NOTE

Albinism and leucism in Blonde Rays (*Raja brachyura* Lafont, 1871) (Elasmobranchii: Batoidea) from the Irish Sea

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Abstract
The authors describe the first case of leucism and the second case of albinism in Blonde Rays (*Raja brachyura* Lafont, 1871), and summarise previous reports of similar colour abnormalities in other species of Batoidae.

Natural intraspecific variation in animal colouration is widespread and has triggered important theoretical advances in both evolutionary biology and behavioural ecology (Jacquin et al., 2017). Various types of abnormal colouration have been recorded in both wild and farmed fishes, including albinism, leucism, xanthochromism, melanism, ambicolouration, metachromism, and polychromism (Dawson, 1964, 1966, 1971; Dawson and Heal, 1976). In many cases the aetiology of these relatively rare colour aberrations is unclear and several factors may be involved, including non-pathological genetic mutations, skin pathologies, hormonal imbalance, diet and interspecific hybridisation (Quigley et al., 2016).

Albinism is a genetically inherited disorder controlled by several different genes in which the pigment melanin is either absent or non-functional, resulting in a lack of normal pigmentation in both the skin and iris (eye). Leucism, on the other hand, is controlled by a single recessive allele, which generally results in either complete or partial lack of pigmentation of the skin, but normal pigmentation of the iris (Clark, 2002; Bigman et al., 2015; Jones et al., 2016). In some cases the term 'partial albinism' has also been used, but by definition, the condition is impossible (Van Grouw, 2006).

Although at least 633 species of extant Batoidea (skates and rays) are currently recognised worldwide (Ebert and Stehmann, 2013; Last et al., 2016; Weigmann, 2016), leucism, and more rarely, albinism and 'partial albinism' (sic), has only been reported in 22 (c.3.5%) species to date (Table 1). In the absence of specific details

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Table 1. Batoid species exhibiting albinism and/or leucism.

Family	Common Name	Species	Date	Location	Method	Depth (m)	TL (mm)	DW (mm)	Weight (g)	Sex	Colour Aberration	Notes & Collection Reg. No.	Reference
Torpedinidae	Marble Electric Ray	Torpedo marmorata Risso, 1810	10/9/2009	c.1.3 km off Piran (45o 32.05'N, 13o 31.90'E), Trieste Gulf, Slovenia (northern Adriatic)	demersal trawl		235	150		immature male	albinism		Lipej et al. (2011)
Torpedinidae	Marble Electric Ray	Torpedo marmorata Risso, 1810	11/9/2009	c.1.3 km off Piran (45o 32.05'N, 13o 31.90'E), Trieste Gulf, Slovenia (northern Adriatic)	demersal trawl		278	185		immature female	albinism	Piran Marine Biology Station	Lipej et al. (2011)
Torpedinidae	Common Torpedo	Torpedo torpedo (L.)	c.1998	Lagoon of Bizerte, NE Tunisia (Central Mediterranean Sea)			244	151	227	mature female	albinism	Laboratoire de Biologie Marine, Tunis	Ben-Brahim et al. (1998)
Narcinidae	Giant Electric Ray	Narcine entemedor Jordan & Starks, 1895	August 1988	Bahia Almejas (24o 24'N, 111o 35'W), S Baja California, Mexico (E Pacific Ocean)			690			mature male	leucism	Ne0898	Sandoval-Castillo et al. (2006)
Narcinidae	Lesser Electric Ray	Narcine bancrofti (Griffith & Smith, 1934)	13/06/2014	E of Port Aransas (27.782oN, 097.038oW) , Texas, USA (Gulf of Mexico)	demersal trawl	c.13	217	109		immature male	leucism	GCRL 36550	Jones et al. (2016)
Rhinobatinae	Halavi Ray	Glaucostegus halavi (Forsskål, 1775)	4/9/2004	25.6 km E of Zarzis (33o 29'N, 11o 25'E), Gulf of Gabes, S Tunisia (Central Mediterranean Sea)	long line	28-30	1023	336	3005	female	albinism	RHI-Rhh-01	Ben Souissi et al. (2007)
Arhynchobatidae	Aleutian Skate	Bathyraja aleutica (Gilbert, 1896)	26/07/2007	Prince William Sound (60.162667oN, 147.09oW), Alaska, USA	demersal trawl	220.2	436	265		immature female	albinism	CAS 237990	Bigman et al. (2015)
Arhynchobatidae	Roughtail Skate	Bathyraja trachura (Gilbert, 1892)	20/09/2011	off Redwood National Park (41.664306oN, 124.135578oW), California, USA	demersal trawl	1079.3	490	254		immature female	leucism	CAS 237991	Bigman et al. (2015)
Rajidae	Blonde Ray	Raja brachyura Lafont, 1871	7/3/2011	6.4km N of Guernsey (English Channel)	demersal trawl		800	560		immature male	albinism & xanthism	Blue Reef Aquarium, Portsmouth	Ball et al. (2013)
Rajidae	Blonde Ray	Raja brachyura Lafont, 1871	11/10/2016	Irish Sea (53.19oN, 05.16oW)	demersal trawl	135	785	580	3000 (gutted)	immature female	albinism	NMINH:2017.17.1	this paper
Rajidae	Blonde Ray	Raja brachyura Lafont, 1871	26/06/2016	Irish Sea (53o 14'N, 05o 20'W)	demersal trawl	130	570	410	1200 (gutted)	immature female	leucism	NMINH:2017.7.1	this paper

