PSYCHE.

THE DIFFUSION OF INSECTS IN NORTH AMERICA. Plate 2.[1]

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The abundance and diversity of insect life during the warmer months are sufficiently striking to attract the attention of even those not especially interested in insects. To others of a more inquiring mind the questions arise as to the means by which they came, and, being here, how it is that they are able to remain. It is to the first proposition that this discussion will be directed.

The careful observer of insect life will not fail to remark the gradual changes that are constantly taking place in the insect fauna of any single area of country. Some species, on account of changed conditions, due largely to the industries of man, are disappearing, while others, before unknown, are, or seem to be, taking their places. Probably there are few scientific men who have not, again and again, had the question put to them in this way: "Is there a constant creation of new insects going on, or are these we see only the old ones?" The question is easier asked than answered, but I shall try to throw some light upon the somewhat obscure problem by an arrangement of a portion of the data at present obtainable, and which tend to throw light upon the subject not so much of insect creation, as of insect diffusion. But at the outset I must call attention to the fact that this kind of research can only follow on after considerable progress has been made in classification, and considerable knowledge obtained of the structure and habits of the forms entering into the problems which we are to study. Again, as elsewhere in the realms of zoological science, it sometimes occurs that affinities may appear in the earlier stages of development and disappear entirely in the later stages. For this reason we cannot even yet in many, perhaps the majority of cases, work out our problems with a feeling of assurance that we have reached conclusions that are final and may not, in the future, need revision. But no progress is made in any science without effort, and some failures are inevitable, so that, generally speaking, the best results are only such until some one else does better.

Insect diffusion began in America a long way back in the obscure past, just how far we do not know, but the remains of an ancient insect fauna have been pre-

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[1] Revised from a lecture delivered, February 11, 1903, at the University of Chicago. The map was drawn especially for me by Dr. J. W. Folsom.

served for us in the rocks and shales, so that we are given a point from which to begin our investigations. Perhaps the Tertiary deposits in Wyoming and Colorado, though including but a mere fragment of the vast host of insects that must have been entombed in the rocks, have yielded us the greatest amount of information relative to the ancient fauna of America, containing as they do, and in profusion, not only representatives of every order of insects known to-day, but types of every dominating family which at present exists. We have also been further fortunate in having so faithful a student as Mr. S. H. Scudder to study this material, for it contains not only numberless bodies of the more stable insects like the Coleoptera, but even those of APHIDIDAE and microscopic parasitic insects, whose bodies are of the most fragile nature. We are thus put in possession of facts that go to show that, as to-day, the aphides were probably in part viviparous, and we have besides the special sexual forms of the ants and the triungulin larva of the MELOE thus preserved for us. A study of this material has given us some surprising facts. Among the most significant, and quite apropos to our subject, is the fact that a careful investigation of the Rhynchophora obtained, as compared with the forms now existing in this country, shows that the recent American Rhynchophorous fauna agrees better in its broad features with the Tertiary fauna of Europe than with the Tertiary fauna of America. Though possibly a little in advance of its proper place, it may not be entirely out of order to call attention here to a fact well known to entomologists and especially to lepidopterists; viz., that where a species is found both on the Atlantic and Pacific slopes, and which also occurs in Europe, individuals taken from the Pacific coast region are more nearly like those found in Europe than are those found along the Atlantic coast. In a list of Coleoptera common to both this country, northern Asia, and Europe, published by the late Dr. John Hamilton, in 1889, 487 species were enumerated, and an almost immediate revision of this paper by the Swiss entomologist, M. Alfred Fauvel, added eight more to the list. In these lists, however, no distinction was made between such as were introduced in articles of commerce and such as came in a strictly natural manner. Thus it will be seen that even in Tertiary times, as also in our recent past, there has been a close relationship between the insect fauna of North America, northern Asia, and Europe.

Geologists are in possession of sufficient data to show conclusively that, during some period of the world's history, the region about the Arctic circle enjoyed a climate as temperate as we have at the present time, while the region now included in the northern United States abounded in tropical animal and vegetable life. Thus there might have been, and probably was, a free intercourse between North America and northern Asia via the northwest, and, possibly, with Europe via the northeast; but of this last we are not so certain. At present, while insects from the eastern

hemisphere in many cases readily become naturalized in North America, it is very rare indeed that the reverse is the case. The reason for this is not understood, nor do we know for a certainty how far back in the past these conditions have obtained; but the general opinion among entomologists is, that the trend of diffusion was from the northwest and not toward it.

