



A ZEBRA BUTTERFLY
(Heliconia charithonia)

THE SLEEPING HELICONIAS OF FLORIDA

A Biological Mystery in a Fascinating Setting

BY FRANK MORTON JONES

The Royal Palm State Park, where the observations on the sleeping Heliconias were made, has already been described in NATURAL HISTORY by Mr. H. F. Schwarz ("Swinging the Net in Southern Florida," July-August, 1923) and those who know the biological interest of that region hope that it may soon be part of a National Park including all of the nearly primeval subtropics that remains in our country. In connection with the nocturnal gatherings of the Heliconias, it may not be amiss to refer to another butterfly mystery, the assembly of the "monarchs" for their southern migration. A part of one such flock is shown at the entrance to the American Museum's Hall of Insect Life.—THE EDITORS.

IN the *Atlantic Monthly* for September, 1918, William Beebe gave one of his characteristically vivid and poetic word-pictures of tropical wild life, including a description of the sleeping habits of the Heliconia butterflies. Late one afternoon, in a little glade in the tropical forest bordering the "Convict Trail," he found two groups of Heliconias going to rest. One by one the butterflies alighted on the tips of projecting leafless twigs (two species in separate bushes), folded their wings, and slept—soon so soundly that Beebe was able to pick off one butterfly and then replace it upon its twig without awakening it or the others. All the sleeping butterflies faced northeast. Each had its own particular twig, to which after flight it always returned. When first discovered, sixty-three butterflies were counted, sleeping in the two bushes; three weeks later, "many of the twigs . . . were vacant, and most of the Heliconias were tattered and forlorn, just able to keep at their fluttering level"; and after two more weeks, only three butterflies flapped slowly in to their

sleeping-bush from the darkening forest. One by one the others had perished, until only this remnant of the flock remained.

That these, the most "casual and irresponsible" of butterflies, should have a habit presupposing memory, sociability, caution,—for so Beebe interpreted his observations,—seemed to verge on the incredible; and this, doubtless was the reaction of most entomologists upon reading Beebe's paper; but forgotten in our literature are earlier records confirming and almost duplicating these observations.

In view of the fact that these sleeping-assemblages of Heliconia are almost unique in our knowledge of the lepidoptera, and that most of the published references to them are fragmentary and without pretence of prolonged observation, we welcomed the opportunity for closer study afforded by several visits to Royal Palm State Park, Dade County, Florida, covering the period between January 8 and April 6, throughout which these butterflies were always present and usually fairly abundant.

Throughout our first stay (in 1927),



A ROOSTING-PLACE FOR THE NIGHT

The newly-emerged *Heliconia* selects a dead branch with numerous twigs—often a branch with many dry, dead leaves—and returns to this spot nightly until opportunity occurs to join a sleeping group of its fellows

charithonia was seen every day, but its sleeping-assemblages were not then looked for or observed. It was noted, however, that the butterfly occurred in certain circumscribed areas, within which either singly or in pairs it might always be observed, though unrepresented in the intermediate areas. In the light of later observations, these frequented areas constitute the boundaries of customary flight on the part of distinct sleeping-groups whose components seem to keep within a few hundred feet of their sleeping-bush. Here, in characteristic slow-flapping wavering flight, these insects keep fairly close to the edge of thicket and jungle, to

which they retreat when alarmed. Sometimes, with upright wings they feed upon flowers. Often they bask in the sun with wings outspread. If seen in pairs, one is usually in leisurely pursuit of the other, the second in flight following the leader in all its windings above and through the herbage, always maintaining the same short distance between the two, thus suggestive of the spaced flight of pelicans. This was not observed to be a mating flight, and Doctor Wittfeld's observations indicate that mating habitually takes place at the time of the emergence of the female from her pupa.

