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OCEANIC CURRENTS AND THE MIGRATION OF PELAGIC BIRDS

WITH THREE ILLUSTRATIONS

By S. C. BROOKS

The naturalist who voyages on the great oceans can usually escape much of the supposed monotony of the trip by watching the life in or over the water. But if our naturalist be eastbound on the main North Atlantic ship lanes he is likely to find that wild life fails him about the third day out, and until the crossing is nearly over he may sunburn himself all day for a paltry storm petrel or two. On almost any ocean there is day after day when scarcely a bird, beast, or fish appears to break the monotony, and contrasted with this, here and there a few minutes or hours of teeming abundance, when every field of the binoculars shows a dozen birds or a hundred, and porpoises, orcas, or that cynosure of all passengers' eyes, "real whales," are seen on every hand. Why should things be so badly arranged?

The reason is not far to seek if one looks upon the ocean not merely as an open space for birds to fly around on, but as one organic whole with its own geography which is inseparably intertwined with the life in and upon it. This is likely to escape attention, and many ornithologists with passerine predilections might well, as did the writer at first, accept with resignation the lean with the fat, all as ordained by an inscrutable Providence, and thus miss the real beauty of the picture unrolled before his eyes. Although the general picture is seen by many sea-going naturalists and most oceanographers, it is perhaps here not out of place to outline for the terrestrial ornithologist some of the larger relationships involved.

It has been the writer's good fortune to have made in recent years several ocean voyages, including five across the North Atlantic and several on or across the Pacific. As a strictly amateur ornithologist he has had much to learn, and much cause for bewilderment, but in the course of these voyages the broader relationships have gradually impressed themselves upon him, until they have come to be a really absorbing study. In this gradual emergence of a new point of view, the writer owes a great deal to the interest and many courtesies accorded by officers and men of many ships, and especially to Officer Germayne, then of the R M S "Makura", who really supplied the key to the whole problem by pointing out the relationships at the Pacific equatorial margins.

These relationships are well seen by one who makes the trip from San Francisco to Tahiti. Embarking in the late afternoon, he sees for the rest of the day the

gulls and cormorants, the auklets, murres, and guillemots, which are sure signs of proximity to land. The next morning he may still see a few stray gulls, and by dint of patient watching perhaps also a storm petrel or two, which only long familiarity can help him to identify more closely. [The book "Birds of the Ocean" by W. B. Alexander (Putnam's, 1928, New York and London), has been found a valuable aid, especially in the Pacific area.]

Then there may be five or six days during which the most faithful watching will yield only here and there a storm petrel, or, especially toward the last, an increasing abundance of flying fish and rarely a lonely petrel or a tropic-bird or two. Then within a few degrees of the equator, the scattered cumulus clouds become thicker and grayer, a confused swell makes up, rain squalls come and go, and birds appear. At first there is only a greater abundance of storm petrels, with here and there petrels of other kinds hunting along utterly indifferent to the ship, or small groups of tropic-birds flying along with the ship, off to one side or high overhead. Then scattered groups of various petrels appear, and finally for an hour or two there are birds on every hand. If one is not too far from land, a few hundred miles perhaps, as in the case of the south equatorial drift north of the Marquesas, one may also see multitudes of sooty or crested terns. Occasionally one sees the grayish blue form of a shark gliding along, or a big purplish-brown hammerhead lazily twisting around as though trying to get a better view of the ship. Flying fish, while not so closely localized as the birds, are breaking the water every few seconds, and bewitch the beholder by their myriad sizes, shapes, and antics, and their bewildering patterns and shades of deep brown, opal blue, yellow and purple. Then the sun comes out again, the sea takes on its deep tropical blue, the birds become more and more scarce, and gradually, as the ship moves on, the ocean resumes its desert aspect.

If it were daylight all the time, this same sequence might be seen in a more or less striking fashion twice or perhaps even three or four times. Inquiry soon reveals that this sequence marks the time of passing the edge of one of the great currents. There are three of these to be crossed: the two westerly equatorial drifts, driven by the constant "trades", and between them the counter-equatorial current carrying part of the piled up waters back eastward. Where two such oppositely flowing currents touch, there is always turbulence which stirs up the deeper waters and tends to bring them to the surface. [For a simple discussion of oceanic circulation and its causes the reader may be referred to J. Johnstone's "An Introduction to Oceanography" (Boston, Small, Maynard & Co., 1923). A more detailed treatment will be found in Bull. Nat. Research Council, 1932, No. 85.]

