

## ESPECIALLY FOR FIELD COLLECTORS

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### FIRST IMPRESSIONS OF THE TROPICAL FORESTS OF SOUTHEASTERN BRAZIL AND THEIR LEPIDOPTERA

by E. P. WILTSHIRE

Before leaving England for Rio de Janeiro, I had noted that several subscribers of the Lepidopterists' Society inhabited that city; some of these were private citizens, others employees of at least two scientific institutions. A rapid glance at Seitz, *Macrolepidoptera of the World*, Vol. 5, had shewed me that the neighbourhood of Rio was a favourite collecting ground for Lepidoptera. It looked as though I should not be able to make any valuable scientific discoveries during a stay of a few years there, but that my outlook would be broadened.

Now, after a year at Rio, during which all too little time could be spared for entomology, I venture to summarise my impressions of the Lepidoptera of the city and its neighbourhood and of general conditions affecting their life and their study, in the hope that these may interest readers outside Brazil. They fall into the following subject headings:

The study: state of knowledge.

The butterfly industry.

The habitat: state of botanical knowledge.

Representation of groups of Lepidoptera.

Characteristic patterns, including *mimetic* and melanistic; extreme adaptations.

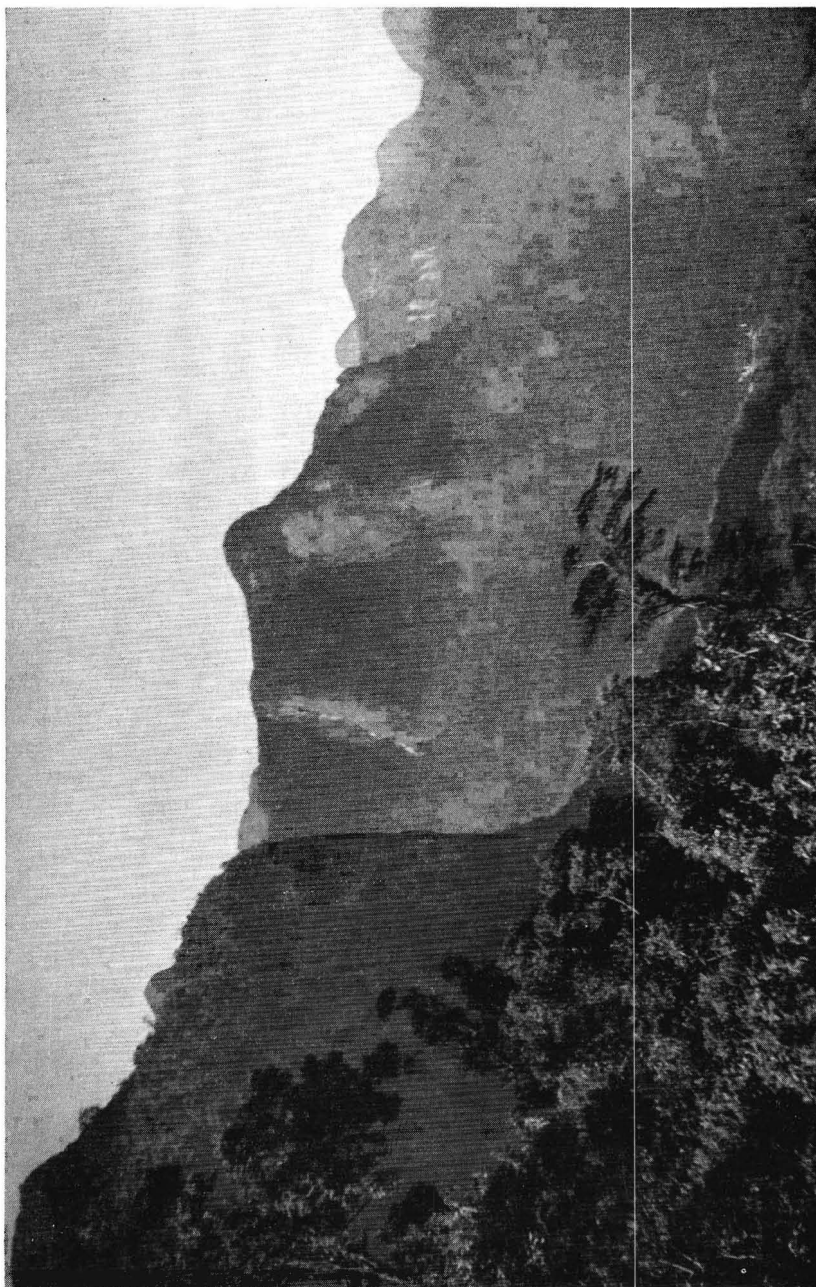
Phenology.

