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Evidence of dystocia in an oviparous shark

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Abstract

Dystocia, or obstructed labor, is a well-documented phenomenon in various captive vertebrates, including fish. However, despite the documentation of dystocia in several viviparous (live-bearing) Chondrichthyan species (i.e., sharks, rays, skates, and chimaeras), there are no reports to date of dystocia in any oviparous (egg-laying) species. Here we present a case of a captive female epaulette shark (*Hemiscyllium ocellatum*) that demonstrated symptoms of dystocia in a research-related captive breeding programme. This communication serves as documentation that dystocia can occur in oviparous Chondrichthyans, and this information can help inform researchers and veterinary practitioners for improved care.

KEYWORDS
captive breeding, eggbinding, elasmobranch, husbandry, reproduction

Dystocia or obstructed labor, a condition in which a female cannot undertake parturition/oviposition, is a phenomenon documented across an array of vertebrates, including mammals, birds, reptiles, and fishes (i.e., Cornelis et al., 2022; Feldheim et al., 2022; Harcourt-Brown, 1996; Krautwald-Junghanns et al., 1998; Léchenne et al., 2012; Lehman et al., 2012; Melidone et al., 2008). In the case of oviparous (egg-laying) species, dystocia is a case of postovulatory egg stasis, and eggs are fully formed but oviposition is delayed or ceased altogether (Melidone et al., 2008).

For Chondrichthyans, a subclass of fishes including sharks, rays, skates, and chimaeras, both oviparity and viviparity are exhibited across the taxon, but there are only a handful of reports of dystocia, all from viviparous species (George et al., 2017; Henningsen et al., 2004; Jung-Schroers et al., 2015; Leite et al., 2020; Mahon et al., 2004; Stoskopf, 2017). These incidences include captive and wild cownose rays (*Rhinoptera bonasus*) (Mitchill, 1815) (Cavalcante et al., 2016; George et al., 2017; Leite et al., 2020), spotted eagle ray (*Aetobatis narinari*) (Euphrasen, 1790) (Mahon et al., 2004), blacktip shark (*Carcharhinus limbatus*) (Valenciennes, 1839) (Mylniczenko et al., 2017), blacktip reef sharks (*Carcharhinus melanopterus*) (Quoy & Gaimard, 1824) (Jung-Schroers et al., 2015), bonnethead shark (*Sphyrna tiburo*) (Linnaeus, 1758) (Stoskopf, 2017), spotted wobbegong (*Orectolobus maculatus*) (Bonnaterre, 1788) (Gordon, personal communication reported in Henningsen et al., 2004), and sand tiger sharks (*Carcharias taurus*) (Rafinesque, 1810) (Wyffels, 2020).

To our knowledge, there are no documented cases of dystocia in an oviparous elasmobranch, despite being documented in birds (i.e., Harcourt-Brown, 1996; Krautwald-Junghanns et al., 1998) and oviparous reptiles (i.e., Melidone et al., 2008). Here we present evidence of potential dystocia in a small oviparous Chondrichthyan common in aquaria, the epaulette shark (*Hemiscyllium ocellatum*) (Bonnaterre 1788). We hope that this report serves as an accessible record for other researchers and veterinary professionals to provide timely intervention in the future for other oviparous sharks, skates, and chimaeras.

Epaulette shark reproduction is classified as single oviparity (Awruch, 2015), where female egg production occurs from July to January annually (Heupel et al., 1999). Physiologically, the right ovary creates follicles in pairs of decreasing size, where after the oviducal glands produce half of the egg cases, the largest pair of follicles are ovulated into each egg case. These egg cases are then retained for several days so that the remainder of the case can be formed, sealed, and hardened via sclerotization. Oviposition then occurs within a few days of the complete formation of the egg cases. This process then repeats every 2–4 weeks, where follicles for future cycles are developing in the background continuously during the reproductive season (Koob & Callard, 1999).

