Reprinted from Section II of Proceedings of Indo-Pacific Fisheries Council, 1955

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DIOCESAN PRESS, MADRAS

CORRELATION OF HYDROGRAPHIC AND METEOROLOGICAL FEATURES WITH THE FLUCTUATIONS IN CERTAIN FISHERIES IN THE WATERS OFF JAPAN

by

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The anomalous feature of the Kurosiwo Current during the years from 1936 to 1947 is a remarkable example of hydrographic variation. The winter fishery of the yellow-tail along the Pacific side of Japan was of good intensity in the years 1924, 1938 and 1952—years in which unusually strong current conditions prevailed in association with the anomalous behaviour of the Kuroshiwo, resulting in heavy damage to many set nets.

The years 1936 to 1940 were comparatively warmer both in the Japan Sea and the Pacific Ocean and these were years of rich sardine, skipjack and tunny fisheries which declined in the colder years which followed (1941-1947). This colder period was however associated with an increase in the squid and the Pacific saury fisheries. But with the gradual rise of the water temperature from the coldest years of 1944 and 1945 back to the normal by about 1948 and 1949, the yields of the small tunas and the large sardines slowly increased along the coast on the Japan Sea side.

The sardine fishery was abundant in the northern part of the Japan Sea from 1923 to 1940 but declined rapidly from 1941 along the coasts of Northern Korea and Hokkaido. It is presumed that during the warm years the fishery stretched to the extreme north; for the return of the adult sardines to the spawning ground to the southeast of Kyushu in autumn and winter was checked by the warm northward current. The journey to the spawning ground in the peak period of spawning was thus obstructed, and even the eggs and larvae spawned on the way were destroyed by the sudden cold in the autumn and winter. In this way the sardine stocks were considerably reduced.

Based on the survey made by the Soyo Maru it has been shown that, as compared with the spring of 1932, in the spring of 1941 the spawning populations of the Pacific saury abounded with eggs and larvae in waters of 16°-18°C in the Japan Sea while longline samples from depths of 50-200 m. showed pollack to be plentiful especially in the zone of upwelling of the cold water mass at temperatures from 1° to 3°C.

The fluctuations in the abundance of the swarms of *Euphausia pacifica* Hansen in the Japan Sea affords another instance of the correlation of temperature with such phenomena.

From January to May 1948 the swarms were abundant on the coast on the Japan Sea side. The dense swarms moved successively along the coast from Gotō Island in the Nagasaki Prefecture to Wakasa Bay, coinciding with the migration of sardine, mackerel and squid. The temperature pattern showed that these movements corresponded to a shift in the optimum temperature range of 12°-14°C.

As with the cold water circulation in the Japan Sea, in the Okhotsk Sea the range of the dichotherm water (3° to -2°C) representing the Oyasiwo Current which results from melting ice, extended to the south, year after year, from 1939 to 1942. A rapid increase in the yields of squid and Pacific saury appeared in recent years after 1945.

During the past 200 years poor rice crops have occurred in several years† ($\propto \sqrt{P_s - P_a}$) on the Northeast coast of Japan when the anomalous behaviour of the prevalent cold Oyasiwo Current resulted in unusually cool summers. These cool years show somewhat similar climatic features to normal winters, i.e. the development of the Siberian High (P_s) and the Aleutian Low (P_a) due to the prevalence of the northward warm current (a branch of Pacific Drift Current) in the preceding year. Consequently, the greater the pressure gradient, the stronger the winter monsoon ($\propto \sqrt{P_s - P_a}$) strengthening the anticyclonic atmospheric circulation around the Aleutian Low.

Finally, the Oyasiwo Cold Current pushes southwards from the Okhotsk Sea along the Kurile Islands on the Pacific side. Hence, a year of preponderance of the northgoing warm current (rich crop of rice and rich tuna fisheries) precedes a year of preponderance of the southgoing Oyasiwo Cold Current (poor rice harvest, cool summer, good fishing for squid, pacific saury and winter yellow-tail). Fur-

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† 1755, 1783, 1833, 1837, 1866, 1869, 1884, 1902, 1905, 1913, 1923, 1931, 1934, 1941, 1945 and 1953.

thermore, after such southward incursions of the cold current, the increased water density in combination with the pressure gradient due primarily to the North Pacific High and secondarily to the Okhotsk High again induces the cyclic northward drive of the warm current.

Thus there is a succession of rich years and poor years, both as regards the fisheries and the rice harvests. It has been seen that the years of cool summer in Northern Japan are preceded by a winter in which there is a characteristic distribution of water temperature as between an area of temperatures colder than normal in the Northwestern Pacific west to Kamtchatka and an area of temperatures warmer than normal in the Northeastern Pacific northeastwards to the Aleutians. This might be called the law of regional correlation of water temperatures.

These phenomena may be compared with those found in the North Atlantic Ocean, substituting the Gulf Stream for Kurosiwo, the Labrador Current for Oyasiwo, the Icelandic Low for Aleutian Low etc.

The northward movement of fishing grounds and the decline of the herring fishery off Hokkaido, the cod fishery in the Japan Sea and the whaling industry in the North Pacific Ocean adjacent to Japan, may well be correlated with the secular variation of oceanic climate and particularly with the warming of the Arctic Ocean, as has been pointed out in the case of the North European fisheries.