# CLIMOGRAPHIC STUDIES OF CERTAIN INTRODUCED AND MIGRATORY BIRDS[1]

ARTHUR C. TWOMEY

*University of Illinois*

Considering the relation of animals to their environments, one may conclude that where natural factors limit the range or distribution of a species, usually very few complicated factors are involved. The extent to which these factors actually limit in their effect ordinarily involves not the entire life-cycle of the species or the individual, but some particular or critical period of the life of the organism. Of all the periods in this life cycle, the breeding season followed by that in which the young are raised, is undoubtedly the most critical. At such periods the environmental conditions must be as nearly optimum as possible else catastrophe results. By optimum is meant that which is most suited to the physiological requirements of the individual. The tolerance of the adult is greater than that of the young, and if the conditions under which the young are raised are too far from this optimum, the young will perish though the adult may survive, but such a sequence of events quickly results in the extermination of the race.

It is not the purpose to review here the many studies of physiological conditions and physical factors which control the movements of an organism. Many studies have been made involving temperature, humidity, rainfall, and radiation, as *individual* factors influencing or limiting the distribution of animals, but there are few studies which take into consideration a possible combination of two or more of these factors as indicating the range preference or range limitations of a species. The author has been unable to find any work using two factors as a means of measuring or comparing certain phases of the migration problem of animals, or to explain either the obvious success or equally obvious failure of species introduced into a new environment.

The purpose of this study is to present two distinct problems of avian life history by means of duplex data involving both temperature and humidity. These two problems are: (1) the problem of the introduced species: why it is either a success or a failure; and (2) a comparison of the summer and winter ranges of certain migratory birds as shown in terms of these two factors, temperature and humidity. The first involves the question: Can we, in terms of temperature and humidity, show any cause or reason why certain species have been introduced successfully into certain regions and entirely unsuccessfully into others? The second involves the questions:

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Is there any relation, in terms of temperature and humidity, between the summer and winter ranges of certain species of birds? Do they migrate from one set of physical conditions into a region characterized by a different or by a similar set of conditions? Can the answer to these two questions throw any light on the problem of migration routes or destinations?

In order to analyze the conditions under which different birds are living, climographs have been employed, which show the temperature-humidity conditions within the range of the species involved. These climographs, made for the optimum conditions of the species studied, are used as the basis for comparison of the conditions into which the introduced species are projected or into which the migratory species move.

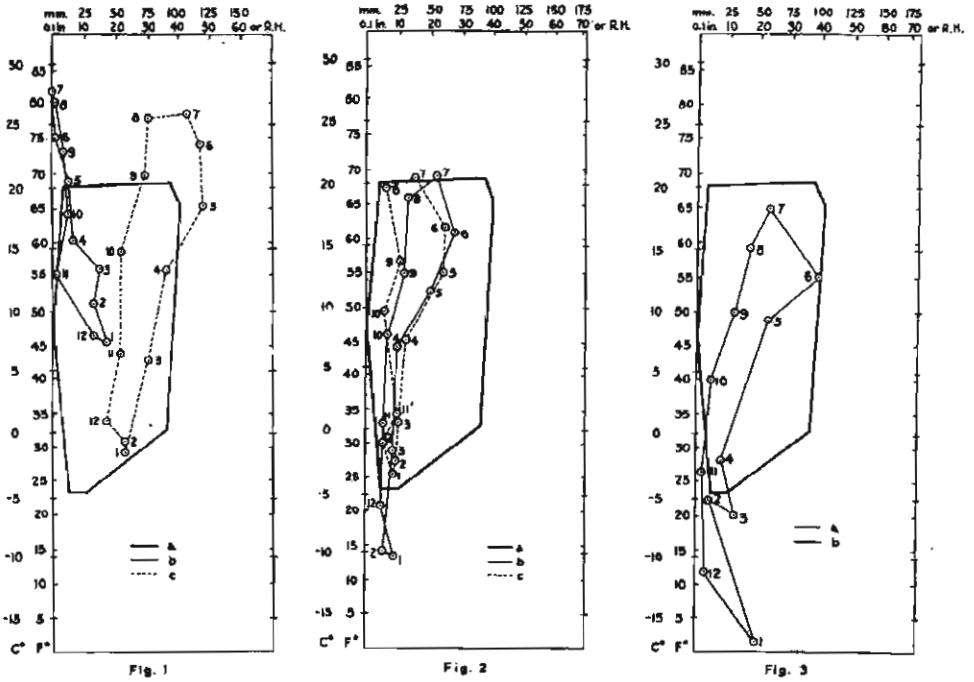
Climographs have been used by ecologists for a number of years to show that a combination of the two factors, temperature and rainfall, play an important part in nature. Both are definitely controlling factors on the environment in general and may be considered as vital to the organisms within that environment. Climographs serve as a basis of comparison for temperature and humidity in various localities (Shelford, '30).

