Philip Hershkovitz
Research Curator
Division of Mammals

BATS and their Menus

"I could distinguish large bats swooping about as they outmaneuvered the fireflies and picked them off in flight."

BATS are world-wide in distribution, but in the tropics they are most numerous and diversified. The warm nights are filled with the soft beat of their wings, the clicking and rasping sounds of their voices, and the constant patter of falling seeds, fruits, and flowers dropped from their feedings. On bright nights when no other animal may be visible, bats can be seen as flitting shadows climbing, diving, turning, skimming over moonlit waters and careening high above the tree tops.

All bats of temperate latitudes are insect eaters, and during the winter they must migrate or hibernate. Not so in the tropics, where there is an abundance of flowers and fruits the year round. Insect eaters live there, too—many more kinds than in northern latitudes—and there are meat eaters, fish eaters, blood suckers, and others with more general tastes.

Insectivorous bats may see or hear their prey, but their usual manner of hunting and navigating, in general, is by echolocation. Bats send out high pitched signals and determine the direction, distance and perhaps the nature of objects by the echoes received. By this means bats flying at comparatively high speed in pitch darkness can avoid obstacles and capture insects with amazing rapidity, up to one and even two per second. Echolocating sounds emitted by bats, particularly those of the larger insect-or fish-catching species, are often audible to the human ear. The sounds made by smaller bats, however, are usually higher and outside our range of hearing. Bats also have a repertory of quite audible squeaks, chirps, hisses and screams for expressing feelings and communicating with other bats.

Insect-eating bats usually catch prey in mid-air with their wing or tail membrane before seizing it with their mouth. An insect too large to be devoured in flight is carried to a feeding place where the bat hangs head down and eats at leisure. A bat feeding roost can be recognized by the piled-up leftovers of wings, legs and other hard parts of insects. The daytime resting roost, in contrast, is in a dark, well sheltered place marked by the accumulation of guano.

One memorable evening in a tropical forest, just as the calls of the tinamous and wood quails died out, I saw a myriad of fireflies scatter out of the trees like bursts of stars. I watched the light of one of the beetles flying straight toward me, then suddenly swerve into a wild, careening flight and abruptly disappear from sight. Then another and another of the drifting lights broke into a swift, zigzagging flight and vanished in mid-air; meanwhile I could distinguish the silhouettes of large bats swooping about and feel the beat of their wings and hear the crunch of their jaws as they outmaneuvered the fireflies and picked them off in flight. The evasive flight tactics of the fireflies prompts the thought that they, too, and perhaps many other insects, possess a sound wave system for warning them of the approach of predators just as bats use their system for detecting prey.

Fruit eaters can find their stationary food by sight or smell and they use their echolocating system in flight for avoiding obstacles. Only ripe, fragrant fruits

"Most nectar and pollen eaters have long noses and extensible, brush-tipped tongues which can be protruded into the floral envelope."

attract these bats and wild figs are a favorite as well as a common food in the the forest. Ripe bananas in orchards or stores are irresistible.

A large number of bats feed on the nectar, pollen, petals and other parts of night flowers. Most nectar and pollen eaters have long noses and marvelously long, extensible, brush-tipped tongues which can be protruded into the floral envelope. Small bats which cannot reach the pollen or nectar of pitcher-shaped flowers from the outside crawl inside as far as need be to get their food. By their various operations in feeding on flowers, bats become pollinating agents and there are night-blooming flowers specially adapted for attracting and feeding bats to insure pollination.

Of the nearly 2,000 kinds of bats known to science only two are proven fish-catchers. One, the hair-lipped bat, or *Noctilio*, widely distributed over tropical America, is about the size of a robin. The other, with the technical name, *Pizonyx*, is smaller and restricted to the coasts and islands of northwestern Mexico. *Pizonyx* is rarely observed and has never been identified in the act of fishing, but the stomachs of captured individuals always contain fish. On the other hand, *Noctilio* is common and easily recognized by its comparatively large size, bright reddish-orange color and a pervading scent not unlike some popular perfumes. The bat is often seen before nightfall skimming over water.