Character of the fauna.

Breeding, catching, and keeping.

#### THE STUDY OF LEPIDOPTERA AND THE STATE OF KNOWLEDGE

Rio is a city of about three million inhabitants. It is the federal capital of one of the largest countries in the world. Brazil's area is in fact greater than that of the U. S. A., and its population around sixty million souls. The city possesses the world's most beautiful harbour, surpassing Hong Kong and San Francisco scenically. Tropical forests, rich in dazzling butterflies and teeming with multitudes of less conspicuous forms, hem the city in on several sides and can be reached by car in half an hour from the city's centre. Air travel is the usual way of visiting parts of Brazil beyond the immediate vicinity of the place of one's residence.



The Sierra Estrela, Petropolis, southeastern Brazil.

Several biological publications are produced regularly by Brazilian institutions, providing a forum for publications of the local naturalists. Taxonomic works on Lepidoptera appearing in these are of a high quality. The number of amateur naturalists however is too low to permit the existence of periodicals catering, as in some parts of the world, especially for them. The city of Rio possesses several entomologists, both Brazilian and foreign, with a good knowledge of the butterflies and moths of the neighbourhood based on many years' experience and study, but none have a detailed knowledge of more than a few families; this is because of the great richness of the fauna, the multiplicity of species, the lack of any popularising or comprehensive work like that of SOUTH'S for the British Isles, and the fact that the volumes of Seitz for the American Noctuidæ and Geometridæ have not been and can never be completed. The Seitz volumes, as far as they go, despite their incompleteness and obsolescence, are indispensable for local students; nothing else comparable is available. The Noctuidæ and Geometridæ are hardly better known than the Pyralididæ and Micros. The types, which must be inspected to identify correctly most of the Lepidoptera one may catch in Brazil (for one cannot rely on an identification based only on Seitz) are mostly to be found in London and Washington, particularly London. In these conditions the local workers are to be congratulated on their actual achievements; their friendly co-operation with visiting entomologists is also noteworthy. At the present rate of study and in view of the great number of forms I think that a hundred years of taxonomic study must elapse before Brazil's Lepidoptera can be as well known as those of Europe today. Until a general survey of the whole fauna is published, most generalisations can only be tentative, and the spread of the study in Brazil will be retarded. Lepidoptera, moreover, are better known than any other order of insect. How ridiculous therefore were the comments which one already used to hear thirty years ago, to the effect that taxonomists had completed their studies of the world's insects and entomologists should therefore turn to other aspects (non-systematic) of their subject. What can be achieved on incomplete foundations?

#### THE BUTTERFLY INDUSTRY

As soon as one steps ashore at Rio, one meets *Morpho* wings, displayed in the windows of curiosity shops. These dazzling blue giant butterflies provide Brazil with a minor industry and article of export. Many shops shew trays of various sizes; some have detached wings arranged in mosaics or forming part of some picture, and these are tasteless products; others on a white cotton field under a sheet of glass, shew a selection of whole (or whole, except for the abdomen) set butterflies; these offend the taste less; a third type of butterfly-curio on sale, and indeed the rarest, is a vertical transparent glass screen representing a leafy branch on which may be perched four or five choice butterflies. As international and local tastes improve, a further development of this third line seems to promise the most attractive product of the butterfly industry.

The butterflies of the genus *Morpho*, used for the above purposes, and for export to dealers all over the world are mostly produced by German professionals in Southern Brazil, *e.g.* Santa Catharina, some 500 miles distant. No other genus is demanded in such numbers; but one sees in the tray selections and screens many other beautiful forms of butterfly, and even a few moths. In order to cope with orders of thousands at a time, these professionals, of course, breed the *Morphos*. This practice would appear to guarantee the survival of the species so used, unlike the case of the Bird of Paradise, threatened with extinction by the feather industry. Yet all agree here that *Morphos* are less abundant in the Rio district than formerly.

