August 18 to October 23; *C. compactus,* August 26 to October 19. The times of flight of the three species nearly coincide and they are competitors in the order named by 80 per cent., 66 per cent. and 45 per cent. of their observed visits. According to the views expressed here, three closely related species having the same habits would not be expected to originate in the same neighborhood. A species having an abundant food supply will simply increase in the number of individuals. The three species above mentioned are not closely related. They have evidently become competitors by migrating from the outside.

In *Andrena* there are three species, each an oligotropic visitor of willows and each having a form, or closely related species, in which the female has the abdomen red. At least as far as these species go, it will refute my view if it can be shown that the red form indicates the development of a new species having the same habits and the same range. I regard the red form as a southern geographical race, or species, and hold that the forms in their distribution merely overlap here.

The views here stated may be expressed in the following propositions:

1. To occupy the same ecological position two species must have the same geographical and phenological range and the same food habits.

2. No ecological position is favorable for an unlimited number of individuals.

3. The origin of new species results from the fact that the dominant species produce more individuals than can occupy the same position.

4. Natural selection then operates in favor of any set of individuals which changes habitat or habits so as to avoid competition with the dominant form.

5. The dominant form retains the original position.

6. The new form becomes specialized in adjustment to the new position.

7. The least specialized members of a group occupy the original position. The specialized members of a group have not driven out the original forms from the original position, but have been driven out by them. The highest specialized members are the ones which have most frequently been driven out of their positions by the competition of lower forms.

8. Specific characters usually are not adaptive.

9. Specific characters are the result of the intercrossing of the members of an ecological segregate and are the result rather than the cause of the segregation.

10. Adaptation to a position is determined by the nature of the position rather than by the characters fitting the organism for it. Usually it does not require the development of adaptive characters and usually is not associated with them.

11. Adaptive characters are the result of the operation of natural selection after the ecological segregation takes place and do not precede the occupation of the new position.

12. An ecological position is more favorable to a limited number of individuals with imperfect adaptive structures than to a great number of individuals having more perfect structures.

13. An ecological basis for morphology is found in the change of habits which requires an old organ to be used for a new purpose. An ecological basis for evolution is indicated by the endless taxonomic difficulties resulting from adaptation to function.

14. Species having the same habits are produced by geographical migration.

15. Species having different habits are produced by ecological selection.

Charles Robertson.

'BARRIERS' AND 'BIONOMIC BARRIERS'; OR ISOLATION AND NON-ISOLATION AS BIONOMIC FACTORS.

During the last three months there have appeared in Science a most interesting series of communications, contributed by both zoologists and botanists, on the influence of isolation as a factor in the evolution of species and subspecies. While there has been some disagreement as to the facts in the case, especially from the side of the botanists, the zoologists appear to differ mainly in respect to the application of terms to phenomena about the existence and relations of which there is practically

no disagreement. Following President Jordan's original statement of the case in the issue of SCIENCE for November 3, 1905, and my own comment thereon in the issue for November 24, 1905, is a communication by Professor E. A. Ortmann, in the issue for January 12, 1906, entitled 'Isolation as One of the Factors in Evolution,' about which I wish to offer a few words in the way of comment.

In this communication Professor Ortmann states, apropos of the previous papers by Jordan and myself, that he 'can not strongly enough endorse' Jordan's view 'that isolation is a factor in the formation of every species on the face of the earth'; 'for,' he continues, 'it is absolutely unthinkable that two species may be derived from one ancestral species without the action of isolation.' To continue the quotation further, Ortmann says:

> All the instances introduced by Allen as opposed to this view are rather in support of it. He concludes that in variations of certain widely distributed species, which pass into each other from one extremity of the range to the other, no isolation by barriers exists, but that there is continuous distribution. Indeed, there is continuous *distribution*, but there is no continuity of *bionomic conditions*. These different bionomic conditions pass into each other, and, consequently, we have varieties, and not species. This is clearly the first step toward complete isolation, and for complete isolation 'barriers' in most cases are not absolutely necessary features.

Under the new definitions of 'barriers' and 'isolation' this may, in large part, be conceded as true, but as not wholly true, even under these new premises. If President Jordan originally meant by isolation and barriers 'bionomic isolation' and 'bionomic barriers,' as he has since stated that he did,[1] and as Professor Ortmann now claims that he did, instead of isolation and barriers as commonly accepted by students of the geographic distribution and geographic evolution of animals, the case is, of course, quite changed by the afterthought of fuller definition. It may, further, explain Ortmann's statement that my presentation of the case 'demonstrates again that the principle of isolation or separation is not generally understood in its full meaning.'

But let us consider for a moment just what are the real facts covered by the statement: 'Indeed, there is continuous *distribution*, but there is no continuity of biologic *conditions*.'

