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First record of severe hypopigmentation in a tiger shark Galeocerdo cuvier from the southwestern Atlantic Ocean

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Abstract

This study reports the first record of severe hypopigmentation in a tiger shark from the southwestern Atlantic Ocean. The specimen was captured by an industrial bottom-set gillnet fishery within the Lagamar marine complex, southeastern Brazil, a region recently recognized as an Important Shark and Ray Area (ISRA). The individual exhibited a white body coloration, retaining only faint remnants of the species' characteristic dorsal pigmentation pattern. Owing to the absence of the head, the condition was conservatively interpreted as severe hypopigmentation consistent with leucism. Such extensive pigment loss may reduce the effectiveness of the disruptive coloration typically exhibited by juvenile tiger sharks in heterogeneous coastal habitats. This record expands current knowledge of pigment abnormalities in elasmobranchs and highlights the value of fishery-dependent observations for documenting rare phenotypic traits in marine megafauna.

Introduction

Pigment abnormalities are phenotypic alterations resulting from disruptions in the synthesis, transport, or deposition of melanin and other pigments (Bian et al. 2021). These abnormalities include albinism, leucism, piebaldism, melanism, and various forms of partial or complete hypopigmentation, and may be associated with genetic, physiological, or environmental factors (Venizelos and Benetti 1999; Whitehead et al. 2025).

Reports of pigment abnormalities in elasmobranchs have increased over recent decades, driven by advances in research efforts, photographic documentation, and citizen science. Nevertheless, documented cases remain limited when compared with the currently recognized diversity of chondrichthyan species (Arronte et al. 2022; Skelton et al. 2024). Pigment abnormalities have been recorded in several shark and ray families, including Carcharhinidae, Triakidae, Scyliorhinidae, Etmopteridae, Narcinidae, and Rajidae (Sandoval-Castillo et al. 2006; Escobar-Sánchez et al. 2014; Finucci 2021; Arronte et al. 2022; Rodrigues et al. 2023; Wargat et al. 2023).

Although the ecological consequences of these abnormalities remain poorly understood, severe hypopigmentation may affect camouflage, predator–prey interactions, susceptibility to ultraviolet radiation, and other ecological processes, particularly during early life stages when natural mortality is already high (Cortés 2002; Bottaro et al. 2008). Conversely, records of hypopigmented individuals surviving to juvenile and adult stages suggest that such conditions are not necessarily incompatible with survival in natural environments (Skelton et al. 2024; Whitehead et al. 2025).

The southern coast of São Paulo State forms part of the Lagamar marine complex, one of the most important areas for sharks and rays in the southwestern Atlantic and recently recognized as an Important Shark and Ray Area (ISRA) (Santos et al. 2025). The region supports a high diversity of elasmobranchs and serves as an important habitat for juveniles of several species, including the tiger shark, *Galeocerdo cuvier* (Péron and Lesueur 1822) (Santos et al. 2022).

Despite its broad geographic distribution and frequent interactions with fisheries, reports of pigment abnormalities in *G. cuvier* remain scarce in the scientific literature (Sandoval-Castillo et al. 2006; Balanin et al. 2023; Whitehead et al. 2025). Therefore, the present study describes the first case of severe hypopigmentation in a juvenile *G. cuvier* captured in southeastern Brazil, contributing to the knowledge of colour abnormalities in elasmobranchs and their occurrence within an important shark conservation area.

Material and Methods

Data used in the present study were obtained through a fishery monitoring programme conducted in the coastal waters of Cananéia, southeastern Brazil. The region is part of the Cananéia-Iguape estuarine-lagoon system and the broader Lagamar marine complex, comprising a heterogeneous mosaic of coastal and estuarine habitats, including mangrove forests, estuarine channels, islands, rocky shores, and sandy and muddy bottoms (Miyao et al. 1986). The coastal dynamics of the region are influenced by the interaction between estuarine discharge and adjacent shelf waters, resulting in spatial and seasonal variation in environmental conditions.

