PUBLICATION AND PRESENTATION

CONFERENCES, SEMINARS, WORKSHOPS

1. Oral presentation on “The Diversity of Skates and Rays from Saurashtra Coast – The Peninsular Region of Gujarat, India” in the Nation conference on Present Day Biology: Recent Advancements in Biological Sciences on 10th – 11th December 2011 at St. Xavier’s College, Ahmedabad.
2. Oral presentation on “Catch composition of Ray fishes (Elasmobranchii, Batoids) from Gujarat coast, India” in the UGC-SAP & DST-FIST sponsored International Conference on Path and Prospects in Applied Biosciences, 30th – 31st July, 2022 at Veer Narmad South Gujarat University, Surat.
3. Poster presentation on “Elasmobranch Fish Identification Using YOLO – A Deep Learning Approach” in the World Ocean Science Congress on 27th – 29th February, 2024 at IIT – Madras Research Park, Chennai.
4. Completed hands-on training program on “Capillary Sequencing & Fragment Analysis” sponsored by Gujarat State Biotechnology Mission, DST, GoG from 21st – 25th March, 2022 at Gujarat Biotechnology Research Centre, Gandhinagar.

J. Exp. Zool. India Vol. 27, No. 1, pp. 575-580, 2024 | DOI: https://doi.org/10.51470/jez.2024.27.1.575 | *ISSN 0972-0030*
DocID: https://connectjournals.com/03895.2024.27.575 | Crossref | eISSN 0976-1780

FIRST RECORD OF MANGROVE WHIPRAY, *UROGYMNUS GRANULATUS* (MACLEAY, 1883) (ELASMOBRANCHII : DASYATIDAE) FROM GUJARAT, NORTH-WEST COAST OF INDIA

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(Received 24 August 2023, Revised 13 September 2023, Accepted 28 September 2023)

ABSTRACT : This paper describes the occurrence of *Urogymnus granulatus* (Macleay, 1883) (386 mm DW), also known as the Mangrove whipray, in the state of Gujarat, India. This represents a new distributional range for this species. These occurrences indicate a concealed diversity of stingrays in this region. To elucidate taxonomic information, morphological species descriptions and a molecular barcode of *U. granulatus* (Macleay,1883) were generated in this study. This report contributes to a better comprehension of the local diversity and distribution of batoids in Gujarat, which is essential for the development of fishery management strategies.

Key words : First record, *Urogymnus granulatus*, DNA barcoding, Elasmobranchii, Gujarat, India.

How to cite : Ajay U. Baldaniya and Pradeep C. Mankodi (2024) First record of Mangrove whipray, *Urogymnus granulatus* (Macleay, 1883) (Elasmobranchii : Dasyatidae) from Gujarat, North-West Coast of India. *J. Exp. Zool. India* **27**, 575-580. DOI: https://doi.org/10.51470/jez.2024.27.1.575

INTRODUCTION

Members of the dasyatid genus *Urogymnus* (Müller and Henle, 1837) currently has a six valid nominal species *U. acanthobothrium* (Last, White and Kyne, 2016), *U. asperrimus* (Bloch and Schneider, 1801), *U. dalyensis* (Last and Manjaji-Matsumoto, 2008), *U. granulatus* (Macleay, 1883), *U. lobistoma* (Manjaji-Matsumoto and Last, 2006), *U. polylepis* (Bleeker, 1852) (Froese and Pauly, 2023). However, it is pertinent to note that till now the genus *Urogymnus* (Müller and Henle, 1837) has no representatives in Gujarat so far, but this is the first study that has reported *Urogymnus granulatus* as first species of genus *Urogymnus*. It is a marine and brackish water fish, it is most commonly found in shallow inshore waters, such as those that are close to mangroves, estuaries, sand flats and sandy substrates, it can be found as deep as 85 metres (Carpenter and Niem, 1999). *U. granulatus* is a species having a patchy distribution in the Indo-Pacific region from the Seychelles - Maldives to the Caroline, Santa Cruz Islands and Australian waters (Randall and Van Egmond, 1994; Last *et al*, 2016a).

The coastline of Gujarat, which runs along the western side of India (Gopalkrishnan, 2018) is the longest in the country. It is a habitat to a variety of ecosystems, including mangroves, salt marshes, coral reefs, and seagrasses (Worldbank, 2020) and it is well-known for the abundance of marine diversity (Johri *et al*, 2021), Despite the documented occurrence of *U. granulatus* in various parts of the India, there has been a notable absence of records confirming its presence in Gujarat. This knowledge gap highlights the importance of conducting comprehensive research to expand our understanding of elasmobranch diversity along the Gujarat coast and contribute to the overall knowledge of marine biodiversity in the region.

MATERIALS AND METHODOLOGY

Single specimen of *U. granulatus* was landed at the fish landing centre of Okha Harbour (22° 27' 19.71 N, 69° 4' 18.58 E) in Gujarat, India (Fig. 1). The specimen was caught by a commercial fishing boat. Photographs of the sample were taken and its identification was confirmed based on Last *et al* (2016a) and Kumar *et al* (2021). Morphological measurements of specimen were based on batoid measurements proposed by Bigelow and Schroeder (1953), Compagno and Roberts (1982), Manjaji (2004), which are based on modifications of Compagno

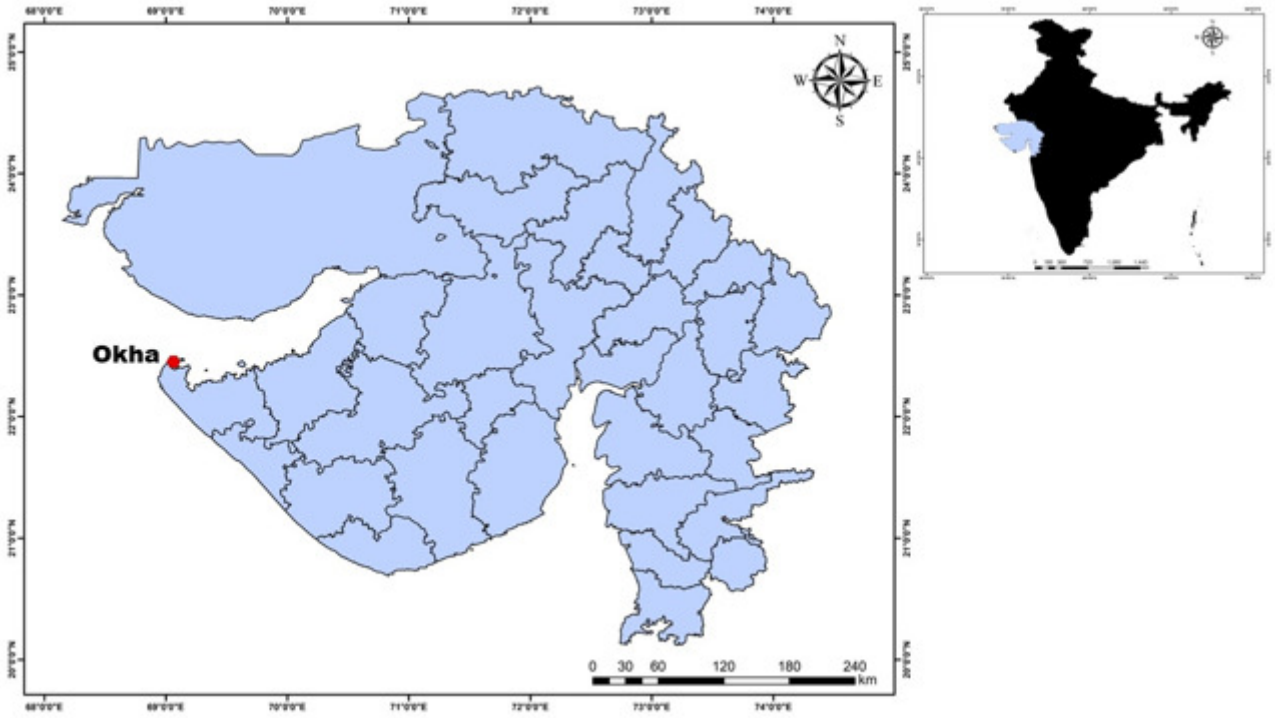

Fig. 1 : Map showing fish landing centre of Okha Harbour, Gujarat, India.

