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MIGRATION OF THE PACIFIC PLOVER TO AND FROM THE HAWAIIAN ISLANDS.

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SINCE primitive times the phenomenon of Bird Migration has excited peculiar interest, and although much of the mystery formerly attaching to it has been dispelled by the prosaic facts brought to light by modern investigations, it still presents enigmas to stimulate the imagination and invite study. *How* birds migrate is now beginning to be understood, and the present practice of tabulating dates of arrival and departure and collating the facts gathered by numerous observers in different parts of the country is likely ere long to give us the solution of many as yet unsolved problems. *Why* birds migrate is quite another question, likely to resist satisfactory solution for some time to come if, for no other reason, than from the very nature of the case we can have comparatively few facts to guide us, and speculation must largely take the place of deduction.

When we consider the number of miles traveled, the widely different characters of the regions chosen for summer and winter abodes, and the perils necessarily attending the passage between them, the migration of no other of our birds appears so wonderful as that of the Golden Plover. In part the migration route of the eastern form of the Golden Plover (*Charadrius dominicus*) is well understood, and those interested in the subject are referred to a sug-

gestive paper by Austin H. Clarke¹ on the probable method by which the bird is guided safely across the Atlantic from Nova Scotia to South America. In the present paper will be presented such facts in regard to the migration of the Pacific Plover (*Charadrius dominicus fulvus*) as the author was able to gather during his stay in the Hawaiian Islands — from 1894 to 1904, together with certain deductions therefrom.

Isolation of the Hawaiian Islands.— It may be premised that no other part of the earth's surface is so far distant from continental areas as the Hawaiian Archipelago. The islands are about 2000 miles from the coast of California on the east; about the same distance from the Aleutians on the north, and the Marquesas group on the south; and not much further from Japan, reckoning from the outermost of the chain of low islands and reefs which stretches from Hawaii some 700 miles towards the Asiatic coast. It is important to note, however, that, assuming the availability of these islands as stepping stones for birds, there would still be an interval of more than 2000 miles between the most northwestern of the chain and Japan. Hence, if we reject as untenable the theory of a sunken southern continent, of which the Hawaiian Archipelago is the northernmost and now the only visible remains, the original introduction into Hawaii of its mammals, birds, insects and plants presented greater difficulties than were presented to the fauna and flora of any other part of the world.

So remote and isolated have these islands been since their formation, and so few and uncertain Nature's carrying agencies — the birds, the winds, and the ocean currents — that after the islands were thrust up out of the sea ages must have elapsed before they received the parent stocks of the many and diverse forms of plant and animal life peculiar to them.

That the difficulties of stocking the archipelago with life, great as they must have been, were not insurmountable is proved by the fact that enough waifs found their way to the islands to clothe them with verdure and stock them with animal life. As a result of the competitive struggle which followed upwards of 900 species of plants, numerous insects, including many distinct genera, seven

¹ Auk, 1905, pp. 134-140.

species of lizards, more than fifty species of birds, and at least two mammals, finally made good their foothold on the islands and flourished, some more, some less, according to their nature and adaptability.

Avifauna of the Hawaiian Islands.—Among other inhabitants of the islands are some 45 species of passerine birds, one hawk, an owl, a mud hen, a gallinule, a stilt, a duck, a goose, and a few others. All of these I pass by for the moment, and come to certain migrants from North America which regularly journey between the islands and the continent both spring and fall. Four of these migrate in great numbers, viz., Golden Plover, Turnstone, Wandering Tattler, and Bristle-thighed Curlew; the Shoveller Duck and Pintail also visit the islands in considerable numbers. In addition to these are perhaps a dozen other ducks and geese whose occurrence in the islands is more or less casual, and the same remark applies to a dozen or fifteen wading birds. Altogether, including the regular migrants, the casuals, and the accidentals, the visiting birds make quite a respectable winged army.

Islands accidentally discovered by present migrants.—It is not supposable that birds ever put to sea to seek unknown lands by a hitherto untraveled route. We know that millions of birds of many species are annually, or semiannually, driven out to sea by storms, especially species that migrate near the sea coast. Many, perhaps most, of these storm-driven waifs never see land again, but become wing weary and find watery graves. Some few, however, reach safe havens in oceanic islands, and in this way no doubt such islands have received their bird colonists.