The dim, fading light and the swift, unpredictable movements of the bat make it impossible to see how *Noctilio* catches fish. In an experiment recently conducted with special cameras on captive *Noctilio*, it was ascertained that the bat drags its large feet through the water and hooks whatever small fish may be near the surface with its long, sharp, recurved claws. *Noctilio* may actually see the particular fish it tries to gaff or it may hook it by chance. *Noctilio* also catches and eats insects over water and far from water and it may live indefinitely on insects alone.

The omnivorous bats are primarily insectivorous, but also prey on other bats and small, nocturnal vertebrates such as frogs, lizards, mice and whatever roosting birds they can kill. Large insects, including beetles, moths, and larvae, are favorite articles of diet, and fruits, particularly bananas, are eaten along with the insects and small animals feeding on them. The largest New World bat, the so-called false vampire, is an omnivore. Its body is about the size of a large rat and its wingspread exceeds three feet. It hawks in wide, smooth circles with an unhurried stroke of the wings. The clicking or echolocating sound made by this bat is loud and rasping. The prey is trapped with the wings and seized with a crunching bite behind the neck.

True vampire or blood-sucking bats are confined to the New World tropics. There are three kinds, all the size of a mouse. *Desmodus* is the common, widespread species found almost everywhere in forests and cattle country from Mexico to Chile and Argentina. *Diaemus* is like *Desmodus* but prefers the blood of birds to that of mammals. *Diphylla* is very poorly known, but presumably its habits are like those of *Diaemus*.

Vampires subsist on fresh blood alone. All parts of their mouth are designed for bloodletting and drinking and nothing but a trickle of liquid could pass through their thread-slender gullets. They scoop out a small piece of skin with their sharp, scimitar-shaped front teeth, press their tongue against the wound, and by curling the sides of the tongue downward against the cleft lower lip form a tube through which the blood flows into the mouth. To assist the flow the vampire pumps and licks the wound with its tongue and sucks with its mouth. It may also enlarge the incision with its teeth. A vampire can consume about two ounces of blood in one night's feeding. This is more than one or two times the weight of the bat. Vampires are slow flyers but by using their wings as forelegs they scurry nimbly along the ground and over their victims. Their bodies are exceedingly soft and smooth to the touch. If echolocation is used by vampire bats for finding objects they may also resort to other senses for discriminating between obstacles, individuals of their own kind, and their prey, which includes other species of bats.

One of my earliest acquaintances with vampire bats was made many years ago in the boundary area between Ecuador and Peru. I was traveling with a family of Indians in a dugout canoe on a tributary of the Amazon. It was the dry season, the river was low, and we spent the nights on mosquito-free sand bars. Ordinarily such sand bars are free of bats, too, and we slept under the stars to enjoy the rare night breeze. At dawn, after the first night, we saw that the little

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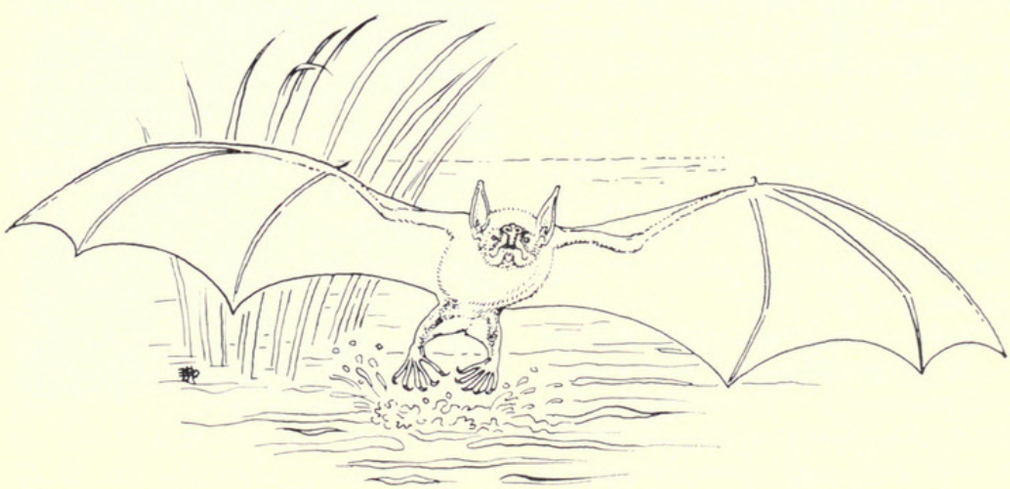

"Noctilio *drags its large feet through the water and hooks whatever small fish may be near the surface with its long, sharp, recurved claws.*"

ROBERT F. INGER
CURATOR, AMPHIBIANS AND REPTILES

DEPARTURE OF *BORNE*
ZOOLOG

Fig. 1: Dr. Robert F. Inger and Mr. F. Wayne King display anti-leech stocking to be worn for protection against land leeches in Borneo.

