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# They are all Transsexuals

The popular anemone fishes are mostly known for their symbiosis with giant sea anemones, their interesting behaviour, and beautiful colours. But they also have another lesser known but interesting side to their lives: Their life cycles includes transsexual 'stunts'

Anemone fishes are hermaphrodites. They have both male and female gonads. However, once hatched, the female gonads are suppressed, thus turning them all into male when juvenile. Among young fish, it's all boys, no girls.

In the early part of their life cycles, after some days out in the blue as pelagic larvae, anemone fishes settle on the coral reef once they find a suitable host sea anemone. Usually, there are a small group of anemone fishes in one large sea anemone. The first one in the pecking order in a sea anemone turns into a female and mates with number two, which will remain a male. The rest of the fishes in the pecking order also remain males. They are not allowed to mate with the female. Only the number one male in the pecking order, the alpha male, can mate with the female.

The phenomenon of sex reversal is a fascinating part of anemone fish life history. Sex change occurs in many fishes. For example, it is now well established that most wrasses (*Labridae*) and parrot-

A reared batch of anemone fishes of the species *Amphiprion melanopus*, and they are all boys!



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## Boys, girls or what?

fishes (*Scaridae*) begin adult life as females and later assume the more colourful male phase. Similar changes are widespread among groupers (*Serranidae*).

### A leader with no balls

What sets the anemone fishes apart in this respect, however, is that the sex change goes

from male to female. As mentioned above, the largest and most socially dominant fish in a particular anemone is generally the female whose

gonads are functioning ovaries with remnants of degenerated testicular tissue. The smaller male, which in species such as *A. frenatus* and *P. biaculeatus* may be less than half the size of the female, has gonads that are functioning testes but also possess non-

functioning or latent ovarian cells. If the dominant female dies or is experimentally removed, the male's gonads cease to function as testes, and the egg-producing cells become active. Simultaneously, the largest of the non-breeding individuals becomes the functioning male.

This adaptation allows continuous reproduction; without it, an adult would ▶

The clownfish, or anemonefish, are the subfamily *Amphiprioninae* of the family *Pomacentridae*. Currently 27 species exist, of which one is in the genus *Premnas*, and the rest are in the subfamily's type genus *Amphiprion*. The other pomacentrids are called damselfish.

Clownfish and damselfish are the only species of fish that can avoid the potent stings of an anemone. There are several theories for how this avoidance is accomplished.

In a study published in the journal *Nature*, evolutionary biologist Peter Buston and colleagues report that clownfish in Papua New Guinea reefs can change their sex at will for social reasons. ■

The humphead wrasse (*Cheilinus undulatus*) is a wrasse that is mainly found in coral reefs. It is also known by the name "Napoleon wrasse", "Maori wrasse", or "Napoleonfish", or "So Mei" (in Cantonese, or "Mameng" (in Philippines).

Some males grow very large, with one unconfirmed report of a Humphead Wrasse that was 229cm long and weighed 190.5 kg



### Sex change the other way around

Some fish change sex from males to females, like the anemone fishes. In different species, it may be the other way around, such as in humphead wrasses. Adult females are known to change into adult males.

The factors that control the timing of sex change are not yet known, nor how 'decisions' are made about which fish changes sex. We still have much to learn about the biology of this species. The humphead wrasse is long lived, but breeds very slowly. It takes quite a long time, possibly up to five years, with the fish reaching about 35-50 cm in total length before individuals reach sexual maturation. This has made it an endangered species, as it is not being regenerated fast enough to compensate for fishing. Its meat is in high demand Southeast Asia, selling at over US\$100 per kilogram.

Humphead wrasse mate in pairs formed within larger social groups that form temporary aggregations. Sometimes spawning aggregations can number several hundred fish in areas with no fishing pressure. Planktonic eggs are released into the water column and drift away from the spawning site.

After hatching, the larvae stay in the water until they settle on the substrate. Population sizes and structures are not yet known for this species. Juveniles occur in coral-rich areas of lagoon reefs, among live thickets of staghorn *Acropora* sp. corals, in seagrass beds, murky outer river areas with patch reefs, shallow sandy areas adjacent to coral reef lagoons and in mangrove and seagrass areas inshore. They tend to move into somewhat deeper waters as they grow older and larger. ■



Some sea anemones like this *Stichodactyla haddonii* host unusually many specimens of anemonefish. We don't know for sure but this high number of fish may be due to a lack of mature clownfish in the host.

have to await the arrival of a fish of the appropriate sex (which it would be only 50 percent of the time), thereby losing valuable breeding time, or it would have to seek out a mate, leaving its anemone and thereby risking predation both on itself and on its symbiont.

Within the tropics, spawning occurs throughout most of the year, although there may be seasonal peaks of activity. In subtropical or warm temperate seas, as, for example, in southern Japan, reproductive activity is generally restricted to spring and summer when water temperatures are at their highest. At Enewetak Atoll (located at about 11°N in the central Pacific), spawning is strongly correlated with the lunar cycle: most nesting occurs when the moon is full or nearly so. Moonlight may serve to maintain a high level of alertness in the male, which assumes most of the nest guarding duties. Moreover,

because newly hatched larvae are attracted to light, moonlight may draw them towards the surface, thereby facilitating their subsequent dispersal by waves and currents.

