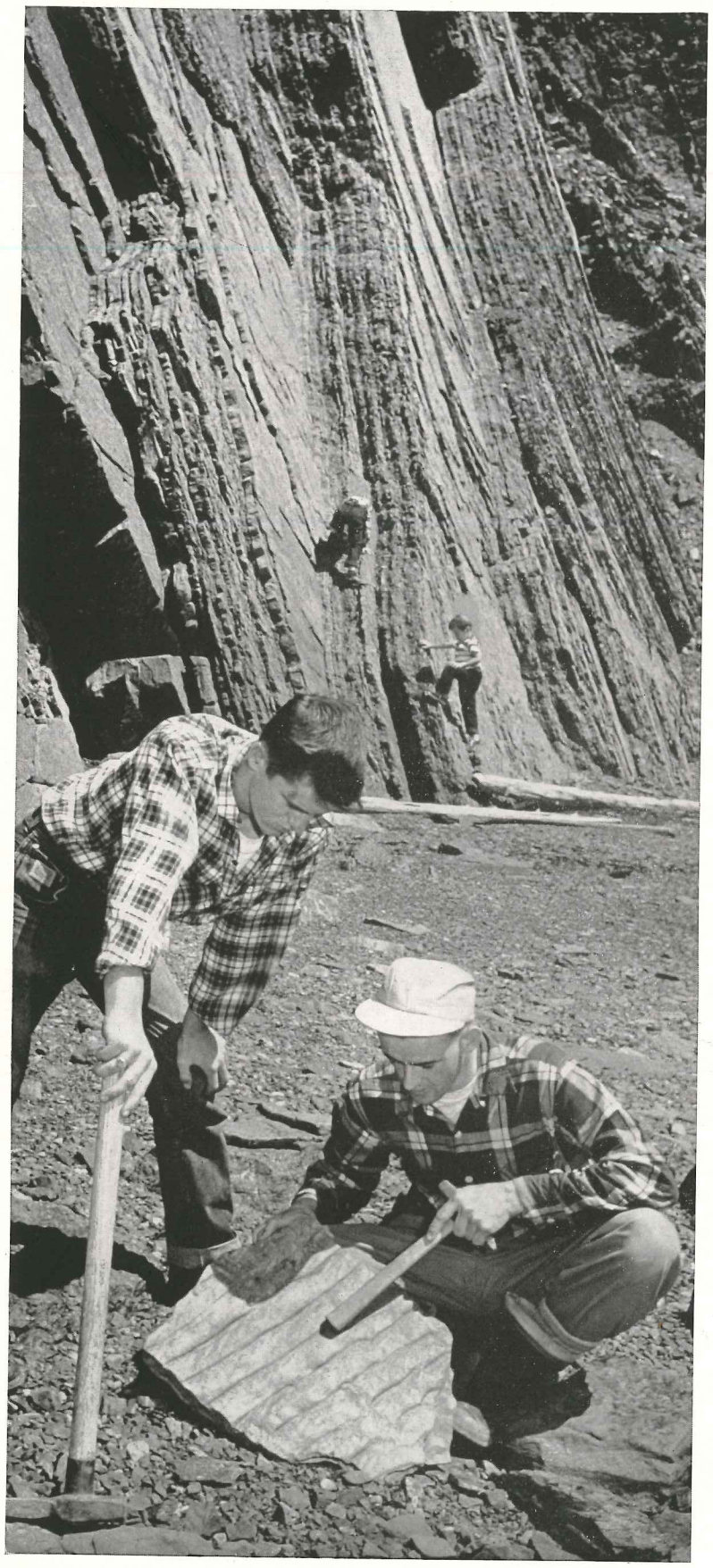

faster than the changing current?

A cheer went up. A few moments before the reversing tide would have dragged him upon the jagged rocks, Frank Martin reached the other shore. A man's endurance and careful planning had defeated Fundy's mighty tides.

Our family had a feeling of satisfaction as we prepared to leave this extraordinary part of the world. Our specimen tubes were carefully packed. So were the rubber boots that had measured off so many miles of mud flats. One painful task remained: to winnow the children's rock collection to a wieldy weight.

"We can do without this," I said, discarding a fist-sized fragment.

"But that's my prettiest one!" Paul howled in anguish.

"And these aren't necessary," I continued.

"Oh, no!" wailed my daughter. "*Any* rock but that one!"

So instead of bidding goodbye to the rocky shores of Fundy, we took 10 pounds of them home with us.

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Experts Read a Rocky Autobiography Written by the Sea

Ancient seas built the shores that Fundy's tides now erode. Layers of sediment on the shallow bottom became stone under the water's weight; geological upheavals turned them on end to form cliffs like these near Parrsboro.

Two mineral collectors study ripple marks made by long-forgotten waters.

Keeping House for Tropical Butterflies

Scientists Learn New Secrets of Insect Evolution and Courtship by Building Butterfly "Hotels" in the Trinidad Jungle

By Jocelyn Crane

Department of Tropical Research, New York Zoological Society

With Photographs by M. Woodbridge Williams

A FLOCK of tame butterflies can be as troublesome as a cageful of monkeys—but butterflies are a lot more fun.

For instance, I don't know a better way to start a tropical day than to step out of our laboratory here in the Northern Range of Trinidad, pick a big bunch of yellow lantana blossoms, take them inside our butterfly "hotel," and watch the brilliant-hued guests come rollicking up to feed.

Quickly I'm surrounded by a rainbow swirl of wings—scarlet and black, orange, crimson, iridescent blue and gold. Soon the butterflies smother my lantana, dipping their long tongues into the nectar-laden flowers.

Sentiment ends right there, however, because our studies of butterfly behavior, coloring, and heredity keep us too busy to have much time for simple enjoyment of our fluttering pets.

Jungle Station Probes Insect Behavior

Our laboratory at Simla, in Trinidad's Arima Valley, is a jungle field station of the New York Zoological Society; its director is Dr. William Beebe. Here we are learning things about the private lives of butterflies that have never been known before.*

Perhaps our most fascinating study concerns their complicated courtships. We have found, for example, that in two species the scarlet color of a wing patch is an important recognition sign. A male is most attracted by a female bearing his own colors. We now have proof that orange and blue are vital hues for other species.

We know, too, that hindwing quivers, forewing flutters, and aerial acrobatics are other ways in which butterflies signal one another during courtship. And we have even learned to distinguish four different scents that a single butterfly species can produce to attract the male or female or to repel an enemy.

Our concern with butterfly zoology, however, does not let us live a life of peaceful contemplation. Instead, we often feel as harassed as the manager of a resort hotel. We have to furnish not only the comforts of home and excellent food for our insects, but suitable companionship and nursery space as well. And we go further by supplying a maternity ward and a baby-sitting service. Finally, few hotel men have to worry, as we do, about wild beasts gobbling up the guests.

Lizard "Humbugs" Butterfly

One day in January, shortly after our arrival in Trinidad for the research season, I saw a rare yellow butterfly high in the cage among the jasmine vines, flapping its wings helplessly. A second look showed that the insect was held fast by a large green tree lizard which absolutely had not been in the cage when we went away six months before.

