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First Observation of Mating in the Bamboo Shark *Hemiscyllium freycineti* (Chondrichthyes: Hemiscylliidae)

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Andrew S. Cornish (2005) First observation of mating in the bamboo shark *Hemiscyllium freycineti* (Chondrichthyes: Hemiscylliidae). *Zoological Studies* **44**(4): 454-457. Although much is known about the reproductive biology of sharks, remarkably few species have been observed mating outside of aquaria. In this report, an opportunistic sighting of a pair of the bamboo shark, *Hemiscyllium freycineti* (Quoy and Gaimard), mating in Irian Jaya, Indonesia was made, the first time the reproductive behavior of any hemiscyllid has been described from the wild. Various aspects of courtship and copulation in *Hemiscyllium freycineti* are compared and contrasted with those of other species reported in the literature.
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Sharks typically show low fecundity, slow growth, and a late age of sexual maturation, life history characteristics that leave them vulnerable to overexploitation (Branstetter 1990, Musick 1999). Such species may undergo stock collapses and even be driven to extinction if resource managers do not pay special attention to their unique management requirements (Musick 1999). Sharks are heavily targeted due to the value of their fins in Asian cuisine (Bonfil 2002), and understanding how they reproduce will be key to managing their fisheries. Remarkably, despite such concerns and a high public profile, mating has only been described in the wild for 6 species (Hennemann 2001, Pratt and Carrier 2001).

The family Hemiscyllidae (Orectolobiformes), generally known as bamboo sharks, comprises a small family of inshore bottom-dwelling sharks occurring in the tropical western Pacific and Indian Oceans. There are 2 genera, *Chiloscyllium* with 7 species and *Hemiscyllium* with 5 (Compagno 2001). The maximum total length varies from 43 to 107 cm depending on species (Compagno 2001). Although species of *Chiloscyllium* are commonly taken in small-scale fisheries and by trawlers in Asia, very little is known about the reproductive biology of most species although some are known to be oviparous, producing oval egg cases which are deposited on the seabed (Devadoss 1986, Compagno 2001). Mating behavior in the wild does not appear to have been documented for any hemiscyllid although reproduction in aquaria has been described for 3 species: *Chiloscyllium griseum* (Dral 1980), *C. plagiosum* (Masuda 1998), and *Hemiscyllium ocellatum* (West and Carter 1990).

MATERIALS AND METHODS

An opportunistic observation was made of mating *H. freycineti* (Quoy and Gaimard) at Kri I. in the Raja Ampat I. group, Irian Jaya, Indonesia. At around 07:30 on 23 July 2003, a male and female, each around 60 cm in length, were spotted moving slowly into shallow water next to a jetty over the