Table 1 : Morphometric measurements (% DW) of *Urogymnus granulatus* from Gujarat and its comparison with Ishihara *et al* (1993), Rastgoo *et al* (2016) and Kumar *et al* (2021).

Measurements	***U. granulatus* (OR252866)**	***U. granulatus* (Ishihara *et al*, 1993), n=6**	***U. granulatus* (Rastgoo *et al*, 2016)**	***U. granulatus* (Kumar *et al*, 2021)**
Disc width (mm)	386	524-970	964	395
Disc length	104.5	99.2-106.2	103.2	101.3
Snout tip to maximum disc width	48.4	36.4-44.7	-	48.6
Snout length	17.1	22.4-26.2	-	23.2
Interorbital width	19.8	11.6-14.6	21.3	21.5
Spiracle length	7.7	6.1-8.3	-	8.4
Nasal curtain length	6.2	6.1-8.3	-	4.9
Nasal curtain width	13.1	-	-	-
Nostril length	5.2	4.4-5	-	3.5
Prenarial snout length	13.5	14.7-18.4	16.2	17.2
Internarial width	9.9	9.4-11.6	-	12.7
Mouth width	8.8	9.4-10.5	9.8	8.9
Snout tip to 1st gill slits	36.1	34.5-40.4	-	36.7
Ventral head length	52.9	48.54.2	-	50.6
Snout tip to pelvic girdle	87.5	75-82	-	81
Snout tip to anus	90.9	81.8-88.1	89.2	82.3
Width of tail at end of pelvic	10.2	5.7-9.4	-	10.7
1st gill slit length	4.2	3.4-4.5	-	3.3
5th gill slit length	2.8	2.7-3.5	-	3.8
Distance between 1st gill slits	26.8	23-24.5	29.5	24.1
Distance between 5th gill slits	19.2	15.2-17.2	21.9	16.5
Pelvic fin anterior margin	20.1	15.3-18.3	-	17.4
Pelvic fin posterior margin	29.4	10.4-18.6	-	12.1
Pelvic fin length	15.9	-	-	-
Cloaca length	4.6	-	-	-

and Heemstra (1984), Last and Stevens (1994). Total length and tail length could not be measured because tail was chopped. Sex was determined by the presence or absence of claspers. A small piece of muscle tissue from the pelvic fin was collected and tissue was stored in 95% alcohol in the field and transferred to the laboratory for further molecular analysis. Morphometric measurements of *U. granulatus* were taken and comparisons (as % of DW) were made with earlier reports following (Ishihara *et al*, 1993; Rastgoo *et al*, 2016; Kumar *et al*, 2021), which is incorporated in Table 1.

DNA isolation

Genomic DNA was isolated from the tissue sample using HiPurA® DNA Purification Kit (HiMedia). Following instructions of the manufacture, and eluted in 50 µl of elution buffer. Extracted DNA was checked by 0.8% agarose gel electrophoresis with ethidium bromide incorporated in 1x TBE buffer. The concentration of isolated DNA was diluted to a final concentration of 10 ng/µl using a UV spectrophotometer.

Amplification and sequencing

The barcode sequence of the COI gene was PCR amplified using the primers Fish F1 (5'- TCA ACC AAC CAC AAA GAC ATT GGC AC3') and Fish R1 (5'-TAG ACT TCT GGG TGG CCA AAG AAT CA-3') (Ward *et al*, 2005) in 25 µL reactions using 2X PCR TaqMixture (MBT061, Himedia) containing 10ìM of each PCR primer and 1 µl of template DNA. Thermal conditions consisted of initial preheat at 95^{0}C for 3 min, denaturation 94^{0}C for 30 s, annealing 50^{0}C for 30s, extension 72^{0}C for 35 s, repeated for 29 cycles, followed by a final extension for 3 min at 72^{0}C. PCR products were visualized in a 1.2% agarose gel. Purified amplicons were then subjected to cycle sequencing using Big Dye Terminator v3.1 chemistry and subsequently sequenced on an ABI 3500XL Genetic Analyzer following the protocol of the manufacture.

Sequence analysis

We assembled the forward and reverse DNA sequences and edited using Tracy software tool. These sequences were subjected to a Sequence match analysis using NCBI's Basic Local Alignment Search Tool (BLAST) and exported as FASTA file for further evolutionary analysis. The sequence of this specimen has been deposited in GenBank under the assigned accession number of OR252866. Sequences were aligned using ClustalW as implemented in MEGA11 (Tamura *et al*, 2021). Sequence divergence values within and between species were calculated using the Kimura 2 Parameter (K2P) distance model of nucleotide substitution. Neighbour-joining (NJ) trees of K2P distance were created to provide graphic representation of divergence with 1000 bootstrap replications.

RESULTS

This study presents a new distributional record and provides a diagnostic characteristic for *U. granulatus* from Gujarat, India. Short taxonomy descriptions are provided in this work, along with morphometric data for specimens that are compared to previously known specimens and a molecular phylogeny of specimen that is presented along with Photographs.

Systematic accounts

Class : Elasmobranchii

Order : Myliobatiformes

Family : Dasyatidae

Genus : Urogymnus (Müller & henle, 1837)

Species : *Urogymnus granulatus* (Macleay, 1883) (Figs. 2 and 3).

Diagnosis

Urogymnus granulatus has an oval disc with various white spots, granular on the dorsal surface. Thick disc through the trunk, distinctly longer than width. Pectoral fin apex broadly rounded and short snout with a weak apical lobe. Tail broad, tapering toward caudal sting. Ventral surface white or with black blotches.

Description

Urogymnus granulatus is characterized by a thick, oval shaped disc, raised slightly at mid-scapular region and the length of the disc is slightly greater than the disc width. Morphometric measurements in % of disc width (DW) is presented (Table 1). Disc length 104% of DW; preorbital snout moderately short; pectoral apices thick and rounded rather than angular and free rear tip narrowly rounded; eyes moderately large, widely spaced. eyes are nearly followed by the spiracles, spiracle length 7.7% of DW; interorbital space broad its width 19.8% of DW; Spiracles large, subrectangular to sickle-shaped, situated dorsolaterally; Mid shoulder space is roughly covered with fine denticles that begin from interorbital space reaches onto the tail and no enlarged thorns on the body. Pelvic fins subtriangular, short and length 15.9% of DW; Tail broad-based, subcircular in cross-section. tail width at pelvic end 10.2% of DW; Claspers of adult male not observed; Ventral head length 52.9% of DW. Snout relatively short in length, slightly produced, and obtuse with weak apical lobe. snout length 17.1% of DW; snout tip to first gill slit distance 36.1% DW; Prenarial snout length 13.4% of DW; Nostrils narrow and slightly oblique,

Fig. 2 : Dorsal view of *U. granulatus* (OR252866) collected from Fish landing centre of Okha harbour, Gujarat, India.