#### THE HABITAT; STATE OF BOTANICAL KNOWLEDGE

Rio is situated on the coast just north of the Tropic of Capricorn. Rain may fall in any month of the year; and the average annual rainfall is 43" and more in the mountains. There is no frost at sea level but a cooler season (May-August) during which heat-waves are not unknown, is called "winter" by the inhabitants and not without reason, as wild life responds in a marked way. The climate is thus tropical but not equatorial. The adjacent mountains have peaks hardly exceeding six thousand feet; the typical mountain forests are those situated between one and three thousand feet, at cloud-level.

In the plain, no forest remains, the habitats being either cultivation, marshland, mangrove swamps, or dunes. In the mountains there are various forests under official protection, including those adjacent to the city of Rio. The mountains of this neighbourhood are, characteristically, towering granite domes, often forming chains, and except where the bare rock is too steep for any soil, were once completely forested. Parts of them are now still forested even where unprotected; other parts have been built on, or cultivated, or converted to pasture. The Rio climate produces a very humid type of tropical forest, particularly at cloud-level, composed of many different species of tree, most of which bloom at a definite season profusely; these trees cannot however be said to have a tree-top layer with a biocenosis distinct from that at ground level, as has been reported from flatter tropical forests, *e.g.* the Amazon and Guiana. Owing to steep gradients, all biocoenoses are partly intermingled. The trees are covered with epiphytes and creepers, such as orchids, bromeliæ and woody lianas, and at ground level too there is a wealth of creepers such as Passion-flower, and herbs and shrubs. The tree-trunks of almost all species are covered also with lichens and algæ; some of these are red; but the greenish-white lichens are the more expansive and give the forests around Rio their characteristic pale-trunked appearance, almost approaching that of a birch-wood. The Notodontidæ are especially characterised by cryptic coloration for rest on this type of background. In the immediate vicinity of Rio the number of species of native trees is about four hundred, to which must be added about one hundred introduced kinds in parks and plantations. There is no popular work to aid in identifying these trees, let alone the herbs which must be equally numerous. Whether he seeks known larvæ on a given foodplant or wishes to describe and publish original observations, the lepidopterist's task is thus rendered harder.

## REPRESENTATION OF GROUPS

To compare strictly the number of species in each family in the local fauna is difficult, as a complete list does not exist, and different methods of sampling must be used for different families. Groups attracted to mercury vapour light, which is the most productive means of capture, will appear to outnumber those not so attracted, *e.g.* the diurnals, in proportion not corresponding to the true.

The total number of species of Lepidoptera in the vicinity of Rio is not yet ascertainable but my impression is that it is tenfold that of southern Europe, and twenty or thirty times as many as in the British Isles (about 2200).

The Noctuidæ (=Phalænidæ) are by far the most numerous family, in richness of species, and in it the Quadrifids outnumber the Trifids. The family appears to be three times as numerous as the next most numerous groups coming to light, the Geometridæ and Pyralididæ. These two seem to outnumber by similar proportions the next most numerous groups, the Arctiidæ, Notodontidæ, Sphingidæ, and Saturniidæ, which are however better known, having attracted more attention because of their size or colouring. It is regrettable that the most numerous are the least known.

The relative number of species in different groups must not be confused with the number of individuals of a single species. At certain seasons and places, the enormous numbers of one species (*Cosmosoma teuthras erubescens*) to light, gives the impression that the Syntomidæ outnumber all other groups; at other seasons and places, the Pyralididæ. Among the day-fliers the appearance during a short flight season of countless individuals of *Actinote pellenæa* makes the Acræinæ (Nymphalidæ) seem the most numerous butterfly group in Rio.

## CHARACTERISTIC PATTERNS, INCLUDING MIMETIC AND MELANISTIC

It is commonly said that tropical Lepidoptera are larger and more brilliantly coloured than temperate ones.

It is a fact that there are larger forms in the tropics; and Brazil indeed has the species with the largest wing-span in the world (the Noctuid moth *Thysania agrippina*). This moth, however, is cryptically marked as in the Holarctic genus *Boarmia*, so as to be inconspicuous when resting on tree trunks.

