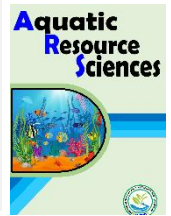




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Threatened Species Series

Threatened Fishes of the World: *Centrophorus Granulosus*: Recommendations for Sustainable Conservation

Sakariye Ahmed Hashi¹, Md. Golam Sarwar¹, Tasnim Akter Akhi¹, Mst. Meherun Nesa¹, Most. Afrina Akter Kona², Md. Farhan Anjum Prodhan Zahin¹, Md. Mishel Ahmed³, Taiyef Morshed Turzo⁴ and Md. Yeamin Hossain^{1*}

¹Department of Fisheries, University of Rajshahi, Rajshahi 6205, Bangladesh

²Department of Fisheries Technology, Bangladesh Agriculture University, Mymensingh-2202, Bangladesh

³Department of Fisheries Management, Bangladesh Agriculture University, Mymensingh-2202, Bangladesh

⁴Department of Microbiology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

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ABSTRACT

The Gulper Shark (*Centrophorus granulosus*) playing an important ecological and nutritional role by providing protein, omega-3 fatty acids, and essential minerals. However, its slow growth, late maturity, and low reproductive output make it highly vulnerable to exploitation, highlighting the significance of this study in supporting global conservation priorities, particularly under IUCN Red List and Sustainable Development Goal 14. This study is based on a comprehensive review of existing literature, conservation reports, and global fisheries data, with a focus on population trends and threats, especially in poorly documented regions such as the Western Indian Ocean. Findings indicate that European populations have declined by at least 30% over three generations, leading to its classification as Endangered. Major threats include unregulated deep-sea fishing, bycatch, habitat degradation, deep-sea mining, pollution, and climate-induced changes. Limited data and weak fisheries governance further exacerbate the situation. To ensure sustainable conservation, the study recommends science-based catch limits, seasonal closures, selective fishing gear, and the establishment of marine protected areas in critical habitats. Strengthening international cooperation through Regional Fisheries Management Organisations and compliance with CITES regulations are essential. Community engagement through alternative livelihoods is also crucial for long-term conservation success.

Introduction

The Gulper Shark (*Centrophorus granulosus*, Bloch & Schneider 1801) is a deep-sea Squaliformes Shark belonging to the family Centrophoridae (Finucci *et al.* 2024). It occurs widely on continental slopes and outer shelves of the Pacific, Atlantic, and Indian Oceans, typically between depths of 300 and 1,400 m

(Finucci *et al.* 2024). The Gulper Shark (*Centrophorus granulosus*) is a medium-sized, up to 176 cm total length, deep-water shark with a widespread yet patchy global distribution in the Atlantic and Indo-Pacific Oceans. It has been recorded from the continental shelves and upper slopes at depths of 50–1,500 m, and mostly 300–1,100 m (View 2009a). The family Centrophoridae, established in 1859, includes two genera: *Centrophorus* and *Deania*,

*Corresponding author

Email address: yeamin.fish@ru.ac.bd (Md. Yeamin Hossain)

with a focus on the former in this paper. *Centrophorus* was first proposed by Müller & Henle in 1837 and was characterised by its lack of an anal fin and the presence of a spine before each dorsal fin, alongside being grouped with three other shark genera (White et al. 2013). *C. granulatus* were caught with bottom trawl and longline between 500 and 1300 m depth off the continental slope of Galicia and the Galician Bank (north-eastern Atlantic) between 1996 and 1998 (Bañón et al. 2008). The main biological data obtained were: a maximum recorded size of 166 cm TL (total length); females mature at 147 cm TL; between 1 and 10 mature oocytes by females of 55–80 mm diameter, and as many as 6 pups per litter, and size at birth ranging between 35–47 cm TL. These results differ greatly from those compiled in the literature, suggesting different populations or perhaps a possible misidentification (Bañón et al. 2008).