Fig. 3 : Ventral view of *U. granulatus* (OR252866) collected from Fish landing centre of Okha harbour, Gujarat, India.

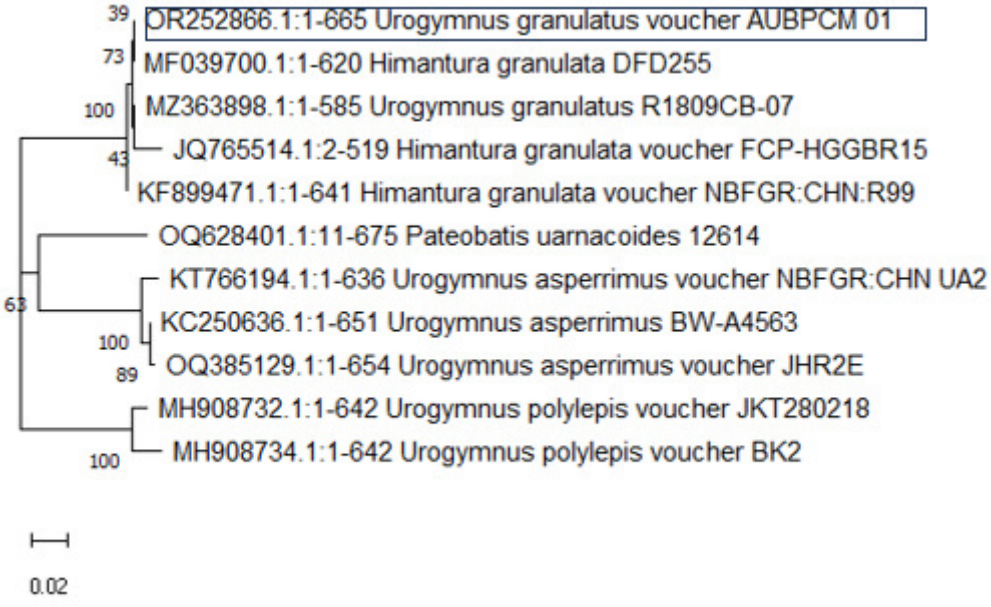

Fig. 4 : K2P distance neighbour -joining tree of *U. granulatus* (OR252866) from Gujarat, India.

length of nostril is 5.2% of DW; Nasal curtain small, with posterior margin finely fringed, nasal curtain length 6.2% of DW, nasal curtain width 13% DW; internarial width 9.9% DW; Mouth small, its width 8.8% of DW, labial furrow and folds prominent; Gill opening margins moderately S-shaped, smooth-edged; length of first gill slit 4.2% of DW, length of fifth gill slit 2.8% of DW; distance between first gill slits 26.8% of DW; distance between fifth gill slits 19.2% of DW. Dorsal surface brownish and covered with small white spots, Ventral surface white.

DNA Barcoding

To provide a graphical depiction of the patterning of divergences, Neighbour Joining (NJ) trees of Kimura two-parameter (K2P) distances were built (Fig. 4). The results of a phylogenetic study and a comparison of the DNA barcodes of the present Gujarat specimen (OR252866) with those of *U. granulatus* from GenBank (KF899471, MF039700, MZ363898) demonstrate a match of more than 99.5%.

DISCUSSION

The present specimen was identified as *U. granulatus* (Macleay, 1883) based on DNA barcoding and morphological characters. This study has reported the first report on Taxonomic characteristics with morphometric data for *U. granulatus* from Gujarat and were compared with earlier reports from Andaman waters, India (Kumar *et al*, 2021), Maldives Islands (Ishihara *et al*, 1993) and the Persian Gulf, Iran (Rastgoo *et al*, 2016). The morphometric characteristics of the present female specimen corresponds with the earlier recorded specimens of Kumar *et al* (2021), Ishihara *et al* (1993), Rastgoo *et al* (2016) was observed.

Assessments on stingrays are often troublesome in view because of the close by similarity in appearance of species (Last *et al*, 2016b). *Urogymnus granulatus* was

previously considered as a *Himantura granulata*, but based on morphological and molecular insights published in 2016 now these species are considered as *Urogymnus granulatus* (Last *et al*, 2016c). In India, *U. granulatus* were previously recorded from Kerala (Bineesh *et al*, 2014), Maharashtra (Kottillil *et al*, 2023), Gulf of Munnar (Jena *et al*, 2023), Zuari estuary Goa (Bhavan *et al*, 2023), Andaman waters (Kumar *et al*, 2021) and also listed in the Checklist of Chondrichthyans in India by Akhilesh *et al* (2014). The current report with genetic data confirms the occurrence of *U. granulatus* in the Gujarat filling a gap in the known distribution range of species. According to the IUCN red list of threatened species, this species was assessed as Vulnerable (Manjaji *et al*, 2020).

Gujarat is one of the most productive fisheries regions in the Arabian Sea region, and the marine ecosystem's marine faunal composition is highly diverse (Johri *et al*, 2021). Nonetheless, there are a dearth of thorough scientific investigations on elasmobranch biodiversity, distribution, and fisheries in Gujarat, as well as specific studies on elasmobranch status assessments (Sutaria *et al*, 2015; Johri *et al*, 2019; Johri *et al*, 2020).

Based on the latest findings, and previous elasmobranch studies in the region, detailed scientific exploration is necessary for the diversity assessment, conservation and determination of the ecological significance of this species. This finding provides new geographical data on the marine fauna of the Gujarat state. The present study emphasizes an urgent need for more concentrated diversity studies on Elasmobranch from the Gujarat Arabian Sea region, which would support better management, conservation planning and understanding of the diverse ecosystems in the Gujarat and Indian Exclusive Economic Zone.

ACKNOWLEDGMENT

First author would like to thank SHODH-Scheme of Developing High quality research, Education Department, Government of Gujarat for providing fellowship for the Ph.D. research work. The assistance of the Jayanti Hadiya is also appreciated during field survey. Author is also thankful to the Fishermen and Traders of the Okha Harbour. The first author would also like to thank Mr. Agradeep Mohanta for his constant support and encouragement. Miss. Foram Jadeja is thankfully acknowledged for helping in map preparation.

Conflicts of interest : The Authors declare that they have no conflict of interest.

Ethics approval consent to participate : The specimen is not under the listed category of experimental animals which need ethics approval.

Authors' contribution

Conceptualization: Ajay U. Baldaniya; Methodology: Ajay U. Baldaniya; Formal analysis and investigation: Ajay U. Baldaniya; Writing - original draft preparation: Ajay U. Baldaniya; Writing - review and editing: Ajay U. Baldaniya; Pradeep C. Mankodi; Resources: Pradeep C. Mankodi; Supervision: Pradeep C. Mankodi.

Funding : No specific funding was received for conducting this study.

Competing interests : The authors have no competing interests to declare that are relevant to the content of this article.

REFERENCES

Akhilesh K, Bineesh K, Gopalakrishnan A, Jena J, Basheer V and Pillai N (2014) Checklist of chondrichthyans in Indian waters. *Mar. Biol. Assoc. India* **56**(1), 109-120. https://doi.org/10.6024/jmbai.2014.56.1.01750s-17.

Bhavan S G, Bella K, Kv A, Mayekar T, Vasudevan C, Rajkumar S and Kumar P (2023) Spatio-temporal patterns in the distribution of juvenile elasmobranchs in a tropical Indian Ocean estuary, Zuari-India. *Marine Biodiversity* **53**(3), 1-11. https://doi.org/10.1007/s12526-023-01338-z

Bigelow H B and Schroeder W C (1953) Fishes of the western North Atlantic. Part 2 sawfishes, guitarfishes, skates and rays, chimaeroids. Sears Foundation for Marine Research, New heaven, Yale University.