That the Golden Plover, like the other migrants from the North American coast, discovered Hawaii accidentally is hardly open to doubt. I see no necessity for presupposing the existence of sunken continents, or of ancient continental extensions, to account for the presence on the islands of the Plover and other North American birds, like the Night Heron, Gallinule, and Coot. The presence there of the weak-winged passerines is another matter, and it must be admitted that proof of the existence of an ancient continent stretching from the islands southward towards Australia would simplify a very difficult problem. So far, however, as our North American birds are concerned, it need be assumed only that long

ago some thousands of Pacific Plover and other species, when following the usual southward migration route along the Asiatic coast in fall were accidentally driven to sea, and that a greater or less number were able to maintain themselves on the wing long enough to make a lucky landfall of the low islands to the northwest of Hawaii. The flight from Japan to the nearest island eastward would involve a flight about as prolonged as that from the Aleutian Archipelago to Hawaii, or some 2000 miles. The chain of low islets once gained, it would be but a question of time for migrants, step by step, to reach the larger islands of Hawaii, 2000 miles or so to the eastward. After wintering, a sufficient number may have essayed the flight back across the ocean to the Asiatic coast the following spring, and then northward to their Siberian breeding grounds with their Asiatic fellows. Having once discovered the islands and learned their suitability as winter quarters, they would no doubt return over the same route, and thus in time establish a regular fly line or migration route from the Asiatic mainland to the islands. Later, as the position of the islands became better known, the part land, part water route would naturally be exchanged for a shorter all water route. It is possible, however, that the old Asiatic route has never been wholly abandoned, and that it is still favored by a certain number of the island migrants; for plover, turnstones, curlew and tattlers have been observed on Laysan, about 600 miles northwest of Hawaii, late in May. These birds were probably about to migrate, but it is of course impossible to tell whether they were headed directly for America or for America via Asia.

Absence of fog.—The original discovery of the Hawaiian Islands by birds was undoubtedly greatly facilitated by the fact that, although fog is common on the mountains at altitudes of 5000 feet and upwards, it never occurs at sea level; and as its absence favored the original avian discoverers so it continues to favor annual migrants.

Date of discovery of the Islands by American migrants.—As to the length of time the Pacific Golden Plover and its fellow migrants have been visiting the Hawaiian Islands, or when they first discovered the group, it were idle to speculate. Their arrival probably antedated by thousands of years that of the Natives, which is supposed to date back only some twenty centuries. Certain of

the bird colonists from America, like the owl, night heron, gallinule and coot, have resided in the islands so short a time that they have changed very little from their American ancestry. Others, like the hawk, stilt, and goose, have changed more, and hence presumably have been residents of Hawaii a longer time. Changes of color, proportion, and size, however, be they great or small, cannot be used as time measures, except in the vaguest way, since practically next to nothing is known of the length of time they require. We are perhaps justified in concluding that none of the above species have changed sufficiently to call for isolation from their American ancestors for periods to be reckoned by geologic intervals rather than by thousands of years.

Spring migration of Plover.—The impulse to migrate in spring is by no means simultaneous among all the plover that winter in the islands, or that winter on any one island; nor apparently is it the rule for large bodies of plover to migrate together. The plover and turnstones, probably often in mixed companies, begin to leave for the north early in April, and the migration continues till at least the latter part of May (probably even later), being dependent apparently on the state of preparedness, or the inclination of individual birds.

When the time to migrate comes, small parties, from a dozen or even less, to flocks of 200 or more, strike boldly out to the northward, apparently without hesitancy or doubt of the result. Mr. Haswell of Papaikou, which is on the coast about 15 miles north of Hilo, soon after daybreak during the early days of April, 1900, saw several flocks rise to a great height and, after widely circling about a few times as if to orient themselves, finally disappear in a northerly direction.