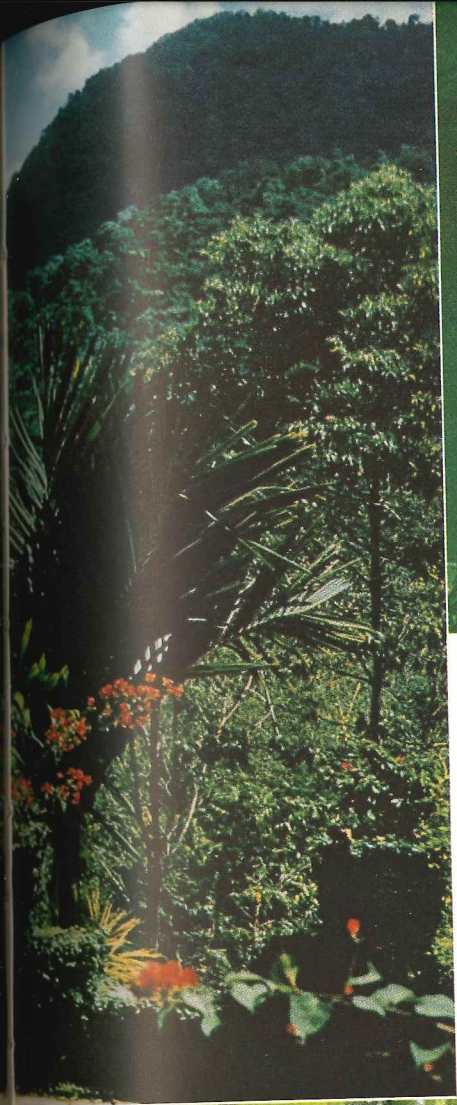
At my indignant yell, Dr. Beebe, the staff, and Ram Dial, our Hindu caretaker, all rushed up to peer through the screening. Meanwhile I climbed on a bench, grabbed the lizard, and released the battered butterfly.

Ram gave a delighted chuckle. "That lizard humbug your butterfly? I watch him grow all the time you been gone!" The reptile must have sneaked in when he was little and found a good living in our lush green insectary.

This year most of our butterflies are living in a big new cage of aluminum frame and netting, provided by the Aluminum Company of America and the Alcoa Steamship Company. Designed by staff entomologist Henry Fleming, it has all the latest improvements (page 198). The cage lets in the sun and air, but keeps the glare out, and stays cooler than our older bronze-wire enclosures.

Best of all, the new insectary cannot rot or be eaten by termites. Its predecessor

* See, in the National Geographic Magazine: "Who's Who Among the Butterflies," by Austin H. Clark, May, 1936; and "Strange Habits of Familiar Moths and Butterflies," by William J. Showalter, July, 1927.



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Butterflies Flock to the Author's Wand Like Farmyard Chickens Coming to Be Fed

At Simla, on Trinidad's jungled slopes, New York Zoological Society biologists study tropical wildlife in one of the world's most unusual laboratories. Inside the wire mesh of Simla's big insectaries, butterflies feed, court, and live out their short lives under the probing eyes of scientists.

To discover the habits of her winged charges, author Jocelyn Crane became a combination hotel manager, dietitian, and flight surgeon. She learned to pacify jittery subjects, mend tattered wings with Scotch tape, and coax ailing patients with special dishes.

These photographs show Miss Crane at work with her brilliant specimens. Left: She drops a net over an escapee. Below (both pages): Hungry flyers flock to lantana blooms fixed on a wand. Above: A *Dryas,* its wings like leaping flames, balances for lunch.

Kodachromes by M. Woodbridge Williams, National Geographic Photographer

literally collapsed one rainy morning two years ago when the resident termites stopped holding hands. We cannot, unfortunately, use preservatives or poisons on wood supports, lest the chemicals also liquidate the butterflies.

The scenery inside the new cage is a cross between a formal garden and a jungle. There are small trees, grass, a flagstone path, a lily pool, blossoming shrubs, wild flowers, vines, wild plantains—even orchids. And the butterflies take to their new hotel with all the nonchalance of seasoned travelers checking in at the Waldorf-Astoria.

Dr. Beebe Starts "Flutter Inn"

Our butterfly housekeeping in Trinidad began in 1950 when William Beebe bought a wonderful old house on a jungled mountainside in the Arima Valley. This, along with 200 acres of surrounding wilderness, he later presented to the New York Zoological Society. In a large flat space originally blasted out of the rock behind the house for tennis courts, Dr. Beebe was able to carry out his long-cherished plans for a butterfly house in the tropics.

My own interest in studying living butterflies—an ambition that has been abundantly fulfilled at Simla—began about the age of ten, when I leaned over a glass case in the American Museum of Natural History to memorize the name of a dazzling morpho from Brazil.

Aside from the observations of a few early naturalists on flight habits and the distastefulness of some butterflies to their enemies, most tropical forms have been known only from dried museum specimens.

Taxonomists, working in museums often far removed from the living insects, still have trouble in accurately separating tropical species. Some kinds, although distinct, resemble each other so closely that a hand lens is necessary to tell them apart. Others vary so much from one individual to another that, without rearing numerous broods of known parentage, it is impossible to tell how many species actually exist.

In our butterfly hotels at Simla, however, we can study the living insects and sort them out under conditions approximating those of the open jungle.

As satisfying as it is to glimpse the flash of bright-colored wings in the jungle, it is downright frustrating to try to study the insects under these conditions. We see only scraps of behavior patterns, hints of the reasons for their colors and of the way their sense organs work. We can learn little of their delicate adaptations to living.

Neither can we learn much by keeping butterflies in small laboratory cages. Geneticists and commercial breeders, it is true, can raise many species that way. But although healthy caterpillars may result, scarcely anything can be learned of the normal habits of the caterpillars' parents. It is like studying the food and table manners of African Pygmies by shutting them up in a New York apartment.

We needed a place where we could keep butterflies under observation day and night, give them plenty of flying space, bring together those whose social activities are of special interest, and perform experiments on them under conditions of ease both to the butterflies and to ourselves. At last, here in Trinidad, we found exactly the right place. In these warm, damp mountains, butterflies are numerous and lively throughout the year.

Trade Wind Demolishes First Guests

At first we had almost as much trouble with our tropical insectary as an Eskimo trying to build an igloo at the Equator.

We started off with a modest cage of bronze netting tacked to wooden posts, measuring 12 by 18 feet and 9 feet high at the ridgepole. After congratulating Henry Fleming on planning the roof with a specially steep slope, to cope with tropical downpours, we dubbed the structure "Flutter Inn," stamped the earth down neatly inside, placed a bunch of fresh scarlet blossoms on a stand in the middle, and hopefully introduced our first tenants—two black-and-red erato butterflies (*Heliconius erato hydara*) and a lone great

Scarlet-splashed Swallowtail Coils → Its Tongue Like a French Horn

Tiny shinglelike plates that make up their wing surfaces earn butterflies and moths the name Lepidoptera, or scale wings. Sizes vary from the 11-inch wingspan of a giant Atlas moth to the 1/8-inch spread of the tiny *Nepticula*.

This *Papilio anchises,* magnified 9 times, has recently emerged from the chrysalis. Beginning life as an egg, it passed through the stages of larva, or caterpillar, and pupa, or chrysalis, to become a fully developed butterfly (pages 212-215).

The insect's proboscis uncurls for feeding.