Bineesh K, Akhilesh K, Sajeela K, Abdussamad E, Gopalakrishnan A, Basheer V and Jena J (2014) DNA barcoding confirms the occurrence rare elasmobranchs in the Arabian Sea of Indian EEZ. *Middle-East J. Scientific Res.* **19**(9), 1266-1271. https://doi.org/10.5829/idosi.mejsr.2014.19.9.13662.

Compagno L J and Roberts T R (1982) Freshwater stingrays (Dasyatidae) of Southeast Asia and New Guinea, with description of a new species of Himantura and reports of unidentified species. *Environ. Biol. Fishes* **7**, 321-339. https://doi.org/10.1007/BF00005567.

Compagno L J V and Heemstra P C (1984) *Himantura draco* : A new species of stingray (Myliobatiformes: Dasyatidae) from South Africa, with a key to the Dasyatidae and the first record of *Dasyatis kuhlii* (Müller & Henle, 1841) from southern Africa. J.L.B. *Smith Institute of Ichthyology* special public. **33**, 1-17.

Froese R and Pauly D (2023) FishBase. *Urogymnus* Müller & Henle, 1837. Accessed through: World Register of Marine species at : https://www.marinespecies.org/aphia.php?p=taxdetails&id=206604 on 2023-07-12.

Gopalkrishnan A (2018) *Marine Fish Landings in India*. Technical Report, CMFRI, 1–16.

Ishihara H, Homma K, Takeda Y and Randall J E (1993) Redescription, distribution and food habits of the Indo-Pacific dasyatidid stingray Himantura granulata. *Japanese J. Ichthyol.* **40**(1), 23-28. https://doi.org/10.11369/jji1950.40.23 .

Jena S, Kalaiselvam M, Jayalakshmi S and Jena G (2023) Biodiversity of the ray fish along the southeast coast of India with their conservation status: A comprehensive overview. *Europ. Chem. Bull.* **12**, 1580-1591. https://doi.org/10.31838/ecb/2023.12. 4.121.

Johri S, Livingston I, Tiwari A, Solanki J, Busch A, Moreno I, Fellows R S, Doane M P and Dinsdale E A (2021) Reducing data deficiencies: Preliminary Elasmobranch fisheries surveys in India, identify range extensions and large proportions of female and juvenile landings. *Front. Mar. Sci.* **8**, 619695. https://doi.org/10.3389/fmars.2021.619695 .

Johri S, Solanki J, Cantu V A, Fellows S R, Edwards R A, Moreno I, Vyas A and Dinsdale E A (2019) 'Genome skimming'with the MinION hand-held sequencer identifies CITES-listed shark species in India's exports market. *Scientific Reports* **9**(1), 4476. https://doi.org/10.1038/s41598-019-40940-9.

Johri S, Tiwari A, Kerr E N and Dinsdale E A (2020) Mitochondrial genome of the Smoothnose wedgefish *Rhynchobatus laevis* from the Western Indian Ocean. *Mitochondrial DNA Part B* **5**(3), 2083-2084. https://doi.org/10.1080/23802359.2020.1765209.

Kottillil S, Gupta T, Manoharakrishnan M, Rao C and Shanker K (2023) Insights from catch composition and historical records of elasmobranchs in the Malvan fishery on the central west coast of India. *J. Fish Biol.* **2023**, 1-18. https://doi.org/10.1111/jfb.15416

Kumar R R, Venu S, Akhilesh K and Bineesh K (2021) Report of zonetail butterfly ray, *Gymnura zonura* (Bleeker, 1852) and mangrove stingray *Urogymnus granulatus* (Macleay 1883) (Chondrichthyes: Myliobatiformes) from Andaman waters, India. *Thalassas: An Int. J. Mar. Sci.* 1-9. https://doi.org/10.1007/s41208-021-00302-7.

Last P R, White W T, de Carvalho M R, Séret B, Stehmann F W and Naylor G J P (2016a) *Rays of the World*. Cornell University Press, Ithaca.

Last P R, Naylor G J and Manjaji-Matsumoto B M (2016c) A revised classification of the family Dasyatidae (Chondrichthyes: Myliobatiformes) based on new morphological and molecular insights. *Zootaxa* **4139**(3), 345-368. http://doi.org/10.11646/zootaxa.4139.3.2.

Last P, Naylor G, Séret B, White W, de Carvalho M and Stehmann M (2016b) *Rays of the World*. CSIRO publishing.

Last P R and Stevens J D (1994) *Sharks and Rays of Australia*. CSIRO, Australia, 1–513, col. pls. 1084.

Last P R and Compagno L J V (1999) Dasyatididae. stingrays. In : Carpenter K E and Niem V H (eds.). FAO species identification guide for fishery purposes. *The living marine resources of the Western Central Pacific*. Vol. **3**. Batoid fishes, chimaeras and bony fishes part 1 (Elopidae to Linophrynidae). FAO, Rom, p. 1479-1505.

Manjaji Matsumoto B M, White W T, Fahmi, Ishihara H and Morgan D L (2020) *Urogymnus granulatus* (amended version of 2016 assessment). *The IUCN Red List of Threatened species* 2020: e.T161431A177282313. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T161431A177282313 .en. Accessed on 07 July 2023.

Manjaji B M (2004) Taxonomy and phylogenetic systematics of the Indo-Pacific whip-tailed *Stingraygenus himantura* Muller & Henle 1837 (Chondrichthyes: Myliobatiformes: Dasyatidae). University of Tasmania.

Randall J and Van Egmond J (1994) Marine fishes from the Seychelles: 108 new records. *Zoologische Verhandelingen* **297**(3), 43-83.

Rastgoo A, Fatemi S, Valinassab T and Mortazavi M (2016) First report of mangrove whipray *Himantura granulata* (Macleay, 1883) from the Persian Gulf, Iran. *Iranian J. Fish. Sci.* **15**(3), 1224-1229.

Sutaria D, Parikh A, Barnes A and Jabado R W (2015) First record of the sandbar shark, *Carcharhinus plumbeus* (Chondrichthyes: Carcharhiniformes: Carcharhinidae) from Indian waters. *Marine Biodiversity Records* **8**, e126. http://doi.org/10.1017/S1755267215001025.

Tamura K, Stecher G and Kumar S (2021) *MEGA 11: Molecular Evolutionary Genetics Analysis*. Version 11. *Molecular Biology and Evolution.*

Worldbank (2020) Protecting India's Coastline: Gujarat. Available online at: https://www.worldbank.org/en/news/feature/2023/07/11/protecting-indiascoastline-gujarat.

