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PROSPECTS FOR THE DEVELOPMENT OF TUNA FISHERIES IN THE SOUTH PACIFIC

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The southward and eastward spread of Japanese skipjack fishing has run roughly as far as 10° south and 175° west. Fishing statistics highlight the significance of hydrological disturbances caused by islands, and also of the whole network of tropical and equatorial currents and counter-currents.

A highly active fishing zone is centered on the convergence of the equatorial current and the northern equatorial counter-current. (MAGNIER et al. 1973).

In August, this convergence generally occurs at 3 to 5° N. The area fished by the Japanese in August 1975 (see attached maps) concurs with the convergence of August 1973 during the "MINEPO" cruise by ORSTOM researchers aboard the CNEXO oceanographic vessel "Coriolis" (figure 3).

A. Island-influenced waters

Skipjack fishing in the South Pacific could well be developed in the zones of oceanographic disturbance associated with islands.

The initial results achieved by the Japanese in Tahiti and New Caledonia are promising. In Tahiti, from 15 February to the end of March 1975, daily catches ranged up to 35 tonnes. Skipjack were generally small (1.5 to 3 kgs); schools were densely concentrated within larger groups. During the same period, daily catches of 10 to 15 tonnes of 10-15 kg skipjack were made at 10° S and 148-149° W. Prospects in this area would appear particularly encouraging.

Between the Bélep Islands and the Chesterfields in New Caledonia, three tuna boats produced excellent yields (10 to 30 tonnes per day) in February and March 1975, despite relatively rough seas. Many schools of yellowfin with a high percentage of large fish (70% > 6 kgs) have been reported in this area.

Daily catches of 10 tonnes were recorded by a pole-and-line vessel operating near Wallis and Futuna in late March 1975.

B. The network of currents and counter-currents

Work by ORSTOM in Noumea [DONGUY (J.R.), ROTSCHI (H.), 1970 - DONGUY (J.R.), HENIN (C.), ROUGERIE (F.), 1976 - JARRIGE (F.), 1968 - MERLE (J.), ROSCHI (H.), VOITURIEZ (B.), 1969] has shown that surface circulation in the tropical south-west Pacific area is more complex than is commonly thought to be the case.

As opposed to the single anticyclone region covering the whole of the South Pacific, two independent zones may be distinguished from Australia to 130° W. West of 160° W, two counter-currents appear: the southern equatorial counter-current, and the southern tropical counter-current. East of 160° W, only one - independent of the first two - may be distinguished. While the characteristics of these counter-currents have been determined, their seasonal variations and their influence on the productivity of the area, that of fishing in particular, require further study.

The northern tropical convergence (25 to 30° N) appears to be undergoing fairly extensive skipjack fishing. We were able to study the southern tropical convergence as a result of work on hydroclimates, based on information on commercial shipping, by DONGUY and HENIN.

Since November 1971, a vessel belonging to the Sofrana Unilines Shipping Company has been providing us with regular monthly observations of surface temperature and salinity as noted every 40 miles from New Caledonia to New Zealand, further information being occasionally supplied by naval and oceanographic vessels. Each crossing has shown the existence of a clear thermal front around 170° E and between 25° S and 30° S. It produces temperature variations of up to 1° for 10 miles, total magnitude being 3°. A more accurate description would be "thermohaline front", as it coincides with a sharp rise in salinity from 0.2 to 0.5°/oo. Thus, the front appears to be the dividing line between two bodies of water, warm and relatively unsalty to the north, and temperate and salty to the south. Information from New Zealand on the area between Fiji and New Zealand shows that the front extends to 178° E (figure 4). It was very clearly brought out by the NORTHERN HYDRO cruise (August 1975) by R/V "TANGAROA", of the New Zealand Oceanographic Institute (B.A. Stanton priv. inf.). Temperature and salinity readings between 23 and 35° S, gathered during a return trip from New Zealand to Fiji, are given in figure 5. There has been shown to be a very pronounced thermohaline front at 26° S; it may prove to be associated with substantial tuna concentrations. The thermohaline structure north of the front, in waters with a temperature of 24 - 25°C, shows a homogeneous warm surface layer of about 50 meters which should provide good catches by seine netting. Figure 6 contains bathythermogrammes made in March 1976 by the New Zealand Defence Scientific Establishment (Crook F.G., priv. inf.).

The extension of the southern tropical convergence is situated in the south of French Polynesia. The presence of thermal fronts in this area was determined in a hydrographic survey by the French Navy, during missions by the "Lotus" from September 1957 till September 1958. There would appear to be particularly significant thermal fronts around the Austral Islands (figure 7).

