



SEA-BIRDS

JAMES FISHER

AND R. M. LOCKLEY



C & R E

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James Fisher and R. M. Lockler



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The aim of this series is to interest the general reader in the wild life of Britain by recapturing the inquiring spirit of the old naturalists. The Editors believe that the natural pride of the British public in the native fauna and flora, to which must be added concern for their conservation, is best fostered by maintaining a high standard of accuracy combined with clarity of exposition in presenting the results of modern scientific research. The plants and animals are described in relation to their homes and habitats and are portrayed in the full beauty of their natural colours, by the latest method of colour photography and reproduction.

To
JULIAN HUXLEY
in gratitude for his guidance
and encouragement, and in recollection of the
many happy days we have spent together,
watching sea-birds

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EDITORS' PREFACE

IT IS NATURAL that in a series dealing with the wild life of the British Isles sea-birds would be a subject planned for early publication; and in fact this book was announced as forthcoming five years ago. That it has not been completed earlier is not due to any want of industry on the part of its authors. On the contrary, in their researches for this book they have found their subject so absorbing that they have made the interval an opportunity to continue to publish numerous scientific papers, and two monographs, on sea-birds. James Fisher is the author of *The Fulmar* (1952); and R. M. Lockley, author of *Shearwaters* (1942), has just published *Puffins* (1953). There could, in fact, hardly be any other pair of authors better qualified to describe the sea-birds of the North Atlantic than these with the experience of many years of field work and visits along the coast and islands, from Spitsbergen and Iceland in the cool north, to Madeira and the Salvages in the warm south, of that great demi-ocean. They have made their visits often together, and lived much on the small remote islands where sea-birds breed.

The North Atlantic, busiest ocean in the world, is revealed in the opening chapters not as a monotonous watery plain, but as an intricately varied, densely inhabited foraging ground for sea-birds. This avian community, though remarkably homogeneous in different sections of the broad expanse of the North Atlantic, is fascinating in the variety of the species that compose it, and in the complexity of their movements and migrations. The annual migrations of some species extend the total range of the community from the arctic to the antarctic. These long transatlantic migrations, verified by ringing, take species from east to west between Europe and North America, and from north to south between Greenland and South Africa, Britain and South America.

The authors tell us of the primitive progenitors of the sea-birds, dating from over sixty million years ago, and the evolutionary adventures of their descendants, including the notorious extinction of the strange flightless great auk, the sad decline of many other fine species, also the rediscovery of the cahow after it had been presumed extinct. They have paid special attention to geographic distribution, and have provided a unique collection of maps, giving us, for the first time, the distribution of most species of North Atlantic sea-birds.

Chief among the authors' interests has been the study of sea-bird numbers. They were largely responsible for organising the surveys of that splendid and typical North Atlantic animal, the gannet, which provided biology with the first reasonably accurate figure for the world population of any single and fairly numerous bird species. They have, from their own notes and those of many amateur and professional bird-watchers, produced interesting statistics of the total population of the fulmar, the Manx shearwater, the puffin and many others. Incidentally, such careful counts, site by site, reveal the continuous change that is going on in sea-bird populations, often directly or indirectly due to man's influence.

The chapters on life-history are preceded by a general account of social and sexual behaviour which throws light upon the significance of the prolonged and, to the observer, entertaining, mutual ceremonies of these strictly monogamous birds, their pair-formation, their fidelity to their mates, their nest-sites and their parental duties; at the same time problems of instinct and learning ability are discussed. The life-histories include much original field-work by the authors, who have been responsible for several discoveries concerning the incubation and fledging of a number of sea-birds.

We read of the birds' ecology, their sharing of the wild frontiers of the land where they nest, their niches in the economy of the ocean. We learn of the contrasts between cliff-dwelling and hole-nesting

species, of how the guillemot and razorbill chicks, exposed to many dangers on the open rocks, hasten their feather-growth and depart to the sea in two weeks, while the young puffins, safe in the darkness of their burrows, delay their departure for seven weeks, and are finally deserted by their parents; we learn of the strange lives of the shearwaters and small petrels which wander after the breeding season between the North and South Atlantic Oceans, living in perpetual summer—the Tristan shearwater “wintering” in our northern summer, and the Manx shearwater enjoying its “winter” in the southern summer off the coasts of South America.

But we have said enough to indicate the richness of knowledge brought together in this volume which we confidently recommend as indispensable to everyone interested in the birds of the sea.

THE EDITOR

AUTHORS' PREFACE

THE HEROES of our story are rather over a hundred species of birds whose life is a sea-life, whose habits enable them to earn at least part of their living in, or on, salt water, and which have been seen in the Atlantic Ocean north of the Equator.

The North Atlantic is the scene of our book, the great ocean that is now the most travelled by man. Its two sides are provided with an almost equal variety of sea-birds: sixty-eight species, or rather over half are common to both. Of all Atlantic countries Britain, considering its size, has the greatest number of sea-bird species; with no less than eighty, it can boast on its list all but six of those that have been seen on the Atlantic coast of Europe. The British Isles therefore make a good headquarters for a survey of the sea-birds of the North Atlantic. In Britain, and from Britain, the writers of this book have explored the eastern Atlantic sea-bird stations, and enjoyed many fine islands and memorable experiences. One or the other of us has sought the sea-birds south to the frigate-petrel burrows of the Salvages, near the Canary Islands; north to the ivory-gull colonies on the nunataks that rise from the ice-cap of Spitsbergen; or from 30°N. nearly to 80°N., a distance of more than three thousand miles; west we have ranged to Iceland, the Faeroes, Rockall, St. Kilda and the Blaskets of the Kerry coast; east we have travelled to Heligoland, and as far as Laesö in the Kattegat and Gotland in the Baltic, with their off-lying islands of sea-birds. There is no coastal county in England, Wales or Scotland that has not been visited by us both, and not one in Ireland that has not been visited by one of us.

No good British sea-bird cliff or island has been overlooked in our search for what the naturalist searches for; our experience and enjoyment has been long and continuous because both of us are, each in his somewhat different way, obsessed with sea-birds and with islands. We have spent a combined total of nearly seventy years sea-bird watching.

We have seen the little crags and green island swards of the Isles of Scilly and the drowned coast of Cornwall; the granite cliffs and puffins of Lundy; the chalk of south England east from Dorset; the flats and shingles and dunes of Essex and Suffolk and Norfolk, and the sanctuaries of Havergate and Minsmere and Walberswick and Cley and Blakeney and Salthouse, with terns and avocets and many kinds of marsh-birds. One of us has spent many years of his life in the county of Pembroke, living on Skokholm, and on other islands and peninsulas of the Welsh coast; of its sea-birds he has written many books, and on Skokholm established the first permanent coastal bird observatory in Britain; the other has spent parts of twenty seasons in North Wales, and has worked its coast from St. Tudwal Islands to the Little Orme. Both of us know the Yorkshire bird-cliffs most of the way from Flamborough Head to Saltburn; and we have explored the shore of Durham, where bird-cliffs and black industry mix. In Northumberland we know Cullernose Craster, and Dunstan-burgh and Bamburgh Castle, and the cliffs north of Berwick, and other places where sea-birds nest; and we have been to the Holy Island, and to Coquet Isle, and to various of the Farne Islands, where the guillemots and kittiwakes are tame. We have seen the steep cliff-hill of the south part of the Isle of Man, and the sanctuary of the Calf; and have visited the inland gull colonies of North Lancashire and the Lakes.

In Scotland we have, at one time or another, visited every important sea-bird station: in the east St. Abb's Head, Fast Castle, Tantallon Castle, the Bass Rock, the exciting Isle of May, and many others; in the west the Lowland coast from the Mull of Galloway in Wigtownshire up-Clyde as far as Ailsa Craig, whose magnificent gannetry has been the scene of many weeks of enjoyment and experiment in efforts to improve the counting of nesting sea-birds. Our visits farther north have taken

us to Fowlsheugh in Kincardineshire, and round the bird-cliffs of the Aberdeen-Banff border—Penna Head, Troup Head and others. West along into the Moray Firth we have hunted out the bird-cliffs as far as they go, which is to Covesea in Morayshire.

