ANNALES

Anali za istrske in mediteranske študije
Annali di Studi istriani e mediterranei
Annals for Istrian and Mediterranean Studies
Series Historia Naturalis, 35, 2025, 1

UDK 5 Annales, Ser. hist. nat., 35, 2025, 1, pp. 1-170, Koper 2025 ISSN1408-533X

UDK 5

ISSN 1408-533X
e-ISSN 2591-1783

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KOPER 2025

ISSN 1408-533X
e-ISSN 2591-1783

UDK 5

Letnik 35, leto 2025 številka 1

Tisk/*Stampa/Print:*

Založništvo PADRE d.o.o.

Izdajatelja/*Editori/Published by:*

Zgodovinsko društvo za južno Primorsko - Koper / *Società storica del Litorale - Capodistria*©
Inštitut IRRIS za raziskave, razvoj in strategije družbe, kulture in okolja / *Institute IRRIS for Research, Development and Strategies of Society, Culture and Environment / Istituto IRRIS di ricerca, sviluppo e strategie della società, cultura e ambiente*©

Sedež uredništva/*Sede della redazione/*
Address of Editorial Board:

Nacionalni inštitut za biologijo, Morska biološka postaja Piran /
Istituto nazionale di biologia, Stazione di biologia marina di Pirano /
National Institute of Biology, Marine Biology Station Piran
SI-6330 Piran /*Pirano*, Fornače/*Fornace* 41, tel.: +386 5 671 2900,
fax +386 5 671 2901;
e-mail: annales@mbss.org, *internet:* www.zdjp.si

Redakcija te številke je bila zaključena 20. 06. 2025.

Sofinancirajo/*Supporto finanziario/*
Financially supported by:

Javna agencija za znanstveno-raziskovalno in inovacijsko dejavnost Republike Slovenije (ARIS)

Annales - Series Historia Naturalis izhaja dvakrat letno.

Naklada/*Tiratura/Circulation:*

300 izvodov/copie/copies

Revija Annales, Series Historia Naturalis je vključena v naslednje podatkovne baze / *La rivista Annales, series Historia Naturalis è inserita nei seguenti data base / Articles appearing in this journal are abstracted and indexed in:* BIOSIS-Zoological Record (UK); Aquatic Sciences and Fisheries Abstracts (ASFA); Elsevier B.V.: SCOPUS (NL); Directory of Open Access Journals (DOAJ).

ANNALES · Ser. hist. nat. · 35 · 2025 · 1

Anali za istrske in mediteranske študije - Annali di Studi istriani e mediterranei - Annals for Istrian and Mediterranean Studies

UDK 5 Letnik 35, Koper 2025, številka 1 ISSN 1408-53 3X
e-ISSN 2591-1783

VSEBINA / *INDICE GENERALE / CONTENTS*

received: 2025-05-12 DOI 10.19233/ASHN.2025.10

DISC DEFORMITY IN A JUVENILE FEMALE BROWN RAY, *RAJA MIRALETUS* (FAMILY: RAJIDAE), FROM NORTHEASTERN MEDITERRANEAN (TÜRKİYE)

Deniz ERGÜDEN
Marine Science Department, Faculty of Marine Science and Technology, Iskenderun Technical University, 31200 Iskenderun, Hatay, Türkiye
e-mail: deniz.erguden@iste.edu.tr; derguden@gmail.com

Cemal TURAN
Marine Science Department, Faculty of Marine Science and Technology, Iskenderun Technical University, 31200 Iskenderun, Hatay, Türkiye

Servet Ahmet DOĞDU
Iskenderun Technical University, Maritime Vocational School of Higher Education, Underwater Technologies, 31220, Iskenderun, Hatay, Türkiye

Deniz AYAS
Faculty of Fisheries, Mersin University Yenişehir Campus, 33160, Mersin, Türkiye

ABSTRACT

This study describes a female specimen of the brown ray Raja miraletus *Linnaeus, 1758, found along the coast of the city of Aydıncık (Mersin Bay, Turkey) in the northeastern Mediterranean Sea, exhibiting disk deformities. The deformation is located on the right disk portion of the specimen, with no other deformities observed on the rest of the body. The juvenile female specimen measures 22 centimeters in disk diameter, 31.7 centimeters in total length, and weighs 186 grams. This specimen represents the first recorded abnormality of the species* R. miraletus *in Turkish Mediterranean waters, and this report provides the first information on the presence of abnormalities in female specimens of the species* R. miraletus.

