European crab leaps to Pacific prominence

Andrew Cohen made a disturbing discovery last week while poking around coastal mud flats in southwestern Washington.

State researchers had invited Cohen, a marine ecologist with the San Francisco Estuary Institute in Richmond, Calif., to survey a stand of non-native cord grass that was invading the shallow waters of Willapa Bay. Just 30 minutes after donning his boots and wading into the water, Cohen stumbled upon the first evidence that an even more reviled species had emigrated to Washington. He had found the molted shell of a male European green crab (*Carcinus maenas*).

Cohen knows this alien crab far better than he'd like to. Nine years ago, it turned up in San Francisco Bay. By 1993, it was moving up the California coast, rapaciously feeding on any shellfish its size or smaller. Last year, it was spotted in a bay in Oregon.

"With the green crab on the West Coast, we are witnessing a truly astounding event," says Armand M. Kuris of the University of California, Santa Barbara (UCSB). Non-native species typically expand their West Coast range by no more than 50 miles in 40 years, he observes. Last week's sighting indicates that the European green crab has leapfrogged 700 miles in 6 years.

What's more, wherever it invades, small, near-shore invertebrates all but disappear, says Elliott A. Norse, president of the Marine Conservation Biology Institute in Redmond, Wash.

In Bodega Bay, Calif., for instance, Edwin D. Grosholz of the University of New Hampshire in Durham has shown that the green crab has culled 90 percent of the small shore crabs (*Hemigrapsus oregonensis*) and native clams (*Nutricola*). A single 3-inch adult green crab can eat 40 clams daily.

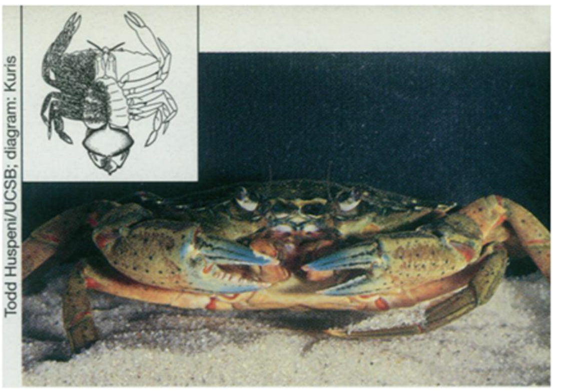
To date, most of the West Coast shellfish that this invader has consumed "have not been economically important," Grosholz notes. That situation stands to change as the green crab continues its northward trek. Washington, home of the nation's largest oyster-rearing operations, and Oregon also have substantial fisheries for Manila clams, mussels, and the prized Dungeness crabs, whose tiny young mature in the same rocky marine shallows that green crabs prefer.

Kuris and Kevin D. Lafferty, also at UCSB, have estimated the value of West Coast fisheries vulnerable to this predatory crab. In Oregon and Washington alone, it comes to some $44 million per year—roughly twice the value of similar fisheries in California.

Though no one knows how the green crabs arrived, they probably hitched a ride in the ballast water of a docking cargo ship or in a box of marine bait shipped from the East Coast. These same crabs savaged northern East Coast waters when they first arrived from Europe sometime in the early to mid-1800s. They are blamed for destroying New England's softshell clam fishery.

Just 2 days before finding the green crab at Willapa, Cohen and one of his hosts had been attending a symposium that focused on the potential introduction of predators to control the invasion of alien marine organisms. At the meeting, Kuris described his studies of a parasitic barnacle, *Sacculina carcini*, that sterilizes male and female green crabs.

The larva of this so-called castrating barnacle, which lives throughout *C. maenas'* native range, bores into the crabs and in the course of several months infuses its host with a network of its own tissues. Eventually, the parasite forms an egg sac that extends outside the crab, beside its gonads. For all practical purposes, Kuris says, an infected *C. maenas* soon constitutes little more than an egg-production facility for the barnacle.



Todd Huspeni/UCSB; diagram: Kuris

Green crab with inset diagram showing (left side only) the invasive web of structures that develops when the crab is infected with a castrating parasitic barnacle.

If his studies find that introducing the alien barnacle won't present undue risks to native marine animals, Kuris says, this parasite might someday be considered for release as part of a strategy to rein in the green crab. That invader now controls ecosystems in portions of Australia, Japan, Canada, and South Africa, as well as the U.S. coasts. —*J. Raloff*

Quick screening yields better catalysts

Fuel cells that convert methanol and water into electricity may one day offer a clean, portable source of power for electric vehicles. To date, however, the materials used as catalysts to perform this conversion haven't been efficient enough to make such fuel cells practical.

Now, researchers have developed a technique to screen potential catalysts rapidly. They mix together small amounts of metals in different proportions and then identify visually which combinations work best. With this method, "we can spot catalytic compositions that we would never have considered" with an approach based on chemical theory, says Eugene S. Smotkin of the Illinois Institute of Technology (IIT) in Chicago.

Smotkin had been looking for new materials by trying to deduce which metals would blend well with platinum to catalyze efficiently the breakdown of methanol in a fuel cell. "I had some success," says Smotkin, "but the process was laborious and time-consuming." Thomas E. Mallouk of Pennsylvania State University in State College suggested that they look instead at a large number of catalysts simultaneously.

Using an ink-jet printer, Mallouk and his colleagues laid down hundreds of daubs of different metal combinations on conductive carbon paper. They immersed the array of spots in a mixture of methanol, water, and a fluorescent dye that glows under acidic conditions. When they applied an electric voltage, the best metal combinations triggered an electrochemical reaction that increased the acidity of the solution around those spots. Simply by observing which spots glowed, the researchers could identify good candidate materials.

Smotkin then tested the most promising ones in fuel cells and found that a particular blend of platinum, ruthenium, osmium, and iridium is much more active than the platinum-ruthenium alloy now considered the best catalyst available. Using the old strategy, "I never would have considered iridium," he says. Smotkin, Mallouk, and their colleagues report their findings in the June 12 SCIENCE.

Robert C. Haushalter of Symyx Technologies in Santa Clara, Calif., says scientists there have been examining the same kinds of materials with similar methods (SN: 11/1/97, p. 278).

After using this technique to search for methanol fuel cell catalysts, the researchers at IIT and Penn State began developing such combinatorial methods to find catalysts for cells that run on hydrogen and oxygen, which power some of today's electric vehicles (SN: 11/13/93, p. 314). Methanol fuel cells are "at least a decade away," Smotkin says. —*C. Wu*

E. Reddington *et al.*/SCIENCE

Each spot in the array consists of a different mixture of three catalytic metals (left). The best blends glow when an electric voltage is applied (right).