Like many deep-sea elasmobranchs, *C. granulatus* exhibits a suite of life-history traits associated with extreme k-selection slow growth, late maturity, long gestation, and low fecundity (usually only 1–2 pups per litter) (Finucci et al. 2024; FAO 2010). The Gulper Shark is thought to be fairly widespread in the Mediterranean Sea because of its geographic range. Still, focused fishing and its proneness to being caught as bycatch hint at drops in numbers in some areas (View 2009a). In European waters, the species is suspected to have declined by at least 30% over three generations (View 2009a). Consequently, the Little Gulper Shark is assessed as Vulnerable under criterion A2b, inferred from declines of its congener, the Lowfin Gulper Shark (*C. lusitanicus*), also assessed as Vulnerable in the region (View 2009a).

Major knowledge gaps regarding the endangered status of the gulper shark species (*C. Granulosus*) exist in the Western Indian Ocean (WIO) region (Table 1). Small-scale fishery catches lack proper documentation, and fishery and trade regulations vary and are often incomplete across countries. Current laws are inadequate for cartilaginous fishes, and there are few actions to reduce fishing deaths. Different issues negatively impact how well these fisheries are run (Muthiga et al. 2024).

Deep-water sharks, like gulper sharks, are slow to grow, mature late, live a long time, have small litters, and don't breed often. Because of these traits, they're easily overfished and struggle to bounce back after

their numbers drop ((Secretariat et al. 2025). The Gulper Shark (*C. granulatus*) is being threatened by deep-sea fisheries as well as inadequate data and management in most regions, especially in the Western Indian Ocean. The species' biological natural vulnerability and offshore pressures due to harvesting and trade highlight the pressing need for area-specific research and conservation efforts. This review aims to evaluate the conservation standing, vulnerability, and management problems facing the Gulper Shark (*C. granulatus*). It will also propose conservation plans, mainly for the Western Indian Ocean.

Common Name

Leaf scale Gulper Shark, known as Squalé-chagrin De L'Atlantique in French, Quelvacho Negro in Spanish, and Hiu Botol in Indonesian, is its common name (View 2009b). *C. granulatus*, commonly known as the Gulper shark, is classified as an endangered species according to the IUCN status, with the assessment conducted in 2024 (CITES 2016).

Taxonomy

Kingdom: Animalia

Phylum: Chordata

Class: Chondrichthyes

Subclass: Elasmobranchii

Division: Selachii

Order: Squaliformes

Family: Centrophoridae

Genus: *Centrophorus*

Species: *C. granulatus*



Fig. 1: *Centrophorus Granulosus* from science learning Hub in 2024

Identification

Gnostic characters refer to small to moderately large sharks characterised by cylindrical or slightly compressed bodies, absence of ridges between fins, and a specific arrangement of gill slits and eyes. These sharks have a range of features, including a short to elongated snout, smooth lips, and strong, compressed

teeth. They possess two dorsal fins with significant grooved spines, large angular shapes, and an asymmetrical caudal fin with a variable lower lobe. The overall colouration is greyish to blackish brown,

Distribution and abundance

The Gulper Shark is found in temperate and tropical waters across all ocean basins, excluding the eastern Pacific (Fig. 2). In Australia, it has a disjunct

Table 1: Available studies on *Centrophorus Granulosus* from different countries

Country	Waterbody / Location	Aspect Studied	Reference
Turkey	North Aegean Sea	First documentation of the Little Gulper Shark, <i>Centrophorus uyato</i>	Guallart (2006)
Spain	North-western coast of Galicia, Eastern Atlantic	Biological observations on the gulper shark (<i>Centrophorus granulosus</i>)	Bañón et al. (2008)
India / Cyprus	Cypriot waters, Eastern Mediterranean	First genetically confirmed records of the little gulper shark (<i>C. uyato</i>)	Kousteni et al. (2021)
Egypt	Alexandria, Mediterranean Sea	Morphological aspects of the dorsal fin in eight shark species, including first records in Egyptian waters	Azab et al. (2019)
Western Indian Ocean countries	Indian ocean	Enhancing resilience and the health of the Western Indian Ocean: 2022-2024 Partners Programme	Muthiga et al. (2024)