In the West Highlands we have explored the mainland promontories of Kintyre and Ardnamurchan, and the islands of the Clyde and Inner Hebrides. We have searched the cliffs of western Islay closely from a slow aeroplane. The curious headland of Ceann a 'Mhara on the lovely sunnyside of the Island of Tiree has been investigated, as have the odd-shaped Treshnishes, home of seals, and the cape of Mull. The island of Eigg, where the shearwaters nest in a mountain; the magnificent but somewhat birdless island of Skye, and some of its attendant islets and stacks; both the lonely coast of Ross and its islands—Priest, Tanera, Glas Leac Beg and many others, where Frank Darling first worked out his theory of bird sociality by studying herring-gulls.

In the North Highlands we have watched the birds of the Black Isle Coast, and those of East Ross where the coast continues north of the Cromarty Firth to Tarbat Ness. In East Sutherland Dunrobin Castle itself becomes a bird-cliff, because fulmars are now prospecting it—and there we have seen them; in West Sutherland we have travelled nearly the whole wild coast, in instalments spread over several years; we know the crags of Stoer; the Torridonian sandstone precipices of Handa, the best bird island in Sutherland; the lonely cliffs on each side of remote Sandwood Bay—and Eilean Bulgach opposite which only half-a-dozen naturalists have visited; the high promontory of Cap Wrath, and the higher cliff of Clò Mor to the east of it—the highest mainland cliff in Britain—where the guillemots on two-hundred-foot stacks must be observed from six or seven hundred feet above sea-level; Fair-Aird Head and the home cliffs and caves of Durness; the huge white crags and stacks of White Head; the complex of islands and cliffs that stretches thence to Caithness, whose headlands too, we know, and their birds—Holborn Head, Dunnet Head, John o' Groats and Duncansby Head, Noss Head and Berriedale Ness.

In many years, and many boats (as well as from aircraft), we have enjoyed the Outer Hebrides from North Rona (which many call the loneliest place to have been inhabited in Britain) to Barra Head. We have seen the seals and birds of Rona, and counted the gannets of its lonely neighbour Sula Sgeir; and have hunted out the coast of the Lewis, and much of Harris. One of us has slept some nights on the Shiantas, among the rats that may be affecting the population of that vast remote puffinry; and has several times threaded the maze of the Sound of Harris, and eight times has been to St. Kilda, whose unsurpassed cliffs and towering stacks have to be seen to be believed (and are sometimes thought not believed). We have traversed the Long Isle—North Uist, Benbecula, South Uist and Barra—and many of its attendant isles, and carried on to sail close under the cliffs of Mingulay and Berneray, which for remoteness, grandeur and personality are rivals—much overlooked rivals—to those mighty precipices of St. Kilda, Conachair, Soay and Boreray.

One hundred and ninety-one miles west of St. Kilda, and about three hundred miles from the mainland of Scotland, lies a tiny rock which has been a magnet for us both—not only because of its bird-problems, but because it is a tiny remote rock! Fisher flew over Rockall in 1947. In 1948 Lockley spent twelve days in a trawler fishing within sight of, and on occasion very close to it. In 1949 Fisher sailed there in H. G. Hasler's sixteen-ton yawl *Petula*, and spent some time investigating it at close quarters.

One of us has visited Sule Stack, the lonely gannetry thirty miles west of Orkney; and we have enjoyed nearly every island, from North to South Ronaldsay, from Eynhallow to Hoy, and have seen sea-birds in a great range of surroundings. Neither of us is a stranger to the well-named Fair Isle, a great migration and sea-bird station. We know the Shetland gannetries of Noss and Hermaness, where

thousands nest—though forty years ago there was none. We have stood at the top of Foula's Kam and gazed ~~twelve hundred and twenty feet to the auk-scattered sea below.~~ We have sailed in and out and round about, the stacks and rocks and skerries, and voes and geos of straggling Shetland, and seen many a fine cliff, from Sumburgh in the south to Saxa Vord in the north; from Noss on east to Pap Stour on west. We are no strangers to Fitful Head, or Hillswick, or Ronas Voe, or Burra Firth; or to Hascosay, the bonny isle of Whalsay, Fetlar, Bressay or Mousa; or to the Out Skerries, nearest British land to Norway.

Perhaps in Ireland we have not seen all we should; but one of us knows the windy corner of Kerry, the end of the world, where the pure Irish survives on the Blasket, and where the fulmars now glide and play round Inishtearaght, Inish-na-Bro, and Inishvickillaun; and where the gannets make white on the serrated pinnacles of the Little Skellig, second gannetry of the world. He knows, too, the little gannetry of the Bull, and its neighbour the Cow, and other crags of Cork from Cape Clear Island and Dursey Island east to Great Newtown Head. In Clare the cliffs of Moher bring sea-birds to nest among many beautiful flowers. We have seen the bird-colony of the Great Saltee in Wexford, and that of Lambay not far from Dublin. One of us knows the many fine, high cliffs of Mayo and Sligo, and some headlands of the maze-coast of Donegal; the other has watched fulmars haunting the curious inland cliffs of Binevenagh in Derry, and hunted out the basalt coast of Antrim and the Giant Causeway.

Between us, then, we have seen much of the coast of our glorious islands; but we have not seen nearly enough, and we hope to see what we have already seen, all over again. And we would see the west side of the ocean we have grown to love, and compare it with the Britain we know, and other sea-bird countries we have seen—the tuff and lava and basalt of Iceland, the basalt crags of Faeroe, the dissected plateaux of Spitsbergen, the misty cliffs of Bear Island, the drowned coast of Norway with snow-coated Lofotens and dark fjords like corridors, the friendly limestone of Sweden's Gotland, the skerry-guard of Stockholm and Uppland, the dunes of Denmark and the Dutch islands, the red sandstone cliffs of Heligoland (the only cliffs in western Germany), the chalk and granite of northern France, and the islets of Brittany; the benign, sunny slopes and little scarp-precipices of the Channel Islands where one of us lived for a while; the warm, shearwater islands of the Portuguese Berlengas, the Madeiran Desertas, and the Salvages; and the gulleries and terneries of the Camargue, within the Mediterranean.

This book is not a comprehensive survey of a problem based upon a lifetime's experience nor yet a full bibliographical compilation. We have paused in field-work simply to offer this book as a stimulant, which we hope very much it will be. We intend it as no more. It is a statement of some of the facts concerning the wonderful sea-birds of the North Atlantic, and of some of the interesting problems connected with their lives and their evolution. It is intended to exhibit the ignorance of ornithology as much as its knowledge, and to draw attention to what needs doing as much as to what has been done. It is our wish, we must also add, not only to take the reader with us—if he will come to the east side of the North Atlantic where the sea-birds are more in our personal experience, but also to the western seaboard, which is zealously worked by the ornithologists of the United States and Canada and described by them with such enthusiasm and thoroughness in numerous books and journals. One of us has corrected the galley proofs of this book in an aircraft bound for North America, on the beginning of a journey among the sea-birds of that continent; as he left Britain, Ailsa Craig flashed white with gannets in an April evening sun, and the first bird he saw in the New World through Newfoundland clouds next morning, was a gannet.

For help, encouragement and information we have more friends to thank than we can mention.

