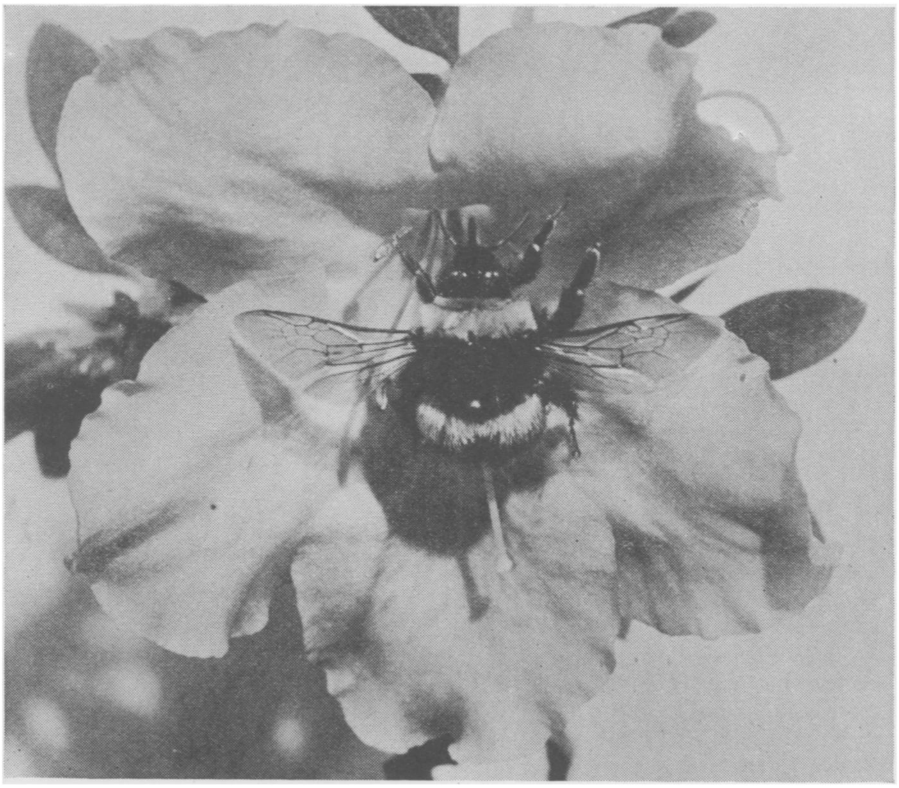
"Modern" Insects Prefer Bright Lights

Ecology

By Frank Thone

Bright lights, life tuned up to jazz tempo, a hot time being had by all—such is the road to racial damnation, according to all the prophets from Jeremiah down to Anthony Comstock. The prophets may be right so far as human-kind is concerned, but in the paradoxical world of the insects that swarm in the heavens above, in the earth beneath and even in the waters that are under the earth, the dictum is reversed. Bright light, high temperature and a fast rate of life processes are the things that the most advanced and up-to-date hexapod citizens thrive on, beating their slower, more cool-blooded neighbors in the evolutionary race.

Such at least is the thesis set forth by Prof. Clarence H. Kennedy of Ohio State University, in a communication to the official journal of the Ecological Society of America. And other naturalists, looking over his opinions, declare that his generalization holds, in a broad way, for many other forms of life besides the insects. Prof. Kennedy seems to have hit upon a scientific principle that will do a great deal toward unravelling many tangled questions about the distribution and evolution of animals and plants.



BEES AND THEIR RELATIVES, fast, energetic, lovers of the bright sun, rate as "moderns" among insects

"Metabolism" is the key word in Prof. Kennedy's theory. Metabolism is one of those scientific terms that is just now graduating from the technical vocabulary of the specialist into common English, as calories and vitamins did a short time ago. Lots of people talk about metabolism now, and in a few years we'll all be using it without batting an eye.

Metabolism is simply a shorthand word meaning the process of turning the food we eat and the air we breathe into the energy of muscular work and mental activity and bodily warmth. It means, in brief, the whole give-and-take of energy that goes on inside us. It is one of those useful "steamer-trunk" words, that doesn't take up much room but can have a lot packed into it.

Well, then, according to Prof. Kennedy the up-and-coming insects, the ones that have got along farthest and fastest in the evolutionary course of things, are the ones with the highest rates of metabolism. The most advanced, most "modern" insects have the fastest physiological processes, turn food into energy most rapidly, grow from helpless infant grubhood to maturity in the least time. An advanced insect like a bee may live its whole life in less than a month, and some of the more highly evolved flies can complete a life-cycle, from egg to egg-laying adult, in as little as ten days. In contrast with such insects as these are creatures like the Mayflies, which require a whole year to come to maturity, June-beetles, which take two or three, and as an extreme case the seventeen-year cicada, which lives underground for more than half a human generation before it emerges for its brief day in the upper air.

The short-lived, quick-breeding insects in general have high metabolism rates; the long-lived, slow-breeding ones low metabolism rates.