Under some conditions this upwelling of ocean waters is sufficient to bring to the surface great masses of deep water which is rich in dissolved nutriment: mainly nitrates and phosphates. Just here begins the food chain which culminates in the bird life which is so conspicuous. This is what happens at the boundaries between the equatorial and counter-equatorial currents, and to a lesser extent at the outer margins of the former. The upwelling water has been cold, dark, and perhaps lacking in oxygen—hence barren; but let it have the warmth and sunlight of the tropics and it will blossom with countless billions of microscopic plants, the phytoplankton; and with this come countless billions of zooplankton—animals which feed upon the phytoplankton and upon each other. From these on, by devious paths, the food chain of prey and captor leads up to the flying fish, the sharks, the whales, and the birds. That is why one usually sees these obvious forms most abundantly where great ocean currents meet.

In the North Atlantic ship lanes the same play is staged with different actors.

Instead of the equatorial currents there are the Gulf Stream and its continuation, the North Atlantic Drift, and the Arctic Current; instead of confused swell and squalls of rain there are slicks and fogs. Tropic-birds are replaced by jaegers and skuas; and different species of the petrel group, usually here spoken of as shearwaters and fulmars, are flying or swimming about, often in great flocks. The dry twittering of phalaropes and the white flash of their bellies as they rise from the water and make off to either side seem more appropriate to shore birds on a sandy beach or salt

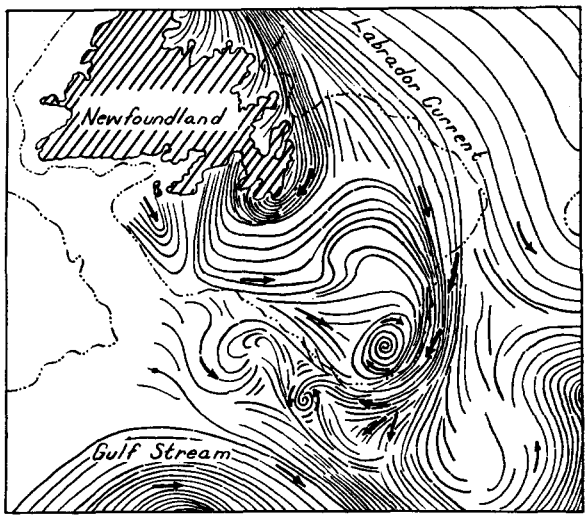

Fig. 31. Surface currents in the vicinity of the Grand Banks and Newfoundland. (After Smith, 1924.)

marsh than they do to the mid-ocean. Scattered swallow-tailed and arctic terns replace the flocks of sooties and crested terns. Here too, perhaps, one sees less of sharks and more of porpoise racing with the cut-water or doggedly hurrying, school after school, toward some unguessable objective. The flashing black and white of the young orcas, or the distant sudden spurt and lazy drift of a whale's spouting, lend life to the water, as do the antics of flying fish, distant though they be from their traditional home in the tropics.

But the underlying plan is the same. Where the Arctic Current meets the Stream there is a complex and shifting system of currents and eddies (see fig. 31), with turbulence and upwelling. There one may pass from the blue water of the Stream, with floating gulf weed (*Sargassum*), and perhaps here and there the iridescent float of a Portuguese man-of-war, into the gray-green water of the Arctic Current with its thousands of jelly fish, and in a few hours back again into the Stream. Each time, at the margin, one is likely to see the surface display of that abundance of life which has made the Grand Banks one of the great fisheries of the world.

It is not always true of the North Atlantic ship lanes, as it is of the eastern Pacific, that most of the ocean appears wholly desert. Here the complications of dilution by rain or melting ice, evaporation, summer warming, and winter cooling, and the tendency of ocean currents to deviate to the right in the Northern Hemi-

sphere—all of these determine a complex circulation in which upwelling occurs and conditions for plankton growth are often favorable. The complexity of the circulation may be seen in figure 32.

