OCEANOGRAPHY OF LINGAYEN GULF

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EIGHTEEN TEXT FIGURES

INTRODUCTION

No previous work of somewhat extended nature has been done on the waters of Lingayen Gulf, although mention may be made of the investigations carried on in connection with a study of the marine fauna of the western part of the gulf by Domantay (1937).

The present work embodies the results of a one-year oceanographic survey in which a maximum of ten hydrographic stations was occupied at nearly corresponding dates for twelve successive months from August, 1953, to July, 1954.

The investigation follows a similar pattern reported for Manila Bay (Megia et al., 1953). The primary purpose was to collect physical and chemical data for determining seasonal changes in the oceanographic properties of the gulf.

Description of the region.—Lingayen Gulf is an almost semicircular incursion of the South China Sea on the west coast of Luzon island. An almost continuous chain of islands and rocks, mostly low, wooded and separated by shallow channels, fringes the gulf on the western side. A series of shoals extends nearly halfway across the entrance from Cape Bolinao. The shore around the head is low and sandy.

Southeast winds prevail for the greater part of the year. Southwest gales blow from 3 to 15 days from July to October. The typhoon (cyclone) season occurs from mid-September to the end of October.

Several rivers drain into the gulf; Dagupan River in the south is the largest. Fig. 1 shows the bottom topography.

Station plan.—Fig. 2 shows a layout of the stations occupied during each of the twelve cruises.

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MATERIALS AND METHODS

Equipment, materials and methods of investigation are essentially the same as those outlined by Megia and Sebastian (1952).

Boat.—The "M/V David Starr Jordan", a 30–ton 135–H.P. research vessel of the Bureau of Fisheries, was assigned exclusively for the work. It was the same ship employed in the Manila Bay survey.

Thermometers and water bottles.—Watanabe deep sea reversing thermometers were used. These consistently gave readings reliable to 0.02°C. Two-plug valve type Nansen bottles of liter capacity were used as water samplers.

Observations.—Serial observations were made for samples taken at 0, 2, 5, 10, 20, 30, 50 meters below the surface. At certain stations samples were taken down to 75, 100, 150, and 200 meters.

Analytical procedure.—Chlorinity determinations were made with the modified Oxner-Knudsen method, using a Knudsen bulb, burette, and 15-ml automatic tap pipette. Standardization was made against a secondary sea-water standard obtained from Woods Hole standard sea water. Chlorosities were converted to chlorinities by the Thompson conversion tables (Cl/1 at 20°C. to Cl(‰). Accuracy in these determinations is within 0.02 ‰.

Dissolved oxygen determinations were made with a modified Winkler titration method, using standard potassium iodate solution of 0.01 normality, sodium thiosulfate solution of 0.005 normality and 0.1 per cent (by weight) sodium furoate. Precision of the determination is about 0.02 ml/1 of sea-water.

Inorganic phosphates were determined by the method of Deniges. Synthetic sea-water of about 18 ‰ chlorinity was used. The accuracy of the determination is from 5 to 10 per cent.

TEMPERATURE

Surface temperature.—Fig. 3 shows the monthly distribution of surface temperature. The highest surface temperatures were observed during the months of May to August, with values about one degree more than those for the other months. The highest average monthly value was 30.81°C in June. Maximum temperature value was 31.49°C. at station 9 in May.

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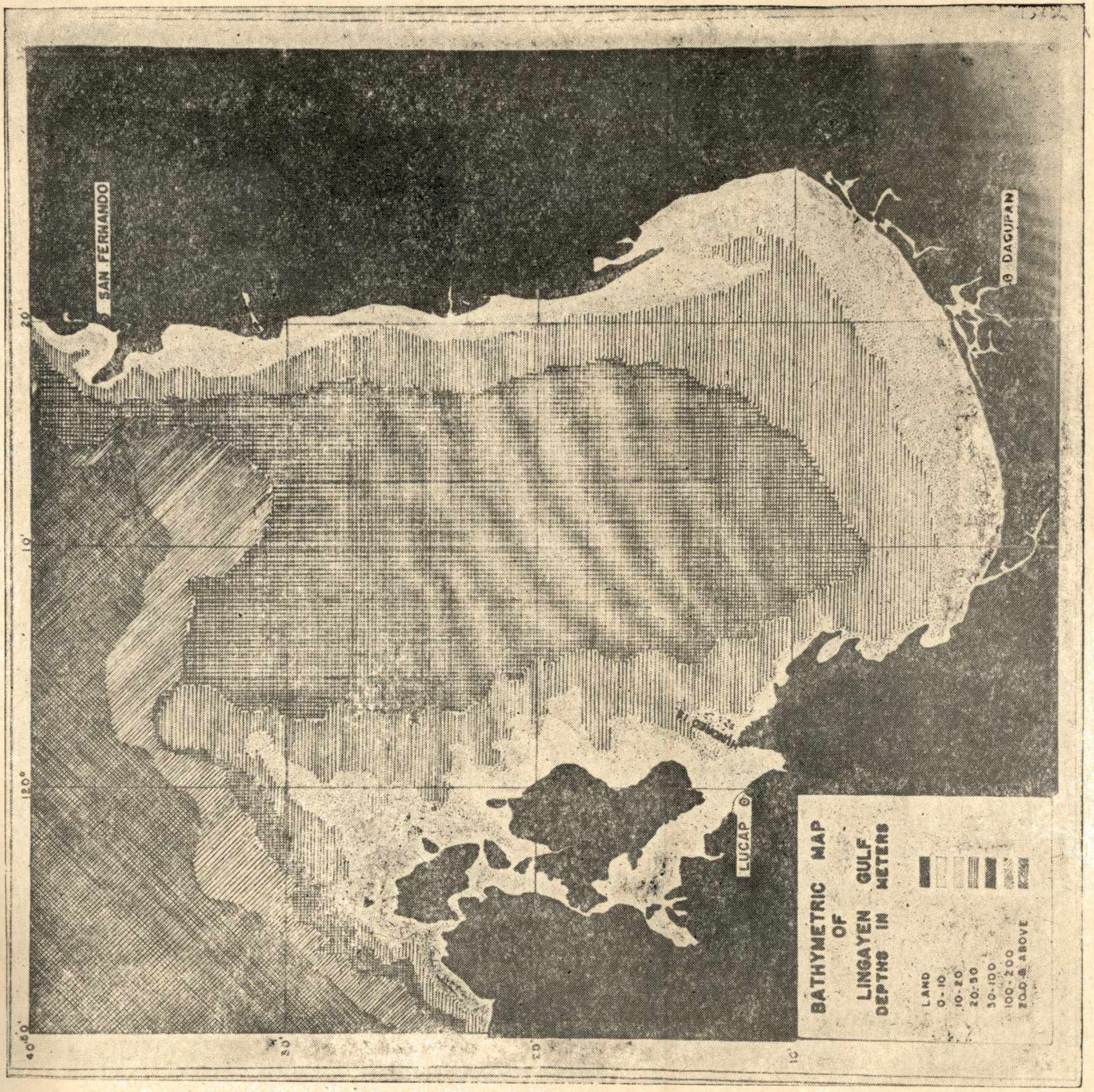

FIG. 1. Bathymetric map of Lingayen Gulf

The lowest temperatures were obtained during the winter months from December to February. The lowest monthly average value was obtained in December, 27.99°C. Minimum value was 27.17°C. at station 6 in February.