The *G. cuvier* examined in this study was captured by an industrial fishing vessel operating bottom-set gillnets and subsequently recorded during fishery monitoring. The specimen was identified, photographed, and subjected to biometric examination, with measurements and body mass recorded according to the condition in which the individual was landed. External examination and photographic records were used to characterize the distribution and extent of the pigmentation abnormality, including residual pigmentation and other visible skin alterations. The pigmentation condition was subsequently classified following the recommendations of Wargat et al. (2023).

Results

In May 2022, a juvenile male *Galeocerdo cuvier* exhibiting an unusual pigmentation pattern was recorded during fishery monitoring. The specimen was captured southeast of Bom Abrigo Island, at an average depth of 16 m (Fig. 1). Because the head had been removed prior to landing, total length could not be obtained. The distance between the insertion of the pectoral fin and the posterior tip of the caudal fin was 97 cm, and the eviscerated body mass was 1.975 kg.

External examination revealed a predominantly white body coloration, with faint remnants of pigmentation along the anterior dorsal region forming diffuse greyish markings corresponding to the species' characteristic pattern. No apparent lesions, scars, or other external pathological conditions associated with skin depigmentation were observed.

Because the head was unavailable for examination of ocular pigmentation and following the recommendations for the classification of pigment abnormalities in elasmobranchs proposed by Wargat et al. (2023), the specimen was conservatively classified as a case of severe hypopigmentation consistent with leucism.

Discussion

Reports of pigment abnormalities have been described for an increasing number of shark and ray species (Arronte et al. 2022; Skelton et al. 2024). Nevertheless, such occurrences remain uncommon relative to the number of known species and the vast number of observations conducted in natural environments. Furthermore, reporting frequency may be influenced by detection bias, as anomalously coloured individuals are more likely to attract the attention of fishers, divers, and researchers (Veena et al. 2011; Santos 2021).

For *G. cuvier*, reports remain particularly scarce. Sandoval-Castillo et al. (2006) documented an albino embryo from the eastern Pacific, whereas Whitehead et al. (2025) reported piebald individuals from the Maldives. Therefore, the present record represents one of the few documented occurrences of hypopigmentation in the species and, to the best of our knowledge, the first reported case from the southwestern Atlantic.

Although the ecological consequences of hypopigmentation remain poorly understood in elasmobranchs, the context in which this individual was recorded suggests potential implications for camouflage. Juvenile *G. cuvier* primarily inhabit shallow coastal environments and exhibit movement patterns associated with structurally complex habitats, including reef systems, estuarine areas, and coastal zones characterized by different substrate types (Holmes et al. 2014; Ajemian et al. 2020; Lipscombe et al. 2020). During this ontogenetic stage, the species' characteristic dark lateral stripes are more conspicuous and are thought to function as disruptive coloration, reducing visual detection in heterogeneous environments.

The specimen reported herein was captured within the Lagamar region, a coastal mosaic composed of islands, rocky shores, sandy and muddy bottoms, estuarine channels, and extensive mangrove forests (Miyao et al. 1986). In heterogeneous environments, the loss of the species' characteristic pigmentation pattern could potentially reduce the camouflage efficiency normally provided by these body markings (Caro 2005). Although this hypothesis cannot be directly evaluated from a single record, it suggests that severely hypopigmented individuals may experience ecological challenges not encountered by normally pigmented conspecifics.

This record also reinforces the ecological importance of the Lagamar lagoon complex, which has been recognized as an Important Shark and Ray Area (ISRA), as one of the principal areas of occurrence for juvenile elasmobranchs in the southwestern Atlantic (Sadowsky 1967; Santos et al. 2022). Although isolated occurrences of pigment abnormalities have limited direct conservation implications, the documentation of rare phenotypes within essential habitats contributes to our understanding of the biological diversity supported by these ecosystems and highlights the importance of long-term monitoring programmes.

