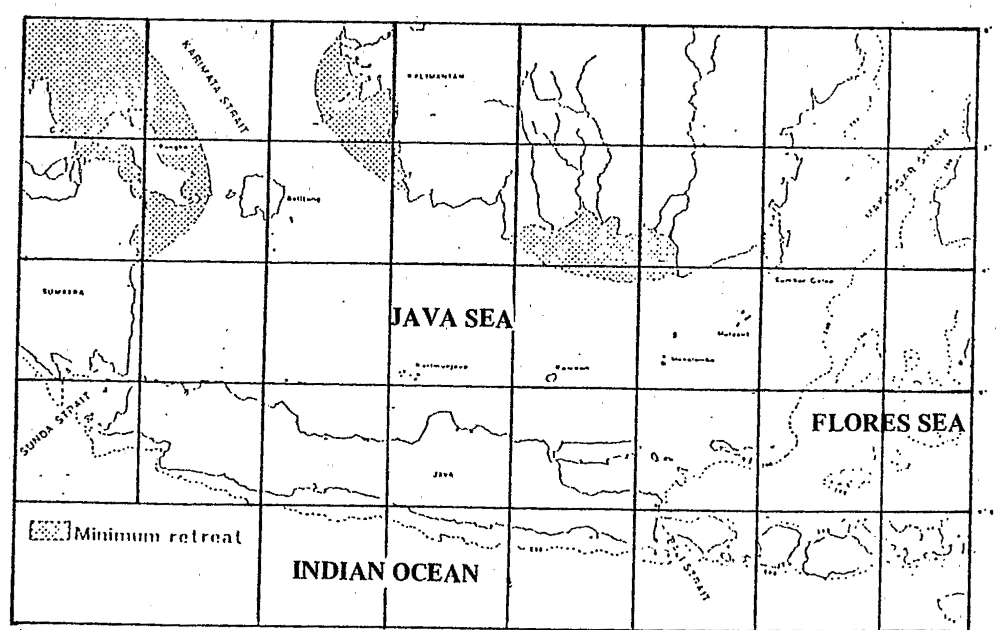


Fig. 8b – Retraite minimale de l'isohaline 32‰ en mer de Java.
– Minimum retreat of the 32‰ isohaline in the Java Sea.
Gambar 8b – Kebalikan peredaran isohaline minimum 32‰ di Laut Jawa.

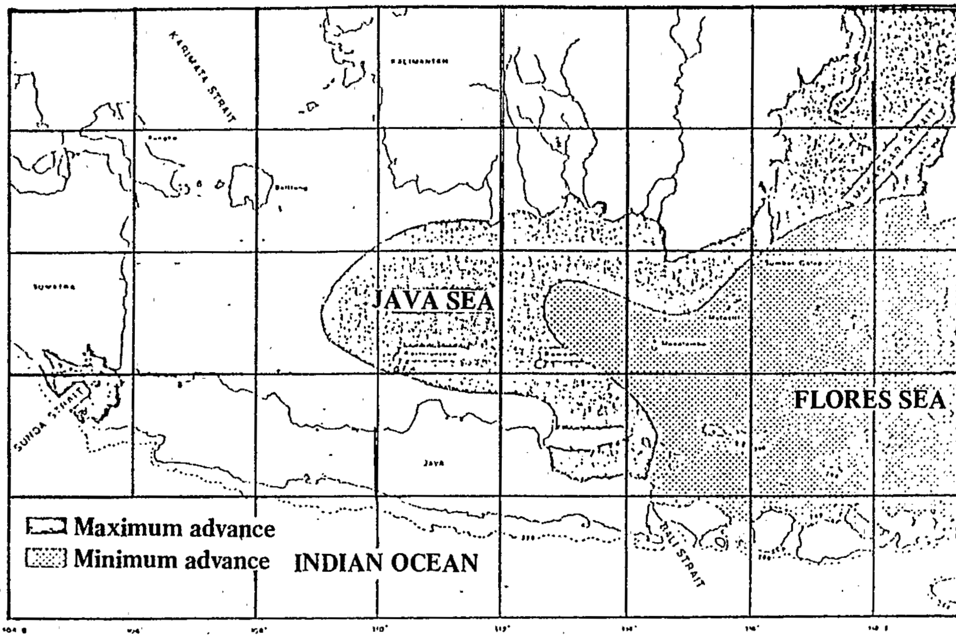


Fig. 8c — Advancée maximale et minimale de l'isohaline 34‰ en mer de Java.
— Maximum and minimum advance of the 34‰ isohaline in the Java Sea.
Gambar 8c — Peredaran maksimum dan minimum isohaline 34‰ di Laut Jawa.