Upon our arrival at the Park in mid-March, 1929, the warden, Mr. W. D. Wheelock, immediately called our attention to a sleeping-assemblage of *Heliconias* in a dead

and almost leafless bush standing at the edge of other and living herbage less than a hundred yards from the Lodge. He reported that in early January two such assemblages had been present, this one having persisted and absorbed the other, which had been located about a hundred feet distant on a swaying vine in an open-slatted nursery shed. In January, by his count, more than forty butterflies occupied the two roosts. As we observed them from mid-March into early April, between twenty and thirty were usually present, nightly, in the dead bush. Some of these were bright and fresh, apparently recent

emergences; others were tattered and worn and might well have been survivors from the January flock. We kept them under daily observation until our departure, April 6, making night and morning visits to the Heliconia roost, and (then) unsuccesful efforts to secure satisfactory photographs of the sleeping insects. Our longer stay in 1930 gave greater opportunity for observation, at earlier seasonal dates; and to avoid repetition we have consolidated our record of observations for the two years.

Of six observed roosting-places, three were at the edge of dense living herbage, in dead bushes or broken branches having many fine twigs; two were in pendulous vines, almost leafless but with twigs and interlaced ramifications; one was among the close-set wiry dead stalks and the bare aerial roots of a neglected fern-basket hanging in a slat-house. None was less than two feet or more than eight feet from the ground. Noise and proximity of buildings had no deterrent effect, for the roost longest in observed occupancy was almost in contact with a corrugated-iron shed in which a noisy engine and pump ran many hours of the night and day.

In the late afternoon, Heliconias, one by one, commence to drift in to the vicinity of the sleeping-bush. With devious slowness they explore the whole neighborhood, pausing here and there on

some projecting bit of herbage, sometimes basking for a time in the last horizontal beams of sunlight, sometimes alighting on the roost only to leave it again for further exploring flight. About a populous roost, at sunset, the air is filled with butterflies in swirling flight, which continues in decreasing number of participants as one by one the flock finds a resting-place and hangs motionless in the sleeping posture. Up to almost full darkness, late comers continue to arrive, some apparently flying directly to the roost without preliminary exploring flight and joining the sleeping group; and more



AN EARLY MORNING PICTURE
(Five minutes exposure)

In its sleeping position Heliconia clings to its roost, head upward, its legs extended, its tongue partly uncoiled, and with its wings folded and pendulous



PLACE-MEMORY, SCENT, OR WHAT?

Heliconias on Roost B, after the substitution of new twigs. One has the tip of its wing obliquely clipped for identification

than once, after counting the sleepers at the last moment the fading light permitted, we have found that number increased upon visiting the roost at night. The frequently observed preliminary exploring flight, often exhibiting an unmistakably purposeful thoroughness, was at first attributed to a precaution against lurking danger before going to sleep—a gesture like looking under the bed for a burglar; but later observations suggest a more probable explanation.

For the ability of the Heliconias to find and identify their sleeping-bush, two explanations seem possible; this might be by place-memory, or by scent. We made two experiments which seem con-

clusive. In 1929 the flock of thirty butterflies occupied a few twigs of a large dead bush. One morning we cut out these few twigs, and tied them up in another bush about ten feet distant from their original location, and at the same height from the ground. The new location was not directly visible from the old one, but was within the usual radius of the preliminary exploring flight of the assembling flock. In the late afternoon we watched the behavior of the arriving butterflies. The usual performance of exploring flight about the roost was manifested. In this flight they coursed back and forth through the space formerly occupied by their roosting-twigs, and it seemed obvious to us that there was some recogni-

tion of change. In their wider flight, several butterflies paused upon the old twigs in their new position, only to leave them again and rejoin the flying group. Gradually the flock came to rest upon twigs in the old roosting-bush, close to the vacant space left by the removal of the roost itself. After dark, twenty-seven butterflies were found sleeping on these new twigs, and one, alone, on the transferred twigs ten feet away. Next night, this one rejoined its fellows in the old bush.

