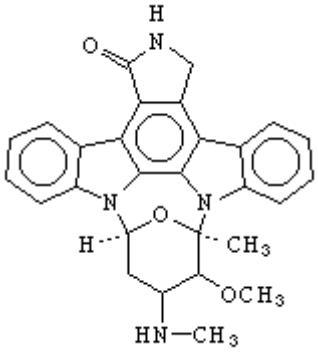
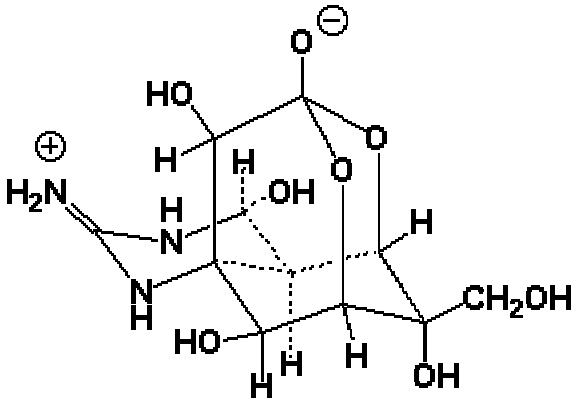
Toxins

Aposematic colouration (see section: Mimicry) is known as a common defence mechanism among marine invertebrate animals. Numerous conspicuously coloured sponges, soft corals, tunicates and sea slugs contain toxic or destasteful chemical compounds which are highly deterrent to their predators. This holds true for polyclad flatworms as well.
Investigation of the chemical defence mechanisms of the polyclad flatworms *Pseudoceros concineus* and *Planocera tentaculata* revealed the occurence of highly toxic chemical compounds such as staurosporine derivatives (Schupp et al., 1997 and 1999) and tetrodotoxin (Miyazawa et al., 1987), respectively.



< Staurosporine and its derivatives belong to a group of organic chemical compounds called indolocarbazole alkaloids. They are known as potent antibiotics and strong insecticides. Two of these compounds, 3-hydroxy-3'-demethoxy-3'-hydroxystaurosporine and 11-hydroxy-4'-N-demethylstaurosporine, were isolated from the marine polyclad flatworm *Pseudoceros concineus* and his favored food, the ascidian *Eudistoma toealensis (Tunicata)*. Both animals are brightly coloured and show a high abundance in the mangroves of Truk Lagoon, Micronesia. Feeding experiments with tropical reef fish showed that the crude extract from the ascidian was highly deterrent towards fish, suggesting that staurosporine acts as a highly potent chemical defence substance against predators (Schupp et al., 1997). It is not known yet, wether the flatworm's metabolism is able to produce staurosporine by itself. It is more likely that the actual source of the toxic compound is the ascidian. After feeding on the poisonous tunicate the polyclad flatworm becomes unpalatable because it stores the toxin in his own tissues.



< Tetrodotoxin is a non-protein organic compound (aminoperhydroquinazoline) and one of the strongest paralytic toxins known today. It is a very specific blocker of voltage-gated Sodium (Na+) channels, large integral membrane proteins that form pores through the plasma membrane of neuronal cells that allow Na+ ions to cross. Pores (=gates) open and close in response to a variety of stimuli such as changes in membrane potential or the presence of certain chemicals outside or inside the cell. Their proper functioning is absolutely essential for neuronal action potentials. Tetrododoxin, however, blocks these channels irreversibly leading to rapid paralysis through interference with neuromuscular conduction.

Tetrodotoxin and its precursors have been found in high concentrations in mucus, digestive organs, eggs and reproductory organs (oviduct) of the polyclad *Planocera multitentaculata* (Miyazawa et al., 1987; Noguchi et al., 1991) suggesting that these flatworms possess tetrodotoxin as a defense or alarm substance against predators.

Tetrodotoxin has also been isolated from widely differing animal species, including the pufferfish (photo: *Arothron nigropunctatus*, order: *Tetraodontiformes*), parrotfish, poison arrow frogs of the genus *Atelopus*, the blue-ringed octopus, starfish, angelfish, and xanthid crabs. Since pufferfish is a delicacy (Fugu) in Japanese cuisine, poisoning from tetrodotoxin is of major public health concern in Japan. The gonads, liver, intestines and skin of pufferfish can contain levels of tetrodotoxin sufficient to produce rapid and violent death. The flesh itself may not usually be toxic. Traditionally, a very small amount of liver is consumed with the meat. The resulting numbing sensation of the lips and tongue is considered part of the true dining experience. Since Fugu is prepared and sold in special restaurants by trained and licensed individuals most poisoning episodes (30-100 persons/year) occur from home preparation and consumption of misidentified and/or mislabelled frozen fish products.

To learn more about pufferfish poisoning, see the *US Center of Food Safety & Applied Nutrition* (FDA/CFSAN) website.

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