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First recorded case of leucism in the velvet belly lantern shark *Etmopterus spinax* (Squaliformes: Etmopteridae)

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Abstract

The capture of a female specimen of the velvet belly lantern shark *Etmopterus spinax* with abnormal skin coloration is reported. The specimen was captured off northern Spain (Bay of Biscay, North-eastern Atlantic) in 2021 by bottom trawling. The lack of dermal melanophores combined with a normal retinal pigmentation, lead us to considerate the specimen as leucistic. This is the first case of leucism in *E. spinax* and the second record of colour aberration in the family Etmopteridae. A comprehensive updated review of published literature on albinism and leucism in chondrichthyans is also provided.

KEYWORDS

abnormal coloration, albinism, leucistic, North-eastern Atlantic, shark

1 | INTRODUCTION

Pigmentation disorders, which are rarely observed in the wild, occurs as either a deficiency (hypomelanosis; e.g., albinism, leucism, piebaldism, and xanthism) or an excess (hypermelanosis; e.g., melanism) of pigmentation (Jawad & Ibrahim, 2018). Albinism is a genetically inherited condition in which the pigment protein melanin is either absent or non-functional (Reum et al., 2008) resulting in a total lack of normal pigmentation in both the skin and iris. On the other hand, leucism is a genetic disorder controlled by a single recessive allele expressed as the complete or partial loss of skin pigmentation but with a normal iris pigmentation (Bigman et al., 2016; Clark, 2002). Colour abnormalities are known to occur in all vertebrate groups and specifically in chondrichthyes, they have been reported in a wide variety of chimaera, ray, and shark species. In the present paper, we report the occurrence of a case of leucism in the velvet belly lantern shark *Etmopterus spinax* (Linnaeus, 1758).

Etmopterus spinax is a small-sized (up to 45 cm in length) deep-water squalid shark that possess the capability to produce bioluminescence due to the presence of photophores in its body (Claes & Mallefet, 2011). The species inhabits the eastern side of the Atlantic Ocean, from Iceland and Norway to Gabon and the Mediterranean Sea and it is usually found near or well above the bottom along the outer continental and insular shelves and upper slopes, at depths from 70 to 2490 m, but mostly between 200 and 600 m (Ebert & Dando, 2020).

2 | MATERIAL AND METHODS

On 04 November 2021, a female specimen of *E. spinax* with abnormal coloration was captured by bottom trawl off northern Spain (43°33′34″N; 05°19′37″W) at a depth of 568 m (Figure 1) during the annual research survey "Demersales". The individual was identified and frozen on-board. Once in the laboratory, it was defrosted and morphometrics to the nearest millimetre were recorded following Compagno (1984) and compared with those of a normal specimen of similar length captured in the same haul. The specimen was then preserved in 10% formalin, later transferred to 70% ethanol, and deposited in the fish collection of the Instituto Español de Oceanografía in Santander.

In addition, a thorough review of records of albinism and leucism in chondrichthyans was undertaken. The list was based solely

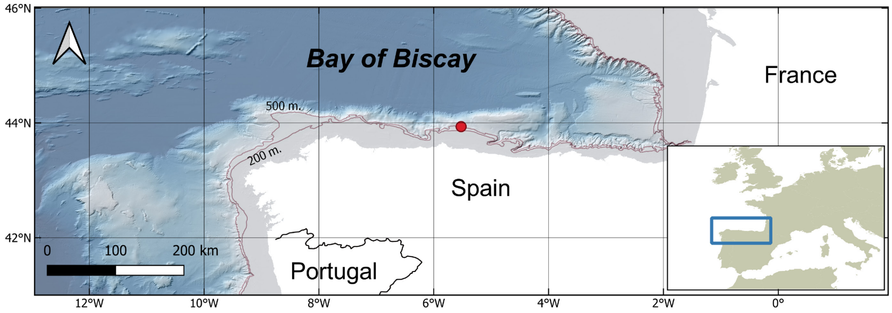

FIGURE 1 Capture site of leucistic specimen of *Etmopterus spinax* in the northern Spanish continental shelf (North-eastern Atlantic) (red circle).