Anemone fishes are unique among damselfishes in forming permanent pair bonds that sometimes last for years. In other damsels, one male may mate with several females during a single spawning episode, and different sets of females are often involved in subsequent spawnings. However, pair-bonding in most species of anemone fishes is very strong and is correlated by the small size of their territories (centered on their sea anemone) which is, in turn, correlated with the unusual social hierarchy that exists in each "family" group.

### On edge

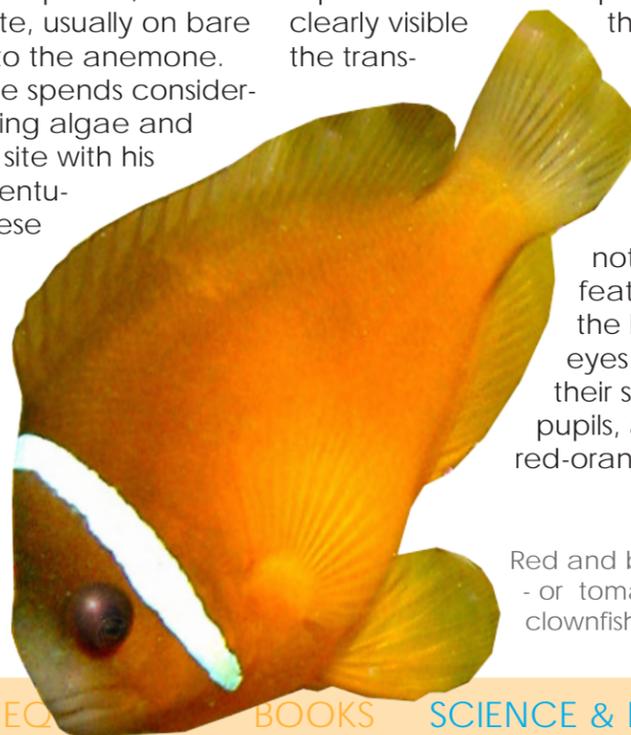
Several days prior to spawning, there is increased social interaction, as expressed by chasing, fin-erection,

and nest preparation. The male becomes particularly bold and aggressive, chasing and nipping his mate. He also displays by fully extending his dorsal, anal, and pelvic fins, while remaining stationary in front of or beside her. During the nuptial period, he selects a nest site, usually on bare rock adjacent to the anemone. Initially, the male spends considerable time clearing algae and debris from the site with his mouth; he is eventually joined in these activities by his mate.

Spawning, which occurs most often during morning hours, generally lasts from about 30 minutes to more than

two hours. Once it commences, the tiny, conical ovipositor of the female is clearly visible. A number of eggs are extruded through this structure on each spawning pass, when the female swims slowly and deliberately in a zig-zag path with her belly just brushing the nest surface. She is followed closely by her mate, who fertilizes the eggs as they are laid. Numerous passes occur during each spawning session. The number of eggs deposited ranges from about 100 to over 1000, depending on the size of the fish and on previous experience. In general, older, more experienced pairs produce more eggs than do recently formed pairs.

Anemonefish eggs are elliptical or capsule-shaped, are about 3-4 mm in length, and adhere to the nest surface by a tuft of short filaments. They incubate six to seven days. Just prior to hatching, the embryo, which has undergone rapid development, is clearly visible through the transparent parent egg membrane: the most noticeable features are the large eyes with their silvery pupils, and the red-orange yolk



Red and black - or tomato clownfish



### How to determine the sex on a fish

Often you cannot determine the sex of a fish just by looking at it. Determination of the sex and gonadal maturity of a fish is often necessary to determine the sex. A typical sex identification problem is facing biologists in groupers. A newly developed method by the fish sex change expert, Alam Mohamed at Sesoko Station, Japan, is an accurate and reliable determinate of the sex of live groupers using 5-10 mg gonadal tissue samples, harvested using non-lethal gonadal biopsy. Alam's fish survive the operation and there is no serious infections resulting from the surgery. Alam's method is therefore quickly spreading around the world. ■

sac that is responsible for the general colour of the entire egg mass throughout incubation, the nest is guarded and cared for by the male. He chases other fishes from its neighbourhood, especially potential egg-eaters (e.g. wrasses). The male frequently visits the nest to fan the eggs with his pectoral fins and to remove dead eggs and debris with his mouth. The female is mainly occupied with feeding during this time, but occasionally assists the male with his duties.

The embryos hatch one night after about a week (dependent on the species) and the tiny embryos swim to the surface guided by the moonlight and out on the open ocean, away from predators, and to a life as pelagic larvae for one or two weeks (also dependent on the species). Out on the blue the larvae grows by feeding on zooplankton, and returns another night to settle on the reef, detecting a suitable host sea anemone, and the life cycle has once again made on full round. ■