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PRECOPULATORY BEHAVIOUR OF *PTEROPLATYTRYGON VIOLACEA* (MYLIOBATIFORMES: DASYATIDAE) IN THE NORTHWESTERN MEDITERRANEAN

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ABSTRACT

The pelagic stingray, Pteroplatytrygon violacea*, is a batoid belonging to the family Dasyatidae, whose reproduction remains poorly understood. This paper describes two rare precopulatory behaviour events involving two adult pairs observed in French and Spanish waters in August 2018. It identifies distinct behavioural stages: grasping, pairing, body rotation, and clasper flexion. The persistent inverted posture of the female suggests a potential male-induced tonic immobilization, a behaviour not previously documented in pelagic rays. These observations provide the first well-documented account of precopulatory behaviour in the pelagic stingray and suggest possible reproductive adaptations in this highly migratory elasmobranch species.*

Key words: pelagic stingray, copulation, reproduction, France, Spain, Mediterranean

COMPORTAMENTO PRECOPULATORIO DI *PTEROPLATYTRYGON VIOLACEA* (MYLIOBATIFORMES: DASYATIDAE) NEL MEDITERRANEO NORD-OCCIDENTALE

SINTESI

Il trigone viola, Pteroplatytrygon violacea*, è un batoideo appartenente alla famiglia Dasyatidae, la cui riproduzione rimane ancora poco conosciuta. Lo studio descrive due rari episodi di comportamento precopulatorio che hanno coinvolto due coppie adulte osservate nelle acque francesi e spagnole nell'agosto 2018. Vengono identificate diverse fasi comportamentali distinte: presa, formazione della coppia, rotazione del corpo e flessione dei pterigopodi. La persistente postura invertita della femmina suggerisce una possibile immobilizzazione tonica indotta dal maschio, un comportamento mai documentato in precedenza nelle razze pelagiche. Queste osservazioni forniscono la prima descrizione ben documentata del comportamento precopulatorio nel trigone viola e suggeriscono possibili adattamenti riproduttivi in questa specie di elasmobranco altamente migratrice.*

Parole chiave: trigone viola, copulazione, riproduzione, Francia, Spagna, Mediterraneo

INTRODUCTION

The pelagic stingray, *Pteroplatytrygon violacea* (Bonaparte, 1832), is the only pelagic species within the family Dasyatidae (Mollet, 2002; Last *et al*., 2016). It is widely distributed throughout the world's oceans (Mollet, 2002) and well-known in the Mediterranean (Barone *et al*., 2022). Unlike other stingrays, this species inhabits pelagic and oceanic habitats ranging from the margins of continental and insular shelves to the open ocean, typically within the upper 100 m (Ebert & Stehmann, 2013). However, a recent study has shown that the bathymetric range of *P. violacea* can extend to depths of up to 480 m (Poisson *et al*., 2024). Like in other Myliobatiformes, such as mobulids, observing the reproductive behaviour is particularly challenging due to the species' elusive occurrence in the Mediterranean (Ziani *et al*., in press). The high mobility of *P. violacea* within the water column likely drives behavioural adaptations associated with its lifestyle, including reproductive adaptations that ensure successful copulation, as observed in other pelagic elasmobranch species (Pratt *et al*., 2001; Duffy & Tindale, 2018; McCallister *et al*., 2020). This paper reports two well-documented observations of *P. violacea* pairs exhibiting precopulatory courtship behaviour.

MATERIAL AND METHODS

At 8:30 p.m. on 8 August 2018, an interaction between two individuals of *P. violacea* (pair 1) was recorded just beneath the surface by a free diver using a GoPro Hero 5, approximately 5 km offshore from Cap Sicié, France (Fig. 1). The interaction lasted one minute and involved a mature adult male-female pair, each approximately 40 cm in disc width. The depth at the site was 80 m, with clear conditions and weak currents. No other biological activity was recorded at the time, and the diver was alone with the pair of rays. The second sighting (pair 2) was recorded on 29 August 2018 by a Spanish free diver off Cape de Creus (Catalonia, Spain), a few kilometres from the coast, also in clear waters (Fig. 1; 3Cat, 2018). The two video sequences were used for subsequent behavioural analysis.