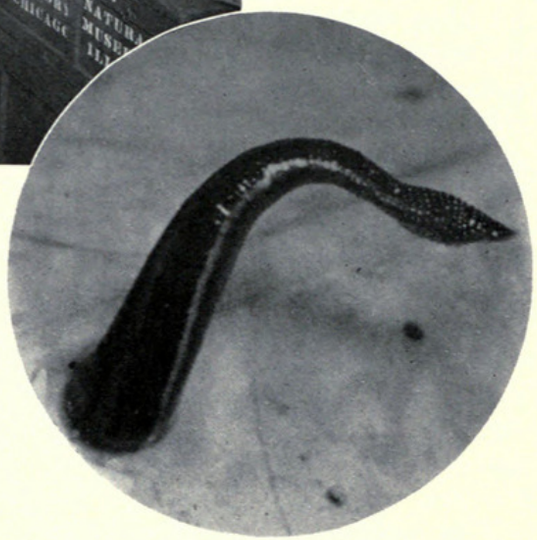

Fig. 2: Land leech posed on a leaf and reaching out for a victim (actual size of leech about one and one-half inches).

THE Borneo Zoological Expedition, 1962, will leave Chicago on August 18. It would be more correct to say that the personnel—Dr. Bernard Greenberg of Roosevelt University, Mr. F. Wayne King of University of Chicago, and myself—will leave then. For the equipment and the supplies left in June.

The main purpose of the expedition is to gather information on the breeding activity of frogs living in the tropical rain forests that cover most of Borneo. Frogs and toads living in the Temperate Zones generally have relatively short breeding periods restricted to a part of spring. We suspect, on the basis of fragmentary information, that in tropical rain forests, which are warm and wet at all times, frogs and toads breed all year round.

Most zoologists now think that the major groups of frogs and toads evolved in the wet tropics. As the breeding patterns are important to the evolutionary success of any kind of animal, we must learn what they are in tropical frogs.

The field work connected with this research program will consist of collecting monthly samples of about six species of frogs, making notes on their behavior, and recording daily rainfall, temperature, and relative humidity.

We also need to know how far an individual frog (of the species we will study) moves and how fast it matures in order to understand the full implications of its breeding habits. To get this information we plan to mark, measure, and release frogs along several forest streams. By recapturing (hopefully!) a number of these marked frogs, we will learn not only their rates of growth and movement but also how large the populations are.

As time permits, we will work on other field studies, all aimed at increasing our knowledge of the distribution and interrelationships of the animals in the rain forest. One of these problems, an investigation of the reptiles and amphibians living in epiphytic plants, will be the special concern of Mr. King. Epiphytes are plants, such as bird's nest ferns, pitcher plants, and orchids, that grow attached to trees and whose roots do not reach the ground. Mr. King will try to discover not only what species of reptiles and amphibians live in such plants but also their abundance, their vertical distribution, and the weather conditions under which they live.

What collecting is done on this expedition will be subordinated to solving the particular biological questions raised by study of material previously collected during the Museum's Borneo Zoological Expeditions of 1950 and 1956.

Though we are concerned primarily with the biological problems, we are naturally forced to consider logistical ones. What supplies and equipment will we need? When and how do we ship them? The second question is easy to answer, merely requiring a telephone call to one of the export agents in Chicago. The answer to the first question depends on our previous experience in Borneo and the specific projects we will tackle in the field.

Out of curiosity, we counted the different kinds of items we are taking into the field. We found we had 173, not including our field clothing. Many of these items are strictly for housekeeping: for example, we have three packets of sewing needles, a folding table, an alarm clock, two can openers, three jungle hammocks, and similar uninspiring but vital equipment. Collecting equipment includes 30 snake bags, two potato rakes (for tearing apart rotting logs), 500 blowgun corks, three headlights, dip nets, etc. For preserving and packing specimens we have—among many other things—5,000 numbered tags, 2,000 plastic bags, 115 pints of formalin, three plastic hydrators, and dissecting instruments.

