

Ask Rachael

Q. I'm all for efficient lighting, but the bulbs come in those awful plastic containers that I can't recycle. Is there any way to buy energy-efficient bulbs in Vermont without contributing to the landfill?

A. More and more people are asking about this, so thanks for your question. Currently, few retailers have a choice about the type of packaging they get. Efforts are underway to bring more environmentally friendly compact fluorescent bulb (CFL) packaging to Vermont stores, so it's worth the trouble to talk to the store manager about your concerns, and to write to the manufacturer of your favorite CFLs. Also, consider the fact that, because CFLs last so much longer than incandescents, you'll buy about one-eighth as many light bulbs. Fewer bulbs will mean less waste.

Rachael is a business development specialist at Efficiency Vermont. Do you have questions about energy use in your home or business?

Write to askrachael@efficiencyvermont.com or call toll-free 1-888-921-5990 and a customer service representative will answer your question.



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The inside story

By Bill Amos

The hill we live on supports two dairy farms, some beef cattle, and a few horses. A bucolic peacefulness descends as the animals graze upon the green slopes.

Though the scene seems tranquil, it isn't — the process of digesting plant material isn't easy. A plant cell is protected inside a tough cellulose box, and the only way an animal can get at the nourishing cytoplasm within is to break apart the box by mechanical or chemical means.

Herbivores have specialized innards containing microscopic symbiotic companions. The gut of a horse is a straight-through system like ours, but a cow has a compartmented stomach that allows partially digested food to be brought back to the mouth for relaxed chewing; this "cud" chewing directly affects the breakdown of cellulose. Both the equine and bovine digestive systems also support vast populations of microscopic creatures most of us know nothing about.

Intestines (including ours) harbor bacteria that benefit their host, or at least do it no harm. Most animals deprived of their intestinal flora will continue on their way, although perhaps uncomfortably, until re-inoculation takes place. (Remember taking antibiotics for an infection and the intestinal distress that followed?)

Intestinal flora and fauna have little difficulty getting to their destination. Spores and cysts are everywhere. A calf or foal takes in protozoan cysts with its first solid meal, and bacterial spores even earlier.

One-celled protozoans in animal stomachs and intestines are unlike those anywhere else. They cannot live in the presence of oxygen, though they thrive in the methane-rich atmosphere of digestive tracts.

These protozoans are mostly ciliates, the size of paramecium familiar to biology students; but, the similarity ends there. Their complexity is astonishing. Some look like Maurice Sendak's toothed monsters from *Where the Wild Things Are*, others like whirling dervishes, still others like asymmetrical aliens from another planet.

One ciliate in particular, *Diplodinium*, is notable. Translated into terms we can understand, microscopic features within its single cell include the equivalent of a



illustration by Adelaide Tyrol

backbone, brain, nerves and nerve cord, lips, tentacles, legs, muscles, bladder, esophagus, and colon.

Digestive tract protozoans like *Diplodinium* forage energetically, competing for food in the dense, mushy surroundings amongst equally hungry bacteria, yeasts, spirochetes, different kinds of protozoans, even tiny worms.

What a feast for these Lilliputian creatures! Smashed, moistened plant substance flows along, first partly decomposed by bacteria living in the mash. Protozoans then have a wide menu set before them: broken cells, globs of cytoplasm, liberated sugars and oils, other one-celled animals, and the bacteria themselves. A thick organic soup envelops them as they gulp in all that their little one-celled bodies can hold.

Surrounded by such rich nourishment to satisfy their intense metabolism, the tiny animals reproduce rapidly, even though each individual survives no more than a day.

Nearly 130 species of ciliated protozoans are known to flourish in hoofed animals. In addition, cattle support two species of amoebas and five kinds of flagellates. There are at least 50,000 ciliates per cubic centimeter of a healthy cow's gut, 30,000 of them belonging to a single species, totaling six pounds of living protozoan substance per cow.

Each day, the ciliate population supplies about 2.5 ounces of protein for a cow to absorb, and when they die, their tiny corpses provide up to 20 percent of a cow's total nitrogen requirements. In sheep and goats, the ciliate count is four times higher. We know nothing about the countless other species living as wild herbivores, all of which harbor their own intestinal zoos.

What does this arrangement

mean to a host mammal, and what do ciliates get out of it? The picture is far from clear. You can "defaunate" a cow of its ciliates — it is not a big deal for the cow, but only as long as bacteria remain to break down cellulose into carbohydrates.

Given a choice, the cow does better keeping its ciliate zoo intact. Some protozoans produce enzymes capable of breaking down cellulose into carbohydrates, a bit of chemistry that helps the cow by furnishing greater quantities of high-energy food than by the action of bacteria alone.

But other ciliates, unable to produce enzymes, have developed an alternative. They hold bacteria captive within their cells as chemical tools, ensuring themselves a steady supply of carbohydrates before the cow gets the leftovers.

Intestinal ciliates aren't parasites; neither do they enjoy a shared beneficial association with the cow, although in some instances an elementary mutualism exists. In biological terms, they are mostly "commensals" — one individual benefiting from the relationship, the other simply accepting the situation.

Stand beside a cow, your hand on its rumbling flank, and know that deep in the dark, warm, oxygenless, churning digestive tract, untold millions of busy little animals are living successful lives. The placid bovine, completely unaware, is entirely comfortable with the situation. 🐄

Bill Amos is a retired biologist and author. He lives in St. Johnsbury. This weekly column is produced by Northern Woodlands. A selection of these columns has been collected in The Outside Story.