On Mating Behavior of the Blotched Fantail Ray,

*Taeniura meyeni*

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Abstract

This report documents the first observed complete mating event of the blotched fantail ray, also known as the marbled ray, *Taeniura meyeni*. The event showed several, thus far undocumented, behavioral traits within batoid mating, including blood drawing by the male during copulation. This blood, channeled through the male's gill slits, appeared in intervals of 1.2 seconds ($SE = 0.03, N = 12$), indicating that the male was—at least partially—still able to breathe while mating. Another prominent aspect of this copulation was the frequency of the pectoral disc rim undulation, which remained constant for the female during the entire copulation while it strongly fluctuated in the corresponding male. This mating event also indicated that polyandry might be a possibility for this species due to the simultaneous attachment of a second male over the entire duration of the first male's copulation, followed by attachment of a third male once the observed copulation was over.
Mating observations among free-swimming batoids are rare and have only been documented for a very few species (e.g., Chapman et al., 2003). As a result, some aspects could only be assumed thus far (e.g., McCourt and Kerstitch, 1980; Yano et al., 1999). In this report we describe the first documented mating event among blotched fantail or marbled rays, Taeniura meyeni (Müller and Henle, 1841), also known by the junior synonym T. melanospila (Bleeker, 1853) or T. melanospilos (Froese and Pauly, 2008). Despite wide distribution in the western Pacific ocean, the biology of this species is barely known (e.g., Last and Stevens, 2009).

Although only one copulation was videotaped, this event offers some first explanations of superficial injury to the female while the male was holding on to her and a likely reason for frequency change of the male's pectoral disc rim undulation according to the mating stage he was in.

**Keywords:** batoid, injury, polyandry, reproduction, rim undulation

**Observation**

On July 31, 2012, at 12:35 pm, a mating event of blotched fantail rays was videotaped with a ‘GoPro Hero 2’ camera in the respective housing. The event took place at a site called "Bajo Alcyone" at Cocos Island 5 m below the surface in about 30 m depth of water.

Five rays, one larger female and four males of similar size were swimming in a rather tight cluster when first noticed. During the initial positioning of the males along the female's rim, one of the males left. Two of the remaining males (m1, m2) positioned themselves opposite of each other at either side of the female's pectoral fin disc, with the third male (m3) in between at the posterior end of the disc. At one point, the two males (m1, m2) positioned at the lateral margin of the female, grabbed the respective areas simultaneously with their mouths (Fig. 1a).

![Figure 1a](image-url) **Figure 1a.** Sequence of a mating event among blotched fantail rays. (a) Two males (m1, m2) position themselves at the posterior margin of the female's pectoral disc, where m1 grabs the female's pectoral disc rim (arrow), a third male (m3) is positioned in between while a forth male swims off.
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Since it appeared that m1 needed the female as leverage to turn towards her, his grasp on her pectoral disc margin must have increased and blood started to be rhythmically pumped out of his right gill slits (Fig. 1b).

**Figure 1b.** Sequence of a mating event among blotched fantail rays. (b) Female's blood pumping out of m1's gill slits, inset shows the situation 1.2 seconds later; right clasper pivots toward the female's cloaca (soft circle, inset).

Twelve continuous plumes of blood were registered flowing out of the male's gill slits, with an average of 1.2 seconds ($SE = 0.03$, $N = 12$) between them. While holding on, m1 brought his right clasper towards the female's cloaca in a cross-pivoting manner (Fig. 1b inset). While rotating his right clasper into a more central position with reference to the female's body, the left clasper was actively turned out of the way but then moved sideways once copulation was in progress. By using the right clasper, the more distal one with reference to the female's urogenital system, m1's intention was to position himself in a 'ventral to ventral' position (Yano et al., 1999) with the female later in the intromission (Fig. 1c).

**Figure 1c.** Sequence of a mating event among blotched fantail rays. (c) m1 rotates and starts inserting his right clasper (arrow) into the female's cloaca.
During the first phase of the copulation, m1 was not yet positioned opposite the female's cloaca (Fig. 1d).

**Figure 1d.** Sequence of a mating event among blotched fantail rays. (d) m1 rotates towards the female while holding onto her.

Whether m2, who was still attached to her as well, influenced male 1's chosen position cannot be determined. Later during copulation, m1 moved into the previously mentioned 'ventral to ventral' position (Yano et al., 1999), allowing him to align his active clasper with the female's urogenital system (Fig. 1e).

**Figure 1e.** Sequence of a mating event among blotched fantail rays. (e) m1 positioned into the 'ventral to ventral' position.

While intromission occurred, the female kept swimming with the same undulation frequency as before mating started. Her oscillation frequency, expressed by the wave-like motion along the pectoral disc's rim (e.g., Clark and Smits, 2006), remained basically constant throughout the entire observation, averaging 1.7 Hz ($SE = 0.04$), 1.6 Hz ($SE = 0.06$) and 1.5 Hz ($SE = 0.07$) during the pre-mating, mating, and post-mating phases, respectively. Each value reflected the average of
three consecutive cycles. The frequency for m1, however, was irregular. Prior to mating, it averaged 0.8 Hz (SE = 0.06), remained at 0.6 Hz (SE = 0.02) while grabbing the female and then subsequently holding on to her pectoral disc. While in 'ventral to ventral' position, his frequency reached 1.6 Hz (SE = 0.12) and was then reduced to 0.8 Hz (SE = 0.06) once the copulation was terminated.