Key words: Rajiformes, abnormality, pectoral disc deformity, Mersin Bay, Eastern Mediterranean

DEFORMITÀ DISCALE IN UNA GIOVANE FEMMINA DI RAZZA QUATTROCCHI, *RAJA MIRALETUS* (FAMIGLIA: RAJIDAE), PROVENIENTE DAL MEDITERRANEO NORD-ORIENTALE (TURCHIA)

SINTESI

Lo studio descrive un esemplare femmina di razza quattrocchi Raja miraletus *Linnaeus, 1758, trovato lungo la costa della città di Aydıncık (Baia di Mersin, Turchia) nel Mediterraneo nord-orientale, che presenta deformazioni del disco. La deformazione è localizzata sulla parte destra del disco dell'esemplare, senza altre deformazioni osservate sul resto del corpo. Il giovane esemplare femmina misura 22 centimetri di diametro del disco, 31,7 centimetri di lunghezza totale e pesa 186 grammi. Questo esemplare rappresenta la prima anomalia registrata della specie* R. miraletus *nelle acque turche del Mediterraneo e questa relazione fornisce le prime informazioni sulla presenza di anomalie negli esemplari femmina della specie* R. miraletus.

Parole chiave: Rajiformes, anormalità, deformità del disco pettorale, Baia di Mersin, Mediterraneo orientale

INTRODUCTION

In the Mediterranean Sea, there are 15 skate and ray species belonging to the family Rajidae (Froese & Pauly, 2025; IUCN, 2025). Of these, 14 species are reported from Turkish waters, and 13 are distributed in Mersin Bay, Northeastern Mediterranean (Turan *et al.,* 2025).

The brown ray, *Raja miraletus* Linnaeus, 1758, is distributed along the Atlantic coast from northern Spain to Morocco and is also widely reported throughout the Mediterranean Sea, including its eastern regions (Golani *et al.,* 2006; Froese & Pauly, 2025). This species has been observed to inhabit depths ranging from 17 to 462 meters (Mytilineou *et al.,* 2005), with a common occurrence between 50 and 150 meters (Bianchi *et al.,* 1999).

A review of the extant literature reveals a preponderance of documented studies concerning morphological abnormalities in adult skate individuals. These abnormalities include albinism, leucism, and other atypical colorations. Examples of such studies can be found in the works of Quigley *et al*. (2018a,b; 2019a,b), Lara-Mendoza & Guerra-Jiménez (2020), and Capape *et al*. (2015a). Furthermore, missing or additional fins (Williams, 1935; Ellis, 2005; Antoni *et al*., 2012; Moore, 2015) and anophthalmia (Ehemann *et al*., 2022) were reported. In some studies (Hoenig & Walsh, 1983; Heupel *et al*., 1999), deformed skeletons and other physical deformities to the body (Ramírez-Amaro *et al*., 2013; Moore, 2015; Capape *et al*., 2015b; Capapé *et al*., 2018) were also observed.

In the Mediterranean Sea, there have been documented cases of morphological abnormalities in skates, primarily characterized by the absence of fusion between the pectoral fins and the head region (Metin *et al.,* 2009; Akyol & Aydin, 2018) and in the anterior region of the disc deformities (reduced snout and a notch on each side of the rostrum) (Capapé *et al.,* 2018). Additionally, there have been reports of tail abnormalities (Capapé *et al.,* 2015b; Mnasri *et al.,* 2010; Capapé *et al.,* 2018; Marouani *et al.,* 2019). As demonstrated in the study by Capapé *et al*. (2018), aberrant coloration patterns are infrequent. Furthermore, Gajic *et al*. (2023) stated that a single ocellus is present on the dorsal surface of the left pectoral fin.

This study presents the first documented instance of a morphological abnormality characterized by a distinct deformity on the surface of the right pectoral fin disk in a female specimen of the species *R. miraletus* in the Mediterranean Sea. It is noteworthy that no additional structural deformities were identified in the remaining anatomical structures of the specimen, suggesting that this is not a systemic developmental concern but rather a localized anomaly.

MATERIAL AND METHODS

A female specimen of *R. miraletus* exhibiting morphological abnormalities (Fig. 1) was collected during routine bottom trawling operations conducted on January 9, 2018, off the coast of Aydıncık in the Mersin Bay (36° 06 ′N, 33° 18 ′E) at depths ranging from 65 to 80 meters. Standard biometric procedures

