

MARINE RECORD

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Morphological and functional abnormality in the spiny butterfly ray *Gymnura altavela*

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Abstract

Background: A variety of abnormalities have been described for sharks, rays and skates across different ecoregions. Morphological and functional anomalies in these species, however, were not yet documented in distributions from the Canary Islands, the spiny butterfly ray *Gymnura altavela* (Linnaeus, 1758) and from in situ observations. The aim of the present study is to fill these knowledge gaps.

Results: A female spiny butterfly ray *G. altavela* with an unfused anterior part of the right pectoral fin to the neurocranium was observed in the port of Sardina del Norte (Gran Canaria Island) during a visual scuba diving census.

Conclusion: The size and the observation of the activities swimming, burying and preying confirmed the adaption of the specimen for the anomaly and underdeveloped electrosensory system in its survival. The limited knowledge of teratogens and their triggering factors, and the striking similarity with an anomaly reported for *G. poecilura* (Shaw, 1804) from South India, suggest genetic expression aberrations or mechanical obstructions during gestation as origin for the disorder.

Keywords: Gymnuridae, Elasmobranch, Congenital disorder, Malformation, Adaption, Batoids, Swimming behaviour, Sardina del Norte, Canary Islands, Temperate Northern Atlantic

Background

Occurrences of abnormalities have been widely reported for various elasmobranch species in different ecoregions. Records for skates and rays include bicephalism in the Magdalena Transition (Castro Aguirre and Torres Villegas 1979) and Basian (Guida et al. 2014), hermaphroditism in the Ionian Sea (Dalù et al. 2003), aberrant appendages in the Patagonian Shelf (Deli-Antoni et al. 2012) and in the North Sea (Ellis 2005), lack of gill-slit and underweight in brackish waters from the Tunisian Plateau (El Kamel et al. 2009), absent tip of the snout in the South European Atlantic Shelf (Forster 1967), incomplete rostrum in the Southwestern Caribbean (Ramírez-Hernandez et al. 2011) and albinism in the Southern Gulf of Mexico (Wakida-Kusunoki 2015).

Failure of the anterior part of the pectoral fin to join with the head during embryonic development are not

rare in batoids (Tortonese 1956) and have been reported in, e.g the Adriatic Sea (Valle 1931), the Virginian (Gudger 1933), the Sea of Japan (Honma and Sugihara 1971), the Humboldtian (Lamilla et al. 1995), the Aegean Sea (Metin et al. 2009), Southeastern Brazil (Ribeiro-Prado et al. 2008), the Tunisian Plateau (Mnasri et al. 2010) and the Panama Bight (Mejía-Falla et al. 2011).

Congenital abnormalities for the genus *Gymnura* (Hasselt, 1823) have been reported in the smooth butterfly ray *Gymnura micrura* (Bloch & Schneider, 1801) from the Amazonia (Nunes and Piorski 2009), and the long-tailed butterfly ray *Gymnura poecilura* (Shaw, 1804) from South India and Sri Lanka (Bennet 1964; Day 1878; Easwaran 1967; Suresh and Raffi 2012) (Table 1).

Reports of cases with disorders in elasmobranch species from the Canary Islands, the spiny butterfly ray *Gymnura altavela* (Linnaeus, 1758) and from in situ observations were not collected so far. In this sense, the present communication is a novel report of an abnormality in an elasmobranch species in this region based

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Table 1 Summary of observed anomalies in the genus *Gymnura*. Realm as defined by Spalding et al. (2007)

Species	Anomaly description	Disc width (cm)	Depth (m)	Sex	Number of cases	Realm	Study
<i>Gymnura micrura</i>	Dorsal fold on the tail	17.8–21.7	8–25	-	2	Tropical Atlantic	Nunes & Piorski (2009)
<i>Gymnura poecilura</i>	Unfused anterior part of both pectoral fins to the neurocranium	15.2	-	-	1	Western Indo-Pacific	Day (1878)
<i>Gymnura poecilura</i>	Unfused anterior part of both pectoral fins to the neurocranium	8.9	-	-	1	Western Indo-Pacific	Bennet (1964)
<i>Gymnura poecilura</i>	Unfused anterior part of both pectoral fins to the neurocranium	22.5	8–18	Male	1	Western Indo-Pacific	Easwaran (1967)
<i>Gymnura poecilura</i>	Unfused anterior part of the right pectoral fin to the neurocranium	47.5	Coastal	Female	1	Western Indo-Pacific	Suresh & Raffi (2012)
<i>Gymnura altavela</i>	Unfused anterior part of the right pectoral fin to the neurocranium	137	8–13	Female	1	Temperate Northern Atlantic	The present study

on data from *G. altavela* during a visual scuba diving census.

