lation encompassing most of the range of variation in the two races concerned. Nevertheless, each character may "blend" from one extreme manifestation to the other. This is the sort of complex to be expected if two populations, already heterogeneous and with characters inherited through many sets of factors, are thrown together and interbreed.

Winter ranges of races of Lincoln Sparrows have been mapped. The race *gracilis* has a restricted winter range. The other two races are wide spread in winter, but with local concentrations where there are favorable conditions.

The amount of individual variation (presumably genetic) in characters appears to us to be of the same order as that encountered in Fox Sparrows (*Passerella iliaca*) and Song Sparrows (*P. melodia*). In Lincoln Sparrows there is no reason to believe that in any one type of character there is less raw material in the way of variation upon which natural selection may work in the production of races. There are, however, fewer characters that differentiate conspicuously. Such characters as ventral spotting, coloration of ventral spots, bill shape, length of claw of hallux, that differentiate in races of Song Sparrows and Fox Sparrows, have not done so in Lincoln Sparrows. Yet, the reason they have not may be that there has been no selective pressure, for clearly there is some individual variation in all these features in Lincoln Sparrows.

A sort of organic selection may operate in Fox Sparrows and Song Sparrows to induce diversification. For example, Fox Sparrows by temperament (probably hereditary) may be especially given to pushing into new regions and new habitats; certainly they appear to have accomplished this. The attempt to colonize would set up new habits in the individual and throw the bird under new selective influences so that racial evolution would be relatively rapid. The Lincoln Sparrow, on the other hand, by rigidly adhering to a certain ecologic niche for purely psychologic reasons (there might be others) would not differentiate greatly even though giving rise to variants upon which selection might work. The bird is not adventurous. Species that are aggressive in the sense of range expansion, geographically or ecologically, and yet not too adaptable individually, should form large rassenkreise. We can see in the natural history of the Lincoln Sparrow, then, factors which we think are partly responsible for lesser racial differentiation compared with its generic relatives.

Museum of Vertebrate Zoology, Berkeley, California, January 17, 1935.

CONTINENTAL LAND MASSES AND THEIR EFFECT UPON BIRD LIFE

WITH TWO ILLUSTRATIONS

By P. A. TAVERNER

It seems that no particular attention has ever been called to the effect that relative shape and size of the large continental land masses may have upon bird populations, especially of migratory species; yet an important relation exists between them. It is obvious that no population can increase permanently beyond the number that can be carried through the most difficult season. The amount of live stock that a ranch can carry is not measured by summer pasturage but by its winter resources. Similarly, no northern area can, except temporarily, possess more migratory birds than can be supported through the winter in southern quarters. No improvement in northern conditions can ever increase migratory bird populations

beyond the limits imposed by southern factors. Any large-area map shows that the possibilities of summer and winter ranges of many birds vary considerably. We are not thinking here of the different ecological conditions—the distribution and character of desert, marsh, forest, etc.—but of the fundamental differences in land areas. In the northern hemisphere these differ strikingly.

North America is triangular in shape, the broad base to the north, the pointed apex to the south. Land areas are immensely more extensive north than south, and

Fig. 30. Summer and winter ranges of Eastern American Robin.

their capacity for raising birds greatly exceeds that for wintering them.

Europe and Asia present a very different picture. Their combined outlines are approximately rectangular. Europe is particularly favored in this respect, for the land masses southward include the broadest part of the great continent of Africa and it is evident that birds of northern Europe have greater land areas available in winter than in summer. On the basis of relative land areas, southern Europe and northern Africa could return to northern latitudes more birds than can well be accommodated, or at least can fill northern regions to their full capacity. Contrary to North American conditions, the wintering area exceeds that of summer. Asia is slightly different. Southward it shows a slight taper and considerable expanses of water but in no such pronounced degree as does North America. Its great southern land masses promise far greater winter resources. Its facilities for migratory winter population are intermediate between those of Europe and America.

South America and Africa reverse North American conditions inasmuch as they present wintering areas that are enormously greater than summering areas. In fact the latter are so reduced as to hardly seem worthwhile exploiting by an extensive migrational system. It is not unlikely that this is the factor that has discouraged or prevented in the southern hemisphere the highly developed migrational movements that are so characteristic of the bird life of the north.

It has often been pointed out that in Europe bird conservation is generally disregarded and that everything that flies is pursued relentlessly as a legitimate object of sport and gastronomy. Yet in spite of this, Europe possesses more birds than does North America, where law, tradition and practice are to the contrary. Undoubtedly Europe's greater winter resources based upon the more favorable shape of its land masses is an important factor in producing this paradoxical state of affairs. North America cannot carry enough seed stock through the winter to populate the north to capacity and consequently cannot expect the same density of bird population as Europe, that can depend upon a sufficiency or a superabundance of seed. It is probable that these fundamental conditions explain to a large extent the

difference of attitude towards conservation on the two continents. The necessity for conservation of bird life obviously is greater in North America than in Europe or Asia.

In illustration of the peculiar American conditions, the summer and winter ranges of two birds typically affected, have been mapped—for the Eastern American Robin, *Turdus migratorius migratorius,* and the Common American Golden Plover, *Pluvialis dominica dominica.* These maps have been traced from an "interrupted homolographic equal area projection" that reduces the distortion involved in representing a spherical surface on a plane, to a minimum, so that the relative sizes of the parts indicated are not appreciably affected. In spite of the adaptability of the robin it clearly is impossible, even when the relative productivity of the two areas is considered, for the small winter quarters to support sufficient breeding material to populate to capacity the whole of the great northern area. In this particular case the adverse conditions are intensified by the fact that the wintering area is already utilized by a resident Southern Robin, *Turdus migratorius achrusterus,* which occupies an identical ecologic niche and whose competition reduces the number of intruders that can be accommodated. The case of the Plover is similar, though its

Fig. 31. Seasonal ranges of Common American Golden Plover; summer range in North America, winter range in South America.

seasonal ranges are separated by many hundreds of miles. In summer it occupies the great expanse of the widest part of the northern continent; in winter it is confined to the pampas in the constricted tail of South America. The two areas are strikingly different in size.

Of course this difference in continental shape will not affect all birds equally. Sedentary species may not be affected at all. With other species, differences in food productivity and ecologic conditions may in varying direction and degree compensate for differences in regional areas. But taking bird life as a whole, when ninety per cent of the birds of a great region periodically and of necessity have to be packed into a much smaller area already occupied by an intensely competitive population, and at the season of least productivity, factors are present that set definite and positive limits to population.

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