## The Problem of the Introduced Species

Since the coming of settlers into North America, many attempts have been made to introduce various species of birds into America, both from Europe and from the Orient. There have been some outstanding failures. The English Sparrow and European Starling are among the notable but unfortunate successes; each bird has been able to adapt itself to varied and extreme conditions. This is proven by the fact that the English Sparrow has had such a wide range over North America, the Hawaiian Islands, Bermuda, Cuba, South America, Australia and New Zealand and by the fact that the Starling is certainly doing exceedingly well in its new North American environment. It appears that the birds do very well anywhere outside the tropics but do not fare so well beyond latitude 50 degrees. Other imported birds, as the Hungarian Partridge, for example, have been outstanding successes in certain definite localities, though failures in others. This shows that the bird has a limited range tolerance and cannot exist under such a wide range of the limiting factors of temperature and precipitation as can a bird like the English Sparrow. The European Sky Lark is another notable example because of its very local successes in the United States. The Chinese Starling brings out a further example of a bird that has spread but locally. It apparently cannot stand cold temperatures and has remained on the Pacific coast, moving gradually southward as far as Portland, Oregon. Many more examples could be cited, but all seem to show that imported birds will perish unless they obtain an optimum both of temperature and precipitation highly similar to those existing in their native habitat at least during the critical time of nesting.

The following examples show how climographs which consider only temperature and rainfall throw light on the reasons for some imported birds being successful in their new environment, for others being complete failures, and still others showing partial or local success.

The Hungarian Partridge (*Perdix perdix perdix*) is a good example of the last type, an importation locally successful. It is a bird which has a wide range in its habitat preference. Introduced from central Europe a few years



Climographs for Hungarian Partridge

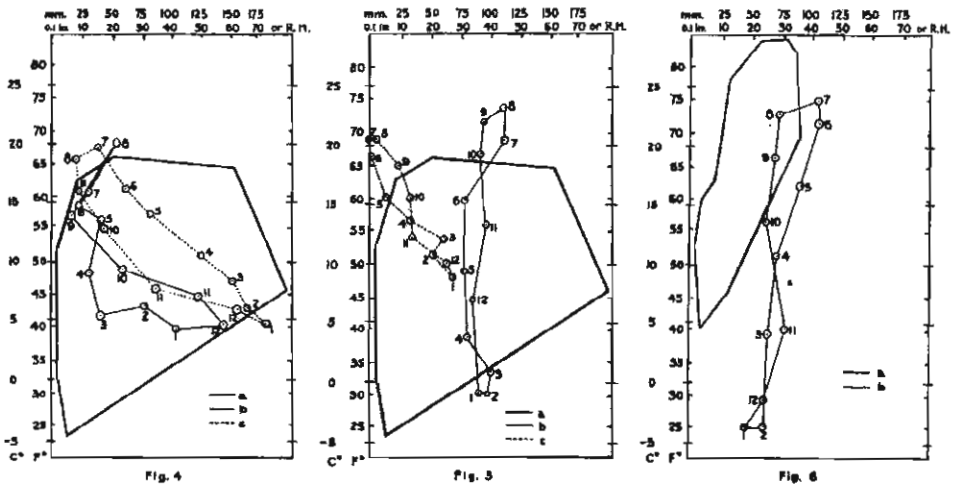
FIG. 1. (*a*) European optimum
(*b*) Frenso, California
(*c*) Columbia, Missouri.

FIG. 2. (*a*) European optimum
(*b*) Havre, Montana
(*c*) Great Falls, Montana.

FIG. 3. (*a*) Edmonton, Alberta
(*b*) European optimum.

ago, it has been distributed by extensive plantings throughout the United States and Canada. It has flourished exceedingly well in some states, while in others, it has failed completely. In California, Missouri, and New Jersey, the Partridge has failed to establish itself despite the state wide planting operations. Available data show that these states have all that is required for the physical comfort of the bird, and food is not scarce. The yearly

optimum for the temperature of each state is nearly identical with that of central Europe. There is also a close correlation in respect to yearly mean rainfall. But when, by means of the climograph, the optimum conditions of temperature and rainfall for each month had been established for the range of the Partridge in central Europe, and this compared with the climographs of these areas of failure (fig. 1), very little correlation is in evidence. Studying the climograph (fig. 1), one sees clearly that in both cases the months that fall outside the optimum conditions are 5, 6, 7, 8, and 9 (May to September),



Climographs for European Skylark

FIG. 4. (*a*) European optimum
(*b*) Victoria, British Columbia
(*c*) Portland, Oregon.

