

SEX CHANGING FISH

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(1) Do you own a pet fish or know someone who does? Is the fish a boy or a girl...or both?! Fish are one of the few animals that are capable of changing their sex during their lifetime. Not all fish can do it, but some can and this gives them a reproductive advantage. Clown fish, parrot fish, gobies, wrasses, moray eels and even some sharks can change sex.



Clown Fish

(2) When an organism begins life as a male and then changes into a female, this is called *protandry*. When an organism begins life as a female and then changes to a male, this is called *protogyny*. Proto- means "original" and -andry refers to male, while -gyny refers to female. In general, changing from one sex to the other is called sequential hermaphroditism. A hermaphrodite is an organism that has the sex organs of both a female and a male. Sequential hermaphroditism means that one sex organ forms first and then is replaced by the other over time. Some fish exhibit simultaneous hermaphroditism if they have both male and female sex organs at once.

(3) Sex change in fish can be caused by changes in the social structure of the group. For example, clown fish usually form groups consisting of a dominant female and dominant male couple surrounded by small and sexually immature male fish. The female is the most dominant and largest fish. All clown fish are first born as males, but if the dominant female dies then her partner, the dominant male, will undergo protandry to change sex and become the large dominant female. The largest sexually immature male will undergo rapid growth to transform into the dominant male and become the mating partner of the new dominant female. Becoming the dominant female is advantageous because there's no need to find a new mate, as one will develop from the immature males. Since they change from male to female, clown fish are protandrous hermaphrodites.

(4) Egg cells are very large and energetically costly to make while sperm are small and require less energy. Male to female sex change is an advantage for the clown fish because increased size greatly benefits the reproductive potential of the female but has little effect on the reproductive potential of the male.

(5) In blue-streaked cleaner wrasse, their social group consists of a large dominant male and group of sexually mature females which form a harem. All the wrasse begin life as females. When the dominant male dies, the largest and most dominant female undergoes protogyny to become the dominant male. The presence of a dominant male suppresses the ability of the other females to change sex until he dies. Since they change from female to male, wrasse are considered protogynous hermaphrodites. For this species, it's a greater advantage to have the male be the larger one because his size helps him defend the harem from predators and rivals while increased size does not necessarily increase female fertility in wrasse.

(6) When two male wrasse are put into a fish tank, the larger male will suppress the ability of the smaller male to stay a male. The smaller male will transform back into a female. This is a great survival advantage for wrasse because two females or two males can become mates because one member of the two can always change sex. Some fish can only make a sex change once, but others exhibit bi-directional sex change and this allows them to go back and forth between the two sexes. Of the two directions of sex change, protogyny is more common than protandry and occurs 75% of the time in sequential hermaphroditic fish species.

(7) Some sex changes are due to age. The California sheephead wrasse will go from female to male at the age of 4. At this point, the wrasse's ovaries will degenerate and sperm producing structures will begin to grow. The amount of time it takes to transform into a male is slowed down by the presence of other

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large males in the area or sped up by their absence.

(8) Size is another factor in sex change. Scientists know that the largest and most dominant great white sharks are the females. There is speculation that great whites exhibit protandrous sex change from male to female and that when a male gets large enough, he will change into a female. This change provides a species survival advantage because it ensures that only the largest and most experienced great whites will have the ability to give birth to live shark pups. It takes 11 months for baby sharks to gestate and the mother's size and

ability to catch food and defend her territory will be critical during this time.

(9) Fish born with male XY sex chromosomes will still have these chromosomes when they change into females. Fish born with female XX sex chromosomes will still retain these chromosomes when they change into males. What causes sequential hermaphroditism is most likely a change in the function of an enzyme called aromatase. This enzyme controls the ratio of androgens (male sex hormones) and estrogens (female sex hormones) that are produced in fish.

Article Questions

- 1) What is the difference between protandry and protogyny?
- 2) How is sequential hermaphroditism different from simultaneous hermaphroditism?
- 3) In clown fish, what happens when the dominant female dies?
- 4) Why is it an advantage for female clown fish to be larger and more dominant over the male?
- 5) In blue-streaked cleaner wrasse, what happens when the dominant male dies?
- 6) What type of sex change is exhibited by great white sharks and what species survival advantage is provided by this sex change?
- 7) How does aromatase affect the ability of sequential hermaphrodites to change sex?