Students of the geographic distribution and geographic or climatic evolution of species and subspecies, and also of minor local variants, among North American birds and mammals, both in the field and through handling vast numbers of museum specimens, are, perhaps, as familiar with the general facts of geographic variation as are investigators in any other field of biology. Let us apply a little of this 'common knowledge' to the statement that "for complete isolation 'barriers' in most cases are not absolutely necessary features." We may take for illustration any one of hundreds of conspecific groups, such as the song sparrows, the quails, grouse, woodpeckers, ground squirrels of several genera, tree squirrels, hares, field mice of various genera, etc., where an intergrading group of well-marked geographic forms has collectively a continuous range of hundreds, and often of several thousand miles in, it may be, both an east and west and a north and south direction. The extremes, or the peripheral forms, are so diverse in size, coloration, food habits, etc., that if one of these extreme forms were to be transferred to the home of the other it would be impossible for the two to intermingle through interbreeding, or for either to survive the changed conditions of environment. Yet between them there is no impassable physical barrier to continuous distribution, nor any break in the continuity of intergradation. Between such forms there is evidently a *bionomic barrier*. They have, indeed, become so divergent that were the connectant forms swept out of existence over a wide area by an epidemic of disease, or by some topographic or climatic change of conditions, the surviving extremes of the series could be considered by systematists in no other light than as fully segregated and sharply defined species.

But how is it between two contiguous and less differentiated forms? In eastern North

[1] SCIENCE, N. S., Vol. XXII., No. 570, p. 715.

America, from the Gulf of Mexico to Alaska, there are no abrupt and insuperable barriers, either topographic or climatic, to the continuous distribution of many forms of life; the diversity of conditions, due primarily to climate, however, is so great that few, if any, species of mammals range throughout this whole area, or of birds that have a breeding range of this great extent. Each climatic zone has its peculiar associations of life, made up by the overlapping of the ranges of different sets of species, whose final boundaries are formed for each by a particular combination of climatic conditions. Aside from the temperature zones, just considered, other climatic factors, as especially that of rainfall, become active in passing from the eastern border of the United States westward to the Rocky Mountains and the Pacific coast. There thus arise a large number of faunal areas aside from those dependent on zones of temperature. The transition between these also is not sufficiently abrupt, except where locally complicated with topographic barriers, to prevent the continuous distribution of many species of birds and mammals. But the transition at certain points between contiguous forms is much more rapid over certain comparatively narrow belts than elsewhere. If we take some central point in the eastern United States, as for instance Columbus, Ohio, we may go east, west, north or south for several hundred miles in an area where the amount of local or climatic differentiation is so small as to be practically indistinguishable; in other words, we are in the central portion of a large area where the conditions of life are comparatively uniform, and are reflected in the practically constant characters—color, size, etc.—of its animals. If, however, we pass westward to about the ninety-eighth meridian, on the same parallel, we meet with wholly different conditions; we are then in a transition belt, where the characters of the animals are unstable; we have left the eastern phases of many of the mammals that range continuously westward, but have not yet reached the Great Plains phases that come in and for a long distance take their place as stable western forms representing the equally stable eastern forms we have left behind. We are in a comparatively narrow belt of intermediates—in some respects the *bête noir* of the systematist, in others constituting an invaluable key to otherwise intricate problems in evolution—which in turn reflect the action of intermediate conditions of environment between two well-marked areas. There is no barrier, topographic, climatic, or even bionomic, under any reasonable use of these terms; the transition belt is narrow, seldom more than thirty to fifty or a hundred miles in width; there is every opportunity for interbreeding, and no barrier other than the sedentary disposition of individual animals. If this fulfills Professor Ortmann's definition of 'no continuity of bionomic conditions,' and meets President Jordan's definition of 'isolation,' we at least understand each other.

J. A. ALLEN.

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SPECIAL ARTICLES.

ON THE BREAKING-UP OF THE OLD GENUS CULEX.

WITHIN the past two years attempts have been made to break up the old genus *Culex* into smaller genera based chiefly or wholly upon the structure of the claspers of the male. That too great stress has been laid upon this character in many cases is the opinion of more than one systematic worker in the Diptera. Thus such very closely related species as *sylvestris* and *cantator* are separated into distinct genera, while, on the other hand, such very diverse forms as *sollicitans, squamiger, bigotii, annulatus, janitor* and *discolor* are placed in one and the same genus. In this as in other cases, any attempt at a classification founded upon a single character is certain to produce unsatisfactory results; only by taking into consideration the habits and entire life cycle of the various forms can anything approximating a natural grouping be formulated.

The writer has recently been able to make a long-contemplated study of the species of this country placed by Theobald in the genus *Culex* in the first two volumes of his mono-