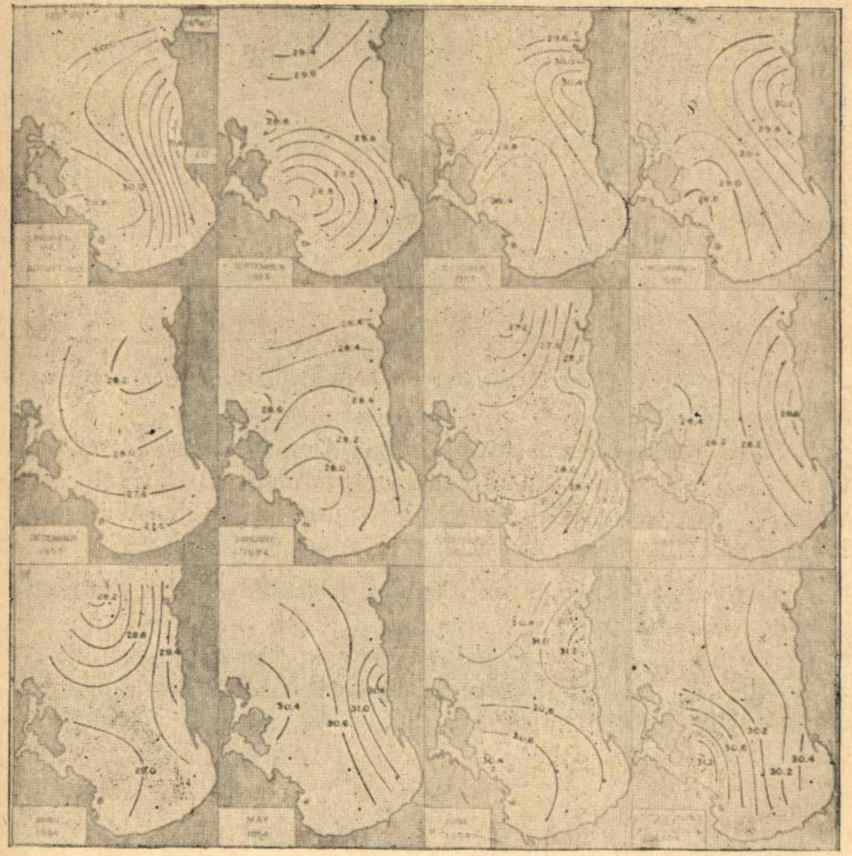

FIG. 3. Monthly distribution of surface temperature

The annual temperature range is relatively small, only 2.82°C., compared to 4.3°C. for Manila Bay.

Fig. 4 shows the close relationship between air temperature and surface water temperature throughout the survey.

The survey brings out the fact that the variation in the surface temperature of the gulf is seasonal in nature, as is that of Manila Bay.

Temperature at 20 meters.—Fig. 5 shows the monthly distribution of temperature at 20 meters. This follows closely the

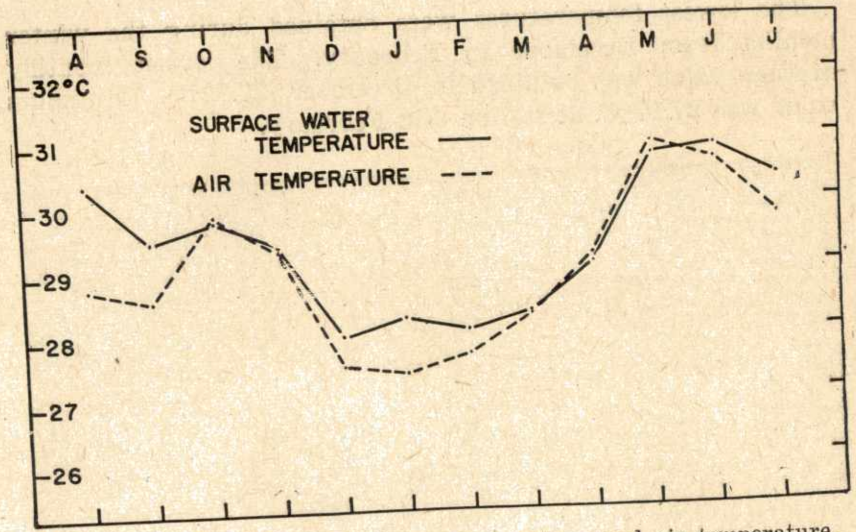

FIG. 4. Average surface water temperature and air temperature.

pattern of surface temperature distribution—highest from May to August and lowest during the winter months. The highest value of 30.73°C. was observed at station 10 in June while the lowest, 26.51°C., was at station 6 in February.

Temperature at other depths.—Fig. 6 shows the distribution of temperature in a vertical section across the gulf during the months of February and September, through stations 3, 4, 5 and 6. The average monthly temperature trend for all depths is also given in fig. 10.

CHLORINITY

Surface chlorinity.—A study of the monthly average surface chlorinity shows that the mean range is not large, from 15.89 ‰ in September to 18.47‰ in May, or a mean annual range of 2.5 ‰. This is much lower than that for Manila Bay, 7.3 ‰, which is considered unusually large. The monthly distribution of surface chlorinity is shown in Fig. 7. The low values obtained and the close packing and decrease in value of the isochlors from the months of August to December show the effect of freshening due to heavy river discharge, especially during these rainy season months.

Chlorinity at 20 meters.—Fig. 8 shows the monthly distribution of chlorinity at 20 meters below the surface. An inward

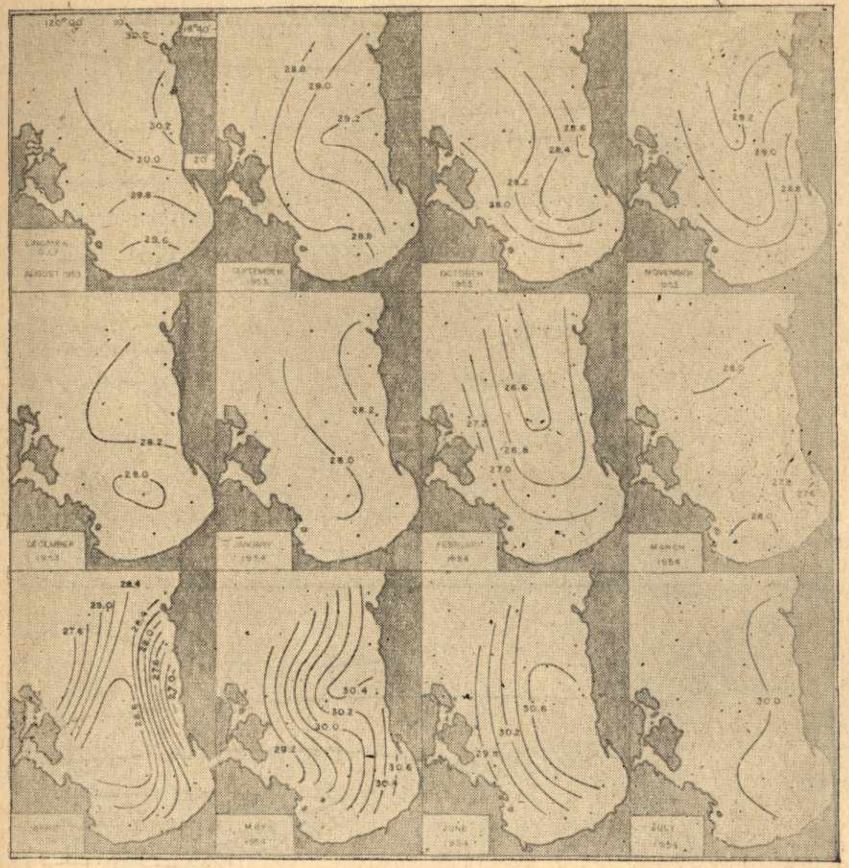

FIG. 5. Monthly distribution of temperature at 20 meters.

