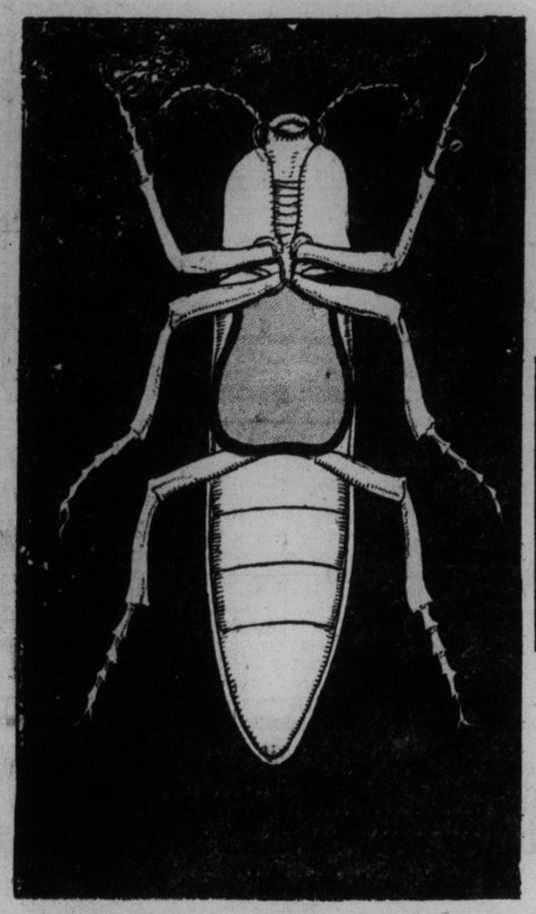
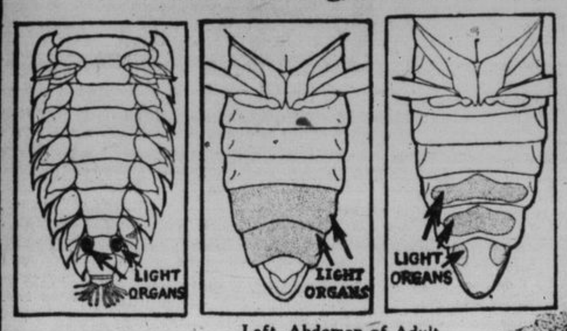
How Science Has Stolen "Cold Light" from Bugs



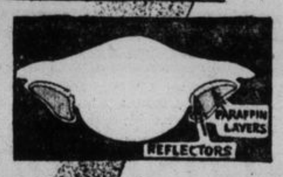
This "Automobile Bug" or Pyrophorus Noctilucus, Common in the Southwest, Has Its Light Organs in the Upper Part of Its Body, Instead of in Its Tail. They Shine Through Two "Headlights" On Its "Shoulders."

Research Reveals Secret of the Firefly's Glow, and Experts Now Seek Better Illumination Through It



Development of Firefly's Light Organs in Abdomen of Larva.

Left, Abdomen of Adult Male; Right, Abdomen of Adult Female, Showing Further Development of Light Organs.



Above, Cross Section of Adult Male's Organs of Light; Right, Cross Section of Larval Light Organs Showing Reflectors.

CAN you remember the first time you ever saw a firefly?

It was probably when you were a toddling child.

And most likely it was a quiet Summer night, just after a shower.

You saw it flitting across the lawn or higher among the dark tree branches—flashing its little tail-light off and on in a way that was fairy-like, mysterious and altogether entrancing.

Presently, perhaps, you saw a thousand of them, and you thought it was the most wonderful sight you had ever seen.

And then—if you were a normal child with a child's destructive curiosity—you started chasing fireflies.

If you lived in these United States you probably called them "lightning bugs."

And if your parents didn't stop you, you put them in a bottle and hid the bottle under your pillow in the nursery, and after the other lights had been put out you brought the bottle from its hiding place and found you had a substitute for a candle—with the advantage that lightning bugs couldn't burn your fingers or set fire to the sheets.

In short—you "discovered" and made use of the principle of "cold light."

But it was a feeble light at best—not much good for practical purposes. And as you grew older you lost your interest in fireflies—unless you happened to become a scientist.

The chief difference—perhaps the only fundamental difference—between a scientist and an ordinary man is that your scientist has never lost the curiosity which all human beings have when they are children.

You lost interest in fireflies and "cold light" when you grew up. The scientist, on the other hand, kept right on chasing lightning bugs and experimenting with the light they gave. He put them in his laboratory instead of under the nursery pillow, but he was actuated by the child's idea. He thought they might be made to yield a light that wouldn't burn his fingers or "set fire to the sheets."

Such a light, obviously, would be of great value for scientific and commercial purposes if it could be perfected. Every method of lighting now known produces a great quantity of heat. The sole object of a candle, lamp or electric bulb, when used for illumination purposes, is to produce light. Yet 92 per cent of the energy goes off in heat and only 8 per cent is transformed into light. The process that goes on in a firefly's tail, apparently, produces 99 per cent light and only a fraction of 1 per cent heat, if any heat at all. If science, patterning after the firefly, invents a method by which all the combustion energy is used in light, without heat waste, artificial light would be infinitely less expensive than it now is.