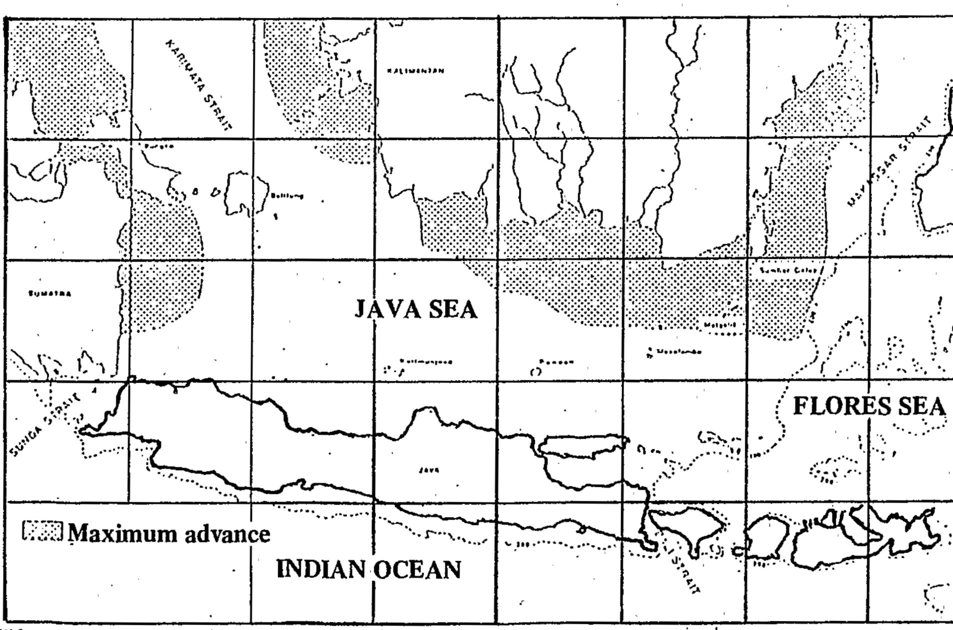


Fig. 8d — Avancée maximale de l'isohaline 30‰ en mer de Java.
— Maximum advance of the 30‰ isohaline in the Java Sea.
Gambar 8d — Peredaran masimal isolaline 30‰ di Laut Jawa.