Gymnura altavela is distributed from tropical to warm temperate continental shelf waters on both sides of the Atlantic Ocean, including the Mediterranean Sea, the Black Sea and the Madeira and Canary Islands. Maximum size is assumed to be 200 cm disc width. Its limiting life history, patchy and discontinuous distribution, and habitat dependent characteristics make it intrinsically vulnerable to population depletion. This species was classified as ‘Vulnerable’ on the basis of a suspected continuing decline of at least 30 % (Vooren et al. 2007). In the Canary Islands, *G. altavela* is distributed over the complete archipelago, being more abundant in the eastern islands (Bravo de Laguna and Escáñez 1975).

Materials and methods

On 22 and 28 July 2007, and 6 July 2008, during underwater visual census in the port of Sardina del Norte (28° 09' N and 15°41' O), Gran Canaria Island, an unusual female individual *G. altavela* with 137 cm disc width was observed. Size, activity, depth, water temperature and behaviour were recorded.

Results

The interior margin of the specimens’ right pectoral fin was detached from the braincase and the rostral ridge. It appeared as a free lobe slightly projecting forward from the disc plane, with the lateral margin pointed towards the exterior margin of the disc. The anterior margin of the disc was incomplete from the rostral ridge up to the lateral extreme of the spiracle. At the proximal end, the disc was absent up to the neurocranium, extending from the rostral ridge to behind the posterior margin of the spiracle. Epidermis pigmentation was absent at the proximal part of the lobe with a similar appearance, in colour and texture, of the white epidermis from the ventral side (Fig. 1).

All observations occurred in the same area between 8.0 and 10.7 m depth and a water temperature of 21 °C. The individual was found buried in the sand during all three encounters. During the first observation, the individual was startled by an angel shark *Squatina squatina* (Linnaeus, 1758) and left swimming (Additional file 1: Movie S1). Swimming was observed between 0.1 and 2 m above sand -and rock substrate. During swimming, the snout position was slightly pointed upwards, compared to what was observed in other individuals of *G. altavela*, and the posterior end of the lobe pointed downwards. During the third observation, a successful predation event was observed on the bogue *Boops boops* (Linnaeus, 1758) of approximately 10 cm total length, which were very abundant in the area. It was only possible to measure the individual, which was very susceptible to the authors’ presence, during the second



Fig. 1 *Gymnura altavela* (Linnaeus, 1758), female of 137 cm disc width with a morphological and functional abnormality of the right anterior disc, observed in the port of Sardina del Norte, Gran Canaria Island

encounter. No significant changes were observed on the anomaly between the observations of 2007 and 2008.

Discussion

The present communication is not only the first description of an elasmobranch disorder in the Canary Archipelago, but also a novel report for recording the first anomaly in *G. altavela*, and observing the individual in its natural habitat on several occasions, with different activities, and with a resighting after one year. Numerous anomaly reports were obtained from catch landings of free swimming elasmobranchs (Blanco-Parra and Niño-Torres 2011; Capapé et al. 2015a; Capapé et al. 2015b; Castro Aguirre and Torres Villegas 1979; Dalù et al. 2003; El Kamel et al. 2009; Forster 1967; Gudger 1933; Honma and Sugihara 1971; Metin et al. 2009; Mnasri et al. 2010; Moore 2015; Nunes and Piorski 2009; Orlov 2011; Ramírez-Hernandez et al. 2011; Ribeiro-Prado et al. 2008; Sandoval-Castillo et al. 2006; dos Santos and Gadig 2014; Valle 1931), but none of them observing the specimen actively in its environment.