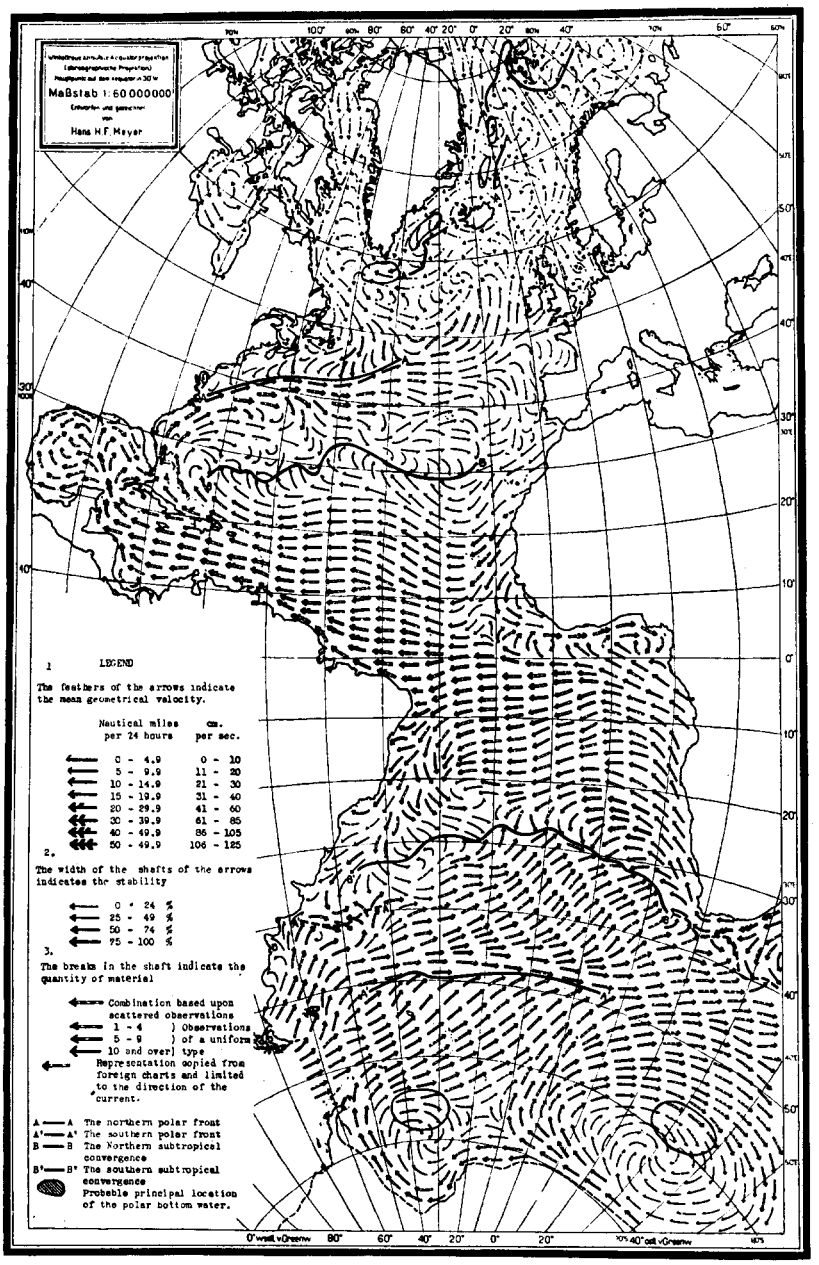

Fig. 32. Surface currents of the Atlantic Ocean in February. Note particularly the polar fronts: A-A and A'-A', and the subtropical convergencies: B-B and B'-B'. (After Meyer, 1928.)

Accordingly, it often happens that birds, especially kittiwakes, may be encountered in fair abundance all across the Atlantic north of the fortieth parallel. This is well shown in figure 33, which is redrawn after figures given by Jesperson (1926, 1930), in his paper "On the Frequency of Birds Over the High Atlantic Ocean." Other papers show the same general picture (Nicholson, 1928; Nicholson and Nicholson, 1931).

Jesperson's papers are particularly interesting because of his simultaneous determinations of the abundance of birds and of the larger plankton forms. These larger forms were scarce where birds were scarce, and abundant where birds were most frequently seen. Figure 33 shows how this abundance of food organisms, as shown by the type of shading, is everywhere correlated with the abundance of birds. Many readers will recall that where the Humboldt Current is diverted to the left by the earth's rotation as it flows north along the Peruvian coast there occurs this same correlation of the upwelling of fertile ocean water, abundance of plankton, and myriad birds—the source of the famous guano of commerce (Murphy, 1923).