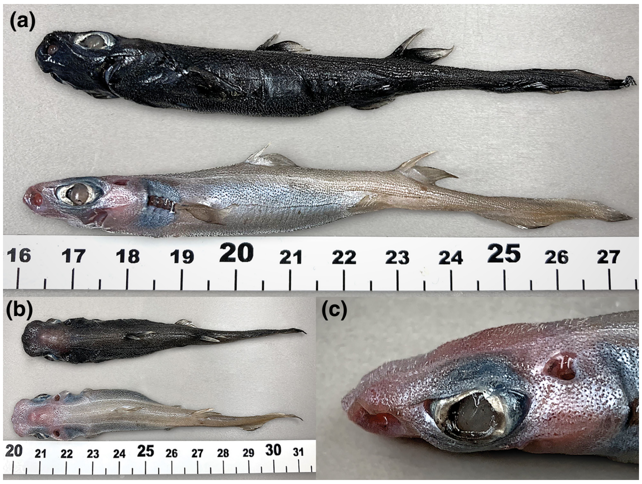

FIGURE 2 (a) Dorsal view of a normal (up) and leucistic (down) specimens of *Etmopterus spinax*. (b) lateral view of a normal (up) and leucistic (down) specimens of *E. spinax*. (c) eye showing normal pigmentation in the albino *E. spinax*, indicating that the individual displays leucism. Photographs were taken to fresh specimens.

on records published in journals and books. Anecdotal reports from web pages and/or blogs were excluded.

3 | RESULTS

The normal coloration of *E. spinax* (Figure 2a,b) is dark brown on dorsal surface, underside of snout and abdomen abruptly black and thin black marks above and behind the pelvic fins and along the caudal fin. The specimen with abnormal coloration was shiny white on body and fins, greyish underside of snout, abdomen, and margin of the caudal fin (Figure 2a,b) and the eyes showed a normal retinal pigmentation (Figure 2c). Hence, it was considered as a leucistic shark. In addition, photophores were present although it is not known if these were functional.

No morphometric differences between the leucistic specimen and the normal *E. spinax* individual of similar size were observed (Table 1). Albinism and leucism has been reported in 61 species (37 sharks, 23 rays and one chimaera) corresponding to 31 families (Table 2). Of these chondrichthyan species, six (9.8%) showed both albinism and leucism, whereas an equal number of species was observed showing albinism or leucism (27; 44.3%). Only in one species (1.6%) the distinction between albinism or leucism has not been reported.

TABLE 1 Morphometric measurements (in mm) for the leucistic and one normally pigmented specimen of *Etmopterus spinax*

Measurements	Leucistic	% Total length	Normally pigmented	% Total length
Total length	113		116	
Precaudal length	83	73.5	86	74.1
Pre-narial length	3	2.7	3	2.6
Preoral length	9	8.0	9	7.8
Preorbital length	8	7.1	8	6.9
Pre-spiracle length	17	15.0	17	14.7
Head length	29	25.7	29	25.0
Head height	8	7.1	9	7.8
Head width	12	10.6	12	10.3
Interorbital length	10	8.8	9	7.8
Mouth length	2	1.8	2	1.7
Mouth width	7	6.2	8	6.9
Pre-first dorsal fin length	39	34.5	39	33.6
Pre-second dorsal fin length	66	58.4	64	55.2
Inter-dorsal space	21	18.6	20	17.2
Preanal length	63	55.8	63	54.3
Pre-pelvic length	57	50.4	58	50.0
Pectoral fin base length	5	4.4	5	4.3
Pectoral fin height	6	5.3	6	5.2
Pelvic fin base length	6	5.3	6	5.2
Pelvic fin height	5	4.4	5	4.3
First dorsal fin base length	5	4.4	5	4.3
Second dorsal fin base length	6	5.3	7	6.0
Caudal fin dorsal margin	26	23.0	25	21.6
Weight (g)	6.03	–	6.2	–
Eye	Normal		Normal	
Sex	Female		Female	

4 | DISCUSSION

The present paper reports the first case of skin colour abnormality in *E. spinax* and the second for the genus. Prior to the present record, one albino specimen of its congeneric *Etmopterus lucifer* Jordan & Snyder, 1902 was captured in 1984 off the North Island in