But there came a tremendous climatic change, and the northern ice sheet plowed its way southward, crushing and grinding the rocks into sand, clay, boulders, and pebbles, leveling down the elevations, filling up the channels of rivers and the beds of lakes, at the same time transforming the once tropical country into that of the frigid north. How long this condition continued we do not know; but while it did continue, all intercommunication from northern Asia and Europe by the way of the northwest was necessarily cut off. Presumably the ice sheet began to melt away along its southern border in the now United States, gradually uncovering the land to the northward. How rapidly this area was again covered by vegetation and reoccupied by animal life we do not know; nor can we state how far beyond the termination of this ice sheet the flora and fauna had been obliged to retreat. We know that, in our day and in case of the present glaciers, one can almost stand on the edge of the ice and collect insects of the temperate zone; but this really proves nothing in the case of the huge ice sheet covering millions of square miles of area and being probably hundreds of feet in thickness. But, be these facts as they may, it seems very probable that the country as fast as it was uncovered by the receding ice became occupied by plant and animal life *from the south.* Indeed, it hardly seems possible that the trend of diffusion could have set in from any other direction; but how much of a basis for this diffusion was left along the south Atlantic and Gulf coasts we do not know.

Reoccupied by plant and animal life, we have a country as first discovered by the white man, comprising an immense inland plain, the eastern border bulwarked by the Appalachian mountain system, low and broken, it is true, and by the much more stupendous and continuous Cordilleran system to the west, open to the Gulf to the south and to the frigid zone to the northward. This area, now known as the basin of the Mississippi River, because of its being largely drained to the south by that river and its tributaries, was comparatively level, and though heavily timbered to the south and east, was scantily or not at all timbered to the west and north. The drainage to the north, being by the Saskatchewan into Hudson Bay and the Mackenzie into the Arctic Ocean, was, perhaps, a less potent factor in the problem of restocking this country with insects. We have now three natural gateways, so to speak, through which insects not introduced by commerce must make their way into North America. These are by way of northern Asia into Alaska, and thence south and east; by way of Central America, through Mexico; and by way of the

West Indies into Florida. Relative to the last I may be permitted to give a word of caution. South American forms may reach Florida by two lines of diffusion; one by way of the Antilles, the other by way of Panama, Yucatan, and Cuba, as illustrated by *Halisidota citripes*.

We will now take up each of these several gateways of natural dispersion and discuss them separately as the northwestern, the southwestern, and the southeastern sources of diffusion, after which we will consider another series of avenues taken by such species as have been introduced into North America through the agency of man.

Diffusion from the Northwest.

(*See map. Boreal trend, F. F.*)

It is obviously impossible to discuss all the species, or even genera, that appear to have come to us, or perhaps rarely gone from us, via this direction. I have, therefore, selected the Coccinellidae, or lady-beetles, as an illustration, for the reasons that the species are common, well known, and generally diffused over North, and in some cases over South, America, and that the family is represented generally over the world, species of the genus Scymnus having been found in America, Europe, New Zealand, Galapagos and Hawaiian islands, and also in the American Tertiary deposits in Colorado and Wyoming. For illustrations I have as a rule selected our most common species. *Coccinella 5-notata* occurs in Siberia, Alaska, Hudson Bay, Greenland, Kansas, Utah, California, and Mexico. *Coccinella trifasciata* occurs in Lapland, Siberia, Oregon, and about Lake Superior. *Harmonia 12-maculata* occurs from Siberia to Hudson Bay and Lake Superior. *Megilla maculata*, one of our most common species, occurs from Canada and Vancouver south to Chile, with a larger variety of it occurring in Brazil. *Eriopis connexa* occurs from Vancouver to the Straits of Magellan, and though confined to the west coast in North America extends to the east coast in South America, and has been taken on the Andes at from nine to ten thousand feet above the sea. The common *Hippodamia parenthesis*, a representative of *H. amoena* in Siberia, occurs from Oregon to Kansas and New Jersey. It is one of our most numerous and beneficial species. *Coccinella 9-notata*, even more abundant and beneficial, occurs from Canada to Guatemala. *Coccinella affinis* occurs from the Lake Superior region southward to Honduras, while *C. sanguinea* occurs all over North America and from Alaska to Patagonia.