Not only length of life-cycles but rate of movement will help us to judge the evolutional position of an insect. It might be stated as a jingle: the lower the slower. Of relatively primitive rank, Prof. Kennedy says, are "usually stupid insects, which, except spasmodically when excited, are very slow in their movements. Contrasted to these are the higher flies, the butterflies, the ants, bees and wasps which are as a rule very active insects, many of which are on the wing for long hours day after day."

Insects are cold-blooded animals, and are therefore directly dependent on the warmth of the sun for their body temperature. They differ in this from man and the warm-blooded animals, which can keep up their body heat by burning part of their food-fuel and are therefore able to keep awake and going even during freezing weather. No matter how energetic an insect naturally is nor how high its normal metabolism rate, it can not continue its life-processes when the air around it is cold.

"Modern" insects like a warm environment, because that is what enables them to live at the high rate set by their natural metabolic processes. Primitive ones do not like to have it too warm, because higher temperatures make physiological demands on them which their lower metabolism is not prepared to meet. The result of (*Turn to page* 211)

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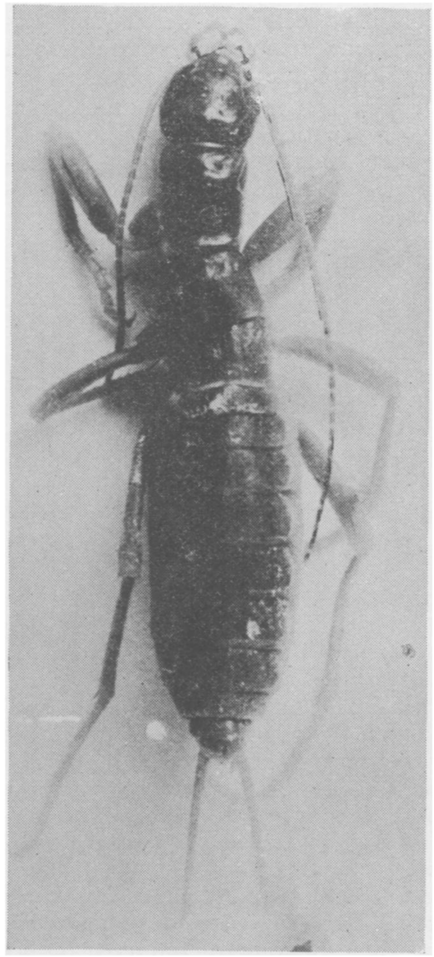
this contrast, according to the Ohio entomologist, is a sorting of the highly evolved from the more primitive insects along three general lines. Taking the world as a whole, he says, the "modern" insects prefer the tropics, while the primitive keep to the cooler temperate zones and even to the arctic. They also inhabit the upper levels in mountainous regions.

As a champion example of the slow, old-fashioned insect that likes it cold, Prof. Kennedy points to *Grylloblatta*. This creature is a sort of missing link between crickets and cockroaches, two relatives in a primitive order of insects that was represented on earth scores of millions of years ago, when the coal beds were being formed. It is neither cricket nor cockroach, but has some of the characters of each. Its name expresses its nature, for it is a compound of *Gryllus,* which is the Latin name for cricket, and *Blatta,* which is what entomologists say when they want to be polite about the cockroach. *Grylloblatta* is found only in cool, northerly regions, or well up in the mountains, and in nature requires three growing seasons of four months each to go from egg to adult. When reared in captivity it has to be kept on ice in a refrigerator.

Prof. Kennedy's own specialty has been dragonflies and their kin. These are in general a primitive order of insects, but they show a wide range of difference in degrees of evolution. Prof. Kennedy drew up a list of all the dragonfly species on which he could get distribution data. He found that the more highly specialized ones were to be found in the tropics, and that from the equator the distribution curves sloped downward toward the north and south, terminating finally in the least highly specialized dragonflies in the coolest regions. Other insects studied in lesser detail showed the same tendency.

A second way in which the more advanced insects show their preference for heat is in their choice of seasons. In the temperate zones, where the insect breeding season warms up at first slowly and then more rapidly in the spring, to a high point after midsummer, and then shows a temperature decline until frost time, the appearance of the insects can almost be plotted on the curve of daily temperatures. The primitive, coolness-loving insects come first—such things as Mayflies, stoneflies, caddisflies and many of



GRYLLOBLATTA, the insect that has to be raised in a refrigerator—one of the "slowest" and least modern of hexapods

the beetles. Then, as the season advances and the days become longer and warmer, the livelier, more highly organized insects put in their appearance, until in late July and August we have the heyday of the butterflies, wasps and dragonflies. Here also belong the many species of flies—for little though we may like them, flies are highly evolved insects and from their own point of view great successes in the world.

Finally, this temperature preference among insects sorts them out according to the places where you will find them at any given time, and according to the hours when they are abroad on any given day. The more advanced, warmth-loving, high-metabolism insects prefer the bright light of day, and may most commonly be found flying in open places, especially around midday. The more primitive, low-metabolism species that prefer to keep cool are to be sought in the shady woods, or creeping beneath stones and logs. Those that venture into the open at all avoid the hot part of the day, and come forth in the morning or evening dusk, or even as nocturnal fliers, when it is quite dark.

