Morphological abnormality in thornback ray *Raja clavata* in the Irish Sea

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**Abstract** A free-swimming thornback ray *Raja clavata* specimen demonstrating significant morphological abnormality is reported, captured by beam trawl in the Irish Sea off north Wales, UK. The anterior sections of both pectoral fins were separated from the head section for a length of approximately 140 mm extending from the rostrum tip to a point posterior of the spiracles, along with abnormal morphology of the gill slits. This phenomenon has been observed elsewhere but is the first documented example of this abnormality in the eastern Irish Sea, despite widespread targeting of the species across the region by commercial and recreational fishers. Possible causes and consequences of the observed abnormality are discussed.

**Keywords** Deformity · Morphological abnormality · Thornback ray · Rajidae

Despite widespread monitoring and sampling by researchers, there are relatively few reports of morphological abnormalities in free-swimming, mature elasmobranchs, although numerous examples exist of embryo abnormalities (Bensam 1964; Mancini et al. 2006; Driggers et al. 2012; Guida et al. 2014). Moore (2015) therefore suggested that the majority of these embryonic abnormalities might be fatal beyond birth. The few documented examples of morphological abnormalities in adults largely include albinism and other atypical colouration (Capapé et al. 2018; Lara-Mendoza and Guerra-Jimenez 2020), missing or additional fins (Taniuchi and Yanagisawa 1987; Williams 1935; Ellis 2005; Antoni et al. 2012; Moore 2015), deformed skeletons (Hoenig and Walsh 1983; Heupel et al. 1999; Thorburn and Morgan 2004) and other physical deformities to the body (Ramírez-Amaro et al. 2013; Moore 2015; Capape et al. 2015; Capapé et al. 2018). The causes of such occurrences in adults remain poorly understood, and further reporting can help understand both the causes and implications of such abnormalities (Heupel et al. 1999).

The thornback ray *Raja clavata* Linnaeus, 1758, is the dominant skate (Rajidae) species in inshore waters around Britain and Ireland (MarLIN 2021), where it is targeted by commercial and recreational fishers, in mixed demersal trawls, fixed nets and by rod and line (Quintana 2018). The species is present along the coast of the eastern Atlantic from the Strait of Gibraltar to Scandinavia (Quero et al. 2003), throughout the Mediterranean (Golani et al. 2006) and has been recorded off South Africa (Smith and Heemstra 1986), Mauritania (Maurin and Bonnet 1970), Morocco (Lloris and Rucabado 1998) and in the Black Sea (Bilecenoğlu et al. 2014). The species is listed as near threatened by the International Union for the Conservation of Nature (IUCN 2021).
On 28th August 2020, a thornback ray specimen weighing 1.45 kg was captured in Caernarfon Bay, north Wales, UK (53°09′47″ N, 4°29′10″ W) with a 4-m beam trawl from the RV Prince Madog, at 19–22 m depth and approximately 7 km offshore, as part of an elasmobranch population monitoring survey across the region (Fig. 1). Dissection of this specimen was not possible. Based on the total length of the individual (Table 1) and the length of the claspers (Fig. 2), the specimen was identified as a male approaching sexual maturity (ICES 2009). The specimen showed a clear symmetrical separation of the anterior sections of the pectoral fins from the head (Fig. 2a). This separation extended from the snout and periorbital region, reaching posterior of the spiracles to the gill slits (Fig. 2a), to a length of approximately 140 mm. The gill slits also showed abnormalities relative to those usually observed in the species, with only 2–3 visible on each side as opposed to the usual five, and those gill openings present appearing much larger than in usual specimens (Figs. 2b and 3). The anterior-most of the right-hand gill slits was notably located at the intersection of the wing and the head section (Figs. 2b, 3 and 4). No sign of physical injury or scarring was evident.

Aside from these significant deformities, the specimen had no other unusual morphological features, markings or colouration and was in good

**Table 1** Morphometric measurements of the thornback ray specimen with significant morphological deformities

| Measurement   | Length (mm) |
|---------------|-------------|
| Total length  | 600         |
| Disc width    | 425         |
| Clasper length| 86          |
| Pectoral edge | 200         |

Fig. 1 Catch location (black arrow) of the deformed thornback ray *Raja clavata* in Caernarfon Bay, northwest Wales, UK. The location in relation to the wider UK is indicated on the right of the figure.
condition. The individual was tagged with a Floy® disc identification tag prior to release from the survey vessel. Apparently approaching sexual maturity and at 600 mm $L_T$, it appears the observed deformities had not caused physical impairment or interference with normal biological processes for the specimen, which demonstrated strong vitality and low levels of physical injury after capture in the trawl.

