

PRESIDENTIAL ADDRESS TO THE SEVENTH PACIFIC SLOPE
MEETING OF THE LEPIDOPTERISTS' SOCIETY

Ladies and gentlemen:

It is a very special pleasure for me to take part in your meeting here to-day and to be able to deliver the Presidential Address in person. This is not the first time that I have had the pleasure of visiting the New World: my happiest entomological recollections are bound up with the American continents. In North America — in Canada and the United States — it is true that I have not yet had many opportunities of working as a collector and field entomologist, but in South America I have been able to spend over two years altogether, collecting and conducting entomological studies, chiefly in the mountains and lowlands of Bolivia and in the Amazonian jungles of northern Brasil. The identification and study of the rich insect collections made there is still far from completed, but certain fundamental results are already apparent, and I should like to tell about them now.

One of the most stirring experiences for the naturalist is a trip from the Bolivian highlands down over the eastern slope of the cordillera and into the hot jungles of the tropical lowlands. Nowhere on earth, save for certain parts of the south slopes of the Himalayas and in the mountains of western China, do the most extreme zones of climate lie so close together as on the eastern slopes of the Andes. Two or three hours by automobile suffice to go from the icy heights of the Altiplano, the high plateau of Bolivia with its thin, cold, snowy air, up over passes of almost 5000 meters elevation, down into the hot, humid valleys of the Yungas, in the tropical rainforest region on the eastern slopes of the mountains. For the lepidopterist this means the chance of studying two completely different Lepidoptera faunæ in immediate proximity: the high mountain fauna above tree line, with its thoroughly "holarctic" aspect, and the "neotropical" fauna of the valleys: two sharply differing and non-intergrading complexes.

I should like to say something about this most interesting butterfly world of the Cordillera Real of Bolivia, but before doing so a few words are necessary concerning the zoogeographical relationships of the other parts of Bolivia and of all South America generally. In the tropical lowlands of Bolivia we find that fauna of Lepidoptera which in the strict sense is called *neotropical*. It represents a component of the primeval

forest fauna distributed over the whole tropical virgin forest region of northern South America, which has remained substantially unchanged since Tertiary times. It is rich in ancient species with only limited subdivision into chiefly wide-ranging subspecies. Numerous families found only in South America give evidence of a very long independent development of this fauna. The Morphidæ, Brassolidæ, Ithomiidæ, Heliconiidæ, Dalceridæ, Mimallonidæ and Megalopygidæ are some examples of such families occurring in the tropical forest fauna of the New World, having no or only very few near relatives in the Old World. It may be concluded that most of these groups developed during upper Cretaceous or early Tertiary times in the northeastern land mass, the Archiguayana of VON IHERING, which was then still isolated from the rest of South America by the Amazon Sea; and only later did they spread out, by dividing into additional forms so far as climatic relationships permitted, into the present day distribution pattern of continental South America. The present fauna, and the flora well, of the tropical primary forest of South America should consist, in substantial part, of elements of former guayanian origin. In the territory of the South American tropical lowland forest there has been probably no significant change in climate since the Tertiary, and there is thus no reason for any substantial movement of animals and plants, so that in general the Tertiary fauna is still to be found there even to-day.

In contrast to this nearly static lowland fauna stands the fauna of the Yungas, the rainforests on the eastern slopes of the Cordillera. This Yungas fauna extends between roughly 500 and 3500 meters from Colombia to the knee of the Andes near Santa Cruz de la Sierra in Bolivia, its southern limit, and includes a large number of endemic species. It is striking, however, that although the number of species definitely decreases from north to south, the differences in the relative composition of species are significantly greater going from lower to higher elevations than from north to south. Typical butterfly species of the Yungas are for example: *Papilio isidorus* Doubl. in the lower forest levels; *Papilio warscewiczii* Hopffer in the upper; species of the large entirely neotropical pierid genera *Catasticta* and *Dismorphia*; the satyrid genus *Pedaliodes*; and many others. This fauna which, even though impoverished, extends upward to tree line, is exceptionally interesting and is certainly by far the richest in species in South America. In its development it is, geologically speaking, comparatively young. The raising of the Cordillera in the early Tertiary—a process which apparently continues to this day—first laid the groundwork for the de-

velopment of this tropical mountain fauna. As already remarked, living conditions in the tropical lowlands can hardly have changed significantly since the middle Tertiary, and therefore for a long time there has been no effective external compulsion for the forms present there to change; in the Yungas area, however, because of the unfolding and mountain-building, forms occurring there were forced either to adapt to the changing living conditions by appropriate movements or else to be exterminated. Add to this the isolation of smaller or larger populations and their consequent subspecific or even specific breaking up occasioned by geologic events and certainly also by climatic fluctuations of the Pleistocene, and we have the explanation for the origin of the widespread richness of the modern Yungas fauna. The evolution of this animal world of the tropical mountain forests from the tropical lowland fauna of the Tertiary is clearly evident from the close relationship of the members of the two faunæ, while on the other hand there is no trace of relationship to the high cordillera and highland fauna. In summary, then, the statement may be made that the rain forest fauna of the Andean east slopes consists substantially of elements of Archiguayanan origin. Elements of the present day fauna of central and southern Brasil, whose origin may be derived from the old Brazilian land mass, the Archibrasil of VON IHERING, and which consequently occasionally show near relationships to corresponding African and southern Asiatic form (*e.g.* the *Acræidæ*), nonetheless play a substantial role in the lowlands of southeastern Bolivia, but participate in only a very subordinate way in the composition of the Yungas fauna.