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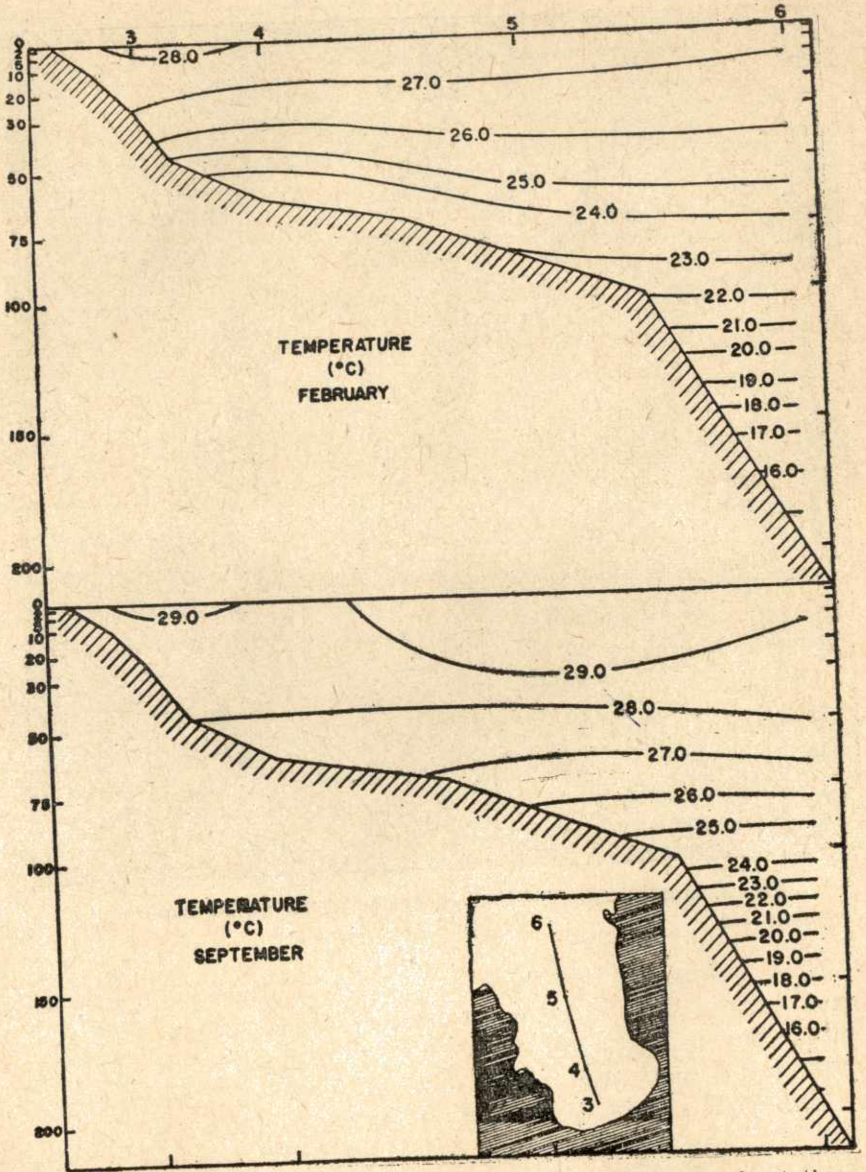

FIG. 6. Temperature distribution in a vertical section through stations 3, 4, 5 and 6 for February and September.

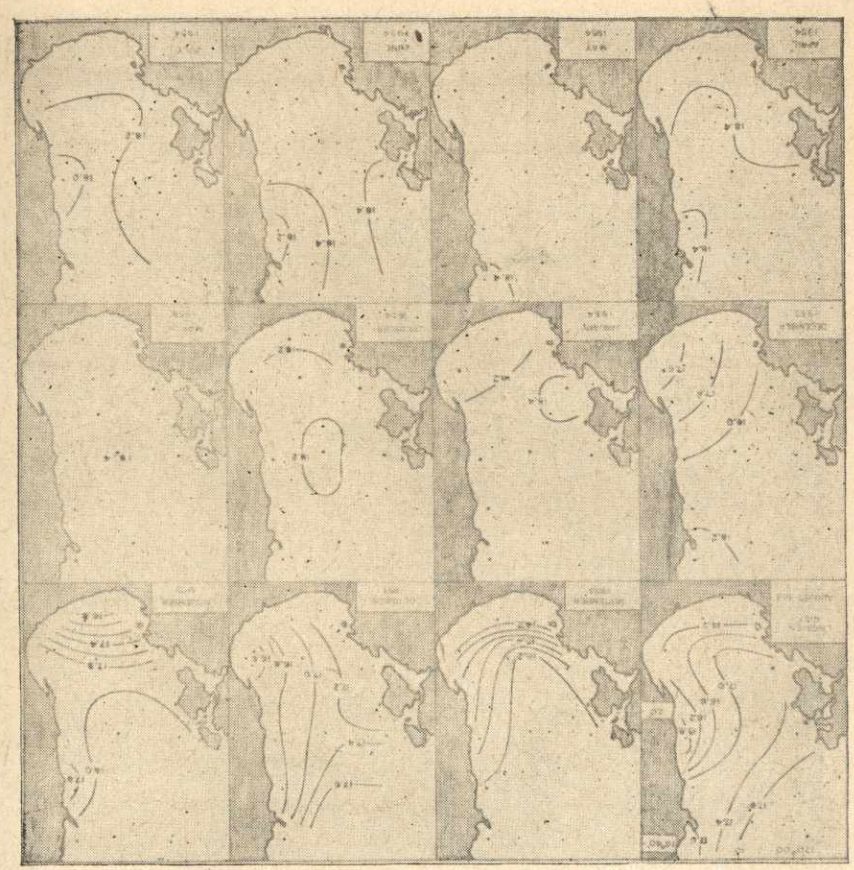

FIG. 7. Monthly distribution of surface chlorinity.

shifting of the high isochlors is evident for October to December. This may probably be explained by the fact that there is a reduction in the volume of river flow just after its peak in September.