Our search of the literature has been chiefly pursued in books belonging to the Zoological Society London, the Alexander Library at Oxford, the Royal Geographical Society and the London Library and we thank G. B. Stratton and W. B. Alexander particularly. Among those who have given us valuable help or information (they have no responsibility for the use we have made of it) are B. M. Arnold, R. Atkinson, J. Buxton, T. Cade, F. Darling, E. A. G. Duffey, A. Ferguson, Finnur Guðmundsson, H. G. Hasler, P. A. D. Hollom, J. S. Huxley, the late P. Jespersen, G. T. Kay, Miss J. Keighley, T. C. Lethbridge, H. F. Lewis, C.-F. Lundevall, S. Marchant, R. C. Murphy, E. M. Nicholson, R. S. Palmer, R. Perry, R. T. Peterson, L. E. Richdale, M. Romer, F. Salomonsen, H. N. Southern, D. Surrey-Dane, N. Tinbergen, L. Tuck, L. S. V. VENABLES, H. G. Vevers, K. Williamson and V. C. Wynne-Edwards. Mrs. E. Marshall patiently typed several drafts of most of this book. J. I. Trotter prepared the final copies of most of the maps. One of these is on a mapnet invented by the late Professor C. B. Fawcett and is used with his permission and that of the Royal Geographical Society (e.g. [Fig. 24](#)). Another mapnet, devised by one of us (J.F.) is used for the first time in this book; it is based on the South Pole with the oceans in three petals, and is useful for showing the range of many sea-birds that have a primarily southern distribution (e.g. [Fig. 22](#)). J. Fisher's fellow *Naturalist* editors have been encouraging; and Eric Hosking in particular has found us many unique photographs. R. Trevelyan, of Messrs. Collins, has been most ingenious and helpful. The American Ornithologists' Union, who published our frontispiece first in the *Auk*, have very kindly allowed us the use of it; this fine painting by Roger Peterson of the interesting cahow, long thought to be extinct, embellished the paper by R. C. Murphy and L. S. Mowbray on their recent rediscovery of its breeding grounds.

Ornithologists' wives do many (if not most) of the chores that husbands normally do. We thank them for more things than they probably remember.

JAMES FISHER
R. M. LOCKLEY

THE NORTH ATLANTIC OCEAN ITS STRUCTURE AND ITS SEA-BIRDS

THE ATLANTIC OCEAN is a big broad blind alley, kinked like a zig-zag, its jagged north end blocked with ice, its broader south butt cornered by the cold stormy narrow eastern entrance to the Pacific Ocean and by the warm, windy and wide western gate to the Indian Ocean. It resembles two wedges, the apexes towards the North Pole, one of them truncated midway and at that point connected sideways with the base of the other.

The birds inhabiting the more northerly of these wedges, the North Atlantic, are the birds of this book. Two of these birds have become extinct in historical times: the great auk was never seen alive after 4 June, 1844, and the last Labrador duck was shot in 1875, though some say one was shot in 1878. The number of living species that remain is about one hundred and eighteen, of which eighty-six have been seen on the western seaboard of Europe (which includes Iceland), and ninety-three on the eastern seaboard of the New World (including Greenland).

However, for an understanding of the environment to which the North Atlantic birds are adapted, a description of the whole ocean is necessary, and to this we must proceed.

The extremely simple fundamental shape of the Atlantic invites diagrammatic caricature (Fig. 1). It is the second largest ocean in the world. It is, on an average, over two and a quarter miles deep, and in some places nearly six. It is, on an average, three thousand five hundred miles across (maximum about five thousand); and is nine thousand miles long. Its area has been estimated as thirty-three million square miles, and its volume as seventy-five million cubic miles. It is a vast place, with many miles of coast, upon which much of civilization depends: considering its size, it has few islands. In comparison, the Indian Ocean is not quite as large (about twenty-eight million square miles); but the Pacific (about sixty-four million square miles) has nearly twice the area, and is ten thousand miles across its widest part. The Arctic Ocean (about five and a half million square miles) is small and nearly full of ice at all times of year; in spite of this it is at times very full of life. Finally, it is usual to describe the cold waters round the Antarctic Continent (itself the same size as the Arctic Ocean) as the Antarctic Ocean.

South of the normal steamship route from Britain to New York the Atlantic is almost everywhere over two miles deep, and in large areas more than three. But down mid-ocean, following the tropical kink in the zig-zag, runs a very long submarine ridge, above which is less than two miles of sea; it is only broken by deeps for a short distance on the Equator, and it rises to the surface in places—in the northern hemisphere at the Azores and St. Paul Rocks, and in the south at the lonely isles of Ascension, Tristan da Cunha and Gough. Other oceanic Atlantic islands, such as Bermuda in the north and South Trinidad and St. Helena in the south, rise abruptly from very deep parts of the ocean. A sketch-chart will be found in Fig. 2c.

It will be seen that there are prominent shallows along the east coast of southern South America north of the mouths of the Amazon and along the Guianas, in parts of the Caribbean Sea and the Gulf of Mexico (there are also marked deeps in these tropical waters), off the New England States, Nova Scotia and (most particularly) Newfoundland, and round Britain, the Channel and the North Sea, and round Iceland. A submarine ridge, over which the sea is five hundred fathoms or less, cuts the North Atlantic entirely from the Norwegian Sea and the waters of the Polar Basin; Shetland, the Faeroes and Iceland lie on this ridge. Davis Strait is shallow, and the waters of Labrador and Hudson's Bay very

shallow. Where the waters are less than a hundred fathoms deep, what they cover is usually described as the Continental shelf. This has its own particular community of birds.

For practical purposes, and because all charts and maps mark the Arctic Circle and the Tropic of Cancer, we have classified the North Atlantic and its birds into arctic, temperate and tropical areas based simply on latitude. In our analysis of breeding-distribution, for instance (see here), we regard birds nesting north of the Arctic Circle as arctic, those nesting south of the Tropic of Cancer as tropical, and those nesting between as temperate. However, the temperature of neither air nor water arranges itself in the Atlantic, according to latitude.* For instance, if we examine the July air isotherms over the world north of the Tropic of Cancer we see that that for 45° F. runs well south of the Arctic Circle in the areas Greenland-Baffin Island and Bering Strait, and well north of it off Scandinavia, avoiding Lapland altogether.

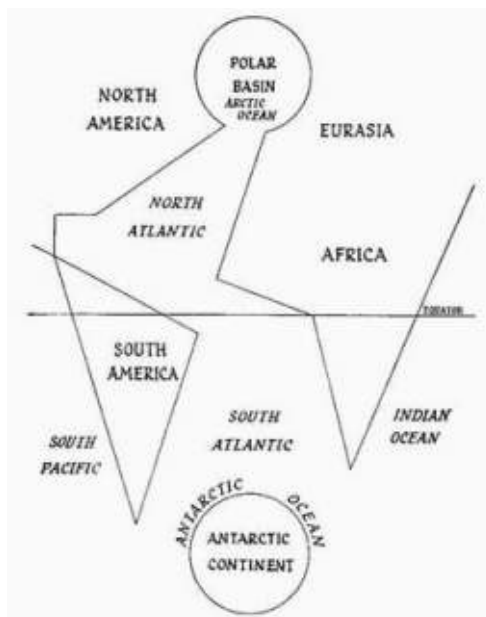


FIG. 1
Diagram of the Atlantic Ocean

If we examine a map of the world (showing particularly the lands between the Tropics), we see that the summer isotherm for 80°F. (July in the northern hemisphere, January in the southern) runs well north of the Tropic of Cancer in Mexico and the southern States, and in Africa and Asia, and south of the Tropic of Capricorn in Africa and Australia; yet large parts of the tropical Pacific and Atlantic Oceans never reach an average summer air temperature of 80°F.

In the North Atlantic there is not only relatively little direct correspondence between isotherms and latitude, but there is a good deal of difference in position between the same isotherms under the surface, on the water surface and in the air.