The duration of the overall copulation phase lasted 89 seconds. After 42 seconds the first plume of a transparent fluid started to appear, which then continued to rather free-flow for about 8 seconds. These plumes were likely seminal fluids that were squeezed out of the female's cloaca while the clasper was still inserted. The first clot of sperm appeared after 73 seconds. The termination was then accompanied by a plume of sperm and seminal fluids released from the male's active clasper (Fig. 1f).

**Figure 1f.** Sequence of a mating event among blotched fantail rays. (f) plume of sperm and seminal fluids are released from m1's active clasper after terminating the mating event.

As soon as the last plume of sperm was ejected, the male started shaking the active clasper. While swimming off, this maintenance behavior continued but now both claspers were involved. However the left, previously inactive, clasper was observed to be more actively shaken than the right clasper.

The two remaining males (m2, m3) continued to hold on to the female, without showing an effort to mate as well for the duration of observation.

**Discussion**

During this mating sequence, several features stood out. Chapman et al. (2003) mentioned durations of mating events ranging between 24 and 33 seconds for southern stingrays, *Dasyatis americana*. Although the current report only describes a single event, the duration of 89 seconds stands out, particularly since the female kept swimming in a continuous and steady manner for the duration, and was not at
rest on the bottom like other elasmobranchs (e.g., Tricas and Le Feuvre, 1985; Pratt and Carrier, 2001; Cornich, 2005) or just drifting. It cannot be determined from these observations if the 89 seconds’ duration represents a typical mating time span for the species, or if this is at one extreme or the other of the range of time usually spent in a mating event.

Clasper motion, function and maintenance

Ritter and Compagno (2013) showed that clasper maneuverability among chondrichthyes can be extensive and the way the male flexed and pivoted his active clasper in this documentation attests to that. Not only did the active clasper move during the pre-mating and mating phase, but the inactive one moved also. The inactive clasper was first actively repositioned to likely enable the active clasper to turn towards the later alignment with the cloaca of the female. It has been mentioned in the past that only one clasper was observed to be active (e.g., Dempster and Herald, 1961; Tricas and Le Feuvre, 1985; Pratt and Carrier, 2001). However it has never been shown if ‘inactive’ meant an actual inability of motion or just a non use during the actual copulation event. Ritter and Compagno (2013) demonstrated that both claspers are capable of freely moving, hence both of them could be used for insertion. Considering that the two marbled ray males were attached to the opposite sides of the female, and assuming each would have used the same procedure as was observed for m1, it stands to reason that likely both claspers are active and which one is used solely depends on the chosen position on the female and is not anatomically driven lack of functionality.

Clasper maintenance has been noted in the past after mating attempts by related species. In this report, the post-mating shaking with the involved clasper indicates a cleaning attempt to rid himself of remaining sperm. However, one would expect that the active clasper showed some form of flaring (Ritter and Compagno, 2013) or anything else that would flush the clasper, but the main shaking was not performed by the active clasper but the previously inactive one.

Biting phase

During the biting phase, both males (m1, m2) were holding on to the female while she seemed to drag them along. That could be part of the reason why she started to bleed, since m1 needed to clamp down harder in order to prevent contact loss with her and to proceed with the actual rotation to mate. That this male was still able to pump water through his gills is supported by the rhythmic squirting of blood out of them. Since m1 was likely not actively swimming but was being towed by the female, and was able to at least partially breathe, it could explain the male's rather long duration of the actual intromission.

That the female started to bleed when the male clamped down does not support the notion that the female's skin, as already shown for some batoids, is
thicker as a response to dimorphic dentition (Nordell, 1990, 1994; Kajiura et al., 2000), where the males’ teeth are longer than the females’, and hence should prevent injury. However, the skin of the female might still be thicker in the rim area but the assumed increased pressure of biting down by the male might be too intense for the skin thickness and flexibility to compensate.

Since it appears that the female pulled at least the male with whom she was later mating through the water, his two times increase of undulation frequency may thus provide support for squirting the sperm into the female rather than for locomotion.

Open questions

Although not successful in a mating attempt while in visual range of the videographer, m2 kept holding on after the termination of m1’s intromission. For the remainder of the observation period, m2 did not move to maneuver himself into a better position once the first male terminated his copulation. While a second intromission with m2 would be likely, since closely related species, e.g. southern stingrays, show polyandry (Chapman et al., 2003), it cannot be determined from this observation. Interestingly, and also potentially indicating polyandry in this species, m3 started to grab the female once the first male swam off, but not at the same site of attachment of the first male.

Beside multiple matings, other reproduction related questions remain unanswered for this species. For instance, it is unknown if blotched fantail rays show an annual or bi-annual cycle (e.g., Pierce et al., 2009), or if the documented mating during day-time hours is typical or is the exception for this nocturnal species.

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References


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