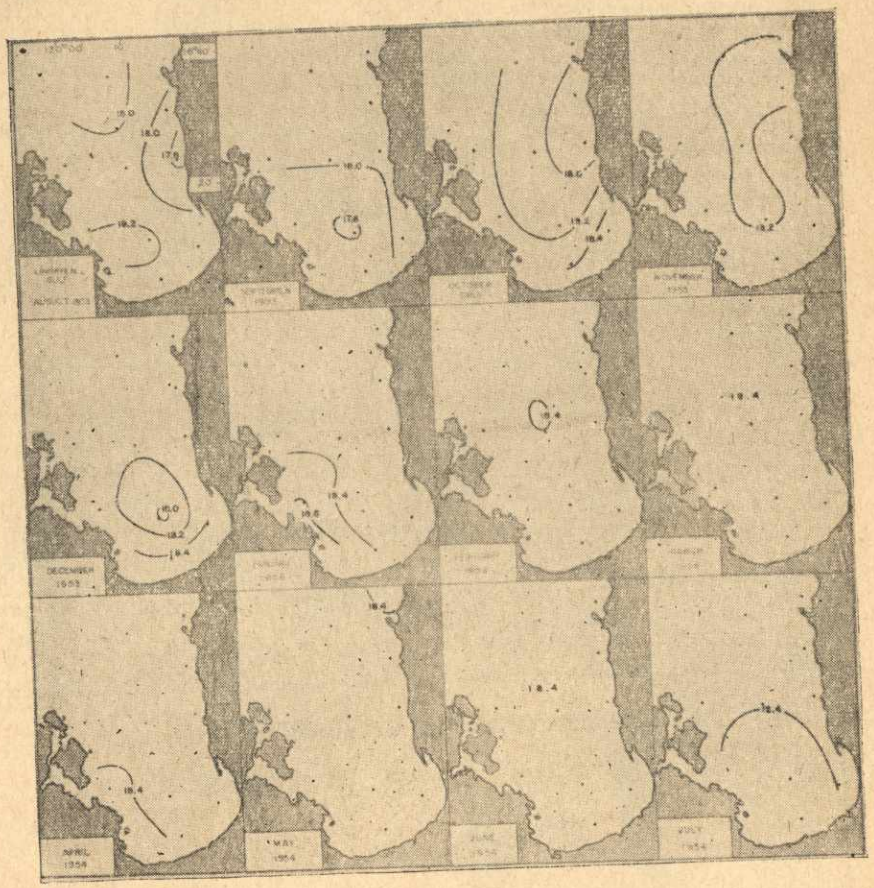

FIG. 8. Monthly distribution of chlorinity at 20 meters.

Chlorinity at other depths.—Fig. 9 shows the distribution of chlorinity in a vertical section across the gulf during the months of February and September, through stations 3, 4, 5 and 6.

Fig. 10 shows the average monthly trends in temperature and chlorinity computed for all depths.

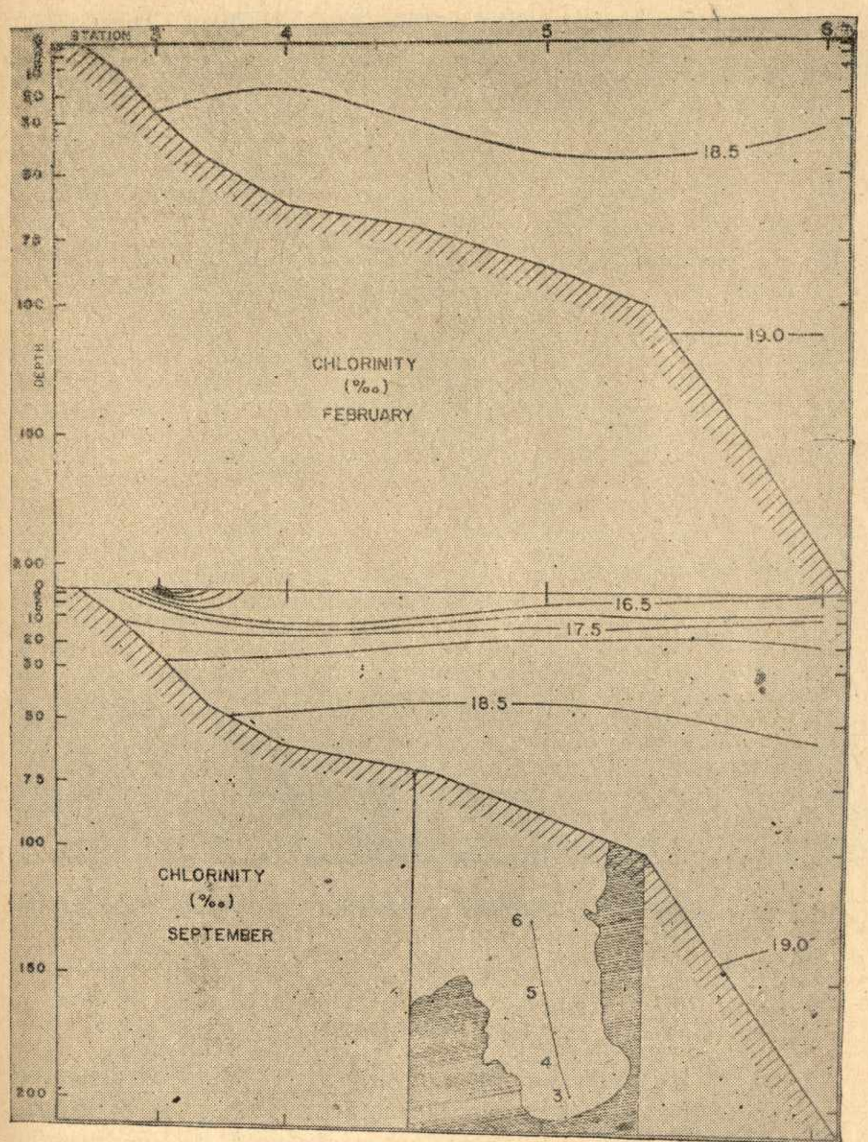

FIG. 9. Chlorinity distribution in a vertical section through stations 3, 4, 5 and 6 for February and September.

