CLEAN CRABS

A crustacean's quest for cleanliness

BY JOAN AREHART-TREICHEL

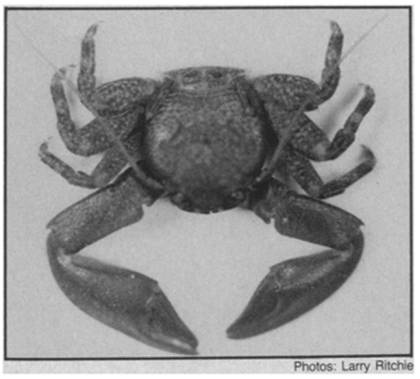
Tiny crabs, no bigger than a thumbnail, live in the cool Pacific waters off the coast of southern California. The crabs, like shrimp and other crustaceans, engage in body-cleaning behavior. But the females of this species, *Petrolisthes cabrilloi*, are particularly zealous about body cleaning. They have the same fetish for it that *Hausfrauen* have for housecleaning. Behind the female crab's large pair of claws and three pairs of walking legs, near her derrière, is a tiny pair of legs that looks like a miniature set of windshield wipers. A dainty brush can be seen on each wiper. She uses these little legs to frequently clean her body.

Now, the *Hausfrau*'s penchant for cleanliness is rather obvious—to please herself, her husband and children. But it's hard to believe that the tiny female crab is trying to please a mate since male crabs aren't known for conjugal devotion, or that she's a super mama since she stops caring for her young once her eggs hatch into larvae. So why is she so hepped up about body cleanliness?

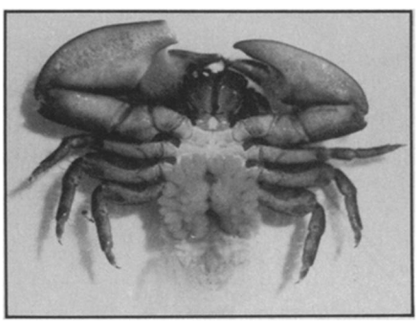
The answer has now been found by Larry Ritchie, a doctoral student in biological oceanography at the Scripps Institution of Oceanography in LaJolla, Calif. The female crab is busy cleaning herself of a parasite that, if it establishes itself on her abdomen, can make her sterile. Her supercleanliness is a heroic effort to safeguard the survival of her species. This is the first time that a crustacean has been found to use a behavioral means of defense against parasites.

Ritchie's initial interest wasn't *P. cabrilloi*, but rather the parasite that infects her—*Lernaeodiscus procellanae*. During the past 70 years, researchers have learned that the parasite has a bizarre life cycle indeed, especially during the invasion of the host and its reproductive phase. The female larva attaches herself to the body of the female *P. cabrilloi* crab and forms a sac known as the kentrogon. It is no larger than a dust particle. The kentrogon expels into the host a mass of cells which travel to the crab's abdomen where they develop into the adult female parasite. The male parasite, on the other hand, reaches sexual maturity during the larval stage and is nothing more than a glorified gonad living within the female parasite.

Once the adult female parasite is established on the crab's abdomen, she lays her eggs there, and the male parasite inside her fertilizes the eggs. The female parasite has a reason for laying her eggs in this part of the crab. It is where the female crab usually carries her own fertilized eggs until they hatch into larvae. Consequently, the crab cares for the parasite's



Photos: Larry Ritchie



P. cabrilloi infested by parasites.

eggs as if they were her own. Such surrogate mothering wouldn't be hard on the crab if the female parasite didn't, in thankless and malicious return, go on to sterilize the crab's reproductive system and trick her into thinking the parasite eggs were her own brood.

Ritchie's concern of the moment wasn't for the victimized crab, however. He was eager to learn more about the parasite. He raised female larvae of the parasite and tried to infect female *P. cabrilloi* crabs with them. But after eight months of trying, not one kentrogon had established itself on the female crab.

He then started to notice that whenever he introduced the female parasite larvae into the presence of the female crabs, they stopped whatever they were doing to hastily clean themselves with their tiny windshield wipers. What's more, if he overwhelmed the crabs with parasites, the crabs dispensed with cleaning, tried to climb out of their containers in desperation or even went into shock and died. Thus, the crabs use cleaning to keep the parasites off their bodies, Ritchie realized. But if the crabs are overwhelmed with parasites, they realize that even cleaning is not an adequate defense and try to escape or have a nervous breakdown. Ritchie then tested this hypothesis to make sure he was right. He removed some of the crabs' cleaning legs, and sure enough, the parasite larvae were then able to establish kentrogons and invade the crab. Thus the adult female parasite was established on the host abdomen.

This discovery so intrigued Ritchie that he decided to set his interest in the parasite aside, at least for the present, and to explore the female crab's defensive cleaning behavior. He asked himself: Since the female *P. cabrilloi* has evolved her cleaning behavior to maintain her species, would a female crab of a species not normally a host to the parasite also try to clean the parasite larva off if it were put in her presence?

He took females of a related crab species from the nearby Gulf of California—*Petrolisthes gricilis*—and exposed them to the parasite. The parasite appraised the crabs from this species, attached itself to them, then realized that they had evolved too far away physiologically to be good hosts for the parasite. Meanwhile, the crabs evaluated the parasite that had attached to them. Not realizing that the parasite couldn't use them as a host, they slowly started using their cleaning legs to get rid of the parasite. But it took these crabs a full 5 minutes to arrive at defensive behavior, whereas *P. cabrilloi* females take only 15 seconds to get their cleaning legs into motion. More crucial, *P. gricilis* was unable to remove the kentrogon larva and was invaded by the parasite.

"This finding was exciting," Ritchie recalls. "It showed natural selection at work. Although evolution has not selected for *P. gricilis* to use cleaning as a defense against parasites, the crab still tried but lacked the evolutionary know-how to succeed."

Thus Ritchie's tangential wanderings into the cleaning behavior of *P. cabrilloi* ended up shedding light on the parasite—his initial interest—after all. He now realizes that the parasite probably evolved its elaborate reproductive mechanism, the microscopic kentrogon, as a counterdefense against *P. cabrilloi*'s ancestors that evolved cleaning behavior as a defense against the parasite. In other words, if the parasite could manage to get the tiny kentrogon established on the crab, then the chances were great that the crab would be fooled into accepting the parasite when she became established on the abdomen of the crab, and the parasite would continue as a species.

"It's a cause and effect evolution between a parasite and a crab trying to outwit each other in survival," Ritchie concludes. □