Predation and Defence

Polyclad flatworms are soft, juicy, and delicate worms. During evolution they had to evolve strategies to protect themselves from all the hungry reef animals (especially fish and crustacea) that might eat them. One general principle is camouflage which means in first line to become invisible by being exclusively active at night or by matching both the texture and the colour of the food they prefer to feed on. Surprisingly, some strategies involve colours! In vertebrate animals with well developed vision, such as fish, colour patterns have often evolved as signalling displays for intra- and inter-species communication. Flatworms, however, have very poor eye sight and it is very unlikely that they can sense much more than light and dark and passing shadows. Thus, their brilliant colour patterns have evolved entirely for defense against predators, mainly fish, which have excellent eye sight.

As known from a variety of marine invertebrate animals (sponges, sea slugs, soft corals, tunicates), conspicuous colouration is often associated with the presence of toxic or distasteful defense substances. Species producing poisons might profit from advertising the presence of those compounds. If a conspicuous colour can be associated behaviorally with an unpleasant dining experience, then the predator might avoid the prey upon a second encounter. Natural selection would thus increase variants that have conspicuous colouration and live long enough to reproduce and spread the conspicuous colour trait in the population. Therefore, one can assume that conspicuous colours are mostly associated with the presence of toxic and bad-tasting compounds that warn potential predators that the animal is full of distasteful chemicals and not worth attempting to eat. This warning display strategy is known as *aposematic colouration.*

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Pseudoceros bifurcus Prudhoe, 1989 with an hugh bite mark testifying an aborted feeding attempt, assumably by a fish. Due to the excellent regenerative capacity of flatworms, epithelial cells at the edge of the wound have already closed over the lesion. In a few weeks the missing body part will be replaced completely.

(PHOTO © Erwin Koehler, www.medslugs.de).

This aposematic colouration might hold true for polyclads as well as there is no direct evidence for predation so far. Although worms have been detected bearing large tears in their flesh these are probably caused by aborted feeding attempts - assumably by fish. As fish feeding experiments under lab conditions revealed, worm pieces were quickly spat out whereas other prey was consumed by the tested fish. Investigation of polyclad chemical defense mechanisms revealed that several polyclads contain strong toxins such as tetrodotoxin (see section: Toxins). These findings suggest that flatworms are warning of their unpalatability and that their visual predators, fish, will quickly learn to avoid them by recognition of their distinct and bright colour pattern. Experiments performed by Hing P. Ang and Leslie J. Newman provide the first experimental evidence of aposematic colouration in pseudocerotid flatworms. Coloured and uncoloured agar models of flatworms were used to determine whether a fish predator, the moon wrasse *Thalassoma lunare*, could learn to avoid colourful flatworms on the basis of their colour pattern. The results showed that uncoloured models were more significantly attacked than coloured models and that there was no significant difference between attacks made to live flatworms and their respective models. These results clearly indicate the operation of aposematism in brightly coloured flatworms and demonstrate the operation of mimicry as the agar models were essentially non-living mimics of the flatworms.

Thus, brilliant colour patterns and conspicuous behaviour are indeed an effective antipredation strategy. Todays diversity of conspicuous coloured polyclad flatworms is the work of natural selection, which is an ongoing process. There is a strong individual selection for variants that have conspicuous colouration combined with toxicity or a very bad taste.

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