

THE TRAP-LANTERN AS AN INSECT EXTERMINATOR.

BY HAROLD BOLCE.

To determine whether the beneficial insects captured in trap-lanterns outnumber the noxious species destroyed by these lures, entomologists throughout the United States are conducting interesting experiments.

At one station classification of the insects caught in a lantern, run every night for five months, disclosed that to a great extent it was the beneficial insects that had been captured. Species like lace-wings (*Chrysopa*), ground beetles, lady-bug beetles, fireflies, and ichneumon flies were decoyed in vast numbers, while many pests rampant in the orchard where the tests were made avoided the flame.

One orchard in eastern New York in which scientists conducted trap-lantern work was overrun with the plum curculio, yet during five months only three specimens of this pest were trapped, and that capture broke the curculio record among scientific experimenters with trap-lanterns.

The bee moth was a pest in the neighborhood, but only two were lured to destruction. A single chinch bug was caught and only twenty-three buffalo tree-hoppers (*Ceresa bubalus*, Fab.), an insect famed because of its resemblance in shape to the American bison. The buffalo tree-hopper is frequently no less destructive both to fruit and shade trees than the periodical cicada, and as it is an exceedingly quick and active flyer, it is a matter of surprise that the lanterns secured so few victims of the species. Even greater wariness was displayed by that persistent enemy of husbandry, the common squash bug (*Anasa tristis*, DeG.), not a single individual having been caught. In contrast to the seeming instinct of cunning which prompted these injurious insects to shun the light, the destruction at this station of ichneumon flies and other hymenopterous species devoted to the interests of the farmer constituted a large per cent of the entire capture. It is a matter of interest, too, that twenty-five per cent of the insects destroyed were the aquatic species known as caddice flies, which are not of economic value to agriculture, being neither beneficial nor injurious.

Another strange fact revealed by the tests was that, of the harmful insects that were destroyed, the great majority were males. In warfare upon adult insects, it is always the hope of entomologists to destroy the egg-layers and thereby secure immunity from multiplying generations to come. But in one of these experiments, 1,101 noctuid moths were captured, 968 of which were males. Of the crambid moths seventy-nine per cent were males, while the males of the May-beetles in the same series of tests constituted ninety-three per cent of the trap-lantern mortality of that species for that season.

Moreover, the entomologists made the discovery that, of the few female insects caught, the majority were individuals that had accomplished their destructive work for the season in nurturing a pestilent brood, and who in the ordinary process of nature would soon have come to the end of their career.

Experimenters have been much impressed with the surprising variety of trap-lantern mortality among insects. The tests have not been conducted exclusively by entomologists. Lights gleaming at night in orchards in America indicate that many fruit-growers have installed trap-lanterns for the slaughter of pests. While the results as to the kind of species caught have been a constant source of surprise, there is no question that the possible insect mortality by this method is very great. In a cotton field in Texas, three trap-lanterns in a single night destroyed 24,490 insects, representing nearly 400 species. In this big capture the injurious kind outnumbered slightly the beneficial.

The wide variety of results, so far as numbers are concerned, will be readily seen when it is stated that in a trap-lantern run steadily every night in New York state for nearly half a year, only one and one-half times as many insects were captured as were taken in one of these lanterns operated for a single night in Texas. In many orchards, trap-lanterns set a few rods apart attracted altogether different sets of species.

The student of entomology who wishes to secure without delay a large collection of insects can achieve that end by establishing a trap-lantern. In many of the scientific experiments an ordinary lantern was fastened to a brick set in a common milk pan. This was nearly filled with water, over which was poured a little kerosene. The whole contrivance was set on the top of a post about four feet high. In this oily moat around the brick pedestal of the lantern the insects met their death in vast numbers.

During the past several years enough information has been definitely obtained to guide investigators as to the best time for catching various species. Many insects a-wing throughout a season will for months resist the enticements of the flame only to rush at another period to destruction. For example, the apple tent-caterpillar moth (*Climacampa americana*) was lured only from June 15 to July 15. At all other periods the lantern burned for this pest in vain. It

was only in August that the garden web-worm (*Loxostege sticticalis*) was found to be susceptible to the allurements. The garden crambus (*Crambus hortuellus*) was enticed only in July, while the vagabond crambus (*Crambus vulgivagellus*) was tempted only from August 15 to September 15. Two of the cutworm moths (*Feltis venerabilis* and *gladiaria*) were attracted only in September.