Our next experiment, made in February, 1930, even more clearly indicated that recognition of the roost is by place-memory, not by scent. In preparing for a flash-light photograph of the strongest

group then under observation, we had attempted, in the daytime, some rearrangement of the twigs of the roost. In this attempt, so many dry leaves and brittle twigs fell off, that we feared we had ruined the roost for further occupancy. As a last and not very hopeful effort, we cut away all the remaining branches of the roost and brought others from a distant brush-heap, tying them into place as nearly as possible in the old site. At dusk, without any obvious hesitation the butterflies accepted this substitution, and that night they slept upon the new twigs in the usual numbers. The roost-location, and not an imparted odor, identified the sleeping-place.

Mr. Beebe noted that individual butterflies, recognizable by tears or imperfections in their wings, occupied the same twigs night after night, and he believed that each insect had its own particular twig to which it always repaired for sleep. In 1929, by rough drawings of the furcations of the twigs of the roost and by note of the number of butterflies resting on each, we determined that some nightly shift in the relative positions of the sleeping insects usually takes place. We then discovered that the butterflies could easily be marked for identification by snipping pieces from their wings while they slept. Memorandum was then made of the twigs occupied by insects thus variously marked for individual identification, and night after night their posi-



PROTECTIVELY PATTERNED

Five sleeping Heliconias. In color and outline their longitudinal stripes merge into the dry roots and stalks of their roost

tion on the roost was determined and recorded. Many of them did occupy the same twig for a short succession of nights. Usually some of the marked butterflies occupied new positions. None maintained the same position for many successive nights, and some of the shifts of position were from one side of the roost to the other, from night to night. That is, there was some evidence that place-memory is definite enough to extend to the location of individual twigs, but abundant evidence that continuous occupancy of them is far from the general rule.

Unless alarmed, or unless the crowding of later arrivals occasions some readjustment of position, each butterfly after

assuming its sleeping posture upon the roost usually remains there motionless throughout the night. Each clings to its twig or leaf, head upward, its wings closed over its back and pendant; the legs are somewhat extended and the body is thus held away from contact with the support; the abdomen is hidden within the margin of the hind wings; the antennæ are held straight and erect, slightly divergent, and almost parallel with the costa of the front wings; the tongue is partially uncoiled, forming an open circle of about one-eighth inch diameter, its inner rim often bearing an adherent droplet (sometimes a hardened globule) of nectar (?).

The sleeping flock usually forms a fairly compact group in which twenty or thirty butterflies may be crowded together within a radius of twelve or fifteen inches, sometimes with little outlying groups on adjacent branches or twigs. In these sleeping-assemblages most of the Heliconias face the same way. In attempting to photograph such a group, however, it is often found that a position chosen to secure a broadside picture of the group includes some individuals which present an edgewise view to the camera. Nor do different flocks all face toward the same point of the compass, and one whole flock was observed to reverse its position from one night to the next, perhaps because some change had been made in the adjacent herbage, incident to photographing the group. We believe that the position of the twigs or leaves composing the roost is one determining factor, and that the

direction of strongest light has some orienting influence.

While daylight persists, the roosting butterflies continue to be alert and ready to take flight if closely approached. After full darkness they seem unaware of near-by sound or movement, and even brilliant lights unless very close elicit no response. A jarring touch of the supporting twigs or a brilliant light held within a few inches of the roost arouses them; and even if none takes flight, antennæ are waved, feet are shifted uneasily, often the palpi are alternately spread apart and closed, exhibiting conspicuously their pale inner surfaces.



A TROPICAL TREE-SNAIL

In warm, humid weather brightly colored tropical tree-snails creep out from their hiding places in the jungle at Royal Palm State Park

At night, by careful handling, one after another of the sleeping butterflies may be picked off from the group, even sometimes replaced again, without awakening the rest; but never did we succeed in picking off the whole flock without arousing some remnant of them into flight. When violently awakened, the whole flock literally *explodes* into flight in all directions; and although brilliant light exerts a weak attraction to some, most of the members of the flock cling to the first object into which they bump, and in the morning may be found hanging to adjacent herbage within twenty or thirty feet of the roost.

