Technical Papers

Equatorial Undercurrent in Pacific Ocean Revealed by New Methods

Townsend Cromwell, R. B. Montgomery,[1] and E. D. Stroup

Pacific Oceanic Fishery Investigations, U.S. Fish and Wildlife Service, Honolulu; Brown University, Providence, R.I.; and Pacific Oceanic Fishery Investigations, U.S. Fish and Wildlife Service, Honolulu

Indications of an eastward current at the equator beneath the westward South Equatorial Current came originally from the drift of long-line fishing gear in use from vessels of the Pacific Oceanic Fishery Investigations of the U.S. Fish and Wildlife Service. Direct observation of drifting objects, or "drags," from the Service's research vessel *Hugh M. Smith* during Aug. 1952 proved the existence of this eastward current in the central Pacific near the equator in the lower part of the surface layer and upper thermocline.

The surface current at three stations was observed by following a surface drag continuously for several days and determining its movement by celestial navigation. On 12 of the 18 days devoted to following the surface drag, deep drags with identifying surface floats were released. The velocity of the deep drag was measured relative to the motion of the surface drag by following the identifying float with the vessel and tracking the surface drag by radar up to ranges of 5 mi. Vector subtraction then gives the deep drag's true velocity, which can be used to make a close estimate of the velocity of the deep current.

The surface drag (Fig. 1) consisted of two 150 by 12-ft panels of fine-mesh netting joined end to end and buoyed to locate the top of the mesh 2 ft below the sea surface. The use of netting combined large resistance with ease of handling and stowage. A pole carrying a radar target and one carrying a flag and light were attached to the downwind end of the nets.

The deep drags (Fig. 2) were similar to a common form of sea anchor. Each consisted of a light muslin cone attached to an aluminum alloy hoop weighted at the bottom and buoyed at the top so that it would remain upright. Piano wire of diameter 0.72 mm joined the deep drag unit to two streamlined floats, one at the sea surface and the other slightly submerged. The drags used were 3 and 4 m in hoop diameter, so large that retrieval was impossible and a drag could be used only once.

Wind resistance of the poles prevented perfectly free movement of the surface drag with the current, and water resistance of the wire and floats similarly affected the deep drags. Corrections to reduce the drag velocities to current velocities are being determined, and a complete account of the data and results is being prepared for later publication. However, the submerged countercurrent can be described now in terms that will not be altered by these corrections.

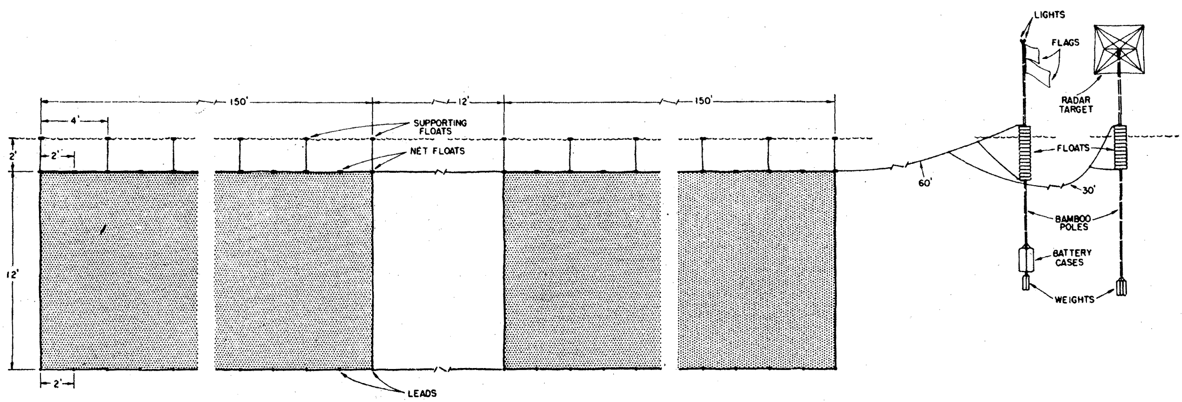

Fig. 1. Drag used to measure the surface current.

The 12 observations of the deep current were made near 150°W from 2°54′S to 7°05′N. The first, at 2°54′S at a depth of 200 ft, gave a northwesterly current of a little less than half a knot.

The following eight observations were in almost daily succession during the second drag station. The first four of these from 0°14′N to 1°31′N at depths in the lower part of the surface layer and upper thermocline indicated currents with easterly components. At the first of them, at 0°14′N, the surface current was nearly 1 knot north, while the deep drag indicated an east current stronger than 1 knot. The last four observations on this station, from 1°50′N to 2°43′N, revealed zonal flow directed west.