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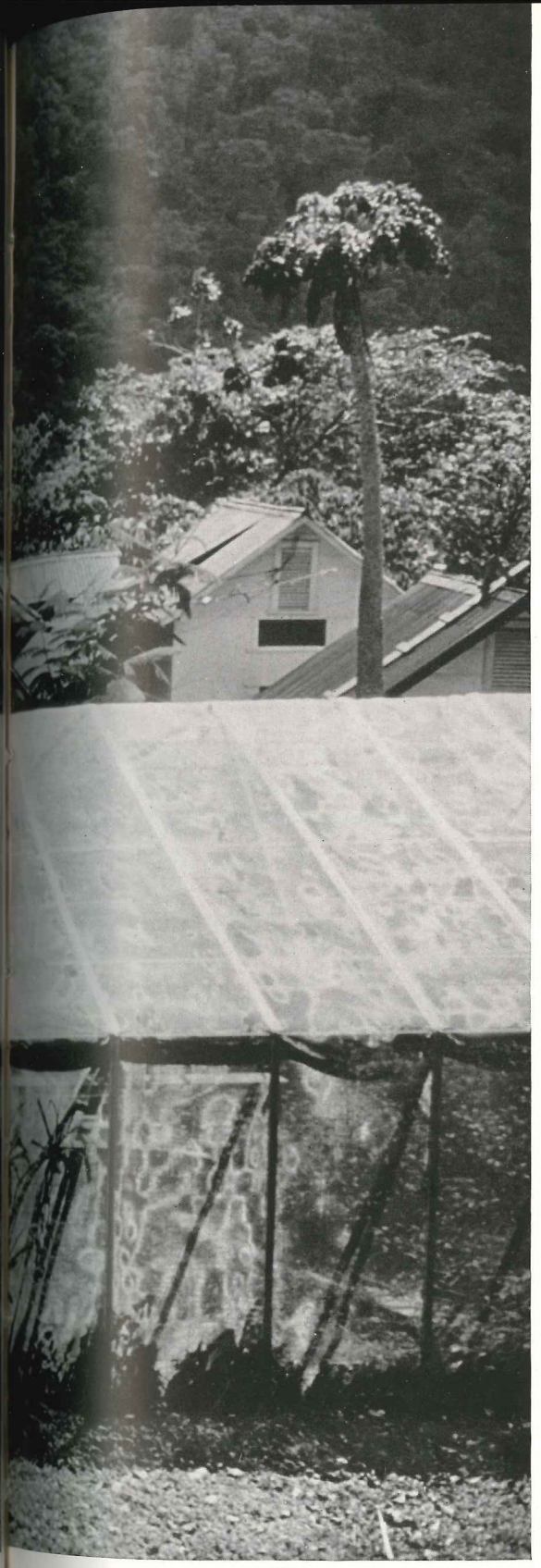
Butterflies in Their Aluminum Bungalow Live Side by Side with Scientists . . .

This view shows Simla's largest and newest butterfly cage beside the living quarters and laboratory. Dr. William Beebe, Director of the New York Zoological Society's Trinidad Field Station, accepts a gift of insects.



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. . . at Sun-drenched Simla

A papaya tree lifts bunched foliage above the compound. Trees cover the slope of Arima Valley in background.

blue morpho (*Morpho peleides insularis*).

Ignoring the flowers, all three flapped wildly against the roof and later were blown flat against the west end by the afternoon trade wind. Next morning there was no sign of them except for a few scattered scraps of blue and scarlet wings.

It took nearly three months to learn how to keep several species of tropical butterflies happily together in the same cage. We found our Trinidad butterflies need lots of deep shade, bright sun, and high humidity—simultaneously. Also, they are as particular about their food as a spoiled child getting over the measles. The morphos, for instance, would much rather eat rotten bananas than sip the sweetest nectar. The heliconiids prefer a diet of nectar from lantana plants.

Enemies Prey on Winged Guests

Most of our guests thrive on sociability, but can't stand overcrowding. And above all, if they don't have a minor jungleful of green growing things around them, neither ample space, nor sun, nor shade, nor the right food or companionship, nor any amount of tender loving care will keep them flying. After we had learned all these things, more and more species settled in successfully.

Meanwhile, our problems with enemies multiplied, and even now they are still with us. Lizards are the least among them, although occasionally a ground-living ameiva will sneak in through a door left carelessly ajar. Inside, he lurks around the edges, biding his time to catch an inmate as it sunbathes carelessly near the ground.

Large praying mantids find their way in now and then and grow fat before they are caught in the net.

Ants are a particular nuisance. Some eat butterfly eggs before I can gather them for hatching in the laboratory. And there is one fierce, solitary kind that will seize a weakened insect and literally devour it alive. Others are scavengers, promptly carrying off dead insects before we can salvage the casualties for our collections.

Worst of all are the spiders. They stretch webs in strategic places and make a good living in spite of our precautions. Every morning the cages are cleared with a broom poked into all the corners, high and low. Good housekeeping is vital.

Just the other day we caught a new enemy at work, one even more difficult to destroy because it spins no web. When I first came upon the tragedy, all I could see was a big

←Roundup Time at Flutter Inn Enthralls Young Visitors

Many tropical butterflies like to wander freely from bright sunlight to dense shade; they thrive on high humidity. To make temperamental charges feel at home, Simla's lepidopterists fill their cages with tropical plants. Wire screening keeps butterflies inside and excludes lizards and birds.

Miss Crane here tempts an insect onto her flower-decked herding wand.

Bystanders from a near-by Hindu settlement watch outside the cage.

↓Golden Pasture Lures Diners

Butterflies, often finicky eaters, recognize favorite foods by color as well as by scent. Faced with paper flowers, new adults instinctively choose colors preferred by their species.

A quartet of *Heliconius erato* flocks to the bright-yellow blossoms of a lantana bush. They ignored the same plant when its gaudy blooms were hidden. Three of these eratos wear paint over their natural red wing spots (opposite).

Wing-cuffed Butterflies Get New Colors

To see if color has an effect on courtship, Miss Crane paints wing surfaces of *Heliconius erato,* a common tropical variety. Gently capturing a subject, she anesthetizes it with a carbon-dioxide fire extinguisher and fastens it to a board with wax-paper strips. Patients show no ill effects from the operation. ↓The butterflies responded to artificial colors most like their own natural orange-red. Saffron wing patches, for example, attracted countless males. A covering of black reduced the female to a wallflower. This subject gets a coat of yellow. The author uses quick-drying model-airplane lacquer.

orange dryas hanging in mid-air, wings folded, swaying gently back and forth. When I looked closer, I found a jumping spider, only a third of an inch long, gripping the butterfly's thorax with fangs sunk in deep and legs clinging. Its hind legs paid out a fine silk lifeline, which led up to the leaf half a foot overhead and from which the spider and butterfly dangled.

I let out a shout, and Woody Williams, making pictures for this article, had time to set up his camera and make a flash shot before the spider moved (page 216).

As we watched, the tiny spider pulled itself and its enormous prey back up the dragline to the leaf. Here it began to suck juices from the butterfly, now quite inactive from poison injected by the spider's minute fangs.

Banquets Planted for Finicky Eaters

Butterfly enemies continue to be our major problem; in comparison, feeding has become a simple matter, after our first mistakes. At the very beginning we planted plenty of flowers liked by butterflies—Spanish needles, lantana, and the local milkweed. Now, in addition, we hang up orchids and other delicacies in season, and every day we bring in fresh-cut flowers.

Little by little we discovered the preferred foods of our more finicky guests. They don't like much variety; each kind goes to its own few favorites, day after day, like a small girl who always orders chocolate sodas while her best friend sticks to vanilla malts.

Different species have definite color preferences. To some, color is even more important than scent; careful experiments with paper flowers have proved it. Newly emerged butterflies that have had no chance to see real flowers will come first to yellow paper blossoms or to blue ones, depending on the family to which the insects belong.

Our eratos, melpomenes, and ricinis—all species of the genus *Heliconius*—will not visit their favorite lantana if the bright yellow-and-orange blossoms are hidden, even though the odor is there. However, if one small petal—fragrant but nectarless—lies by itself on the ground, some hungry individual is sure to swoop down, uncoiling its proboscis as it goes.

The fruit eaters, on the other hand—morphos, caligos, preponas, and some wood nymphs—depend largely on smell in locating their food. In the butterfly houses they suck greedily on bananas, papaws, mangoes, and cashew fruit, all generally too ripe for our own lunch table. Nevertheless, we once scandalized some mango-loving visitors by presenting the very first mango of the season to the appreciative butterflies.

We didn't think that our caged butterflies could get into trouble with their food, but the accident-prone ones can—and frequently do. One troublemaker is the orange-and-yellow-flowered tropical milkweed, closely related to the more familiar milkweeds farther north.

The pollinating system of milkweed blossoms is a tricky business, in which the monarch butterfly (*Danaus plexippus*) often plays an important part. Here in the tropics, as in the north, these strong flyers use milkweed both for food and for laying eggs. The flowers, however, are not convenient for a big butterfly to stand on, being small, slippery, and set at awkward distances from one another. The monarch, therefore, often slips while dining, his foot catches briefly deep in the blossom, and in the struggle needed to pull it free a pollen sac may stick to his leg and be carried off to another blossom.