TABLE 2 Review of known records of chondrichthyan species exhibiting colour abnormalities: Albinism (A), Leucism (L), Unknown (U)

Family	Species	Abnormality	Reference
Hexanchidae	*Notorynchus cepedianus*	L	Herald (1953), Ebert (1985)
Squalidae	*Squalus acanthias*	A	Frøiland (1975), Castro (2011)
	Squalus acanthias	L	Coad and Gilhen (2002), Quigley, MacGabhann, and Duane (2018)
	Squalus megalops	A	Sanda and De Maddalena (2003)
Centrophoridae	*Deania calcea*	A	Moura et al. (2015)
Etmopteridae	*Etmopterus lucifer*	A	Finucci (2020)
	Etmopterus spinax	L	This study
Somniosidae	*Centroscymnus coelolepis*	L	Deynat (2003)
Dalatiidae	*Dalatias licha*	L	Bottaro et al. (2008)
Squatinidae	*Squatina californica*	L	Escobar-Sánchez et al. (2014)
Orectolobidae	*Orectolobus japonicus*	A	Iwamasa and Okano (1980)
Heterodontidae	*Heterodontus portusjacksoni*	U	Veena et al. (2011)
Hemiscyllidae	*Chiloscyllium plagiosum*	A	Clark (2002)
Ginglymostomatidae	*Nebrius ferrugineus*	A	Taniuchi and Yanagisawa (1987)
Stegostomatidae	*Stegostoma fasciatum*	A	Nakaya (1973)
Cetorhinidae	*Cetorhinus maximus*	A	Frøiland, 1975
Lamnidae	*Carcharodon carcharias*	L	Smale and Heemstra (1997), Kabasakal (2020)
	Lamna nasus	A	Frøiland (1975)
Odontaspididae	*Odantaspis ferox*	L	Fergusson et al. (2008)
Scyliorhinidae	*Cephaloscyllium ventriosum*	A	Becerril-García et al. (2017)
	Scyliorhinus canicula	A	Hoare (2009), Quigley, MacGabhann, and Duane (2018), Quigley (2021)
	Scyliorhinus canicula	L	Quigley, MacGabhann, and Duane (2018)
	Scyliorhinus duhamelli		Mnasri et al., 2010
	Scyliorhinus stellaris	L	Quigley and Flannery (1989), Quigley, MacGabhann, and Duane (2018)
	Galeus melastomus	L	Mulas et al. (2020)
Triakidae	*Galeorhinus galeus*	A	Deynat (2003), Quigley, MacGabhann, and Duane (2018)
	Hemitriakis japanica	L	Furuta (1985)
	Mustelus californicus	A	Herald et al. (1960), Cohen, 1973; Talent (1973)
	Mustelus schmitti	A	Teixeira and Araújo (2002)
	Triakis semifasciata	A	Follett (1976)
Carcharhinidae	*Carcharhinus amboinensis*	L	McKay and Beinssen (1988)
	Carcharhinus dussumieri	L	Gopalan (1971)
	Carcharhinus isodon	L	Jones et al. (2006)
	Carcharhinus limbatus	L	Sancho-Vázquez et al. (2015)
	Carcharhinus melanopterus	A	Manojkumar (2011)
	Carcharhinus obscurus	A	Bejarano-Álvarez and Galvan-Magaña (2013)
	Carcharhinus plumbeus	L	Saïdi et al. (2006), Ergüden et al. (2020)
	Galeocerdo cuvier	A	Rider et al. (2002); Sandoval-Castillo et al. (2006)
	Scoliodon laticaudus	L	Veena et al. (2011)
Sphyrnidae	*Sphyrna lewini*	A	McKenzie (1970)
Arhynchobatidae	*Bathyraja aleutica*	A	Bigman et al. (2016)
Arhynchobatidae	*Bathyraja trachura*	L	Bigman et al. (2016)
Rhinobatidae	*Glaucostegus halavi*	A	Ben Souissi et al. (2007)

(Continues)