The primary cause of the ocean currents, and of the prevailing winds which are associated with them, is the rotation of the earth. The plot of the Atlantic currents and Atlantic winds is almost, though not quite, coincident. To a very large extent the distribution of Atlantic water temperature and to a large extent that of air temperatures, is a consequence of these currents and prevailing winds. However, in parts of the Atlantic evaporation and the melting of ice produces temperature and salinity gradients which themselves produce consequent currents. Hence the web of sequence and consequence, of cause and effect, becomes complex. We must examine the great equatorial current first, for almost every one of the more important sea masses in the Atlantic owes its existence to it. It is quite justifiable to write in terms of sea masses, for, as we shall see, the Atlantic waters are by no

means homogeneous and can be divided, sometimes with strikingly sharp boundaries, into volumes possessing very diverse properties.

We need scarcely remind the reader that if he faces a globe, poised in the ordinary way with North at the top, and spins it as the earth naturally rotates, the points on its surface will travel, as they face him, from left to right. The points travelling with the greatest velocity will be those on the equator, and the two points represented by the Poles will travel with no velocity relative to the earth's axis.

In general terms it is true that, as the earth rotates, its atmosphere rotates with it. However, there is a certain effect due to inertia or drag; and this effect, obviously, is greatest at the equator, where the surface velocity is greatest. The effect operates on all objects but can put only liquids and gases into a dynamic state. Upon these Coriolis's force—the deflecting force of the earth's rotation—acts in a simple manner. It sets them in motion in a direction which, at the equator, is opposite that of the rotation of the earth. Thus if we examine a map of the prevailing winds and ocean currents of the world, we find pronounced positive east-to-west movements in all equatorial regions. The liquids and gases thus displaced circulate into the temperate regions and perform return movements into the higher latitudes where the Coriolis's force is less. Consequently, in the northern hemisphere water and wind currents tend to turn right-handed, whereas in the southern hemisphere they turn left-handed. (Exceptions to this rule are mostly found in minor seas, where the impact of the currents upon coasts may cause contra-rotation.) The main clockwise movement of the northern hemisphere wind and currents is very obvious.

The Atlantic equatorial current can be traced from the African coast south of the equator westwards as far as the sea reaches. Approaching the coast of Brazil it attains a remarkable speed. It sets past the isolated oceanic island of Ascension so that even in calm weather it leaves a wake of turbulence which must make that island unusually visible from far off by its numerous birds and inhabitants.

Just north of the equator the lonely St. Paul rocks, which represent the pinnacles of a submerged steep-sided mountain over thirteen thousand feet high, face the full strength of the great equatorial current, especially in August, when the associated south-east trades are blowing their hardest. During the cruise of the *Challenger* in 1860 H. N. Moseley saw the great ocean current "rushing past the rocks like a mill race." A ship's boat was quite unable to pull against the stream.

The equatorial current divides when it impinges on the corner of Brazil at Cape São Roque. The northern element—the Guiana coast current flows past the mouth of the Amazon with sufficient rapidity to displace the outgoing silt 100 miles or more in a northerly direction; and it continues steadily past the mouth of the Orinoco and Trinidad to flow with scarce-abated force into the Caribbean, mainly through the channel between Trinidad and Grenada in the Windward Islands.

Through the Caribbean the current flows from east to west, turning northerly and entering the Gulf of Mexico through the fairly narrow channel between Yucatan and Cuba. It is no doubt aided here by the climate, for this part of the world is very hot, and not excessively wet, and there is much evaporation of the waters of the Caribbean and the Gulf of Mexico, which has to be replaced. The current finally comes up against the coast of Louisiana and Texas and proceeds to turn right-handed, escaping finally through the narrow gap between Florida and Cuba, into the Bahama Seas.

Here the Gulf Stream is formed, not only by the waters escaping from the Gulf of Mexico but by the more northerly elements of the equatorial current which impinge upon the outer shores of the West Indies and are deflected northwards. This north equatorial current flows across the ocean from the Cape Verde Islands and the joint product swings quickly east again, narrowing in width but probably

gaining in velocity, to sweep past the tail of the Great Bank of Newfoundland and thence to carry on what is now called the West Wind Drift (because of its associated air currents). The most direct continuation of this drift flows northwards and eastwards past the west coast of Ireland (giving off a branch towards Iceland), between Rockall and the Hebrides, through the channel between Shetland and Faeroe, north-eastward up the coast of Norway, whence elements strike east into the Barents Sea and north to reach Spitsbergen. It is because of this warm drift that, of all lands reaching latitude 80°N, Spitsbergen has been the most accessible. If it was not for the Gulf Stream, many Oxford expeditions could never have explored there in the Long Vacation and got back in time for the Michaelmas Term.

So far we have described the simplest and best-known currents of the North Atlantic. The fate of the waters in their return circulation is more complex. Much of the return circulation is below the surface, for cool water is denser than warm water. In the lower latitudes of the North Atlantic, between the westward-flowing north equatorial current, and the eastward-flowing Gulf Stream and drift, there is an area of clock-wise milling. The centre of this area is the part of least water-movement, and bears some resemblance to an oceanic desert. This is the Sargasso Sea, usually windless, too, with masses of the floating Sargasso weed, which has berry-like air vessels, and is used by sea-birds as a resting platform; but on the whole this stagnating area is as devoid of animal life as it is of movement.

There is a corresponding and not dissimilar area in the South Atlantic, which also has calms. It has never been named, though it could well be called the Southern Sargasso. These Sargasso areas contain fewer plants and animals than any other part of the ocean. In both there is a rather fluctuating and not very well marked line or lines of convergence between the warm equatorial waters and the comparatively cool temperate waters.

We must now return to the temperate waters, which, as we have seen, form a drift right across the North Atlantic and into the Polar Basin, starting on the west below latitude 30°N. and reaching latitude 70°N. or more on the east side. The counter-movements and mills consequent on this great temperate drift are mostly in an anti-clockwise direction. Thus the waters of the North Sea tend to rotate anti-clockwise, running south down the British coast, east and north round the Heligoland Bight, and north-west from southern Norway. In the Norwegian Sea two major and several minor anti-clockwise mills can be detected, and the waters of the Barents Sea also tend to revolve anti-clockwise.

But the greatest counter-movement in the North Atlantic is composed of the Greenland and Labrador currents, carrying cold, heavy water south past Labrador, past Newfoundland and far down the United States' eastern seaboard. This great counter current sets south along the east coast of Greenland down the Denmark Strait between Greenland and Iceland, round Cape Farewell, the southern tip of Greenland carrying with it many bergs tumbled from the sliding glaciers of the inhospitable east Greenland coast, runs north some hundreds of miles up the west coast of Greenland, then west and once more south, collecting the ice of Davis Strait and Baffin Island, and pursues its final course down the Labrador shore. As it turns the corner of Newfoundland and passes over the great shallow Banks, it deposits its last icebergs and suddenly impinges on the northern boundary of the Gulf Stream or West Wind Drift. Here a long, well-marked line of convergence extends for many hundreds of miles. The cold water sinks rapidly under the warm, and much turbulence is the result. Many organisms are brought to the surface. There is a steep temperature-gradient and frequent climatic upheavals, including fogs. It is largely because of the cold Labrador current that New York, though a full ten degrees farther south, enjoys a climate similar to that of London though with great extremes of temperature.

The Atlantic thus is a mosaic, not a homogeneous area. Each patch in the mosaic is characterised by some peculiarity of climate. In practically all areas the water, the prime constituent, is in a state of

continual movement. The fortunes and distribution of our sea-birds depend on this environment, continually in turmoil. We must beat the bounds, then, of the North Atlantic and discover how our birds and their lives are interlocked with this climate and scenery.

A suitable place from which to begin our tour of the North Atlantic is the St. Paul Rocks. On these three species of sea bird nest on them—the brown booby *Sula leucogaster*, and the noddy terns, *Anous stolidus* and *A. minutus*. The islands have been visited by many naturalists, including Charles Darwin who spent some hours of the afternoon of 15 February 1832 obtaining bird specimens with his geological hammer!