ARTICLE Conference Proceedings | ISBN: 978-93-90996-06-3

Received 17th January 2022
Accepted 3rd March 2022

THE DIVERSITY OF SKATES AND RAYS FROM SAURASHTRA COAST-THE PENINSULAR REGION OF GUJARAT, INDIA

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Abstract
The super class Pisces makes up more than half of the 55,000 species of living vertebrates. Fishes are very diverse animals and can be categorised in many ways. Fish species diversity is roughly divided equally between marine (oceanic) and freshwater ecosystems. Elasmobranchs are among the largest of the marine fish species. Sharks, rays, skates, saw-fishes form a distinctive group of fishes that are collectively referred to as Elasmobranchs. The elasmobranch is a relatively less studied group of fishes. The study on elasmobranch diversity was carried out between December 2020 to November 2021 from the Saurashtra Coast – the peninsular region of Gujarat. The diversity study was carried out by frequent monthly visits to the major fish landings centres such as Okha, Porbandar, Mangrol, Veraval and Diu. The total skates and rays landed as regular fishing at near shore area fishing and incidental components by the three main gears, trawl net, drift net and hooks-and-lines. During the study, a total of 7 species of skates and 7 species rays were examined and identified morphologically and morphometrically. The IUCN status of the species was recorded and it was found that 2 species are Near Threatened, 3 species are Endangered, 3 species are Vulnerable, 4 species are Critically Endangered and 2 species are Data Deficient. The study provides the information of the diversity, distribution and globally IUCN status of the skates and rays found in Saurashtra region. The data will be helpful to fill up the data deficiency in elasmobranch diversity. This will eventually help in making the conservation policies for elasmobranch fisheries.

Key-words: *Elasmobranch, Skates, Rays, Diversity, Gujarat*

Introduction

The Indian Ocean covers approximately 29% of total ocean area ranks third largest ocean (Venkataraman & Raghunathan, 2015). India – a mega biodiversity nation is an integral and largest part of the central Indian Ocean region along with other countries Bangladesh, Indonesia, Maldives, Malaysia, Myanmar, Thailand and Sri Lanka (Gopi & Mishra, 2015). The mainland coastline is divided into two parts - Eastern and Western coastline. Gujarat state has the longest coastline of around 1,650 km i.e., 21% of the total coastline and 32% of total continental shelf of India with diverse coastal habitats situated on western part of the India (Joshi et al., 2017). The state of Gujarat, along the west coast of India, witnessed remarkable development in the marine capture fisheries sector. (Gopalkrishnan, 2018). Gujarat is bounded by the northwest Arabian Sea, naturally gifted with abundant marine fishery resources with a total of 306 species of marine and coastal fishes which includes rich Elasmobranch and Osteichthyes resources (Parmar et al., 2015; Solanki et al., 2016; Joshi et al., 2017; Joshi et al., 2018; Beleem et al., 2019; Raval et al., 2020; Sidat et al., 2021; Singh et al., 2021; Bhatt et al., 2022). It can be divided arbitrarily in four coastal stretches; Gulf of Kachchh, Saurashtra Coast, Gulf of Khambhat and South Gujarat Coast (Joshi et al., 2017). Gulf of Cambay, Gulf of Kachchh and Saurashtra peninsula have many major and minor fish landing centres. The Saurashtra – peninsular region of Gujarat covers the largest part of the total coastline around 750 kms and having around 7 major and several minor fish landing centres (Present Study).

In recent few decades, we have witnessed increased commercial interest in cartilaginous fishes,

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primarily due to the depletion of many bony fish stocks as well as the desire to obtain elasmobranch meat, cartilage, liver oil, and fins (Stehmann, 2002). The batoids constitute a significant group of cartilaginous fishes which includes skates and rays which are important for maintaining the sustainability of the marine ecosystems as middle to apex predators (Last et al., 2016). The skates and rays are bottom dwellers and thus play a vital role in soft-bottom and vegetated marine habitats by maintaining ecosystem services through predation and bio turbulation (Bhagyalekshmi & Kumar, 2021). In general, skates refer to large species with long snouts, and rays refer to smaller species with short snouts. The Skates and rays are contributing around 45-50 % of total elasmobranch catch (CMFRI, 2020). Rays and skates exhibit greater diversity of species than other elasmobranchs, they exhibit a relatively conservative dorso-ventrally flattened body morphologically and have an apparent preference for restricted habitats, as opposed to their restricted distribution and high number of endemic species (Ebert & Compagno, 2007). A hindrance in elasmobranch research in India is a lacking of comprehensive taxonomic studies and conclusive checklists. On regular interval basis documentation of elasmobranchs in respective niche and their taxonomy is an essential component for conservation and management of these declining resources (Akhilesh et al., 2014). The present study was designed to fulfil the lacuna of such information which reports an extended, updated checklist of batoids from the Saurashtra coast, together with comments on their taxonomic status, IUCN category and validity of occurrence.

Material and Methodology

The present investigation was carried out at the major fish landing centres of Saurashtra Coast *viz.* Okha, Porbandar, Mangrol, Veraval, Diu etc. The study was carried out between December, 2020 to November, 2021. During the study period, monthly field visits were carried out at all the selected landing centres for the elasmobranch's diversity (Figure 1).

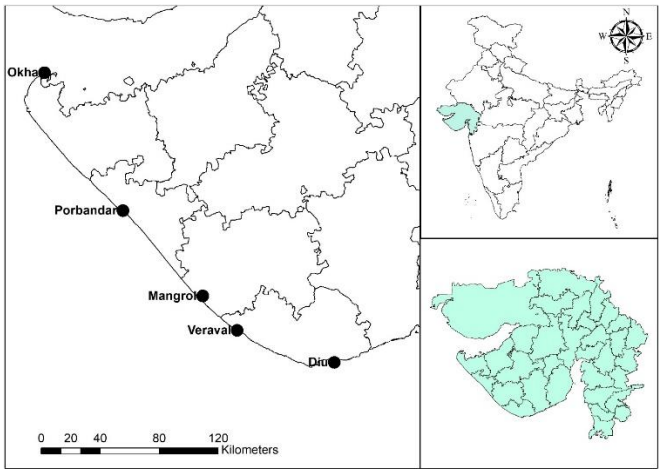

Figure.1 Map of Study area along the Saurashtra coast, Gujarat, India – Okha (22° 27' 02.26" N 69° 03' 52.03" E), Porbandar (21° 38' 35.01" N 69° 35' 26.77" E), Mangrol (21° 06' 45.92" N 70° 05' 34.18" E), Veraval (20° 54' 05.98" N 70° 22' 12.72" E) and Diu (20° 43' 09.72" N 70° 58' 58.58" E).

The interactions with local fishermen and boat owners were also carried out for the regular updates of the elasmobranch fishing activities. During the landing of the catch, specimens were segregated and carefully observed for unusual sightings. This activity was performed as some of the elasmobranchs are conserved under the Wildlife Protection Act, 1972. The selected specimen from the catch was put aside and on field photographic documentation was carried out. The morphological, morphometric and meristic characters were also recorded for further investigation. The identification was carried out using standard literatures, available keys and web portals (Day, 1878; Day, 1889; Jhingran, 1983; Compagno, L.J.V. 1999; Fricke et al., 2022; Froese & Pauly, 2022; WoRMS, 2022). The IUCN red list data was used to determine the conservation status of studied species (IUCN, 2022).

Result and Discussion

The present study reports a total of 14 species of batoids belonging to 3 orders, 7 families and 11 genera (Table 1). The family Dasyatidae Jordan & Gilbert, 1879 was found more diverse with five different species and five distinct genera followed by Rhinobatidae Bonaparte, 1835 (1 genus, 3 species); Torpedinidae Henle, 1834 (1, genus; 2 species). The remaining families i.e., Aetobatidae

Agassiz, 1858; Gymnuridae Fowler, 1934; Rhinidae Müller & Henle, 1841 and Glaucostegidae Last, Séret & Naylor, 2016 were consisting single genus and species (Figure 2a to 2n). Out of all the reported species, four species categorized as Critically Endangered (CR) followed by three Endangered (EN); three Vulnerable (VU); two Near Threatened (NT) and two Data Deficient (DD) as per IUCN Red Data List (IUCN, 2022). Akhilesh et al. (2014) prepared a checklist of 227 chondrichthyan species belonging to 11 orders and 41 families from Indian marine and coastal habitats. He also mentioned that 27 species (12%) have doubtful status with regard to their occurrence because their distributional range does not fall within Indian waters. Another study conducted by Tyabji et al., (2020) reported a total of 57 species of elasmobranchs which includes 36 species of sharks and 21 species of rays from the Andaman and Nicobar Islands, India. Singh et al., (2021) reported a total of 11 species of elasmobranchs with 6 species of batoids from Sutrapada coast of Gujarat, India. Zafaria et al., (2018) conducted a survey on elasmobranch diversity from territorial waters of Bangladesh and reported a total of 20 species which included 12 species of Batoids.