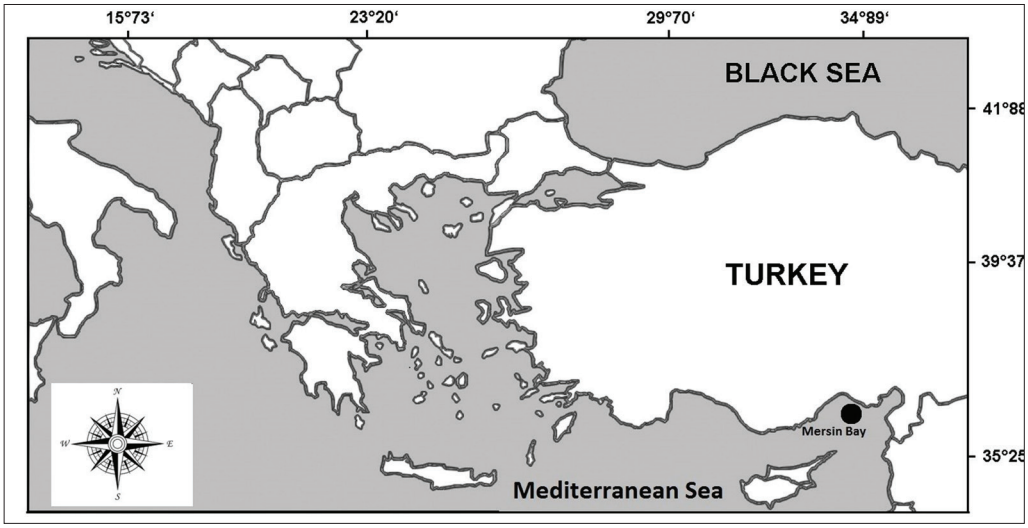

Fig. 1: The capture site (•) of *Raja miraletus* ***Linnaeus, 1758 from Aydıncık coast (Mersin Bay, Türkiye).***
Sl. 1: Zemljevid obravnavanega območja z lokaliteto ulova (•) vrste *Raja miraletus* ***Linnaeus, 1758 ob obali mesta Aydıncık (Mersin Bay, Turčija).***