The female epaulette shark in this report was collected from Balgal Beach, Queensland, Australia (−19.021387, 146.418124) for research purposes in March 2020 (see Wheeler et al., 2022 for collection and transport details). At capture, the shark was 68 cm in total length, and mass was 1.14 kg. The shark was immediately transported to the Marine and Aquaculture Facility Unit at James Cook University where it was maintained individually in a 1000-L long oval aquarium connected to a 5500-L reservoir and a heater/chiller system maintaining water temperature at 25°C. The shark was provided a 30 × 80 cm PVC pipe as shelter and fed 2% of its body weight with a mix of pilchard and prawn three times weekly (totaling 6% of body weight per week) following recommended feeding regimes for benthic sharks (Janse et al., 2004). All research conducted in this study was assessed and approved by the James Cook University Animal Ethics Committee (protocols A2655 and A2739), and collection occurred under the relevant Queensland Fisheries (#200891 and #255136) and Great Barrier Reef Marine Park Authority (GBRMPA G19/43380.1 and G21/44922.1) permits.

The shark in this report began producing egg cases in July 2020, and over the course of the next 4 months the individual successfully produced 11 egg cases over 5 cycles averaging 19.5 days in length per cycle (Table 1). The mean time of egg case encapsulation within a cycle (i.e., the number of days that egg cases were detected in utero via daily palpations) was 7 days (Table 1). For comparison, other female epaulette sharks in this same research programme encapsulated egg cases for on average 5.3 ± 3.2 days (Wheeler, 2023).

Starting in October 2020, during the egg case encapsulation stage of the fifth reproductive cycle, the individual began refusing food, exhibiting a mix of lethargy and sporadic swimming behavior followed by increased ventilation rates, and became unresponsive to touch. The shark also stopped seeking shelter during daytime hours, which is normal behavior in this species given their nocturnal nature (Wheeler et al., 2022). Furthermore, in the 3 days prior to mortality, small clots of fresh blood were observed in the tank. The shark died 4 days after the initial onset of symptoms.

Upon necropsy, there was one egg case within each oviduct (Figure 1), and both cases were similarly sized to previously deposited egg cases from this individual (Table 1). Significant bruising and redness were noted on the ventral side, particularly around the cloaca. The one active ovary appeared normal, where several pairs of developing follicles descending in size were observed along with several corpora lutea. All other tissues (i.e., liver, gastrointestinal tract; Figure 1) presented normally.

If dystocia is suspected, proper veterinarian assessment and surgical removal of bound egg cases and administration of antibiotics could be warranted to prevent septicaemia (Abou-Zahr et al., 2019; Harcourt-Brown, 1996). Furthermore, there is documentation of the use of oxytocin to induce oviposition in reptiles and birds with varying degrees of success (Abou-Zahr et al., 2019; Di Ianni et al., 2014; Harcourt-Brown, 1996), but to our knowledge oxytocin intervention is untested in oviparous elasmobranchs and requires future research. Koob and Callard (1985) noted that exogenous intramuscular progesterone (P_4) injections (2 mg of P_4 in 200 μL oil) induced early oviposition, which may be another avenue to explore as a treatment for dystocia in oviparous elasmobranchs.

Dystocia can be caused by improper husbandry (i.e., water temperature and feeding regime, i.e., Sladky, 2018), but we do not believe that was the cause in this case, as water temperature was held consistently as that of the wild breeding season (Heupel et al., 1999), and feeding regimes were consistent per recommendations (Janse et al., 2004). Five other female epaulette sharks have been breeding successfully under the same husbandry conditions for 4 years, further lending support that husbandry issues were not the cause of dystocia herein. Dystocia can also be caused by abnormally large fetus/egg size; however, the length and width of egg cases found during the necropsy in this case were similar to eggs deposited in previous cycles (Table 1).

In the future, we recommend intervention at early stages if the individual is overdue for oviposition, refusing food, and behavior has shifted toward periods of hyperactivity and lethargy. It is important to note that we have observed that some female epaulette sharks naturally reduce feedings in the 1–2 days prior to oviposition, so it is important to track reproductive cycles and identify if the individual has surpassed its average cycle length. In the case of the female

TABLE 1 The female epaulette shark's (*Hemiscyllium ocellatum*) reproductive data means of cycle length (from one set of egg cases to the next), egg case encapsulation time (time the egg cases were present in uteri), counts of the viability of egg cases (with a properly formed yolk sac or wind), and the mean length and width of egg cases (cm).

