

TAXONOMIC RECORDS OF *TENGUELLA GRANULATA* (DUCLOS, 1832) AND *TENGUELLA CEYLONICA* (DALL, 1923) (MOLLUSCA: GASTROPODA: MURICIDAE) FROM ALIBAG, RAIGAD, MAHARASHTRA ON THE WEST COAST OF INDIA

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ABSTRACT

In this paper, we report the new distributional records of *Tenguella granulata* (Duclos, 1832) and *Tenguella ceylonica* (Dall, 1923) from the rocky shore of Alibag, district Raigad, Maharashtra, west coast of India. The comparison of both species with respect to shell morphology, operculum, SEM of radula and penis anatomy is presented in the present work. This paper provides a comparative comprehensive taxonomic description of both species for taxonomic purposes.

Keywords: *Tenguella*, *Muricidae*, *New Distributional Record*, *Indo-West Pacific*, *Alibag*

INTRODUCTION

Muricidae is a family of diverse carnivorous marine snails with more than thousands living and fossil species all over the world commonly known as muricids or murex. They are generally abundant on intertidal rocky shores playing an ecologically important role as predators (Barco *et al.*, 2010, 2012). Being terminal carnivores they feed on molluscs, barnacles and other varieties of prey (Subba Rao 1993). As per the recent classification by Bouchet *et al.*, (2017), family Muricidae Refinesque, 1815 comprises 12 subfamilies. The Muricids of Family Muricidae are common Neogastropods with a valid number of genera or subgenera of 200 and valid number of total species or subspecies as 1763 (Houart, 2018).

Since the first decade of 19th century, several reports of few species of family Muricidae were there from India (Annandale and Kemp 1916; Cheriyan 1968; Crichton 1941; Gravely 1927, 1942; Hornell 1921, 1941; Melvill 1893, 1898, 1928; Melvill and Standen 1898, 1899, 1901, 1903; Melvill and Sykes 1897, 1898; Menon *et al.*, 1961; Nevill 1875; Preston 1904, 1909, 1910, 1914, 1916; Ray 1948, 1977; Satyamurti 1952; Smith 1878, 1894, 1899, 1903, 1904, 1906; Subrahmanyam *et al.*, 1952; Subba Rao and Mookherjee 1975; Atapattu 1972; Surya Rao and Subba Rao 1991). But, the first comprehensive report of the Muricidae family as whole from India was given by N. V. Subba Rao and K. V. Surya Rao in 1993 in the occasional paper no. 153 of ZSI, India. In this paper they reported a total 99 species under 7 subfamilies and 28 genera from seas around India. Again, after this, many researchers have worked on the individual reports of a few species from different coasts of India (Subba Rao *et al.*, 1995, Tan and Singurdsson 1996, Vishvakiran 1999, Subba Rao 2000, 2003, 2005; Tewari *et al.*, 2002, Dutta *et al.*, 2008, 2010; Stella and Raghunathan 2009, Kurve and Kurve 2010, Joshi *et al.*, 2013, Houart 2011, Kumbhar and Rivonkar 2012, Houart *et al.*, 2013, Palanisamy and Khan 2012, Pawar 2012, Rao *et al.*, 2013, Sussan *et al.*, 2012, Shaikh and Bhalerao 2012).

In 2015, Tripathy and Mulkhopadhyaya updated that, the family is represented in India with 7 sub-families, 25 genera, 8 sub-genera and 89 species. Many researchers further studied muricids across India (Ravinesh and Bijukumar, 2015; Ravi Kumar *et al.*, 2015; Ravichelvan *et al.*, 2015; Sary and Pramod Kiran, 2016; Stella *et*

al., 2015; Ravi Kumar et al., 2017; Hourt, 2017; Pawar et al., 2017; Kantharajan et al., 2017; Salas et al., 2018; Marimuthu and Tripathy, 2018; Ravinesh et al., 2021 and Hourt, 2021.) Some of them have studied the western region of Maharashtra with respect to Muricidae; however, regions of Konkan, especially Raigad district have lesser studies of muricid taxonomy. The intertidal marine coastal diversity of Alibag shore including marine muricid rock snails were studied earlier sporadically by various scientists (Tan and Singurdsson 1996, Khade and Mane 2012, Pawar 2012) but still there is much more yet to be reported.