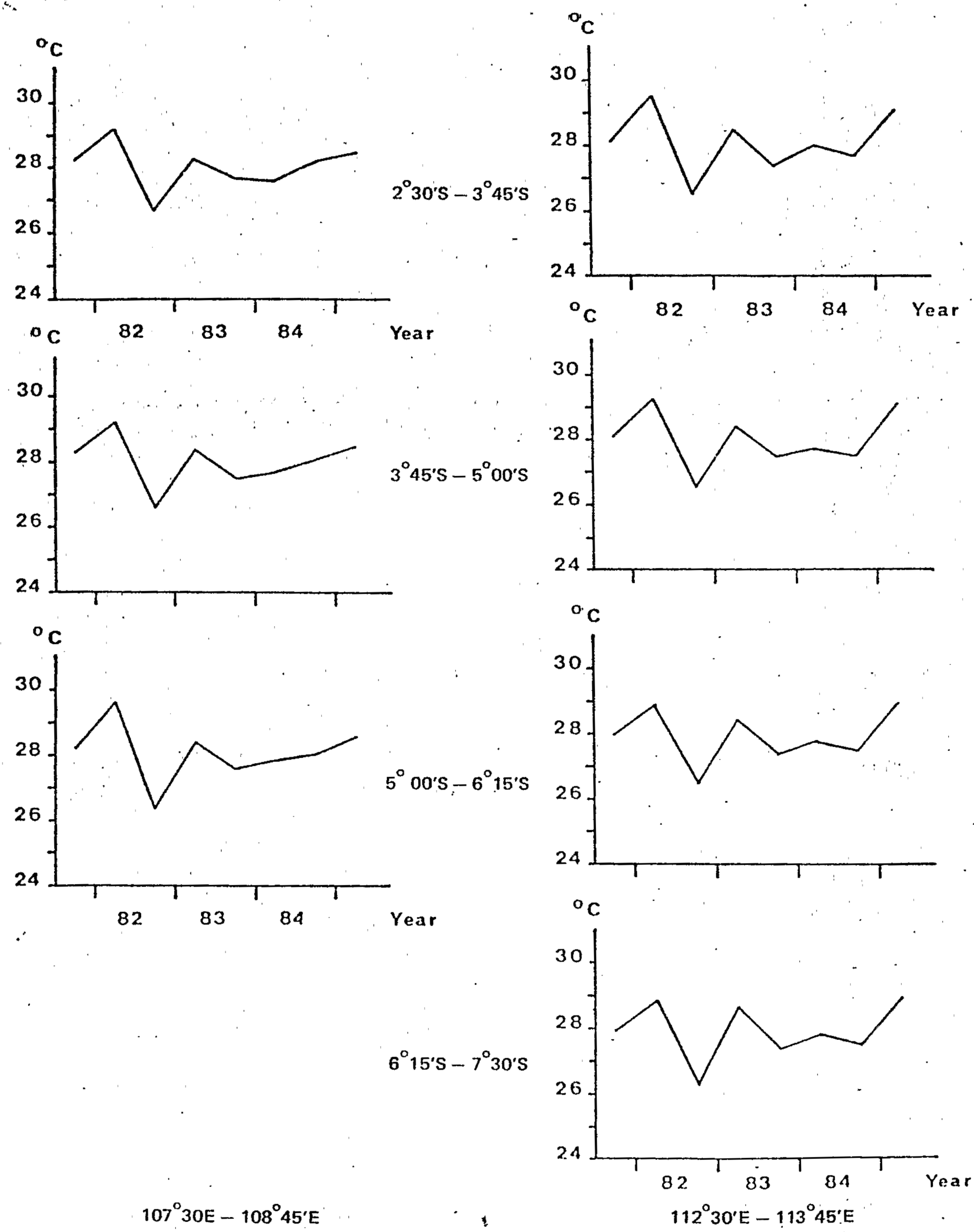


Fig. 9 – Evolution de la température de surface de juin 1981 a juin 1985 en mer de Java (Données GOSSCOMPT).
– Evolution of the sea surface temperature from June 1981 to June 1985 in the Java Sea (GOSSCOMPT data).

Gambar 9. – Evolusi suhu permukaan dari Juni 1981–Juni 1985 di Laut Jawa.

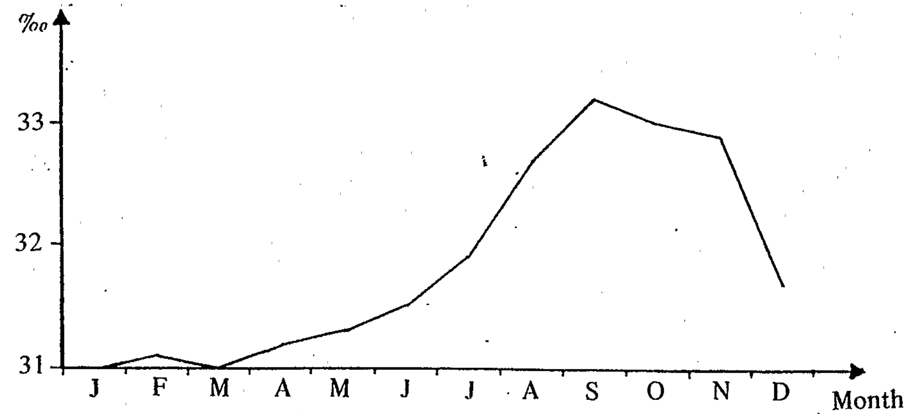


Fig. 10 — Salinité de surface mensuelle (moyenne 1951–1953) en mer de Java.
— Monthly surface salinity (average 1951–1953) in the Java Sea.
Gambar 10. — Salinitas permukaan bulanan (rata-rata 1951–1953) di Laut Jawa.