Cycle number	Cycle length (days)	Time with egg cases in uteri (days)	Viable egg cases (counts)	Wind (empty) egg cases (counts)	Mean egg case length (cm)	Mean egg case width (cm)
1	-	5	2	1	9.1	4.2
2	27	10	2	0	9.3	4.0
3	16	8	2	0	9.5	4.1
4	16	4	2	0	8.6	3.6
5	19	9	2	0	9.5	4.1
Mean (± SD)	19.5 ± 5.2	7 ± 3			9.1 ± 0.8	4.0 ± 0.3

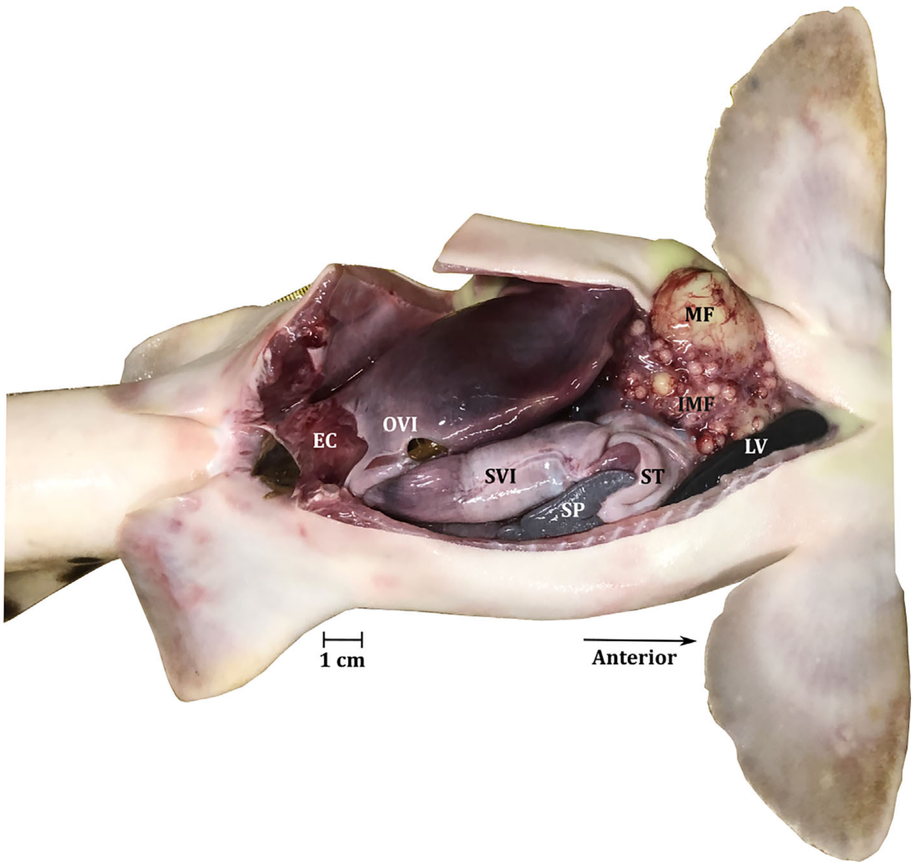

FIGURE 1 Post-mortem necropsy showing one of the two fully formed egg cases (EG) in the oviduct (OVI). The active right ovary was composed of both immature (IMF) and mature (MF) follicles, and the liver (LV; only the left lobe is pictured), spleen (SP), gastrointestinal tract including the stomach (ST) and spiral valve intestine (SVI) presented normally.

herein, the individual was still within the normal range of cycle length when mortality occurred (Table 1). From personal communications, we are aware that elasmobranch oviparous dystocia cases have occurred in public aquaria, but these incidences have gone unreported on a broader more accessible scale. Therefore, in cases of mortality we recommend necropsy, laboratory analyses, and better transparency and documentation of these occurrences as they allow researcher and veterinarian intervention at the first signs of dystocia for optimal outcomes in the future.

AUTHOR CONTRIBUTIONS

This project was conceived and designed by C.R.W. and J.L.R. Data were collected and analysed by C.R.W. The manuscript was prepared by C.R.W. and J.L.R.

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