The subfamily Ergalataxinae was introduced in 1971 by Kuroda, Habe & Oyama with only 3 to 4 genera which now has valid 22 genera with valid 149 species (Houart 2018). Claremount et al., (2012) resurrect the genus *Morula* to *Tenguella* confirming its belonging to subfamily Ergalataxinae. Genus *Tenguella* Arakawa, 1965 has 7 known species with major distribution in the Indo-West Pacific region (Houart et al., 2019). Out of 7 species, two species namely *Tenguella granulata* (Duclos, 1832) and *Tenguella ceylonica* (Dall, 1923) have been reported earlier from India (Subba Rao 1993, Houart 2017). *Tenguella granulata* occurs commonly on most of the east and west coasts of India, it is highly common in tropical Indo-Pacific region (Cernohorsky 1967, Subba Rao 1993). *Tenguella ceylonica* from Chennai, Tamilnadu of India was studied by Houart, 2017. Recently, we found live specimens of *Tenguella granulata* (Duclos, 1832) and *Tenguella ceylonica* (Dall, 1923) from the rocky shore of Alibag, district Raigad, Maharashtra, west coast of India. Further the paper provides detailed comparative study of both species with respect to shell morphology, operculum, radula and penis anatomy.

MATERIALS AND METHODS

Abbreviations

For Museums and websites BNHS: Bombay Natural History Society, Mumbai, India; MNHN: Muséum national d'Histoire naturelle, Paris, France; WoRMS: World Register of Marine Species; GBIF: Global Biodiversity Information Facility; *For Shell Morphology* SL: Shell Length; SW: Shell Width; SP: Sub-sutural cord; IP: Infra-sutural cord; IR: Infra-sutural ramp; SC: Siphonal Canal; P1: Shoulder Cord; P2-P5: Primary Cords of the convex part of the teleoconch whorl; D1-D4: Abapical denticles; N: Nucleus; *For Radular details* CC: Central Cusp; Ld: Lateral Denticle; Lc: Lateral Cusp; Md: Marginal Denticle; Mc: Marginal Cusp; LT: Lateral Teeth, *For Operculum morphology* OL: Operculum length; OW: Operculum width; n: Nucleus; MG: Marginal growth; CE: Columellar edge; LE: Labial edge; StE: Sutural edge; SpE: Siphonal edge.

Study area

Alibag is a small coastal fishing town in district Raigad of Maharashtra on the west coast of India. Alibag is a long, open sandy beach (18°63'90" N, 72°87'21" E) with few isolated but prominent rocky patches. The rocky patch between Varsoli and Alibag beach encounters heavy water current only during high tide with moderate force. Based on personal observations we found that the area is mainly covered by edible



Figure 1: A, Habitat of *Tenguella granulata* (Duclos, 1832) and *T. ceylonica* (Dall, 1923) at intertidal rocky shore of Alibag (18°38'58"N, 72°51'47"E), Maharashtra, India completely covered with oysters bed *Saccostrea cucullata* (Born, 1778). B, Live *Tenguella ceylonica*, indicated by an arrow, within its habitat. C. Live *Tenguella granulata* indicated by an arrow, within its habitat.

oyster beds followed by rock snails, chitons, crabs and other crustaceans, sea anemones, brittle star, barnacles, red-green algae with diverse macrobenthos.

Taxon Sampling

The specimens were collected by hand from intertidal rocky patches of the Alibag coast during low tide in June 2020 (18°38'58''N, 72°51'47''E). The habitat of the collected specimens is mainly rocky substratum having a dense bed of edible oyster *Saccostrea cucullata* (Born, 1778) (Figure 1A). Live animals were photographed in the field before collection (Figure 1B). The animals were washed thoroughly with marine water, preserved in 95% ethanol and voucher specimens are housed in the museum of Bombay Natural History Society (BNHS).

Morphological analysis for primary identification

A stereomicroscope (Carl Zeiss ZEISS Stemi 2000C, Germany) was used to observe shell and operculum morphology for each specimen included in the study. A digital Vernier calliper (accurate to 0.1 mm) was used for shell measurements. Photographs of the shell were taken with Canon EOS 700 D. Primary morphological identifications were confirmed by using reference keys of Houart (2017), Houart *et al.*, (2019), Tan (1995) along with accessing the taxonomic information from WoRMS (<http://www.marinespecies.org/aphia.php?p=taxdetails&id=716639>).

Global Distribution map creation using R software

The Global Distribution maps were created using open-source component R software with R version 4.2.1(2022-06-23 ucrt) and R studio 2022.07.2 Build 576. The global distribution data with only preserved specimen and fossil records having latitude and longitude data were downloaded from GBIF for *Tenguella granulata* in .csv file format. Similarly, the global distribution data including all records with or without latitude and longitude data in .csv file format were taken from GBIF and Houart 2017 research article for *Tenguella ceylonica*. This data with Alibag specimen coordinates were imported in R software and processed with R programming commands for getting red spots for earlier distribution, red hollow square spots for without lat long mentions and blue spot for present distribution display.