We also have some delicate instruments such as a hygrometer with a 200-

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CAL EXPEDITION

foot extension cable, which we will use for reading the temperature and relative humidity in the bird's nest ferns, and a recording thermohumidigraph (Fig. 3) for use in more accessible places. In addition to these we have a tape recorder, rain gauge, clinometer (for measuring heights of trees and epiphytes,) compass, surveyor's tape, and assorted photographic equipment.

As the success of any expedition nowadays depends upon the quality and quantity of field notes, we have paper, notebooks, waterproof ink, and pens.

One piece of field clothing requires special mention—anti-leech stockings (Fig. 1). The humid forests of Borneo are rich in land leeches and in some areas and times every leaf of every bush seems to have a hungry leech reaching out for the next passerby (Fig. 2). These animals are interesting, but their fondness for human blood makes protection against them important. We learned on previous trips that an over-stocking made of muslin and tied over one's trousers below the knee cut down the leech bites significantly.

With the exception of one item, we are taking no food from here. All of that will be purchased in Borneo. The exception consists of two cans of high-protein pablum—not for us, but for the tadpoles we hope to raise.

All this material, believe it or not, fit into 15 medium-sized boxes. With such an assortment of things, the contents of each box had to be listed and the boxes numbered. Museum men always have in their minds the horrible example of the large expedition (not from this institution, we hasten to add) that arrived at its base camp with 100 boxes and not a single packing list.

Months ago a tentative field base was selected on the basis of our previous experience in Borneo and study of our collections. The chosen site was in Sarawak and we applied for and received permission to work there from the authorities in Sarawak.

In many ways this expedition reflects the national and international cooperation vital to scientific progress. Mr. Tom Harrisson, Curator of the Sarawak Museum, has graciously offered to continue the cooperation and help he gave previous expeditions of Chicago Natural History Museum. Similarly, other agencies of the Government of Sarawak have been helpful as in the past. Our Museum hopes that previously published results of our work on the Bornean fauna and future publications growing out of this expedition will be of value to the government and people of Sarawak.

At the national level, the expedition is largely financed by the National Science Foundation. Part of the cost, however, will be borne by Chicago Natural History Museum and Roosevelt University. Finally, the field work and subsequent research will be carried out by representatives of three Chicago institutions—our Museum, Roosevelt University, and the University of Chicago.

Fig. 3: Thermohumidigraph for recording temperature and relative humidity is placed in field chest for shipment to Borneo.

BATS—

(*Continued from page 3*)

girl in our company had been bitten by a vampire bat on the very tip of her nose. The child felt nothing and apparently suffered no ill effects. The next three nights of our journey were spent in the same way and each morning we discovered that another bit of the tip of the girl's nose had been sliced away and oozed blood. During these nights all of us were equally exposed to vampires. Yet, a single bat preyed on the same victim night after night. Was it the same bat that attacked the child each night in successively different camps or was it a different bat each night? Did the vampire prefer the girl because of a predilection for her type of blood or because she slept more profoundly than the others?