Family	Common Name	Species	Date	Location	Method	Depth (m)	TL (mm)	DW (mm)	Weight (g)	Sex	Colour Aberration	Notes & Collection Reg. No.	Reference
Rajidae	Spotted (Homelyn) Ray	Raja montagui Fowler, 1910	7/5/2008	Stokes Bay, near Portsmouth (English Channel)	demersal trawl		613	413		mature male	albinism	tagged & released	Ball et al. (2013)
Rajidae	Spotted (Homelyn) Ray	Raja montagui Fowler, 1910	16/08/2017	Irish Sea (53o 23.5'N, 05o 19.2'W), east of Howth, Co. Dublin, Ireland	demersal trawl	104	495	290	850	adult male	albinism & xanthism	NMINH	Quigley and MacGabhann (in prep.a)
Rajidae	Thornback Ray	Raja clavata L.	11/8/2011	North Sea, W coast of Norway (62o 19' 25", 05o 39' 07"E)	rod & line		830	570		mature male	albinism	tagged & released	Ball et al. (2013)
Rajidae	Thornback Ray	Raja clavata L.	c.1893	E of Isle of May, Firth of Forth, E Scotland (North Sea)			828	537		female	albinism	Edinburgh Museum	Traquair (1893)
Rajidae	Thornback Ray	Raja clavata L.	22/03/1989	Dingle Bay, Co Kerry, SW Ireland	demersal trawl		580	925	1415	female	leucism	NMINH:1989.58	Quigley and Flannery (1994)
Rajidae	Thornback Ray	Raja clavata L.	13/09/1929	12.8 km off Scarborough, Yorkshire, UK (North Sea)			775			female	leucism		Clarke (1929)
Rajidae	Cuckoo Ray	Leucoraja naevus Muller & Henle, 1841	February 1938	96 km NE of Aberdeen, E Scotland (North Sea)	trawl			350		mature female	albinism ?	Scottish Home Office Laboratory, Aberdeen	Wilson (1951)
Rajidae	Cuckoo Ray	Leucoraja naevus Muller & Henle, 1841	17/11/2017	Irish Sea	trawl			350			leucism		Quigley and MacGabhann (in prep.b)
Rajidae	Blue Skate	Dipturus batis (L.)	c.1926-1931	off Aberdeen, E Scotland (North Sea)			588	416		female	albinism ?	Scottish Home Office Laboratory, Aberdeen	Wilson (1951)
Rajidae	Blue Skate	Dipturus batis (L.)	21/04/1951	SE of Aberdeen, E Scotland (North Sea)	long line	140	1040	735		immature male	albinism ?	Scottish Home Office Laboratory, Aberdeen	Wilson (1951)
Rajidae	Japanese Common Skate	Okamejei kenojei (Muller & Henle, 1841)	c.2001	Japan, Western Pacific							leucism		Ishihara et al. (2001); Bigman et al. (2015)
Platyrhininae	Striped Pan Ray	Zanobatus schoenleinii (Müller & Henle, 1841)	26/07/2016	off Ouakarn (14o 43' 25"N, 17o 29' 21"W), 5 km N of Dakar, Cape Verde Peninsula, Senegal (NE Atlantic Ocean)	captured by diver	2	518	284	1087	adult male	leucism	IFAN-Z. sch. 01	Diatta et al. (2013)

