THE LEPIDOPTERISTS' NEWS

Volume 8 1954 Numbers 1-2

PRESIDENTIAL ADDRESS
TO LOS ANGELES MEETING OF THE LEPIDOPTERISTS' SOCIETY

My dear Colleagues:

I wish that I might be with you — but distance forbids and also a body of unfinished business far greater than would be expected of a man at last retired. My remarks will in a sense be an echo of Dr. JORDAN'S of last year, — for I too have long been impressed by the ways in which our Lepidoptera throw light on many a phase of Science.

And firstly, like Dr. JORDAN, I think of the concept of ***species***. "Species" is an entity that has been often and variously defined, and yet with the exception of a few to whom it seems to have no definite meaning, these definitions represent the same conception of Nature: the one I would emphasize is the one also emphasized by HUEBNER, a century and a half ago: he called *species* "Gattung" — "was sich gattet". This is my own definition, and also I think nearest to general acceptation. Those individuals which, under natural conditions, interbreed freely among themselves, and ***not*** freely enough with outsiders to blur the picture, constitute one species. In the Lepidoptera we are as far along as all but a few groups in implementing this idea, through our knowledge of breeding behavior and of crossing in many sample groups. One may cite especially the work of GEROULD and HOVANITZ on the Sulphur Butterflies.

But this problem needs vastly more study, and the Lepidoptera are a fine group to work on it. Consider merely the cases which are sometimes called "Rassenkreise" — where we can follow a species around a large loop, with no sign of sterility or any type of marked break, until we return to the starting place, and find that the two ends no longer breed together; thus what is one species if we go about the circle one way behaves as two at some one place. GOLDSCHMIDT long ago studied a case of this type in the eastern races of the Gypsy Moth, and in that case found the sterilizing factor was a break-down of the machinery of sex-determination, finding that when widely separated populations were crossed intersexes and supersexes appeared, instead of normally sexed individuals. But there are many other cases of such circles in the Lepidoptera calling for study. And in none of them do we yet know the cause of the sterility. I have already noted the case of the Buckeye, and it has attracted some attention though I think no one has experimented with it. In this case *Precis cœnia* and *P. zonalis* meet in southern Florida, Cuba, and the Isle of Pines and behave as two completely distinct species; but in the Southwest and Mexico they appear to

intergrade completely. There is only one possible fact leading to suspicion. In this western blend zone there is a very high percent of melanism, and in some fishes at least such melanism is associated with the physiological disturbance going with semisterility. But so far in the Lepidoptera the very frequent inheritable melanics show no sign of genetic disturbance.

A more useful case making its loop also around the Gulf and Caribbean is the Rattle-box Moth (*Utetheisa ornatrix*). This species shows its blend zone in the West Indies, but in an area from Kansas to Texas behaves as two species. It is multiple-brooded, and I believe from its biology would be much easier to handle for a series of generations than any butterfly; and it also has a very brilliant series of Mendelian characters in color and pattern; but so far no one has seen fit to study it. I can think of no other species which ought to be such a temptation to the geneticist, though we have several other North American Lepidoptera which are worthy of more careful examination. For instance if L. P. GREY is right, *Argynnis atlantis* has two representatives in Manitoba, which must be presumed to intergrade in the far north. This is hardly a fit subject for line-breeding, but intensive collecting in the critical part of Canada might give an answer. Another challenge for more western workers is the relation between *Samia* (*Platysamia*) *columbia, S. gloveri,* and *S. euryalus.* Are they three species or even four (*S. nokomis*), or all races of one, and is there perhaps a rassenkreis in the zone where *S. columbia* and *S. gloveri,* or *S. gloveri* and *S. e. kasloensis* meet? This again is a species which can be reared.

So far we have considered patterns that could be put on a map, and speciation as possibly racial (the *Varietät* of STAUDINGER, which I must remind the hearer is not at all the "variety", but the "subspecies" or "race" of American tradition). But there is another side to the problem of speciation. We should assume that really it is a physiological incompatibility that separates species, and it is by no means necessary that physical separation should have come first and incompatibility later. We must take up the suggestion that the physiological barrier came first. Let us consider the accident of cell division called a ***translocation.*** Studies on *Drosophila* and elsewhere show that this is a common accident, and very often leads to a condition where descendants of the translocated individual can breed with each other much more effectively than with the parent stock. So in some cases a translocation leads to a new group of individuals isolated from the parents, and so physiologically an incipient species.

Let us consider what might happen to such a group. It is obvious that at first they would try to mate as freely with the parent stock as with each other, and being semisterile a large part of such matings would be wasted. So we would have a very strong pressure of natural selection, which could go in any of several ways.