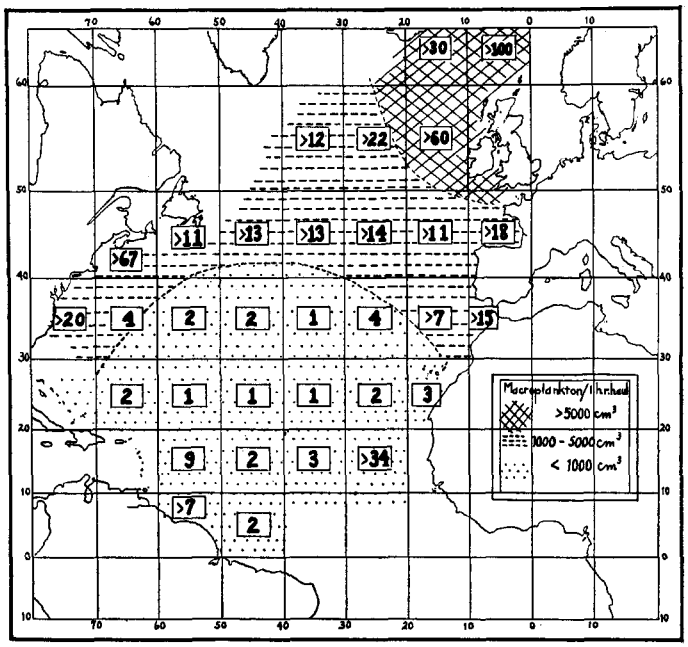

Fig. 33. Distribution of macroplankton and bird life in the North Atlantic. The abundance of plankton in each 10° square is shown by the shading, and the average number of birds seen per day is given by the figures in the corresponding squares. The sign > means that birds were seen in flocks and probably numbered more than the figure given. (After Jesperson, 1926 and 1930.)

Confining one's travels to regular ships' lanes one sees only here and there a cross section of some branch of a larger distribution. Could one but map at different seasons the distribution of different species, and especially could one learn the type and abundance of their food, what might one learn as to their migrations! How are they led to move from their breeding grounds out over the trackless ocean,

often literally thousands of miles from land, and back again, perhaps to some one tiny island, the recurrent focal point of their wanderings? A remarkable example of such behavior is the shy albatross (*Thalassarche cauta eremita*), a subspecies which musters only a hundred or so individuals, which scatter over the Pacific in winter, but return to Pyramid Island in the Chathams to breed (Murphy, 1930). The drifts of food, which are not merely haphazard but rather in their turn more or less regularly determined by seasons and ocean currents, may well be factors in guiding migrant birds where all other landmarks seem to be lacking. When the sooty terns, for example, were taken from Bird Key in the Tortugas and liberated off Cape Hatteras, did the rich feeding grounds along the margins of the Gulf Stream play any part in guiding them back? Perhaps other factors too must be considered, such as the density of the air, which Jones (1926) regards as the thing which determines the northerly limits for the Wandering Albatross.

These questions challenge the imagination and make an ocean voyage for the ornithologist a much more exciting and profitable thing than the mere tabulation of daily observations, or even the seeing of unfamiliar species. Here is a problem worthy of the best thought that can be given it.

So the ornithologist at sea, whether he be on regular lanes or cruising less frequented waters, should look upon the ocean as a whole. He should study its waters, their chemistry, their flow; the life in them as well as over them. For thus will he come to see, with previously unimagined variety of scenes and actors, the drama of the life of the ocean.

LITERATURE CITED

Jesperson, P.

1926. On the frequency of birds over the high Atlantic Ocean. Verhandl. VI. Internat. Ornithologen-Kongress Kopenhagen: 163-172.

1930. Ornithological observations in the North Atlantic Ocean. The Danish "Dana"-Expeditions 1920-22. Oceanographical Reports, No. 7: 1-36.

Jones, F. W.

1926. Some observations on the flight of sea birds. Trans. Proc. Royal Soc. South Australia, 50:36-44.

Meyer, H. H. F.

1923. Die Oberflächenströmungen des Atlantischen Ozeans im Februar. Veröff. Inst. Meereskunde, n.s., Series A, No. 11.

Murphy, R. C.

1923. The oceanography of the Peruvian littoral. Geographical Review, 13:64-85.

1930. Birds collected during the Whitney South Sea Expedition XI. Amer. Mus. Novitates, No. 419:1-10.

Nicholson, E. M.

1928. Bird notes from the North Atlantic. British Birds, 22:122-133.

Nicholson, E. M., and Nicholson, B. D.

1931. An ornithological transect of the North Atlantic. British Birds, 24:266-274.

Smith, E. H.

1924. Ice drift in the North Atlantic. U. S. Coast and Geodetic Survey, Hydrographic Office, Pilot Chart of the North Atlantic Ocean, Supplement.

University of California, Berkeley, June 6, 1934.