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Short communication

# First encounter with a live male blanket octopus: the world's most sexually size-dimorphic large animal

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**Abstract** The first encounter with a live male blanket octopus, *Tremoctopus violaceus* Chiaie, 1830, illustrates the most extreme example of sexual size-dimorphism in a non-microscopic animal. Females attain sizes of up to 2 m long—almost 2 orders of magnitude larger than the 2.4-cm-long male. Weight ratios between the sexes are at least 10 000:1 and are likely to reach 40 000:1. Sexual selection and the unique defensive strategy of carrying cnidarian stinging tentacles may both have contributed to the evolution of this extreme size-dimorphism. Such dimorphism is not seen in any other animal remotely as large.

**Keywords** blanket octopus; *Tremoctopus*; sexual dimorphism; evolution; defences; *Physalia*

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The blanket octopus (*Tremoctopus violaceus* Chiaie) is a rarely encountered pelagic species that spends its entire life cycle in the open ocean. Until now the male was only known from dead individuals collected in trawls and plankton nets. Our observation, photography, and collection of a living male (Fig. 1a) was made during "blackwater hangs" (night dives suspended over deep water) off the northern Great Barrier Reef, Australia (off Ribbon Reef No. 15-072, c. 15°30′S, c. 145°48′E). The animal approached dive lights at c. 8 m deep. It is 2.4 cm in total length and weighs 0.25 g. It is mature with a fully developed testis and reproductive tract. This specimen is lodged in the collections of Museum Victoria (MV F92175). By contrast, females (Fig. 1b, photograph from the Azores, Atlantic Ocean) attain sizes of up to 2 m long (Nesis 1987). We examined a submature female of this species in the collections of Museum Victoria, Australia (MV F78148). It was collected from the Tasman Sea, between Australia and New Zealand. It is 80 cm in total length and weighs 2.9 kg, over 10 000 times heavier than our male. The largest females are over twice this length (Nesis 1987) and are likely to weigh closer to 10 kg, a mass dimorphism of up to 40 000:1.

The blanket octopus (family Tremoctopodidae) is one of four related families of pelagic octopus that show sexual size-dimorphism. The other groups are the argonauts or "paper nautiluses" (family Argonautidae), the football octopus (family Ocythoidae) and a deeper water octopus *Haliphron atlanticus* (family Alloposidae). All have small to miniature males. It appears however that *Tremoctopus* has the most extreme size-dimorphism. The males in the first two groups are similar in size to male *Tremoctopus* but the females reach less than 1 m long (Nesis 1987). *Haliphron* females are much larger (can reach at least 3 m long, O'Shea unpubl. data) but the males are also much larger, reaching up to 30 cm in length (Verrill 1881).

The most extreme examples of sexual size-dimorphism come from marine or parasitic taxa where females are difficult to locate (Ghiselin 1974).