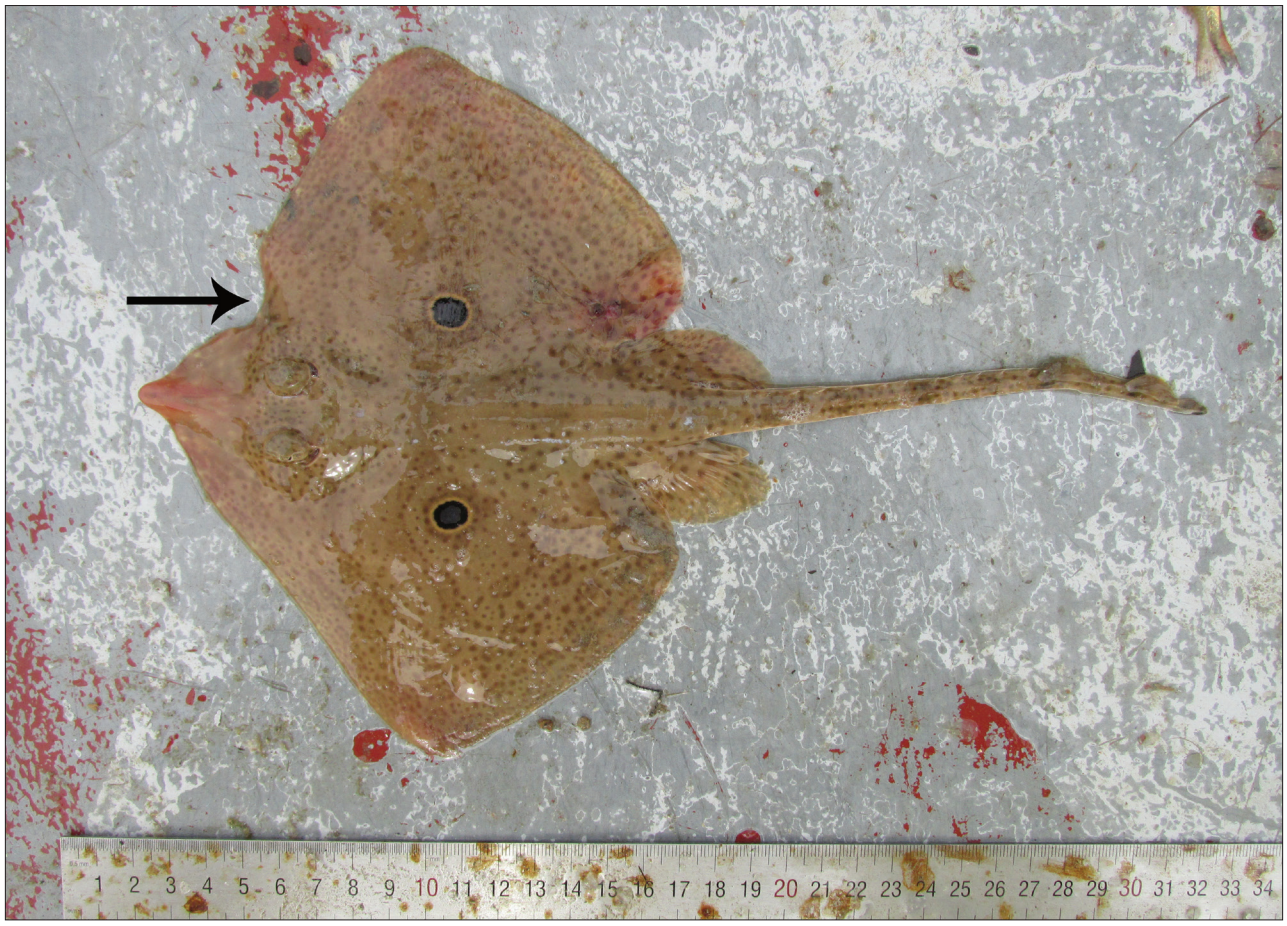

Fig. 2: The deformity of the disc part (right pectoral fin part) of *R. miraletus* ***caught in the Mersin Bay, Türkiye (black Arrow showing the anterior region of the disc).***
Sl. 2: Deformacija dela diska (desni del prsne plavuti) primerka vrste *R. miraletus****, ujetega ob obali mesta Aydıncık (Mersin Bay, Turčija) (črna puščica označuje anteriorni predel diska).***

were applied, and all linear morphometric measurements were recorded to the nearest millimeter. Total body weight was recorded to the nearest gram. Taxonomic identification was based on diagnostic criteria defined by McEachran & Dunn (1998), Compagno *et al.* (1989), and Schneider (1990). The abnormal specimen has been preserved and archived at the Mersin University Marine Life Museum under catalog number MEUFC-24-11-150 (see Fig. 2). This ensures that the specimen will be available for future morphological and genetic studies.

RESULTS AND DISCUSSION

During a commercial bottom trawl operation in Mersin Bay (Northeastern Mediterranean, Türkiye), between 65-80 m depth contours, two specimens of *R. miraletus* were captured. Among these, only one individual exhibited a notable disc deformation, while the other specimen appeared morphologically normal, with no observable anomalies (Fig. 2 and Fig. 3). *R. miraletus* is a relatively diminutive species within the family Rajidae, and it is characterized by a distinctly angular disc. The body is generally circular in outline, with pectoral fins that are broader than they are long, forming a sinuous margin along the lateral edges. The snout is notably short and rounded, and the pectoral fins exhibit well-defined angular extensions on their lateral extremities, contributing to the species' distinctive morphology.

The brown ray (*R. miraletus*) can be readily distinguished from other sympatric skate species inhabiting the Eastern Mediterranean by the presence of two prominent, symmetrical ocelli located on the anterior dorsal surface of its pectoral fins. Each ocellus is composed of a central light blue spot, encircled by a narrow black or dark blue ring, which is bordered by a broader outer ring of yellow-orange coloration. These distinctive markings are not only

Fig. 3: The normal specimen of** R. miraletus **in Mersin Bay, Türkiye.
Sl. 3: Normalni primerek vrste** R. miraletus **iz zaliva Mersin, Turčija.

visually striking but may also play a role in species recognition, camouflage, or predator deterrence (Barone *et al.*, 2022).

R. miraletus is an oviparous elasmobranch species, meaning it reproduces by laying eggs. According to Mendez *et al.* (2022), sexual maturity is attained at a total length (TL) of 39.0–44.0 cm in females and 36.0–40.0 cm in males, corresponding to disc widths (DW) of approximately 24 cm and 22 cm, respectively. The species undergoes embryonic development within the egg capsule over a period of approximately five months before hatching. At birth, the total length of neonates ranges from 5 to 11 centimeters. Noteworthy disparities in size at maturity have been documented among different regions. For instance, in northwestern European populations, McCully *et al.* (2012) documented considerably elevated size thresholds, with minimum maturity sizes recorded at 55.0 centimeters total length (TL) for males and 60.0 centimeters TL for females. Furthermore, the estimated mean size at 50% maturity was 78.2 centimeters for males and 85.6 centimeters for females. The maximum recorded size of immature individuals was 91.0 centimeters for males and 93.0 centimeters for females, suggesting the potential influence of geographical or ecological factors on growth and reproductive parameters.

The juvenile female specimen of *R. miraletus* exhibiting disc deformity was measured at a total length (TL) of 31.7 centimeters, with a disc width (DW) of 22 centimeters, and a total weight of 186 grams (Fig. 2). For comparison, a morphologically normal female specimen of the same species, collected from the same locality off the coast of the city of Mersin (Aydıncık Bay, Türkiye), measured 43.0 centimeters in total length (TL), 29.0 centimeters in body width (DW), and weighed 249 grams. This specimen is depicted in Fig. 3. Table 1 presents detailed morphometric comparisons between the abnormal and normal individuals. Despite the evident external disc abnormality, no differences were seen in the morphometric proportions between the two specimens, suggesting that this deformity had a limited impact on external body morphology.