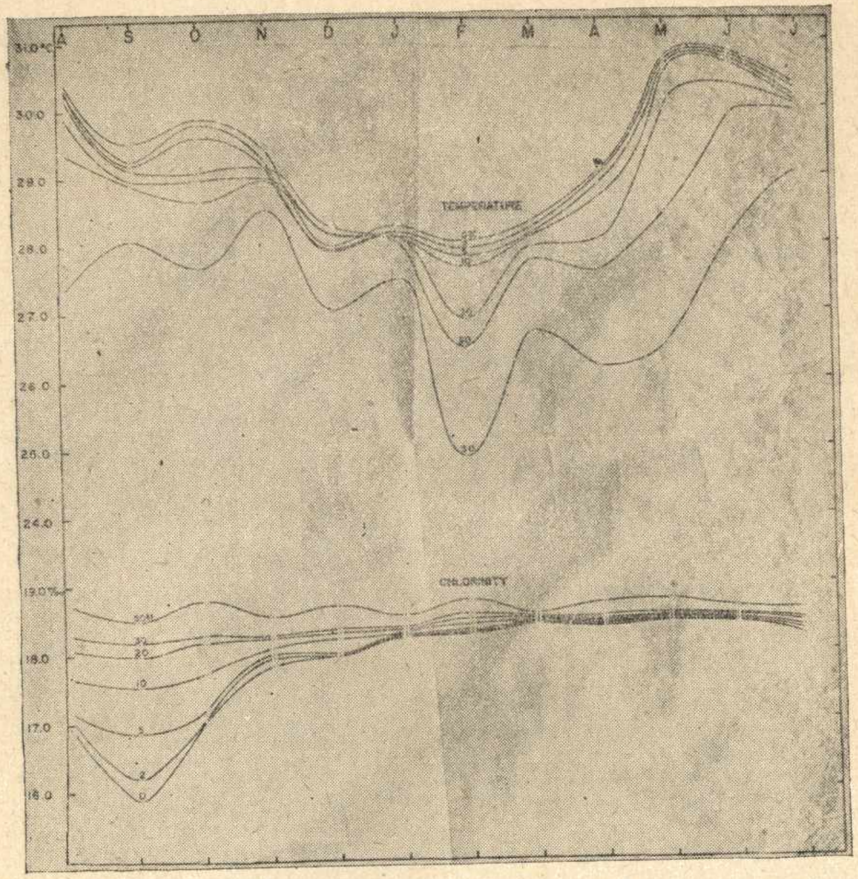

FIG. 10. Average monthly trends in chlorinity and temperature for all depths.

DISSOLVED OXYGEN

Figs. 11 and 12 show the monthly distribution of dissolved oxygen at the surface and at 20 meters. Values are expressed in mg-at/1. Maximum values were observed in February to May. The highest concentrations were not found close to the tributaries, and since this is about the time of little run-off, these high values may be due to biological activity.

Fig. 13 shows the distribution of dissolved oxygen in a vertical section across the gulf in February and September through stations 3, 4, 5 and 6.

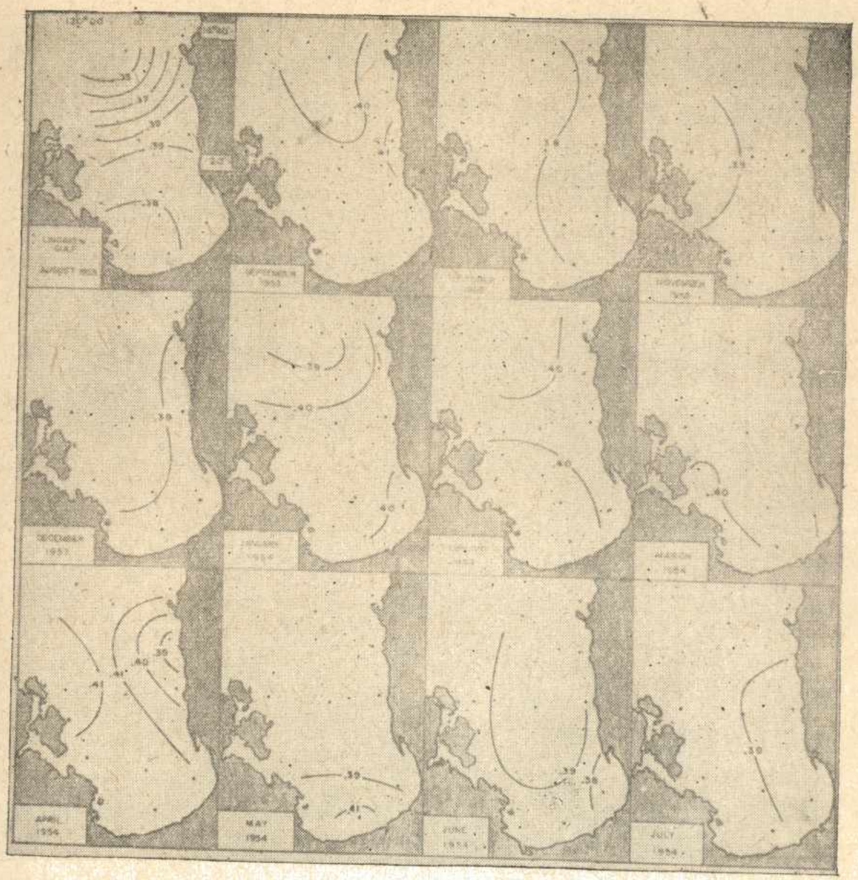

FIG. 11. Monthly distribution of dissolved oxygen at the surface.

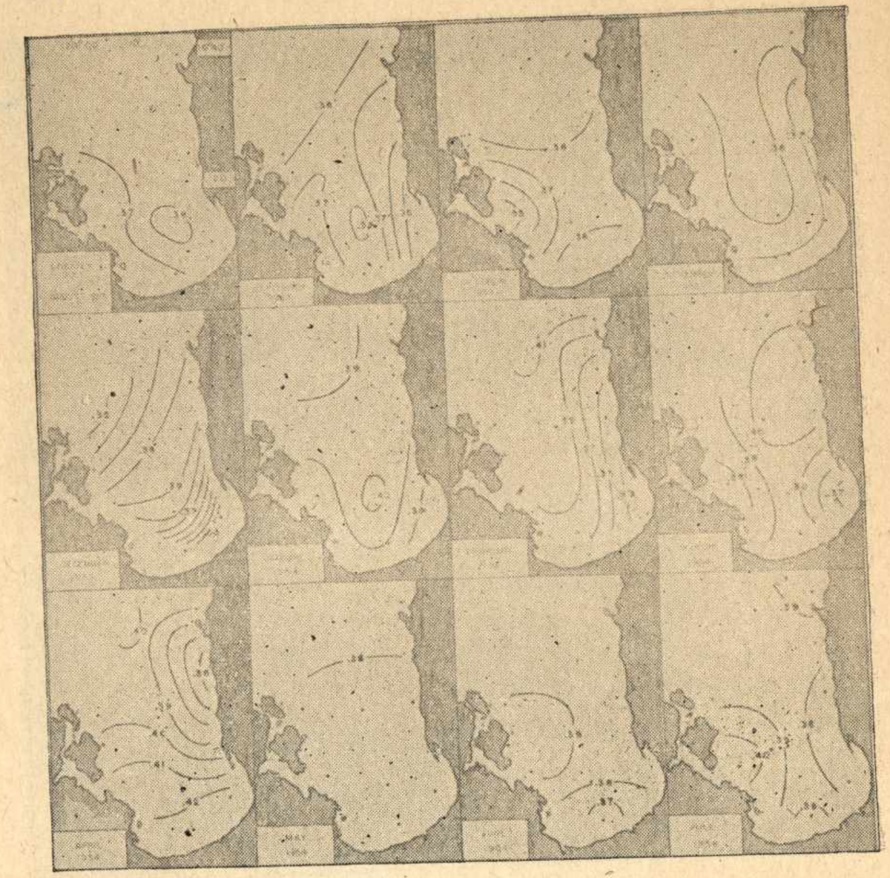

FIG. 12. Monthly distribution of dissolved oxygen at 20 meters.