Systematics:

Class: Elasmobranch

Order: Myliobatiformes

Family: Aetobatidae Agassiz, 1858

Genus: *Aetobatus* Blainville, 1816

***Aetobatus flagellum* (Bloch & Schneider, 1801)**

Diagnosis: Disc rhomboid, much broader than longer; Head distinctly recognizable from the rest of the body; longitudinal groove between eyes on top of head which is extended to the midline of its shoulder; Floor of the mouth with a row of papillae. Outer corner of pectoral fins pointed; Skin naked (Figure 2a).

Colour: Upper surface of the disc and pelvic fins uniform dark greenish bronze coloured, without spots (Figure 2a).

Family: Gymnuridae Fowler, 1934

Genus: *Gymnura* van Hasselt, 1823

***Gymnura poecilura* (Shaw, 1804)**

Diagnosis: Disc rhombus-shaped, twice as broad as long; Tip of the snout projects slightly in angular form; Tail almost as long as disc with a small weak serrated spine at the proximal part; Low median ridge is present on both the sides of tail; Skin smooth (Figure 2b).

Colour: On dorsal side varies, generally various shades of grey with light greenish yellow reflection. Circular creamy - yellow spot scattered all over the dorsal surface. Ventral surface yellowish or whitish. Tail whitish with a broad blackish band, much wider than pale interspaces (Figure 2b).

Family: Dasyatidae Jordan & Gilbert, 1879

Genus: *Pateobatis* Last, Naylor & Manjaji-Matsumoto, 2016

***Pateobatis bleekeri* (Blyth, 1860)**

Diagnosis: Disc oval and flat; snout narrowly triangular; a large rounded tubercle in the middle of back and three smaller one before and three more behind; Tail more than 3 times longer than the disc, and is without cutaneous fold (Figure 2c).

Colour: Uniform dark - brown above, ventral surface white with broad dark - brown margin; increasing in area with age (Figure 2c).

Genus: *Brevitrygon* Last, Naylor & Manjaji-Matsumoto, 2016

***Brevitrygon walga* (Müller & Henle, 1841)**

Diagnosis: Snout pointed and acutely projecting; Disc sub circular, slightly longer than broad or as broad as long; Spiracles nearly equal to eyes; Mouth undulated with two buccal processes on floor of mouth; Tail whip like, slightly longer than disc length, without upper and lower cutaneous fold, with 1 or 2 large serrated spines; Inter-orbital space concave; A series of small spines between root of tail and caudal spine (Figure 2d).

Colour: Dull grey or brown above, whitish below (Figure 2d).

Table 1. Elasmobranchs collected from Coastal region of Saurashtra, Gujarat, India with IUCN Status of the species (IUCN, 2022).

Class/Order/Family/ Genus	Species	English Name	IUCN Status	Okha	Porbandar	Mangrol	Veraval	Diu
Elasmobranchii								
Myliobatiformes								
Aetobatidae Agassiz, 1858								
Aetobatus Blainville, 1816	*Aetobatus flagellum* (Bloch & Schneider, 1801)	long headed eagle ray	EN	P	A	A	A	A
Gymnuridae Fowler, 1934								
Gymnura van Hasselt, 1823	*Gymnura poecilura* (Shaw, 1804)	Long tail butterfly ray	VU	P	A	A	P	A
Dasyatidae Jordan & Gilbert, 1879								
Pateobatis Last, Naylor & Manjaji-Matsumoto, 2016	*Pateobatis bleekeri* (Blyth, 1860)	Bleeker's whipray	EN	P	A	A	A	A
Brevitrygon Last, Naylor & Manjaji-Matsumoto, 2016	*Brevitrygon walga* (Müller & Henle, 1841)	Scaly whipray	NT	P	P	P	P	P
Maculabatis Last, Naylor & Manjaji-Matsumoto, 2016	*Maculabatis gerrardi* (Gray, 1851)	Sharpnose stingray	EN	A	A	P	P	P
Pastinachus Rüppell, 1829	*Pastinachus ater* (Macleay, 1883)	Broad cow tail ray	VU	P	P	A	P	A
Taeniura Müller & Henle, 1837	*Taeniura sp.*		DD	P	A	A	A	A
Rhinopristiformes								
Rhinobatidae Bonaparte, 1835								
Rhinobatos Linck, 1790	*Rhinobatos annandalei* Norman, 1926	Annandale's guitarfish	CR	A	P	A	P	A
	Rhinobatos lionotus Norman, 1926	Smoothback guitarfish	CR	A	P	P	A	A
	Rhinobatos punctifer Compagno & Randall, 1987	Spotted guitarfish	NT	P	A	P	A	A
Rhinidae Müller & Henle, 1841								
Rhynchobatus Müller & Henle, 1837	*Rhynchobatus djiddensis* (Forsskål, 1775)	Giant guitarfish	CR	A	P	P	A	A
Glaucostegidae Last, Séret & Naylor, 2016								
Glaucostegus Bonaparte, 1846	*Glaucostegus granulatus* (Cuvier, 1829)	Granulated guitarfish	CR	P	P	P	P	A
Torpediniformes								
Torpedinidae Henle, 1834								
Torpedo Duméril, 1806	*Torpedo sinuspersici* Olfers, 1831	Variable torpedo ray	DD	P	P	A	P	A
	Torpedo marmorata Risso, 1810	Marbled electric ray	VU	P	A	A	A	A

Genus: *Maculabatis* Last, Naylor & Manjaji-Matsumoto, 2016
***Maculabatis gerrardi* (Gray, 1851)**

Diagnosis: Disc slightly wider than long; Snout forms widely obtuse angle; Tail several times longer than disc; Tail without upper or lower folds (Figure 2e).

Colour: Dorsal surface of disc brown or grey, with obscure pale spots. Tail banded (Figure 2e).

Genus: *Pastinachus* Rüppell, 1829
***Pastinachus ater* (Macleay, 1883)**

Diagnosis: Broad rhombic disc; Dense band of blunt denticles form wide band on central disc in adults; Small heart-shaped or starry based thorns on mid-shoulder; Usually four small thorns on shoulder often barely larger than surrounding denticles; Small eyes with wide inter orbital space; Mouth small; Nostrils slit like; Snout short, blunt, with small lobe at tip and without denticles; Very broad tail base, flattened anteriorly, becoming more cylindrical distally, about twice disk width or less, with a posteriorly located sting, the ventral skin fold is very deep but does not reach the tail apex. Pelvic fins large, tips narrowly rounded (Figure 2f).

Colour: Uniform dark greyish brown to black dorsally, often with fine black edge around disc and pelvic fin, white ventrally. Tail fold and tail tip black under surface white, ventral tail with black areas before sting (Figure 2f).

Genus: *Taeniura* Müller & Henle, 1837
Taeniura sp.