FIG. 5. (*a*) European optimum
(*b*) Brooklyn, New York
(*c*) San Jose, California.

Climograph for Texas Bob-white

FIG. 6. (*a*) Native optimum in Texas and Mexico
(*b*) Urbana, Illinois.

the critical periods in the life cycle of these birds. It is during these months that the eggs are laid and the young are hatched and reared. California is too hot and dry during the nesting period; Missouri and New Jersey experience too much rain and high temperatures during this critical period.

On the other hand, in south and central Alberta (fig. 3) where the Hungarian Partridge has flourished and has spread over a very wide area within a brief span of about fifteen years, the climograph falls within the optimum conditions of its native habitat in central Europe. Months 1, 2, 3, and 12 fall

considerably below the optimum, but low temperatures during this time of the year do not, apparently, affect the birds. However, it is clearly seen that the critical months 5, 6, 7, 8, and 9 all fall very well within the optimum conditions.

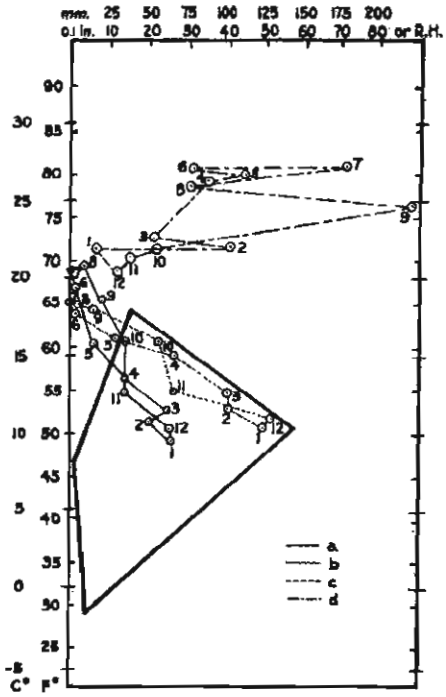



Fig. 7

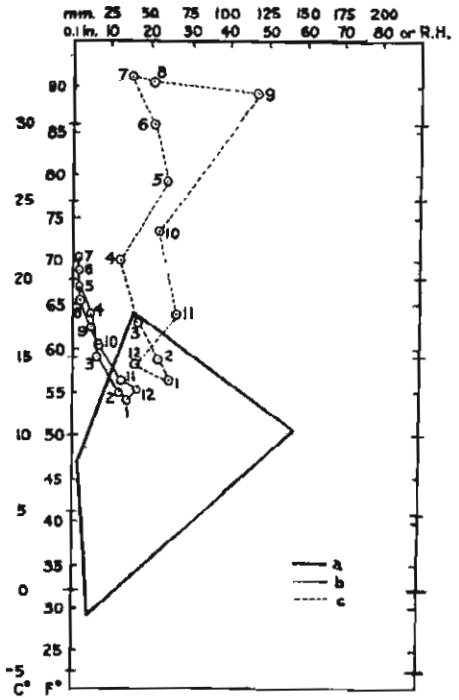



Fig. 8

Climographs for Long-Billed Dowitcher

FIG. 7. (*a*) Breeding optimum in Alaska
(*b*) San Jose, California
(*c*) Santa Cruz, California
(*d*) Havana, Cuba.

FIG. 8. (*a*) Breeding optimum in Alaska
(*b*) San Diego, California
(*c*) Corpus Christi, Texas.

The birds have likewise been successful in parts of Montana where state wide plantings were carried on. The north central portions of the state have the largest successful populations as indicated by the climograph (fig. 2). Great Falls lies inside the optimum for all months, though Havre has months 1, 2, and 12 falling outside. Here again is evidence that in localities where the birds are successful, the critical months of 5, 6, 7, 8, and 9 are all inside the native optimum conditions.

A similar example can be cited in the case of the Texas Bob-white (*Co-*

*linus virginianus texanus*) which was thought capable of flourishing successfully in Illinois. Extensive plantings were made around Urbana and numerous other areas in the state, but all were total failures. Figure 6 brings out one very probable reason for the failure. The optimum conditions of temperature and rainfall in Urbana are almost entirely outside of the optimum conditions for its native habitat in Texas and New Mexico. One would prophesy in advance by reference to such a chart, that the planting of this bird was pre-doomed to failure.