RESULTS AND DISCUSSION

The two *P. violacea* individuals of pair 1 were estimated to be sexually mature based on the disc width of approximately 40 cm and the length of the male's claspers (Fig. 2). The recorded behaviour lasted one minute and did not include copulation.

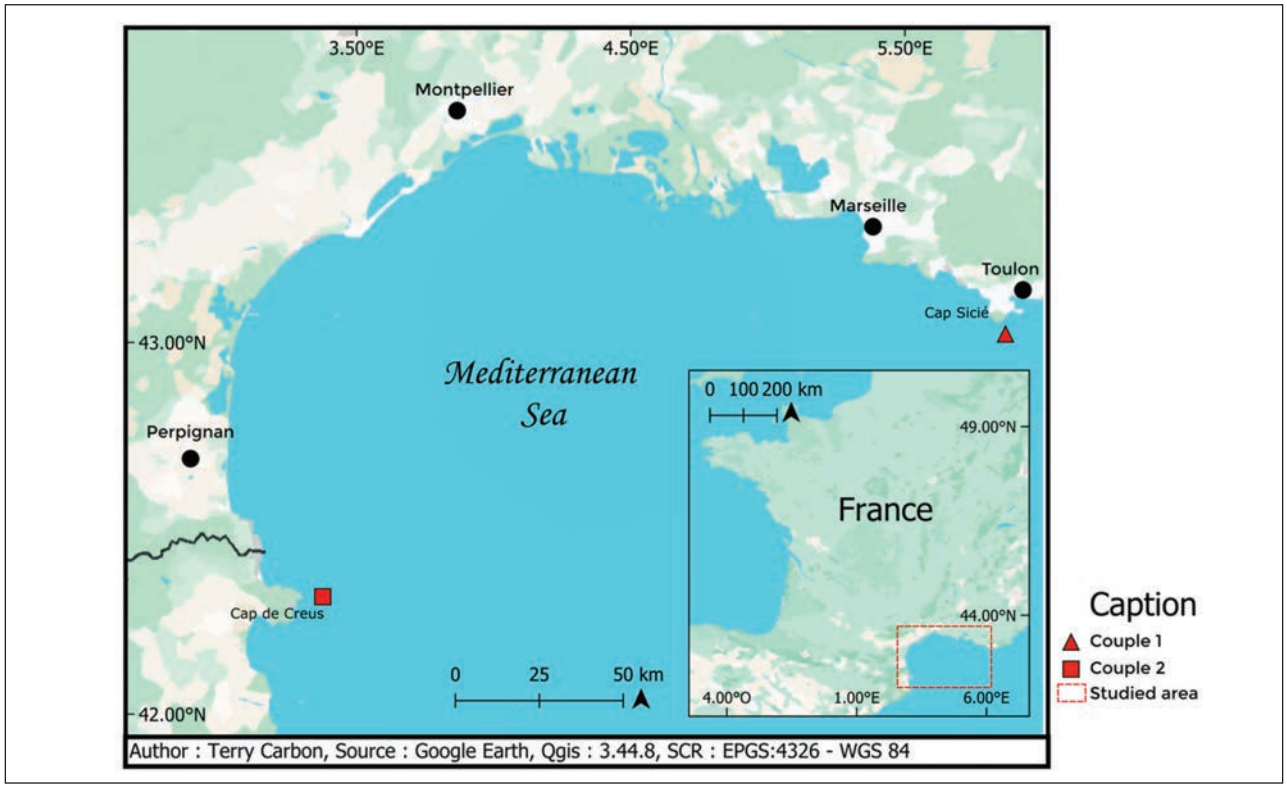

Fig. 1: Geolocation of paired** Pteroplatytrygon violacea **off the French (pair 1) and Spanish (pair 2) coasts.
Sl. 1: Geolokacija parov vijoličnega morskega biča** (Pteroplatytrygon violacea**) ob francoski (1. par) in španski (2. par) obali.