As soon as we ascend beyond tree line, which on the east side of the Cordillera Real lies between 3000 and 3500 meters, we encounter a fauna completely different from that of the above-mentioned forest areas. Not one species of the true neotropic fauna is to be seen, while forms fly here which, at first glance, make a pronounced holarctic impression. By its very nature this fauna of the high Andes and of the Bolivian highlands — the Altiplano — is not very rich. Only species adjusted to the most extreme conditions are in a position to endure the raw climate of altitudes exceeding 3500 meters. A whole series of species, especially those that live in the high valleys of the Cordillera, during the cold dry period fly in the sunshine low over the ground in protected places. During the summer rainy season insect life at these heights is presumably nearly impossible because of the heavy snowfall. Among the butterflies the following belong to this winter-flying group: the pierid *Phulia illimani* Weymer, the nymphalid *Argynnis inca* Stgr., the lycænid *Itylus speciosa*

Stgr., and the hesperiid *Hesperia limbata nigella* Weeks. Various moths may also be taken at light during this cold dry season. The upper limit of lepidopterous life on the Cordillera Real lies somewhat over 5000 meters where, at the glacier's edge on the last upper fringes of vegetation, fly the pierids *Phulia paranympa* Stgr. and *Piercolias huanaco* Stgr.; and also *Colias euxanthe* Felder and *Argynnis inca* Stgr. again, as well as a few species of noctuids, are still to be found at these heights.

As already mentioned, the butterfly fauna of the high altitudes of Bolivia is composed, for the greater part, of species belonging to genera of chiefly holarctic distribution such as, for example, *Colias*, *Argynnis* or *Hesperia*, or at least to genera having their nearest relatives in the holarctic, such as the pierid genera *Phulia* and *Piercolias*, probably most nearly allied to the central Asiatic genus *Baltia*. The fauna originally native to the high Andes region was presumably of Patagonian — Chilean origin. Apparently in consequence of the raising of the land since the early Tertiary it was exterminated in the areas above tree line. In connection with this it should be recalled that near Potosi, at an elevation of over 4000 meters, a tertiary fossil flora was found which certainly once prospered at lower, warmer levels. The remnants of the original fauna, derived probably from the old patagonian — Chilean land mass (Archiplata of VON IHERING) has maintained itself only in the comparatively warm inner Andean dry valleys. The pierids, *Teriocolias atinas* Hew. and *Mathania carrizoi* Giacomelli, are such forms of Patagonian origin. The fauna of the Bolivian Cordillera and of the Bolivian highlands is comprised, therefore, in general of a comparatively few elements from the old Archiplata and of a much larger proportion of holarctic elements which first arrived from the North during and after the raising of the land. Which route this immigration might have taken is, to be sure, still very uncertain, since numerous forms show a closer relation to the fauna of eastern and central Asia than to that of North America. It seems certain, however, that this immigration took place at different times and in several waves, of which the latest arrived after the last glaciation, geologically speaking in the most recent times. Also the effect of the Pleistocene glaciations may be recognised in the present representation of forms in the highland fauna, since it must be accepted that during each glacial maximum the forms, in a manner similar to that known in the northern hemisphere, were forced down into restricted refuge areas in which they were then able to develop new forms. The faunal shifts due to the glaciations seem certainly to have been far less extensive in South America than in the Old World. Established generic differentiations,

such as the two pierid genera *Phulia* and *Piercolias*, whose nearest allies were noted above to live in central Asia, are apparently the results of an isolation induced by an earlier glaciation. The division of both these genera into numerous closely allied species with frequently very limited ranges, however, is likely to have been a consequence of the last glaciation. The highly polytypic genus *Colias*, however, widespread in Eurasia and in North America, appears to have invaded South America in geologically very recent times, since the last glaciation, because the high Andean species of this genus are only slightly differentiated into subspecies and still show great similarity in every respect to their relatives in Holarctica.

Many interesting peculiarities might be mentioned about the butterflies of the Bolivian highlands and the Cordillera Real, such as the interesting, apparently temperature-controlled, variation in wing color in *Colias euxanthe* Felder, which is orange yellow at high elevations, dull yellow green down near tree line, with intermediates of every degree in the intervening levels. The slower operation of metabolism at the lower temperatures of high altitudes and the consequently reduced excretion, apparently result in only incomplete elimination of the uric acid metabolism products which are deposited in the wings as pigments. A similar instance has been shown already in the Heteroptera.

I hope I have not bored you too much with these short and everywhere incomplete observations on the butterfly fauna of the Cordillera Real. My intent was to draw your attention to the butterfly world of these magnificent and magnificently contrasting mountains, a world still largely unknown in its details, and to the many still unanswered questions of distribution, origins and ecology of the various species as well as the influences which the extreme conditions of life impose upon them.

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