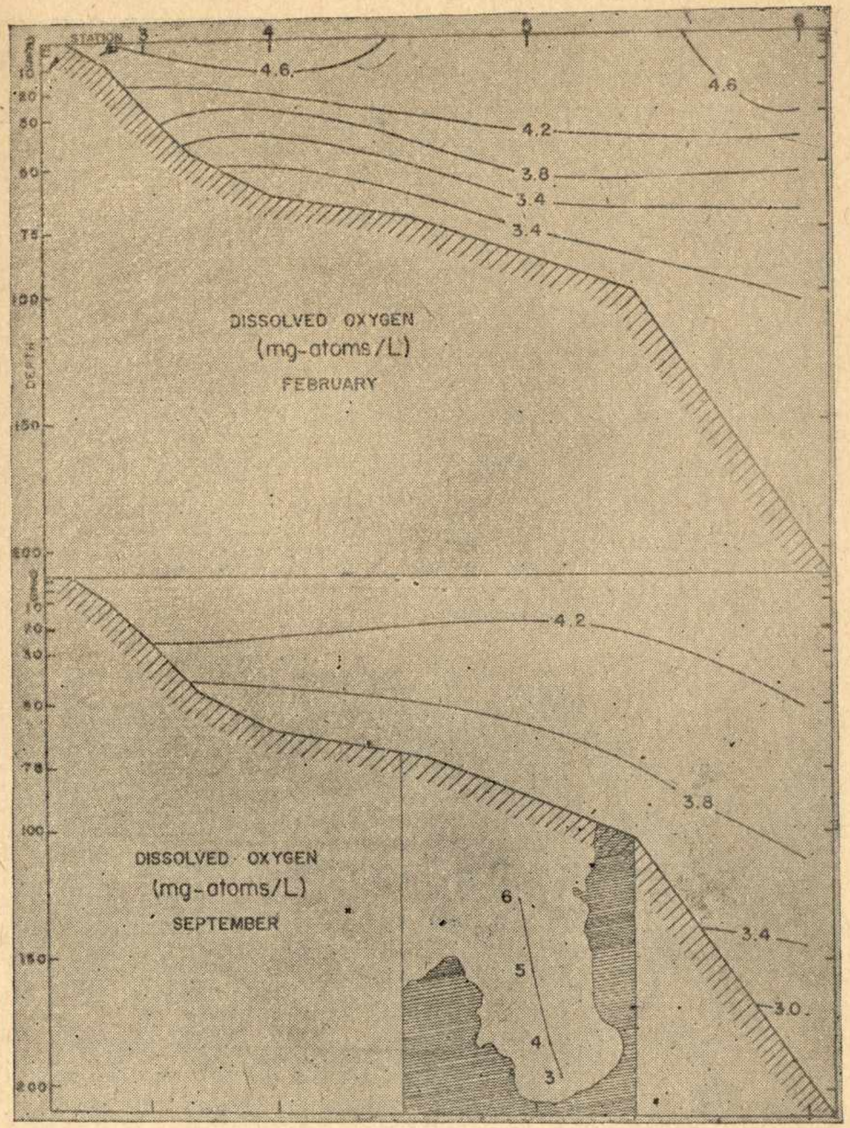

FIG. 13. Distribution of dissolved oxygen in a vertical section through stations 3, 4, 5 and 6 for February and September.

Fig. 14 shows the seasonal variation in oxygen saturation (per cent) and phosphate content from the surface to 75 meters at station 5.

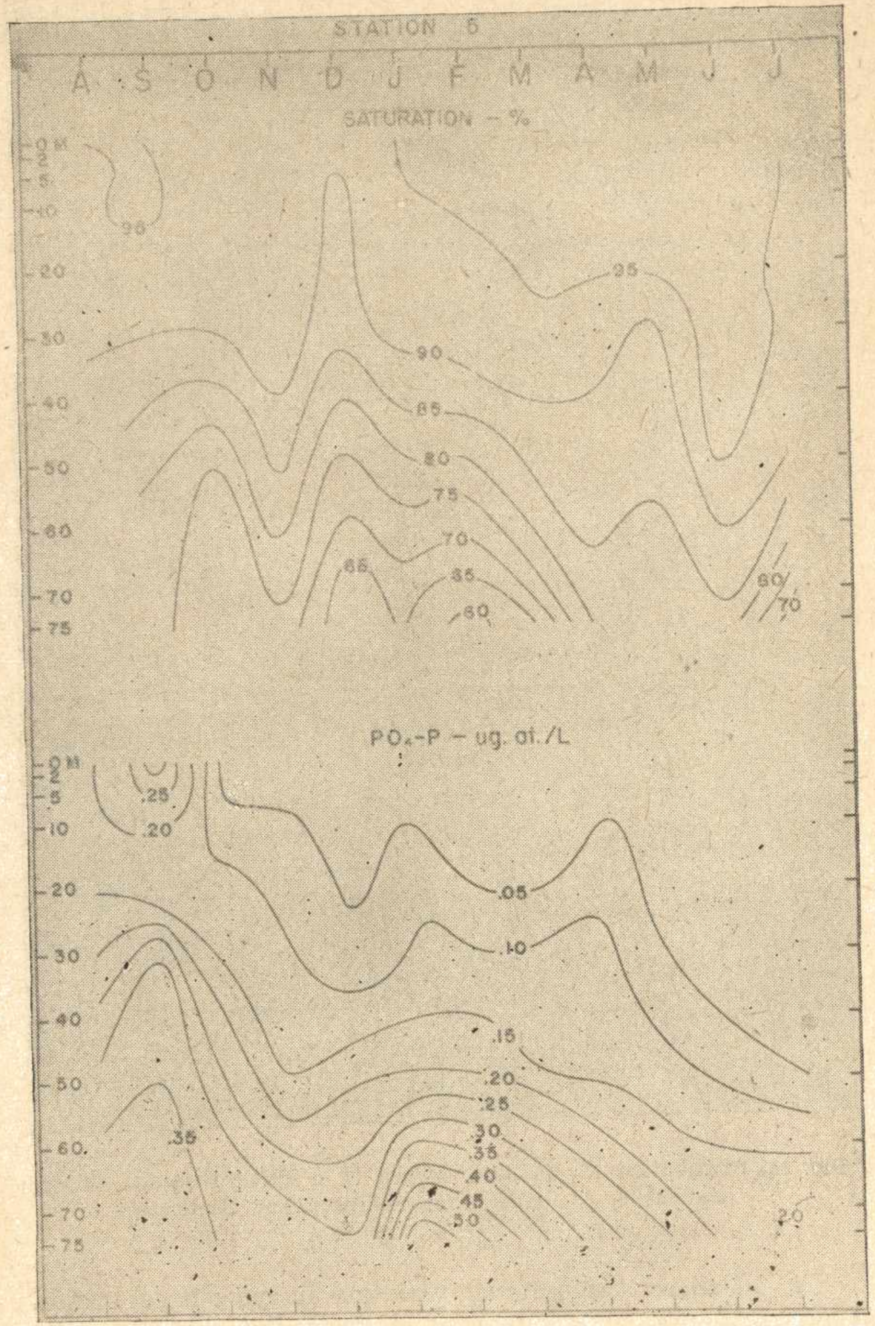

FIG. 14. Seasonal variation in oxygen saturation (per cent) and phosphate

INORGANIC PHOSPHATES

Figs. 15 and 16 show the monthly distribution of inorganic phosphates at the surface and at 20 meters. Only small variations exist from month to month and from place to place, but it is observed that low phosphate content exists at the surface from January to July and at 20 meters from April to July. Maximum values were obtained in August and September. This apparently brings out the direct association of phosphate abundance with fluctuations in river discharge.