RESULTS

Systematics

Family Muricidae Refinesque, 1815

Subfamily Ergalataxinae Kuroda, Habe & Oyama, 1971

Genus *Tenguella* Arakawa, 1965

Type species (type by original designation): *Tenguella granulata* (Duclos, 1832) Indo-West Pacific.

Tenguella granulata (Duclos, 1832)

(Figure 2, A and B)

Synonymy

1832	<i>Purpura granulata</i>	Duclos	Annales des Sciences Naturelles	26: p. 111, pl. 2, fig. 9
1832	<i>Purpura tuberculata</i>	Blainville	<i>Nouvelles Annales du Muséum d'Histoire Naturelle</i>	1: p. 204, pl. 9 fig. 3
1835	<i>Purpura tuberculata</i> var. <i>cingulifera</i>	Kiener	<i>Famille des Purpurifères</i>	pl. 5 fig. 10a

Vernacular name: Mulberry shell, Granulated drupe

Type locality: Australia

Examined material: Lectotype of *Purpura granulata* (image examined from Houart *et al.*, 2019: fig. 23). 4 syntypes of *Purpura tuberculata* Blainville, 1832 (image examined from National Museum of Natural History, Paris, France; Collection: Molluscs (IM); Catalogue number: MNHN-IM-2000-777). 1 specimen of *Tenguella granulata* (Duclos, 1832) from Papua New Guinea, Papua Niugini, stn PR214, 08/12/2012, 1-8 m (no other information), MNHN (image examined from National Museum of Natural History, Paris, France; Collection:

Molluscs (IM): Catalogue number: MNHN-IM-2018-5291). 1 specimen of *Tenguella granulata* (Duclos, 1832) from Vanuatu, SANTO, stn RAP15, 15°36,6'S, 167°01'E, 2 m, MNHN (image examined from National Museum of Natural History, Paris, France; Collection: Molluscs (IM): Catalogue number: MNHN-IM-2018-5284).

Other material: 1 Voucher specimen of *Tenguella granulata* (Duclos, 1832) preserved in museum of Bombay Natural History Society (BNHS), Mumbai, India; Catalogue number: BNHS_Gastro 2159a.

