= Cleaning symbiosis =

Cleaning symbiosis is a mutually beneficial association (symbiosis) between two species , where one (the cleaner) removes and eats parasites and other materials from the surface of the other (the client) . Cleaning symbiosis is well @-@ known among marine fish , where some small species of cleaner fish , notably wrasses but also species in other genera , are specialised to feed almost exclusively by cleaning larger fish and other marine animals . Other cleaning symbioses exist between birds and mammals , and in other groups .

Cleaning behaviour was first described by the Greek historian Herodotus in about 420 BC , though his example (birds serving crocodiles) appears to occur only rarely .

The role of cleaning symbioses has been debated by biologists for over thirty years . Some believe that cleaning represents selfless co @-@ operation , essentially pure mutualism . Others such as Robert Trivers hold that it illustrates mutual selfishness , reciprocal altruism . Others again believe that cleaning behaviour is simply one @-@ sided exploitation , a form of parasitism .

Cheating , where either a cleaner sometimes harms its client , or a predatory species mimics a cleaner , also occurs . Predatory cheating is analogous to Batesian mimicry , as where a harmless hoverfly mimics a stinging wasp , though with the tables turned . Some genuine cleaner fish , such as gobies and wrasse , have the same colours and patterns , in an example of convergent evolution . Mutual resemblance among cleaner fish is analogous to Mullerian mimicry , as where stinging bees and wasps mimic each other .

= = History = =

In his Histories (book II) , the ancient Greek historian Herodotus wrote :

As [the crocodile] lives chiefly in the river , it has the inside of its mouth constantly covered with leeches ; hence it happens that , while all the other birds and beasts avoid it , with the trochilus it lives at peace , since it owes much to that bird : for the crocodile , when he leaves the water and comes out upon the land , is in the habit of lying with his mouth wide open , facing the western breeze : at such times the trochilus goes into his mouth and devours the leeches . This benefits the crocodile , who is pleased , and takes care not to hurt the trochilus .

Herodotus thus claimed (circa 440 BC) that Nile crocodiles had what would now be called a cleaning symbiosis with the bird he called the trochilus , possibly a sandpiper ; but while he was right about the existence of cleaning symbioses , there is little evidence for it in crocodiles . In 1906 Henry Scherren quoted John Mason Cook , son of travel agent Thomas Cook , as reporting from Egypt that he had seen some spur @-@ winged plovers approach a crocodile , which opened its jaws for them :

Mr. J. M. Cook , of the celebrated tourist agency , when in Egypt in 1876 , " watched one of these birds , and saw it deliberately go up to a crocodile , apparently asleep , which opened its jaws . The bird hopped in , and the crocodile closed its jaws. in what appeared to be a very short time , probably not more than a minute or two , the crocodile opened its jaws , and we saw the bird go down to the water 's edge . " There were several of these birds about , and Mr. Cook shot two of them , which Dr. Sclater identified as Spur @-@ winged Plovers ; so that the question as to what bird enters the mouth of the crocodile is now set at rest .

MacFarland and Reeder , reviewing the evidence , found that

Extensive observations of Nile crocodiles in regular or occasional association with various species of potential cleaners (e.g. plovers , sandpipers , water dikkop) ... have resulted in only a few reports of sandpipers removing leeches from the mouth and gular scutes and snapping at insects along the reptile 's body .

= = A disputed relationship = =

Cleaning symbiosis is a relationship between a pair of animals of different species , involving the removal and subsequent ingestion of ectoparasites , diseased and injured tissue , and unwanted

food items from the surface of the host organism (the client) by the cleaning organism (the cleaner) . Its status has been debated by biologists , with viewpoints ranging from pure mutualism through to a form of exploitative parasitism by the cleaner .

Marine biologist Alexandra Grutter explains :

Cleaning associations involve cleaner organisms that remove ectoparasites and other material , such as mucus , scales and skin , from the body surfaces of other apparently co @-@ operating animals . The latter are often referred to as hosts , customers , or clients . Cleaning behaviour is one of the most highly developed inter @-@ specific communication systems known , with clients striking elaborate postures which have generally been assumed to make ectoparasites more accessible to cleaners .