1) The entire new stock could be swamped and exterminated by waste matings.

2) Further mutations might take place, which reduce and then eliminate the sterility.

3) There could be some change such as timing of broods, preferred ecology, distinctive mating behavior, or different choice of food, which would eliminate the likelihood of waste matings.

4) Structural changes might occur, making mating uncomfortable or impossible.

5) The new stock could dominate and exterminate the old one in part of its distribution area, presumably in a marginal area. . . then if both stocks should exterminate each other in some intermediate area we would have actual geographical speciation. I personally think this would be an unusual case, and that geographical speciation is on the whole a relatively rare kind, except in island areas or mountain colonies where complete isolation by purely external means might last a long time.

In the first two of these cases obviously we end as we started, with a single species; in the last two we clearly end with two, and *speciation* has taken place.

There is a sixth possiblity in the case of species which mate more than once; namely that the semisterility should go on by further mutation and selection, to complete sterility of the sperm of each species in the passages of the other. This case seems very possible in many mammals, but is likely to be rare in insects. Yet one may well think of the casual mating habits of the Saturniids.

On the whole the Lepidoptera are certainly a group in which this problem can studied very well; in fact we have very many "sibling" or I would prefer to say "twin" species of the type which would be the natural result of this type of speciation. These are closely related species, one pretty obviously directly derived from the other, and separated not geographically but by some point of behavior or ecology which would keep them separate. I may cite the following as a few out of many samples:

Pieris napi in its races and *P. virginiensis* (food, preferred haunt and life cycle)

Phyciodes tharos and *P. batesi* (multiple and single brooded, with hardly any overlap of flight time)

Phyciodes campestris and *P. orseis* (for western biologists to study)

Papilio zolicaon, P. rudkini, and *P. bairdi* (food plants)

Euphydryas chalcedona, E. editha, and *E. anicia* (ecology?)

Halysidota tessellaris and *H. harrisii* (food plants)

Colias eurytheme and *C. philodice* (preferred haunts and normal food); these two are known to be still semisterile.

Erynnis persius, E. lucilius, and *E. baptisiae* (food plants)

Leucania pseudargyria and *L. ursula* (single and double broods)

Semiothisa granitata and *S. sexmaculata* (food?)

Pseudoboarmia umbrosaria and *P. buchholzaria*

Eufidonia notataria and *E. discospilata*

Xanthotype sospeta and *X. urticaria* (flight time).

The phenomenon is by no means limited to the United States; one need only mention the European *Ectropis crepuscularia* and *E. bistortata* or *Colias hyale* and the recently discovered *C. alfacariensis* (*australis*).

These few examples may show how important, types of variation other than racial are likely to prove, and I hope may reduce the "subspecies" category from its present supremacy to its proper position as merely one kind, and not the most tangible kind of variation.

But speciation is far from the only biological problem for which the Lepidoptera are eminently fitted. It is only necessary to mention the work of CARROLL WILLIAMS and his group on the physiology of metamorphosis and diapause, with their relation to hormones in particular. Here the Lepidoptera meet the Bugs on equal terms, and each contributes to the understanding of the other.

And a final field in which I believe the Lepidoptera give us a very important body of knowledge is that of zoogeography, a matter in which I have a little special interest. For this we need to use groups of creatures in which the classification is sufficiently advanced so we know what forms are really related and which merely resemble each other; and there are several groups of Lepidoptera where our knowledge has reached this level. These data will throw light on the migrations of life in the past, and thus indirectly on the history of the Continents. One may mention in particular the pattern of the races and populations of *Pieris napi* and *Papilio machaon,* which when we understand them should give data both on the glacial periods and on the time which it takes to make a species. For in these two complexes we have all levels from the ephemeral field-form to the fully established species. VERITY has also given us a mass of data on the subspeciation of the Palæarctic Melitæas, which will give us further data on the problem when we shall have learned to interpret it.

Another zoogeographical and geological problem is the question of continental shift; if and when the continents have moved, and whether WEGENER'S idea of a gradual series of shifts is more or less sound than the earlier theory of a single great opening of the Atlantic Ocean sometime between the late Permian and the beginning of the Cretaceous ages. I fear that the Lepidoptera will give no data on the main part of this problem, for they are mostly far too young, and the small residue have suffered far too much extinction; but the study which ZEUNER has made of the Bird-Wing Butterflies (*Troides*) shows the type of work which may throw light on the possibility of lesser and somewhat later movements.

So as we go on with the Lepidoptera we are studying the taxonomy, morphology, and biology for our own interest; but we shall also remember the great light they throw on the broader phases of evolution, on physiology, and even on the history of the Earth.

(signed) WILLIAM T. M. FORBES
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