Species coming from the eastern to the western hemisphere do not necessarily occupy the same climatic areas in both. The following will suffice to illustrate this

point. *Lina lapponica*, one of the Chrysomelidae, in Europe occurs only in the far north and on the highest mountain ranges, feeding, as with us, on willow; but in North America it has become diffused in the lowlands to the southwest part of the country, from Alaska to Texas. A vile-odored carabid beetle, *Nomius pygmaeus*, occurs only rarely in southern France, Hungary, and Greece, while in North America it is found in the Appalachian mountain system from Georgia northward to Nova Scotia, and in Canada, Washington, and Oregon, thus describing in its distribution an almost complete half circle. How it ever reached this country is still a mystery. These instances are cited here in order to show that it is not at all extraordinary for insects to be found in the far north in the eastern hemisphere and in the far south in the western.

Again, insects found in high altitudes in the tropics may be closely related to others occurring in the lower lands farther to the north. A good illustration of this is offered by a species of Hemiptera belonging to the genus EMESA, found almost directly under the equator at an elevation of 16,500 feet above sea level,—the highest altitude at which animal life has ever been found,— but whose nearest ally is *Emesa longipes*, a bug that is common all over the middle west, and at elevations of not over five or six hundred feet.

DIFFUSION FROM THE SOUTHWEST.

(*See map. A, Pacific Maritime: B, Tropical Subalpine: C, Atlantic Maritime.*)

We will now pass to a consideration of diffusions from the southwest. Central America and Mexico have long seemed to me to be biological headquarters, veritable insect nurseries for the propagation of new species to be sent northward. It is here that we have the greatest wealth of material and, I regret to add, the least knowledge thereof, for these countries are far more healthy for insects than for entomologists. I never see a collection of insects from that country, or read of those that are known to occur there, that I do not devoutly hope that some institution with funds to be devoted to research may have this lack of information brought to its notice.

In discussing the northward diffusion of South and Central American forms, I shall be obliged to select two or three genera as typical, and with but an occasional exception confine myself to them, though others might be chosen as illustrations nearly or quite as satisfactorily.

The old genus HALISIDOTA, among the moths, and DIABROTICA and MYOCHROUS, of the Coleoptera, though perhaps no better illustrations than others, are such as I am best acquainted with, having given them somewhat careful study.

The home of the HALISIDOTA certainly appears to be in South America. There are many forms in Central America and Mexico that require further study before much can be said of their relationships, but that many of the species inhabiting the United States originated in these countries, the offshoots of South American forms, can hardly be doubted. There is a form very closely resembling our *H. tessellaris* and, in fact, Dr. Dyar informs me is sometimes so labeled, which is found from Argentina northward, at least as far as Costa Rica. As we can trace many of our species southward to Yucatan, it seems not unlikely that this may prove to be the stem from which both *H. tessellaris* and *H. citripes*[1] have sprung. It will be observed that the former has spread over the eastern United States, and the latter to Texas and Florida, by what appear to be two separate courses, one almost directly north and the other east by way of Yucatan and Cuba into Florida (Atlantic Maritime, C. C. C. and a, b, on map). In the north Atlantic coast region *H. tessellaris* has thrown off what is known as *H. harrisii*, the adults of which cannot be separated; but the larvae of the latter can subsist only on the foliage of the sycamore, while those of the former will perish if placed on the sycamore. *Halisidota caryae* follows almost exactly the distribution of *H. tessellaris*, but there is evidently a splitting up somewhere in Central America, as *H. agassizii* (Pacific Maritime? A. A, on map), which closely resembles it, extends northward into California, where it appears to be displaced by *H. angulifera* with its variety *alni*, the former being the low coast form and the latter the mountain form of *H. maculata*, which last species extending into the mountain regions of Oregon, Washington, and British Columbia, sweeps broadly to the eastward through the extreme northern United States and Canada to Nova Scotia and New England. If this theory is correct, we have a species entering North America from Central America, passing north along the Pacific coast to British Columbia, and making its way east and south with the tide of diffusion from the northwest. Dr. Harrison G. Dyar, of the United States national museum at Washington, to whom I am indebted for information on this point, thinks it quite possible that *H. maculata* may have originated in this manner and that *H. agassizii* is the stem, there being somewhere to the far south a connecting link between the latter and *H. caryae*.

What may be termed the *H. argentata* system (Tropical Subalpine, B, on map) extends from southern Mexico to Vancouver, sending out *H. subalpina* into Arizona and Colorado, and the coast species, *H. sobrina*, into California. Another system, *H. edwardsii*, in all probability emanates from *H. hemihyalea*, in southern Mexico or even farther south, extending into the Sierra Nevadas of California, but down in Mexico *H. labecula* is thrown off, and extends along the Rocky Mountains north into New Mexico and Colorado.