For specific examples we may look for a moment at one or two orders of insects. One group includes the flies and their relatives. The flies themselves, as already noted, are relatively advanced insects. They click into Prof. Kennedy's scheme very nicely, arriving in full numbers when the season is well advanced, breeding rapidly, flying fast and showing a decided preference for open, sunny, warm places. Their less advanced relatives, the mosquitoes, are never in sight when the flies are, but hide in the woods or under shrubbery by day and fare forth to make us miserable by night. They breed rapidly also, but it may be noted that whereas flies lay their eggs in the fetid heat of decaying offal, mosquitoes breed in water, which is of course always more or less cool. The twilight-loving gnats occupy an intermediate position between flies and mosquitoes.

Another order that affords interesting examples is the group that includes grasshoppers and their kin. The grasshoppers themselves are among the most advanced members of this order, and they are found prevailingly in open grasslands—pastures, fields, prairies—singing their shrill happiest when the day is bright and hot. If you search in the cool woodland ravines nearby you will find few grasshoppers, but creeping among the damp dead leaves under foot there will be numbers of their more primitive kin-insects; grouse-locusts, and the cleanly woodroaches, cousins of the disreputable immigrant swarms whose liking for the dampness and dark of cellars and plumbing-cracks drives the housewife distracted. And when night comes on, another more or less primitive section of the grasshopper clan joins in the chorus: the dark crickets of the ground, the snowy crickets of the tree-tops and the interminably arguing katydids.

Examples like this might be piled one on another, but these serve to illustrate Prof. Kennedy's point. Other scientists, surveying their own special fields, have stated that the principle seems to hold for other things besides insects. Dr. H. E. Ewing of the U. S. National Museum, whose specialty is the study of the primitive (*Turn to next page*)

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groups of creatures that stand below the insects on the evolutionary scale, says that the principle of "distribution by temperature preferences" holds good in his field also.

"The most widely distributed animals in the world are not human beings, as we sometimes think," Dr. Ewing said. "They are mites, primitive tiny eight-legged things lower in the scale than spiders. Species of mites, together with spring-tails, which are exceedingly primitive insects, make up more than 90 per cent. of the known fauna of the desolate continent of Antarctica, and these creatures are also found on the highest, coldest slopes of glacier-bearing mountains.

"Not long ago, up in the mountains of the Pacific Northwest, I found a strange creature related to the mites and spiders, but even more primitive. It seems to be a 'surviving ancestor' of the daddy-long-legs or harvestman; only its legs are short. The land where this cold-loving animal was found is geologically very ancient. Though it is now a part of the American continent, it was once a great island, most of which has now sunk under the ocean, and many of its animal inhabitants seem to be immigrants that came from the Asiatic side a very long time ago."

Probably the greatest difficulty in the application of the theory will be met when it comes to the warm-blooded animals. These are all high-metabolism organisms, but because they have learned the trick of keeping themselves warm by burning part of their food as fuel, and have also found out how to protect themselves inside of coverings of clothes, fur or feathers, they are not so directly dependent on the temperature of the surrounding air as their cold-blooded brethren. There are indications, however, that even here the rule will apply at least in a broad way.

Among the cold-blooded vertebrates the marine fishes, free to rove the seven seas, may also be difficult to marshall under the flag of the new theory. But even among these, it is worth while noting the strange, butterfly-bright, highly specialized, "modern" inabitants of the warm waters over the coral reefs of the tropics, as contrasted with the more conservative codfish and herring and mackerel of northern seas.

The members of the plant kingdom seem to fall into line fairly well. The jungles of the tropics are the home of some of the most highly evolved forms of plant life, while the conifer forests, with trimmings of the primitive willows, poplars, birches and alders, rule the arctic and subarctic belts. When Kipling wrote of Britain's "dominion over palm and pine" he was only anticipating, as poets often do, a generalization of science.

And just as the more primitive insects appear predominantly in the cool spring and the more advanced ones in the hot summer, so do our spring woods show forth simple flowers and our summer pastures the more complicated ones. Bloodroot, trillium, trailing arbutus, Solomon's seal, Jack-in-the-pulpit, and earliest and lowliest of all, skunk cabbage, are flowers much farther down in the evolutionary scale than the summer-blooming goldenrod, sunflower, Indian paintbrush, toadflax and horsemint. And it may be noted also that the flowers of the cool spring are flowers of the woods, while those that come in the height of summer are much more given to sunning themselves in open fields and meadows and along treeless roadsides.

Prof. Kennedy's theory is as yet only in its preliminary form. Both he and other scientists are busy scanning their lists of wild-life acquaintances to see how well it will hold, and where and how much it will need to be modified. But as a bold, broad generalization, into which the larger facts of the natural world seem to fit, it has been well received and will doubtless prove a useful window for scientists to look through, at the world in which we live.

Science News-Letter, April 6, 1929

Paper milk bottles are being tried out in some parts of New York City.

To keep young salmon from "detouring" and being lost in irrigation canals and diversion ditches an engineer has devised a way of creating an electrified zone of water, which acts as an effective stop sign for the fish and turns them back to the main route.