Family	Common Name	Species	Date	Location	Method	Depth (m)	TL (mm)	DW (mm)	Weight (g)	Sex	Colour Aberration	Notes & Collection Reg. No.	Reference
Dasyatidae	Southern Stingray	Dasyatis americana Hildebrand & Schroeder, 1928	November 2012	Campeche Bank (18o 40′ 38″N, -19o 05′ 25″N, 92o 27′ 07″ - 92o 05′ 11″W), Tabasco, S Gulf of Mexico	demersal long-line	10-40		820		female	albinism ?		Mendoza-Carranza et al. (2016)
Dasyatidae	Southern Stingray	Dasyatis americana Hildebrand & Schroeder, 1928	25/01/2014	San Pedro (18o 39′ 32.35″N, 92o 28′ 13.45″W), Tabasco, S Gulf of Mexico	demersal long-line	18-25		640	9850	sub-adult female	albinism	ECOSC 7561	Wakida-Kusunoki (2015)
Dasyatidae	Southern Stingray	Dasyatis americana Hildebrand & Schroeder, 1928	7/10/1975	New Stump Point (West Bay), S Pamlico Sound, Carteret County, North Carolina, USA	seine net	1.5		243	374	female	leucism	UNC 10460	Schwartz and Safrit (1977)
Dasyatidae	Common Stingray	Dasyatis pastinaca (L.)	March 1975	Zarzis, Gulf of Gabes, Tunisia (Mediterranean Sea)	trammel net		730	460	3125	female	leucism		Capape and Pantoustier (1975)
Dasyatidae	Short-tail Stingray	Dasyatis brevicaudatus (Hutton, 1875)	June 1971	Whangaparoa Bay, Hauraki Gulf, New Zealand							albinism		Talent (1973)
Gymnuridae	Smooth Butterfly Ray	Gymnura micrura (Bloch & Schneider, 1801)	08/08/2010	Sao Miguel mud, 8.4 km off Alagoas State, Brazil (09o 40′S, 35o 40′W), S Atlantic	shrimp trawl	22	175	252	120.32	immature female	albinism	MUFAL-1448	Reis et al. (2013)
Myliobatidae	Cownose Ray	Rhinoptera bonasus (Mitchill, 1815)	22/05/1959	near Great Shoal Light, Wicomico River. Tangier Sound, Chesapeake Bay, Somerset County, Maryland, USA	seine net		1470	971	c.1364	mature male	leucism		Schwartz (1959)
Myliobatidae	Cownose Ray	Rhinoptera bonasus (Mitchill, 1815)	23/05/1960	6.4 km ESE of Horn Harbour, N of Mobjack Bay, W Chesapeake Bay, Maryland-Virginia, USA	pound net	c.10		c.890		mature female	leucism	contained 325 mm DL normally pigmented male embryo	Joseph (1961)

Family	Common Name	Species	Date	Location	Method	Depth (m)	TL (mm)	DW (mm)	Weight (g)	Sex	Colour Aberration	Notes & Collection Reg. No.	Reference
Myliobatidae	Bat Ray	Myliobatis californica Gill,1865	18/06/1989	off El Ramoso (c.25oN), Magdalena Island, Baja California Sur, Mexico (E Pacific Ocean)	shrimp trawl		339 (SL)	735		mature female	albinism	CICIMAR 2049	de Jesus-Roldan (1990)
Mobulidae	Giant Manta Ray	Manta birostris (Walbaum, 1792)	c.2001	Japan, Western Pacific							leucism		Ishihara et al. (2001); Marshall et al. (2009)
Mobulidae	Giant Manta Ray	Manta birostris (Walbaum, 1792)	2006-07	off Inhambane, S Mozambique (E Africa) & Revillagigedo Archipelago (Mexico)	observed						leucism		Rublin (2002); Marshall et al. (2009)
Mobulidae	Alfred Manta Ray	Manta alfredi (Krefft, 1868)	2006-07	Maldives, Indian Ocean	observed						leucism		Marshall et al. (2009)

on eye colour, some cases which were previously described as exhibiting 'albinism' or 'partial albinism' could have been either true oculocutaneous albinos or leucistic specimens (Clark, 2002).

The Blonde Ray *Raja brachyura* Lafont, 1871 is a commercially important species in NW Europe, particularly in southern Irish and UK waters, primarily at depths <100m (Ellis, 2015). The species attains a maximum TL and weight of at least 1200 mm (Stehmann and Burkel, 1984) and 18 kg respectively (Anon, 2016). In NW European waters, McCully et al. (2012) reported a minimum TL at first maturity of 550 mm and 600 mm for males and females, and 50% maturity at 782 mm and 856 mm respectively. They also noted that the largest immature males and females measured 910 mm and 930 mm respectively.

Wheeler (1978) described the normal dorsal colouration of *R. brachyura* as 'light brown with a few creamy-white blotches and dense dark spots which extend up to the very edge of the disc and on to the tail'. A normally coloured immature female specimen of *R. brachyura* from the Irish Sea, measuring 610 mm TL, 450 mm disc width (DW), and weighing 1.7 kg (whole) is shown in Figure 1.