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[1] According to Dyar's latest list this is found in South America.

What is now known as *Phyoptera astur* Cramer occurs in South America north to Arizona and New Mexico. *Heterocampa biundata* occurs from Panama through Guatemala and Mexico to Florida and New England. *Macrocampa marthesia* is known from Brazil through Central America to Texas, Georgia, and Maine. The two latter species do not occur on the Pacific slope.

The genus DIABROTICA, of the Chrysomelidae, offers some good illustrations of the diffusion of species of Coleoptera from the far south to the north into North America. There are in Columbia and Venezuela, about one hundred known species of DIABROTICA, of which eleven extend into Guatemala, eight into Mexico, and one into the United States. Several of our most common species of this genus can be traced directly to Central America, *D. longicornis* having been found in Yucatan. In fact, with but a single exception all of our fifteen North American species can be traced into Mexico, and some even farther. Only recently a Mexican species, *Diabrotica peregrina*, has been found just over the Rio Grande River, at Brownsville, Texas. Elsewhere (Journ. ent. soc. N. Y. vol. 3, p. 158–160; vol. 4, p. 67) I have discussed the diffusion of the genus at considerable length, and it is unnecessary to repeat here what was there stated, except to call attention again to the fact that our *D. vittata* has a very close relative in *D. trivittata* on the Pacific coast, and that our *D. 12-punctata* has an equally near relative in *D. soror*, also of the Pacific coast, while in each case there is an intermediate species that seems to connect the two. This phenomenon I attribute to the fact that the original stem species may have become separated far to the south, and one branch followed the Pacific and the other the Atlantic Maritime trends, and Professor Cockerell's *D. vittata* var. *incerta*, coming between the former and *D. trivittata*, would seem to give us an illustration of an intermediate species in the process of evolution, while in *D. tricincta*, which occupies a similar relation to *D. 12-punctata* and *D. soror*, the evolution has advanced further and we have what we term a good species. From some more recent studies of *Myochrous denticollis* and allied species of that genus, it would seem that something similar might have taken place with reference to the northeastward trend of diffusion. Since mapping the distribution of the genus MYOCHROUS in the United States, in 1901,[1] I have found that *M. squamosus* occurs in Illinois and Kentucky, thus indicating that the latter, like *M. denticollis*, has swept broadly to the north and eastward.

The common *Dynastes tityus* occurs from Brazil through Central America and Mexico, and in the United States from Texas to Illinois and east to southern New York and New England. The Cotton boll weevil, *Anthonomus grandis*, which is spreading its devastating hosts through the cotton fields of Texas, was unknown on

[1] Journ. N. Y. ent. soc., 1901, vol. 9, p. 127–132, pl. 9.

this side of the Rio Grande up to a few years ago, when it began its depredations in the vicinity of Brownsville, Texas. Among the Hemiptera or true bugs the Chinch-bug and the Harlequin cabbage-bug offer excellent illustrations of the trend of insect diffusion from the southwest.[1]

Diffusion from the Southeast.

(*Antillean trend, D, on map.*)

Of the remaining entrance gate, that of southern Florida, I will say that there is no doubt that many species have made their way up through the Antilles from South America. The distribution of *Calidota strigosa* illustrates that fact, and there are many other illustrations; but as the United States has recently gained such a supremacy in the Greater Antilles, we may confidently look for considerable activity in the study of the insect fauna of these islands, and I would rather not anticipate the results of this work. I believe, however, that we shall find the Central American and Mexican route the more important.[2]

In taking up the introductions by the agency of man, I should like to approach that subject by here calling attention to what appears to have been such an introduction of *Aphodius lividus*,[3] which must have become established at a point somewhere in the West Indies, from whence it has spread to Florida, and from there pushed its way westward to extreme southern California, entering the state at a point where the mountains are more easily passed through, and started up the Pacific coast. This is a new line of diffusion, and quite a suggestive one as well.

The Eastern Gateway, and the Diffusion Westward of Species Introduced Through the Agencies of Man.

(*The Transappalachian trend, E, on map.*)

I have recently discussed this trend of diffusion quite at length[4] and it is unnecessary to repeat what I have there stated, except to state that the Appala-

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[1] See my paper published in the Journal of the Cincinnati society of natural history, vol. 18, p. 141–155.