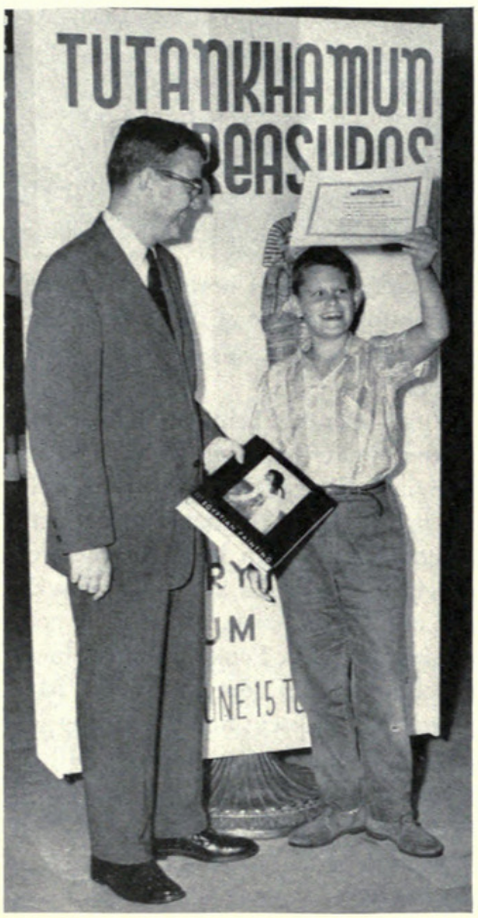
Years later, in Suriname, I achieved a more intimate acquaintance with a vampire bat. Sleeping accommodations for the first night on the banks of my Saramacca River camp in Suriname were provisional. I used a hammock as did also our native assistant, while my companion, Dr. Jack Fooden, rolled himself in a blanket and slept on his cot. Mosquitoes were absent and no netting was used. Minutes after turning off the kerosene lantern and dropping off to sleep I was awakened with a violent start by a sharp pain on the big toe of my left foot. A vampire bat had bitten me. (It is strange that some victims are awakened by the attack of a vampire bat, while others sleep soundly through repeated attacks.) With the aid of a flashlight I saw that a thin sliver of skin about one-half inch long had been sliced out of my toe. A finely honed razor could not have cut more neatly. I bandaged the bleeding toe with a handkerchief, covered my feet with a sheet and wrapped the edges of the hammock around me. All the while the hungry bat remained in attendance, now flying back and forth, now hanging nearby in watchful expectancy. I spent the early part of the night warding off attacks made by the animal each time it thought I had fallen asleep. The vampire finally

(*Continued on page 8*)

CHICAGO NATURAL HISTORY MUSEUM *News*

50 Millionth Visitor

On July 2, Chicago Natural History Museum welcomed its 50 millionth visitor since the present Museum building opened in 1921. The special guest was



"My gosh, this is really something!" was John Witte's reaction when informed by Director E. Leland Webber that he was the Museum's 50 millionth visitor to its present building.

John McFaul Witte, 12 years old, of nearby Westchester, Illinois. He had come to the Museum with his parents, Mr. and Mrs. John S. Witte, and a young friend, Steve Larson, especially to see the *Tutankhamun Treasures.*

The 50th millionth visitor was greeted by Director E. Leland Webber, who presented him with a $500 Life Membership certificate in the Museum and a book on ancient Egyptian art. John and his family then enjoyed a personally conducted tour of the King "Tut" exhibit by Dr. Mohammed H. Abd-Ur-Rahman, First Curator of the Egyptian Museum, who has accompanied the *Tutankhamun Treasures* on their American tour.

The first annual attendance figure of one million visitors to Chicago Natural History Museum's present building was reached in 1927. In 1937, 14-year-old John Ladd, of New York City, had the distinction of being the Museum's 20 millionth visitor. (Mr. Ladd wrote us recently from his home in Belmont, Massachusetts, that he is "finishing up a period of graduate study in anthropology at Harvard University with Panamanian archaeology as my present area of specialization. Although circumstances have kept me away from Chicago and the Museum, I have followed its growth and changing exhibits through the Bulletin, and as an archaeologist have been especially grateful for the Museum publications.") Since the war, Museum attendance has continued to rise, reaching 1,307,567 in 1961, a gain of 63,193 over the preceding year. In the first six months of 1962, there have been 671,866 visitors.