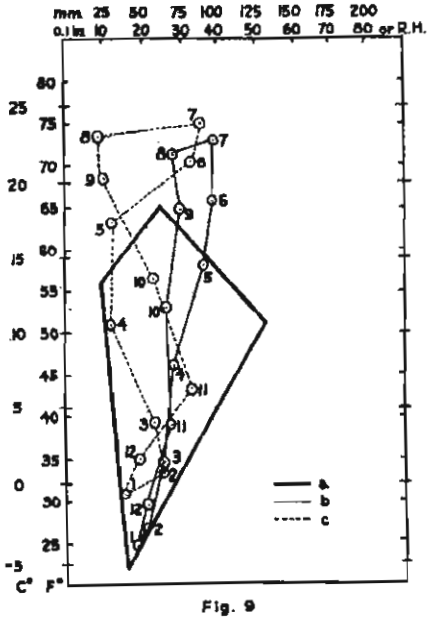



Fig. 9

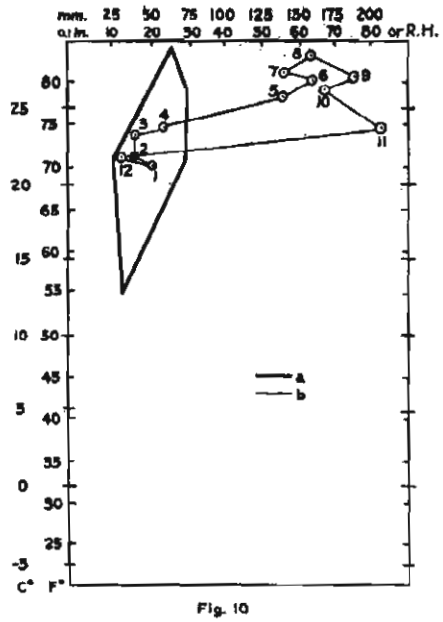



Fig. 10

Climograph for Bohemian Waxwing

FIG. 9. (*a*) Breeding optimum for Edmonton, Alberta; Ungava, Quebec; and Moose Factory, Ontario
(*b*) Chicago, Illinois
(*c*) Pittsburgh, Pennsylvania.

Climograph for Kirtland's Warbler

FIG. 10. (*a*) Breeding optimum—counties of Oscoda, Crawford, and Roscommon, Michigan
(*b*) Bahama Islands.

The European Skylark (*Alauda arvensis*) is a common bird in England and central Europe. The optimum distribution in England and Germany shows a considerable range for this bird (fig. 5). It was introduced into Brooklyn, New York about 1870 where it flourished for twenty years. Many accounts of it were published in "The Auk" during this time, but it

had disappeared by 1899. A severe blizzard in February, 1888 was supposed to have caused its doom.

From the above account, it appears that they were fairly successful in Brooklyn. On glancing at figure 5, it may be seen that the optimum ranges of temperature and rainfall for Brooklyn fall precariously within the Skylark's native optimum conditions. It is important, however, to stress the fact that the critical breeding and nesting months of 5 and 6 fall within the native optimum conditions though the subsequent semi-critical months fall just outside. In Portland, Oregon where is was introduced in 1889, the Skylark spread locally and flourished for twenty to twenty five years. The climograph (fig. 4) shows that the greater part of the year falls within the Skylark's optimum range, especially for the months of 5 and 6, and no critical months fall far outside. That 7 and 8 fall outside would indicate a precarious situation, however.

From all data available it seems evident that the Skylark is a success in the neighborhood of Victoria, B. C., where it was planted in April, 1913. Fifteen years later it was still present near Victoria and frequently has been heard singing. A glance at the climograph (fig. 4) shows clearly that the optimum temperature and rainfall for all the critical months of the year fall within the native optimum; only August is slightly outside. Similar plantings were made near San Jose, California in 1896 (fig. 5). It was reported that they were doing well the following year, but that they finally vanished. The optimum range for San Jose shows that the critical months of 5, 6, 7, 8, and 9 are all considerably outside the bird's native optimum and one would not expect its survival.