From here we move to the coast of South America between the Equator and the Caribbean: this is a mud-coast and not, as are many tropical coasts, a coral coast. Indeed, there is no sign of the coast or coral barrier-reef off Brazil until some distance south of the Equator. If we start at the Equator, on the islands in the mouth of the Amazon, we find a typical river bird-community. The water is fresh for some considerable distance outside into the ocean and the birds consist of skimmers (*Rynchops nigrus*) and various river-loving terns such as the gull-billed tern *Gelochelidon nilotica*, the yellow-billed river-tern *Sterna supercilii*, and the large-billed river-tern *Phaëtusa simplex*. Off-shore the true sea-birds come in, and Murphy records species such as Leach's petrel, Wilson's petrel, the Tristan great shearwater, the great skua, boobies and tropic-birds. North of the Amazon mouth the Brazilian Guiana coast is forested down to the muddy shore. Many small rivers, often choked with the debris of tropical forests, flow into it.

In French Guiana, however, rocky promontories and islets appear, and they are inhabited by some sea-birds; regrettably little is known about the species involved, but they probably include boobies and tropic-birds. Along the coast of Dutch and British Guiana we are once more in a muddy coast with no headlands or islands. North-west of the mouth of British Guiana's main river, the Essiquibo, there are some shell-beaches, but most of the coast is of mangrove-swamp jungle, in which the only animal resembling a sea-bird is the Mexican or bigua cormorant *Phalacrocorax olivaceus*. Over the Venezuelan border we are at once in the delta of the great river Orinoco. It is a land of dense mangrove forest and a very large number of low wooded islands. Off-shore the immense tonnage of mud and silt is seized by the equatorial current and driven northwards towards Trinidad, which it thus provides with a very wide continental shelf. As Murphy (1936, [see here](#)) writes, "The delta of the Orinoco is not the home of birds that can be called marine ... Only our adaptable old friend the Big cormorant seems ... at home."

Generally speaking, from the mouth of the Amazon to the mouth of the Orinoco the coast scarcely harbours a breeding sea-bird. However, the British islands of Trinidad and Tobago, off the northeast corner of Venezuela are provided with rocky promontories and many islets on which sea-birds nest. The brown pelican *Pelecanus occidentalis*, the red-footed booby *Sula sula*, the man-o'-war or frigate-bird *Fregata magnificens*, nest on low trees or on mangroves. On the bare Soldado rock the sooty tern *Sterna fuscata*, and the two species of noddy, nest. One tubenose, Audubon's shearwater *Puffinus I'herminieri*, nests on Tobago, which is its southernmost breeding place on this coast. The gull-billed tern nests in fresh water marshes.

West of Trinidad we are in the Caribbean Sea and following the coast, which for 250 miles more has a wide continental shelf, with small islands dotted in it. Opposite the western part of Venezuela however, the water is much deeper close in-shore, and the off-coast islands of Curaçao and other Dutch possessions rise from a deep sea. Both the islands of the shallow shelf, such as Los Hermanos and the Testigos, and these Dutch islands, have many sea-birds, including three kinds of boobies, man-o'-war birds, tropic-birds, noddies and sooty terns. At least eight species of terns are found at Aruba

the westernmost of the Dutch islands. But there are few species which can be described as oceanic though the boobies are marine; many of the sea-birds probably nest on the islands rather than on the mainland because of the additional safety and the existence of outcrops of rock such as are not found along the interminable mangrove coast.

Of all coasts that we have so far considered, those of northern Venezuela are the driest, and the Caribbean is the hottest part of the North Atlantic region. The western Caribbean, however, has intense summer rain; in spite of this, evaporation is great and the equatorial current is boosted along flowing into the Gulf of Mexico with some rapidity.

In the Antilles, which form the eastern and northern boundaries of the Caribbean Sea, we find islands clad still in fairly thick jungle vegetation, with coastal mangroves, but also many sandy islets and bars and real coral reefs. Though the Guiana coast was too muddy to support coral reefs, these are found fringing the islands north of Venezuela, such as Curaçao. There are also many reefs along the western shore of the Caribbean, particularly at the corner of Nicaragua and Honduras, at the end of the shallow Mosquito Bank. Throughout the West Indies the distribution of sea-birds is linked primarily with available food, but that of the breeding adults probably also with available nesting-sites. Isles where there are exposures of rock or sand are much favoured, but some species as we have seen including the red-footed booby, the brown pelican, the biguá cormorant, the darter *Anhinga anhinga* and some terns, nest in trees. One very rare petrel *Pterodroma hasitata* ([see here](#)) nests above the tree line on some of the West Indian islands, among the rocks of steep mountains.

A typical sea-bird islet in the West Indies is Desecheo, described by Alexander Wetmore. This lies in the hot dry zone west of Porto Rico. It is a rocky islet with cliffs and a gravel beach, and a thin top-soil covered with a dense thicket of cacti and the curious West Indian birch. Here brown boobies nested on the ground among the thickets and floundered through the prickly pear and cactus. Sooty terns nested on ledges, on shelves on the limestone cliffs, and B. S. Bowditch found a few bridled terns *Sterna anaetheta*, nesting on flat ledges. This species also breeds on the little islets or cays of the Barrier Reef south of Jamaica, among the broken coral rock and the mangroves.

North of the Antilles the low-lying British islands of the Bahamas occupy a large area of the western Atlantic. The blue Atlantic beats directly against steep east-facing limestone cliffs, while to the west there are shelving beaches. Many of these islands are covered with cacti, and the sea-grape *Coccolobis*, which forms low, thick vegetation in which brown boobies nest, scraping slight hollows in the ground and lining them with grass. In some Bahamas the man-o'-war bird builds its nest quite on top of the prickly pears, though more normally on the mangroves in the swamps, together with brown pelicans and the double-crested cormorant of Florida *Phalacrocorax auritus floridanus*. Upon the more exposed sandspits in the Bahamas several kinds of tern breed, including the gull-billed tern, the little tern *Sterna albifrons*, the roseate tern *S. dougallii*, Cabot's tern *Thalasseus sandvicensis*, and the sooty tern.

The coast of the Gulf of Mexico is low-lying, with coral reefs and an extensive continental shelf especially off Yucatan. Breeding sea-birds are scarce, except terns and the ubiquitous biguá cormorant, which is as much a fresh-water as a salt-water bird. The Sandwich tern, which is known as Cabot's tern in North America, breeds in several parts of the Gulf coast of Mexico, which is more suited for terns than for any other sea-birds. On the grassy islands among the lagoons and marshes on the Texas coast, the gull-billed tern and Forster's tern *Sterna forsteri*, are found. The beautiful Caspian tern *Hydroprogne caspia*, also nests in a few places on sandy islands, and there is an interesting outpost breeding-station of the white pelican *Pelecanus erythrorhynchos*, on the Laguna de la Madre, south of Corpus Christi, near the Border. The rest of the population of this fine bird is found

in western North America.

~~Along the Louisiana coast, where there are many protected reservations, there are very big colonies of the laughing gull *Larus atricilla*, especially in the marshy islands of the Mississippi delta which are overgrown with grass and low mangroves. One of the reservations is in the Breton Islands 114 miles off the main Louisiana coast. Here are great colonies of terns on low flat sandy spits including Caspian, Cabot's and royal *Thalasseus maximus* (Bent 1921). Forster's and common tern *Sterna hirundo*, also nest in the Breton Islands, as do numbers of the extraordinary black skimmer, and an aberrant tern whose lower mandible is prolonged and with which it scoops food from the surface of the sea. The peninsula of Florida has to its west an immense continental shelf, along the lower end of which is a famous chain of Keys. Beyond Key West, at the terminus of the Key railway, many miles to sea, lie the dry Tortugas, flat islands of coral, their surface, largely of coral sand, clothed in parts with dense cactus as well as with bay cedar, with many bare and grassy spaces between. On the cedars and the cactus immense numbers of noddy terns nest: often over the nests of the sooty terns on the ground below.~~

The Florida coast has one of the best stations in the U.S.A. for the roseate tern. The darter, which most North Americans allude to as the water-turkey (it is a fresh water lover), and the double-crested cormorant of Florida, commonly nest in trees in many swampy places along the coast. Brown pelicans nest by lagoons and in mangrove-keys on both sides of the peninsula.