= = = Selfless co @-@ operation = = =

Grutter and her colleague Robert Poulin , reviewing over thirty years of debate by biologists on cleaning symbioses , argue that " Cleaning symbioses may not be mutualistic associations but rather one @-@ sided exploitation " . They quote , for example , C. Limbaugh as writing in 1961 : " From the standpoint of the philosopher of biology , the extent of cleaning behavior in the ocean emphasizes the role of co @-@ operation in nature as opposed to the tooth @-@ and @-@ claw struggle for existence " .

= = = Mutual selfishness = = =

In 1971 , mathematical biologist Robert Trivers wrote more carefully " Cleaner organisms and their hosts meet the preconditions for the evolution of reciprocally altruistic behavior . The host 's altruism is to be explained as benefiting him because of the advantage of being able quickly and repeatedly to return to the same cleaner " (i.e. mutual selfishness) .

= = = One @-@ sided exploitation = = =

By 1987 G. S. Losey wrote less optimistically " Cleaners are nothing but very clever behavioral parasites ... that have taken advantage of the rewarding aspects of tactile stimulation , found in nearly all vertebrates . " Poulin and Grutter remark that " Over the last few decades , ... the opinion of scientists regarding cleaning symbioses has changed , from selfless cooperation , to a mutually beneficial interaction , and finally to a one @-@ sided exploitation . "

= = Biological range = =

Cleaning symbiosis is known from several groups of animals both in the sea and on land (see table) . Cleaners include fish , shrimps and birds ; clients include a much wider range of fish , marine reptiles including turtles and iguanas , octopus , whales , and terrestrial mammals . Cleaning symbioses with reptile clients include fish cleaning the teeth of American crocodiles (Crocodylus acutus) , geckos eating mosquitoes on Aldabra giant tortoises (Geochelone gigantea) and scarlet crabs (Grapsus grapsus) , and three species of Galapagos finches removing ticks from marine iguanas (Amblyrhynchus cristatus) .

The best known cleaning symbioses are among marine fishes , where several species of small fish , notably of wrasse , are specialised in colour , pattern and behaviour as cleaners , providing a cleaning and ectoparasite removal service to larger , often predatory fish . Cleaner species , as shown in the table , vary widely in their degree of dependence on their clients . Some are essentially pure obligate symbionts like the cleaner wrasse ; some are opportunistic or facultative symbionts , like the orange chromide or some cleaner shrimps ; and some , like the oxpeckers , combine a little eating of parasites (beneficial to client) with taking of blood (harmful to client) , their favoured food .

= = Mimicry among cleaner fish = =

= = = Mutual mimicry among cleaner fish = = =

Many cleaner fish in different families , such as the Caribbean neon goby (Elacatinus evelynae) and the cleaner wrasse (Labroides dimidiatus) , share the distinctive combination of a long narrow body , a longitudinal stripe , a blue colour , and small size . " Convergent signalling among cleaners , using size , stripes and colour , should facilitate their recognition by fish clients . " This is analogous to Mullerian mimicry where genuinely aposematic species (such as wasps) mimic each other 's warning colours .

= = = Aggressive mimicry of blennies to cleaner fish = = =

The sabre @-@ toothed blenny (Aspidontus taeniatus) is a predatory blenny , an aggressive mimic which accurately resembles the bluestreak cleaner wrasse , not only in colour and pattern , but also in the ritualised dance the cleaner wrasse makes when potential client fish swim nearby . However , instead of providing the cleaning service that it signals , it bites off pieces of healthy skin , scales and mucus from the host and then swims rapidly away to safety .

The effect of aggressive mimicry in a cleaning symbiosis is analogous to Batesian mimicry , where a harmless " edible mimetic species copies the warning signal of a noxious , aposematic model species , thereby gaining protection from predators " . As in Batesian mimicry , the rate of successful attacks on cleaning clients by the bluestriped fangblenny (Plagiotremus rhinorhynchos) , which like the sabre @-@ toothed blenny mimic the bluestreak cleaner wrasse (Labroides dimidiatus) , is frequency @-@ dependent , meaning that the mimicry is more effective when the cheating fangblenny is rare compared to the cleaner wrasse . The difference , however , is that the aggressive mimic is inserting itself into a co @-@ operative relationship (between cleaner and client) , whereas " Batesian mimics insert themselves into an antagonistic predator ? prey interaction (where the models are the unpalatable prey) . "