## The Problem of the Summer and Winter Range

The second problem involves a comparison of the summer and winter range of certain migratory species of birds. Possible causative agents of migration are not considered in this paper. The fact of migration—that certain birds leave a definitely circumscribed area of summer activities, and after a long journey, winter in another circumscribed area—is considered here. A comparison of this summer and winter area in terms of temperature and humidity has been made in an effort to ascertain whether there is any relation between them in terms of these two climatic factors. Birds having a "definitely circumscribed" summer and winter range have been chosen merely because such birds indicate a relatively limited climatic tolerance, and hence are much more easily studied than wide-ranging, highly tolerant species. Finally, the choice of species has been limited because of the small number of weather stations in the extreme north and in the area of winter distribution, from which data could be obtained to construct the climograph of the area. The following examples show two things: the climatic relationship of the summer breeding and the inter ranges, in terms of temperature and humidity, and the fact that "strays" from the normal range, driven perhaps by storm

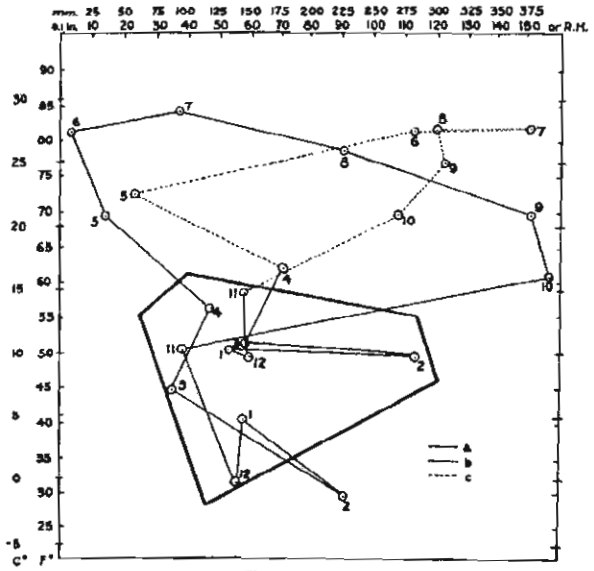



Fig. 11

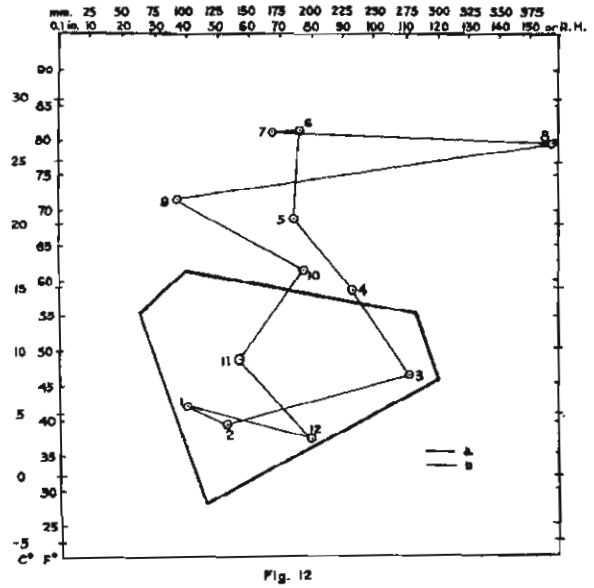



Fig. 12

Climographs for Tree Sparrow

FIG. 11. (*a*) Breeding optimum—Churchill, Manitoba; Moose Factory, Ontario; Ungava, Quebec
(*b*) St. Louis, Missouri
(*c*) Charleston, Illinois.

FIG. 12. (*a*) Breeding optimum—Churchill, Manitoba; Ungava, Quebec; Moose Factory, Ontario
(*b*) Nashville, Tennessee

or other event from the normal migration route of the species, are actually far out of their optimum.

The Long-billed Dowitcher (*Limnodromus griseus scalopaceus*) arrives on its breeding grounds in northern, north central and north western Alaska late in May. The nesting occurs during June, and by the middle of August the young are fully grown and ready for the fall migration. The optimum conditions for these months, 5, 6, 7, 8, and 9 for this Alaskan area have been used in plotting the optimum summer conditions, with the results shown in figures 7 and 8 by the area involved in the heavy black figure. From this optimum breeding area the birds migrate down the California coast, and are common winter residents along this coast from San Diego to southern California. Within this range three points were selected: San Diego, San Jose, and Santa Cruz, California. The mean monthly temperatures and humidities for these three localities are plotted in figures 7 and 8. It is interesting to note that the months 10, 11, 12, 1, 2, 3, and 4 all fall within the optimum summer range of the species in all three locations. In other words, the winter conditions of the temperature and humidity factors in San Diego, Santa Cruz, and in San Jose, California, are within the range of those same conditions in northern Alaska in the summer, and that the Longbilled Dowitcher, in migrating from Alaska to San Diego, San Jose, or Santa Cruz for the winter, has simply exchanged one set of conditions for the same set of conditions in another locality. The Dowitcher is also found in winter at Corpus Christi, Texas. By plotting the climograph for this location in winter, it is found that the winter months 12, 1, 2, and 3 fall within the range of the Alaskan summer conditions. At Havana, Cuba, the Long-billed Dowitcher is a rare straggler, and Havana is outside the normal winter range of the species. The climograph of Havana (fig. 7) shows clearly that one would not expect the Dowitcher there at any time of the year except by accident, for not a single month touches the summer conditions in the Alaskan breeding area.