It is probable, however, that day migration is not the rule with plover and other shore birds. Apparently it is more usual for the flocks to feed by day and leave just before nightfall, as do many other birds in different parts of the world. Mr. R. C. L. Perkins states that several times he "witnessed these departures always late in the afternoon, or just before dark." He adds: "When about to return to the north the plover frequently assemble in very large flocks, and before setting out on their journey, rise to an enormous height in the air, even beyond the range of sight. I have

once seen two such flocks start from the same point, the one following the other after an hour's interval." (Fauna Hawaiiensis, Vol. I, pt. iv, p. 449, 1903.)

It is interesting to note that plover are occasionally sighted from passing ships. Naturally they attract little attention and never are recorded in the ship's log. I found one ship captain, however, who remembered to have seen a flock of plover passing north in spring. The date was uncertain but the ship was about midway between San Francisco and Hawaii, and the plover were steering a course which would carry them to the neighborhood of the Aleutians.

Where data are so scarce and difficult to obtain it is worth noting, as bearing on the season and course of the spring migration of island birds, that Townsend captured a Pacific Plover, which boarded the 'Albatross' May 19, 1890, when 600 miles south of Kadiak. This bird was probably an island migrant nearing the end of its long flight. Elliott, also, speaking of the turnstone, states that he "met with it at sea 700 miles from the nearest land, flying northwest towards the Aleutian Islands, my ship being 800 miles west of the Straits of Fuca."

Physical condition of spring migrants.—During the last two months of their stay in the islands both the migrating plover and turnstones get very fat, and it is probable that individuals that are not in good condition do not attempt the flight, or if they do, do not survive the attempt. Towards April most plover seem to be in full breeding plumage, and I feel sure that none of the birds assuming the breeding dress remain behind, unless sick or wounded. There is, however, a small contingent, both of plover and turnstones, that summer in the islands, and these appear to consist wholly of immature individuals, which, as a rule, are thin and not in good trim.

Speed of migrating Plover.—The migration of plover over a wide ocean involves two factors: (1) Ability to go without food for the time necessarily consumed in the flight. (2) Ability to make the journey without resting and yet not overtax the physical powers. As stated above, apparently all the migrating birds in spring are in good order, and some of them, especially the males, are exceedingly fat. They are thus in condition to exert their utmost powers for a considerable period and to do without food. I know of no actual tests of the speed of plover. From my own observations

I believe that when not fatigued the plover can easily enough fly 50 to 75 miles an hour, but it is doubtful if such speed can be maintained for any great length of time. I am confident, however, that a speed of 40 miles an hour is well within the bird's powers. At this rate the flight from Hawaii to the Aleutians, a distance of about 2000 miles, would consume a little more than two days; or, allowing a speed of 35 miles an hour, the time occupied would be two days, 9 hours. At first thought it does not seem possible for plover to fly continuously for so many hours without rest and food; yet the above statement cannot be far from the truth. If the birds fly faster, the journey requires less time but the expenditure of more vital force; if, slower, they husband strength at the cost of time. In either event the result would be about the same. Of the extreme limit of the plover's endurance in continuous flight we know nothing; nor do we know what proportion of the birds that start across the ocean are successful in making the flight. That the effort is too much for many individuals is hardly to be doubted, especially for young of the year, which are comparatively weak and unpractised of wing.

A leaf from the notebook of Dr. E. A. Mearns is of interest in this connection. On the 9th of October, when on a transport bound for San Francisco, and one day out of Honolulu, Mearns noticed a lone plover, which joined company with the ship for nearly two days. On the 10th his note book records that the bird was still circling around and above the ship, as if designing to come aboard. Sometimes it flew close alongside and whistled plaintively. Once it rose very high in air and flew out of sight, probably trying to sight land on which to rest, but it soon returned from its fruitless quest. At 5 p. m. on the 10th it seemed weak and tired, but was still flying feebly alongside, its call notes continually growing fainter with waning strength. It was lost sight of at dusk, and was never seen again, but its fate is only too certain.