lacking conspicuous markings (East 1967). The pectoral fin of *C. lusitanicus* is moderately long, exceeding that of similarly sized *C. granulosus*. The first dorsal fin is short and more triangular, with a height of 1.6–1.9 times the soft-fin length, compared to

distribution, occurring on the east coast from northeast Queensland to Wooli, and on the west coast from Dirk Hartog Island to the Montebello Islands (Name et al. 1801). *C. granulosus* is found on the upper continental slopes and outer continental shelf of temperate and

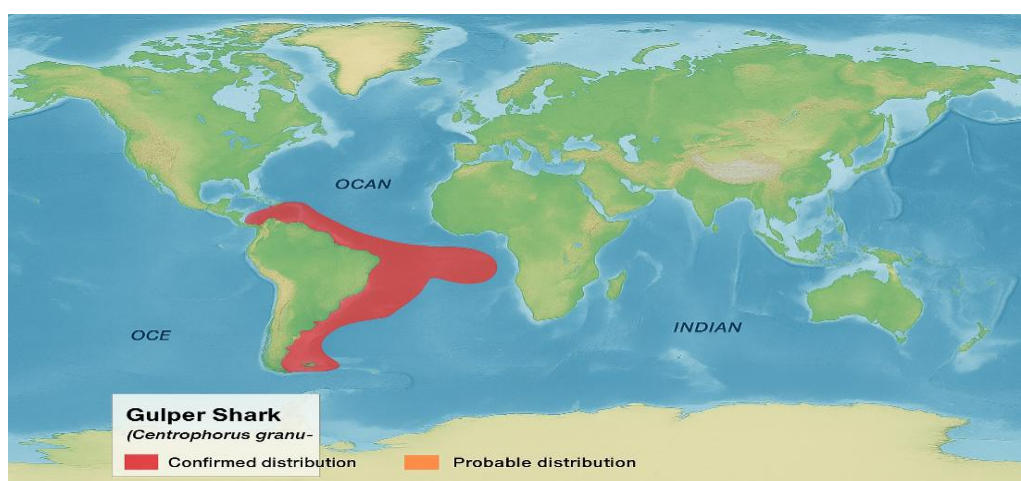


Fig. 2. Map showing the geographical distribution of *Centrophorus Granulosus*

2.1–3.0 in *C. granulosus*. Additionally, *C. lusitanicus* shares maximum size, denticles, and pectoral-fin rear tips characteristics with *C. uyato*, but features a long first dorsal fin (1.6–2.0 times the base length of the second dorsal fin) that is low relative to the second dorsal fin (Wienerroither et al. 2015).

tropical seas, particularly in the Northeast Atlantic near France, Spain, and Portugal, as well as in the Mediterranean, along the Atlantic coast of Africa, in the Gulf of Mexico, Caribbean, Western Indian Ocean, and West Pacific (Regions 2008). Gulper sharks (*Centrophorus spp.*) are heavily fished across all

oceans, yet their taxonomy and biology remain poorly defined, making them highly susceptible to over-exploitation. This study provides distribution, size-frequency, and reproductive data for three species (*C. harrissoni*, *C. moluccensis*, and *C. zeehaani*) that have been largely depleted from the south-east Australian upper continental slope due to fishing practices (Graham and Daley 2011).