The Bohemian Waxwing (*Bombycilla garrula pallidiceps*) is a bird whose wanderings are extensive. It nests regularly from western Alaska across northern Canada to northeastern Manitoba. Plotting the climograph for the summer range within this extensive breeding area, widely separate stations were selected—Edmonton, Ungava, and Moose Factory. These give the form represented by the heavy black outlined area of figure 9 when the breeding months of the Bohemian Waxwing are plotted. This species winters near Chicago, Illinois, and around Pittsburgh, Pennsylvania. Figure 9 shows that in the climograph of Chicago and Pittsburgh the months of 5, 6, 7, 8, and 9 all lie outside the breeding range of this bird, while the rest of the year, including those months spent by the bird outside of its summer range, all fall within the climograph of the two cities. Here again the bird has exchanged its summer range for a winter range involving the same set of conditions.

Kirtland's Warbler (*Dendroica kirtlandi*) has perhaps the most restricted breeding range of any of our song birds, for it is known to breed in only three counties of the state of Michigan—Oscoda, Crawford, and Roscommon. The winter range is restricted to the Bahamas and at least as far south as the Caicos Islands. The climograph of the Bahamas winter range is shown in figure 10. In this same figure the summer breeding range is indicated by the heavy outlined area. It is interesting here to note that the months of 12, 1, 2, 3, and 4 of the Bahamas winter range fall inside of conditions within the optimum breeding area during the breeding season.

Finally, the Tree Sparrow (*Spizella arborea arborea*) offers an excellent example. The breeding range of this bird is the Hudson Bay area of Canada. Its southern limit extends into the central and south central United States. The heavy black line in figures 11 and 12 represent the summer breeding optimum which comprises the same set of conditions found at Churchill, Manitoba, Moose Factory, Ontario, and Ungava, Quebec. The climograph illustrated by figure 11 shows that for Charleston, Illinois, the months 11, 12, 1, 2, and 3 fall within the breeding optimum. Likewise, the months 11, 12, 1, 3, and 4 are within the optimum for St. Louis, Missouri. A further example (fig. 12) shows that the months of 11, 12, 1, 2, and 3 for Nashville, Tennessee, are all within the summer optimum. Thus this bird also tends to choose the same set of conditions for its winter range as that of its breeding optimum.

I wish to acknowledge my indebtedness to Dr. A. R. Cahn of the Department of Zoology of the University of Illinois, under whose guidance the work was done.

## Summary

1. Bird species of limited distribution live within a limited set of environmental factors which form the optimum conditions for that species.

2. If that species be introduced into a new locality, in which the environmental conditions during the critical period of the year are too diverse from the native optimum, the species will not be able to maintain itself, and will disappear. In localities where the local optimum lies partially within the native optimum, the species may linger in a precarious state, or may be eliminated at any time by serious local disturbances in the climatic factors.

3. Birds which live under a wide range of tolerance tend to establish themselves quickly and to spread rapidly over their new environment.

4. Climographs may be used to show whether or not an introduced species will thrive successfully in a given locality.

5. Barring other factors of the environment such as food and shelter, a species introduced into a new locality is destined to failure unless the optimum conditions of temperature and humidity coincide with those conditions in the native habitat, at least during the critical season of the breeding period.

6. The main reason for failure of introduced birds is that the critical

nesting period falls outside of the optimum conditions in the native habitat.

7. Extremes of temperature and rainfall do not necessarily affect introduced birds after the critical period has passed.

8. Migratory birds with a restricted summer range, tend to seek the summer optimum of temperature and rainfall in their winter range.

9. Migratory birds with a wide climatic tolerance of both nesting and winter ranges are not strongly affected by the two factors of temperature and rainfall.

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