It may seem remarkable that this tired wanderer apparently never alighted on the water to rest. However, I recall only one instance in which an unwounded plover has been known to alight on the water and again take wing.¹ In considering this question it

¹ Rothschild, *Avifauna of Laysan*, pt. 1, xiv, 1893.

must not be forgotten that neither by birth nor habits is the plover a swimmer. It is a true wader, and though, like all of its family, it can swim when compelled to and can even alight on smooth water and again take wing, it does so probably only in very exceptional instances, and perhaps never when in migration.

Could we assume that this particular individual made a direct course from the Aleutians to the point where intercepted by the transport, the incident would be valuable as affording a tolerable idea of the limit of the endurance and wing power of a plover. The bird, however may have lost its way and have taken a very indirect course to the point where it was first seen from the ship. Unaware of the proximity of the islands to which it was bound, and which it might have reached in a few hours more, it became confused, and made the fatal mistake of following the ship's course. Before it finally succumbed to fatigue, it followed the ship for about 500 miles. Thus at the least calculation it flew 2500 miles before it succumbed to fatigue, and probably very much further.

Time of arrival of migrants in Alaska.—As the migration of the plover (and also the turnstone) from the islands begins during April and continues till into May, and possibly even later, the birds should arrive in Alaska at corresponding dates, the flight probably consuming not much more than two days. As a matter of fact, however, the mainland breeding grounds of the plover in Alaska are snow bound till well into May, and Turner states that the Pacific Plover does not arrive at St. Michael till about June 1, a statement corroborated by Nelson. Although there is no necessary precise correspondence between the breeding time of the Pacific Plover in Siberia and in Alaska, it is interesting to note the statement of Seebohm that the plover arrives on the Yenesay River, Siberia, June 5; and, referring to water birds generally, he adds that "very few eggs are laid on the tundra before the last week of June." (Geog. Dist. of the Charadriidæ, 1888, p. 58.) Where the plover and turnstone, which leave Hawaii early in April, spend the interval till the melting snow bares the hillsides in Alaska and exposes the previous season's crop of *Vaccinium* and *Empetrum* berries, upon which the plover in spring chiefly feed, is left to conjecture. As the Aleutian chain is nearly 1200 miles long, however, and as comparatively little is known of its birds in spring, it is possible that early

migrating shore birds sojourn on them until advancing summer prepares the mainland for their occupancy. This conjecture is to some extent supported by the statement by Elliott that a few straggling plover land on the Pribilofs in April, or early in May, on their way north to breed, but never remain long.

Breeding range of the Golden Plover.— Without doubt the chief breeding ground of the Pacific Plover is eastern Siberia, but a considerable number breed on the American coast of Bering Sea from the vicinity of Bristol Bay (where taken by McKay at Nushagak, June, 1881) to near Bering Straits. The plover breeding on Kotzebue Sound, north of the Straits, is *dominicus* (Grinnell), as also is the one breeding at Point Barrow (Murdock). Apparently *fulvus* does not breed at all in the interior of Alaska, these regions being occupied solely by *dominicus*. It concerns us to note in passing that, unless Palmén is mistaken in his identification, *dominicus*, not content with its wide habitat in the interior of Alaska, crosses the Straits, and breeds on the Chukchi Peninsula.¹ Thus the summer ranges of the two forms actually inosculate, the Asiatic form crossing to America and the American form crossing into Asia — an apparent anomaly in the case of geographic forms.

Hawaiian Plover breed in Alaska.— It is of course impossible to absolutely identify the Pacific Plovers breeding on the coast of Alaska with the winter visitors to Hawaii, yet there are certain facts tending to show that they are the same. (1) It is to be noted that of the winter visitors to the Hawaiian Islands not one is an exclusively Asiatic species. (2) The form of the Wandering Tattler which regularly migrates to and from the Islands is not the Asiatic form *brevipes* but the American form *minor*. (3) There is evidence that the Bristle-thighed Curlew, also a winter visitor to the islands, breeds in Alaska, while it is not known to breed in Asia. As the two last named birds, which breed exclusively in America so far as known at present, regularly winter in the islands, it is a fair inference, in the lack of evidence to the contrary, that the plover and turnstone, as also the other waders which winter casually in the islands, as the Sanderling, Pectoral Sandpiper, Sharp-tailed Sandpiper, Jack Snipe, Knot and others, also come from Alaska and not from Asia.