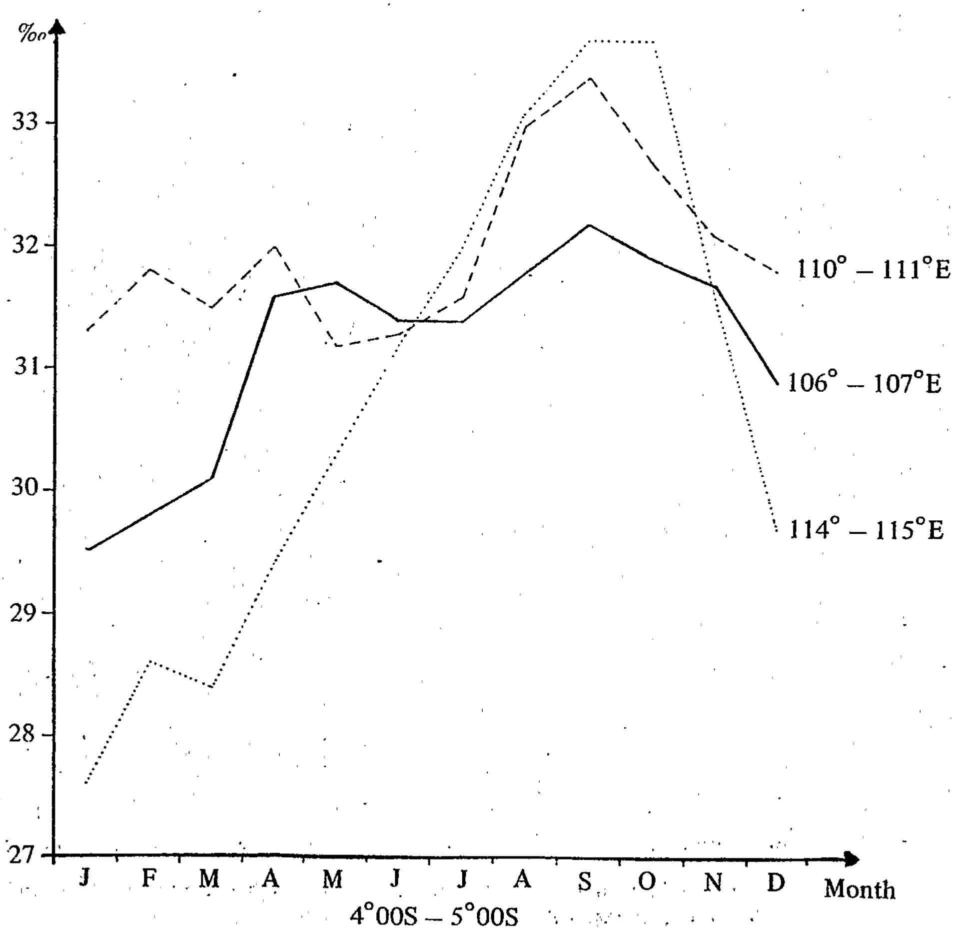


Fig. 11 — Salinité de surface entre 4°S et 5°S à différentes longitudes.
— Surface salinity between 4°S and 5°S at different longitudes.
Gambar 11 — Salinitas permukaan antara 4°S dan 5°S pada garis bujur yang berbeda.

