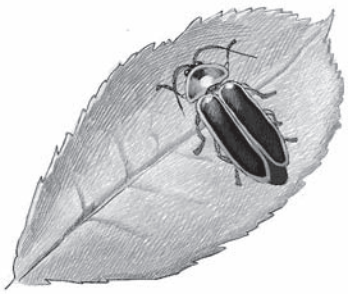
CHAPTER 5

COMPETING WITH GENERAL ELECTRIC

The Glowworm



Ouch! You're hurting me! Please don't pinch my wings so tight. You can hold me in your hand, but just don't crush me! Please remember to set me free. If you like, I'll tell you something special. Okay?

It wasn't hard for you to catch me this June evening, was it? In the dark, you can easily see all of us flying. During the day, you wouldn't notice us at all. You don't find us interesting during the day, do you! Yes, I know, it's our light that you find so fascinating. If you'll just turn me over carefully, you can see the two greenish yellow light spots on my underside. That's the reason

you only see our light when we fly overhead. Can you turn me right-side-up again, please? Ouch! Be careful! I'm no more than about one-third of an inch (10 mm) long. You have to be very careful with your big, clumsy fingers, if you don't want to squash the living daylights out of me!

Now turn on your light, and look me over. By the way, if you were in South America right now and laid my relative, the cucuju, in your hand right next to me, you wouldn't need your light. The cucuju's light is so bright that you would be able to inspect both of us without any additional light at all. That's the reason why lots of people there catch cucujus and keep them in little cages, to be used as lanterns.

Unattainable Light Efficiency

It's true that I am just a little unattractive beetle, but still, I'm a miracle direct from God's workshop. "Glow worm" *(lampris and Phausis)* or "small St. John worm" are our man-made names. Actually, they are misleading names, as I'm not a worm, and I don't glow. I actually generate "cold" light. That means, in my process of generating so-called bioluminescence, no heat is generated at all. That's really the astounding accomplishment that your engineers have not yet been able to match. One of your normal incandescent lamps transforms only a maximum of 4% of the input energy into light. Even a fluorescent lamp turns only 10% of the input energy into light. The rest is wasted in heat. You have to admit — your lamps are more like ovens than lights. For me, the Creator achieved the greatest possible efficiency in transforming energy into light — that is, 100% of input energy is converted. You really can't do better than that.

Now look at my neck shell. It protects my head better than the crash helmet your motorcyclists wear. Besides that, my Creator formed the hard material in such a way that it is transparent in front of my eyes, and nowhere else. That means I can look out on the world through this window.

If you could please turn off your "oven," I can show you the rest better in the dark. Do you see all the little points of light over in the grass? Those are our little females. They can't fly. At mating time, they creep out on the blades of grass. As soon as a male approaches them, the female stretches her tail, with her light organ, up into the air. That makes the greenish yellow light visible, and the male comes to mate.

Included among my relatives — and I have more than 2,000 different kinds of relatives — is the so-called Black Light Beetle *(photinus pyralis)*. In his family, the males and females communicate by means of flashes of light. One of these flashes lasts only 6 hundredths of a second. What is remarkable is that the male sends these flashes at an exact interval of 5.7 seconds. The females answer in exactly the same rhythm, but 2.1 seconds later. So far, nobody really knows exactly why they turn the light on and off so quickly.

In the summer, my mate lays the eggs on a damp spot under a leaf. At first, half-grown larvae develop from the eggs. They spend the entire winter on the same spot and then, in the spring, emerge from cocoons as adult glowworms.

The frogs are among our enemies. If one of them eats too many of us at once — and this does happen from time to time, unfortunately — then even the frog begins to glow in the dark. That must look funny to them! This is because even our eggs give off a little light, as do, of course, the larvae and pupa, too.

What enables us to give off light? I guess you'd be interested to know? In 1887, the Frenchman Raphael DuBois found, in the luminescent mucus of the boring mussel *(Lithophaga)*, the two substances that are absolutely necessary for producing light. If these react with each other, light is produced. The Frenchman called one substance luciferin and the other luciferase. The chemical composition of the second substance remains a mystery. Even today, it is only known that it consists of about 1,000 amino acid units. That means that its structure is highly complicated and extremely difficult to figure out. I can only marvel at what great effort the Creator put into us tiny creatures. In

studying the other substance, the luciferin, American scientists recently discovered that the number of oxidized luciferin molecules exactly matches the number of transmitted light bursts. This is a confirmation of just how energy is transformed completely into light. Oh, I see you're getting bored, but the matter really is much more complicated than I can explain to you.

A Shutter for a Light Switch

By the way, let me tell you something else that you almost certainly don't know anything about. Have you ever heard of the lantern fish *(Photoblepharon palpebratus Steinitzi)*? You haven't, have you? It's true we are not related, but he also produces light. Actually, he doesn't generate the light himself, but he obtains it from luminescent bacteria, whose light is produced by a similar chemical reaction to the one that produces my light. An individual bacterium is so small that its light can't be seen. Only a colony of millions produces light strong enough for you to see. The bacteria sit on an oval-shaped light organ underneath the eye. At this location they are nourished with energy and oxygen through a densely branched network of the fish's tiniest blood vessels. Besides this, the Creator installed a kind of shutter for the lantern fish, a black eye fold, that the fish can drop down and in this way "turn off " the light. If he wants to, the fish can send out blinked light signals. The Creator's ideas are boundless. He "lets there be light" in the most varied ways.

Flashing Trees

I even have relatives in South Asia. They're quite fond of gathering together in the thousands in trees by the river bank, where they all blink in unison. Travelers in Burma or Thailand haven't been able to find adequate words to express the overwhelming impression this evokes. Sometimes, many of these trees are clumped together; then it's not unusual for each leaf to have a lightning bug on it. You can just imagine how the trees flash. Science has not yet been able to figure out why they

all flash at the same time. Maybe the Creator just wants you humans to marvel at His fantasy?!

Reflector Principle

Back to me once again — and then please let me fly away. I still have to tell you about the wonderful light organ with which the Creator equipped me and my friends with. Basically, it consists of three layers of cells. The lowest layer is formed with cells whose plasma is filled with tiny little edged crystals. These crystals act as a reflecting wall — something like the reflectors on a bicycle. The middle layer consists of the actual light cells. They are filled with round particles, the mitochondria, which function as miniature power plants responsible for providing energy. These light cells are equipped very richly with the finest nerves and respiration tubules. The third and outer layer is the skin. At this part of my body, the skin is transparent, so that I can shine my light on humans and animals.

Miniature Railway

I admit that my appearance is not as impressive as the Brazilian railroad worm *(Phrixothrix)*. This beetle larva has two orange lights that "glow" on its front end. If it spots danger, then it turns on a row of 11 green lanterns on its right and left sides, so that it looks like a small train in the darkness.

I don't look like a train. Ladies don't put me in their hair either, as they do with my South American cousin, the speed beetles *(Elateridae)*. Those beetles glow in the dark like diamonds. As for me, I can only blink and my light is only one color. But I still praise my Creator for making me such a small miracle. You, too, ought to join in and praise the Creator.

Now, if you wouldn't mind letting me go first.