Five out of the six reported anomaly cases in the genus *Gymnura* describe unfused pectoral fins. Four of these cases are reports for *G. poecilura* in the same ecoregion with individuals between 8.9 and 47.5 cm disc width, of which three had both pectoral fins unfused. The latter all present a disc width below the reported size at birth by James (1966) of 23.7 - 25.6 cm. Presumably, the smallest individual described by Bennet (1964) might have been confused with an embryo in normal development. The instance reported in the present study is evidently the largest observed individual in the genus so far (Table 1).

The low numbers of anomaly reports known in the genus *Gymnura* suggests they are less prone to different types of disorders. However it should be considered that these species also receive less attention from researchers in scientific production compared to other elasmobranch species. Yet, this is the only observed case of this species by the authors during systematic and periodic underwater census since 2006 in this area and others in the Canary Archipelago, with the main effort in Gran Canaria.

The partial lack of the disc in way of the rostrum will affect locomotion, manoeuvrability, prey detection, prey capture efficiency and burial that will require specialized adaptations and a higher energy budget for survival compared to individuals with a complete disc. Locomotion and manoeuvrability will be affected by the different shaped pectoral fin. The radiographic image in the study of Suresh and Raffi (2012) showed that the pectoral fin propterygium was not curved towards the neurocranium in way of the splanchnocranium. Instead, a bigger radius was observed pointing the propterygium towards the tip of the snout. The individual will also have a considerable disadvantage in detecting and trapping a prey with the

anterior part of its disc, and for burying in the sand. By inferring from the descriptions of Jordan (2008) and Maruska (2001), the electrosensory system in the anterior part of the disc will be partly absent and underdeveloped. In spite of the above-mentioned hindrances to develop activities, instances while preying, swimming and burying were recorded. The size of the individual and its ability to compete with other elasmobranch species for the same food resource indicate the ability to compensate for the malformation in its survival. Even though, the individual will still be less competent compared to others.

The lack of fusing of the pectoral fins is a congenital disorder as the attachment of the pectoral fins to the head is a secondary development for embryos in batoids (Bigelow and Schroeder 1953). Genetic disorders were also suggested as underlying cause (Tortonese 1956). The present report is interesting in view of a similar description for such a pectoral fin anomaly in *G. poecilura* by Suresh and Raffi (2012). The analogy of the two cases is prominent in shape, location, and texture. Some difference was observed in more protruding, and absent pigmentation patch, of the lobe in the latter study. Given the striking similarity of the condition between *G. poecilura* (Suresh and Raffi 2012) and *G. altavela* from the present study in the Western Indo-Pacific and the Temperate Northern Atlantic, respectively, and the lack of antecedents of elasmobranch anomalies in the Canary Islands, the authors advance genetic expression aberrations or mechanical obstruction during the embryo development as possible reasons for the anomaly. It is not clear however whether this disorder is either or not triggered by alterations in the marine environment. There is no conclusive data to define the cause of the anomaly or to conclude that embryos with a similar disorder will have the same survival success based on the occurrence of a single individual.

Morphologic deformations, and especially congenital disorders, are poorly understood in elasmobranchs. Castro Aguirre and Torres Villegas (1979) pointed out early the lack of research corroborating teratogens that cause congenital disorders. The need for more detailed studies on abnormal embryos linked to the embryological, genetic and ecotoxicological approaches as highlighted by dos Santos and Gadig (2014) is underlined with this case.

Additional file

Additional file 1: Movie S1. Video recording in the port of Sardina del Norte (Gran Canaria) of a female *Gymnura altavela* (Linnaeus, 1758) (137 cm disc width) with a morphological and functional abnormality of the right anterior disc, startled by an angelshark *Squatina squatina* (Linnaeus, 1758). (MP4 27241 kb)

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Availability of data and materials

The dataset supporting the conclusions of this article is included within the article as photographs, video and geographical coordinates.

Authors' contributions

Both authors conceived the study, participated in the field data collection, data analysis, background analysis, preparation of the manuscript, and read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Ethics approval and consent to participate

Not applicable.

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