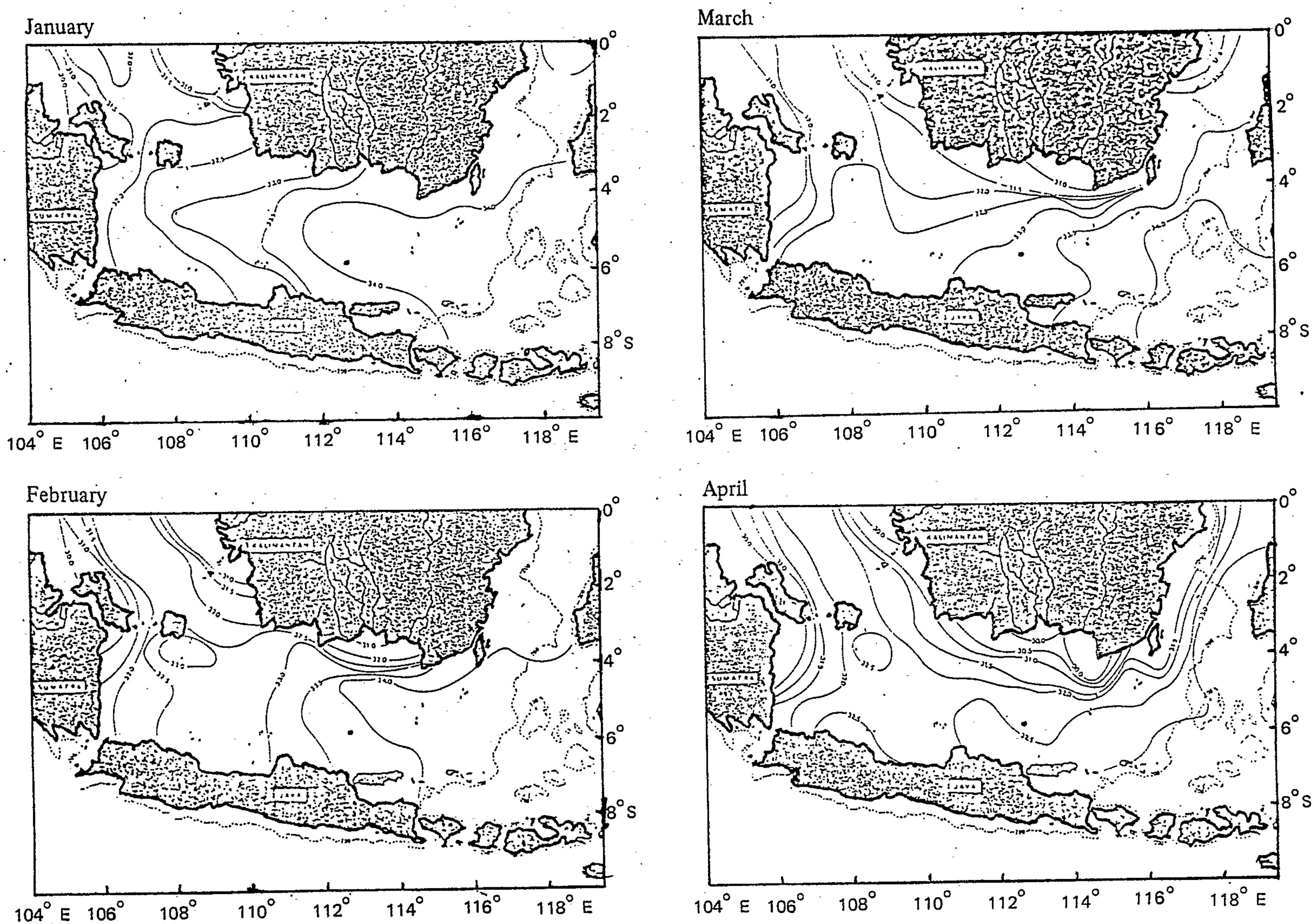
ANNEX I
Lampiran I

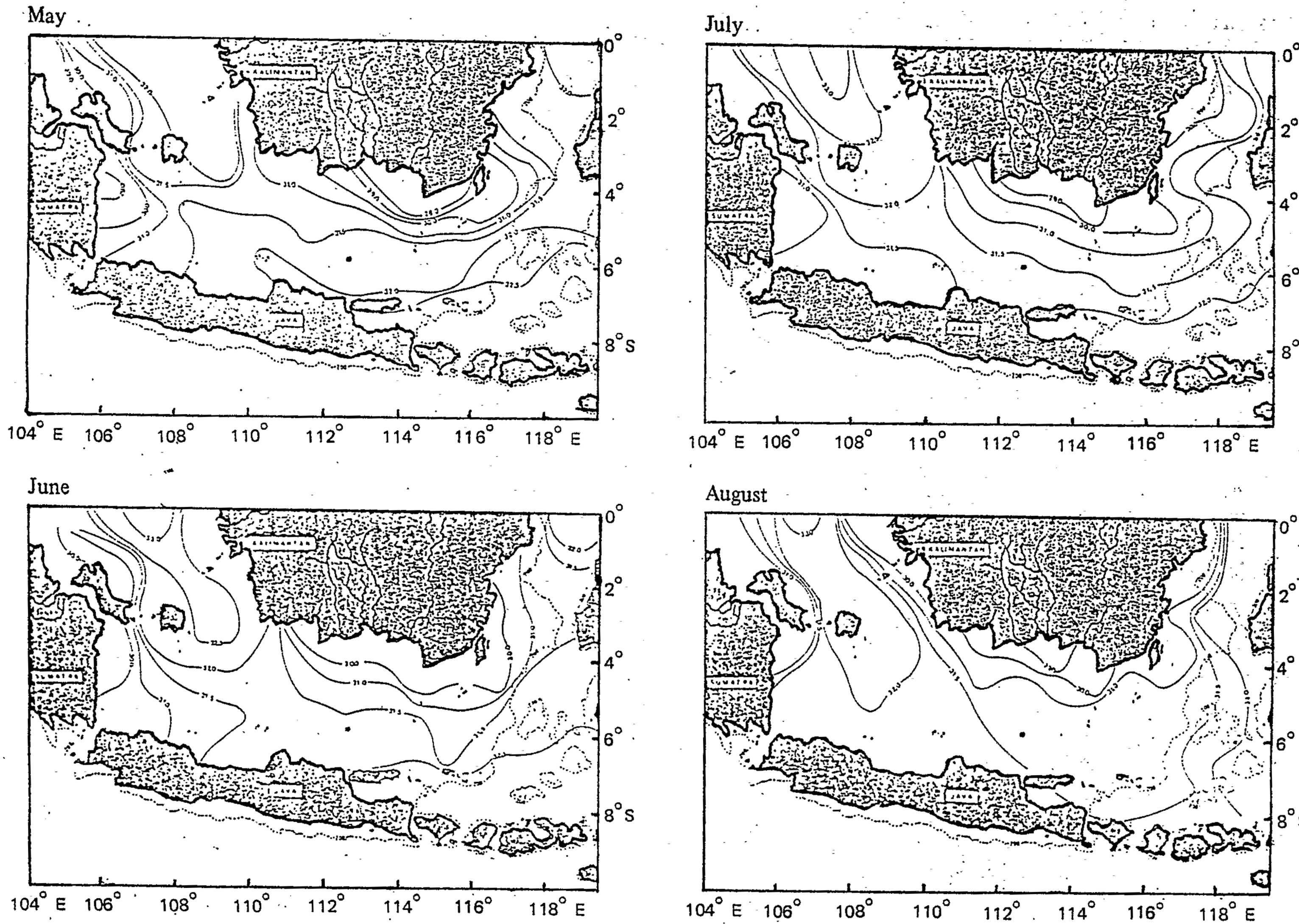
Cartes mensualles de la salinite dé surface d'après les données de VEEN, 1953.