TABLE 2 (Continued)

Family	Species	Abnormality	Reference
Rajidae	*Okamejei kenojei*	L	Ishihara et al. (2001)
	Dipturus batis	L	Wilson (1951)
	Leucoraja naevus	L	Wilson (1951), Quigley et al. (2019)
	Raja brachyura	A	Ball et al. (2013), Quigley, de Carlos, et al. (2018), Quigley (2019)
	Raja brachyura	L	Quigley et al. (2018, 2019); Quigley (2021)
	Raja clavata	A	Quigley (2021)
	Raja clavata	L	Traquair (1893), Clarke (1929), Quigley and Flannery (1994), Ball et al. (2013), Quigley (2021)
	Raja montagui	A	Ball et al. (2013)
Narcinidae	*Narcine bancroftii*	L	Jones et al. (2016)
	Narcine entemedor	L	Sandoval-Castillo et al. (2006)
Torpedinidae	*Torpedo marmorata*	A	Lipej et al. (2011)
	Torpedo torpedo	A	Ben-Brahim et al. (1998)
Dasyatidae	*Bathytoshia brevicaudatus*	A	Talent (1973)
	Dasyatis pastinaca	L	Capapé and Pantoustier (1975)
	Hypanus americanus	L	Schwartz and Safrit (1977), Mendoza-Carranza et al. (2016)
	Hypanus americanus	A	Wakida-Kusunoki (2015)
Gymnuridae	*Gymnura micrura*	L	Reis et al. (2013)
	Gymnura micrura	A	Lara-Mendoza and Guerra-Jiménez (2020)
Mobulidae	*Mobula birostris*	L	Ishihara et al. (2001), Marshall et al. (2009)
Myliobatidae	*Mobula alfredi*	L	Marshall et al. (2009)
	Myliobatis californica	A	De Jesús-Roldan (1990)
Rhinopteridae	*Rhinoptera bonasus*	L	Schwartz (1959), Joseph, 1961
Urotrygonidae	*Urotrygon nana*	A	Anislado-Tolentino et al. (2016)
Zanobatidae	*Zanobatus schoenleinii*	L	Diatta et al. (2013)
Chimaeridae	*Hydrolagus colliei*	A	Reum et al. (2008)

New Zealand (Finucci, 2020). According to Ebert and Dando (2020), the size at birth in this species is between 8 and 14 cm so, at a total length of 11.3 cm, the specimen can be considered as a new-born individual.

Currently, an overall total of 1257 elasmobranch species are recognised worldwide (Ebert & Dando, 2020). However, cases of albinism and/or leucism, have been reported in the literature only in 61 species of chondrichthyans (4.9%) to date (Table 2). According to several authors (e.g., Reis et al., 2013; Sandoval-Castillo et al., 2006; Talent, 1973) colour aberrations appear to be most commonly reported in teleostean fishes than in elasmobranchs. In the absence of a checklist on albinism in bony fishes, this statement cannot be verified.

Given the number of cases reported to date, everything seems to indicate that albinism and leucism are truly rare in nature among chondrichthyan species. For instance, the capture of a single specimen of *E. spinax* showing colour abnormality among thousands of individuals of this species observed during the bottom-trawl surveys carried out in Spain since 1983, seems to be in agreement with this hypothesis. Several theories have been proposed for this scarcity of records in elasmobranchs such as their relatively low natural presence in nature (Bottaro et al., 2008) or that their lack of coloration makes them visible to both prey and predators (Talent, 1973; Vilter, 1937) resulting in low probabilities of a long survive. However, the presence of large individuals, whether albino or leucistic (e.g., Bottaro et al., 2008; Deynat, 2003; Nakaya, 1973) seems to indicate that these conditions do not compromise feeding capability. In addition, the lack of pigmentation does not appear to affect neither sexual maturity (Becerril-García et al., 2017; Bottaro et al., 2008; Taniuchi & Yanagisawa, 1987) nor reproduction (Joseph, 1961). Since the individual reported in the present study is a new-born specimen, we cannot make any assumption whether its aberrant colouration will compromise either its growth or survival.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

No data availability statement necessary as there are no data.

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