Treasures A Success

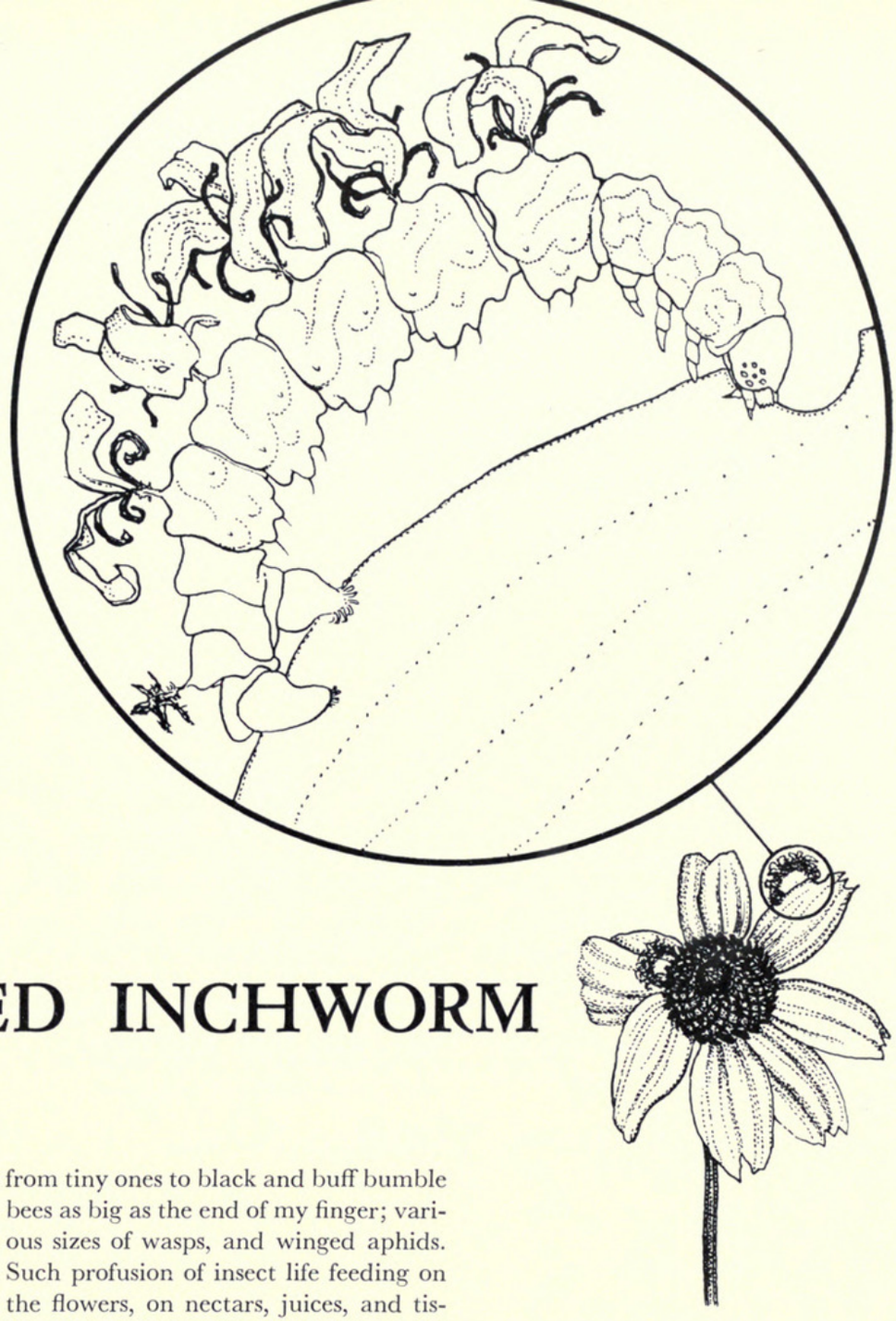
When the last visitor left the *Tutankhamun Treasures* late on July 15, the final day of their exhibition here, attendance figures for their one month's display in Chicago had reached 123,722. Between 9 A.M. and 8 P.M. on that final Sunday, 8,839 persons—a record for the Chicago showing—saw the priceless, 3000-year-old objects from King Tutankhamun's tomb, which had been permitted to leave Egypt for the first time. The exhibit was brought to Chicago under joint sponsorship of the Museum and the Oriental Institute of the University of Chicago.

Next stop for the *Tutankhamun Treasures* will be Seattle, followed by San Francisco and Los Angeles. Before returning to their permanent home in the Egyptian museum in Cairo, the treasures will tour American cities for another year.

His Excellency Mahmoud Riad, Ambassador of the United Arab Republic to the United Nations, and Dr. Ahmed Fakhry, Professor of History of Ancient Egypt and the East at the University of Cairo, discuss the King Tutankhamun Treasures with guests at the preview of the exhibit held June 14. The Ambassador made a special trip from New York to Chicago to be present at the preview.