Many butterfly species that are fond of milkweed nectar, however, are not so strong as the monarch. So they are often caught, usually by the proboscis. They may flap wildly in the trap for minutes at a time. Usually they free themselves, but occasionally I have to come to their rescue. They never seem to learn from their horrid experiences and at the next chance flutter right back into trouble.

Tame Insects Harass Photographer

In our work with butterflies one of the biggest and best surprises has been the astonishing tameness of some species. It is like the differences among ducks. Some of them, mallards, for instance, are easily tamed and settle into a barnyard as if born there. Others never become domesticated.

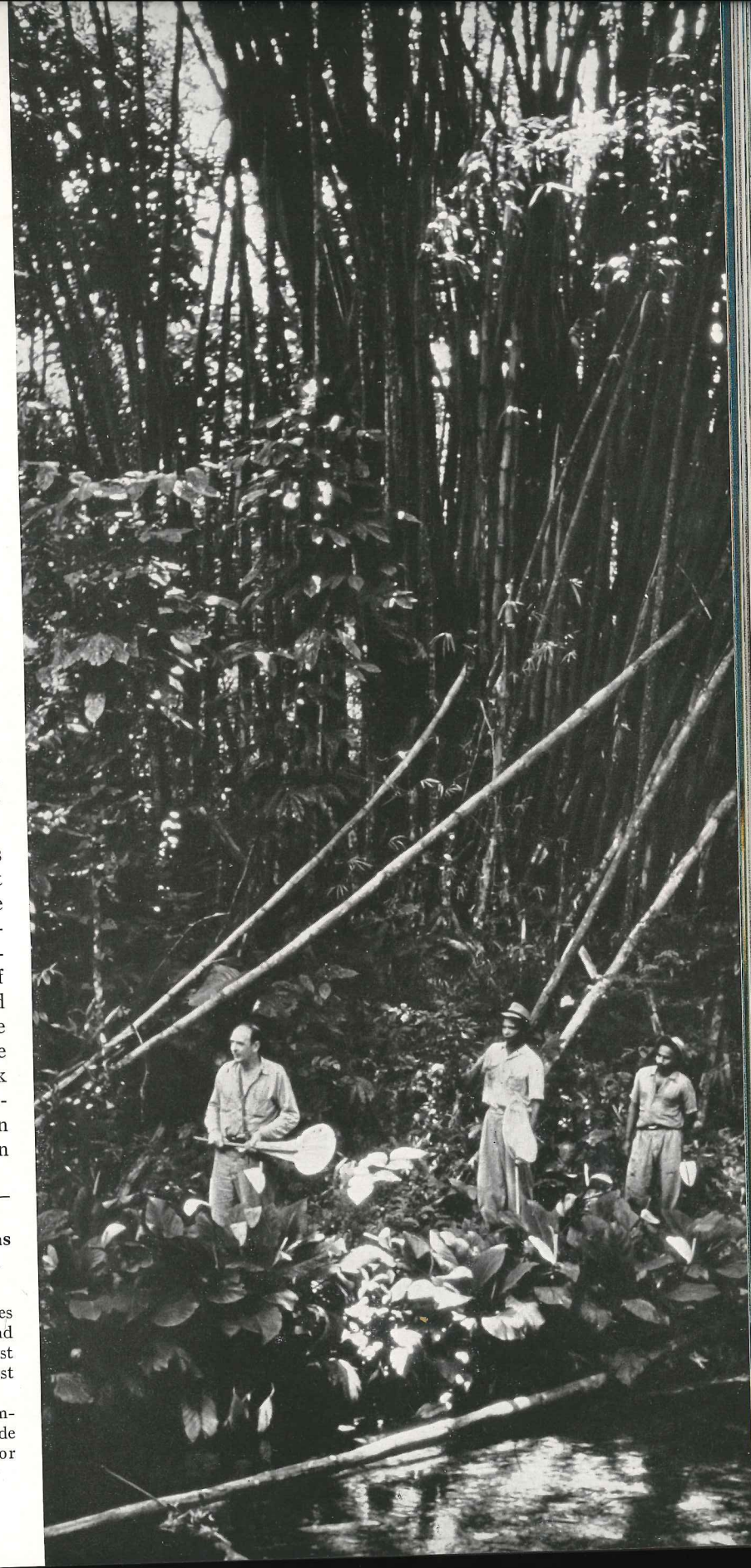
In the same way, butterflies may make themselves at home almost as soon as they are released inside the cage. Others bat constantly against the screen and refuse to eat.

Even the easily tamed ones, however, may take a long time to settle in. It all depends on whether the cage is already "seasoned" with butterflies of their own kind. Butterfly odors, clinging to screens and plants, undoubtedly make the difference. There is nothing like a whiff of its own scent to make a butterfly feel at ease.

Once a butterfly has settled in, his tameness becomes one of our big rewards. It makes any pleasure we ever had before from mounted specimens seem trifling.

If you come in with a bunch of his favorite flowers, he will fly to you as you enter. He starts to feed, and you can lift him, still on his blossom, without disturbing his meal. He will even crawl on your finger and let you lift him to another flower. You can pick him up gently by the wings and put him somewhere else. He probably won't stay put, but as he flutters casually away he shows no panic whatever. To remind yourself of the difference, try taking such liberties with the next able-bodied wild butterfly you meet.

When Woody Williams was photographing at Simla, huddled over the feeding bench for close-ups, the butterflies sometimes made nuisances of themselves. They would light on his hand when he was about to release the shutter or tickle the back of his neck at crucial moments. One dryas even started to lay an egg on



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Netmen Hunt Specimens Along Bamboo-fringed Arima River

Most of Simla's butterflies come not from open fields and clearings but from the moist and shady Arima Valley forest encircling the station.

Entomologist Henry Fleming and assistants wait beside blossoming arum lilies for prospective cage dwellers.

↑ **Whirring Wings Announce a Suitor**

Like any girl at a party, the female butterfly attracts males with a distinctive perfume. This female sprays the scent from bulbous glands on her abdomen.

↓ **Ardent Wooer Courts a Cloth Decoy**

One or two flaps of the crude lure placed on a stick brought *Heliconius ricini* fluttering to the challenge. Color rather than pattern of the model attracted him.

his flash-gun cord, doubtless mistaking it for the stem of her proper vine.

Best of all, I like feeding a winged guest a bit of fruit. If I hold it a foot away from his perch, he walks toward it until his glistening eyes are only an inch from my finger. Then out comes his proboscis, the sensitive tip curling here and there to sample the delectable mushiness (page 207). In a moment he climbs onto the fruit, and I can carry him about without interrupting his meal.

Yet when I free him after a few days, he will zoom out the door, soar up over the towering mahoganies, and be just as wild as he ever was.

Butterflies Mope When Sick

Butterflies are like puppies, canaries, monkeys, and children: you can always tell when they aren't feeling right. A sick beetle or boa constrictor may seem very much as usual to a casual eye, but an ailing butterfly is unmistakable. He hangs motionless against the screen for hours or bats about high up near the ridgepole. He hasn't any appetite, never takes part in the giddy chases of his healthy companions, and may spend the night sleeping alone instead of joining the gang on the twigs or leaves of his particular roost.

If his ailments are due merely to a kind of shock after capture, or after he has had his color changed for experiments, a good night's rest will usually fix him up. Sometimes I sprinkle a bit of honey on a flower and gently slide it under his proboscis. It may have the same swift effect as a piece of chocolate cake offered to a small boy in the dumps.

Incidentally, shooing a butterfly where we want him, whether to breakfast, to bed, or in the direction of another butterfly, just won't work. (*Any* butterfly can be as stubborn as a mule.) We can only stir up a lazy one—lots of species take noontime siestas—and hope that he will flutter in the right direction.

Sometimes a reluctant suitor can be led, by means of a sprig held carrot-in-front-of-nose fashion, clear across the cage to the side of his potential mate. But after that the proceedings are strictly up to the butterflies.