Finally, the present case underscores the value of records obtained through collaborations with artisanal fishers for documenting unusual biological phenomena in large marine vertebrates, particularly in

regions where access to specimens is limited and systematic observations remain scarce (Santos et al. 2023; Gajić et al. 2025).

Declarations

Declaration of Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript. The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

Author Contribution

PRSS: Conceptualization, Investigation, Data analysis, Manuscript preparation;VL: Investigation, Manuscript preparation;HC: Investigation, Manuscript preparation:RM: Investigation, Manuscript preparation;APBM: Data analysis, Manuscript preparation;DGN: Conceptualization, Investigation, Data analysis, Manuscript preparation; Supervision.

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Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

1. Ajemian MJ, Drymon JM, Hammerschlag N, Wells RJD, Street G, Falterman B, McKinney JA, Driggers WB III, Hoffmayer ER, Fischer C, Stunz GW (2020) Movement patterns and habitat use of tiger sharks (*Galeocerdo cuvier*) across ontogeny in the Gulf of Mexico. PLoS ONE 15. https://doi.org/10.1371/journal.pone.0234868
2. Arronte JC, Antolínez A, Bañón R, Rodríguez-Gutiérrez J, Ortíz JJ, Martínez JM (2022) First recorded case of leucism in the velvet belly lantern shark *Etmopterus spinax* (Squaliformes: Etmopteridae). J Appl Ichthyol 38:455–461. https://doi.org/10.1111/jai.14326

3. Balanin S, Hauser-Davis RA, Giareta E, Charvet P, Wosnick N (2023) Almost nothing is known about the tiger shark in South Atlantic waters. https://doi.org/10.7717/peerj.14750. PeerJ 11
4. Bian C, Li R, Wen Z, Ge W, Shi Q (2021) Phylogenetic analysis of core melanin synthesis genes provides novel insights into the molecular basis of albinism in fish. Front Genet 12:707228. https://doi.org/10.3389/fgene.2021.707228
5. Bottaro M, Ferrando S, Gallus L, Girosi L, Vacchi M (2008) First record of albinism in the deep-water shark *Dalatias licha*. Mar Biodivers Rec 1. https://doi.org/10.1017/S1755267205001156
6. Caro T (2005) The adaptive significance of coloration in mammals. Bioscience 55:125–136. https://doi.org/10.1641/0006-3568(2005)055[0125:TASOCI]2.0.CO;2
7. Cortés E (2002) Incorporating uncertainty into demographic modeling: application to shark populations and their conservation. Conserv Biol 16:1048–1062. https://doi.org/10.1046/j.1523-1739.2002.00423.x
8. Escobar-Sánchez O, Moreno-Sánchez XG, Aguilar-Cruz CA, Abitia-Cárdenas LA (2014) First case of synophthalmia and albinism in the Pacific angel shark *Squatina californica*. J Fish Biol 85:494–498. https://doi.org/10.1111/jfb.12412
9. Finucci B (2021) First record of albinism in the lanternshark family, Etmopteridae. J Fish Biol 98:1497–1500. https://doi.org/10.1111/jfb.14679
10. Gajić AA, de Loose E, Martin AG, Neuman E, Karalić E (2025) First description of leucism in the deep-sea angular rough shark (*Oxynotus centrina*) and the first documented pigment disorder in family Oxynotidae Gill, 1912. J Fish Biol 106:649–653. https://doi.org/10.1111/jfb.15962
11. Holmes BJ, Pepperell JG, Griffiths SP, Jaine FRA, Tibbetts IR, Bennett MB (2014) Tiger shark (*Galeocerdo cuvier*) movement patterns and habitat use determined by satellite tagging in eastern Australian waters. Mar Biol 161:2645–2658. https://doi.org/10.1007/s00227-014-2536-1
12. Lipscombe RS, Spaet JLY, Scott A, Lam CH, Brand CP, Butcher PA (2020) Habitat use and movement patterns of tiger sharks (*Galeocerdo cuvier*) in eastern Australian waters. ICES J Mar Sci 77:3127–3137. https://doi.org/10.1093/icesjms/fsaa212
13. Miyao SY, Nishihara L, Sarti CC (1986) Características físicas e químicas do sistema estuarino-lagunar de Cananéia-Iguape. Bol Inst Oceanogr 34:23–36. https://doi.org/10.1590/S1679-87591986000100003
14. Rodrigues A, Shkola W, Rangel BS (2023) Extending records of albinism and skin disorders in American cownose rays to southeastern Brazil. J Fish Biol 103:453–456. https://doi.org/10.1111/jfb.15463
15. Sadowsky V (1967) Selachier aus dem Litoral von Sao Paulo, Brasilien. Beitr Neotrop Fauna 5:71–88. https://doi.org/10.1080/01650526709360398
16. Sandoval-Castillo J, Mariano-Melendez E, Villavicencio-Garayzar C (2006) New records of albinism in two elasmobranchs: the tiger shark *Galeocerdo cuvier* and the giant electric ray *Narcine entemedor*. Cybium 30:191–192

