11th PACIFIC SCIENCE CONGRESS

Seasonal variations in the western equatorial Pacific.

By ROTSCHI Henri and LEMASSON Lionel *

Summary

It is considered generally that in the Pacific, the equatorial upwelling is associated to a divergence of the wind-driven surface currents and that this upwelling results in a cooling of the surface waters and their enrichment in nutrient salts. But the existence of the upwelling may be questioned even by the distribution of the nutrient salts at the equator and the east-west variations of their concentrations in the upper layers.

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* Océanographes physiciens, ORSTOM, Centre ORSTOM NOUMEA.

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The surface temperature atlases suggest that west of 180° there is no upwelling ; further, meteorological maps show that at the equator the east component of the trade winds is extremely low when it has not purely desappeared ; thus, as suggested by Knauss, if the Cromwell current is associated to a presure field produced by the divergence of the wind-driven currents at the equator, it should be weak in the western Pacific.

Recent cruises of the N.O. CORIOLIS made with the aim of studying the seasonal cycle along a meridional section at 170°E help to throw some light on the problem,in the western Pacific, of the upwelling as well as of the Cromwell current.

Trimestrial cruises from 20°S to 5°N along 170°E with return along either 165°E , 180° or 160°E have been made in december 1965, march and june 1966, a forth cruise been planed for september 1966. Observations have been made on the classical hydrological features together with determinations of the concentrations of dissolved oxygen, dissolved phosphate, nitrate and nitrite, pH and total carbon dioxide ; between 5°S and 5°N, stations were made every 30 miles.

Between december 1965 and march 1966 the properties of the superficial and subsuperficial waters have varied widely and significantly.

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First of all, the convergence zone of the winds was close to the equator in december and was found between 10-15°S in march ; the location of the surface salinity minimum which is associated with the high rainfall in the wind convergence also changed ; in december, it was found between 5°N and 5°S, whereas in march it was between 4°S and 10°S. Further, in all season, there is, close to a depth of 150 m, a subsurface salinity maximum, where the salinity is sligthly higher than 36,10°/oo its core is at a latitude close to 11°S. In december, this maximum can be followed as far north as 1°N ; thus it crosses the equator. In march on the contrary, it does not crose the equator. Thus, it seems that at the equator in march , a certain form of vertical mixing between the surface and the top of the thermocline which is always associated with the salinity maximum, limits the transport, through the equator in a meridional plane, of important quantities of high salinity waters ; neverthsless, if in december the equator is crossed by the salinity maximum, the high horizontal salinity gradient south of the equator suggests that even during this period the horizontal transport is somewhat limited.

The temperature sections show also important variations of the thermal structure of subsurface waters. In december, the mixed layer has a thickness of 100 m except north of 1°30N where it decreases rapidly towards the north ; in march this

thickness is considerably smaller. The 28°C isotherm which practically coïncides with the lower limit of the mixed layer has a depth of 10 m at the equator whereas in december it was at a depth of 100 m. Similarly, the vertical temperature gradient which is high in december at the equator, in the thermocline limited by the 28°C and 18°C isotherms is much lower in march when the thermocline is not as clearly marked. Nevertheless, the depths of the isotherms 15°C, 20°C and 25°C varies little, except in the equatorial region, between 2°N and 2°S where the apparent effect of the Cromwell current on the vertical distribution of the temperature can be traced down to 400 m, at the 10°C isotherm.

It can be noticed on the distribution of the nutrient salts such as phosphate and nitrate, that between 3°S and 4°N, the waters of the mixed layer have been significantly modified. In december, the phosphate concentration is lower than 0,40 mat-g/m^3 and that of the nitrate is lower than 0,50 mat-g/m^3 in march, the phosphate concentration reaches a value higher than 0,60 mat-g/m^3 whereas the nitrate concentration is higher then 1,0 mat-g/m^3 ; thus, the first has increased by 50 % and the second has more than doubled. These variations of the concentrations which are limited to the equatorial zone can be due to a vertical transport between the upper layer of the thermocline and the surface layers.

Finally, it appears that if in december at the equator none of the properties which have been studied allows to think that there might be an enrichment of the surface layers from the thermocline, there is such an enrichment in march through possible vertical movements associated to limited horizontal exchanges through the equator. But these vertical movements which are not exactly an upwelling since there is no cooling of the surface waters and no apparent diverging of the surface flow do not seem to correspond to a reinforcement of the Cromwell current since the effects of the latter on the distributions in a meridional plane are as marked in december than in march.