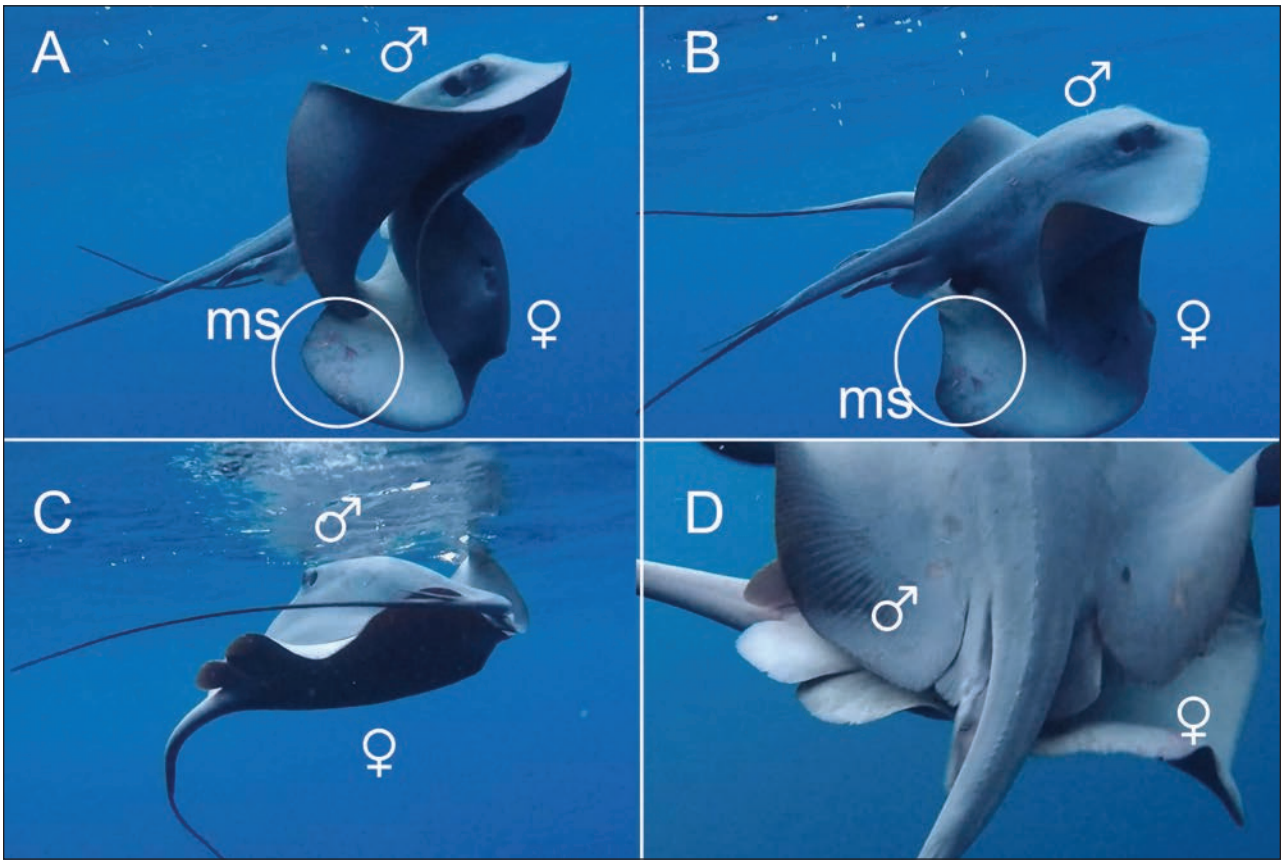

Fig. 2: Behavioural sequences observed during male–female interaction: (a) the male approaches the female and firmly grasps the right pectoral apex of her disc with his mouth; (b) the male holds the female's disc in his mouth and leans against her ventral surface so that they swim belly to belly; (c) still holding the female's disc between his jaws, the male spins around her in an anti-clockwise direction while maintaining a firm ventral contact, and positions her beneath him in an inverted posture; (d) close-up of the pelvic areas of paired individuals: as the male circles the female's body, he begins to erect his claspers, directing them inwards via flexion upon reaching the female's cloacal region. ms = mating scars on the apex of the female's disc left by the male's jaws during biting to secure grip. (Still images extracted from video footage provided by T. Vandezande).
Sl. 2: Vedenjske sekvence, opažene med interakcijo med samcem in samico: (a) samec se približa samici in z usti trdno zagrabi desno konico plavuti (apeks) njenega diska; (b) samec drži samičin disk v svojih ustih in se nasloni na njeno trebušno površino, tako da plavata s trebuhom ob trebuhu; (c) samec, ki še vedno drži samičin disk med čeljustmi, se zavrti okoli nje v smeri proti urinemu kazalcu, pri čemer ohranja tesen trebušni stik, in jo namesti podse v obrnjen položaj; (d) bližnji posnetek pelvičnih predelov parjenih osebkov: ko samec kroži okoli samičinega telesa, začne dvigovati svoja pterigopoda (klasperja) in ju z upogibanjem usmerja navznoter, ko doseže samičino območje kloake. ms = paritvene brazgotine na konici samičinega diska, ki so jih pustile samčeve čeljusti med grizenjem za zagotovitev oprijema. (Slike so izrezane iz videoposnetka, ki ga je posredoval T. Vandezande).

Direct observations of mating in elasmobranchs are rare (Gordon, 1993; Duffy & Tindale, 2018; McCallister *et al.*, 2020) and studies on the reproductive behaviour of myliobatiform ray are particularly limited due to the rarity and elusiveness of such events in the field (Yano *et al.*, 1999; Duffy & Tindale, 2018; Yamaguchi *et al.*, 2021; Ziani *et al.*, in press). Benthic rays typically use the substrate for stabilisation during mating (Pratt *et al.*, 2001; Morson & Morrissey, 2008). In contrast, pelagic elasmobranchs such as *P. violacea* must maintain pairing within the water column (Fig. 2) without external support (Pratt *et al.*, 2001; Henningsen *et al.*, 2004).