17. Santos PR (2021) Recreational fishing as a source for the monitoring of a critically endangered shark in southern Brazil. Fish Res 241:106006. https://doi.org/10.1016/j.fishres.2021.106006
18. Santos PR, Balanin S, Gadig OBF, Garrone-Neto D (2022) The historical and contemporary knowledge on the elasmobranchs of Cananeia and adjacent waters, a coastal marine hotspot of southeastern Brazil. Reg Stud Mar Sci 51:102224. https://doi.org/10.1016/j.rsma.2022.102224
19. Santos PRS, Klafke K, Gadig OBF, Garrone-Neto D (2023) Retrieving records of a rare and threatened shark in a mosaic of marine-protected areas of southeastern Brazil. J Fish Biol 102:1256–1260. https://doi.org/10.1111/jfb.15357
20. Santos PRS, Giareta EP, Domingues R, Leite RD, Garrone-Neto D, Wosnick N, Charvet P, Rios LP, Charles R, Brito VB (2025) Lagamar ISRA factsheet. IUCN SSC Shark Specialist Group. https://sharkrayareas.org/portfolio-item/lagamar-isra/. Accessed 13 August 2026
21. Skelton ZR, Prinzing TS, Nosal AP, Vagner Z, Demman P, Zerofski PJ, Wegner NC (2024) Observations of skin color aberrations in four shark species off the coast of southern California, USA. Environ Biol Fishes 107:391–400. https://doi.org/10.1007/s10641-024-01532-3
22. Veena S, Sujitha T, Raje SG, Raveendra D (2011) Case of leucism in the spadenose shark *Scoliodon laticaudus* (Müller & Henle, 1838) from Mangalore, Karnataka. Indian J Fish 58:109–112
23. Venizelos A, Benetti DD (1999) Pigment abnormalities in flatfish. Aquaculture 176:181–188. https://doi.org/10.1016/S0044-8486(99)00060-5
24. Wargat BN, Adams DH, Habegger ML (2023) Leucism in sharks: a histological examination. J Fish Biol 103:731–734. https://doi.org/10.1111/jfb.15431
25. Whitehead DA, Parmegiani A, Gobbato J, Mizyan M, Askin A, Scroglieri S, Galli P, Seveso D, Montano S, Gayford JH (2025) The phenomenon of piebaldism in sharks: a review of global sightings and patterns. Ecol Evol 15. https://doi.org/10.1002/ece3.71680

Figures



Figure 1

Study area along the southern coast of São Paulo State, southeastern Brazil, highlighting the capture locations of tiger sharks: (A) individual with normal pigmentation; (B) individual exhibiting a pigmentation abnormality consistent with leucism.