Green sea slugs aren't solar powered after all

There are several species of sacoglossan sea slugs that feed on large, unicellular algae and hold onto the algae’s chloroplasts, the organelles that turn plant cells green and convert light to energy. The sea slugs save those bits for at least a couple of weeks until digesting them. Four sea slug species keep the chloroplasts in their digestive glands for months, which makes the slugs green and inspired one of their earlier nicknames, “leaves that crawl.” Another nickname is “solar-powered slugs” because scientists thought that the slugs could use the chloroplasts to make energy to get them through lean times.

But in a disappointment for sea slug fans everywhere, Sven Gould of Heinrich Heine-University Düsseldorf in Germany and colleagues have found that at least two of the four species are not powered by the sun. Their study was published November 20 in the Proceedings of the Royal Society B.

A chloroplast is only one part of the cellular machinery that’s necessary to turn sunlight into energy. The chloroplast has a tiny bit of genetic material that provides pieces for the process, but most of the genes responsible for producing the necessary proteins live in the algal cell’s nucleus. For the sea slugs to be using their acquired chloroplasts for energy, they would need those nuclear genes. Only one species of sea slug, Elysia chlorotica, have been found to make some of the pieces of this energy-production puzzle, but even then it’s probably not enough to put the whole puzzle together. And researchers have been unable to find any relevant genes in two other species, E. timida and Plakobranchus ocellatus.

There’s been tantalizing evidence, however, that the chloroplasts are indeed working. Studies that trace carbon show that the sea slugs are taking up some of the element from the
atmosphere. And the slugs can survive for months in the absence of food. Maybe they really are getting help from the sun, scientists reasoned.

Gould and his colleagues decided to pick apart the evidence, step by step, for two species, *E. timida* and *P. ocellatus*. They looked for genes that would keep the chloroplasts working. They didn’t find any. They then repeated the carbon experiments and found that, yes, in the presence of light, the chloroplasts continued to take in carbon dioxide, which would indicate they were still working. But when the team put the sea slugs through a starvation experiment, the results showed that the slugs weren’t taking advantage of any of that chloroplast energy.

The researchers split the slugs up into three groups, all of which were starved. One group lived in the light. A second group lived in the dark, a natural way to cut off photosynthesis. And a third group had their photosynthesis cut off chemically. The best sign of a starved slug is a decline in weight. If the sea slugs were getting extra help from photosynthesis, then the first group should have lost the least amount of weight. But after 49 days, all the *P. ocellatus* slugs showed about the same amount of weight loss. Weight measurements were more unreliable for *E. timida* because they proved tricky to handle, but their survival didn’t appear to depend on light either. “As far as basic nutrition goes,” the researchers write, “the slugs are apparently not ‘solar powered’ at all.”

The chloroplasts appear to be nothing more than a colorful method of storing food, the researchers say. And though they have yet to repeat their experiments on the other two “solar-powered” slug species, the researchers aren’t optimistic that either of those two will turn out to be powered by the sun either.