It is obvious that facts like these will be of great practical assistance to scientific students seeking to collect insects in numbers.

Of all pests the codling moth (*Carpocapsa pomonella*) has displayed the greatest caution in shunning the traps. For one hundred nights Prof. Stedman kept a lantern burning in an apple orchard infested with these insects. The trees were blooming when he first lighted his lantern and his experiment continued throughout the active season of the pest, but he succeeded in catching out of the thousands in the orchard only two individuals. Prof. Garman of the Kentucky Experiment Station and Prof. Troop of the Indiana station conducted similar experiments; but failed to capture a single codling moth.

Dr. Mark V. Slingerland of Cornell states that thirty years' experiments in the United States with trap-lanterns have succeeded in capturing only eleven codling moths.

A scientific horticulturist interested in the subject has suggested that insects unattracted to ordinary flame might be ensnared by colored lights. The fact that in the daytime certain colors are irresistible attractions to various kinds of insects has suggested to the investigator that if scientists could determine just what color scheme would serve as a lure at night, many pests now able to withstand the temptation of common flame might fall a prey to the trap.

Any project that will give support to the trap-lantern method of extermination will be welcomed by horticulturists, who, noting the enormous numbers of insects lured to their death every night, confidently hope that future scientific progress will make it possible to mete out more extended execution to the noxious species that have levied on their crops. For the purpose of widening knowledge on the subject, entomologists and horticulturists will keep their trap-lanterns burning throughout the United States.

The work of securing complete data on the subject is necessarily slow, requiring an infinite amount of detailed research in identifying specimens caught. It has been such a comprehensive task that some of the stations announce that it has been the most costly experiment they have undertaken, on account of the great amount of clerical labor and scientific skill which had to be employed in the preservation and classification of the army of insects hurling themselves into the traps.

BALLOON MEASUREMENTS OF MAMMOTH CAVE'S HEIGHT.

BY DR. HORACE C. HOVEY.

Mammoth Cave is really a congeries of caverns whose walls and floors have broken through into each other. It is excavated from the St. Louis Limestone, overlaid by the Chester Sandstone, and exists in five tiers between the sandstone and the drainage level. While the general openings are in long halls and avenues, now and then widened into spacious chambers, there are occasionally vertical chasms, which are styled "pits" or "domes" according to the point of view. For example, Little Bat Avenue ends in an ugly black hole called the Crevice Pit. Spark's Avenue, on a much lower level, leads to the Mammoth Dome, which opens upward through the Crevice Pit. That is to say, Crevice Pit and Mammoth Dome are identical.

The full history of attempts to measure this vast chasm would fill many columns. The main facts of interest are as follows: Mr. Wilkins, of Lexington, Ky., was the first to make the attempt, in 1812, in the days of saltpeter mining. He tied a lamp to a rope and lowered it 45 feet. But the rope caught fire and the lamp was dropped into an abyss where it remained for thirty years, when found by Matt, the guide, and it is now in the writer's cabinet. A sprightly young negro, who was let down as a kind of animated plummet, to recover the lost lamp, lost his wits instead. When Edmund C. Lee, C.E., in 1835, attempted to make a map of the cave, he sounded the Crevice Pit and touched bottom at the depth of 280 feet. This was for years accepted as correct.

In 1896 the writer, in company with Dr. R. E. Call, undertook to make an exact measurement. Our first attempt succeeded only in explaining Mr. Lee's error. Our plummet lodged on a ledge and the cord continued to be paid out, its own weight sufficing to carry it down till we happened to discover the trick. A block of stone was then substituted for the lighter weight, and when it caught on the ledge it was jerked off again and sent along on its mission. Thus it reached the floor of the Mammoth Dome immediately under the Pit. Allowance was made for stretching, and the cord was measured by a steel tape. Thus we determined the distance from the brink of the Crevice Pit

to the foot of the ladder in the Mammoth Dome to be 88 feet. From the ladder to the lowest part of the chasm it was found to be 31 feet vertically; making a total distance of 119 feet. All the great pits in the cave have also been measured, the results appearing in our guide-book.