[2] Probably a majority of the Sphingidae came by the way of the Antillean trend. Their long, slender, powerful wings, like those of sea birds, such as the Albatross and Frigate bird, especially fit them for such a journey. The family is a tropical one and has spread from its ancient home to nearly all countries. That these insects are often obliged to brave the sea is shown by the fact that a French gentleman once showed Dr. Hermann Behr, of San Francisco, a collection of insects caught on shipboard after a heavy gale, fifty-four geographic miles off the coast of Brazil. Every one of the insects were sphinges, belonging to three genera.

[3] Also occurs in Transvaal, South Africa.

[4] Thirty-second Rept. ent. soc. Ont. p. 63–67, 1901.

chian system does not approach the Gulf coast at its southern terminus, but leaves a broad avenue that enables species moving eastward to pass on along the Gulf to the Atlantic coast and thence northward. It does, however, to the northward form an almost impassable obstruction to the directly westward migration of insects from east to west, broken only in the State of New York and the country adjacent to the north and south shores of Lake Erie. Here we have a huge gateway through which nearly or quite all species imported from Europe, landing on our eastern seacoast, north of the mouth of the Potomac River at least, make their way into the comparatively level country beyond. Even the Atlantic Maritime brachypterous Chinch-bug followed this trend. It is barely possible that the valley of the Big Kanawha River in West Virginia and Cumberland Gap may offer passageways for an occasional species, but of this we have no proof as yet. In the Cordilleran system there do not appear to be any such openings or gaps for the influx and diffusion of migrating species, except, perhaps, in extreme southern California and Arizona, a country so arid that few species can take advantage thereof if it really exists; hence, a separation in South or Central America usually remains permanent, while in the case of European species and the Appalachians, they might easily make their way south along the Atlantic coast to the Gulf, and in a comparatively short time mingle with the northern branch that has made its way west to the great lakes and thence southward.

A peculiar feature of the problem of introduced insects is that, although we may have knowledge of their habits in their native homes, this is not always to be taken as limiting their actions in this country. The well-known household pest, the carpet beetle, *Anthrenus scrophulariae*, occurs along the Pacific coast, having doubtless been introduced from Asia, but it does not there attack carpets. Soon after it was introduced into the country along the Atlantic coast it began to destroy carpets at a terrible rate, and it is now one of the most destructive of household pests. I can well remember when it was unknown in Illinois, where now it does much injury. In its native home it is a flower-frequenting insect, and I can always find these beetles here in the United States in early spring in the blossoms of tulips, more especially those of a white color. The allied species, *Anthrenus varius*, also introduced, though a noted museum pest, is at about the same season to be found frequenting the blossoms of the Spiraea. These illustrations go to show the extreme flexibility of insects, not only in the matter of food but nearly every other condition that enters into the problem of their diffusion and development. Generally speaking, insects are as plastic as clay in the hands of the potter, and we need only to look to their immense numbers and variety to find proof of this. They make their way over mountain, plain, and desert and are carried hither and yon by the waters of rivers, lakes, and oceans, possibly to change their specific

identity, as species are understood by the present-day entomologist. If a foreigner lands in Quebec, Canada, or Baltimore, Maryland, it will sooner or later find its way to Buffalo, New York, and westward along the shores of Lake Erie, into the great level country beyond the Appalachians, feeding probably, but not necessarily, on the same food plants that it ate in its home in the eastern hemisphere.

In the eighteenth century it was thought sufficient for naturalists to state that such and such species inhabited North America. In the nineteenth century we decided that we must state whether a species was found in Connecticut or Rhode Island, but it would suffice if the statement were made that it was found in Illinois, notwithstanding that there is more difference between the insect fauna of northern and southern Illinois than there is between the latter state and Ohio. In the beginning of the twentieth century we have come to the conclusion that labels, giving the states only, without more explicit information as to localities from which the specimens to which they are attached have been obtained, are of little value to the student of morphology, or in tracing out the distribution of species; nevertheless we cannot entirely overcome the old prejudice relative to political lines forming biological boundaries. At present, there is nothing for the American entomologist beyond the Rio Grande River. Of course we know that there are insects there, but, by an unwritten law of our own construction, we prohibit ourselves from knowing much of their identity or affinities to species found on our own side of that river. Mexican and Central American species are either excluded from our collections, or, if admitted, are crowded down in the corners and labeled, if indeed at all, as foreign! Thus the most interesting territory in the western hemisphere and what to us is really the most significant, as from out of it whole genera of our insect fauna have been evolved, remains almost a *terra incognita*. Let me illustrate. A phytophagous species starts from South America on its way northward. Even while passing through Central America as well as through Mexico, it is obliged to encounter a diversity of climate, elevation, and food supply. The species in adapting itself to these modifying influences becomes shattered as it were and the fragments are found in Texas, in New Mexico, Arizona, and California. We find these and with the least possible delay, and with no knowledge of their affinities or, in many cases, developmental stages, they are described as so many species and added to our checklists. Can stability in our nomenclature be expected as long as these conditions continue? These same influences are at work in California, and we can see their effects plainly enough there, though both conditions and results are only modifications of what is probably going on farther to the south, and they are of proportionally less value in aiding us to solve our problems in biology and nomenclature. Other modified influences, similar to those at work in California, may be noted in connection with the Antillean and Boreal trends of diffusion, but