Diagnosis: Disc rounded, with head not distinct from it; Tail compressed, longer than body, with mid-caudal serrated spines and without any lateral folds; Mouth with buccal processes; No rostral cartilage; Spiracles wide, behind eyes; five pairs of gill openings on ventral side; Dorsal fins absent; Anal fin absent (Figure 2g).

Colour: Skin smooth in young. Greyish brown dorsally, whitish below; pectorals and pelvics with black edges (Figure 2g).

Figure 2. Ray fishes found from the Saurashtra Coast, Gujarat, India: (a) *Aetobatus flagellum* (Bloch & Schneider, 1801), (b) *Gymnura poecilura* (Shaw, 1804), (c) *Pateobatis bleekeri* (Blyth, 1860), (d) *Brevitrygon walga* (Müller & Henle, 1841), (e) *Maculabatis gerrardi* (Gray, 1851), (f) *Pastinachus ater* (Macleay, 1883), (g) *Taeniura sp.*

Order: Rhinopristiformes
Family: Rhinobatidae Bonaparte, 1835
Genus: *Rhinobatos* Linck, 1790
***Rhinobatos annandalei* Norman, 1926**

Diagnosis: Snout moderate, bluntly pointed, rostral ridges separated, spiracles close behind eye, equal to eye diameter; First dorsal fin well behind pelvic fin; Series of small spines in middle of back; Two skinny flaps on hind margin of spiracles; Nasal valves extending onto internarial space (Figure 2h).

Colour: Body greyish-brown, with indistinct marbling of darker shade and with numerous, round, whitish spots. Ventral surface of body white (Figure 2h).

***Rhinobatos lionotus* Norman, 1926**

Diagnosis: Snout moderate, bluntly pointed, margins scarcely concave; Teeth small, with transverse ridges strongly convex, conical, with flattened base; Spiracles smaller than eye, close behind it, with folds both on front and hind edges; Five pairs of ventral gill openings; Two spineless, dorsal fins; First dorsal origin behind pelvics, at a distance equal to inter-dorsal; Skin with minute denticles, smooth to touch (Figure 2i).

Colour: Uniform brownish grey and whitish below (Figure 2i).

***Rhinobatos punctifer* Compagno & Randall, 1987)**

Diagnosis: disc wedge-shaped; snout relatively short; nostrils weakly oblique; mouth narrow; posterior nasal flaps broad; two spiracular folds, outermost fold slightly taller than inner fold; ridges of rostral cartilage almost parallel, converging slightly anteriorly but not constricted medially; anterior cartilage subtriangular to sickle shaped, usually blunt posteriorly (Figure 2j).

Colour: Dorsal highly variable, plain brownish to greenish brown, faintly or strongly marked with small white spots; the posterior half of dorsal and caudal fins usually dusky or blackish; snout with a pale or dusky tip (Figure 2j).

Family: Rhinidae Müller & Henle, 1841
Genus: *Rhynchobatus* Müller & Henle, 1837
***Rhynchobatus djiddensis* (Forsskål, 1775)**

Diagnosis: Rostrum short, not saw like; Snout triangularly pointed; Mouth strongly undulated, with three forward projections on the lower jaw; Body elongated; First dorsal fin triangular, its origin about opposite to pelvic fin; Spiracles with two cutaneous folds; Row of small tubercles along anterior and inner margins of the orbit and spiracles; Lower caudal lobe short; Tail depressed and nearly equal to trunk (Figure 2k).

Colour: A large black ocular spot on the pectoral fin base. Olive green above with rows of white spots on the upper body, lower surface grey-white (Figure 2k).

Family: Glaucostegidae Last, Séret & Naylor, 2016
Genus: *Glaucostegus* Bonaparte, 1846
***Glaucostegus granulatus* (Cuvier, 1829)**

Diagnosis: Snout elongated; rostral ridges jointed; First dorsal fin well behind pelvic fin; tubercles on the back and a row of compressed spines along its middle, which become obsolete with age; Spiracles slightly smaller than the eye (Figure 2l).

Colour: Reddish grey superiorly becoming dull white beneath (Figure 2l).

Order: Torpediniformes
Family: Torpedinidae Henle, 1834
Genus: *Torpedo* Duméril, 1806
***Torpedo sinuspersici* Olfers, 1831**

Diagnosis: Disc subcircular, broader than long; Snout short, greater than width of mouth and interorbital, subtruncate; Nostrils small, as wide as space between them; Electric organs between head and pectorals; Pelvics moderate, subtriangular; Two small, narrow, non-spinate dorsals, with inner angles rounded, second dorsal a little smaller than the first; No serrated caudal spine; No anal fin; Tail not whip-like, short; Caudal deeper than long, subtruncate, angles rounded; No caudal pits; Skin smooth (Figure 2m).

Colour: Rusty brown above with large dusky spots as large as or larger than spiracles; whitish below, darker below edges of disc and fins (Figure 2m).

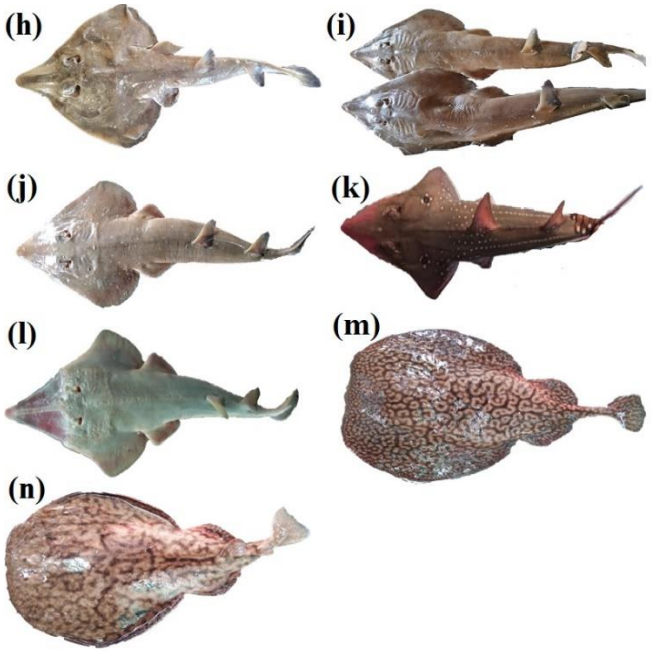

Figure 2 (cont.). **Skate** fishes found from the Saurashtra Coast, Gujarat, India: (h) *Rhinobatos annandalei* Norman, 1926, (i) *Rhinobatos lionotus* Norman, 1926, (j) *Rhinobatos punctifer* (Compagno & Randall, 1987), (k) *Rhynchobatus djiddensis* (Forsskål, 1775), (l) *Glaucostegus granulatus* (Cuvier, 1829), (m) *Torpedo sinuspersici* Olfers, 1831, (n) *Torpedo marmorata* Risso, 1810

***Torpedo marmorata* Risso, 1810**

Diagnosis: Disc broader than long; Short tail; Spiracle separates from eye, with a number of small fleshy tentacles on hind margin; Mouth narrow, without a groove below the lower jaw; Jaws slender with small mono-cuspid teeth; Two dorsal fins, first dorsal fin larger than the second, first dorsal completely over the pelvic base; Caudal somewhat rounded, upper and lower caudal lobes well developed (Figure 2n).

Colour: Dorsal surface with brown reticulations; ventral surface with a brown edge around the disc and lower surface white (Figure 2n).

