First record of albinism in the great white shark, *Carcharodon carcharias* (Linnaeus, 1758)

This note describes the first record of an albino white shark, Carcharodon carcharias, *caught in 50 m of water by G. Els off Boknes, in the Eastern Cape Province, South Africa. The specimen was completely unpigmented, and appeared white with red eyes. It was female and measured 1670 mm total length and weighed 34.5 kg. These observations represent the first record of albinism in this species and in the family Lamnidae.*

Albinism in chondrichthyans is an uncommon phenomenon that has been recorded in both free living and embryonic individuals in the Atlantic, Pacific and Indian oceans (Table 1), a distribution probably influenced in part by the distribution of research facilities. Most records note some information on the albino individuals and some mention that the eye was red. In this report we include information on morphometrics, eyes and skin to compare with information on normally pigmented individuals.

Carcharodon carcharias (Linnaeus, 1758) is a widely distributed member of the Lamnidae.[10] Its great size and apex position in marine food webs has long fascinated people. Recently, it has been the subject of detailed research into its biology and ecology. Information has been collected from fishermen, accidental captures and underwater observations. Bass *et al.*[11] reported on information collected from South Africa and this has been updated in more recent publications.[10,12,13]

A great white shark of 34.5 kg was caught off Boknes (33°44′S, 26°35′E), Eastern Cape, South Africa by Mr Gerhard Els, fishing in 50 m of water on 25 March 1996. He brought the shark to the surface and noticed that it was a brilliant white colour, rather than the typical dark grey or blue grey of most of the common larger sharks in this area. He also noticed that the eye was bright red in colour and apparently lacked a pupil. He initially thought the shark was a mako (*Isurus oxyrinchus*) and offered it to the J.L.B. Smith Institute of Ichthyology. It was fixed in 10% formalin for three weeks, then placed in fresh water for a further four days prior to storage in propyl alcohol in the institute. It was accessioned into the J.L.B. Smith Institute fish collection as RUSI 50000.

Morphometric measurements follow the method and terminology of Compagno[10] and tooth counts are after Applegate.[14] Histological preparations of the skin, taken from below the dorsal fin, and the eye were made. The eye was removed and placed in formalin until sectioned. It was removed from formalin and bisected, then dehydrated, embedded in paraffin and sectioned at about 10 µm. A block of skin was treated in a similar way. Sections were stained using standard haematoxalin and eosin; Masson trichrome technique and the Verhoef (Van Geesen) method.[15] Picro-Mallory stain was also used.[16]

The shark was plain white over the entire body and fins (Fig. 1*a*). Normal individuals are gunmetal blue to grey, brownish grey or blackish grey dorsally and white ventrally, with these colours meeting abruptly along the side of the body, in unique patterns. Normally, the pectoral fin is similarly dark coloured on the dorsal surface, but white ventrally, with a black tip. In normally pigmented individuals there is a black axillary spot at the insertion of the pectoral fin, although Bass *et al.*[11] mistakenly thought it to be absent in South African specimens. The albino individual lacks any of these dark markings, and the axillary region is also white (Fig. 1*b*). Subdermal haemorrhage is evident, particularly along the lateral surface and around the head (Fig. 1*c*). This was caused during capture and subsequent handling.

