

An Observation of Mating in Free-Ranging Blacktip Reef Sharks, *Carcharhinus melanopterus*¹

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Abstract: We describe the mating behavior of free-ranging Blacktip Reef Sharks, *Carcharhinus melanopterus*, at Palmyra Atoll. This is the first primary report of mating in *C. melanopterus* and the first direct observation of mating for an obligate swimming shark species. Similar to that in other nonobligate swimming shark species, mating in *C. melanopterus* was characterized by multiple males following a single female, a male grabbing the female near the pectoral fin and positioning her head down on the bottom, and the insertion of a single clasper. Copulation lasted 68 sec, which is shorter than the durations recorded for most other shark species.

THE MATING OF sharks has been observed for only a small number of species. All published primary accounts of shark mating come from species that are capable to some degree of buccally pumping water over their gills to obtain oxygen (i.e., not obligated to swim at all times under normal conditions to respire; buccal ventilators) (Pratt and Carrier 2001). It is currently unknown if and how the mating behavior of obligate swimming species (those that cannot, under normal circumstances, obtain sufficient oxygen while remaining stationary; obligate ram ventilators) may vary from that of their nonobligate swimming counterparts. It has been suggested that these obligate swimming sharks may mate in shallow water with copulation being brief, or that they may mate while swimming (Stevens 1974, Johnson and Nel-

son 1978, Ebert 1996, Francis 1996, Harvey-Clark et al. 1999). Here we describe a direct observation of mating in the obligate swimming Blacktip Reef Shark, *Carcharhinus melanopterus* (Quoi & Gaimard), and compare these observations to what is already known about mating in nonobligate swimming sharks.

MATERIALS AND METHODS

The mating event we report was observed while scuba diving on the northern forereef of Palmyra Atoll (5° 53' 835" N, 162° 05' 919" W), a U.S. National Wildlife Refuge in the northern Line Islands (central Pacific Ocean). Temperature, depth, and light intensity at the time of the mating were recorded using multiple sensors affixed to the seafloor (Onset Computer Corp.). The density of *C. melanopterus* at nine sites on the forereef at Palmyra was measured during June–August 2006 using 50 × 8 m belt transects located at 10.5 m depth. Each transect was surveyed seven times at approximately 8-day intervals by observers using scuba.

RESULTS

On 8 October 2007 D.J.M. and H.S.Y. observed seven male *C. melanopterus* pursuing a single female rapidly across the forereef. Males assembled themselves in a roughly linear fashion behind the female. Nose to tail spacing between sharks was often less than

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1 m. At the time of first observation, the female already wore superficial bite scars on the anterior portion of its body. Observable portions of the pursuit were largely confined to a depth range of 5 to 20 m. Approximately 7 min after the first observation of the sharks, the male first in line behind the female bit the central portion of her caudal fin, arresting her forward momentum. The female briefly freed herself but was bitten again by the same male just anterior to her right pectoral fin. The male used this grip to forcibly guide her rostrum into the substrate at 10 m depth. It then positioned itself parallel to the female so that both sharks assumed a nearly vertical posture (Figure 1). In this alignment, the male inserted his right clasper into the female's cloaca (09:59:00 Hawaiian time). The sharks remained in copula for 68 sec. The male then separated itself from the female, and both sharks swam off on slightly different trajectories. The mating female and male sharks were each estimated to be approximately 120 cm in total length (TL). Based on observations of clasper calcification in

captured *C. melanopterus* at Palmyra, a male of this size should be sexually mature (Papas-tamatiou et al. 2009). No seminal fluids were observed emanating from the male or female at the break of copula. The other male pursuers dispersed out of sight from the mating pair at the start of copulation.

During sampling for a concurrent population study of *C. melanopterus* at Palmyra, female sharks were caught with large amounts of scarring, generally concentrated on the anterior body flank and pectoral fins. This suggests that the pectoral fin and pectoral region may be a common location for the male *C. melanopterus* to grasp the female during copulation.

The average density of *C. melanopterus* on the forereef of Palmyra was measured as 2.3 sharks per hectare ($SE \pm 0.8$). The average temperature measured at the mating sites in the 2 hr before the onset of mating activity was 28.5°C, and the average light level was 240 lx. Twelve-hour averages (daylight hours) of light and temperature were both lower on the day of the mating than on any of the preceding 5 days.

DISCUSSION

The mating behaviors described herein are the first primary observations of mating in *C. melanopterus* and a first primary report of mating in an obligate swimming shark species. The high density of *C. melanopterus* at Palmyra no doubt increased the probability that this rare event would be observed at that site. The mating behaviors we recorded for *C. melanopterus* are generally similar to mating behaviors described previously for other non-obligate swimming shark species. Consistencies include multiple males pursuing a female before copulation, the male biting the female's body to subdue her, the male using its grasp on the female at the pectoral region to position her rostrum into the substrate for copulation, the male inserting only one clasper, and the animals dispersing separately from each other at the conclusion of copulation (Pratt and Carrier 2001). Previous anecdotal observations of *C. melanopterus* suggest that males may locate females using olfaction

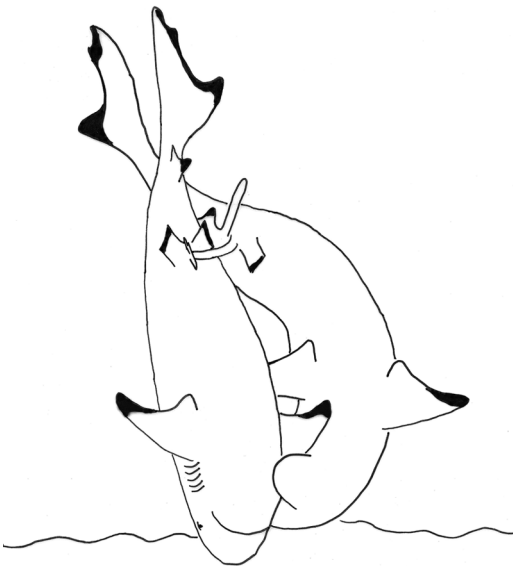


FIGURE 1. Positioning of *Carcharhinus melanopterus* during copulation. The male grasped the female just anterior of the pectoral fin, inserting only one clasper. The position was maintained by the male by pinning the female's head against the substrate.

(Johnson and Nelson 1978). The single-file formation of males following behind the female in this observation may also indicate that these males were responding to a chemical signal produced by the female.

The duration of copula measured for the mating *C. melanopterus* (68 sec) at Palmyra is slightly less than the time durations described in most accounts of copulations of nonobligate swimming species: *Carcharias taurus*, 1–2 min (Gordon 1993); *Chiloscyllium plagiosum*, 5 min (Masuda 1998); *Ginglymostoma cirratum*, ~2 min (Carrier et al. 1994); *Hemiscyllium freycineti*, ~2 min (Cornish 2005); *Hemiscyllium ocellatum*, 1.5 min (West and Carter 1990); *Heterodontus francisci*, 35 min (Dempster and Herald 1961); *Scyliorhinus canicula*, >20 min (Gilbert 1981); *Triakonodon obesus*, 1.5 to >2 min (Tricas and Le Feuvre 1985, Uchida et al. 1990, Whitney et al. 2004).

This account provides insight into the mating behavior of *C. melanopterus* and potentially other obligate swimming sharks. However, it remains only a single sighting, and additional data must be obtained to test the generality of the behaviors we observed.

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