Courtships are usually dizzy affairs, with the male fanning perfume over the female and flying high in whirling-dervish dances. In fact, observing butterfly courtships is as hard on human neck muscles as watching pilots do stunts at a country fair.

As recorded by human eyes and noses, here is what happens during a typical courtship, that of our erato butterflies. The male usually finds the female as she sits on a leaf, gently waving her wings. Sometimes when he starts courting, she takes off, and they do a whirling dance too fast to tell who is chasing whom. And sometimes a female who has been a wallflower for some time will spring into the air and chase a passing male with vigor and enthusiasm.

Whatever the beginnings of the courtship, the female eventually settles, wings closed, and the male zooms up behind. He flutters repeatedly against her, practically touching her hindwings with the tips of his front pair. She then thrusts from the end of her abdomen a pair of bright-yellow scent glands while she flutters her hindwings; doubtless the fanning wafts the perfume, which humans cannot detect, toward the male.

Now the male moves forward and hovers above her and in front, his wings a swift blur of black and scarlet. His fragrant scent scales —these we *can* smell—are uncovered; in this species they are set among a band of silver scales on the front edge of the hindwing. Finally he lands on the leaf beside her, and, if all has gone well, they mate.

Most courtships, however, are casual flirtations only. There is a brief chase, a few flutters of the female's wings, a few swoops by the male, like a pilot buzzing a grounded plane, then each butterfly goes its way.

Females Ignore Wrong Swains

Our most detailed studies are being made of *Heliconius erato hydara* and *Heliconius melpomene,* two slow-fluttering species of the deep jungle. Both are black with scarlet wing patches and extremely difficult to distinguish in the field. However, we found at least one interesting difference in the courtship procedure between the two species.

The melpomene male always starts wafting his scent over the female's odor-receptive antennae while he is hovering in front of her (opposite), while the erato male first fans an unscented breeze from the rear. Neither female is attentive for long to the "wrong" kind of courtship. And, so far, we have no evidence that any of the butterflies we are studying ever hybridize.

When you see two butterflies chasing each other in your own garden, you are not necessarily watching a courtship, even one of these casual affairs. Just as likely it is two males

Magnified 5½ times

Uncoiled Proboscis Serves a Winged Glutton as a Built-in Straw

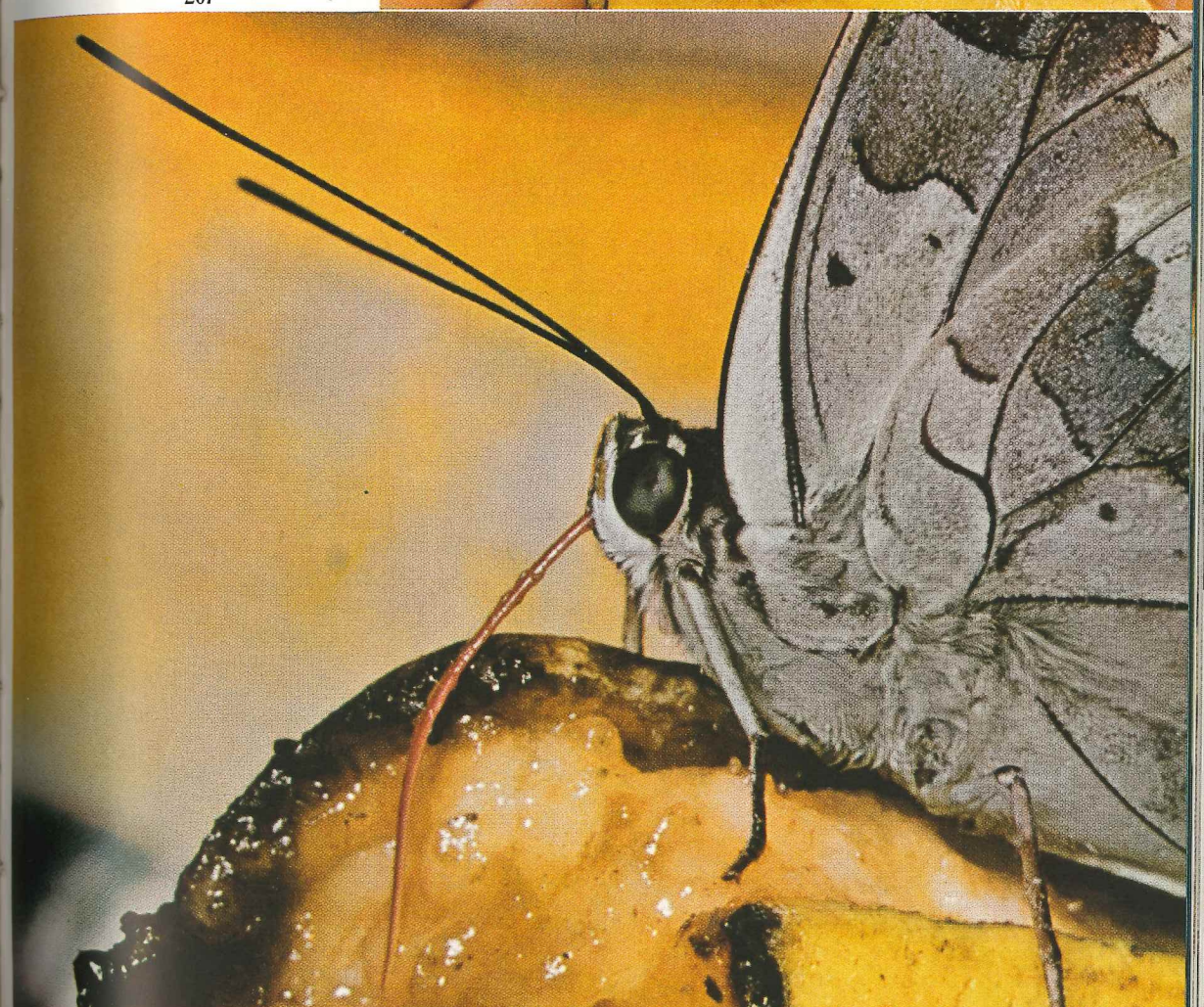
Forced Feeding Revives a Dazed Newcomer →

Butterflies often suffer shock at capture and refuse to eat. When this *Prepona* declined to taste an overripe banana, Miss Crane uncoiled the insect's supple proboscis with forceps and dipped it into the fruit. As the butterfly began to feed, she relaxed her hold, leaving it sucking greedily (below).

↓Prisoner Settles Down to a Pipeline Lunch

Twin tubes on the butterfly's head interlock to form a tongue-like proboscis. Alighting on a flower or piece of fruit, the creature uncurls the apparatus and probes for sugars. On contact, powerful muscles in the insect's head create a vacuum, drawing up the fluid.

Magnified 3 times ↓



engaged in a territorial dispute. Possibly it is only a social whirl, or a male mistaking another male for a female. It may even involve an old busybody female who, after her egg-laying chores are completed, spends a lot of time taking off after old and young of both sexes. Nothing drastic ever happens in these mix-ups; the partners simply separate and head for the nearest flowers.

Scarlet Bands Warn Enemies Away

We are specially interested in the significance of butterfly colors to their owners. For example, I wanted to find out what part, if any, colors play in courtship of these brilliant tropical forms.

The first subject we chose for study was, again, our old friend erato. We wanted particularly to learn if the band of flame scarlet across the black velvet of the butterfly's wing was of any use in its social life.

We already knew one use of that band: it is a classic example of warning coloration. The gaudy erato seems to be distasteful to almost every animal which would normally munch a good-sized insect. If a hungry laboratory frog makes the mistake of snapping up an erato for supper, he gags as it reaches his taste buds, then spits it out with bulging eyes and gaping mouth and shakes his head emphatically back and forth.

Lizards and birds reject the butterflies with equal vigor. And a pet monkey, if he picks one up at all, sniffs it fastidiously, makes a face, lets the horrid object go, and spends minutes scrubbing at his small black hands. Only the insatiable spiders and ants of the butterfly houses will make satisfactory meals from unfortunate eratos.