Tab. 1: Morphometric measurements (mm) of one abnormal and one normal female specimen of *Raja miraletus* ***in the Northeastern Mediterranean.***
Tab. 1: Morfometrične meritve (mm) nenormalne in normalne samice vrste *Raja miraletus* ***v severovzhodnem Sredozemskem morju.***

Measurements	Value (mm) Abnormal Specimen	% (DW)	Value (mm) Normal Specimen	% (DW)
Total length	317	-	430	-
Disc width	220	-	290	-
Disc length	174	79.1	236	81.4
Snout length	18	8.2	24	10.1
Interorbital width	13	5.9	17	7.2
Spiracle length	7	3.2	9	3.8
Anterior pectoral length	21	9.5	28	11.8
Posterior pectoral length	14	6.4	19	8.1
1st Dorsal fin base	31	14.1	42	17.8
2nd Dorsal fin base	28	12.7	38	16.1
Tail length	118	53.6	160	67.8
Tail base width	22	10.0	30	12.7
Total weight (g)	186	-	249	-

Ribeiro-Prado *et al.* (2008) documented that, among all recorded morphological abnormalities in skates and rays, deformities are most frequently observed in the disc region and pectoral fins. Bigelow and Schroeder (1953), as well as Mansri *et al.* (2010), attributed such anomalies to developmental defects during embryogenesis, particularly the failure of the pectoral fins to fuse anteriorly with the head, a condition frequently reported in batoid fishes. Marouani *et al.* (2019) also emphasized that the most prevalent morphological malformations in both skates (Order Rajiformes) and rays (Order Myliobatiformes) involve the incomplete fusion of pectoral fins to the cranial region. Although our specimen did not exhibit this specific condition, the precise etiology of the localized deformation observed in the anterior portion of the right pectoral fin remains undetermined. Of particular note is the absence of any discernible scarring or lesions, suggesting that the observed abnormality is unlikely to have been caused by trauma or injury. Injury or trauma are well-documented etiological factors contributing to morphological defects in elasmobranchs (Moore, 2015; Montero-Hernandez *et al.,* 2024).

According to Capapé *et al.* (2018), pectoral fins play a vital role in the locomotion of skates and rays, serving as the primary means of propulsion and maneuvering. Despite their functional importance, abnormalities affecting the head and anterior pectoral fin regions remain exceedingly rare among batoid species. However, the prevalence of such deformities in skates (e.g., Ellis, 2005; Metin *et al.,* 2019; Clarke, 2021) and stingrays (e.g., Yoshiharu & Sugihara, 1971; Escobar-Sánchez *et al.,* 2009) remains limited. The present study documents, for the first time, a deformity localized in the anterior region of the pectoral fin in a specimen of *R. miraletus* from the Turkish Mediterranean Sea. A comparable morphological anomaly affecting the anterior pectoral region was previously documented by Metin *et al.* (2009) in another species of skate, *R. polystigma*. These observations underscore the rarity of such conditions and highlight the importance of documenting even isolated cases to better understand the developmental and ecological implications of these abnormalities.

Another important category of morphological abnormalities in batoids involves malformations of the tail, often characterized by partial or complete absence of dorsal and caudal fins. Templeman (1965), Mnasri *et al.* (2009), and Orlov (2011) noted that while such injuries are relatively common in stingrays, typically as a result of physical trauma,

Tab. 2: Records of abnormal cases of skate and ray species in Mediterranean regions.
Tab. 2: Zapisi o pojavljanju nenormalnih primerkov skatov v sredozemskih regijah.

Species	Number of Samples	Sex	Abnormal deformity	Capture site	Capture date	Reference
Raja polystigma	1	Male	Head part	Izmir Bay, Aegean Sea, Türkiye	October 2005	Metin *et al.* (2009)
Raja polystigma	1	Juvenile Female	The shape of the end of the tail is forked	Northern Tunisian waters (Central Mediterranean)	May 2010	Mnasri *et al.* (2010)
Raja clavata	2	Male (Juvenile and Adult)	Reduced tail, abnormality at the distal end of the tail	Syria coast, Eastern Mediterranean	April 2013-July 2014	Capapé *et al.* (2015b)
	1	Female	On the tail lack of dorsal and caudal fins		September 2014	
Raja clavata	2	Female	Snout, rostrum and tail Snout and caudal fin	Izmir, Aegean Sea, Türkiye	September 2016 February 2017	Capapé *et al.* (2018)
Raja clavata	1	Female	Absence of tail and asymmetric pectoral fin	Gulf of Gabes (Tunisia, Central Mediterranean Sea)	Early 2016	Marouani *et al.* (2019)
Raja clavata	2	Female	Absence of caudal and dorsal fin			
Raja radula	1	Female	Absence of caudal and dorsal fin			
Raja miraletus	1	Juvenile Female	Pectoral fin abnormality	Mersin Bay, Northeastern Mediterranean	January 2018	This study