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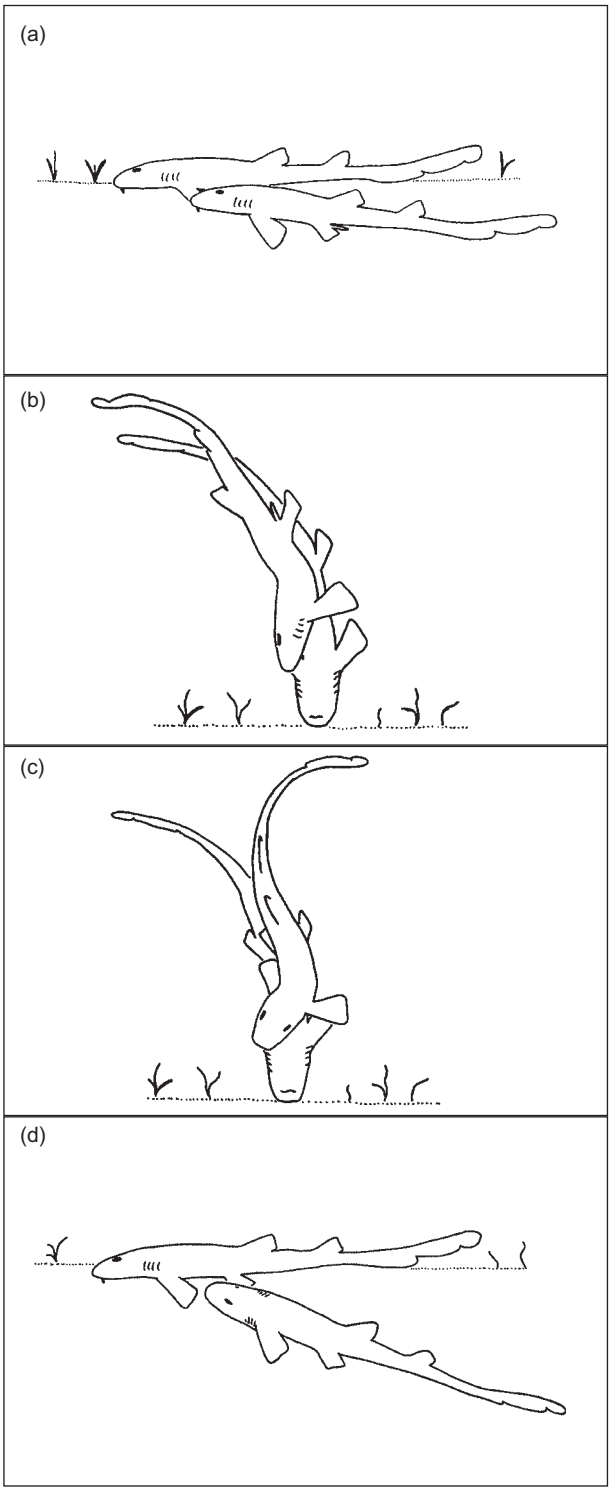

Fig. 1. Courtship and copulation behavior in *Hemiscyllium freycineti*. (a) The male grasps the left pectoral of the female and they move forward together; (b) the pair moves into a head-standing position, and the male attempts to maneuver their ventral surfaces together; (c) copulation occurs; (d) the male releases the female, and they lie on the bottom together for a brief period.

reef flat in front of a diving camp. The reef flat runs approximately 50 m perpendicular to the shoreline with extensive live coral along the reef crest, patches of live coral and sand in the mid-zone, and sand and seagrass close to the shore. The male, who was slightly larger than the female, followed a short distance behind her towards the shore to a depth of around 1 m over sand and seagrass (Fig. 1). Approximately 10 m off the shore, the male grasped the female's left pectoral fin in his jaws while lying alongside and slightly behind her. The pair moved about 5 m forward, and then rotated into a head-standing position with their bodies bent at an angle and tails slowly undulating to maintain this posture. The male maneuvered his ventral surface to face hers and inserted a single, visibly red, swollen clasper into her cloaca. Due to the continued movements of both animals and ripples on the water surface it was not possible to determine which clasper was used. The female showed little resistance, and after around 2 min in this vertical position, the male released the female and the pair separated and lay on the seabed alongside each other. After a period of less than 1 min, the male moved off toward deeper water, followed shortly thereafter by the female.

The species was identified from photographs as *H. freycineti* (Quoy and Gaimard 1824) from Compagno (2001) and confirmed by Gerry Allen who has collected specimens from the same locality (G. Allen, pers. comm., 2003). There does, however, seem to be some confusion over the identity of this species, as an individual clearly of the same species is identified as *Chiloscyllium punctatum* Muller and Henle 1838 in Hennemann (2001).

DISCUSSION

The few shark species for which courtship and copulation have been described show a surprising variety of behaviors given their often very similar morphologies. One feature common to all sharks is internal fertilization using a single clasper of the male to transfer sperm into the female (Pratt and Carrier 2001). Various aspects of courtship and copulation in *H. freycineti* are compared and contrasted with those of other species, although it is acknowledged that as mating was only observed on 1 occasion, other mating behaviors may also occur in this species.