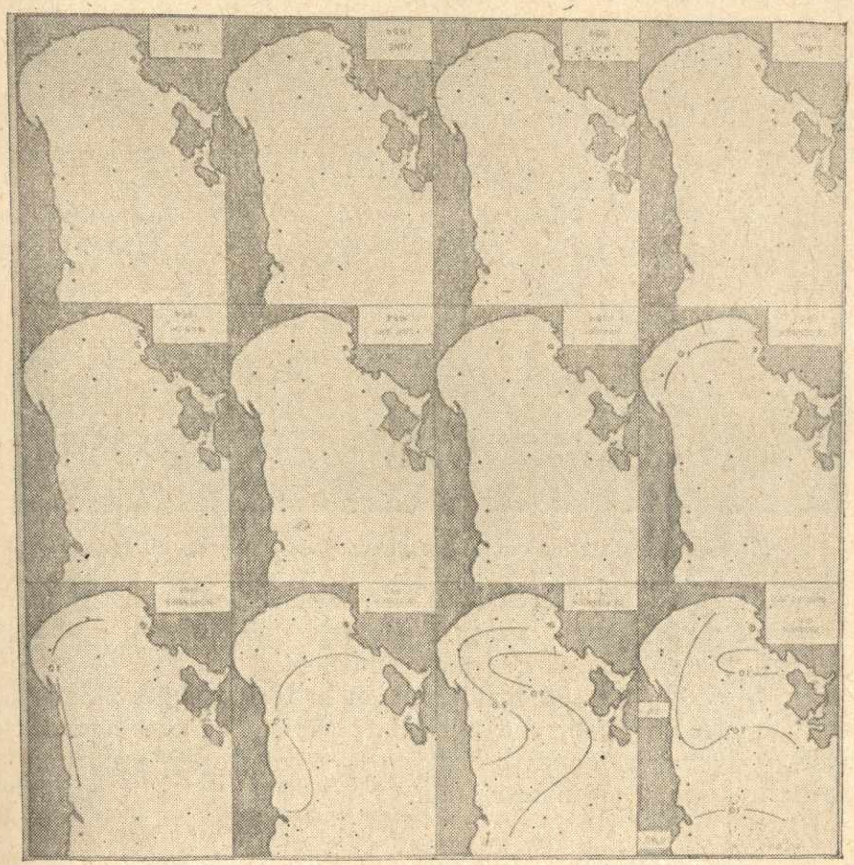

FIG. 15. Monthly distribution of inorganic phosphates at the surface.

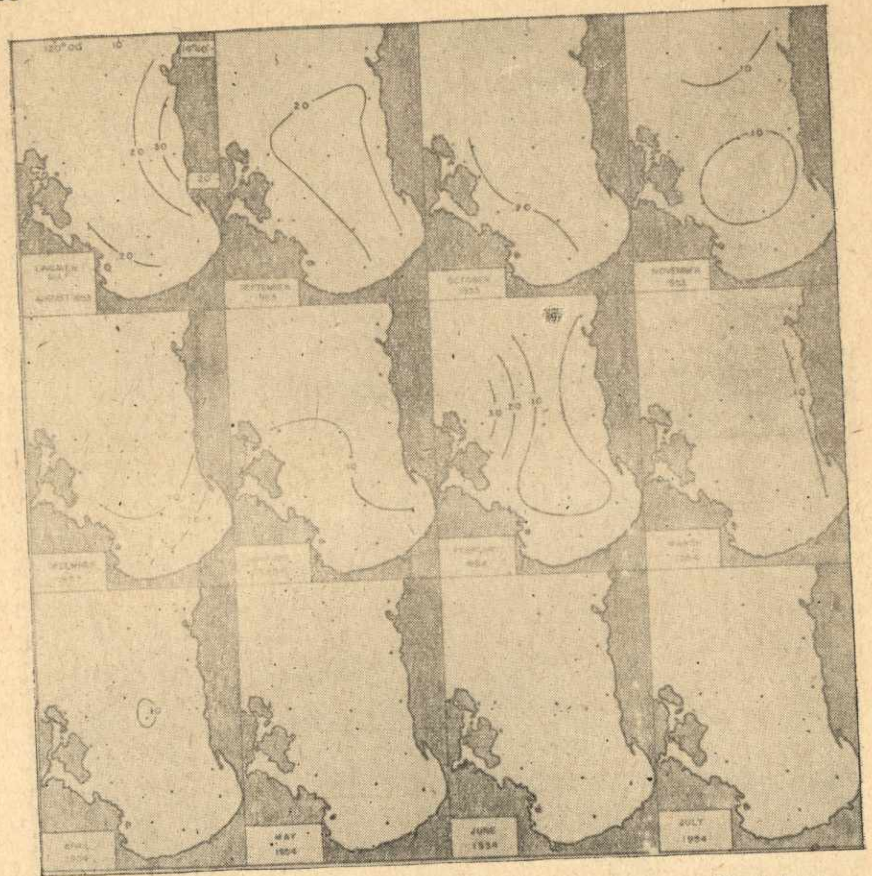

FIG. 16. Monthly distribution of inorganic phosphates at 20 meters.

Fig. 17 shows the distribution of phosphate—phosphorus in a vertical section across the gulf through stations 3, 4, 5 and 6 during the months of February and September.

Fig. 18 shows the seasonal variation in temperature, chlorinity, dissolved oxygen, and phosphate content of the surface layer (0–10 meters) and the bottom layer at station 4 during the entire period of investigation.

SUMMARY

1. Data are presented with figures, showing changes in temperature, chlorinity, and in the concentrations of dissolved oxygen and inorganic phosphates in the waters of Lingayen Gulf during twelve monthly cruises from August, 1953, to

