



Creating the Nation's first BioPark

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Letter From the Desk of David Challinor
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In July 1994, my letter was about commensalism in animals. Commensalism, as you remember, describes the relationship in which two or more organisms live in close attachment and from which one or both may benefit even though neither normally harms or is parasitic on the other. I gave examples: ox peckers eat ticks off antelopes, and small fish groom large ones. In virtually every case in which one organism groomed another of a different species, both seemed to benefit from this commensal behavior. In the last two years, however, research on the evolution of this behavior has tried to quantify the benefits to the groomer and its host or client. A new report summarizes recent research results. (Poulin R. Vickery WL.1996. Cleaning Symbioses: Proximate and Adaptive Explanations. Bio Sci. 46(7): 512-517.)

In the early 1960s, scientists generally described cleaning behavior, especially between different fish species, as an example of the unusual cooperation between such species for their mutual benefit as opposed to the more common competitive struggle for existence. A decade later some scientists described grooming as an early example of the evolution of altruistic behavior by both the cleaner and its host. The host behaved altruistically by swimming to the territory of the cleaner fish to allow it to feed on its parasites. Thus the cleaner had a ready food source delivered to its doorstep and was altruistic in relieving the host of its parasites whenever the host presented itself to be groomed. The host in turn warns the cleaner if a predator approaches, so the cleaner can escape and clean the host again at a later time.

We should be careful before reaching any conclusion about altruism because many client fish respond to objects rubbed against them in the same way they react to cleaners, regardless of whether they have external parasites. This reaction could indicate that cleaners are clever commensals which take advantage of the host's desire for tactile stimulation. Thus the perception of this fascinating relationship between unrelated organisms has changed from one of selfless cooperation to mutually beneficial commensalism. By definition, a parasite harms its host, a commensal does not, but the distinction between the two behaviors is often difficult to find.



The cleaning organism consumes ectoparasites, diseased or injured tissue, from the external surface of the cooperating host, an activity which would seemingly provide the cleaner with a readily available food source. But the full net benefits to either party have yet to be quantified. Does the client truly benefit from being cleaned? Does it live longer, stay healthier, grow faster or have more progeny? Answers to these questions are important because of the rapid expansion of commercial fish farming. About 80% of the salmon sold in the U.S. comes from farm-raised fish. The introduction of cleaner fish into farmed fish stock to reduce external parasites may be a better way of maintaining healthy stock than by using chemical control measures.

Cleaning behavior involving different species is common in nature and I gave several examples in my earlier letter of birds cleaning mammals and reptiles, and invertebrates (crabs and shrimp) cleaning fish. Mutual cleaning within a species is also practiced frequently, especially in primates and in many colonial nesting birds such as penguins. Although grooming removes many external parasites, the practice within a species may be just as important in promoting bonding as a survival benefit as it is for cleanliness alone.

There seems to be more examples of cleaning symbioses among aquatic organisms than among terrestrial ones, probably because it is harder for a fish or a whale to clean itself than it is for land dwellers. Killer whales in the Pacific Northwest, however, evidently groom themselves by rubbing against a bed of round pebbles. Given the enormous external parasite load carried by large whales, one wonders why more cleaners have not adapted to this food source. One answer may be that smaller cleaners might have trouble evolving to stay with whales in their long migrations.

Although the evolution of interspecific cleaning is puzzling, scientists nonetheless have drawn some parameters for cleaner fish behavior. For example, for a fish to evolve as a cleaner it would have to: 1) feed on small external parasites, 2) be smaller than the host to survive on a host's limited food supply, and 3) see well, be nimble, and have a mouth capable of plucking small organisms from the host's scales. Wrasses are a group of 3" long fish that have within their family many full-time cleaner species as well as some species that can readily adopt this behavior when conditions are favorable. In fact many of the wrasses have been such successful cleaners that one unrelated fish species has evolved to mimic them, with the mimics enjoying easy access to large hosts waiting to be cleaned. However, instead of grooming the host for ectoparasites, the mimics dart in and bite off a piece of tissue to eat, thereby behaving as parasites. Thus the interesting question is not so much which organisms are, or have the potential to be, cleaners, but why they became so in the first place.

The first investigators thought the cleaning behavior to be mutually beneficial, but further research indicated that the desire of host fish for tactile stimulation may have evolved before cleaning symbiosis developed. If that is the evolutionary sequence, then the cleaner merely evolved to exploit an existing condition, i.e. exploitation of the host's "scratching or itch-relief behavior." Furthermore, about five experiments have shown that host fish living on a natural coral reef appeared no worse off when all cleaners were removed from their area than the same fish living in association with cleaners. These experiments may have been too short to determine long-range benefits to hosts with access to cleaners, but opportunities now exist for more elaborate and longer controlled experiments in fish farms.

A complicating factor arose when a scientist raised certain host fish from eggs and, when mature, these naive fish assumed a posing motion ready to be groomed when exposed to cleaner fish; they failed to do so when confronted with a similar small fish that was not a cleaner. This suggests that the host's behavior indicates a genetic tendency that causes the host to adjust to a specific (cleaner fish) stimulus. This host behavior can occur even when the host is not parasitized. The cleaner's goal is to have the host continue to come to be groomed, so it is to the cleaner's advantage to groom the host even when the host has no parasites, or if it has some, the cleaner may still groom it even if satiated. Does the cleaner's behavior then suggest that cleaning symbioses may really be only exploitation of the host by the cleaner? If so, should not the hosts have evolved some kind of defensive behavior to protect them from being exploited? These and other questions will continue to arise whenever one behavioral aspect of an organism seems to be understood.

The research described above is a good example of the endless quest for understanding the natural world that has always driven scientists. I think we must accept that we humans will never find all the answers, at least here on earth, but the excitement and the stimulus for those addicted to seeking answers is in the search itself.

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