(Continued on page 8)

Austin L. Rand
Chief Curator
Zoology



The camouflaged inchworm in the black-eyed susan is natural size; the enlargement shows how the camouflage is achieved. The flower parts—pieces of yellow petal and black parts of the florets—are bitten off and attached to the pair of spines on each segment. Silk spun by the caterpillar (and perhaps exuded by the spines) holds the camouflage in place. When the inchworm is on the "eye" of the black-eyed susan, it is very inconspicuous. Note the second caterpillar on the flower.

A DECORATED INCHWORM

WE FOUND one of the most intriguing examples of camouflage in nature in an ornamented or decorated inchworm on the black-eyed susans in our garden on the last weekend in August. The weather was hot, 95° F., and humid, and the black-eyed susans were thriving, drinking in the sunshine and radiating vitality, like zinnias.

This heat seems to suit insects, too, which never have been more plentiful than in these mid-day hours, and the black-eyed susans were favorite places for a host of them:—flies, some small and metallic green, some big, dull and brown, and many intermediate ones; gnats of various sizes; black-spotted, red ladybird beetles, little round, green beetles with long antennae, and slender orange and black beetles; leaf hoppers of several shapes and colors; little grey moths folding their wings along the stems; a red-bodied dragonfly; grasshoppers, some green, some brown; bees, from tiny ones to black and buff bumble bees as big as the end of my finger; various sizes of wasps, and winged aphids. Such profusion of insect life feeding on the flowers, on nectars, juices, and tissues, or on each other, brought special predators, too, such as ambush bugs with their distinctive black markings, which lay in wait, as did the pale, yellowish white crab spiders.

Indicative of the minute animals hidden within the microcosm of a single flower head, we saw tiny, insect-caused galls on the florets, and a diminutive red mite which came out onto a petal and, as we saw through a lens, seemed to scratch its venter with four of its eight legs in quick succession before it ran back among the florets and disappeared.

Then Mrs. Rand picked from a flower what seemed to be a tiny mass of debris of flower parts caught in a bit of spider web. It proved to be an inchworm, a half-inch long, with bits of yellow petals and black floret parts stuck all over its back. Imagine our delight at finding one of these decorated insects—the caterpillars of a greenish, geometrical moth—about which we had read and wondered.

Last year, after having run across a photograph of one posed on a goldenrod, we spent several days in vain search through a nearby goldenrod field. From the photograph, which showed a caterpillar as big as a cigarette, we had not been prepared for anything this small. Now that we knew what to look for—such tiny things—we soon found two more, and installed them on flowers in a dish where we could watch them

(*Continued on next page*)

through a reading glass.

Without their decorations these inchworms, despite their small size, would still have been unusual. They were dark brownish grey with pale grey longitudinal stripes, and each of the central segments had a pair of projections. It was to these that the yellow pieces cut from the petals and the black pieces from the florets of the black-eyed susans had been stuck, presumably with silk spun by the inchworm. The result camouflaged the caterpillar wonderfully against the brown-black, yellow pollen-dotted "eye" of the flower.

Much of the time the inchworm looped along, in its half circle pose, and browsed on the florets as placidly as a cow in a meadow. Once, while we watched it, it actually broke off part of a floret and, bending back, stuck it onto its back. Sometimes the inch-worm's head was liberally covered with yellow pollen grains. The forelegs seem to come into play here, but whether they were wiping the pollen away or pushing it into the caterpillar's mouth we could not tell. Occasionally the inchworm made a short journey out onto a petal, where it was conspicuous against the yellow and where it ate scallops into the edge of the petal. But soon it would return to the dark "eye" with which it harmonized so well.

This type of camouflage seems as wonderful as that of the ocean crabs which put sponges and algae on their backs for concealment or protection. It is quite well known to the entomologists, but seemed dismissed in a very perfunctory way in some of our textbooks by ". . . the larvae of these geometrid moths conceal themselves by attaching bits of plants to their backs . . .," or some such phrase. In a more popular book with the photograph I mentioned above the phenomenon was dramatized on a scale that led me to look for a much larger caterpillar, one that could be watched without difficulty. When we did find it, our first response was one of chagrin,—"is it as tiny as this!" This well illustrates the razor edge we try to travel when we write of the wonderful happenings in nature.