¹ Palmén, Vega-Exped. Vetensk. Iak-t., Vol. V, 1887, p. 342-348; also Stejneger Auk, 1888, pp. 308-310.

Fall migration of Plover.—For some reason or other plover appear to arrive in the Commander Islands in fall very late, according to Stejneger, not till after the 15th of September; the last ones were observed in 1883 on the 28th of October. The turnstone on the other hand touches the Commanders on its return trip much earlier, according to the same author, as early as the last part of July.

Arrival of Plover in Hawaii in Fall.—Passing now to Hawaii, a small number of plover and also turnstones return there as early as the middle, or the latter part, of August. By inference these are the birds which leave for the breeding grounds earliest in spring, and so are the first to complete their parental duties. Or, the first arrivals in Hawaii may be individuals which made the journey to Alaska but for some reason did not breed; or whose nests were broken up; or whose mates were killed, for the Arctic tundras have their bird tragedies as have other lands. Just as the turnstones reach and leave the Pribilofs in small straggling flocks, so they and the plover arrive in Hawaii; and it appears further that in fall, as in spring, they get into good condition for the flight, and then leave in no regular order nor at any set time, but just as the impulse seizes them.

Between the dates of early departure from Hawaii in spring and of early arrivals in fall there is thus an interval of some four months or more, quite long enough to permit the pairs to attend to their parental duties, to get into condition for the return journey, and to make the trip. So far as my observations extend all the first arrivals in Hawaii in fall, both plover and turnstone, are adults in breeding plumage. I may add that they are invariably in good flesh and that some are very fat. Later arrivals, however, no doubt young of the year, are comparatively poor in flesh and require considerable time to fatten.

How migrants find their way across the ocean.—It thus appears that thousands of birds, large and small, make a two thousand mile flight from Alaska to Hawaii in fall and return in spring. To answer the question how they find their way across the trackless waste we must leave the realm of fact and enter that of speculation. Ocean migration routes have generally been plausibly accounted for on the theory that the present fly lines were established ages ago

when the land connections were very different, and when, by means of continental extensions and islands now sunken, part land, part water routes were easily followed. As such changes as the raising or depressing of continents are very gradual and extend through long periods, succeeding generations of migrants are supposed to have scarcely noticed the difference, and, even after the old land marks had disappeared, to have been able to follow the ancient routes through the power of transmitted habit.

This explanation, however, does not apply to the case of the Hawaiian migrants, since there is no reason to suppose that the isolation of the Hawaiian Islands in relation to continental areas was ever less complete than now; and, although a theory has been advanced that the archipelago is the northern apex of a former southern continent, it finds little support from biologic, botanic, or hydrographic investigations. Moreover, such a continent extending southward towards Australia would have been of no assistance to birds migrating from America, though its former existence, could it be proven, would render easy the explanation of the derivation of the Australian elements of the Hawaiian fauna and flora. The presence of two shoals, situated, roughly speaking, midway between San Francisco and Hawaii, has suggested the former existence here of large islands now sunken. If such islands really existed, which is doubtful, they unquestionably would have aided the passage of American birds and plants to the Hawaiian Islands.

In his interesting article on 'The Migration of Certain Shore Birds' quoted above, Mr. Clark argues that prevailing winds, especially the steady trades, offer a reasonable explanation of the way certain birds are, or may be, guided in migrating. Such an explanation seems to apply peculiarly to the case of the American Golden Plover which, as is well known, abandons the North American continent at Labrador and Nova Scotia, and, under ordinary circumstances, makes no landfall till it strikes the Guiana coast, a distance of about 2000 miles. It is perhaps more remarkable that, instead of returning in spring to its breeding grounds by the same route it takes in fall to its winter quarters, it follows an all land route, and traverses the length of two continents, thus furnishing the most extraordinary migration route of any existing bird, as pointed out by Professor Cooke.