The morning awakening and departure of the Heliconias was repeatedly observed. This may be considered a typical record: March 22, evening, 24 Heliconias sleeping in roost; March 23, 6 A.M., all still asleep; 6.15, one flew slowly away while the light was still too dim for its ready

detection as it slipped off into the shadows of the jungle; 6.22, one sat slowly flapping for a few seconds then flew off, followed quickly by another which had given no preliminary signs of approaching flight; 6.35, one departing butterfly bumped into the remaining assemblage, which exploded into flight and immediately dispersed. On other mornings, this explosive flight of the entire flock would be the response to our approach, however cautious.

On cool and cloudy mornings the night's lethargy persists until later in the day, often permitting incautious approach, and continuing until nine o'clock, or even later in time of heavy rain. After repeatedly witnessing the prolonged exploration of the roost neighborhood as a preliminary to assemblage on the roost, and these explosive departures in the morning or at the approach of danger, we



THE STRANGLING FIG

It hangs from many of the trees of the Hammock
as a ropelike vine



THE STRUGGLE FOR SUPREMACY

The Fig vine thickens, and tightens its strangling grip, until the supporting tree is completely enveloped

concluded that the evening flight is one of orientation, by which place-memory is established and maintained—the sudden departure at dispersal of the flock affording no opportunity for this function.

Upon our arrival at the Park, March 18, 1929, we were shown a group of sleeping Heliconias upon a roost which had been in uninterrupted nightly occupancy since early January. It was still being used at the time of our departure, April 6. That is, this site had been in uninterrupted use for three months, and beyond this period we did not know its beginning or end.

In late September, 1929, a hurricane whipped most of the leaves from the trees at the Park, flooded the country to an almost unprecedented degree, and created conditions most unfavorable to insect life and abundance. The warden, Mr. Wheelock, wrote us that some of the

Heliconias had survived the hurricane and that they were in daily flight about the Lodge. Later, however, their numbers decreased, and on December 3 Mr. Wheclock wrote, "There is not a single Heliconia left." He predicted their return in January, when usually they become more abundant. We arrived at the Lodge on January 8, and on the next day saw a bright freshly-emerged Heliconia at the edge of the jungle. Thereafter we saw one or two each day, but not until the 20th did we succeed in locating a sleeping Heliconia. It slept alone, in a pendent leafless vine; the next night it slept in the same spot; the third night it did not reappear. On February 2 we located another, sleeping alone on a bare fern-stalk; for two more nights it slept there, then it, too, did not reappear. Meanwhile, however, we found three other roosts, all within one hundred yards of the Lodge and of each other, and each with several occupants. For our records we designated these roosts B, C,

and D, and in each group we marked some of the individuals for identification. To our surprise, we discovered that there was a constant shift and interchange, from one sleeping-place to another. For example, a marked butterfly which we identified by a single oblique clip from its front wings, was located, sleeping, on twenty-two out of twenty-six consecutive nights; and in this period it made eight changes, back and forth, between roost B and roost C. Its longest observed unbroken stay on one roost was for six successive nights. This explained the previously-observed fluctuations in the numbers present on a roost from night to night, and relieved the Heliconias of the suspicion we had formed, that they frequently stayed out all night; but for that suspicion it seems to have substituted the certainty that some of them maintain two establishments.

One other significant experiment seems worth recording. On February 8 a motor trip was made down the Cape Sable road



THE FINAL STAGE OF THE STRANGLING FIG

Long after the supporting tree has crumbled away, the Fig itself becomes a great tree, whose braced and buttressed roots give independent firm supports

to West Lake and beyond—a distance of twenty-seven miles from the Lodge. Here, over a limited area, Heliconias were found flying in some abundance. Two were captured uninjured, transported to the Lodge, marked with conspicuous and unmistakable wing-clippings, and released. One was never seen again. The first night after its release, the other one was found sleeping on roost B; and for eight of the succeeding eleven nights it was identified among the sleepers on either roost B or roost C, in that period making three shifts between these roosts.