they remain rare in skates. Orlov (2011) emphasized the scarcity of documented tail abnormalities in skates and highlighted the limited number of studies addressing such cases (Mnasri *et al.,* 2010; Capapé *et al.,* 2015a,b). Capapé *et al.* (2015b), for example, documented abnormal tail structures in both male and female specimens of *R. clavata* collected from Syrian coastal waters. Furthermore, Capapé *et al.* (2018) reported snout, rostrum, and caudal fin anomalies in *R. clavata* from the Aegean Sea, Türkiye. Similarly, Marouani *et al.* (2019) described the complete absence of caudal and dorsal fins in female specimens of *R. clavata* and *R. radula*, as well as an instance of asymmetric pectoral fin formation in a female *R. clavata* from the Gulf of Gabès, Tunisia. In addition, Mnasri *et al.* (2010) observed a fork-shaped tail tip in a juvenile female specimen from northern Tunisian waters. A comparative overview of the present case with previously reported deformities in Mediterranean skates and rays is provided in Tab. 2, illustrating the rarity and morphological diversity of such abnormalities.

According to Bensam (1965), members of the family Rajidae are oviparous, with embryonic development occurring within the yolk sac of the egg capsule deposited by the female. He proposed that congenital deformities may have their origins in mutations or developmental disruptions that occur

during the process of early embryogenesis. In support of this assertion, Ribeiro-Prado *et al.* (2008) underscored the potential impact of environmental stressors on the emergence of such abnormalities. In particular, chronic exposure to pollutants, chemical contaminants, or other unfavorable ecological conditions may interfere with normal developmental processes, thereby increasing the likelihood of morphological anomalies in both wild and captive elasmobranch populations.

Although there have been sporadic reports of morphological abnormalities affecting the snout and disc regions in various skate and ray species inhabiting the Mediterranean Sea, the present study documents the first instance of a pectoral fin deformity in a juvenile female *R. miraletus*. To date, no such anomaly has been recorded in this species within Turkish territorial waters. In conclusion, this observation constitutes the first documented instance of a morphological abnormality in *R. miraletus* from the Mediterranean coast of Turkey. This finding contributes novel data to the extant literature on elasmobranch developmental anomalies in the region.

CONCLUSIONS

Consequently, this study documents the first known instance of a pectoral fin deformity in a juvenile female *R. miraletus* from the Mediterranean coast of Türkiye, thereby contributing valuable new data to the limited literature on morphological abnormalities in skates and rays. The absence of scarring or injury lends support to the hypothesis that deformity is congenital, potentially resulting from developmental irregularities or environmental stressors. This case underscores the importance of ongoing biological monitoring and morphological assessments of elasmobranch populations in the Eastern Mediterranean. Future research should aim to determine the prevalence, causative factors, and ecological implications of such abnormalities, particularly in the face of increasing anthropogenic pressures on marine ecosystems.

ACKNOWLEDGMENTS

The authors would like to thank the boat captain and staff for their help in providing the specimens.

DEFORMACIJA DISKA PRI JUVENILNI SAMICI MODROPEGE RAŽE, *RAJA MIRALETUS* (DRUŽINA: RAJIDAE), IZ SEVEROVZHODNEGA SREDOZEMSKEGA MORJA (TURČIJA)

Deniz ERGÜDEN
Marine Science Department, Faculty of Marine Science and Technology, Iskenderun Technical University, 31200 Iskenderun, Hatay, Türkiye
e-mail: deniz.erguden@iste.edu.tr; derguden@gmail.com

Cemal TURAN
Marine Science Department, Faculty of Marine Science and Technology, Iskenderun Technical University, 31200 Iskenderun, Hatay, Türkiye

Servet Ahmet DOĞDU
Iskenderun Technical University, Maritime Vocational School of Higher Education, Underwater Technologies, 31220, Iskenderun, Hatay, Türkiye

Deniz AYAS
Faculty of Fisheries, Mersin University Yenişehir Campus, 33160, Mersin, Türkiye

POVZETEK

Avtorji poročajo o samici modropege raže, Raja miraletus *Linnaeus, 1758, najdene ob obali mesta Aydıncık (Mersin Bay, Turčija) v severovzhodnem Sredozemskem morju, ki kaže deformacije diska. Deformacija se nahaja na desnem delu diska, drugi del telesa pa je brez deformacij. Juvenilna samica je v premeru diska merila 22 centimetrov in v dolžino 31,7 cm ter tehtala 186 gramov. Ta primerek predstavlja prvi primer o ugotovljeni nenormalnosti vrste* R. miraletus *v turških sredozemskih vodah, pričujoč prispevek pa podaja prve informacije o prisotnosti nenormalnosti pri samicah vrste* R. miraletus.

Ključne besede: Rajiformes, nenormalnost, deformacija prsnega diska, zaliv Mersin, vzhodno Sredozemsko morje

REFERENCES

Akyol, O. & I. Aydin (2018): Abnormal *Raja clavata* (Rajidae) in the Aegean Sea: A ghost fishing effect. Turkish J. Fish. Aquat. Sci., 18(2), 357-358.