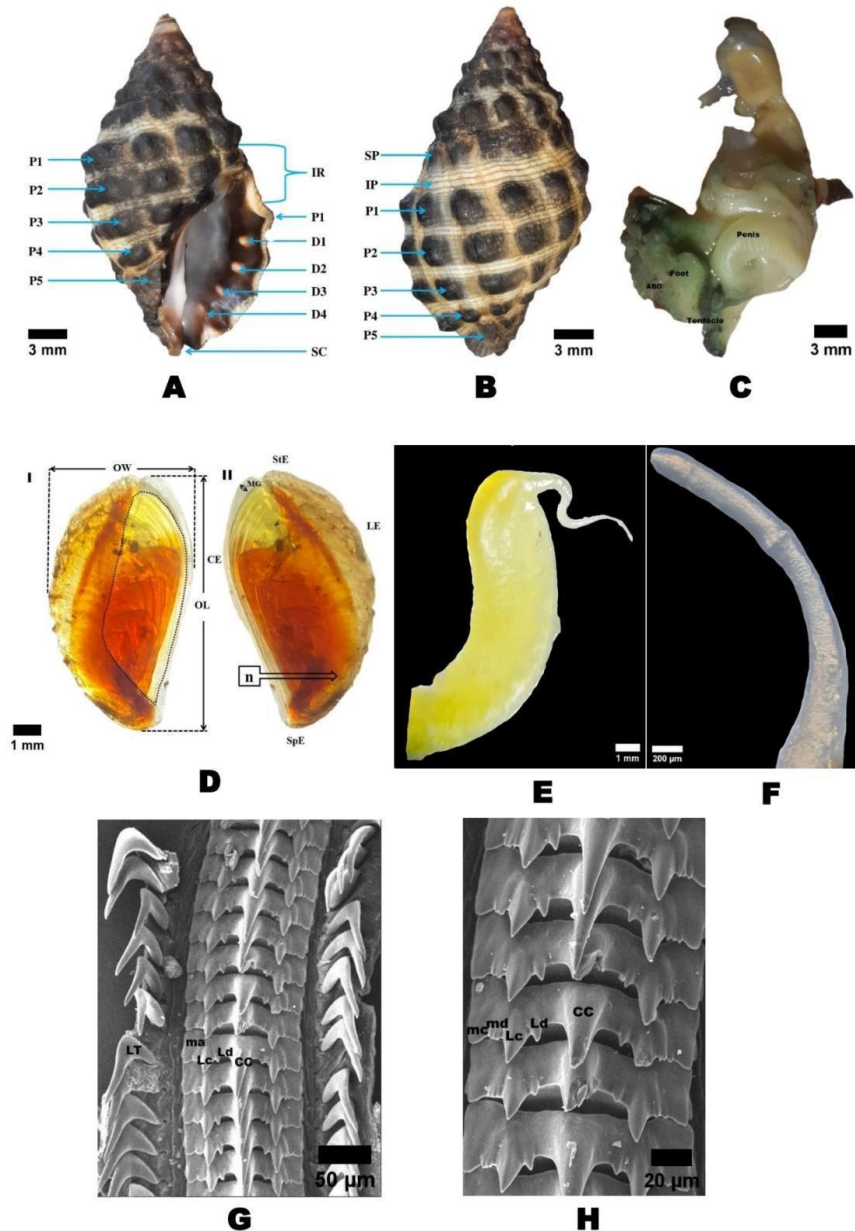


Figure 2: *Tenguella granulata* (Duclos, 1832), SL 26 mm, SW 14 mm, SL/SW ratio 1.85, Voucher Specimen (BNHS Gastro 2159) preserved in museum of Bombay Natural History Society (BNHS) (A) Ventral View (B) Dorsal View (C) Dissected animal soft body part showing penis (D) Operculum I) Internal Surface showing length (OL= 9 mm) and width (OW= 4.76 mm) with operculigerous disc by dotted line. II) External surface showing position of nucleus and growth lines. (MG = 0.52 mm) (E) Penis (F) Penis Tip (G) SEM Radula scale bar 50 µm (H) SEM Radula scale bar 20 µm.

Diagnosis: *Tenguella granulata* (Duclos, 1832)

Shell: Figure 2; A and B, SL 26 mm, SW 14 mm, SL/SW ratio 1.85. (Shell spiral cord and denticle labelling pattern as per Merle D. 2001) Strong, globose, oblong, conical and heavy shell with high spire without varices. Acute granulations are rounded at the base creating transverse lines of distinct blunt ebony black nodules. Tiny spiral cords span between these lines. Shell colour whitish grey with dark brown to black at nodules. Protoconch incomplete. Teleoconch of approximately 4 to 5 weakly convex whorls, suture appressed, obscure up to penultimate whorl, evident on body whorl, undulate; sub-sutural cord (SP) followed by broad infra-sutural ramp (IR) (between SP and P1) and 5 rows of other squarish, hilly tubercles from the shoulder gradually becoming obsolete forward (P1 to P5). Infra-sutural ramp is strongly sloping and concave. Body whorl is spirally sculptured with 3 to 5 finely scabrous, small, equal cords between the nodules and over the rest of the surface. Aperture narrow, oval, with 4 to 5 equal sized, whitish cream denticles with blackish purple right ridge edge; outer lip thickened, margin weakly crenulated with fine, blunt spiral cord ends. Aperture interior purple whitish and outer lip with blackish to creamy white lustering texture. Columella white, smooth without any fold. Brownish purple tinge on middle to upper columella. Anterior canal is short, slender, straight narrow and slightly longer than the posterior. Posterior canal is short and wider. Parietal denticle not prominent.

Operculum: Figure 2; D, I) Internal Surface (OL = 9 mm), (OW = 4.76 mm). II) External surface (MG = 0.52 mm). (Labelling style as per Paulo Vasconcelos et. al., 2012) Operculum corneous, concentric, roughly oval, rigid (shape fitting the aperture), flattened. Nucleus basal towards the siphonal edge slightly turned to the left. Reddish brown in colour with multiple lines of growth. The internal surface shows the attachment area, the noticeable operculigerous disc shown in the figure by dotted lines. The external surface exhibits nucleus location, growth lines and marginal growth details.

Radula: Figure 2; G and H. (The radular labelling pattern as per Herbert G. S. 2015 and Houart R. 2019) Typically rachiglossate type radula with formula 1+R+1. The entire radula measures about 8 mm in length in its fully stretched form which is nearly 30% of the length of the shell, having approximately 191 transverse rows of teeth. This radula is characterised by a large central 3D rachidian tooth, flanked by a pair of marginal teeth. Rachidian teeth with broader base, cutting edge is fringed with a long, moderately broad, sharply pointed, protruding, conical, sickle shaped central cusp (CC) projecting with 90° angle from the base; very small, narrow conical lateral denticle (Ld) pointing more towards central cusp making around 45° angle from the base, situated just at the root of lateral cusp separated by a notch from the base of lateral cusp; moderately long, pointed with broader base, triangular shaped lateral cusp (Lc) projecting with 70° angle from the base, around half the height of central cusp, slightly outwardly radiated lateral cusp giving ‘V’ shape to the rachidian tooth, wide marginal area (MA) with distinguishable marginal fold having three marginal denticles (md) and bipartite marginal cusp (mc). Marginal cusp blunt ended projecting 50° angle from base coplanar with lateral cusp. Lateral teeth (LT) half-moon shaped with broader base and tapering pointed tip.