Initiation of courtship

Courtship in sharks is often preceded by the male following the female, having also been observed in the bamboo shark *Chiloscyllium plagiosum* (Masuda 1998) and horn shark *Heterodontus francisci* (Taylor 1971). It may be initiated by pheromones released by the female as has been hypothesized for the blacktip reef shark *Carcharinus melanopterus* (Johnson and Nelson 1978). Biting of the pectoral fin by 1 sex is another common feature of shark courtship and is believed to initiate mating (West and Carter 1990, Pratt and Carrier 2001). In many species, it is the male who does the biting (Dempster and Herald 1961, Dral 1980, Tricas and Lefeuvre 1985, Masuda 1998, Pratt and Carrier 2001). In the epaulette shark *Hemiscyllium ocellatum*, it may be the female, and later the male (West and Carter 1990). In *H. freycineti*, biting of the pectoral fin also has a practical function as copulating in a vertical position would be considerably more difficult without the male being able to lock himself somehow onto the female prior to insertion of the clasper.

Copulatory position

The head-standing position noted for *H. freycineti* has also been documented for *Chiloscyllium plagiosum* (Masuda 1998), the whitetip reef shark *Triaenodon obesus* (Tricas and Le Feuvre 1985), and nurse shark *Ginglymostoma cirratum*, although the latter also copulates in other positions (Pratt and Carrier 2001). It would seem the male would have considerably more difficulty maneuvering the ventral surface of the female against his own and then inserting his clasper into her cloaca when vertical than if lying side-by-side on the substrate, such as in *Heterodontus francisci* (Dempster and Herald 1961). *Chiloscyllium grisium* also mates with the female while lying side-to-side (Dral 1980), while in *Hemiscyllium ocellatum*, the male lies alongside the female with his caudal fin curved over the female and a clasper inserted under her body into the cloaca (West and Carter 1990). The male of the small-spotted catsharks, *Scyliorhinus canicula*, a rather small species attaining maturity at around 45 cm length (Hennemann 2001), wraps its body into a ring around the female while inserting the clasper (Gilbert 1981), a feat unlikely to be possible for most larger species. It is unclear what the biological significance, if any, is of variations in the copulatory position, and it may be that the position of copulation in individual species is more plastic than the limited numbers of observations for a few species allows us to realize.

Length of copulation

The duration of mating in *H. freycineti*, at around 2 min, is among the shortest recorded. Other hemiscyllids also show short copulations: 5 min in *C. plagiosum* (Masuda 1998) and 1.5 min in *H. ocellatum* with sperm visibly leaking from the cloaca after 45 s (West and Carter 1990). Copulation in the order of a few minutes is also known for *Carcharinus melanopterus* (Johnson and Nelson 1978) and *Ginglymostoma cirratum* (Carrier et al. 1994), while *Scyliorhinus canicula* may take 20 min or longer (Gilbert 1981) and *Heterodontus francisci* 35 min (Dempster and Herald 1961).

Site of copulation

Many of the aforementioned observations have been made in aquaria, revealing little about the natural habitats used by sharks for mating. From the few examples that have been observed in the wild, including *H. freycineti*, there is a trend for some shallow-water (< 100 m) benthic sharks to copulate at very shallow depths. *Hemiscyllium freycineti* copulated in water of around 1 m in depth, *Ginglymostoma cirratum* consistently mates in depths of < 2 m at a traditional site in Florida (Pratt and Carrier 2001), while for *Carcharinus melanopterus*, the male maneuvered the female into such shallow water that her caudal fin lay on the shore out of the water (Johnson and Nelson 1978). The single observation of mating in *Triaenodon obesus* occurred slightly deeper at 7 m (Tricas and Lefeuvre 1985). Such behavior may be an attempt to avoid predators, to minimize disruption from competing males by utilizing habitat rarely used outside of mating, to allow the males to exert more control over the females, or perhaps to allow females to assess males from a vantage point where unsuitable males cannot force a mating, as in *Ginglymostoma cirratum* (Pratt and Carrier 2001).

Conservation

More information is clearly needed on the locations and timing of shark copulation if populations of these vulnerable animals are to be conserved (Pratt and Carrier 2001). If, as has been

shown from long-term studies of the nurse shark (Pratt and Carrier 2001) and sand tiger *Carcharias taurus* (Gilmore 1993), that species travel long distances to mate in traditional sites at predictable times of year, they may be vulnerable to overexploitation at those times and places, as has proven to be the case for some of the larger groupers and wrasses that aggregate to spawn (Domeier and Colin 1997).

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