So it seems clear that this insect offers a good example of warning coloration: a butterfly, protected by an unpleasant smell and taste, tells enemies by its bright colors that it is best left alone.

To find out if economical nature had given the gaudy red patches a use in courtship as well, I worked out a way to change the insect's colors. This was a chore, since no butterfly can stand much handling. Also, chemical bleaches not only faded the colors but were hard on the insect. Unlike peroxide blonds, a bleached butterfly has no energy left at all. However, I finally worked out a method using fast-drying lacquer such as boys employ for model boats and planes (page 201).

In painting a butterfly, I always try to work at night. At that time it scarcely wakes up and is less bothered by the messy business. I put it into a small glassine envelope, and that goes into a little glass-topped box. A stream of carbon dioxide from a small fire extinguisher then anesthetizes the insect.

After that it is placed gently on an insect spreading board, just as if it were going to be pinned and dried for exhibition. Its wings are arranged under strips of paper. If I am clumsy, or in a hurry, or somebody comes to talk, the butterfly wakes up and I am in trouble. The result may be rubbed scales, broken wings, or a battered escapee.

However, if all goes well, any giddy color is possible. Scarlet can be covered with blue or green, yellow or violet. Color can be altogether blotted out with black, or an orange sunburst or magenta band added to the plain hindwings.

In a few moments the paint is dry, the board is carried to the cage, and the fastenings removed. Then the faintly stirring butterfly is hung back among its fellows on the roost. Next morning there he is, flexing his newly tinted wings and feeding as usual, none the worse for his experience (page 200).

Felt "Butterflies" Attract Suitors

We have also experimented with imitation butterflies made of floppy felt on a bamboo wand. The stick has a tiny magnet from a kitchen bulletin board glued to one end. A butterfly model of black or colored felt, held by a pin, is laid against the magnet. Live butterflies sometimes dash at it, or flutter their wings in courtship, when we waggle the model appropriately (page 204). The advantage

(*Continued on page 217*)

Winged Acrobats Hang Upside Down → Beneath Their Shattered Husks

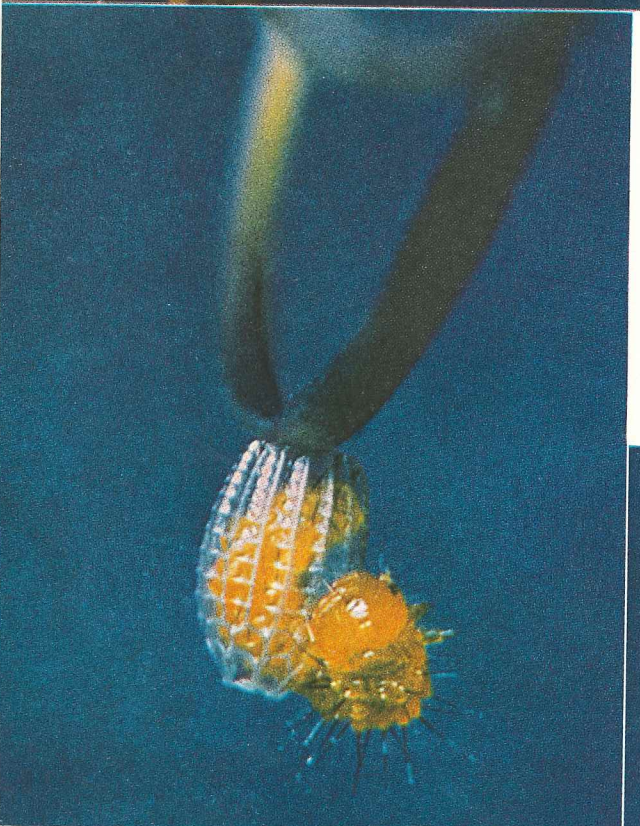
The caterpillar, a sluggish pedestrian, enters the third, or chrysalis, stage of its life to be reborn a creature of the air.

Within the shell-like casing the larva of most species exchanges 16 stubby legs for 6 jointed stilts. A sucking proboscis supplants powerful jaws, compound eyes replace simple ones, and wings and antennae sprout seemingly from nowhere.

Transformation complete, the young butterfly bursts restraining walls and steps forth a gleaming adult.

Heliconius melpomene adults, two hours old, stretch wings for their first flight. (Magnified 3 times.)

Kodachromes by M. Woodbridge Williams, National Geographic Photographer



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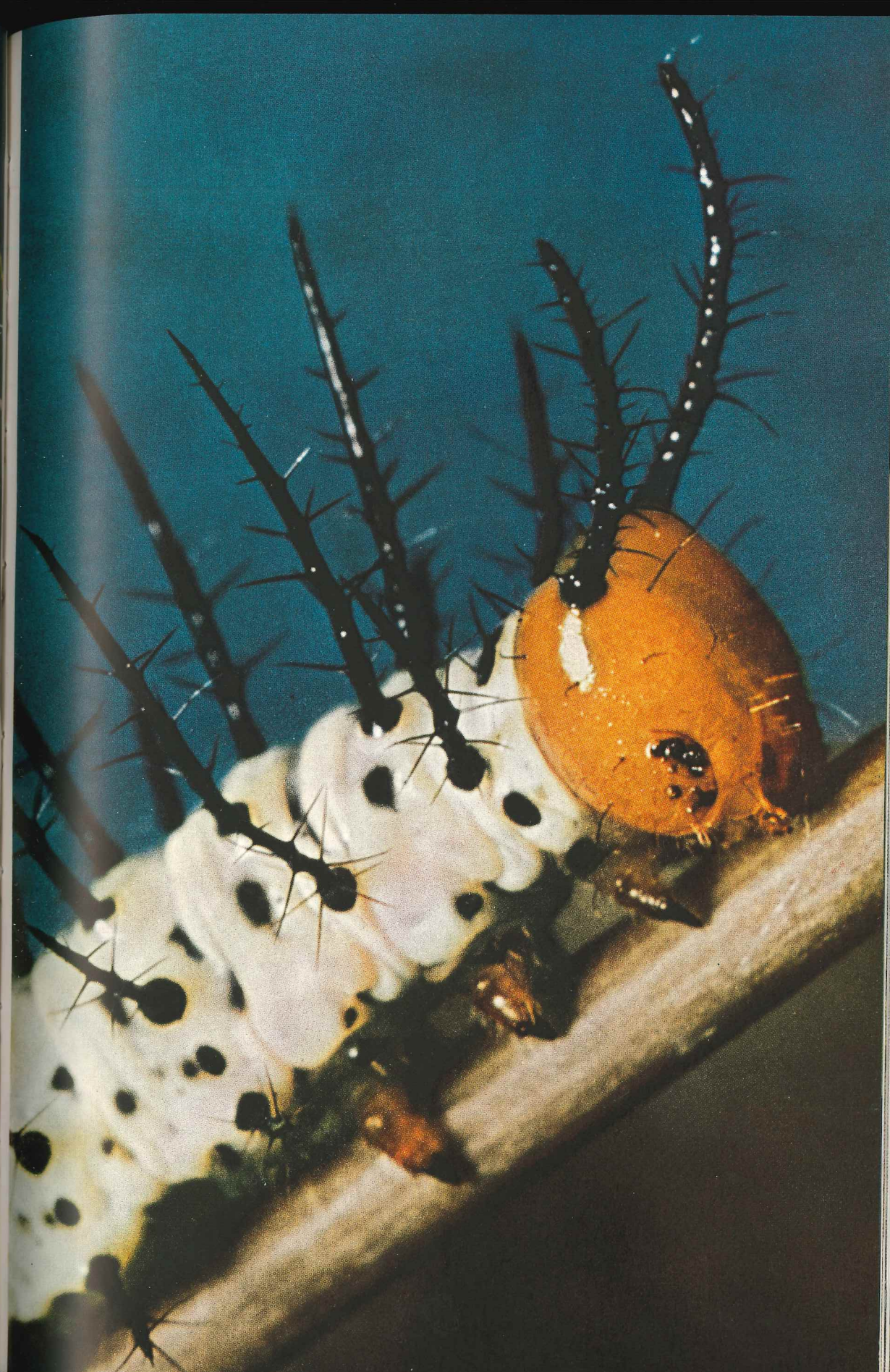
Butterfly Egg on a Slender Vine Suggests a Japanese Lantern

Sequence photographs on these and following pages record the butterfly's entire life cycle, from egg to adult, with *Heliconius melpomene* as chief actor.