Animal: Animal description and penis anatomy

Animal Description - Figure 2; C. The soft body of the animal is having remarkable pigmentations. The sole of the foot has whitish and greenish subcutaneous pigmented grains. Whitish pigmentation is more at the central part of the foot and greenish pigmentation sparsely found more towards boundaries of the foot. ABO is located to the dorsal side of the ventral pedal gland in females. Edge of the sole is marked by multiple light to dark green, whitish and blackish pigmented grains. The sides of the foot are densely blackish below tentacles and light to dark greener edges throughout. The tentacles are with greenish and whitish pigments at the base, black and white pigmented bands surrounding the eyes which are black dots.

Penis Anatomy - Figure 2; E and F. PL- 9 mm. Penis large, muscular, thick, strongly curved, dorsoventrally flat basal portion with long and thin distal portion marked by long flagelliform tip. (Wu S. K. 1973) The greenish yellow coloured pigments are present at the basal portion while the slight yellowish white colour is observed at the distal part of the penis body. Penis flagellum is white in colour and 3/4th the length of penis body. Penial flagellum tip has a small connection like structure attached at the end. This attachment has a little swollen base and tapering apex.

Global distribution: Figure 3. *Tenguella granulata* is a well-known and very common Indo-west Pacific type species of genus *Tenguella*. The type localities are *Purpura granulata* from Australia, *Purpura tuberculata* from Red sea and Madagascar and *Purpura tuberculata* var. *cingulifera* from an unknown location. (Houart, 2019) This species is common throughout the tropical indo-pacific. (Cernohorsky, 1967) As per the GBIF data with its known coordinates its location is reported from South Africa covering Madagascar, Mozambique, Tanzania, Kenya, Somalia, Oman, India, Sri Lanka, Thailand, Malaysia, Vietnam, Philippines, Indonesia till French Polynesia in South Pacific Ocean covering most of the islands coming in between. Further from Japan covering US minor outlying islands in North Pacific Ocean to US and Mexico. From Mexico to Egypt and Israel covering North Atlantic Ocean.

Distribution from India: *Tenguella granulata* is very well distributed at most of the coasts of India. It is highly common on the most of the east and west coasts as well as Andaman, Nicobar, and Lakshadweep islands in India. (Subba Rao, 1993) Earlier this species was documented from Gujrat Okha to Surat, Maharashtra Mumbai, Kerala Thiruvananthapuram, Krusadai Island, Tamil Nadu, Vishakhapatnam, Andhra Pradesh, Bheemunipatnam, Odisha are some of the mentions.

New distribution from India: This paper presents a new distributional record of the species from Alibag, Raigad, Maharashtra.

Habit and habitat: The habitat at the mid intertidal zone is dominated by rocky crevices encrusted with edible oyster beds of *Saccostrea cucullata* (Born, 1778). *Tenguella granulata* has been observed in the present area mostly within crevices and among oyster beds ranging from 0 to 1 m depth.

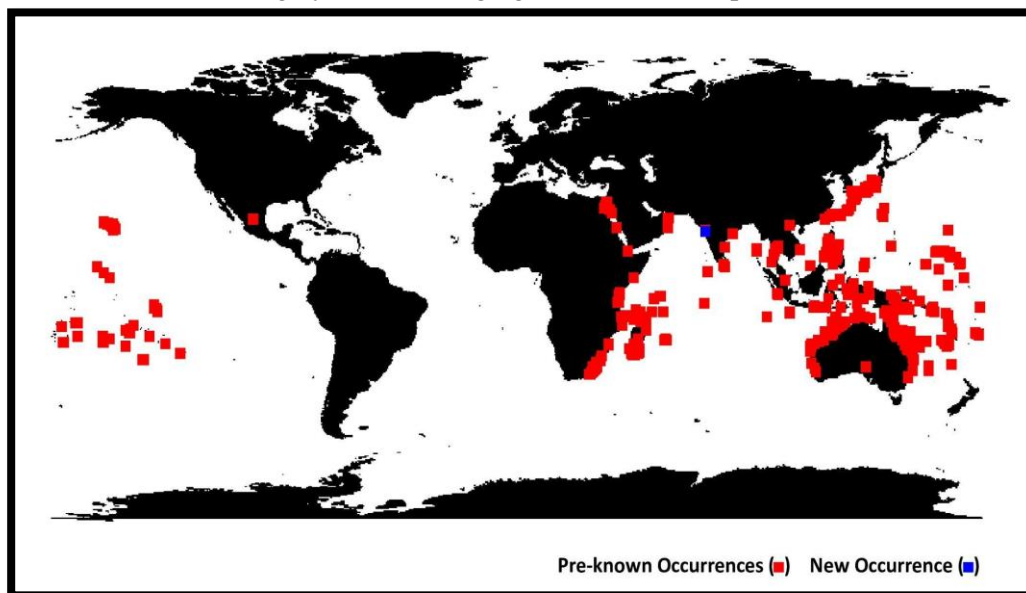


Figure 3: Global Distribution Map of *Tenguella granulata* (Duclos, 1832) with new occurrence of Alibag.