An attempt to apply to the case of the Pacific Plover wintering in Hawaii the same principles so well worked out for the Atlantic coast form is not so successful. About September the wind that prevails in the North Pacific immediately south of the Aleutians is from the northwest. It is generally believed that migrating birds prefer to fly on a beam wind. By heading southwest birds migrating to Hawaii might have the northwest wind abeam till about the neighborhood of latitude 30° where they would be almost sure to pick up the northeast trades. By then changing their course to southeast they would be enabled to fly with wind abeam till they sighted the islands. That they follow such a course in fall and steer their course by either the northwest wind or the northeast trades, there is not a particle of proof that I can bring forward; nor do I know any facts to justify a statement that they do or do not utilize the winds as guides either in fall or in spring.

The results of recent experiments by Prof. John B. Watson with Sooty and Noddy Terns along our south Atlantic coast go far to prove the contention long maintained by many that birds actually possess a sense of direction, tantamount to a sixth sense. If we grant this, as we may ultimately be compelled to do, the ability of birds to find their way both by land and sea is explained without further trouble, and quite independently of landmarks of any kind or of the winds. The possession of such a useful sense will explain many difficult problems of migration, and among others the apparent confidence with which migrants boldly launch out from Hawaii for a 2000 mile flight across the Pacific, without the aid of any compass apparent to human intelligence.

Danger of oceanic migration.—Of the fall migration of the Golden Plover on the Atlantic it may be remarked that while the birds have no landmarks to steer by after leaving the northeast coast, they are yet within comparatively easy flight of the mainland, and, in event of a bad northeastern wind, they can, and in fact often do, take refuge on the New England coast; and further on, in bad weather or in case of unpropitious winds, they alight for rest and food in the West Indies.

The Pacific Plover traverses a much more hazardous route since, when once clear of the Aleutian Islands, it not only leaves all landmarks behind but also all ports of refuge. The Hawaiian Archi-

pelago, with the chain of low islands and sand spits to the northwest afford a reasonable chance for a successful landfall, since unitedly they stretch away in a very thin line for some 2200 miles. Moreover the islands are close enough together so that migrants high in air would not be likely to miss them by passing between. Flocks that chance to get to the eastward of Hawaii, however, are probably doomed, since they would have to fly another thousand miles or so before finding islets on which to rest. The Marquesas group, the first islands of size to the south of Hawaii, is about 2000 miles away, or about 4000 miles from the Aleutians, and it is more than doubtful if even the strong winged plover could fly 4000 miles without rest and food and survive the trip. That many of the migrating shore-birds actually perish at sea admits of no doubt.

In this connection it is of interest to note that in the few instances in which island migrants have been sighted when near their journey's end, going or coming, they exhibit fatigue, and usually evince a strong desire to board passing vessels. The incident noted by Dr. Mearns has been cited. Other instances were reported to me by the captains of two island bound barks who sighted several small flocks of plover during the last days of September, 1900, when from 200-400 miles off Hilo. These birds appeared much fatigued and exhibited a strong desire to board the ships, especially when their calls were imitated.

E. W. Nelson, however, while on the 'Corwin,' October, 1881, saw a small party of plover about midway between the Alaska Peninsula and the Hawaiian Islands. These birds were headed directly for the islands and they flew swiftly on their course, showing no signs either of uncertainty or of fatigue.

Moult of the Pacific Golden Plover.— It is of interest to note that in fall this plover migrates before it moults; in spring it moults before it migrates. The first birds to reach the archipelago in August are, as stated, adults, and while they are practically in full breeding dress they begin to moult into the winter dress almost at once. The moulting season for the species is long, and many individuals, doubtless birds of the year, may be found the last of December still moulting into the fall and winter dress. By the middle of February numerous individuals are already beginning to moult a second time and to assume the distinctive nuptial plumage,

which, in the case of these early birds, is practically completed during the month of March, though individuals continue to moult far into April and some no doubt complete the final stages in Alaska.¹ Doubtless the individuals to moult first in spring are the adults which arrive first, and finish the fall moult first; and doubtless, too, these are the birds first to leave Hawaii for their breeding grounds in Alaska. So protracted is the moult of the species that it is probably true that during the stay of this plover in Hawaii — from middle August till May — there is not a month when some individuals are not moulting.