"We'll try to find out what causes the light in the firefly," argued the scientists, "and then maybe we can produce the same kind of light on a larger scale."

And science at last has solved the mystery, though it hasn't yet been able to adapt its discoveries to practical commercial uses.

The latest and most interesting discoveries in this field have been made by Professor Walter N. Hess, of Cornell University. Professor Hess decided to experiment with the common firefly that he saw on Summer nights on the university campus at Ithaca, New York. It is called the Photorus Pennsylvanica. Instead of beginning with the firefly itself he began with its eggs. An insect goes through three stages before it becomes mature. First it is an egg. Then it becomes a larva or worm. Then it enters the pupa stage (the stage during which it undergoes final transformation). And, last of all, it becomes the full-fledged insect.

When Professor Hess had collected two complete sets of eggs, larvae and pupae, he was ready to begin the study of the development of the light-producing organs in the firefly.

He discovered that the substance with which fireflies produced light was neither phosphorescent nor electrical. He discovered that it was "cold fat." Here is his own language:

"The first indication of the formation of light organs in the embryo is noticeable at the age of fifteen days, just as the embryo revolves from its backward turned position and starts to coil up.

"At this time groups of fat cells, with their large globules, which are colored dark by osmic acid, migrate ventrally in the segments and come to lie in the region of the future light organs. The undifferentiated light organ cells are now continuous with the groups of fat cells above them.

"As soon as the fat cells become localized in the region of the future light organs, their dark-colored globules of fat become smaller in size and fewer in number. In fact, in the fifteen-day embryos there appears to be a gradual gradation from the cells lying next the skin, containing smaller and fewer globules, to the fat cells near the central part of the body, which contain more and larger globules.

"In the sixteen-and seventeen-day embryos the light organs are regular in outline and they have become separated from the other fat cells. The fat globules are now smaller and fewer in number than on the fifteenth day. All cells that compose the light organs are apparently now of the same histological (animal tissue) structure.

"At the age of twenty days there begins to take place a differentiation of the cells of the organs into the photogenic (paraffin) and reflector areas.

"At the age of twenty-two days the light organs of the embryos become functional and appear as two-minute spot-lights.

"The larvae (young) emerge on about the twenty-sixth day of incubation. They require about twenty-two months to reach maturity, at which time they pupate (emerge as adults.)

"In mature larvae, about a half day before pupation, the cells of the fat spheres, which lie near the hypodermis (under skin) in the lower part of the sixth and seventh segments, are liberated and become distributed along the lower skin. They contain numerous fat globules, which appear dark after treatment with osmic acid.

"The fat cells which are liberated from the fat spheres during the last day of larval life and the first one or two days following pupation, compose a layer about three cells deep above the hypodermis. Some of these cells are shown in the light organs.

"The undifferentiated cells of the light organs, at this stage, are all of the same histological or animal tissue appearance, which suggests a common origin.

"The cells in the photogenic (or paraffin) and reflector layers, in the five-day pupae, are clearly differentiated. At this time the cells of both layers still contain some dark-colored fat globules. The rapid division of the cells affects the trachea or air tubes of the body of the insect, so that later these air tubes invest the light organs.

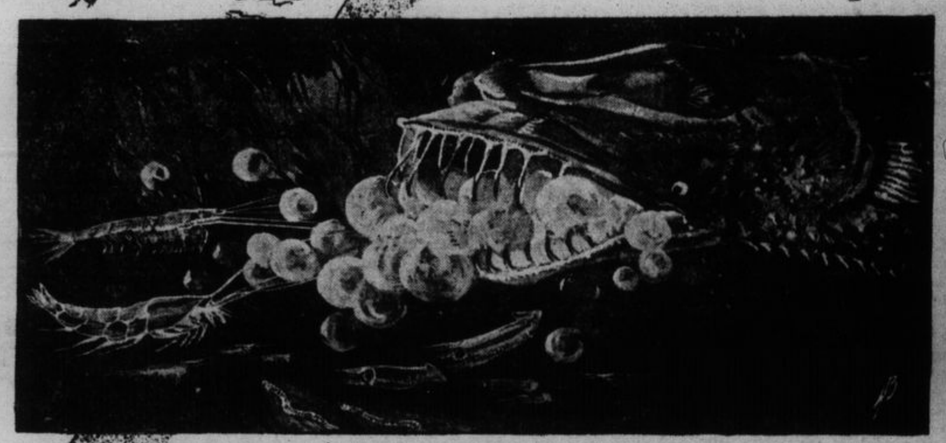
"Shortly before the light organs become mature in both embryo and pupa the fat globules disappear and the organ takes on its characteristic adult structure. The light organs of both larva and adult are formed from fat cells which become differentiated into photogenic and reflector layers of the mature light organs. Hence the light organs are entirely mesodermal (or of middle of the body origin)."

It will be seen that Professor Hess finds that the light organs of animals originate within the animal itself, and that cold light is manufactured from fat, the same as heat-bearing light.