Conclusion

In present study, it was found that the Saurashtra coast consists approximately 7% of total elasmobranch species found in India. It also records approximately 17% of total families found in Indian waters. Overall, the study recorded rich biodiversity of elasmobranchs. This data will be useful for the regulation and management of these protected species in fisheries sector. The present study also emphasizes the further research on the ecology, biology and conservation measures with necessary permissions.

Conflict of interests

The authors declare that they have no conflicts of interest.

Acknowledgement

The authors would like to thank Head, Department of Zoology, The Maharaja Sayajirao University of Baroda, Vadodara for providing laboratory facilities. Authors would like to thank Dr. Imtiaz Beleem, Mr. Jaydeep Barad, Mr. V. K. Gohel, Mr. Tarachand Kumavat, Mr. Sukar Anjani and local fishermen for their valuable help during the field surveys. Miss. Jalpa Jadeja is thankfully acknowledged for helping in map preparation. First and Second authors would like to thank SHODH - Scheme of Developing High quality research, Education Department, Gujarat State for providing fellowship for the Ph. D. research.

References

Addison, P.F.E., Koss, R.S., & O'Hara, T.D. (2008). Recreational use of a rocky intertidal reef in Victoria: implications for ecological research and management. Australasian Journal of Environmental Management, 15, 169-179.

Cox, T.E., Baumgartner, E., Philippoff, J. & Boyle, K.S. (2011). Spatial and vertical patterns in the tidepool fish assemblage on the island of O'ahu. Environ. Biol. Fish., 90, 329–342.

Cunha, E.A., Carvalho, R.A.A., Monteiro-Neto, C., Moraes, L.E.S. & Araújo, M.E. (2008). Comparative analysis of tidepool fish species composition on tropical coastal rocky reefs at State of Ceará, Brazil. Iheringia, Séries Zoologia, Porto Alegre, 98(3) 379–390.

Davenport, J., & Davenport, J.L. (2006). The impact of tourism and personal leisure transport on coastal environments: A review. Estuarine, Coastal and Shelf Science, 67, 280-292.

Fairweather, P.G. (1988). Predation Creates Halos of Bare Space among Prey on rocky seashores in New South Wales. Australian Journal of Ecology, 13, 401-409.

Firth, L.B. et al., (2014). Biodiversity in intertidal rockpools: Informing engineering criteria for artificial habitat

enhancement in the built environment. Marine Environmental Research, 102, 122-130.

Gibson, R.N. (1972). The vertical distribution and feeding relationships of intertidal fish on the Atlantic coast of France. Journal of Animal Ecology, 41, 189–207.

Gibson, R.N. (1982). Recent studies on the biology of intertidal fishes. Mar. Biol. Ann. Rev., 20, 363–414.

Griffiths, S.P. (2003). Rockpool Ichthyofaunas of Temperate Australia: Species Composition, Residency and Biogeographic Patterns. Estuarine, Coastal and Shelf Science, 58, 173–186.

Griffiths, S.P., Davis A.R. & West, R.J. (2006). Role of habitat complexity in structuring temperate rockpool ichthyofaunas. Marine Ecology Progress Series, 313, 227–239.

Griffiths, S.P., West R.J. & Davis A.R. (2003). Effects of Intertidal Elevation on the Rockpool Ichthyofaunas of Temperate Australia. Environmental Biology of Fishes, 68, 197–204.

Jefferson, R.L., Bailey, I., Laffoley, D.d'A., Richards, J. P. & Attrill, M. J. (2014). Public Perceptions of the UK, Marine Environment. Marine Policy, 43, 327-337.

Jones, G.P. (1984). The influence of habitat and behavioural interactions on the local distribution of the wrasse, *Pseudolabrus celidotus*. Environmental Biology of Fishes, 10, 43–57.

Kemp, J.O.G. (2009). Effects of temperature and salinity on resting metabolism in two South African rock pool Fish: The Resident Gobiid *Caffrogobius Caffer* and the Transient Sparid *Diplodus sargus capensis*. African Zoology, 44, 151–158.

Macieira, R.M. & Joyeux, J. C. (2011). Distribution patterns of tidepools fishes on a tropical flat reef. Fishery Bulletin, 109, 305-315.

Martens, L. (2015). From intergenerational transmission to intra-active ethical-generational becoming: Children, parents, crabs and rock pooling. Families, Relationships and Societies, 5, 447-462.

Martins, G.M., Hawkins, S.J., Thompson, R.C., Jenkins, S.R. (2007). Community structure and functioning in intertidal rock pools: effects of pool size and shore height at different successional stages. Marine Ecology Progress Series, 329, 43–55.

Metaxas, A., & Scheibling, R.E. (1993). Community structure and organization of tidepools. Marine ecology progress series, 98, 187-198.

Methratta, E.T. (2004). Top-down and bottom-up factors in tidepool communities. Journal of Experimental Marine Biology and Ecology, 299, 77-96.

Moran, M. J. (1985). The timing and significance of sheltering and foraging behaviour of the predatory intertidal gastropods *Morulamarginalba* Blanville (Muricidae). Journal of Experimental Marine Biology and Ecology, 93, 103-114.

Paine, R.T. (1974). Intertidal community structure, Experimental studies on the relationship between a dominant competitor and its principal predator. Oecologia, 15, 93–120.

Phillips, J.A. (2001). Marine macroalgal biodiversity hotspots: why is there high species richness and endemism is southern Australian marine benthic flora? Biodiversity & Conservation, 10, 1555-1577

Pinn, E.H. & Rodgers, M. (2005). The influence of visitors on intertidal biodiversity. Journal of the Marine Biological Association of the United Kingdom, 85, 263-268.

Fairchild, T.P., Mike, S.F., Sabine, P. & Griffin J. N. (2018). Multiple dimensions of biodiversity drive human interest in tide pool communities. Scientific reports, 8, 15234.

Tsering, L., Pawar H.B., Sreepada, R.A., Sanaye, S.V. & Suryavanshi, U., Tanu. (2012). Ichthyofaunal diversity and ecology of intertidal rock pools of Goa, West Coast of India. Fishing Chimes, 32, 56– 59.

Underwood, A.J. & Jernakoff, P. (1984). The effects of tidal height, wave-exposure, seasonality and rock-pools on grazing and the distribution on intertidal macroalgae in New South Wales, Australia. Journal of Experimental Marine Biology and Ecology, 75, 71-96.

Underwood, A.J. & Skilleter, G.A. (1996). Effects of patch-size on the structure of assemblages in rock pools. Journal of Experimental Marine Biology and Ecology, 197, 63–90.

Wyles, K. J., Pahl, S., Holland, M. & Thompson, R. C. (2017). Can Beach Cleans Do More Than Clean-Up Litter? Comparing Beach Cleans to Other Coastal Activities. Environmental and Behavior, 49, 509-535.

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Catch composition of Ray fishes (Elasmobranchii, Batoids) from Gujarat. Coast, India.

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TO WHOM SO EVER IT MAY CONCERN

This is to certify that **Mr. Ajay Ukabhai Baldaniya** [FoS/2212], Ph. D. Fellow of the Department of Zoology, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara has worked as research trainee at Fisheries Research Centre, Sikka, Gujarat from 27/10/2022 to 05/11/2022 [10 Days]. During, his training period, Mr. Baldaniya has actively participated in the field surveys for the coastal bio-diversity, ecological studies and fish landing studies. He has learned ecological study design, methods of field data collection, fishing activities, post harvesting process of elasmobranchs, laboratory work, data analysis and scientific writing. Overall, I found Mr. Baldaniya very hardworking and passionate researcher. I wish him best wishes for his bright future.

Hitesh

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