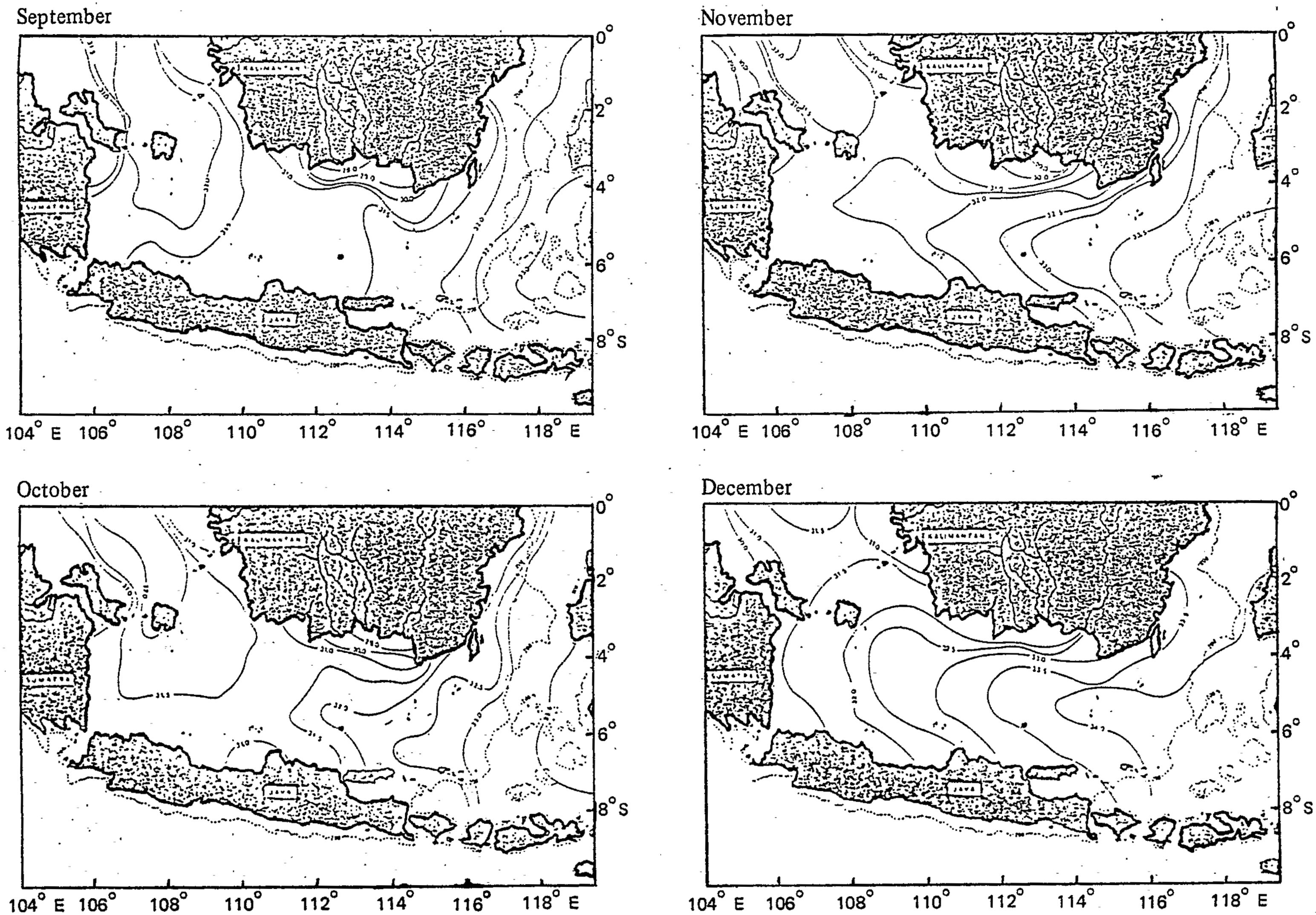
–o–o–o–o–o–o–o–o–o–

Monthly surface salinity charts from VEEN, 1953

Peta salinitas bulanan menurut VEEN, 1953.


January
March
February
April
KALIMANTAN
SUMATRA
JAVA
0°
2°
4°
6°
8° S
104° E
106°
108°
110°
112°
114°
116°
118° E


May
July
June
August
KALIMANTAN
SUMATRA
JAVA
0°
2°
4°
6°
8°S
104° E
106°
108°
110°
112°
114°
116°
118° E


September
November
October
December
KALIMANTAN
SUMATRA
JAVA
0°
2°
4°
6°
8° S
104° E
106°
108°
110°
112°
114°
116°
118° E

ISSN 0216 - 7727

JURNAL PENELITIAN PERIKANAN LAUT
(Journal of Marine Fisheries Research)

No: 51
Tahun 1989

BALAI PENELITIAN PERIKANAN LAUT
Badan Penelitian dan Pengembangan Pertanian
Departemen Pertanian
JAKARTA