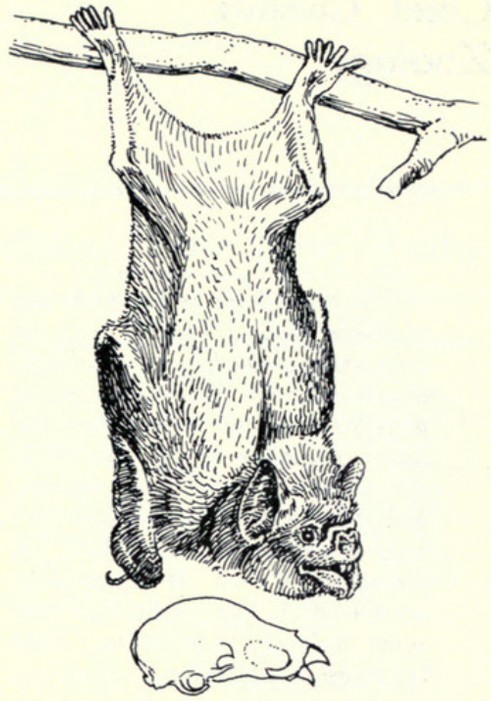
***Bulletin* drawings by E. John Pfiffner. Cover photograph by Joanne Evenson.**

BATS—

(*Continued from page 5*)

gave up and I slept undisturbed for the remainder of the night.

The following night, Fooden and I slept under mosquito net shelters. Just as the light of the lantern faded out, I felt the bat strike my net with its wings. Not finding an opening, it tried Fooden's net with no more success and then flew off to find a meal elsewhere. This bat's quiet but efficient inspection tours became routine, and one night its persistence was rewarded. It found the wall side of Jack Fooden's netting snagged and raised just a crack above the bedding of the cot. The vampire snuggled inside and scurried on its four limbs to the sleeper's face. Sensing the intruder, Jack awoke with a cry, jumped out of bed, seized a flashlight and searched for the bat. I aided, but the alarmed animal escaped through the same opening it had used for entering. Undismayed, the bat hopefully continued its regular nocturnal visits during the rest of our six-weeks' stay on the shores of the Saramacca.



"*The hungry [vampire] bat hanging nearby in watchful expectancy.*" *Lower drawing shows skull with "scimitar-shaped front teeth."*

Vampire bats, insect eaters, fruit eaters, nectar eaters, and the means they use for getting their food are shown in the Museum's Exhibit-of-the-Month—"Bats, The Only Mammals That Fly"—in Hall 15.

MUSEUM NEWS—

(*Continued from page 6*)

Children's Program

"Universe," a color motion picture about a journey through space, will be presented Thursday, August 9, at 10 A.M. and 11 A.M. in the James Simpson Theatre. It is the last in the Museum's summer series of free films for children. The program will also include a cartoon, "Romance of Transportation."

Evening Hours Continue

Summer evening hours of 9 A.M. to 8 P.M. on Wednesday, Friday, Saturday, and Sunday will continue at the Museum through Sunday, September 2. On Monday, Tuesday, and Thursday the Museum doors are open from 9 A.M. to 6 P.M.

The Museum's late evenings coincide with the nights of the free Grant Park concerts which begin at 8 P.M. Dinner is available in the Museum's cafeteria until 7 P.M. on these four evenings each week. Free parking is available in the north parking lot.

After September 3 the Museum will resume its fall schedule of hours—9 A.M. to 5 P.M. seven days a week.

In Memoriam

The Museum reports with regret the death of Cornelius Crane, Museum Benefactor, who died on July 9 at the age of 57 in his summer home in Belfast, Maine. Mr. Crane was the son of Richard T. Crane, Jr., former Museum Trustee, and a grandson of Harlow N. Higginbotham, Museum President from 1898 to 1908.

In 1928 and 1929, Mr. Crane led an eleven months' expedition to the south seas for the Museum, for which his brigantine yacht, *Illyria*, was fitted out with a scientific laboratory. The late Karl P. Schmidt, former Chief Curator of the Department of Zoology, accompanied the expedition as scientific leader. More than 6,000 zoological specimens were collected by Mr. Crane and his party in the Caribbean and in the Pacific. Upon his return, Mr. Crane was named a Museum Benefactor by vote of the Board of Trustees.

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