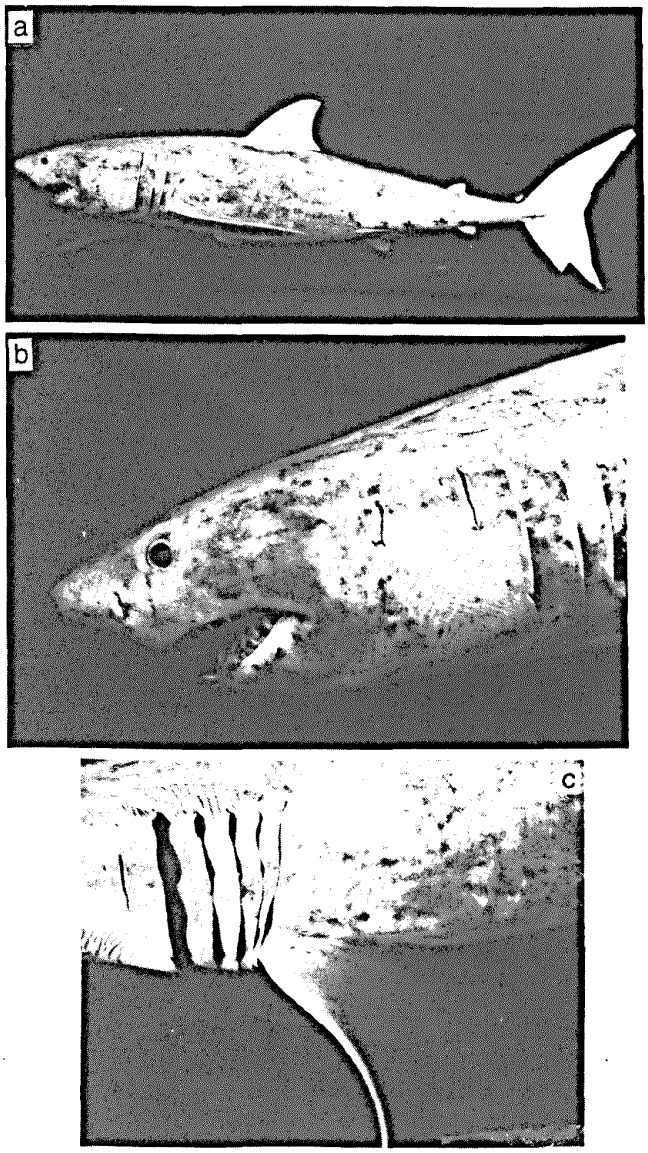

Fig. 1. Photographs of the albino female white shark, *Carcharodon carcharias*, caught off Boknes, South Africa, showing: *a*, the left side of the shark. The notch in the lower caudal fin was made by the fishermen; *b*, the gills and pectoral axil showing the absence of the black spot typical of normally pigmented individuals; *c*, details of the head showing haemorrhage and the typical large round eye which in this individual appeared red, as opposed to black in normally pigmented specimens.

Sections of the skin of the albino white shark show only minute traces of melanin in the dermis, compared to the more widespread distribution of melanin in the normal specimen examined. Melanin deficiency is the cause of the lack of coloration in the albino white shark.

Sections of the eye showed very little melanin in the iris and the tapetal layer compared to normal specimens. The melanin deficiency in the iris and retina is the cause of the red appearance of the eye; light is reflected back from the tapetum and not absorbed, as would occur in normally pigmented individuals. This deficiency in the tapetum would render the eye considerably more

Table 1. Recent reports on albinism in chondrichthyans.

Species	Family	Date	Locality	Ocean	Ref.
Rhinoptera bonasus	Rhinopteridae	1961	Chesapeake Bay	Atlantic	1
Sphyrna lewini	Sphyrnidae	1970	Doboy Sound	Atlantic	2
Mustelus californicus	Triakidae	1973	California	Pacific	3
Mustelus californicus	Triakidae	1973	Elkhorn Slough	Pacific	4
Stegostoma fasciatum	Stegostomatidae	1973	Sumbawa, Indonesia	Indian	5
Triakis semifasciata	Triakidae	1976	California	Pacific	6
Dasyatis americana	Dasyatidae	1977	North Carolina	Atlantic	7
Nebrius concolor	Ginglymostomatidae	1987	Wakayama Prefecture, Japan	Pacific	8
Carcharhinus amboinensis	Carcharhinidae	1988	Queensland	Pacific	9

light sensitive than normal. The photoreceptors were in a poor state of preservation and rods could not be differentiated from cones, although both are normally present in the retina of *C. carcharias*.[17,18] Gruber (pers. comm., October 1996) noted that visual cells are so sensitive that if the eye is kept in the sunlight for a few hours before preservation, the receptors lyse and are no longer distinguishable.