The most frequently reported physical abnormalities in elasmobranchs are usually loss or damage to the fins or tail (Templeman 1965; Mnasri et al. 2009; Orlov 2011; Moore 2015; Capapé et al. 2018), although non-adherence of the pectoral fins to the head has been occasionally observed in batoid species elsewhere, with observations dating back to the 1800s, although available information suggests not usually to the extent observed in the present specimen (Bureau 1890; Gudger and Goffin 1933). Other examples of anterior notches or separation in the pectoral fins of batoids exist in the
literature, to varying degrees (Johnstone 1906; Sae-
mundsson 1909; Gudger and Goffin 1933; Ribeiro-
Prado et al. 2008), and for *R. clavata* in particular
(Vaillant 1908; Williamson 1909; Legendre 1936;
De Buit 1964; Jardas and Homen 1977), although
documented cases of the phenomenon are of single
specimens and the frequency at the population level
remains unknown. As far as we are aware, however,
this is the first recorded observation of this phenom-
emon from Welsh waters and the eastern Irish Sea.

Whilst other rostral deformities may occur due
to the effects of physical injury, such as through
ghost fishing (Akyol and Aydin 2018), parasites or
disease (Heupel et al. 1999; Moore 2015), it has
been suggested that pectoral non-adherence is due
to the failure of pectoral fins to fuse together in
front of the head in early embryonic development,
during which the pectoral fins are separate, before
fusing in medium-term embryos and forming the
complete body disc in late development (Bigelow
and Schroeder 1953). It would therefore appear that
the reduced number of gill slits in the specimen is
likely due to this developmental abnormality and
non-adherence.

Nakamura et al. (2015) showed that the genetic
mechanisms behind batoid fin development differ
between the anterior and posterior sections; thus, the
observed deformity to the posterior pectoral section in
our specimen may be due to disruption to the genetic
pathways that determine anterior pectoral develop-
ment and fusion with the head. Such disruption may
be through natural genetic variation or through pol-
lutant exposure (Boldrini and Pereira 1987; Tomassi
1985). The water quality across the area of capture is
known to be high, however, with low levels of patho-
gens and pollutants (Natural Resources Wales 2019).

Whilst not collected in this study, the genetic analysis
of tissue samples from specimens that demonstrate
this abnormality may allow a better understanding of
the causal factors and of the longer-term implications
of the condition to the individual.

The deformities reported here have been observed
in the species elsewhere, but there are no records in
the literature of pectoral non-adherence in thornback
ray in the eastern Irish Sea or in Welsh waters spe-
cifically. This therefore represents the first recorded
observation of the phenomenon in the region despite
the widespread targeting of the species by commer-
cial and recreational fishers.

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**Data availability** No further data than that presented in this
manuscript are available.

**Declarations**

**Ethics approval** This work received ethical approval from
Bangor University’s Animal Welfare and Ethical Review Body.

**Conflict of interest** The author declares no competing inter-
ests.

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**References**

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

Antoni MYD, Elina DelpiAni G, DelpiAni SM (2012) An
aberrant extra fin in *Zearaja chilensis* (Chondrichthyes:
Rajidae). Cybium 36: 403–405

Bensam P (1964) On a freak embryo of the grey-shark, *Car-
charhinus limbatus* Muller and Henle. J Mar Biol Assoc
India 7(1):206–207

Bigelow HB, Schroeder WC (1953) Sharks, sawfishes, gui-
tarfishes, skates and rays. Chimaeroids. In: Tee–Van J,
Breder CM, Hildebrand SF, Parr AE and Schroeder WE
(eds.), Fishes of the Western North Atlantic. Part 2. Sears
Foundation for Marine Research, Yale University, New
Haven pp 1–514

Bilecenoğlu M, Kaya M, Cihangir B, Ciçek E (2014) An
updated checklist of the marine fishes of Turkey. Turk J
Zool 38(6):901–929. https://doi.org/10.3906/zoo-1405-60

Boldrini CV, Pereira DN (1987) Metais pesados na Baía
de Santos e São Vicente-Biocumulação. Ambiente
1(3):118–127
Bureau G (1890) Sur une monstruosité de la raie estellée (Raia asterias Rondelet). Bull Soc Zool Fr 14:313–316

Capape C, Ali M, Saad A, Reynaud C (2015) Tail abnormalities in thornback ray Raja clavata (Chondrichthyes: Raji- dae) from the coast of Syria (eastern Mediterranean). Cah Biol Mar 56(2):155–161