There is no reason for believing that the plover summering in the islands which, as before stated, are chiefly if not wholly immature birds, participate in the spring moult. At all events the Hawaiian summer plover and turnstones that I have seen were, without exception, in the winter garb.

Why the Plover migrates.— We have thus seen that what at first might appear a physical impossibility — the 2000-mile flight of small birds across an ocean highway, without a single landmark and with only the friendly winds to guide them, if indeed, they utilize these as guides — is not only possible, but the feat is accomplished annually by many thousands of individuals, and that too apparently with no stops for rest and food. The wonder of it is but increased when we realize that these annual flights are undertaken solely for the purpose of making a sojourn of a few brief weeks in Alaska to nest and rear their young. The hazards of such journeys are very great — much greater than any land migration however prolonged — and there is no doubt that of the thousands daring the perils of the trip from Alaska many are lost, either by missing the islands altogether or by being caught in storms; or by reason of insufficient strength and wing power. The flight from the islands to Alaska, though not without danger, is less hazardous than the southern flight, both because a much greater proportion of the migrants are mature and experienced, and because, in case they lose their way, they have two continents as marks to hit.

¹ I have several specimens taken in March and April which were kindly sent me by my friends Mr. Henry Patten and Mr. W. B. Newell of Hilo. These are in spring plumage but show unmistakable signs of molting.

The motive for the fall migration of the plover, like that of the other waders breeding in the far north, is easily understood. Whatever may have been the case in the distant past, to-day the waders have no alternative. They must migrate from the Arctic in the fall or starve. The only choice offered is as to the selection of winter quarters. Thus compelled to migrate, it appears that a certain number of plover and of several other shore-birds find the Hawaiian Islands a winter resort so attractive that to reach them they brave the perils of migration across a wide and stormy ocean. Why then do they not permanently colonize the islands? If adapted to the bird's needs for nine months of the year, why not for the other three?

It cannot be said of the spring migration of these Hawaiian migrants as of the fall, that the birds have no alternative. On the contrary the choice is open, and they would seem to have every incentive to remain, with no very apparent motive to migrate. The chief cause compelling winter visitors to the Tropics to leave and to seek northern regions in which to breed has been supposed to be the overcrowding of the Tropics in spring and the resulting lack of room and of food. No such conditions appear to confront the winter sojourners of Hawaii. During its stay in the islands the plover, as also the turnstone, feed chiefly in the upland pastures and clearings, up to 6000 or 7000 feet, and on newly plowed cane land. Both the sugar planter and the stock raiser have much to thank the plover for, since, while the birds feed on small seeds to some extent, they live chiefly on insects, and according to Perkins, on insects of much economic importance, since they depend largely on the caterpillars of two of the most widely spread and destructive of the island 'cut worms.' These insects are most abundant when the grass on the island pastures is green and luxuriant, and this usually is in winter when rains are most copious. That the supply of food in winter and spring is ample is sufficiently attested by the fact that the birds get into such excellent condition. Even if it be assumed that the supply of food in summer is less than in spring, and hence inadequate for the needs of the thousands that winter here, together with their young, still there is enough to sustain very many more than the comparatively small number of non-breeders that summer here.

From the standpoint of the food supply it is even more difficult to explain why the tattler and the curlew leave the islands in spring, since these birds feed almost wholly along shore where there can be no appreciable difference in the quantity of food summer and winter.

The question why the island plover migrate is all the more difficult to answer when we remember that the islands have been permanently colonized by certain other American birds, such as the Hawaiian Stilt among the Limicolæ, the Night Heron of the Herodiones, the Hawaiian Mud Hen and Gallinule of the Paludicolæ, the Hawaiian Goose, the Short-eared Owl, and the island Buteo. These birds came to the islands as waifs, as did the plover. Finding room, shelter, and food abundant, they wisely elected to roam no more, but to become permanent residents, and to forswear for all time the perilous and unnecessary habit of migration. Since *they* successfully resisted the impulse to return to their former summer homes to nest, then why not the other species? As stated above the failure of the plover and turnstone to become permanent colonists is not because they are crowded out by other species. In fall the migrants from Alaska find the inviting island pastures unoccupied, and as they find them in fall, so they leave them in spring.