Morphometric data (Table 2) are presented with information from normal females collected by one of us (M.J.S.). It is evident that the morphometric data for the albino are similar to those of other *C. carcharias*. The dental formula taken *in situ* (i.e. jaw not excised) was: Left upper dentition 5,5,1,2–2,1,5,5 and lower was approximately ?,6,1–1,6,? using the terminology of Applegate[14] of posterior, lateral, intermediate and anterior, respectively. The posterior teeth of the lower jaw were difficult to count because they were surrounded by tissue. Tooth counts are more accurately made once the jaws are removed. Our counts are similar to counts made by Bass *et al.*,[11] for 32 specimens taken from Natal, of 13–13 upper and 12–12 for lower jaw tooth counts.

Although no attempt was made to age this specimen, it is estimated to have been about 1 year old, according to the preliminary growth study of Cailliet *et al.*[19] The white shark is an apex predator that feeds on a wide variety of prey including teleosts, other chondrichthyans and cephalopods, with marine mammals more dominant in the diet of larger individuals[10,20] (Smale, unpub.). Hunting is generally achieved by stealth and the coloration of the dorsal surface is believed to aid the shark approaching its prey, particularly seals, from below when the sharks are camouflaged against dark substrata, prior to the final rapid phase of the attack.[21] How the albino succeeded in predation is a moot point, and the absence of stomach contents failed to shed light on this shark's choice of prey. It is likely that social interactions, such as mating, would similarly have been affected by its albinism.

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1. Joseph E.B. (1961). An albino cownose ray, *Rhinoptera bonasus* (Mitchill) from Chesapeake Bay. *Copeia* **4**, 482–483.
2. McKenzie M.D. (1970). First record of albinism in the hammerhead shark, *Sphyrna lewini* (Pisces: Sphyrnidae). *Elisha Mitchell sci. Soc. J.* **86**(1), 35–37.
3. Talent L.G. (1973). Albinism in embryo gray smoothhound sharks, *Mustelus californicus*, from Elkhorn Slough, Monterey Bay, California. *Copeia* ***1973***(3), 595–597.
4. Cohen J.L. (1973). An albino grey smoothhound *Mustelus californicus* Gill. *Calif. Fish and Game* **59**(3), 210–211.
5. Nayaka K. (1973). An albino zebra shark *Stegostoma fasciatum* from the Indian Ocean, with comments on albinism in elasmobranchs. *Japan. J. Ichthyol.* **20**(2), 120–122.
6. Follett W.I. (1976). First record of albinism in the leopard shark (*Triakis semifasciata* Girard). *Calif. Fish and Game* **62**(2), 163–164.
7. Schwartz F.J. and Safrit G.W. Jr. (1977). A white southern stingray, *Dasyatis americana* (Pisces, Dasyatidae), from Pamlico Sound, North Carolina. *Chesapeake Science* **18**(1), 83–84.
8. Taniuchi T. and Yanagisawa F. (1987). Albinism and lack of second dorsal fin in an adult tawny nurse shark, *Nebrius concolor*, from Japan. *Japan. J. Ichthyol.* **34**(3), 393–395.
9. McKay R.J. and Beinssen K. (1988). Albinism in the pigeye whaler shark *Carcharhinus amboinensis* (Müller and Henle) from Queensland. *Mem. Qd Mus.* **25**(2), 463–464.
10. Compagno L.J.V. (1984). FAO species catalogue, vol. 4. *Sharks of the World. An annotated and illustrated catalogue of shark species known to date. Part 1. Hexanchiformes to Lamniformes.* FAO *Fish. Synop.* 125.
11. Bass A.J., D'Aubrey J.D. and Kistnasamy N. (1975). Sharks of the east coast of southern Africa. IV. The families Odontaspididae, Scapanorhynchidae, Isuridae, Cetorhinidae, Alopiidae, Orectolobidae and Rhiniodontidae. *Invest. Rep. Oceanogr. Res. Inst.* **39**, 1–102.
12. Randall B.M., Randall R.M. and Compagno L.J.V. (1988). Injuries to jackass penguins (*Sphenescus demersus*): evidence for shark involvement. *J. Zool. (Lond.)* **214**, 589–599.
13. Compagno L.J.V., Ebert D.A. and Smale M.J. (1989). *Guide to the Sharks and Rays of Southern Africa.* Struik, Cape Town.
14. Applegate S.P. (1965). Tooth terminology and variation in sharks with special reference to the sand shark, *Carcharias taurus* Rafinesque. *Contrib. Sci. LA County Mus.* **86**, 1–18.
15. Bancroft J.D. and Stevens A. (eds) (1982). *Theory and Practice of Histological Techniques*, 2nd edn. Churchill Livingstone, New York.
16. Disbrey B.D. and Rack J.H. (1970). *Histological Laboratory Methods.* Livingstone, Edinburgh.
17. Gruber S.H. and Cohen J.L. (1978). Visual system of the elasmobranchs: State of the art 1960–1975. In *Sensory Biology of Sharks, Skates, and Rays*, eds E.S. Hodgson and R.F. Mathewson, pp. 11–105. Office of Naval Research, Dept. Navy, Arlington, Virginia.
18. Gruber S.H. and Cohen J.L. (1985). Visual systems of the white shark, *Carcharodon carcharias*, with emphasis on retinal structure. In *Biology of the White Shark*, eds G. Sibley, J.A. Seigel and C.C. Swift. *Mem. sth. Calif. Acad. Sci.* **9**, 61–72.
19. Cailliet G.M., Natanson L.J., Weldon B.A. and Ebert D.A. (1985). Preliminary studies on the age and growth of the white shark, *Carcharodon carcharias*, using vertebral bands. In *Biology of the White Shark. Mem. sth. Calif. Acad. Sci.* **9**, 49–60.
20. Cliff G., Dudley S.F.J. and Davis. B. (1989). Sharks caught in the protective gill nets off Natal, South Africa. 2. The great white shark *Carcharodon carcharias* (Linnaeus). *S. Afr. J. mar. Sci.* **8**, 131–144.
21. Klimley A.P. (1994). The predatory behavior of white sharks. *Am. Scient.* **82**, 122–133.