Until recently no method has been devised for measuring upward into domes otherwise inaccessible. This summer I demonstrated the practicability of such upward measurements by means of small balloons. As it was a novelty in cave work, my attempts were experimental. My first lot of balloons proved a dead failure because they would not stand sufficient inflation. A new set was obtained to order, made of thinner and more elastic rubber. A 50-foot cylinder of hydrogen gas was forwarded from Cincinnati, and a room at the cave hotel was set apart for our experiments. The balloons were readily inflated to a diameter of 10 inches; and when one was released it soared far above the trees, to the delight of the natives who witnessed the performance.

On June 27, 1903, I entered the cave, accompanied by Mrs. Hovey, Mr. W. S. Miller (cave-agent), J. M. Nelson (guide), and my friend, Gerard Fowke. I had looped five balloons in a cluster, so that if one got away the others could be used, and a light sewing-silk was attached as a guy. We easily measured the height of the vestibule just beyond the cascade, finding it to be 26 feet, the daylight enabling us to watch the ascent of the balloons. When we reached the Rotunda, where Audubon Avenue branches from the Main Cave, a room which our tape-line told us was 164 feet in diameter, we found the advantage of having with us a powerful acetylene lamp, whose rays Mr. Fowke turned upon the balloons as I let the silk slip through my fingers. From floor to ceiling we found to be exactly 40 feet. Our next measurement was at the Church, at the junction of the Main Cave and Archibald Avenue, finding the height to be 49 feet 6 inches. In each case we measured from the floor to the top of the group of balloons. Our scheme worked well.

Thus encouraged, we next attempted that vast subterranean temple, named for an early owner Gorin's Dome. Dr. Call had already measured the depth from the bridge to the bottom as 119 feet—identical with the depth of the Crevice Pit to the bottom of Mammoth Dome. The total height from floor to apex was estimated at 159 feet; but we hoped by ballooning to substitute exactness for guesswork. By means of the acetylene lamp, and special magnesium lights brought for the purpose, the gigantic dome was illumined as perhaps never before. Its mighty alabaster folds swept around us like massive curtains; and the absolute silence was broken only by the music of the pattering drops falling from the pendant stalactites. When the cluster of gaily tinted balloons was sent upward on its mission the sight was extremely pretty. They mounted well for two-thirds of the way, and then were caught by a current of air and wafted from side to side through the sigmoid curves of the great abyss. We drew them back to us, and dried their moistened surface, and tried again and again, only to be baffled by those mysterious atmospheric currents that made the gay globes flutter hither and thither, like willful creatures.

A fatiguing tramp carried us through the Main Cave to the so-called "Chief City," which is not a dome-pit but a vast enlargement of the general passageway. Here again we were doomed to a failure that should have been guarded against. The uniform cave temperature is 54 deg. F., which would, of course, cause some shrinkage of the rubber bags inflated amid a sunny June day outside. The moisture in the domes had also played its part in the same way. So that the balloons were considerably less in size than at starting. We clustered our lamps together, and ignited oiled rags, and by other means tried to coax our messengers to do their duty; but in vain.

Passing over various subsequent experiments, we made a special test of the Mammoth Dome, where our balloons worked perfectly. First we measured from the foot of the waterfall to the level of the ladder, and thence to the highest part of the dome visible; making it exactly 119 feet 6 inches. Then going around by Little Bat Avenue, we measured the height of the ceiling at its junction with Audubon Avenue; also as well as we could the small domes near the Crevice Pit. Our conclusion was that about 35 feet would have to be added to the above in order to get the total altitude of the chasm, namely 154 feet 6 inches. This result, it will be perceived, nearly coincided with the previous measurements made in 1896 by entirely different methods.

Taken as a whole, our experimenting with cave-balloons was successful, and demonstrates the utility of that method of measuring heights not otherwise accessible. We would remark, however, that small specially made hot-air balloons might be better than those inflated by hydrogen gas, for the reason that their fire-balls could be made large enough to defy sprinkling from cascades.