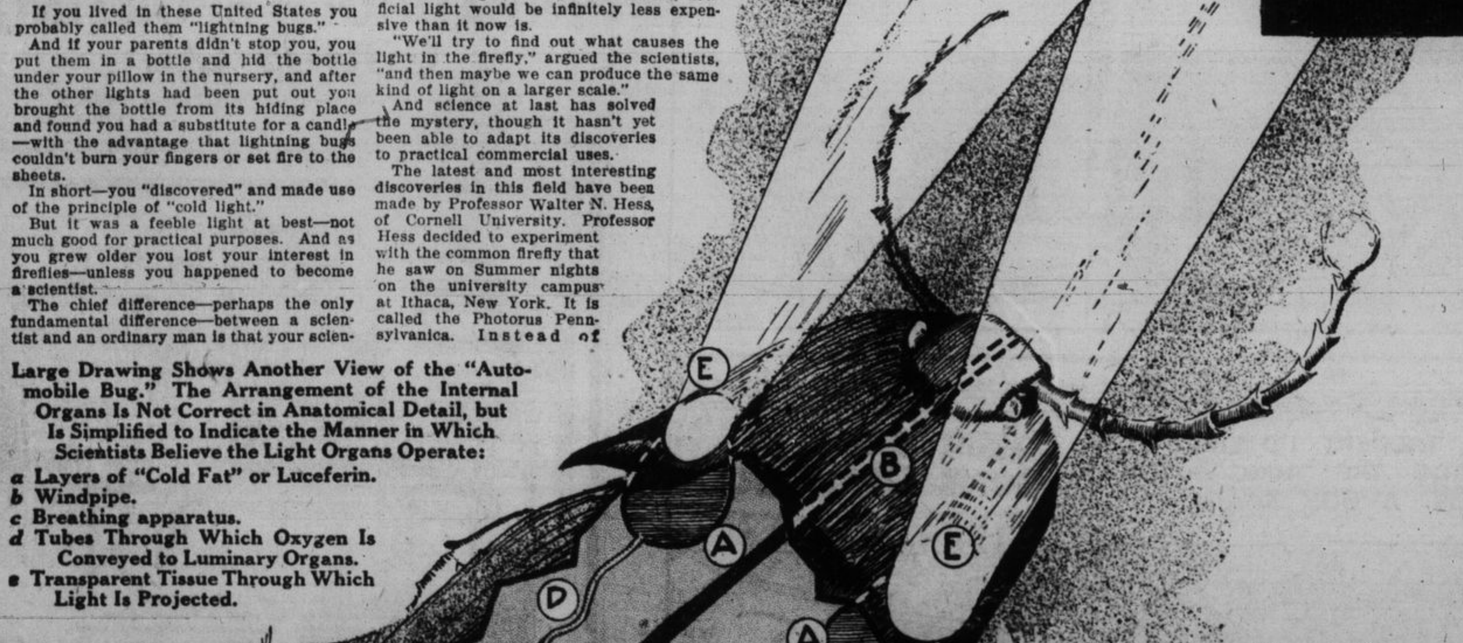
The lightning bug is by no means the only living creature that emits cold light. There are other insects on land, including the amazing Pyrophorus Noctilucus or "automobile bug," familiar in the Southwest, which has two "headlights" on the front part of its body. In the sea there are hundreds of light-producing creatures, one of which is reproduced on this page. Some of them have "headlights" stuck on antennae that project like long eyes from the front of their foreheads; others have luminous organs inside the roofs of their mouths; others have luminous tails, luminous spots, and some glow all over at certain periods.

Experiments at Princeton by Dr. Ulric Dahlgren, who has published more important monographs on luminous creatures than any other scientist, have been conducted with materials obtained from a crustacean in Japanese waters. He has obtained notable results, but the methods as yet are too expensive for commercial use. The Germans are also at work on the same problem.

Dr. Dahlgren affirms that the light is produced by a substance he terms luciferin. It is the same thing Dr. Hess calls "cold fat." Dr. Dahlgren believes the fat becomes luminous by a process of oxidation. To what extent the animals can control the light and by what exact process the oxidization takes place—if it is oxidization—is still undetermined, but rapid strides are being made, and you may be prepared to hear at any time that some scientist has perfected a method by which "cold light" can be made practically useful to the world.



Trap-Mouthed Fish, Thaumatichthys Pagydostomus, Dredged Up From Depth of 3,000 Feet. Light Organs in Roof of Mouth Attract Small Sea Creatures, and Mouth Closes With a Snap on Its Prey.



Large Drawing Shows Another View of the "Automobile Bug." The Arrangement of the Internal Organs Is Not Correct in Anatomical Detail, but Is Simplified to Indicate the Manner in Which Scientists Believe the Light Organs Operate:

a **Layers of "Cold Fat" or Luceferin.**
b **Windpipe.**
c **Breathing apparatus.**
d **Tubes Through Which Oxygen Is Conveyed to Luminary Organs.**
e **Transparent Tissue Through Which Light Is Projected.**