Capapé C, Akyol O (2018) Morphological deformities and atypical colour pattern in thornback ray, Raja clavata (Elasmobranchi: Rajiformes: Rajidae), from İzmir (Turkey, Aegean Sea, Eastern Mediterranean). Acta Ichthyol Piscat 48(3):261–266

Driggers WB III, Hannan KM, Hoffmayer ER, Jensen J (2012) Abnormal blacktip shark, Carcharhinus limbatus, embryo from the northern Gulf of Mexico. J Appl Ichthyol 28(5):827–828

Du Buit MH (1964) Une raie anormale trouvée à Concarneau. Bull Mus Nat Hist Nat 2 ème sér 36: 180–184

Ellis JR (2005) An abnormal thornback ray Raja clavata with additional pectoral fins. Suffolk Nat Hist 41:31–37

Golani D, Öztürk B, Basusta N (2006) Fishes of the Eastern Mediterranean. Turkish Marine Research Foundation, Publication no. 24, Istanbul, Turkey, p 259

Gudger EW, Goffin RA (1933) A second barn-door skate, Raja stabuliforius, with pectorals non-adherent to the head. American Museum novitates; no. 600

Guida L, Walker TI, Reina RD (2012) Skeletal lesions and deformities in large sharks. J Wildl Dis 19(1):27–33

Hoenig JM, Walsh AH (1983) Skeletal lesions and deformities in elasmobranchs from Australian waters. J Fish Biol 54(5):1111–1115

Hoenig JM, Walsh AH (1983) Skeletal lesions and deformities in large sharks. J Wildl Dis 19(1):27–33

International Council for the Exploration of the Sea (2009) Report of the Joint Meeting between ICES Working Group on Elasmobranch Fishes (WGEl) and ICCAT Shark Subgroup, 22–29 June 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:16. p 424

International Union for Conservation of Nature (2021) Thornback ray (Raja clavata). Available online at: https://www.iucnredlist.org/ja/species/39399/103110667. Last Accessed on 24th March 2021

Jardas I, Homen Z (1977) Nouvelles trouvailles sur les anomalies anatomiques des poisons Adriatiques. Bilješke – Zavod za Znanije i Obrazovanje, Dubrovnik. p 9

Jardas I, Homen Z (1977) Nouvelles trouvailles sur les anomalies anatomiques des poisons Adriatiques. Bilješke – Zavod za Znanije i Obrazovanje, Dubrovnik. p 9

Johnstone J (1906) Ichthyological notes. Trans. Liverpool. Biol Soc 20:330–335

Johnstone J (1906) Ichthyological notes. Trans. Liverpool. Biol Soc 20:330–335

Lara-Mendoza RE, Guerra-Jimenez LA (2020) Record of albinism in the smooth butterfly ray Gymnura micrura (Rajiformes, Gymnuridae) from the southeastern Gulf of Mexico. Pan-Am J Aqua Sci 6(3):232–236

Legendre R (1936) Raie boucle anormale trouvée a Concarneau. Bull Soc Zoot France 61:314–315

Lloris D, Rucabado J (1998) Guide FAO d’identification des espèces pour les besoins de la pêche Guide d’identification des ressources marines vivantes pour le Maroc. FAO, Rome, p 263

Mancini PL, Casas AL, Amorim AF (2006) Morphological abnormalities in a blue shark Prionace glauca (Chondrichthyes: Carcharhinidae) foetus from southern Brazil. J Fish Biol 69(6):1881–1884

Marine Life Information Network. (2021). Thornback ray (Raja clavata). Available online at: https://www.marlin.ac.uk/species/detail/2187. Last Accessed on 24th March 2021

Maurin C, Bonnet M (1970) Poissons des côtes nord-ouest africaines (Campagnes de la “Thalassa”, 1962 et 1968). Revue Des Travaux De L’institut Scientifique Et Technique Des Pêches Maritimes 34:125–170

Mnasri N, Boumaïza M, Capapé C (2009) Morphological data, biological observations and occurrence of a rare skate, Leucoraja circularis (Chondrichthyes: Rajidae), off the northern coast of Tunisia (Central Mediterranean). Pan-Am J Aqua Sci 4(1):70–78

Moore ABM (2015) Morphological abnormalities in elasmobranchs. J Fish Biol 87(2):465–471. https://doi.org/10.1111/jfb.12680