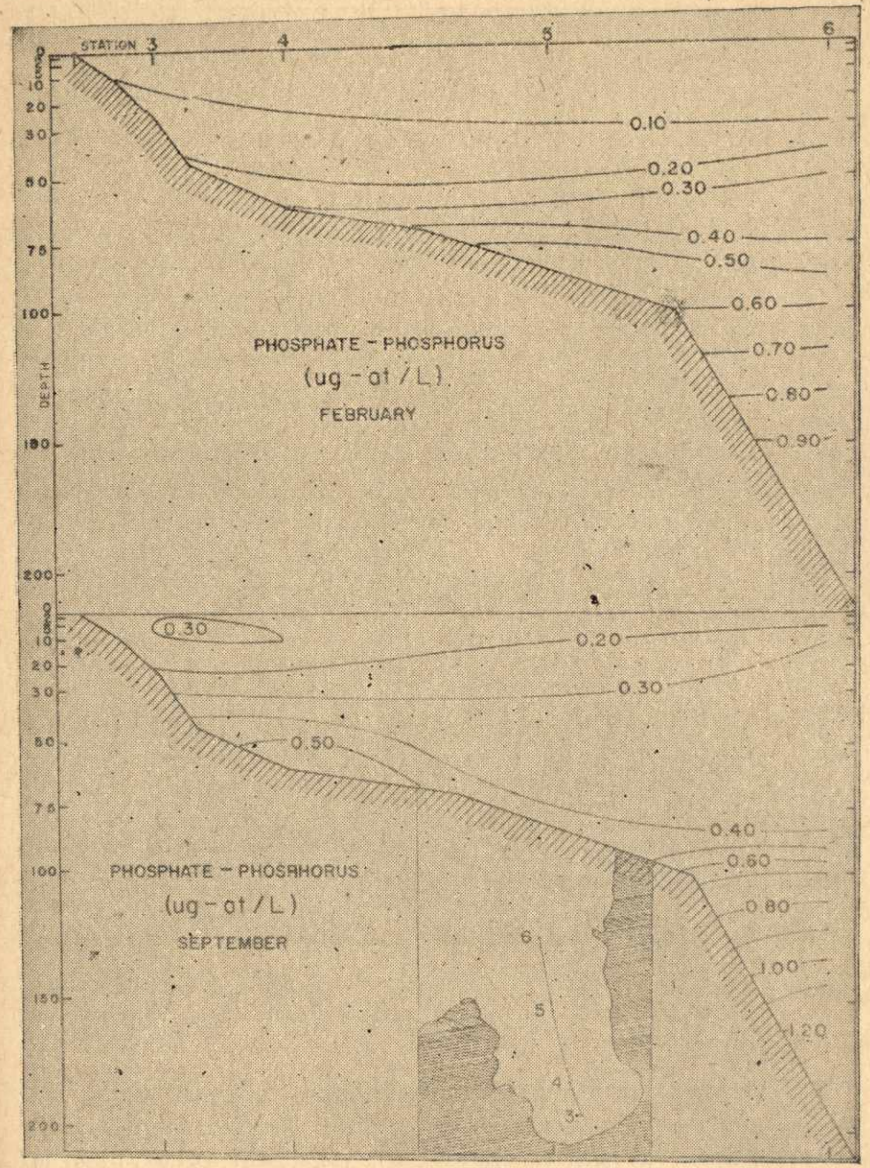

FIG. 17. Distribution of phosphate-phosphorus in a vertical section through stations 3, 4, 5 and 6 for February and September.

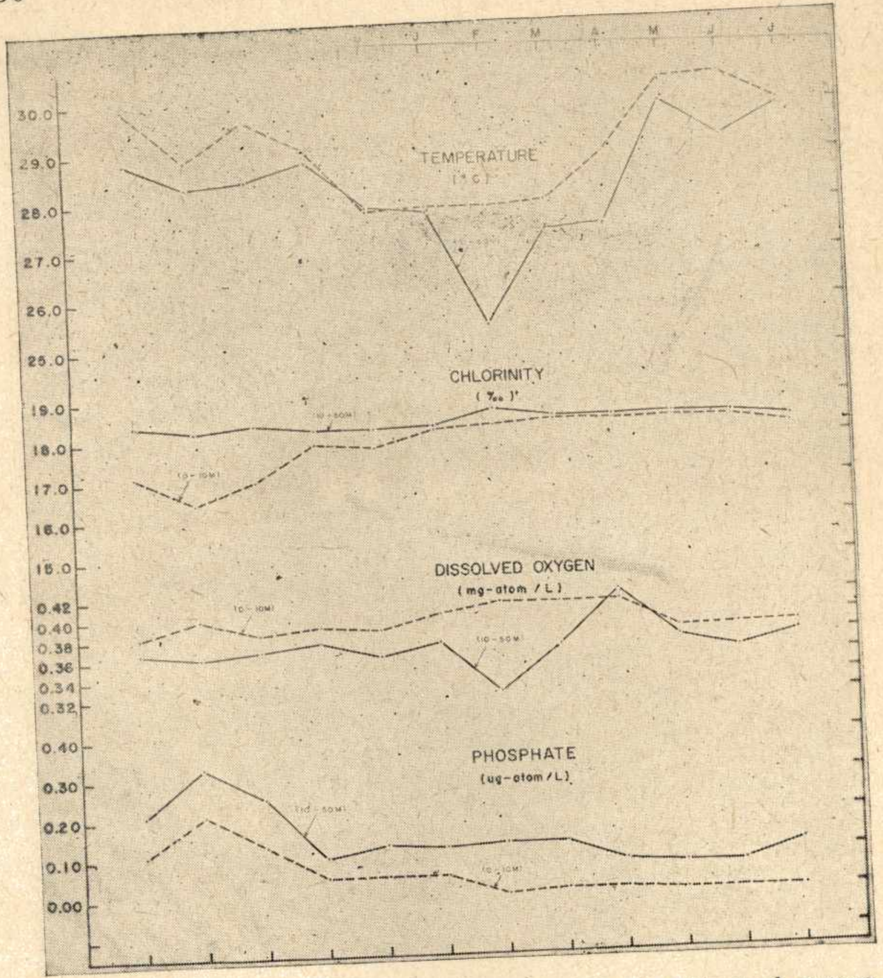

FIG. 18. Seasonal variation in temperature, chlorinity, dissolved oxygen and phosphate content of surface layer (0–10 meters) and bottom layer at station 4.

2. Variations in temperature distribution are seasonal. The highest surface temperatures occur from May to August, with values about one degree more than those for other months. The lowest values are observed during the winter months, December to February. The highest value obtained was 31.49°C. in May and the lowest was 27.17°C. in February.

3. The annual range in temperature is relatively small compared to that of Manila Bay.

4. The monthly average surface chlorinity varied from a

in May or a range of 2.58°/00, much lower than that for Manila Bay, 7.3°/00, which is considered unusually large. The effect upon chlorinity of freshening due to heavy river discharge is shown.

5. Maximum values for dissolved oxygen were observed from February to May. The high concentrations were not found close to the tributaries, and since this is about the time of little run-off, these high values may be due to biological activity, not to river flow.

6. Maximum phosphate content was observed in August and September; minimum values, from January to July. This brings out the direct relationship of phosphate abundance to great river discharge.

7. The seasonal variation is shown of temperature, chlorinity, dissolved oxygen, and phosphate content at the surface layer and at the bottom layer at a selected station for the entire period of investigation.

LITERATURE CITED

DOMANTAY, JOSE S.
1937. Report on the Marine Fauna of the Western Part of Lingayen Gulf. Phil. Jour. Sc.

MEGIA, T. G., M. N. LLORCA and R. G. LAO.
1953. A Contribution to the Oceanography of Manila Bay. Phil. Fisheries Handbook, 8th Pac. Sc. Cong. 1953.

MEGIA, T. G. and A. R. SEBASTIAN.
1955. Equipment and Methods Used in Oceanographic Investigations in the Philippines. Phil. Jour. Fisheries, Vol. 2, No. 2, 1955.

ILLUSTRATIONS

TEXT FIGURES