Naturalists accustomed to British coast conditions can have little notion of the interminability of the low-lying eastern coast of North America. Indeed, on the entire stretch of mainland coast from Southern Mexico to Maine, about four thousand miles, there is not a single cliff, nor indeed a mountain coming down to the sea. All through Florida, Georgia, the Carolinas, Virginia and Maryland to the New England States, runs a complex of lowland and shallow shores, broken in places by inlets such as those of Chesapeake and Delaware Bays and Long Island Sound. This is a tern coast. In the northern parts the effect of the Labrador current is felt and there is a fairly steep decline in temperature, which is why such tropical forms as the brown pelican and Florida double-crested cormorant drop out of the community in South Carolina. One tropical species which is distributed along this coast, however, is the laughing gull; and the gull-billed tern reaches north to Virginia. Rather oddly, two terns, the common tern and Forster's tern, appear to avoid the mainland coast from Florida to South Carolina, though they breed to the west and north of it.

The distribution of tern populations on this Atlantic coast has had a chequered history, and is dealt with in some detail in the chapter on Sea-Bird Populations (Chapter 3, [see here](#)).

In the New England States and Maine we encounter the first truly northern elements in the Atlantic sea-bird fauna, and a community of sea-birds which is intensively watched and studied, as is the very similar community on the eastern side of the Atlantic, ten degrees farther north. We now meet not only some of the terns but some of the gulls that breed in the British Isles. In Maine and New Brunswick, where little cliffs begin and the wooded coast closely resembles the skerry-guard of Stockholm, and other parts of the Baltic archipelago, we find the southernmost auks—black guillemots *Cepphus grylle*, puffins *Fratercula arctica*, and perhaps still a pair or two of razorbill *Alca torda*. We even find tubenoses breeding in Maine, birds which we had last encountered in the Caribbean Antilles. (Apart from Audubon's shearwater and the rare diablottin ([see here](#)), which nest in various of the Antilles, no breeding petrel is found in the western North Atlantic south of Maine, save on Bermuda.)

The rocks and coral reefs of Bermuda, which is 580 miles from Cape Hatteras, the nearest point on the United States mainland, support an interesting little community of sea-birds, which consists

the northernmost outposts of the breeding population of an otherwise completely tropical species, the white-tailed tropic bird *Phaëthon lepturus*, besides the common tern, the roseate tern, possibly the Manx shearwater *Puffinus puffinus*, Audubon's shearwater, and the cahow *Pterodroma cahow*, thought to be extinct for many years.

It is in the Bay of Fundy, then, on the borders of the U.S. and Canada (Maine and New Brunswick) that the northern birds really begin. Here in burrows in the island rocks nest the southern elements of the rather small Atlantic population of Leach's petrel *Oceanodroma leucorhoa*. Here, too, are the representatives of the northern race of double-crested cormorant, which are separated by a gap of some hundreds of miles from the geographical race of the same species belonging to Florida and the Carolinas.

Other birds which come on the scene between Cape Cod and the Bay of Fundy are the great black-backed and herring-gulls, *Larus marinus* and *L. argentatus*, which are now quickly spreading south down the coast, and the arctic tern *Sterna paradisaea*, which still nests as far south as Cape Cod. If we move north to the Gulf of St. Lawrence, we can also bring in an outpost population of the European cormorant *Phalacrocorax carbo*, the ring-billed gull *Larus delawarensis*, which is very closely related to our common gull, the common guillemot *Uria aalge*, and, rather surprisingly, an arctic species, Brünnich's guillemot *Uria lomvia*, whose breeding distribution extends from the Magdalen Islands via Newfoundland and Labrador to the High Arctic. There is a curious relic population of the Caspian tern also here. In many ways the Gulf of St. Lawrence has arctic properties and there is, as we have seen, a very steep gradient in water temperature at its mouth, at the convergence of the west wind drift and the Labrador current. Here we find the southern outposts of the largest temperate North Atlantic sea-bird, the gannet *Sula bassana*—though the majority of its breeding-population is found on the other side of the ocean; and we meet our first kittiwakes *Rissa tridactyla*.

In structure the coasts of the Atlantic right round from Maine via Nova Scotia, the Gulf of St. Lawrence, Newfoundland, Labrador, Greenland and Iceland to Britain, have a good deal of similarity. They have a fairly even supply of estuaries, inlets, beaches, sands, cliffs, skerries, stacks and islands and it is probable that the distribution of no sea-bird is seriously limited by lack of suitable nesting sites.

There are two inland species of North American dark-headed gull, Franklin's gull *Larus pipixca* and Bonaparte's gull *L. philadelphia*, neither of which breeds near the coast.

From the Gulf of St. Lawrence, via Newfoundland, Labrador, Greenland and the Canadian Arctic Archipelago, we find a gradual disappearance of the temperate, sub-arctic and some low arctic species as we progress towards the shores where the sea is still near-freezing in July—the true High Arctic. In Newfoundland we reach the limit for breeding gannets, ring-billed gulls and common terns, and perhaps also Caspian terns. The Leach's petrels breed as far as Newfoundland Labrador, but not farther, and it is doubtful whether the double-crested cormorant now breeds as far. South-west Greenland is less 'arctic' than opposite parts of the Canadian Arctic Archipelago at the same latitude and it is not surprising that some species extend beyond Labrador to West Greenland, though not to Baffin Island and the other Canadian islands. Such species are the razorbill and common guillemot, the latter having only one small colony in West Greenland. The European cormorant extends to West Greenland and previously had a small outpost in Baffin Island, from which it has now disappeared and it is also extinct in Newfoundland Labrador, after much human persecution. The puffin does not breed in the Canadian Arctic but goes far north in Greenland where it is of a distinctive, large arctic race.

Species which extend in breeding-range all the way from Newfoundland to Arctic Greenland and Canada are the herring-gull, great black-back, kittiwake, arctic tern and black guillemot. All these except the blackback reach the High Arctic, if we regard the Iceland gull *Larus argentatus glaucoideus* as a herring-gull, as we think we should.

The glaucous gull *Larus hyperboreus*, does not now breed in Newfoundland, but nests commonly from Newfoundland Labrador all the way to the High Arctic, as does the arctic skua *Stercorarius parasiticus*; two other skuas, the pomarine *S. pomarinus*, and the long-tailed skua *S. longicaudus*, do not breed in Labrador, but farther north in both Canadian and Greenland Arctic. On the west side of the Atlantic-Arctic the fulmar *Fulmarus glacialis*, breeds no farther south than Greenland and Baffin Island, although it nests south to about latitude 50° north on the east side of the Atlantic.