Mating in the water column imposes additional environmental constraints, requiring precise coordination to achieve copulation in the absence of a stable substrate. This includes close swimming, mating bites, and alignment of the pelvic regions. The male must actively and firmly grasp the female's disc to facilitate ventral pairing (Fig. 2) and ensure

correct pelvic positioning during copulation. Pectoral biting appears to be particularly important in pelagic species, as it stabilises both partners within the water column (Hamlett, 2005; Duffy & Tindale, 2018). Documented mating sequences in rays such as *Mobula birostris*, including chasing, pectoral biting, copulation, resting, and separation, highlight the behavioural adaptations required for successful mating in open water (Yano *et al*., 1999, Duffy & Tindale, 2018; McCallister *et al*., 2020; Ziani *et al*., in press). Indeed, long-term studies of mobulid courtship and mating reveal elaborate multistage sequences — from male following, through precopulatory positioning, to copulation and postcopulatory separation — that can involve dozens of individual events and distinct behavioural phases across species (Stevens *et al*., 2018). The consistency of these stages across different mobulid taxa suggests that coordinated body alignment and sustained physical contact are fundamental to reproductive success in pelagic elasmobranchs. Observing such complex interactions in the open ocean is inherently challenging due to the mobility of the animals, the lack of stable substrates, and the difficulty of underwater observation. Therefore, detailed field observations, such as those reported here, offer rare and valuable insights into the reproductive ecology of pelagic stingrays, providing a unique contribution to our understanding of their mating strategies and behavioural adaptations under natural conditions.