Here the female selects a passion vine for her hatchery. Clinging head down from a furled leaf she deposits a single egg. Two previously laid eggs gleam yellow atop the plant.

Insert shows a *Dryas* egg magnified 26 times.
←An *erato* larva breaches its corrugated eggshell.
↓Half emerged, it strains toward the vine.
→Magnified 9½ times, the *Heliconius* caterpillar assumes the aspect of a crawling nightmare, with spines like a burned-over forest.



↑ Dangling Larva Awaits the Close of Its Earthbound Existence

One of nature's most spectacular events, the transformation of lowly caterpillar into fragile butterfly, comes alive in these photographs of *Heliconius melpomene* and those of *Dryas julia* on pages 214-215.

As the time for change approaches, the caterpillar spins a button of silk from which to hang.

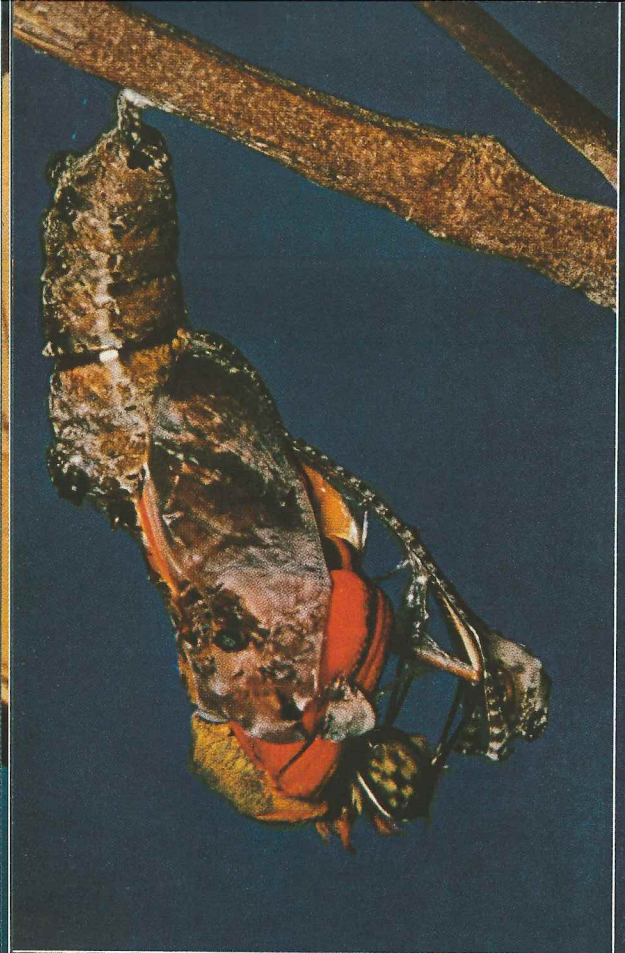
Conversion to the chrysalis begins as the caterpillar sheds its old skin, spines and all (above right). Now the creature is entering the enclosed state from which it will emerge a butterfly. (Magnified 5 times.)

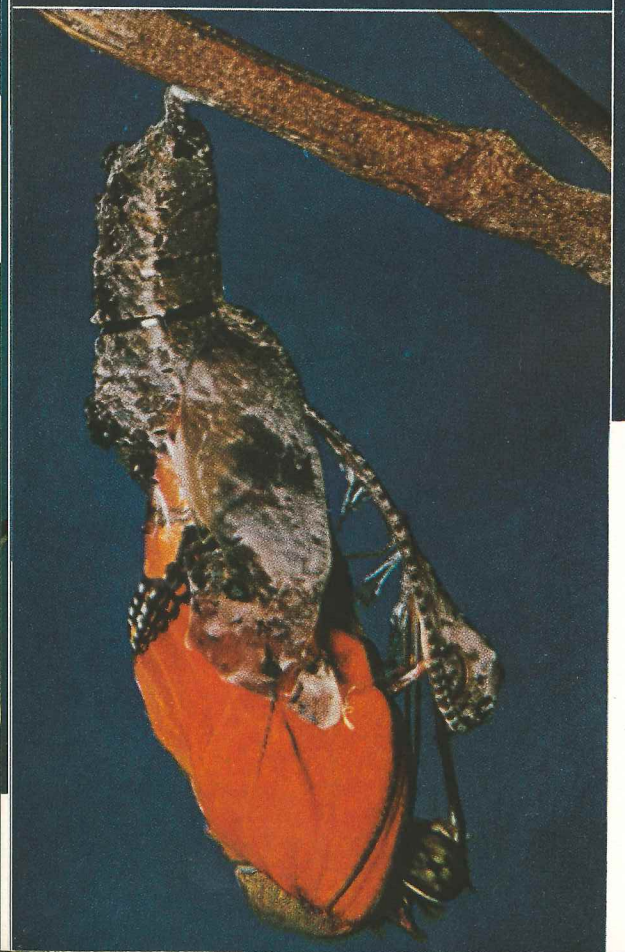
Chrysalis Discards Larval Skin, a Last Link with the Past →

This rare photograph catches the *melpomene* caterpillar in its final stages, just as the old skin flies free in a crumpled ball (left).

Before the old outer layer is shucked off, the insect secretes a new covering of quick-drying material that will serve as shelter during the chrysalis, or pupal, state. Here the new pupal skin covers the developing, upside-down butterfly (magnified 6½ times).

Biologists believe the pupa's leaflike appendages and pointed fringe may be protective camouflage.





Magnified 3 times

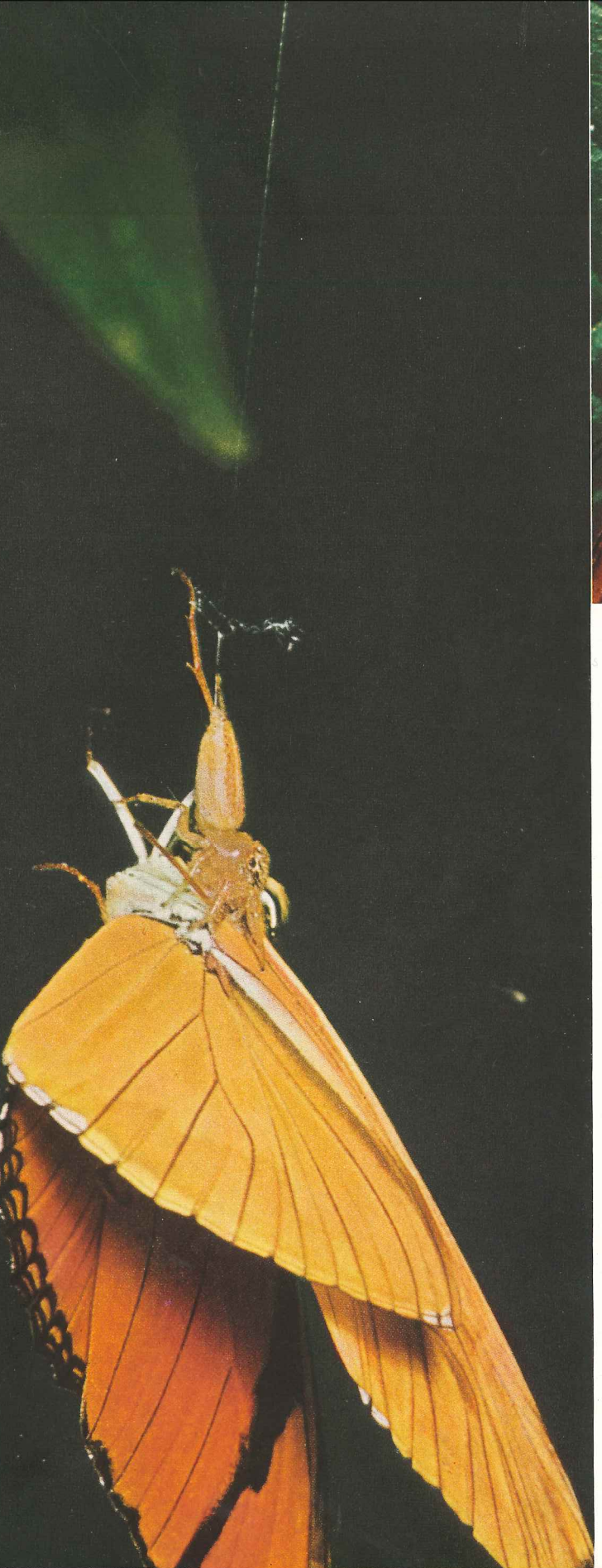
Cinderellalike Beauty Bursts Resplendent from a Drab Abode