Habitat and ecology

Gulper sharks live in deep ocean waters, typically from 200 to over 2,400 meters. They have been observed at depths greater than 4,000 meters (East 1967). These sharks can be seen worldwide, from tropical to very cold regions, and sometimes swim into shallower areas (East 1967). These sharks gather in big groups and mostly consume bony fishes and cephalopods. They reproduce through ovoviviparity, giving birth to 1 to 12 offspring per litter in the Far East and eastern Atlantic. They are often caught for food, and their big, oily livers are valuable to fisheries (East 1967).

Food and feeding habits

Stomach content data shows that *C. squamosus* eats five main types of prey: bony fish, cephalopods, crustaceans, nematodes, and cartilaginous fish. (Nafia et al. 2023). Key species consumed include *Alepocephalus sp.* and *Aphanopus carbo* (Teleostei), *Sepia sp.* and *Octopus vulgaris* (cephalopods), *Aristeus antennatus* and *Nephrops norvegicus* (crustaceans), as well as *Chimaera monstrosa* and *Dalatias licha* (chondrichthyes) (Megalofonou and Chatzisprou 2006). Teleostei are the primary prey, with an index of relative importance of 174.18 (Nafia et al. 2023). The gravid female had one large ovum in its right uterus. Stomach content analysis shows the gulper shark primarily feeds on fish (63.9%) and cephalopods (36.1%) (Megalofonou and Chatzisprou 2006).

Nutritional profile

C. Granulosus is recognised as a nutrient-rich marine species, providing a good source of high-quality protein and polyunsaturated fatty acids, particularly omega-3 (Fish Base 2025) (Table 1). Its muscle tissue contains essential minerals such as potassium, magnesium, phosphorus, calcium, iron, selenium, and zinc, which play key roles in physiological functions and human health (European Commission 2025). The species is also a source of trace elements like selenium and zinc and contains fat-soluble vitamins, including vitamin A. In addition, its lean flesh and balanced

amino acid composition make it a valuable component of a healthy diet, with significant levels of essential amino acids such as lysine, valine, leucine, and threonine. The nutrient profile of *C. granulosus* also includes omega-3 PUFA, moderate fat levels, and negligible carbohydrate content.

Growth pattern

The study found that *C. granulosus* has a maximum size of 166 cm TL, matures at 147 cm TL, produces between 1-10 mature oocytes, and has 6 pups per litter (Bañón et al. 2008). Growth pattern *C. Granulosus* demonstrates that *C. uyato* demonstrates conspicuous sexual size dimorphism. Males were shorter and lighter, with their mean total length at 73.95 cm (45–83 cm) and mean mass at 2,706 g in comparison to the females, whose mean total length stood at 88.08 cm (81–94 cm) and mean mass at 4,997 g. This difference in size would imply that the females could become bigger in size, a feature found in most deep-sea sharks (Lteif et al. 2017).

Reproductive Biology

The reproductive biology of the Gulper shark (*C. granulosus*) female pregnant indicates continuous production depths up and male spatial segregation during production (Table 3). The Female measures 795mm, and the smallest mature male is at 725mm. Each gravid female carries either a single embryo or a large egg

Gulper sharks are ovoviviparous, meaning females give birth to live young that develop from eggs inside their bodies (Dulvy and Reynolds 1997). A female can carry up to six developed eggs, each between 55 and 80 mm in diameter (Bañón et al. 2008). The embryos get nourishment only from the yolk. Gestation takes about two years, which is a long time for sharks (Cotton and Musick 2015). These sharks usually have one or two pups per litter, though sometimes they have up to six (Bañón et al. 2008).

Females create one to ten developed eggs per reproductive cycle (Bañón et al. 2008). Gulper sharks have a concurrent ovarian cycle, so they can reproduce all year (Cotton and Musick 2015). In the Mediterranean, the gonadosomatic index (GSI) is highest in July, suggesting peak reproductive activity (Megalofonou 2007) (Table 4).

Conservation status

The gulper shark in Australian waters is classified as

Least Concern and is considered sustainably managed (Kyne et al. 2021). It has been declared the gulper shark (*C. granulosus*) as Endangered on the IUCN Red List globally (View 2009c).