Antoni, M.Y.D., G. Elina DelpiAni & S.M. DelpiAni (2012): An aberrant extra fin in *Zearaja chilensis* (Chondrichthyes: Rajidae). Cybium, 36, 403-405.

Barone, M., C. Mazzoldi & F. Serena (2022): Sharks, rays and chimaeras in Mediterranean and Black seas key to identification. FAO, Rome, 87 pp.

Bensam, P. (1965): On a freak embryo of the grey shark, *Carcharhinus limbatus* M. & H. J. Mar. Biol. Assoc. India, 7, 206-207.

Bigelow, H.B. & W.C. Schroeder (1953): Sawfishes, guitarfishes, skates, rays and chimaeroids. In: J. Tee-Van, C. M. Breder, S. F. Hildebrand, A. E. Parr & W. C. Schroeder (Eds.): Fishes of the Western North Atlantic. Vol. 2, Memoirs of the Sears Foundation for Marine Research, 577 pp.

Bianchi, G., K.E. Carpenter, J.P. Roux, F.J. Molloy, D. Boyer & H.J. Boyer (1999): FAO species identification guide for fishery purposes. Field guide to the living marine resources of Namibia. FAO, Rome, 265 pp.

Capapé, C., M. Ali A. Saad, H. Alkusairy & C. Reynaud (2015a): Atypical characteristics in the longnosed skate *Dipturus oxyrhinchus* (Linnaeus, 1785) from the coast of Syria (eastern Mediterranean). Thalass. Salentina, 37, 71-80.

Capapé, C., M. Ali, A. Saad & C. Reynaud (2015b): Tail abnormalities in thornback ray *Raja clavata* (Chondrichthyes: Rajidae) from the coast of Syria (eastern Mediterranean). Cah. Biol. Mar., 56(2), 155-161.

Capapé, C., I. Aydin & O. Akyol (2018): Morphological deformities and atypical colour pattern in thornback ray, *Raja clavata* (Elasmobranchii: Rajiformes: Rajidae), from Izmir (Turkey, Aegean Sea, Eastern Mediterranean). Acta Ichthyol. Piscat., 48(3), 261-266.

Clarke, L.J. (2021): Morphological abnormality in thornback ray *Raja clavata* in the Irish Sea. Environ. Biol. Fish., 104, 719-724.

Compagno, L.J.V., D.A. Ebert & M.J. Smale (1989): Guide to the sharks and rays of southern Africa. New Holland (Publ.) Ltd., London. 158 pp.

Ehemann, N.R., F.J. García-Rodríguez & J. De La Cruz-Agüero (2022): Morphological abnormalities in seven American round ray specimens: a review of America's batomorph anomalies. J. Fish Dis., 45(3), 395-409.

Ellis, J.R. (2005): An abnormal thornback ray *Raja clavata* with additional pectoral fins. Suffolk Nat. Hist., 41, 31-37.

Escobar-Sanches, O., F. Galvan-Magana, C.A. Downton-Hoffmann, M. Carrera-Fernandez & V.G. Alatorre-Ramirez (2019): First record of a morphological abnormality in the longtail stingray *Dasyatis longa* (Myliobatiformes: Dasyatidae) in the Gulf of California, Mexico. Mar. Biodiv. Rec., 2, e26.

Froese, R. & D. Pauly (eds.) (2025): Fish Base. World Wide Web Electronic Publications. Retrieved from https://www.fishbase.org. Accessed on 30 April 2025.

Gajić, A.A., J.A. Sulikowski & H. Beširović (2023): An interesting case of a single ocellus in a brown ray from the Adriatic Sea. Mar. Biodiv., 53, 29.

Golani, D., B. Öztürk & N. Başusta (2006): Fishes of the eastern Mediterranean. Turkish Marine Research Foundation, Publication No. 24, Istanbul, Turkey, 259 pp.

Heupel, M.R., C.A. Simpfendorfer & M.B. Bennett (1999): Skeletal deformities in elasmobranchs from Australian waters. J. Fish Biol., 54(5), 1111-1115.

Hoenig, J.M. & A.H. Walsh (1983): Skeletal lesions and deformities in large sharks. J. Wildl. Dis., 19(1), 27-33.

IUCN (2025): The IUCN Red List of Threatened Species. Version 2025-1. Retrieved from https://www.iucnredlist.org. Accessed on 30 April 2025.

Lara-Mendoza, R.E. & L.A. Guerra-Jimenez (2020): Record of albinism in the smooth butterfly ray *Gymnura micrura* (Rajiformes, Gymnuridae) from the southeastern Gulf of Mexico. Pan-Am. J. Aqua. Sci., 15(1), 33-38.

Marouani, S., F. Ben Jarray & S. Karaa (2019): Morphological abnormalities in Rajidae species (Chondrichthyes) from the Gulf of Gabès (Tunisia, Central Mediterranean Sea): What causes? Adv. Oceanogr. & Mar. Biol., 1(2), 1-5.