A notable observation from the present video is the constant inverted position maintained by the female *P. violacea*, suggesting possible male-induced tonic immobilisation. Although this behaviour has not yet been reported in pelagic rays, it is well documented in several shark species, particularly *Triaenodon obesus* (Rüppell, 1837), where dorsoventral inversion and physical contact can induce a temporary paralysis that facilitates copulation (Wourms, 1977; Henningsen *et al*., 2004; Ritter & Amin, 2019). While the observed sequence does not provide direct proof of active catalepsy in *P. violacea*, the female's sustained inverted and passive posture, combined with the male's biting and lateral movement, suggest a possible strategy to enhance stability within the water column, potentially reducing resistance and improving cloacal alignment for copulation. Previous studies on *M. birostris* and *Aetobatus narinari* have reported only partial inversions or twisting during pelvic interactions (Tricas, 1980; Yano *et al*., 1999). The behaviour observed here may therefore represent the first evidence of a cataleptic posture associated with precopulatory activity in the pelagic stingray. Clasper mobility and control are also likely critical for successful copulation in such a highly dynamic, three-dimensional environment (Yano *et al*., 1999; Fitzpatrick *et al*., 2012; Trinajstic *et al*., 2015).

A recent study showed that, with regard to pelagic stingrays, the elevated catch per unit effort in fisheries from July to September in the western Mediterranean Sea may result from the species' seasonal aggregating behaviour during spring and summer associated with the reproductive cycle (Poisson *et al*., 2024). According to Poisson *et al*. (2024), individuals of *P. violacea* appear to aggregate on the continental shelf in the western Mediterranean Sea during summer, moving southwards in early autumn, which may correspond to spawning behaviour and overwintering. Although *P. violacea* is a pelagic and oceanic batoid (Ebert & Stehmann, 2013), females are also believed to move into inshore waters for parturition (Poisson *et al*., 2024). The pelagic stingray is currently listed as Least Concern both in the Mediterranean Sea (Baum *et al*., 2016) and across its global range (Kyne *et al*., 2018); however, further research is required to better understand the seasonal movement patterns of individuals, particularly mature adults and newborns, in order to mitigate mortality caused by bycatch.

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We would like to thank Mr. Thomas Vandezande, the French free diver, for sharing his footage recorded off Cap Sicié (Var, France).

PREDKOPULACIJSKO VEDENJE VIJOLIČNEGA MORSKEGA BIČA (*PTEROPLATYTRYGON VIOLACEA*) (MYLIOBATIFORMES: DASYATIDAE) V SEVEROZAHODNEM SREDOZEMLJU

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POVZETEK

*Vijolični morski bič (*Pteroplatytrygon violacea*) je skat, ki pripada družini morskih bičev (Dasyatidae) in katerega razmnoževanje ostaja slabo raziskano. Avtorji poročajo o dveh redkih primerih predkopulacijskega vedenja, v katera sta bila vključena dva odrasla para, opazovana v francoskih in španskih vodah avgusta 2018. Opredelili so različne stopnje vedenja: grabljenje (oprijemanje), združevanje v par, rotacijo telesa in upogibanje pterigopodov (klasperjev). Dolgotrajna obrnjena drža samice kaže na možno tonično imobilizacijo, ki jo je izzval samec, kar je vedenje, ki ga pri pelagičnih skatih prej še niso dokumentirali. Ta opažanja prinašajo prvi dobro dokumentirani prikaz predkopulacijskega vedenja pri vijoličnem morskem biču in kažejo na možne prilagoditve razmnoževanja pri tej izrazito selitveni vrsti hrustančnic.*

Ključne besede: vijolični morski bič, parjenje, razmnoževanje, Francija, Španija, Sredozemsko morje

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