This leaves the three High Arctic sea-birds of the West Atlantic for consideration—the little auk *Plautus alle*, Sabine's gull *Xema sabini*, and the ivory-gull *Pagophila eburnea*. All three breed in the more northerly parts of the Canadian Arctic Archipelago and Greenland, though the first may not have more than one colony west of Baffin's Bay. Sabine's gull is a rare bird that often nests in arctic tern colonies. The ivory-gull is the most northerly bird in the world in the sense that it breeds nowhere south of the Arctic Circle, but as far north as the land goes. The extraordinary, rare, Ross's or rosy gull *Rhodostethia rosea*, which normally nests in the aldergroves of some north-flowing rivers of eastern Siberia, has once bred in Greenland.

| | CANADIAN ARCTIC | GREENLAND | JAN MAYEN | BEAR ISLAND | SPITSBERGEN | FRANZ JOSEF LAND | NOVAYA ZEMLYA | ARCTIC EUROPEAN RUSSIA | ARCTIC NORWAY |
|-------------------------------------|-----------------|-------------|---------------|---------------|---------------|------------------|---------------|------------------------|---------------|
| Fulmar | + | + | + | + | + | + | + | — | — |
| Shag .. | — | — | — | — | — | — | — | + | + |
| Cormorant <i>extinct</i> | — | + | — | — | — | — | — | + | + |
| Pomarine skua .. | + | + | — | — | — | <i>casual</i> | + | <i>casual</i> | — |
| Arctic skua | + | + | + | + | + | + | + | + | + |
| Long-tailed skua | + | + | <i>once</i> | — | <i>casual</i> | — | + | + | + |
| Ivory-gull | + | + | — | — | + | + | — | — | — |
| Common gull .. | — | + | — | ? | — | — | — | + | + |
| Herring-gull (incl. "Iceland" gull) | + | + | ? | <i>casual</i> | — | — | — | + | + |
| Lesser blackback | — | — | — | — | — | — | + | + | + |
| Great blackback | + | + | — | <i>recent</i> | <i>recent</i> | — | — | + | + |
| Glaucous gull .. | + | + | + | + | + | + | + | + | — |
| Ross's gull | — | <i>once</i> | — | — | — | — | — | — | — |
| Kittiwake | + | + | + | + | + | + | + | + | + |
| Sabine's gull .. | + | + | — | — | + | — | — | <i>once</i> | — |
| Common tern .. | — | — | — | — | — | — | — | <i>casual</i> | <i>casual</i> |
| Arctic tern | + | + | <i>recent</i> | + | + | + | + | + | + |
| Little auk | ? | + | + | + | + | + | + | — | — |
| Razorbill | — | + | — | ? | — | — | — | + | + |
| Brünnich's guillemot | + | + | + | + | + | + | + | + | — |
| Common guillemot | — | + | — | + | — | — | + | + | + |
| Black guillemot | + | + | + | + | + | + | + | + | + |
| Puffin .. | — | + | + | + | + | — | + | + | + |

The breeding sea-birds of the lands and islands north of the Arctic Circle belonging to the Atlantic or the Atlantic section of the Arctic Ocean.

With the exception of a few gulls, sea-birds entirely desert the arctic regions bordering Baffin Bay and Davis Strait in October and do not return until April. From no other part of the northern

hemisphere is there so great a withdrawal of sea-birds to avoid a period of inhospitable climate.

~~The eastern arctic islands—Jan Mayen, Bear Island and Spitsbergen, Franz Josef Land and Novaya Zemlya, which lie across the Polar Basin where it abuts on the North Atlantic, have a very similar breeding sea-bird community to that of Greenland, though none has so many members. We can best make this comparison in the form of a table, adding columns for the Canadian Arctic, Arctic Russia-in-Europe and Arctic Norway. ([see here](#))~~

We now come to the seabird community of Iceland, Faeroe, the British Isles, Scandinavia, the Baltic, and the North Sea and English Channel. This community is very homogeneous, considering the range of latitude over which it is spread, though there are some members which do not reach the southern end of this range and a few which do not reach the north. Among the species which are found over almost the entire twenty degrees of latitude are the Manx shearwater, the storm-petrel *Hydrobatus pelagicus*, the gannet, the shag *Phalacrocorax aristotelis*, the cormorant, the herring-gull, the lesser blackback *Larus fuscus*, the great blackback, the black-headed gull *L. ridibundus*, the kittiwake, the common and arctic terns, the razorbill, the guillemot, and the puffin. Species which occupy the more northerly parts of this temperate European stretch include the great skua *Catharacta skua*, and Leach's petrel (Iceland, the Faeroes and Britain only), the fulmar, the arctic skua, and the black guillemot. The glaucous gull, little auk and Brünnich's guillemot breed (in this part of the Atlantic) only in Iceland.

There is a central group of sea-birds which breeds neither as far north as Iceland nor as far south as Atlantic France; this is headed by the common gull *Larus canus*, and includes also the little gull *minutus*; its other members are terns, the whiskered tern *Chlidonias hybrida* (only casual, in Holland), the black tern *C. nigra*, the white-winged black tern *C. leucoptera* (casual only), the gull-billed tern and the Caspian tern. The populations of all these terns are low, and only two of them (black and gull-billed) have recently bred in Britain, and that casually; their headquarters lie between Holland and the South Baltic. The Baltic Sea, though it has as many breeding terns and gulls as any other part of the stretch of the east Atlantic, lacks tubenoses and has no gannets, shags, kittiwakes or puffins. The long-tailed skua has a somewhat specialised breeding distribution in Lapland, mostly inland. The remaining birds of this temperate stretch of the east Atlantic breed from Britain, the North Sea or the Baltic south beyond its limits; they are the roseate, little and Sandwich terns. Britain is the European headquarters of the roseate tern.

About half the members of this east and north Atlantic temperate sea-bird community are truly oceanic; that is, they may be found in mid-ocean, up to the greatest possible distance from land wherever there are suitable feeding waters. Storm-petrels, Leach's petrels and fulmars are the oceanic tubenoses of this community, and we now find that the Manx shearwater also has a right to be considered oceanic. Among the auks the dovekie and Brünnich's guillemot from the north join the puffins, razorbills and guillemots in ocean wanderings. Here, too, are found all the four skuas of the northern hemisphere and one, but only one, gull—the highly specialised kittiwake. In the waters a hundred fathoms deep or less, that is, on the so-called continental shelf, we find all the birds previously mentioned, together with the gannet, the black guillemot, and gulls of the genus *Larus*—the great blackback, the lesser blackback and the herring-gull. Once we are within sight of shore quite a number of species are added to our list, and the tubenoses, except for the Manx shearwater and fulmar, drop out. Here are the terns, the black-headed and common gulls, and also the cormorant and shag, the one haunting mostly seas in sight of sandy shores, and other seas in sight of rocks.

By far the most impressive of the sea-bird haunts are the breeding cliffs, where the different species are zoned vertically as well as horizontally. Whether the rocks be volcanic or intrusive or extrusive or sedimentary, we are sure to find *Larus* gulls breeding on the more level ground a little

way back from the tops of the cliffs—fulmars on the steeply sloping turf and among the broken rock at the cliff edge, puffins with their burrows honeycombing the soil wherever this is exposed at the edge of a cliff or a cliff buttress, Manx shearwaters or Leach's petrels in long burrows, storm-petrels in short burrows and rock-crevices, razorbills in cracks and crannies and on sheltered ledges, guillemots on the more open ledges where they can stand; perhaps gannets on broad flat ledges or on the flattish tops of inaccessible stacks, cormorants with their nests in orderly rows along broad continuous ledges, shags in shadowy pockets and small caves and hollowed-out ledges dotted about the cliff, kittiwakes on tiny steps or finger-holds improved and enlarged by the mud-construction of their nests, tysties or black guillemots in talus and boulders at the foot of the cliff. These wild, steep frontiers between sea and land are exciting and beautiful. They probably house larger numbers of vertebrate animals, apart from fish, in a small space, than any other comparable part of the temperate world.

Not many sea-birds of the east Atlantic do not breed on cliffs; but the skuas nest on moors, and the terns and black-headed gulls nest on sand and shingle. Many of the *Larus* gulls, and recently the fulmar, are catholic in their taste in nesting sites, and may be found on moors and even sand dunes. Quite a large number of sea-birds can be inland nesters, even including tubenoses. Fulmars now nest up to six miles inland in Britain, and many of the *Larus* gulls at much greater distances. The black-headed gull, in particular, is often a completely inland species, since some individuals nest in England as far as they can from the sea, e.g. in Northamptonshire, and may never visit it except in casual search for food.