Research Required

The information and indications available would appear to provide ample justification for tuna prospection based on the French South Pacific territories. However, such prospection should obviously not be conducted without thorough prior knowledge of the most suitable hydrological conditions.

Before forming fishing fleets in as yet unexplored parts of the South Pacific, it is indispensable to determine the size and the extensions, in terms of both time and space, of frontal zones associated with convergences. Assurance must also be obtained that tuna do indeed congregate along thermal fronts. In addition, island-induced disturbances, especially in French Polynesia, appear to hold great promise for purposes of prospection.

Remote sensing has provided fishing biologists with a suitable instrument for the identification of areas that are hydrologically conducive to tuna concentrations. Cooperation between CNEXO, the Science Faculty of Lille, the ORSTOM, and the Société Interthon, has enabled French teams working off the African coast to obtain most interesting results. They showed how quickly a frontal system can be studied from an aircraft, and the undeniable advantages of airborne remote sensing over oceanographic vessels for the study of tuna associated with thermal fronts /DESCHAMPS (P.Y.), LECOMPTE (P.), VANMOUTTE (J.C.), 1973 - LE FUEN (J.C.), DESCHAMPS (P.Y.), GUILLERM (J.M.), METAYER (M.), 1972 - NOEL (J.), STRETTA (J.M.), 1975 - STRETTA (J.M.), NOEL (J.), 1974 - STRETTA (J.M.), NOEL (J.), VERCESI (L.), 1975/. Projections of tuna concentrations within certain thermal structures have been completed.

"The following may be one of the processes leading to large tuna concentrations:

- Contrasting bodies of water undergoing seasonal change and associated with enriching factors (impoverished cold waters and rich warm waters): tuna present but scattered.
- Large-scale movements of rich waters forming thermal fronts, which in turn give rise to mechanical processes (convergences, divergences), thereby stimulating the development of zooplancton and micronecton: appearance of large tuna concentrations.
- Stabilization of frontal thermal structures with their high micronecton content: tuna remain in surface schools, facilitating purse-seining and pole-and-line fishing.
- Reabsorption of thermal fronts, reappearance of the pre-season situation: tuna scattered.

The sectors of the Gulf of Guinea in which dense tuna concentrations are observed seem to coincide in virtually all cases with areas in which warm waters have withstood the overall breakthrough of cold waters.

This failure of certain areas to obey an overall tendency towards a given thermal situation could be a means of identifying zones in which tuna are likely to concentrate within the near future". (STRETTA et al. 1975).

Experience off the African coast - that of the ORSTOM team in particular - appears to justify scientific prospection in the South Pacific as a preliminary to the creation of fisheries based in French Polynesia, New Caledonia, and Wallis and Futuna. Using a long-range aircraft with appropriate remote sensing equipment, it should be possible to draw up a rational work schedule for an industrial fishery within a period of about two years. Satellites can also be of use, by providing immediate identification of the various bodies of water and the main current network. This would lead to a considerable time saving, as areas unlikely to harbour tuna concentrations would be eliminated.

Satellites alone are not yet sufficient for research into the tuna potential of an ocean area. Despite real progress, especially with the scanning radiometer (S.M.M.R.), it is impossible to obtain by satellite surface temperature readings to the required degree of accuracy. The average margin of error is around 1.5 to 2°C in clear or slightly cloudy weather, and much higher in overcast weather (as is frequently the case in the inter-tropical area). Satellites cannot therefore provide satisfactory detection of thermal fronts featuring temperature variations of around 2 to 3° with gradients not exceeding 1° for 10 miles.

Using an aircraft, temperature readings to within $1/10^{o}C$ can be obtained, with the result that radiometers become fully effective for this type of research.

Mounting the necessary remote sensing equipment aboard an aircraft is easy, and a plane so equipped is at present the most suitable instrument for prospection of marine areas in which tuna are likely to congregate.

In the South Pacific, using conventional equipment aboard an oceanographic vessel, tuna prospection of this type would require 10 years. The results would be of great scientific value, but less valuable for the creation of tuna fisheries.

A further advantage of aircraft is rapid visual prospection without remote sensing equipment. In August 1976 ORSTOM conducted a trial between Wallis and Futuna, using a twin-engined Brittain-Norman. Low altitude visibility (300 - 500 feet) was good. Concentrations of small tuna were observed, associated with large numbers of birds. Current lines, possibly indicating island disturbance zones, were also visible.

In conclusion, remote sensing provides a means of conducting a great variety of marine research work, be it wholly pure or wholly applied. To oceanographers, biologists and physicists, it opens new research horizons that are particularly relevant to a synoptic approach to oceanic phenomena.