It is also a fact that many Brazilian forms have peculiar colour patterns and others have more brilliant hues than are ever seen in temperate latitudes. The butterflies that combine great size and wonderful colouring are indeed unforgettable sights and some of them are common. Though not in the majority, they are with some reason considered characteristic. But Brazil, and other tropical places, are inhabited by countless small, dull forms as well. There are Brazilian Nolinæ, and Eupitheciinæ with a similar pattern to the Holarctic species and even smaller. The Epiplemidæ, an almost exclusively tropical family consisting entirely of rather small, delicate, cryptically col-

oured moths (only distinguishable by their venation from Geometridæ or Drepanidæ) which fly by day in shady places or at sunset around bushes in the mountains near Rio, are the very converse of what the word "tropical" suggests. Although at least one species of Pyralid is as big as a large Hawk-moth and has usually been mistaken for one, I have never elsewhere bred out such minute leaf-miners as I have near Rio. The Satyridæ also have smaller, duller, grass-feeding ground-flying forms than any in Europe. In the Noc-tuidæ the Brazilian "Wainscots" (*Mythimna*, *Leucania*, etc.) are similar to Holarctic forms but if anything smaller; this may be because tropical forest conditions give less scope for the evolution of graminivorous types than the Palearctic and Nearctic regions with steppes and grassy mountains.

Thus around Rio one finds patterns typical of temperate forms side by side with characteristic Neotropical patterns; but it is remarkable that in Brazil patterns do not indicate affinity to the same extent that they do in the Palearctic Region, where one can guess without much fear of error that a white butterfly is a Pierid, and a blue a Lycænid; but not so in Brazil.

We may call the representation of a similar pattern in unrelated groups "convergence" and may regard it in such places as Brazil where it is so common, in some cases as the result of identical environmental influences on different stocks over a very long period.

More has been written about mimicry than other forms of convergence, probably because of the conspicuousness of the characteristic patterns; but the district of Rio contains as remarkable examples of cryptic convergence as of mimetic-aposematic convergence.

On mimicry the remarks, on the genus *Heliconius*, of Dr. SEITZ on p.373 of vol. 5 of his great work are still very apt and one cannot do better than summarise them:

The acrid-smelling Argynnid *Heliconius narcea* has a pattern, form and flight which render it indistinguishable on the wing from a number of Danaidæ, which are also distasteful, including *Melinæa æthra*, *Mechanitis lysimnia* and *Ceratinia euryanassa*. Another Argynnid, in a closely related genus, *Eueides dianassa*, also mimics *Heliconius narcea* perfectly; less closely related are the females of *Eresia eunice* and of the Pierid *Perrhybris pyrrha* and the day-flying females of certain Pericopid and Castniid moths which also mimic the black, yellow, and orange pattern of the above-named butterflies, with which they fly on the outskirts of the city and in the forests around Rio, so that a collector cannot catch a series of any one species without taking some of the other species too. As though sure of the protection afforded by their odour or taste the *Heliconius* and Danaid models fly in open places with a slow, straight flight, often assembling in groups or alighting on flowers and are not shy nor are they hurt if the thorax is pressed or the wings rubbed; possible foes must be familiar with their appearance, taste, and smell, and the colours thus become a warning-uniform which the less distasteful mimics profit by wearing.

Dr. SEITZ' observations are still very true but I might add that since his time these warning colours have become adopted, of course unconsciously and

coincidentally, by the city's buses or "lotações" which are considered the most dangerous element in its fast-moving traffic and are given a wide berth by other road-users.

It may surprise readers familiar with recent work on industrial melanism to hear that melanism occurs in the forests of Brazil. It is quite unassociated with industry. There are of course many dark spots in the tropical forests where sooty coloration is an advantage. One presumes these melanistic species choose such spots for resting.

Many families contain a minority of melanic species in various genera; in the Geometridæ I have noticed one or two polymorphic species whose varieties range from pale to blackish. One of Brazil's largest species, the migrant Noctuid *Erebus odora* L. is melanistic in the male sex and would seem to be an advanced type of organism; but other melanic forms seem more primitive.

