The Protection of the Anemone Fish, *Amphiprion xanthurus*, from the Sea Anemone, *Stoichactis kenti*

The key to the protection of various pomacentrid fishes from the nematocysts of symbiotic sea anemones lies in the curious behavioral process termed 'acclimation'[1,2]. At the start of acclimation, a pomacentrid fish (Genus *Amphiprion* or *Dascyllus*) is stung by a sea anemone's nematocysts; at the end of this period, the same fish is no longer stung. Two major hypotheses seek to explain the acclimation process. The first of these implies that the sea anemone is responding to its symbiotic fish in such a way that its pattern of nematocyst discharge is altered or inhibited[3-5]. The second hypothesis suggests that the sea anemone is the passive partner and that the fish is able to protect itself by somehow altering or affecting its own epithelial mucous coating[1,6-8].

This study of the anemone fish, *Amphiprion xanthurus* Cuvier and Valenciennes and the sea anemone, *Stoichactis kenti* Haddon and Shackleton, both from the Philippines, has resolved some of the discrepancies in the above work and indicates that anemone fishes are protected by something associated with their surface mucous coat.

Reciprocal experiments were conducted in which both acclimated fish (i.e., those living with a sea anemone at the time of the experiment) and unacclimated fish (i.e., isolated from all contact with sea anemones for one week or more) were tested against the same species of sea anemone both with and without acclimated fish of the same species.

The rationale for these experiments was briefly as follows: if only the acclimated fish was *not* stung by sea anemones, both with and without fish, this would indicate that some change had occurred to the fish during acclimation which resulted in its protection. Conversely, if only the sea anemone containing acclimated fish failed to sting the fish (either acclimated or unacclimated), this would indicate some change had occurred to the sea anemone during acclimation which resulted in the fish's protection.

Preliminary tests revealed that the anemone's tentacles adhere to organic material due to the discharge of basitrichous isorhiza nematocysts. Therefore this adhesion response, the 'jumping' back of the fish upon tentacle contact, contraction of the anemone's tentacles and the adherence of small tentacle fragments and blistering of the fish's epidermis were all used as criteria that an experimental fish was being stung by the anemone's nematocysts. Tests with live prey as well as various organic materials were conducted both before and after each experiment to ensure the anemones were fully capable of prey capture. The results of these experiments are given in the Table.

The acclimated fish were not stung by sea anemones, either with or without acclimated fish, suggesting that something had occurred to the fish during acclimation which resulted in its protection. The surface mucous coating apparently served as this protection since an acclimated fish was immediately stung when this coating was wiped off or disturbed (Table). Some 44 additional reciprocal experiments of the same type, only using two species of California sea anemones, *Anthopleura xanthogrammica* (Brandt) and *Anthopleura elegantissima* (Brandt), with *Amphiprion xanthurus* gave the same results: all the unacclimated fish were stung while all the acclimated fish were not. These experiments were of interest because *Anthopleura* had never before encountered any species of anemone fishes in its natural environment, yet *Amphiprion xanthurus* became protected in the same manner as with the tropical sea anemone, *Stoichactis*. In all cases, the acclimated fish's surface mucous coat seems to act by masking the fish's normal stimuli for nematocyst discharge.

Careful inspection of those papers suggesting that the sea anemone was perhaps altering its nematocyst discharge pattern in response to an anemone fish reveal that in some cases these authors were testing fishes acclimated to one species of anemone against an entirely different species of anemone without conducting the necessary reciprocal experiments[3-5].

Results of presenting *Amphiprion xanthurus* to *Stoichactis kenti* anemones

Fish	Anemone (without fish)	(with fish)	Total No. of experiments	Summary of results
Unacclimated	+ (9)	+ (8)	17	Unacclimated fish stung
Acclimated	— (6)	— (7)	13	Acclimated fish not stung
Total No. of experiments	15	15	30	
After wiping off surface of acclimated fish	+ (3)	+ (3)		Acclimated fish immediately became unacclimated

Numbers in parentheses refer to number of individual experiments. + = fish stung; — = fish not stung.

Zusammenfassung. Reziproke Kombinationsversuche zeigen, dass «angewöhnte» Anemonenfische nicht von Seeanemonen genesselt werden, die der gleichen Art angehören, mit der sie zusammengelebt haben. Nicht angewöhnte Fische werden durch Seeanemonen genesselt unabhängig, ob letztere angewöhnte Fische beherbergen oder nicht. Wird die Oberfläche angewöhnter Fische abgewischt, verliert sie ihren Schutz[9].

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