As we go south along the Atlantic seaboard of the Old World we leave behind in the Channel Islands and Brittany the last elements of certain temperate cliff-breeding sea-bird species—the gannet, lesser blackback, great blackback, arctic tern (only a casual breeder so far south), razorbill and puffin. South of the Bay of Biscay we encounter a large sub-tropical and tropical community of about forty species (a few of which belong to sea-bird families but which have become river-birds or inland birds), which is distributed in four main geographical regions—the Lusitanian coast (the Atlantic coast of Spain and Portugal), the Mediterranean, the Atlantic coast of Africa north of the equator, and the Atlantic Islands. These last comprise the Azores, Madeira (to which pertain the Desertas and Salvages), the Canaries and—near the equator—the Cape Verde Islands. Many species breed, of course, in more than one of these regions, though only the herring-gull (rather doubtfully the little tern and cormorant) breeds in them all.

Of the species in the table, the crested pelican *Pelecanus roseus*, the pigmy cormorant *Haliëtta pygmeus*, the Mediterranean black-headed gull *Larus melanocephalus*, and the lesser crested tern *Thalasseus bengalensis* breed on no North Atlantic shore, and the rare slender-billed and Audouin's gulls, *Larus genëi* and *L. audouinii*, are primarily Mediterranean species. It will be noted that three tubenoses have established themselves in the Mediterranean, but that no less than eight species breed in the Atlantic Islands, which have a greater variety of species of this order than any other part of the North Atlantic.

The distribution of breeding sea-birds on these coasts is best illustrated in tabular form :

| | ATLANTIC SPAIN AND PORTUGAL | MEDIT- ERRAN- EAN | ATLANTIC ISLANDS | | | | NORTH ATLANTIC AFRICA |
|---------------------------------|--------------------------------------|-------------------------|------------------|--|---------------|--------------------------|-----------------------------|
| | | | AZORES | MADEIRA DESERTAS & SAL- VAGES | CANAR- IES | CAPE VERDE ISLANDS | |
| North Atlantic | | | | | | | |
| shearwater .. | + | + | + | + | - | + | - |
| Manx shearwater | | + | + | + | | - | - |
| Little shearwater | | - | + | | + | + | - |
| Soft-plumaged petrel .. | - | - | - | + | - | + | - |
| Bulwer's petrel | - | - | | + | + | + | - |
| Frigate-petrel | | - | ? | + | - | - | - |
| Storm-petrel .. | ? | - | - | ? | + | - | - |
| Madeiran fork- tailed petrel | - | - | | + | - | + | - |
| Red-billed .. | | | | | | | |
| tropic-bird .. | - | - | - | - | - | + | - |
| White-tailed tropic-bird .. | - | - | - | - | - | - | + |
| Crested pelican* | - | ? | | - | - | - | - |
| White pelican* | - | ? | - | - | - | - | + |
| Pink-backed pelican* | - | - | - | - | - | - | + |
| Brown booby .. | - | - | - | - | - | - | + |
| Shag | | | - | - | - | - | + |
| Cormorant .. | ? | | - | - | - | + | + |
| Reed-cormorant* | | - | - | - | - | - | - |
| Pigmy cormorant* | - | ? | - | - | - | - | - |
| African darter | - | - | - | - | - | - | - |
| Man-o'-war-bird | - | - | - | - | - | + | ? |
| Herring-gull .. | | | + | + | + | - | + |
| Black-headed gull | - | | | | - | - | - |
| Mediterranean | | | | | | | |
| black-headed gull | - | + | - | - | - | - | - |
| Slender-billed gull | + | + | - | - | - | - | ? |
| Audouin's gull | ? | + | - | - | - | - | - |
| Grey-headed gull* | - | - | - | - | - | - | + |
| Whiskered tern | + | + | - | - | - | - | + |
| Black tern .. | ? | + | - | - | - | - | - |
| White-winged | | | | | | | |
| black tern .. | <i>casual</i> | <i>casual</i> | - | - | - | - | - |
| Gull-billed tern | + | + | - | - | - | - | ? |

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|---------------------|--------------------------------------|-------------------------|------------------|--|---------------|--------------------------|-----------------------------|
| | | | AZORES | MADEIRA DESERTAS & SAL- VAGES | CANAR- IES | CAPE VERDE ISLANDS | |
| Caspian tern .. | — | + | — | — | — | — | ? |
| Common tern | + | + | + | + | ? extinct | — | — |
| Roseate tern .. | — | + | extinct | extinct | — | — | — |
| Bridled tern .. | — | — | — | — | — | — | ? |
| Sooty tern .. | — | — | — | — | — | — | ? |
| Little tern .. | + | + | — | ? | ? | — | + |
| Royal tern .. | — | — | — | — | — | — | ? |
| Lesser crested tern | — | + | — | — | — | — | — |
| Sandwich tern | ? | + | — | — | — | — | — |
| Noddy .. | — | — | — | — | — | — | + |
| African skimmer* | — | — | — | — | — | — | + |
| Guillemot .. | + | — | — | — | — | — | — |

The Sea-birds breeding in the Eastern North Atlantic south of the Bay of Biscay and in the Mediterranean.

*mainly fresh water and estuarine.

**Morocco only.

Of the four main groups of these Atlantic islands, Madeira and the Cape Verdes have probably the largest sea-bird communities, with ten or a dozen species each. One tubenose, the North Atlantic great shearwater, *Puffinus diomedea*, nests on all of them as well as on the Berlengas of Portugal. Bulwer's petrel, *Bulweria bulwerii*, and the little dusky shearwater, *Puffinus assimilis*, also nest on all four island groups. The Madeiran fork-tailed petrel, *Oceanodroma castro*, nests on all but the Canaries. The Manx shearwater nests on the Azores and Madeira, but not yet farther south. The little storm-petrel reaches south to the Canaries (although in small numbers and probably to these Atlantic islands only). The rather rare soft-plumaged petrel, *Pterodroma mollis*, is believed to nest on Madeira; it does so on the Cape Verdes. The beautiful frigate-petrel, *Pelagodroma marina*, breeds on the Salvages (which belong to Madeira but are nearer the Canaries), the Canaries and the Cape Verdes.

The red-billed tropic-bird, *Phaëthon aethereus*, the brown booby and the frigate-bird (man-of-war bird) do not appear farther north than the Cape Verdes. Here the cormorant, which had dropped out in Morocco, reappears as a new race, primarily South African. The bird communities of these islands are only moderately well-known. Most of the sea-birds nest on rocks whose comparative inaccessibility has been both a temptation and a deterrent to the visiting ornithologist. As for the coast of West Africa and the islands lying close to it, no organised investigation of the sea-bird communities of this difficult region has yet been made. We know that one group of species breeds on the Atlantic African coast to Morocco, but no farther south—the shag, herring-gull, the whiskered tern, probably the gull-billed tern, possibly the slender-billed gull. Farther south both white and pink backed pelicans, *Pelecanus onocrotalus* and *P. rufescens*, and the grey-headed gull, *Larus cirrhocephalus*, reach the tropical sea-coast in some places, and the brown booby nests on at least one island off the coast of French Guinea. The Caspian tern, whose world distribution is, to say the least, peculiar, may have breeding stations on this coast, and the little tern, which we had left behind in Morocco, reappears as a separate race on the coast and rivers of the Gulf of Guinea.

The African darter, *Anhinga rufa*, reed-cormorant, *Haliëtor africanus*, and the African skimmer, *Rynchops flavirostris*, haunt the rivers and in places reach the coast; but they are not sea-birds: and on the islands in the Gulf of Guinea the noddy and the white-tailed tropic-bird, *Phaëthon lepturus*, breed. It

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