In the family Saturniidæ, which in Brazil is comparatively numerous and characteristic, some species are large and richly coloured, and highly specialised in some ways, despite the primitive venation of the family; but others are small, dull, and with a melanic tendency; for instance, in the genus *Hylesia* which is typically mouse-coloured, some species are melanic except for the abdomen which seems to preserve the brown ancestral colouring, concealed by the sooty black wings when in the normal resting position. The genus *Automeris*, generally characterised by the vividly coloured central eye on the hindwing, contrasting with a cryptically coloured forewing, has one atypical species (*A. inornata* Walker) where the eye is almost covered with a melanic suffusion. Can one deduce that recently the survival-value, for this species, of the bright eye-warning has proved less than that of a complete melanic cloak? Or is it a primitive melanic form in the early stages of evolving a bright eye, that has changed less rapidly than its relatives in the same environment? Observation of resting habits and breeding experiments would both seem required to answer such a question.

Melanism of a different type is also quite common in day-fliers, and indeed many diurnals in unrelated families shew this tendency. Their melanism may be aposematic or cryptic.

The Hesperiidæ, which are richly represented around Rio, are largely melanic and cryptic. Most of the *Papilio* forms, both of the group with yellow pigmentation and that with red, are strongly melanic. Among the latter group is a form perfectly reproduced in a quite different genus; the predominantly black wings are marked on the upper sides with smaller white and red central patches. Other melanic butterflies have the black upper-sides narrowly banded with metallic blue. The effect of most of the foregoing is cryptic, it being very difficult to follow such forms with the eye when in flight between patches of bright sunlight and deep shade in the depths of the forest.

However the combination of a black upper-side with an orange or yellow cross-band would seem to be aposematic. Insects so marked fly fearlessly and slowly through the glades and are not hard to follow or catch; some of them are doubtless distasteful to predators. This pattern occurs in some Rhopal-



cera but is borrowed by many Heterocera and those having it are day-fliers. To do justice to this subject a long special article profusely illustrated in colour would be necessary; failing this, the reader who wishes to get an impression of the facies of the Lepidoptera around Rio can hardly do better than turn to the LIFE International magazine number of Nov. 24, 1958, though the melanistic and inconspicuous forms are mostly omitted from the fine illustrations there given.

One may conclude with the generalisation that a tropical fauna, to judge from that at Rio, is characterised not so much by larger and more brilliant forms but rather by greater extremes of all kinds, and by a greater richness, both of variety and numbers.

### PHENOLOGY

The Lepidoptera around Rio vary phenologically much the same as do those of subtropical and temperate climates; some species are multivoltine, and the life-cycle of these is as a rule shorter than that of temperate species; others are bivoltine, others univoltine; some have a short adult appearance, others are more spread; some have rigidly short pupal periods of 15 days, while in others individuals of a single generation vary in this period between two weeks and five months. In some species hibernation is obligatory and occurs in the larval stage, though only some of the foodplants lose their leaves: among such is *Morpho laertes* whose scarlet, hairy big-headed caterpillars hibernate in gregarious masses resembling a fruit and suspended from a twig. Local entomologists also tell me that some individual pupæ of other species may hatch after two or three years.

The Spingidæ and large Saturniidæ are on the wing in large numbers in the warmer months but are little seen to light during the cooler; the smaller Noctuidæ, Geometridæ and Pyralidiidæ, however, appear in fair numbers to light even when the giants are not to be seen. At sea-level and up to at least a thousand metres' height, no month in the year passes without one seeing Lepidoptera flying, particularly the day-fliers, but there is a marked increase in numbers in September and a maximum of species and individuals is on the wing in December-April.

### CHARACTER OF THE FAUNA

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The Neotropical has very few species in common with the Palearctic, somewhat more with the Nearctic and Paleotropical faunæ. The three species which I have noticed in and around Rio and also come across in the Old World are: *Peridroma saucia*, *Nomophila noctuella*, *Hymenia* (*Zinckenia*) *recurvalis* (*-fascialis*). All three are known to migrate and the last is a root-crop pest, but doubtless they reside and are well-established as well in Brazil as in the Old World.

Common genera are somewhat more numerous than species but the fauna as a whole, to one coming from the Old World, has a bizarre and unfamiliar



aspect. Some of the most characteristic groups of the Palearctic Region, e.g. *Zygæna*, *Agrotis*, *Argynnis*, are virtually absent while others have closely related vicariants (e.g. *Phyciodes* representing *Melitæa*). *Vanessa* and *Mythimna* (*Leucania*) are genera with distinct but similar species.