I can suggest no very convincing answer to the question, but I may note the significant fact that the present suitability of the islands as a breeding ground for the plover and turnstones is very recent as compared with the birds' acquaintance with them. The cleared strip around each island now planted chiefly to cane, which may be roughly stated to be three miles wide, and the extensive clearings above this strip which serve for pasture for cattle, are less than a hundred years old, most of them less than 50. Prior to their discovery by Europeans all the islands were heavily forested, nearly or quite to the shore. Possibly then the plover and other migrants have been slower to realize the situation than the other species, and do not even yet appreciate the advantages offered by continuous island life.

It may be said too that the spring migration of the plover and turnstone is so intimately interwoven with the function of reproduction, that we are quite safe in assuming that, were it not for the desire to nest, the birds would never migrate. Those in fact which

are not stirred by the impulse to nest, either because too immature or too old, do not migrate; and the intimate connection between migration and reproduction appears further from the fact that all the individuals that migrate don the nuptial dress before they start, a sufficient declaration of their purpose in undertaking the trip; while those that remain retain the dull winter plumage.

It appears to be true of all birds that having once reached their winter quarters, be they near or far from the summer home, no migrating species attempts to return to its summer haunts till stimulated thereto by the profound physiological change consequent upon reproductive activity. This impulse is not primarily due to change of season or to change of temperature, but is periodic and physiological. When once felt, every instinct seems to impel birds to take the shortest route to the spot where they first saw the light, or where they have reared young. This has often been called the home instinct. In the case of many species the phrase is not very happily chosen, though I myself have used it, since that locality is more properly to be called a bird's home where it spends the greater part of its life, rather than where it spends a few brief weeks annually. Nevertheless the power of habit transmitted through thousands of years is very great, and it is probably this influence associated with the reproductive instinct which so far has prevailed over other considerations and caused the plover to migrate from Hawaii in spring.

If the Charadriid birds, the plovers, sandpipers, and curlews, originated in the Arctic, as Seebohm and others believe, and were forced by the exigencies of the ice age to become wanderers over the face of the earth, then indeed the spring migration of the waders from their distant winter resorts is more fitly termed a return home, and the instinct prompting the flight the homing instinct. Originally forced by the ice invasion to abandon their then Arctic Paradise and seek shelter and food in distant parts, as the ice receded they gradually formed fly lines to and from their summer and winter homes till the habit formed during thousands of years became so fixed as to absolutely dominate many species. That it did not dominate all of the original migrants, however, appears from the fact that permanent colonies settled here and there even in tropical regions, showing that under certain circumstances the

habit of migration can be and is overcome. Of the island plover all we can say is that so far as we can see its spring migration to its Arctic breeding grounds is not necessary, except in so far as made so by the tyranny of habit.

This explanation has at least the advantage that it explains nothing, and hence leaves the problem open. It simply shifts slightly the point of view. We perceive that the island attractions have proved sufficiently strong to make permanent residents of certain species which have strayed to the archipelago. In the case of other strays, like the island plover and the turnstone, either the island attractions are not so strong, or the birds' love for their original habitat is stronger, and they continue to migrate, though with much danger and at a great cost in lives.

Before leaving this subject I must add that several independent observers have reported finding a few young plover and turnstones in summer on the coast of Kau, island of Hawaii, and at one time I thought it possible that a few curlews also remained to breed; but in the case of none of these species was I able to fully satisfy myself that the birds reported were nestlings. It is, however, not impossible that occasionally a disabled female plover, turnstone or curlew secures a mate and nests in Hawaii. Indeed it seems highly probable that it is in this accidental sort of way that new avian colonies are occasionally planted. Such indeed may be the explanation of the resident colonies of American species like the coot, gallinule and others above referred to. Possibly, too, young birds of the year remaining for the summer occasionally feel the breeding impulse after their comrades have left for the north and so breed and found permanent colonies.