Table 2. Dimensions and proportions (as % of TL) of an albino white shark (*Carcharodon carcharias*) compared with the mean and range for six normally pigmented juvenile females from the Eastern Cape collected by M.J.S. Measurements after Compagno.[10]

Character	Albino	Normal			n
		Mean	Max.	Min.	
Body mass (kg)	34.5	108.8	210.5	28.0	6
Total length (mm)	1670	2311	3058	1570	6
Precaudal length	77.8	77.2	78.1	76.4	6
Prenarial length	4.1	3.5	4.3	2.5	6
Preoral length	6.0	5.6	6.2	4.5	6
Preorbital length	5.8	5.3	6.2	4.5	6
Prespiracular length	12.0	12.1	15.2	10.3	6
Prebranchial length	21.3	16.8	20.8	1.9	6
Head length	27.8	26.7	27.2	26.1	6
Prepectoral length	25.8	24.8	26.9	23.4	6
Prepelvic length	53.3	53.4	54.3	52.6	6
Snout-vent length	54.8	55.4	56.4	53.9	6
Vent-caudal length	44.9	44.7	47.3	42.5	3
Pre-anal length	68.9	68.4	69.1	67.1	6
Pre-first dorsal length	36.5	34.3	36.0	32.8	6
Pre-second dorsal length	67.8	66.1	67.4	65.0	6
Interdorsal space	22.8	22.2	22.8	21.1	6
Dorsal-caudal length	9.3	10.2	11.0	9.2	6
Pectoral-pelvic space	22.2	22.4	23.2	21.2	6
Pelvic-anal space	10.8	9.7	10.0	9.3	6
Anal-caudal space	7.5	7.8	9.0	6.7	6
Eye length	1.4	1.3	1.5	1.1	6
Eye height	1.5	1.3	1.4	1.1	6
Interorbital space	7.0	6.5	6.9	6.2	6
Nostril width	1.4	1.4	1.6	1.2	6
Internarial space	3.6	3.5	4.0	3.2	6
Anterior nasal flap length	0.2	0.3	0.6	0.1	6
Spiracle length	0.1	0.1	0.1	0.0	5
Eye-spiracle space	5.6	5.8	7.8	4.9	5
Mouth length	3.8	5.8	9.3	4.3	6
Mouth width	8.3	8.1	9.2	6.7	6
First gill slit height	8.4	9.4	10.1	8.0	6
Second gill slit height	8.7	9.1	10.1	8.3	6
Third gill slit height	9.0	9.0	10.1	8.5	6
Fourth gill slit height	8.9	9.0	10.2	8.3	6
Fifth gill slit height	9.2	9.3	9.9	8.2	6
Head height	10.8	13.6	15.5	11.8	6
Head width	13.2	13.5	16.0	9.8	6
Trunk height	12.6	14.9	18.4	12.6	6
Trunk width	12.6	13.4	16.8	8.7	6
Caudal peduncle height	2.9	3.0	4.6	2.3	6
Caudal peduncle width	8.1	6.8	7.2	6.5	6
Girth	46.1	46.3	49.4	42.6	6
Pectoral length	11.1	11.1	11.7	10.4	6
Pectoral anterior margin	22.8	20.9	22.0	20.0	6