Maldives, India, and Sri Lanka. Additional threats include deep-sea mining, marine pollution, and climate change, but these threats are currently relatively minor compared to overfishing (CITES 2016).

Table 2: Nutritional profile of *Centrophorus Granulosus* (Hicks et al. 2019)

Nutrient	Mean Value	Range (Min–Max)	Unit	Basis
Calcium	5.65	1.11 – 28.95	mg/100 g	Wet weight
Iron	0.304	0.071 – 0.977	mg/100 g	Wet weight
Protein	19.9	17.6 – 22.1	%	Wet weight
Omega-3	0.279	0.102 – 0.876	g/100 g	Wet weight
Selenium	19.5	6.0 – 56.9	µg/100 g	Wet weight
Vitamin A	8.25	1.82 – 38.80	µg/100 g	Wet weight
Zinc	0.248	0.118 – 0.466	mg/100 g	Wet weight

Table 3: Reproductive biology of *Centrophorus Granulosus*

Depth (m)	Females No. (gravid)	Size range (mm TL)	Males No. (running)	Size range (mm TL)
300	7 (2)	751–880	–	–
250–300	14 (5)	699–919	–	–
250–300	4 (0)	804–895	–	–
250–300	13 (13)	795–950	1	740
1400	4 (im)	550–629	2 (im)	535–657
250–300	5 (5)	837–925	–	–
1300 / 800	–	–	–	–
550	2 (2)	820–830	9 (7)	710–825
700	–	–	4 (4)	770–819
1330	–	–	2 (im)	435–600
550	2	840–881	3	748–798
750	3	780–920	2	760–775
1400	1 (im)	605	–	600
1330	1 (im)	590–620	2 (im)	510–545
550	1400	1 (im)	–	–
750				
700				

Threats

The main threat to *C. atromarginatus* and *C. granulosus* is unregulated and unmonitored deep-water industrial and artisanal target and bycatch fisheries, driven by international demand for their high-value liver oil. These sharks have conservative life histories, making them susceptible to overexploitation. Fisheries have collapsed over short periods due to depletion of stocks. The gulper shark family is one of the top ten most threatened sharks and rays, with 73% of all species assessed at high to extremely high risk of extinction due to overfishing. Target fisheries for these species have occurred in Japan, Indonesia, the

The decline in deep-water shark fisheries, including the NE Atlantic fishery for *C. granulosus*, is linked to human activity and a decline in population. The Portuguese fishery's declining catches are believed to represent falling yields from a declining stock. Falling liver oil prices and changing fishing patterns may have influenced the closure of the fishery, despite high market demand for deep-water shark flesh in Europe (Regions 2008).

The Gulper shark (*C. granulosus*) is one of the most threatened deep-sea elasmobranchs, which can be explained by its low reproductive production and the great fishing pressure under which it has to operate in the continental slopes (Georgeson 2020; White et al.

2022). In the past, the fisheries focused on the species because its liver oil is a high source of squalene. In the modern environment, the shark has continued to be a

The preservation of *C. granulosus* necessitates rigorous implementation of catch quotas, seasonal prohibitions, bycatch documentation, and the

Table 4: Reproductive parameters *Centrophorus Granulosus*

Parameter	Value	Reference
Sexual Maturity (Females)	~90 cm TL	Megalofonou and Chatzisprou (2006)
Sexual Maturity (Males)	~80 cm TL	Megalofonou and Chatzisprou (2006)
Spawning Season	Continuous, no peak season	Megalofonou (2007)
Fecundity	1–10 ova (avg. 5)	Bañón et al. (2008)
Embryo Development	Prolonged gestation	Guallart (2001)

common part of bycatch in the operations of demersal trawl and longline (Australian Government 2023). Population estimates in recent decades indicate that this has reached more than 80 percent in the global population over the past decades, a trend which has led it to be designated as Endangered by the IUCN SSC Shark Specialist Group (2024). High-value liver oil which is rich in squalene remains an economical incentive; however, the species remains constantly harvested as bycatch during demersal trawl and longlining activity (Australian Government 2023). Population research illustrates that the world has lost over 80% of its population over the last few decades further justifying its Endangered status as stipulated by IUCN (IUCN SSC 2024).