Tenguella ceylonica (Dall, 1923)

Family Muricidae Refinesque, 1815

Subfamily Ergalataxinae Kuroda, Habe & Oyama, 1971

Genus *Tenguella* Arakawa, 1965

Type species (type by original designation): *Tenguella granulata* (Duclos, 1832) Indo-West Pacific.

Tenguella ceylonica (Dall, 1923)

(Figure 4, A and B)

Synonymy

1923	<i>Morula (Morulina) ceylonica</i>	Dal 1	<i>Proceedings of the Academy of Natural Sciences, Philadelphia</i>	75: p. 303 tp 306, details - 305
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Vernacular Name: Nil

Type locality: Sri Lanka

Examined Material: Holotype of *Tenguella ceylonica* (Dall, 1923) from Smithsonian National Museum of Natural History, Washington D. C.; Catalogue Number: USNM 336197. 1 specimen of *Tenguella ceylonica* (Dall, 1923) from Tamil Nadu, India (image examined from Houart 2017).

Other Material: 1 Voucher specimen of *Tenguella ceylonica* (Dall, 1923) preserved in museum of Bombay Natural History Society (BNHS), Mumbai, India; Catalogue number: BNHS_Gastro 2159b.

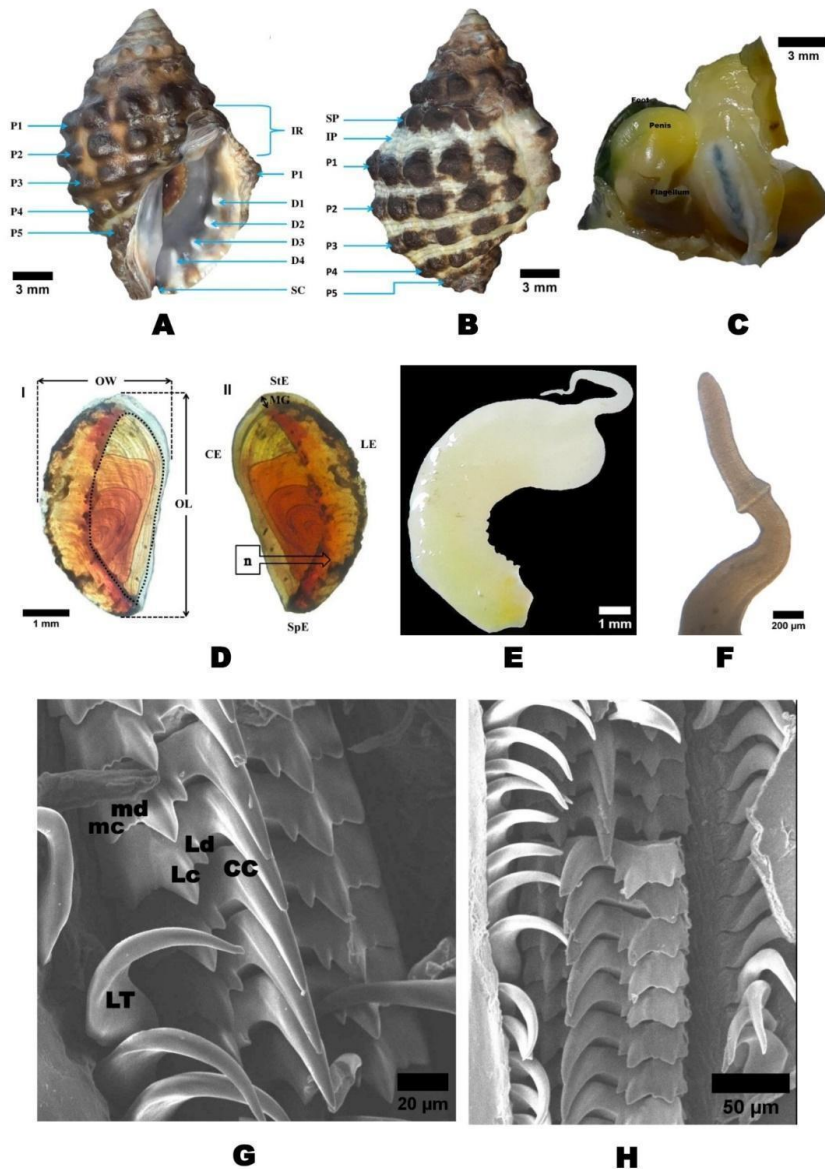


Figure 4: *Tenguella ceylonica* (Dall, 1923), SL 22 mm, SW 15 mm SL/SW ratio 1.46 Voucher Specimen (BNHS Gastro 2158) preserved in museum of Bombay Natural History Society (BNHS) (A) Ventral View (B) Dorsal View (C) Dissected animal soft body part showing penis (D) Operculum I Internal Surface showing length (OL = 7 mm) and width (OW = 3.97 mm) with operculigerous disc by dotted line. II External surface showing position of nucleus and growth lines. (MG = 0.40 mm) (E) Penis (F) Penis Tip (G) SEM Radula scale bar 20 µm X500 (H) SEM Radula scale bar 50 µm X400. **Diagnosis:** *Tenguella ceylonica* (Dall, 1923)

Shell: Figure 4; A and B. SL 22 mm, SW 15 mm, SL/SW ratio 1.46. (Shell spiral cord and denticle labelling pattern as per Merle D. 2001) Shell robust, oval with moderately high conical spire without varices. Blunt ended black nodular ornamentation on the whorls in transverse lines with thread like tiny spiral cords running in between. The shell colour is slight yellowish to whitish grey with dark brownish grey to black nodules. Protoconch incomplete. Teleoconch of approximately 4 weakly convex whorls, suture appressed, obscure up to penultimate whorl, evident on body whorl, undulate; sub-sutural cord (SP) followed by broad, slightly outward and less sloping infra-sutural ramp (IR) (between SP and P1) and 5 rows of other squarish, hilly tubercles from the shoulder gradually becoming obsolete forward (P1 to P5). Body whorl is spirally sculptured with 3 to 4 finely scabrous, small, equal cords between the nodules and over the rest of the surface. Aperture narrow, oval, slightly tilted away from the central axis at posterior canal end, with 4 equal sized, whitish cream denticles with slight purple tinge in between on the right edge; outer lip thickened, margin weakly crenulated with fine, blunt spiral cord ends. Aperture interior whitish to light purple brown and outer lip whitish cream. The outer lip is broader. Columella white, smooth with blackish purple patch on the upper columella. Columellar lip broader with strong anterior columellar tooth. Anterior canal is short, narrow. Posterior canal is short, wide and marked by a small “U” shaped posterior ridge. Parietal denticle is highly prominent and blunt.