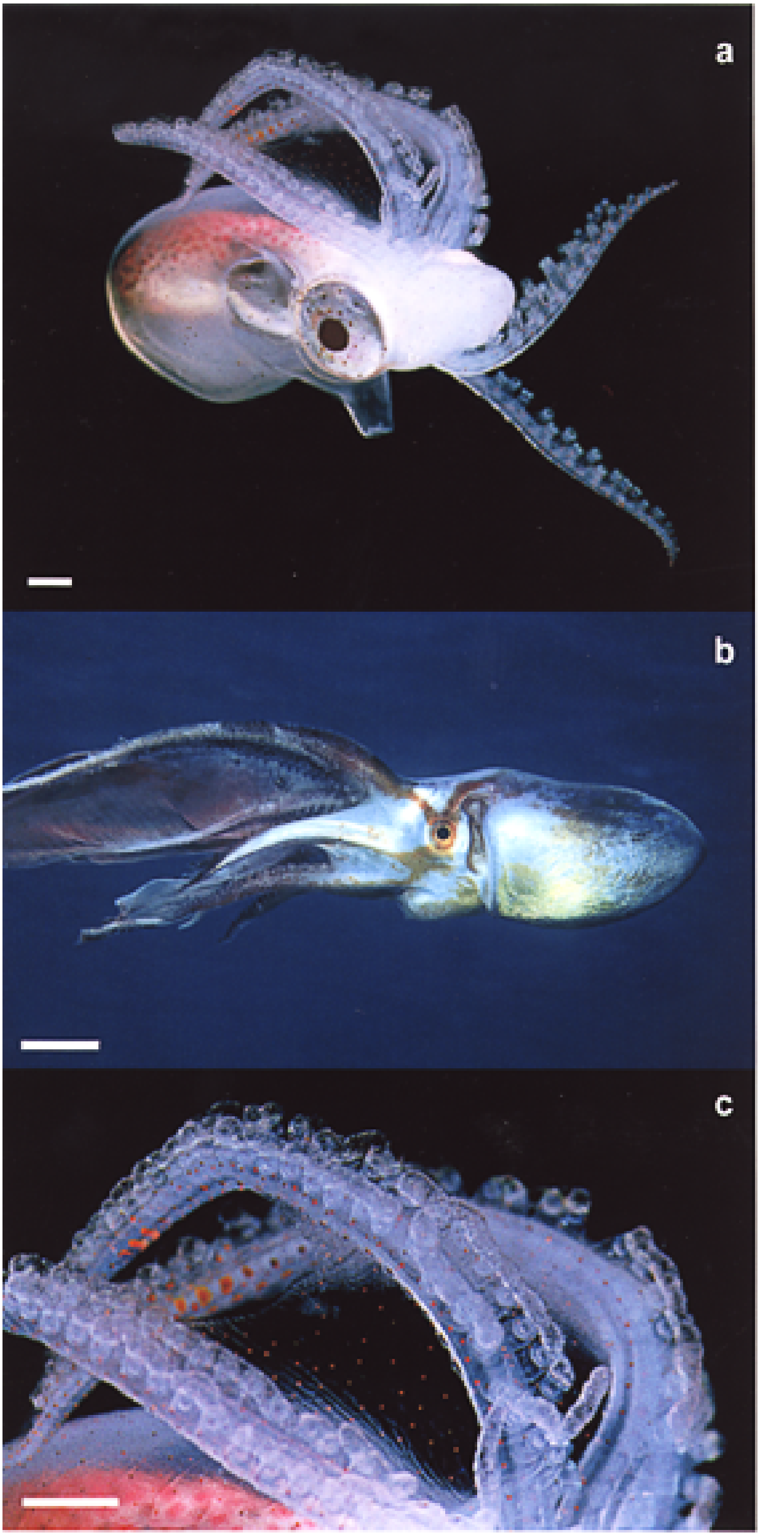


**Fig. 1** **a**, Male blanket octopus (*Tremoctopus violaceus*) from Great Barrier Reef, Australia, scale bar = 1 mm. (Photo: D. Paul.) **b**, Female of same species from Azores taken *in situ*, scale bar = 5 cm. Females can reach 4 times this size. For comparison, the eye of this immature female is the same size as a mature male. (Photo: P. Wirtz.) **c**, Close-up of male upper arms showing segments of cnidarian tentacles used for defence, scale bar = 1 mm. (Photo: D. Paul.)

Males evolve adaptations for locating females (the large eye of the blanket octopus male relative to body size may be such an adaptation; see Fig. 1a) and once a female is located the male's best strategy is to devote all his resources to her. Mature male blanket octopus develop a large modified reproductive arm (hectocotylus) within a spherical pouch (the white swelling between the arms, Fig. 1a). When males mate, this pouch ruptures, sperm is injected into the tip of the modified arm, the arm is severed and passed to the female. The male then almost certainly dies. Regenerating hectocotylised arms have never been found in the numerous trawl-captured males of this species. In benthic arm-dropping octopuses, arm regeneration takes c. 6–8 weeks (Ward pers. comm.). If the male blanket octopus mated more than once, it is likely that animals with regenerating hectocotylus would have been found among the many trawled specimens. The detached arm remains in the female's mantle cavity until used to fertilise her eggs (Thomas 1977).

Sexual selection can drive extreme dimorphism if males compete through their relative ability to find females (Andersson 1994). Being small may not impede the ability to locate females but does allow a male to reduce development time by maturing earlier. Male competition does occur in the blanket octopus since females have been found to contain multiple male arms within their mantle cavities (Thomas 1977). Males are therefore in competition with one another since females will frequently have more sperm available for use than they have eggs to fertilise, so there will be differences between males in reproductive success creating sexual selection.

Our observations suggest that natural selection may also have contributed to extreme dimorphism in this species. Males and immature females defend themselves using sections of stinging tentacles taken from a siphonophore, the Portuguese Man-of-War Jellyfish (*Physalia* spp.) and hold them in the suckers of the two pairs of upper arms (Jones 1963; Thomas 1977). It is unknown how the octopus protects itself from the stinging nematocysts. When we approached the male both in the wild and in captivity, he retracted all arms back over his body (Fig. 1a), exposing tentacle segments (Fig. 1c). Although very effective in such a small animal, larger individuals are unlikely to be able to carry enough tentacle segments to defend themselves. Also, the increased size of suckers in larger individuals may render them unable to carry the narrow diameter *Physalia* tentacles without injury. Females more than 7 cm long have never been observed to carry the siphonophore tentacles (Thomas 1977). It is possible that the unique defensive strategy of this oceanic octopus may have contributed to the evolution of such extreme dimorphism, males finding size refuge in this "borrowed" defence. Females, with potentially linear increases in lifetime reproductive success through increased egg production (particularly when broadcasting planktonic young), may outgrow this defensive refuge. Other marine invertebrates harness cnidarian defences including nudibranch molluscs (such as *Glaucus*, Lalli & Gilmer 1989) and hermit and boxer crabs (Guinot et al. 1995). These species do not show big size differences according to sex, suggesting that the pelagic lifestyle of the blanket octopus (and its three related octopus families) is an essential component of the selective pressure driving this extreme sexual size-dimorphism.

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