Conservation action

The EU Commission and Council are promoting EU-compatible shark fishing restrictions at Regional Fisheries Management Organisations, using CITES and M.O. Conventions (The Shark Alliance 2012).

Recommendations for conservation

Gulper shark catches are sustainable, with priority for protecting at-risk species. Knowledge on elasmobranch fisheries and species is improved through data collection, scientific research, and international conservation measures (The Shark Alliance 2012).

Member nations must stop their ships from specifically fishing for deep-sea sharks in the regulated zone. They should also send all shark data to ICES so they can better assess shark populations. Nations should also try to protect these sharks as well as they can in their own waters (Kotler et al. 2023).

utilisation of selective fishing apparatus to avert overexploitation (CITES 2016; Bañón et al. 2008). Marine protected areas should be created in important habitats, and these areas should use depth-specific methods to protect breeding and feeding grounds. (Graham and Daley 2011). To improve research, it is important to clarify what we don't know about population structure, life history, and classification. We also need to start long-term monitoring to track how populations change. (Muthiga et al. 2024; White et al. 2013). International collaboration via Regional Fisheries Management Organisations (RFMOs) and compliance with CITES standards are crucial to mitigate illicit trade (The Shark Alliance 2012). Fishermen should note that the gulper shark group is prone to harm, given their slow growth and low reproduction rates. Conservation plans that involve community participation should be put in place to promote durable methods. (Secretariat et al. 2025)

In Connection with the sustainable development Goals (SDGs)

The gulper shark (*C. granulosus*), which dwells in the deep-sea habitats, is subject to a major risk of overfishing because the shark grows slowly, matures slowly and also does not reproduce frequently. The Western Indian Ocean (WIO) therefore needs to be conserved urgently. Considering the fact that deep-sea fisheries in the area have grown and limited information exists about sharks' populations, this research paper suggests initiatives to promote sustainable species management and the achievement of the Sustainable Development Goals (SDGs). The subsequent steps are to be made: In order to maintain

marine life, there should be science-based catch limits and seasonal closure to the marine ecosystems which are in vital stages of reproduction. There should be selective fishing equipment that reduces bycatch of deep-sea sharks. Unlawful fishing in the Exclusive Economic Zones needs to be checked and more vigilance implemented. Trans-boundary Marine Protected Areas (MPA) should also include important habitats such as breeding and feeding grounds. The regional marine management plans should incorporate MPA networks as a way of strengthening ecosystem connectivity and flexibility. Conservation efforts implemented by the local communities should also be supported because fishers are extremely significant in conservation and surveillance. Investment must be made into in-depth research of deep-sea ecology, in order to establish the location and population of *C. granulosus* in the WIO. The regional universities, fisheries stakeholders, and other international partners should carry out joint research endeavours to explain the species composition, ecological roles, and environmental contextualization. Such a platform of data-sharing on a regional level would help disseminate research results and make more effective decisions about fisheries management. It is important to harmonize national laws and the international conventions like CITES and FAO IPOA-Sharks. The introduction of another regional information-sharing platform would assist in the further dissemination of studies and make it easier to make decisions on fisheries governance. There is need to align domestic laws with international regulations such as the CITES and FAO IPOA- Sharks. In order to enhance the management of the deep-sea fisheries, it is plausible that countries in the region come up with a joint monitoring and enforcement programmes that would help to confirm that regulatory requirements are met. The views of communities and small-scale fishers, and local stakeholders must also be taken into consideration when it comes to conservation planning and decision-making.

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