Operculum: Figure 4; D, I) Internal Surface (OL = 7 mm), (OW = 3.97 mm). II) External surface (MG = 0.40 mm). (Labelling style as per Paulo Vasconcelos et. al., 2012) Operculum thin, corneous, oval, rigid (shape fitting the aperture), flattened, with terminal basal nucleus slightly turned to left, golden to dark brown in colour with multiple lines of growth.

Radula: Figure 4; G and H. (The radular labelling pattern as per Herbert G. S. 2015 and Houart R. 2019) Rachiglossate radula with the general formula 1+R+1. The entire radula measures about 7.4 mm in length in its fully extended form which is nearly 33% of the length of the shell with about 186 transverse rows of teeth. This can be characterised by a large central three dimensional rachidian tooth, followed on both sides by a pair of marginal teeth. Rachidian teeth with broad base, cutting edge is fringed with a long, sharply pointed, conical central cusp (CC) projecting with 90° angle to the base; a small, very narrow lateral denticle (LD) protruding from the separate base junction of lateral cusp with nearly 45° angle to the base; a moderately long, broad, cone shaped, convex, tapering from both sides to blunted point, lateral cusp (LC) projecting to 70° angle from the base, nearly half the height of central cusp. Marginal area (MA) of the rachidian plate wide and slightly folded into serrated two marginal denticles (md) and blunt marginal cusp (mc) projecting with 50° angle from the base little outward the plane of lateral cusp. Lateral teeth (LT) sickle shaped, with broad base and tapering slender pointed tip.

Animal: Animal description and penis anatomy

Animal Description - Figure 4; C. The pigmentation pattern is distinct in every part of the soft body. The sole of the foot has whitish and yellowish subcutaneous pigmented grains. The central portion of the foot is highly concentrated with whitish pigmentation followed by slight yellowish to greenish pigmentation near the boundaries of the foot. ABO is located to the dorsal side of the ventral pedal gland in females. Edge of the sole is marked by light to dark green, yellowish, whitish and blackish pigmented grains. The sides of the foot are densely blackish pigmented with in between sparse white patches below tentacles and light to dark greener with little black and white edges throughout. The tentacles are with greenish, yellowish and whitish pigments at the base, blackish pigmented bands surrounding the eyes which are black dots.