McCully, S.R., F. Scott & J. Ellis (2012): Lengths at maturity and conversion factors for skates (Rajidae) around the British Isles, with an analysis of data in the literatüre. ICES J. Mar. Sci., 69(10), 1812-1822.

McEachran, J.D. & K.A. Dunn (1998): Phylogenetic analysis of skates, a morphologically conservative clade of elasmobranchs (Chondrichthyes: Rajidae). Copeia, 1998(2), 271-290.

Mendez, L., A. Bacquet & F. Briand (2022): Guide of Mediterranean Skates and Rays. Retrieved from www.ciesm.org/Guide/skatesandrays. Accessed on 30 April 2025.

Metin, G., A.T. İlkyaz **& H.T. Kınacıgil (2009):** Morphologic deformation in a ray: a case report. Turk. J. Vet. Anim. Sci., 33(3), 261-263.

Mnasri, N., O. El Kamel, M. Boumaïza, M.M. Ben Amor, C. Reynaud & C. Capapé (2010): Morphological abnormalities in two batoid species (Chondrichthyes) from northern Tunisian waters (central Mediterranean). Annales, Ser. Hist. Nat., 20(2), 181-190.

Montero-Hernández G., M.J. Caballero, Á. Curros-Moreno, C.M. Suárez-Santana, M.A. Rivero, L. Caballero-Hernández, M. Encinoso, A. Fernández & A. Castro-Alonso (2024): Pathological study of a traumatic anthropogenic injury in the skeleton of a spiny butterfly ray (*Gymnura altavela*). Front. Vet. Sci., 11, 1452659.

Moore, A.B.M. (2015): Morphological abnormalities in elasmobranchs. J. Fish Biol., 87(2), 465-471.

Mytilineou, C., C.Y. Politou, C. Papaconstantinou, S. Kavadas, G. D'Onghia & L. Sion (2005): Deep-water fish fauna in the Eastern Ionian Sea. Belg. J. Zool., 135(2), 229-233.

Orlov, A.M. (2011): Record of a tailless Richardson's ray *Bathyraja richardsoni* (Garrick, 1961) (Rajiformes: Arhynchobatidae) caught off the Mid-Atlantic ridge. Pan-Am., J. Aquat. Sci., 6(3), 232-236.

Quigley, D.T.G., A. de Carlos, D. Barros-Garcia & D. MacGabhann (2018a): Albinism and leucism in Blonde rays (*Raja brachyura* Lafont, 1871) (Elasmobranchii: Batoidea) from the Irish Sea. Bull. Eur. Ass. Fish Pathol., 38(2), 79-88.

Quigley, D.T.G., A. de Carlos, D. Barros-Garcia & D. MacGabhann (2018b): Albino xanthochromic Homelyn Ray *Raja montagui* Fowler, 1910 (Elasmobranchii: Batoidea) from the Irish Sea. Bull. Eur. Ass. Fish Pathol., 38(4), 109-114.

Quigley, D.T.G., A. de Carlos, D. Barros-Garcia & D. MacGabhann (2019a): Leucistic piebald Cuckoo Ray (*Leucoraja naevus* (Müller and Henle)) from the Irish Sea. Irish Natural. J., 36(2), 159-162.

Quigley, D.T.G., A. de Carlos, D. Barros-Garcia & D. MacGabhann (2019b): Further records of leucistic Blonde rays (*Raja brachyura* Lafont) from the Irish Sea. Irish Natural. J., 36(2), 162-164.

Ramírez-Amaro, S.R, G. González-Barba, F. Galván-Magaña & D. Cartamil (2013): First record of abnormal cephalic horns in the California bat ray *Myliobatis californica*. Mar Biodiv. Rec., 6, e11.

Ribeiro-Prado, C.C., M.C. Oddone, M.M.B. Gonzalez, A. Ferreira de Amorim & C. Capapé **(2008):** Morphological abnormalities in skates and rays (Chondrichthyes) from off southern Brazil. Arq. Cien. Mar. Fortaleza, 41(2), 21-28.

Schneider, W. (1990): FAO species identification sheets for fishery purposes. Field guide to the commercial marine resources of the Gulf of Guinea. Prepared and published with the support of the FAO Regional Office for Africa. FAO, Rome, 268 pp.

Turan, C., A. Uyan, A. Soldo, S.A. Doğdu & D. Erguden (2025): Checklist of cartilaginous fishes with current status and conservation strategies in Turkish marine waters. Tethys Env. Sci., 2(1), 31-61.

Yoshiharu, H. & C. Sugihara (1971): A stingray *Dasyatis akajei*, with aberrant pectoral fins from the Japan Sea. Japanese J. Ichthyol., 18(4), 187-189.

Williams, G. (1935): Note on the occurrence of a fin abnormality in the thornbacked ray (*Raja clavata*). Irish Natural. J., 5, 223-225.