The final three drags were used at the third drag station, near 7°N in the Equatorial Countercurrent, where the current was easterly by both surface and deep drags.

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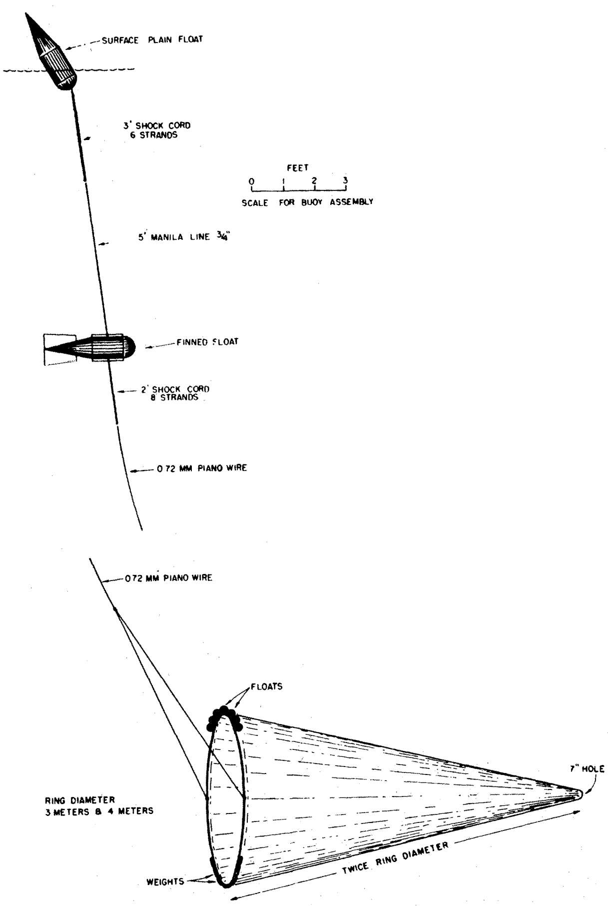

Fig. 2. Deep drag and buoy assembly used to measure the deep current.

The submerged east current was, thus, observed in a narrow zone near the equator, the speed of the axis exceeding 1 knot. It was separated from the Equatorial Countercurrent by water with a westward velocity component.

As mentioned in the opening paragraph, observations of the drift of long-line fishing gear have indicated the presence of the submerged current. The long line is a system of cotton lines suspended from buoys and floated freely in the water, the main mass of line lying, in these trials, in the lower part of the surface layer. This gear has been set very near the equator a number of times on various longitudes and, on several occasions, has moved eastward in spite of opposing southeast trade winds and seas at the surface, suggesting that the submerged current is prevalent near the equator in the central Pacific. Whether or not the current prevails in the eastern and western Pacific and in the Atlantic remains to be determined by further study.

In part, the dynamics of the current seem clear. The surface layer of warm water deepens westward, so that throughout this layer there is an eastward component of pressure-gradient force (*1*). Below the depth of influence of the southeast trade winds, water flows east in response to the pressure gradient. These considerations do not explain the narrowness of the current.

On this basis, the countercurrent at the equator can be expected to extend up to the sea surface when the wind stress is released or sufficiently diminished. Such an occurrence could explain reports of eastward drift of vessels close to the equator in the eastern Pacific and the Atlantic (*2*).

The countercurrent at the equator may, thus, occasionally be observed at the surface but is apparently more prevalent in the lower part of the surface layer and in the thermocline. For this reason the name "Equatorial Undercurrent" is proposed.

References

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Reciprocal Selection for Correlated Quantitative Characters in *Drosophila*[1,2]

Robert R. Sokal and Preston E. Hunter
Department of Entomology, University of Kansas, Lawrence

In recent years a number of mass-selection experiments directed at increasing, as well as decreasing, the magnitude of a given quantitative character have been reported (*1–4*). A constant feature of such experiments has been the occurrence of correlated changes in characters other than the one being selected. Three general hypotheses can account for these correlations: (*a*) unwitting selection for a genetically independent trait, physiologically essential to successful establishment of the main selected character; (*b*) linkage of genes responsible for the correlated characters; (*c*) pleiotropic effects of a single group of genes. The elimination of any one of these hypotheses is extremely difficult and is complicated by the fact that they are neither mutually exclusive nor necessarily collectively exhaustive.

One point of attack on the problem of correlated characters is to select separately for each of a pair of such characters (reciprocal selection) and study changes of both characters in both strains. Reeve and Robertson (*4*) were able to show a correlated response between wing length and thorax length on selection for either character, thus indicating a genetic general size factor. A similar genetic thorax length–wing length correlation was demonstrated in aphids (*5*).

Since early 1952, we have been selecting several strains of *Drosophila melanogaster* for resistance, as

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