On 28 June 2016, the MFV 'Eblana (D 379)' [Skipper: John Lynch, Howth, Co Dublin] captured an immature female leucistic specimen of *R. brachyura* measuring 570 mm TL, 410 mm DW, and weighing 1.2 kg (gutted), while demersal trawling at a depth of 130 m in the central Irish Sea (53° 14'N, 05° 20'W). The dorsal surface was predominantly white with unusually large dark spots extending to the

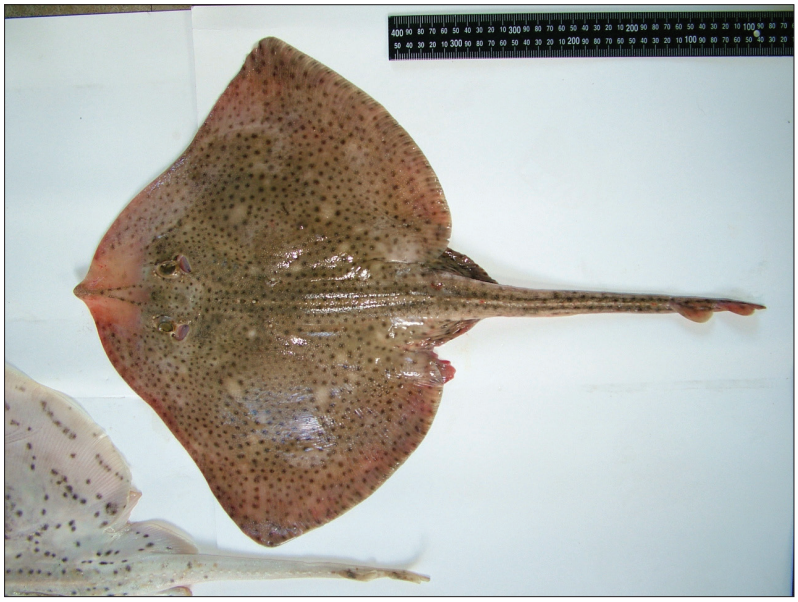

Figure 1. Normally coloured Blonde Ray (*Raja brachyura*).

Figure 2. Leucistic Blonde Ray (*Raja brachyura*).

outer margins of the disc (Figure 2), and the eye colour was normal (black) (Figure 3). The specimen, which represents the first known case of leucism in *R. brachyura*, was donated to the National Museum of Ireland – Natural History Division, Dublin (NMINH:2017.7.1).

On 11 October 2016, the same vessel captured immature female albino specimen of *R. brachyura* measuring 785 mm TL, 580 mm DW, and weighing 3.0 kg (gutted), while demersal trawling at a depth of 135 m on sandy ground in the central Irish Sea (53.19°N, 05.16°W). The dorsal surface was completely white (Figure 4), and the eyes were distinctly orange-yellow (xanthochromic) in colour. (Figure 5). The specimen, which represents the second known case of albinism in *R. brachyura*, was donated to the National Museum of Ireland – Natural History Division, Dublin (NMINH:2017.17.1). Ball et

Figure 3. Leucistic Blonde Ray (*Raja brachyura*) exhibiting normal eye colouration.

Figure 4. Albino Blonde Ray *(Raja brachyura).*

al. (2013) described an immature male albino specimen of *R. brachyura* measuring 800 mm TL, which was captured by a trawler 6.4 km north of Guernsey (English Channel) on 7 March 2011.

The identity of the current specimens was confirmed by comparative DNA barcoding analysis, carried out at the Universidad de Vigo (Spain), using the standard methodology of Barros-García et al. (2016). Analysis of the mitochondrial cytochrome oxidase subunit I gene clustered the albino ray and the leucistic ray specimens with *R. brachyura* and not with *R. montagui* Fowler, 1910 or other closely related Batoidae.

Apart from their aberrant colouration, both of the current specimens were morphologically, meristically and genetically identical to normally coloured *R. brachyura*. Externally, there

Figure 5. Albino Blonde Ray (*Raja brachyura*) exhibiting abnormal orange-yellow (xanthochromic) eye colouration.

were no overt signs of either physical damage or disease. Their gutted condition factors (K = weight*100/TL^3), 0.65 (leucistic) and 0.62 (albino), which were similar to the mean K value (0.64) recorded for normally coloured NW European stocks (Bedford et al., 1986), suggests that neither specimen had been compromised by their aberrant colouration either in terms of growth or survival.

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