Mudflat Menu: Biofilm with a Side of Clamworms

Wild Neighbors

By Joe Eaton

This is the season when the mudflats of San Francisco Bay swarm with southbound migrant shorebirds: willets, godwits, curlews, dowitchers, plovers, and, outnumbering all the rest, western sandpipers. In the late 1980s and early 1990s, scientists from the Point Reyes Bird Observatory (now PRBO Conservation Science) attempted to estimate the birds' year-round numbers. For western sandpipers, they came up with average fall and winter counts of over 100,000 individuals and spring counts of over 500,000. The peak spring count exceeded 700,000. That's a lot of avian biomass, even at nine-tenths of an ounce per bird.

For all these migrants, the Bay is a critically important refueling stop. These birds, some of which travel from the Arctic to Patagonia, need to keep their fuel reserves high. You can see them working their way methodically across the flats, searching for food. Long-billed birds like curlews, godwits, and dowitchers probe deep into the mud; shorter-billed sandpipers and plovers make shallower probes or peck at the surface.

But what are they eating? In the case of the western sandpiper, we used to think we knew. The literature is full of dietary studies in which biologists shot a sample of sandpipers and inventoried their stomach contents. At Palo Alto, small crustaceans called ostracodes made up 63 percent of the total diet, along with clams, mud snails, amphipod crustaceans, and clamworms. Elsewhere, as at the Copper River Delta in Alaska, bivalve mollusks were more important.

It turns out, though, that these small invertebrates may be only a supplemental food source. What the sandpipers are mostly eating is biofilm.

And what is biofilm? It may help to think of it as primordial ooze. A biofilm is a community of microorganisms, including bacteria and algae, embedded in a matrix of polymeric compounds.

They're all over the place: streambed rocks, stagnant ponds, hot springs, Antarctic glaciers, boat hulls, pipes. Dental plaque is a kind of biofilm.

The mudflat version of biofilm is dominated by photosynthetic microalgae, diatoms for the most part, collectively called *microphytobenthos.* It doesn't sound that appetizing to me either, but it had been recognized as a food source for snails and other invertebrates, and a few species of fish. No one had suspected that shorebirds might be grazing it as well.

That was before a team of Japanese, Canadian, and French biologists led by Tomohiro Kuwae caught western sandpipers in the act in British Columbia's Fraser River Estuary. As reported earlier this year in the journal Ecology, they used high-speed video to record the birds' feeding behavior, traditional shoot-and-count stomach content studies, and analysis of the birds' droppings to establish that the sandpipers were actually eating biofilm.

For one thing, the birds behaved differently than they did when pursuing tidal invertebrates. They moved more slowly, which makes sense: biofilm isn't going anywhere. In a movement distinct from either pecking or probing, the birds collected a small dab of biofilm with their bill tip, worked it back and forth in the bill, and swallowed it. The process takes about three-tenths of a second and leaves telltale chains of bill-tip impressions in the mud. The video recordings clearly showed that the sandpipers were not capturing snails or other surface-dwelling invertebrates.

The grazing birds' stomachs were packed with sediment ingested with the biofilm. Both stomach contents and droppings showed chlorophyll levels and stable carbon and nitrogen isotope ratios consistent with a diatom diet. Kuwae and his associates calculated that biofilm could account for half the daily energy requirement of a sandpiper during migration.

This is startling. The sandpipers are eating a whole level lower in the food chain than we thought. Instead of being primarily predators, feeding on worms, mollusks, and crustaceans, they're grazing like bison or wildebeest. Biofilm feeding, the scientists speculate, could be a way of hedging nutritional bets during long-distance migration, reducing competition among species of mudflat-feeding birds, and loading up on carbohydrates for instant energy.

I'm assuming that somebody will confirm biofilm grazing in San Francisco Bay sooner or later. If so, there will be some interesting local complications. The sandpipers would be competing with the invasive Asian hornsnail (Batillaria attramentaria), which hitchhiked here in shipments of Japanese oysters. Batillaria, a diatom-grazing specialist, has already overrun Elkhorn Slough, displacing native snails. Three years ago, UC Davis graduate student Heidi Weiskel discovered the alien snail in our Bay.

In the longer term, the whole shorebird smorgasbord is at risk. San Francisco Bay has been getting deeper over the last century as sediment input has declined, and sea level rise will amplify that trend. The intertidal mudflats haven't kept up. Without human intervention, we could lose that whole extraordinarily productive part of the estuarine ecosystem.

Joe Eaton's "Wild Neighbors" column appears every other week in the Berkeley Daily Planet, alternating with Ron Sullivan's "Green Neighbors" column on East Bay trees.