The predominance, among the Noctuids, of the Quadrifinæ over the Trifinæ, already mentioned, characterises of course both Neotropical and Paleotropical Faunæ.

Characteristic, that is virtually endemic Neotropical groups, are, among others, the Morphinæ, Heliconiinae, Megalopygidæ, Mimallonidæ and in the Noctuidæ, the Diopsinæ.

As already mentioned there is no lack, around Rio, of small, not highly specialised forms; but one is also struck by the extreme length to which specialisation and adaptations have gone. As regards size and brilliance, the Morphinæ are unsurpassed; their social habits are moreover highly developed. As regards length of tail of hind-wings, many families have extraordinary dimensions. Hind-wing lobation as a secondary sexual character with vein-reduction characterises several Arctiid genera, and aberrant hindwings characterises quite a number of small Geometridæ. Larvæ with extremely urticating and large elaborately branching spines are not easily forgotten; remarkable masses of scales and hair-fringes on adults' legs, wings, and bodies, combined with an unusual pose in the natural resting position, often serve as a perfect cryptic device, whose existence it is impossible to guess from a conventional mounted museum specimen and which can only be illustrated by the living animal.

Many of these specialisations occur in groups, e.g. the Hesperiidæ and Saturniidæ, whose neururation is comparatively primitive and whose Palearctic representatives lack them. The Neotropical fauna might therefore be described as consisting to quite a large extent of highly specialised and advanced representatives of comparatively primitive groups, with a penetration of rather generalised, small northern types; though one might argue that some, at least of the latter, e.g. the Nolinæ, are descendants rather of an almost cosmopolitan early fauna which are not particularly favoured or stimulated by present conditions in Brazil.

It is usual to attribute the extravagant specialization of tropical life to the pressure of the struggle for existence over a very long period between forms where climate provides little or no obstacle to dispersion and multiplication.

The facies or general appearance of the Brazilian lepidoptera finds, perhaps, its most similar counterpart in tropical S. E. Asia. The wide separation and barriers between these two regions suggest that environment rather than affinity may account for the resemblance, which of course is superficial.

#### BREEDING, CATCHING AND KEEPING

Finding larvæ is easy, and breeding them up should be no harder in the Rio district than elsewhere for one living in a suburban house within easy reach of the forest; but most people live in flats, which do not favour breed-

ing. The life histories of the great majority of the Lepidoptera are still unknown. Parasitisation seems more intense than in other places known to me.

Catching dayfliers is not difficult in the case of the Hesperiidæ and the weaker-fliers; but the larger butterflies are on the whole more difficult to catch; many of them like high trees; the steeper gradients around Rio make these probably easier to catch there than in flatter tropical areas. Flowering bushes sometimes attract numerous butterflies and render the task easier. Many kinds do not need sunshine to persuade them to fly, and may be caught in dull weather to some extent at least.

The introduction of mercury vapour lamps as a means of taking moths at night has made it easier to obtain a good series of a single species; hitherto the tropics were notorious for the multiplicity of species of which one succeeded in catching singletons only. So great is the number that comes to the new type of lamp at the best season that the problem is how to cope with the multitude. A small trap is quite impracticable, and less damage is done to specimens if one can tempt them into a large room which acts as a trap. To deal with all families it would be best to have two or three persons working in a team at a single light source. A team of several skilled persons, and much equipment would also be required to set and label the catch that would then result.

It is necessary to kill the larger species at once by injection to prevent them damaging themselves and the smaller moths that accompany them to light; this is equally true of the day-flying Morphinæ and Brassolids, though some collectors make do with squeezing the thorax of these.

The collectors in Rio are able to preserve their catches in good condition without undue trouble; the climate is tropical and humid but not badly so, though it would be advisable to avoid the most humid parts, such as Copacabana and Leblon. Drying certainly takes a long time unless one accelerates it with heat. On holidays of a week or ten days I have usually tried to set the catch as soon as possible after capture and have reduced the period of setting to as little as three days by the careful application of solar or electrical heat to the boards, or exposing them before a fire or pressure-lamp. Mites are particularly abundant and it is best to coat store-boxes with melted naphthaline and paraffin-wax.