none of these, nor in fact all of them combined, appear to influence our entomological fauna to the extent that is probably exerted by the southwestern trend of diffusion. The Transappalachian trend of diffusion appears not to exert any such influences, and individuals of introduced species do not vary from those in their ancient home in the eastern hemisphere.

I have attempted to make my position more clear by the construction of a map that shows the various trends of diffusion of which I have spoken. Since so little is known of species occurring in Mexico, Central America, and the Antilles, and their affinities to our own, it is folly to expect that such a map can be made more than tentative, but it is a beginning. Criticism will provoke investigation, and, in any case, some good must come of it and our knowledge be increased. It is not to be supposed that the area covered by these lines is proportionate to the territory covered by the diffusion itself; the lines only indicate directions.

The Pacific Maritime trend of diffusion may include such species as inhabit this coast or such as are forced down or drift down from the higher areas and establish themselves. Some, like *Halisidota angulifera* in California, have a subalpine form, like *H. alni*. The Chinch-bug also is not confined to the sea level, but probably finds the least resistance to its progress there. This trend of diffusion is indicated on the map by the line A. The Atlantic Maritime trend is to be looked upon as occupying a similar position on the east coast, and may be the avenue along which the Pampean forms make their way from the level areas of South America into those of a similar character in North America. But there is probably the same intermingling of tide water and subalpine forms as on the west coast. It must be continually kept in mind that, though the two coasts are, in Central America, often separated by comparatively short distances, yet the climate is as different as might be expected to exist between localities hundreds of miles apart. This latter trend is indicated on the map by the line C, and the Pampean range by a, because insects that subsist on grasses, or such plants as are to be found in treeless areas, will be more likely to push northward along the base of the rocky mountains and then spread broadly to the eastward than will arboreal species that must hold more closely to the wooded sections. Thus, the Diabroticas evidently hold to the north from Mexico, while the Halisidotas must keep to the eastward. Both may spread up the Mississippi River, as the country is both wooded and grassy. As I have shown elsewhere, the Chinch-bug may have followed both the Pampean, a. a, or the main trend, C. Of course the Mississippi River trend, b, lay open to it, but inundations would probably have impeded its progress. The Tropical Subalpine trend may be illustrated by the *argentata* system of the Halisidotas, and by other forms of the high altitudes. The Antillean trend, D, is illustrated by the many tropical species that have clearly entered Florida from the south, and not by the way of

Central America and Cuba, the latter being a branch of trend C, the possible course of D being indicated on the basis of the trend of diffusion of the introduced *Aphodius lividus*. *Cylas formicarius*, the pest of the sweet potato, may have followed this course, but of this the proof is lacking. The Antillean trend may, and again may not, extend northward, as in C. What I have termed the Transappalachian trend, E, is intended to indicate the trend of diffusion especially, though not exclusively, of species introduced through the agencies of man. Most of these, whether they become established along the coast from Virginia northward, or in Canada as far up the St. Lawrence river as Quebec, make their way into New York and west, passing between the low mountains and the south shore of Lake Erie into the comparatively level country beyond. The Boreal trend, F, from the northwest, may perhaps follow more closely to the coast, as indicated by the dotted line, but sooner or later it sweeps broadly to the east to the Atlantic coast and New England, not infrequently sending subtrends into California, Colorado, and even Mexico. I have not indicated southward trends so fully, because there are less of them; they are less important to this discussion, and too many lines, especially in the far south, would complicate and obscure the map, the land as shown being too narrow to display them clearly separated.

Illinois State Laboratory of Natural History,
Urbana, Ill., Mar. 9, 1903.