It is thus apparent that individual Heliconias sleeping alone develop a place-memory which may persist for a number of nights; that a "capacity for sociability," as Beebe expresses it, may become a stronger stimulus, to which the original place-memory is subordinated; and it may well be that in these observed shifts from roost to roost we are witnessing the chance operation of this social stimulus, rather than the apparent ability to remember and recognize several successive sleeping-sites.

Has the group-sleeping habit of the Heliconias any determinable significance of importance to the species? Of the three primary requisites for continuance—food, safety, progeny—it would seem that we might at once eliminate one—food—as having no conceivable relation to this habit. Nor could we find evidence that it has to do with the mating of the sexes. The populous roost under observation in March and April, 1929, included both sexes in numbers not greatly unequal; but as we observed the formation of new assemblages in 1930, a different condition



SWAMP LILIES

The glades are not always monotonous expanses of saw-grass, for they maintain a varied though limited flora. Here and there they are starred with the great snowy flowers of *Crinum*

was found to exist. All the insects we noticed first, roosting alone, were males. The small assemblages beginning in late January were composed exclusively of males, and all Heliconias netted by day were males, which obviously have an earlier seasonal emergence. It was not until almost a month from the observed formation of the sleeping groups, that any females were detected among the sleepers or captured in flight. We could detect no differences of behavior among the insects of the bachelor groups, in comparison with those of the mixed assemblages; and Doctor Wittfeld's detailed observations in regard to the assemblage of males of *charithonia* about

the pupæ of females several days before the emergence of the adults, render it even less probable that the sleeping-assemblages relate in any way to the union of the sexes. Do they then contribute toward the *safety* of the species?

As these butterflies eling motionless upon the roost, with folded wings showing only the dulled colors of their under surfaces, the sleeping group is not to our eyes conspicuous. Repeatedly we have approached a roost and believed it to be bare of occupants, until gradually our eyes picked out from the confused mass of narrowly-striped wings and sunbleached twigs the form of one butterfly after another, and finally the whole group became visible to us. But even if protectively colored—or rather, patterned—why should thirty such butterflies sleeping in a compact group be any safer than thirty sleeping singly and far apart? The reverse would seem nearer the truth.

To this query the behavior of one butterfly, plucked from the sleeping group and held between finger and thumb for inspection, may give a clew. It waves its legs and antennæ, it curves its body out from the concealment of its wings, crescent-formed, and holds it rigid; and from the end of the abdomen it pushes out a rounded, yellow, glandular mass (in the male, double) from which is given off a powerful odor and in some instances a minute drop of fluid. Perhaps we should say perfume, rather than odor, for to our senses it seems flower-like though rank, suggesting the rank sweetness of the *Datura* blossom. We could detect no difference in scent between that of the male and the female butterfly.

The *Heliconias* are foremost among

classic examples of the theory of "warning coloration"—of the possession of conspicuous easily-recognized colors and patterns (usually yellow, orange, or red, and black) by which their inedibility, through the possession of a nauseous smell or taste or of special means of defense, is advertised to their enemies. A great controversial literature has been built up about them and about this theory. Their behavior by day is not incompatible with this theory; for the "zebra" butterflies, slow of flight, seem to advertise their presence and identity, rather than attempt to elude observation. If *Heliconia* is protected by a nauseous odor or taste, advertised to its daytime enemies by conspicuous readily-recognized colors and color-patterns, then its degree of protection, at night, when these warnings are not so apparent, may be increased by the close proximity of large numbers, under these conditions readily recognizable by form, color, or *scent*, as identical in kind and inedible; for thus the injury or destruction of one of the group might conceivably work for the protection of the many.

A recent and able paper on the sounds produced by insects concludes with the query, "Do they serve a really important purpose in the lives of the insects? If not, why have they developed and how?" Perhaps the sleeping-assemblages of *Heliconia* are of no real importance in the economy of these insects. On the assumption that they are of significance, we have presented a suggested explanation which seems in agreement with the observed phenomena; and for this suggestion we have been unable to discover any reasonable alternative.