Nakamura T, Klomp J, Pieretti J, Schneider I, Gehrke AR, Shubin NH (2015) Molecular mechanisms underlying the exceptional adaptations of batoid fins. Proc Natl Acad Sci 112(52):15940–15945

Natural Resources Wales (2019) Wales bathing water quality report 2019. Available Online at: https://naturalresources.wales/evidence-and-data/research-and-reports/water-reports/2019-wales-bathing-water-quality-report/?lang=en. Last Accessed 24th March 2021

Orlov AM (2011) Record of a tailless Richardson’s ray Bathyraya richardsoni (Garrick, 1961) (Rajiformes: Arhynchoptetidae) caught off the Mid-Atlantic ridge. Pan-Am J Aqua Sci 6(3):232–236

Prado CCR, Oddone MC, Gonzalez MMB, de Amorim AF, Capapé C (2008) Morphological abnormalities in skates and rays (Chondrichthyes) from off southeastern Brazil. Arquivos de Ciências Do Mar 41(2): 21–28

Quero JC, Porché P, Vayne JJ (2003) Guide des poissons de l’Atlantique européen, identifier 955 espèces. Les Guides Du Naturaliste. Delachaux et Niestlé, Lonay

Quintana MM (2018) Overview of the Welsh skates and rays dependant vessels 2010–2017. SeaFish. November 2018

Radcliffe L (1928) A barn-door skate (Raja stabuliforius) with abnormal pectoral fins. Nat Hist NY 28: 58 63

Ramírez-Amaro SR, González-Barba G, Galván-Magaña F, Cartamil D (2013) First record of abnormal cephalic horns in the California bat ray Myliobatis californica. Mar Biodivers Rec 6

Saemundsson B (1909) Oversigt over Islands fiske. Skr Komm Havunders 5:1–140

Sampaio PL, Casas AL, Amorim AF (2006) Morphological abnormalities in a blue shark Prionace glauca (Chondrichthyes: Carcharhinidae) foetus from southern Brazil. J Fish Biol 69(6):1881–1884

Smith MC, Heemstra PC (1986) Smiths’ sea fishes. Springer-Verlag Berlin, Heidelberg, New York, London, Paris, Tokyo, pp 1046

Taniuchi T, Yanagisawa F (1987) Albinism and lack of second dorsal fin in an adult tawny nurse shark, Nebrius concolor, from Japan. Jap J Ichthyol 34(3):393–395

Templeman W (1965) Some abnormalities in skates (Raja) of the Newfoundland area. J Fish Board Can 22(1):237–238

Thorburn DC, Morgan DL (2004) The northern river shark Raja tayassuidae (Rajiformes: Rajidae) from the coast of Syria (eastern Mediterranean). Cah Biol Mar 56(2):155–161

Vereshchagin AA (1970) Ichthyological notes. Trans. Liverpool. Biol Soc 20:330–335

Wright AP, Stuart-Steinberg CV, Thiriot T, Cameron AV, Wurzburger B (2014) Characterizing coastal habitats of humpback whales Megaptera novaeangliae using aerial and remote sensing observations. Mar Biodivers 44:549–567

Zdanovichi EA, Vladykov PK, Zeldenrust JA (1982) Fishes of the Mediterranean. University Park Press, Baltimore, p 291

Ziegler SL, Lenfant AF, Schmidt ML (2016) Reproductive morphology of the phocid seal Monachus schauinslandi from northwestern Australia. J Zool Syst Evol Res 54(5):352–362

Zyabulina K, Huang J, Shibaev D, Johnson K, Zabinskaia E, Reshetnikova T, Li Y, Gurevich M, Liu HB, Xiao J, Li W, Han H, Li C, Wang X, Liao T, Zhang H, Wang Y, Liu Y, Huang Z, Ci X, Yuan Z, Wang Z, Liu W, Kuang M, Cao W, Wang J, Gao N, Zhou Q, Pei G, Shi D, Zhao J, Zhang L, Meng X, Ye R, Zhang Z, Liu P (2021) Evolutionary history of the sea snakes reveals their adaptive radiation to the Indo-West Pacific region. Science 371(6534):723–728
Tomassi L (1985) Resíduos de praguicidas em águas e sedimentos de fundo do sistema estuarino de Santos (SP). Ciência e Cultura 37(6):1001–1012

Vaillant L (1908) Sur un individu monstrueux myctéridoïde du *Raja clavata* L. Bull Mus Nat Hist Nat 14:112–113

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

Williamson, D. (1909). Scientific report VI. Abnormalities in *Lophius*, *Gadus* and *Raja*. 25th Ann Rep Fish Scot 1909:53-64

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