Pectoral base	5.4	7.1	7.4	6.6	6
Pectoral height	17.4	18.2	20.7	15.4	6
Pectoral inner margin	5.7	4.6	5.3	4.2	6
Pectoral posterior margin	18.6	17.9	19.2	16.2	6
Pelvic length	8.4	7.7	8.7	6.4	6
Pelvic anterior margin	5.7	6.4	8.8	5.3	6
Pelvic base	5.4	5.6	6.4	4.8	6
Pelvic height	4.3	4.8	6.4	3.9	6
Pelvic inner margin	2.7	3.0	3.5	2.1	6
Pelvic posterior margin	6.3	6.5	7.3	5.6	6
Clasper outer length	0.0	0.0	0.0	0.0	6
Clasper inner length	0.0	0.0	0.0	0.0	6
Clasper base width	0.0	0.0	0.0	0.0	6
First dorsal length	11.4	11.8	12.4	10.9	6
First dorsal anterior margin	12.6	12.8	13.4	11.6	6
First dorsal base	9.0	9.4	10.2	8.6	6
First dorsal height	8.7	9.7	10.9	8.9	6
First dorsal inner margin	2.2	2.5	2.8	2.3	6
First dorsal posterior margin	8.7	9.8	12.1	9.0	6
Second dorsal length	3.3	3.0	3.7	2.6	6
Second dorsal anterior margin	2.7	2.6	3.0	2.1	6
Second dorsal base	1.4	1.3	1.5	1.0	6
Second dorsal height	0.9	1.5	1.9	1.0	6
Second dorsal inner margin	1.8	1.7	2.2	1.4	6
Second dorsal posterior margin	1.4	1.5	2.0	1.1	6
Anal length	3.1	3.0	3.4	2.6	6
Anal anterior margin	2.9	2.7	3.1	2.6	6
Anal base	1.2	1.4	1.7	1.0	6
Anal height	1.4	1.7	2.4	1.4	6
Anal inner margin	2.0	1.8	2.1	1.6	6
Anal posterior margin	1.3	1.6	2.0	1.3	6
Dorsal caudal margin	21.9	22.7	24.2	21.2	6
Preventral caudal margin	17.4	17.2	18.4	16.6	6
Lower postventral caudal margin	12.0	11.3	12.3	10.6	5
Upper postventral caudal margin	11.1	11.2	11.9	10.5	5
Subterminal caudal margin	1.5	1.4	1.6	1.1	6
Terminal caudal margin	3.9	4.1	4.8	3.6	5
Terminal caudal margin	4.3	4.6	5.1	4.3	6
Caudal fork length	10.8	9.9	10.8	8.2	6
Subocular pocket depth	0.0	0.0	0.0	0.0	6
Dorsal midpoint – pectoral insertion	8.7	8.3	16.8	6.7	5
First dorsal midpoint – pelvic origin	13.8	11.9	15.8	13.4	5
Pelvic midpoint – first dorsal insertion	11.4	10.5	14.0	11.0	5
Pelvic midpoint – second dorsal origin	10.7	8.3	11.5	8.9	5
Second dorsal origin – anal origin	1.8	1.3	2.1	1.0	5
Second dorsal insertion – anal insertion	1.2	1.6	2.2	1.5	5
Fork length	89.0	87.1	88.4	85.5	3
Intestinal valves	52.0	51.2	54.0	47.0	5