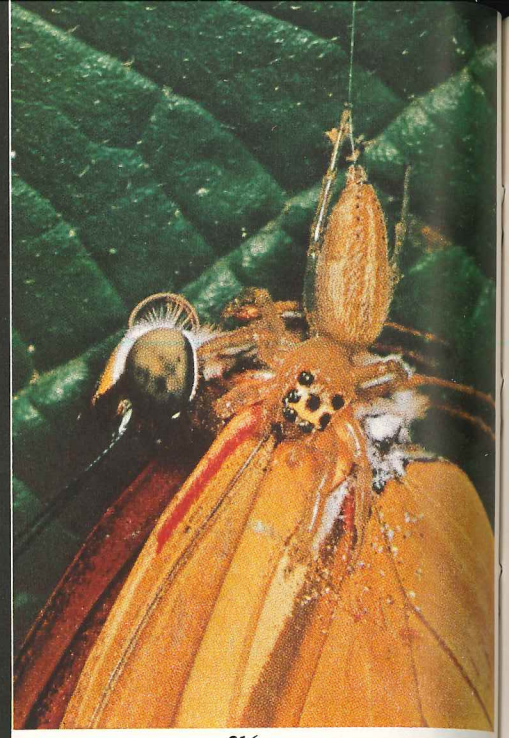
The butterfly's life as a pupa varies with season and temperature. Simla's subjects average between one and three weeks. So swift is the emergence from the chrysalis that few people witness the marvelous event.

These photographs of *Dryas julia,* taken within the space of a minute, reveal the entire escape process from breaching of the dry and withered shell to the insect's first free movements.

As the chrysalis splits (upper left), the butterfly thrusts downward with proboscis stretched back and wings folded capelike (left). Then it crawls free (above), pumps body fluid into spreading wings (right), and, fully expanded, prepares for take-off.

Magnified 5 times →





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↑ Unwary *Dryas* Falls Victim to a Spider's Fangs

Butterflies of tropical Trinidad, unlike those of temperate zones, produce broods throughout the year. These cycles permit unusual studies of behavior and heredity.

Tropical surroundings work against the scientists by producing an abundance of butterfly enemies—the monkeys, birds, lizards, ants, and spiders of the rain forest.

Spiders, deadly and elusive, present the greatest threat. Despite daily cage cleanings, the eight-legged marauders repeatedly build traps for careless butterflies.

This jumping spider, *Thiodina,* hugs its prize close while injecting a paralyzing poison. Not a net spinner, the jumper leaps on its prey while the insect rests on a leaf.

← Silken Strand Supports a Hunter and Outsize Quarry

Some species of butterflies enjoy immunity from larger pests because of a bitter taste. Birds, monkeys, and frogs avoid *Heliconius erato* or spit the insect out after a single bite. Spiders, insatiable killers, prey on all species without discrimination.

Miss Crane first discovered this butterfly's plight when she noticed it swaying upside down near the top of the cage. As she watched, the spider reeled in its line and hoisted the captive, many times its own size. Balancing the victim on a leaf, the spider sucked out the body fluids and left the carcass.

Here, atop the butterfly, the spider swings like a trapeze artist. Silky line rises from its pear-shaped abdomen.

Magnified 3 times

of the models over painted real butterflies is that we can eliminate the effects of odor; results here are due to sight alone.

Our findings from all this painting and waggling have taken several seasons to accumulate, but they are unmistakable. In spite of the importance of motion and scent in courtship, true color also means something.

Generally, the closer the color is to the eratos' own orange-red, the more the females respond with courtship flutters, and the oftener the males give chase. Blues and greens aren't popular, and pure-black females are usually complete wallflowers. Sometimes such a black one will waggle her hindwings as a male passes by, or even spring into the air and chase him clear across the cage, while the male goes unconcernedly on his way.

Egg Laying Confined to Certain Plants

When it comes to the fundamental business of motherhood, however, butterflies pay little heed to the color of plants on which they lay their eggs. On the other hand, the odor of the proper leaves is all-important. Every species, too, has its favorite part of the plant—tiny leaves, tendrils, or arching stems (page 210).

Dr. Beebe started our Trinidad butterfly rearing with one of those profitable accidents that can happen in any laboratory. He wanted, just for fun, to have a jungle vine growing on his desk because he likes to watch its tendrils curl. So one day he went out into the green tangle behind the house, dug up the first attractive little vine he saw, put it in a pot with a stick to cling to, and kept it beside his microscope. A few days later he saw a tiny yellow caterpillar gnawing on the topmost leaf. It had obviously hatched from an unnoticed egg, already laid when the vine was transplanted.

For twelve days he let the caterpillar grow, to the detriment of his tame vine. It ate all the leaves, stem, and tendrils, but economically, from the top down, with a nice instinctive regard for not cutting itself off in mid-air. After shedding its skin four times, it was a handsome caterpillar an inch and a half long, white with black spines and yellow polka dots.

Then it molted into a knobbly brown chrysalis, marked with a double row of shiny gold spots like brass buttons. Nine days later, as we gathered round making bets as to the occupant, out came a black and scarlet erato. It was just the butterfly we were most hoping to rear for work in our first little cage.

That particular butterfly, a female, was mated to a wild-caught male in Flutter Inn and started a long line of flourishing descendants. She herself lived to cavort around the cage with her grandsons, and one sunny morning when I left the door ajar, she simply fluttered out and vanished among the mahoganies. At that point she had reached the age of a butterfly Methuselah; it had been three months and two days since she had come from her chrysalis. Most of our tenants live about eight weeks.

For the past several years we have been able to travel afield to obtain highly variable butterfly species from Surinam, thanks to assistance from the National Geographic Society, the Explorers Club, and other interested contributors.

We brought back to Trinidad, by air and sea, living eggs, larvae, and a few prospective parents. Eventually we reared brothers and sisters with markings that once would have labeled them as distinctly different varieties. Wing patterns ranged through a rampant variety of scarlet and yellow spots and bands and often blazed with sunbursts of radiating lines. By breeding these unpredictable insects, we hope to learn more of how characteristics, both of structure and of behavior, are inherited.

Butterflies Lead Adventurous Lives

This evening I've just come in from a checkup on our current butterfly crop. Many are hanging aloof, each under his own green leaf. But 17 of them are roosting companionably on the same dried vines they have used for weeks.

By the paint spots on their wings I know all their past adventures. Yesterday this erato escaped from a spider web, and I had to mend her torn wing with a bit of Scotch tape. The ricini with the single yellow dot on his hindwing got mixed up last month in a swallowtail courtship and was chased away by both the other butterflies. And just this morning the biggest melpomene of all became a grandfather for the third time.

They are a fine lot, and they are teaching us a great deal—about themselves, about insect behavior in general, and even about evolution in the broadest sense. And before we go north for the summer, we shall have the fun of watching them fly out of their cage, sail over the garden wall, and vanish into their ancestral jungle.