Penis Anatomy - Figure 4; E and F. PL - 8 mm. Penis large, muscular, thick, with greater curvature, dorsoventrally flat, basal portion with long and highly curved form, distal portion marked by long flagelliform tip. (Wu S. K. 1973) Minute greenish yellow coloured pigments are present at the basal portion while the whitish colour is observed at the distal part of the penis body. Penis flagellum is white in colour and 3/4th the length of penis body. Penial flagellum tip has a small connection like structure attached at the end. This attachment has a remarkable swollen base and tapering blunt apex.

Global distribution: Figure 5. The type locality of holotype of *Tenguella ceylonica* was reported at ceylon (Sri Lanka) by Dall, 1923. Dall has also mentioned other records from the Marquesas Islands, Mauritius and Chain

Islands, South Pacific. However, Roland Houart 2017, has mentioned that these localities have never been confirmed further. According to Roland Houart 2017, this species is now confined to a broad area in the eastern Indian and the western Pacific Oceans, particularly in southeastern India, Sri Lanka, Thailand, Indonesia (Sumatra, Java, Bali, Lombok, Java Sea) and the Philippines, probably also Malaysia. As per GBIF there are only 14 occurrences of this species over globe amongst them 3 from Japan, 1 from Malaysia and 1 from Bangladesh were with coordinates and others are without coordinates. (Mentioned in the Figure 5)

Distribution from India: As per GBIF data there are two records from India but without location coordinates. Houart 2017 has mentioned the presence of this species from southeastern India particularly Tamil Nadu. There are no other reported records than this from India.

New distribution from India: Present paper reports new distributional record of *Tenguella ceylonica* from Alibag coast of Raigad, Maharashtra for the first time.

Habit and habitat: Figure 1. The habitat at the mid intertidal zone is dominated by rocky crevices encrusted with edible oyster beds of *Saccostrea cucullata* (Born, 1778). *Tenguella ceylonica* has been observed in the present area mostly within crevices and among oyster beds ranging from 0 to 1 m depth.

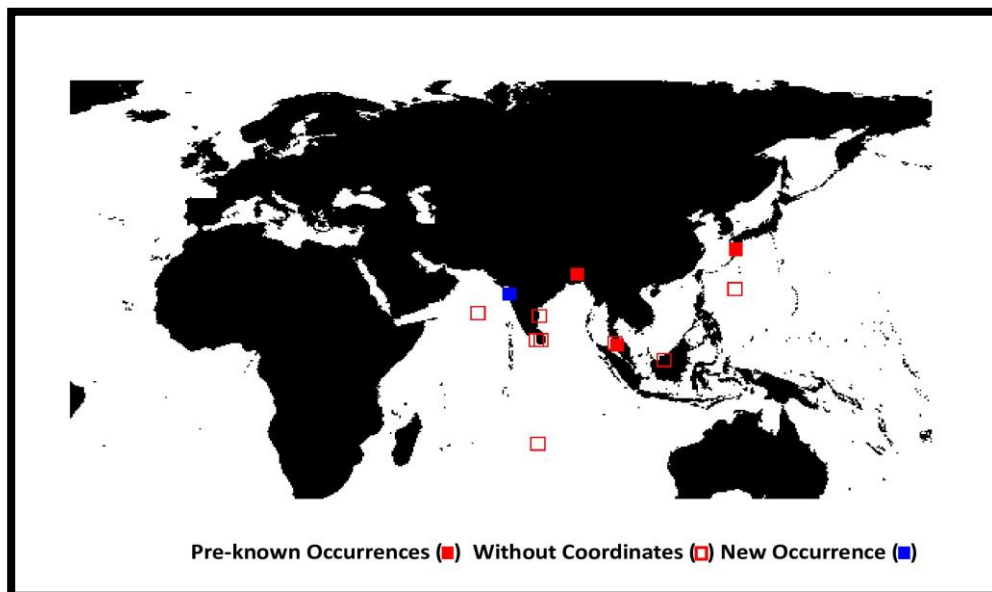


Figure 5: Global Distribution Map of *Tenguella ceylonica* (Dall, 1923) with new occurrence of Alibag.

DISCUSSION

Tenguella granulata is a cosmopolitan species occurring commonly on Indian coasts. The species is already reported from Mumbai, Goa and nearby coasts by Subba Rao, 1993; but this is the first new distributional record of it from Alibag, Raigad, Maharashtra. *Tenguella ceylonica* on the other hand were known from the eastern Indian coasts to the western Pacific oceans (Houart, 2017). But, this record from Alibag, Raigad, Maharashtra the western coast of India shows new distribution and further range extension by the species.

The morphology of the shell of *T. granulata* and *T. ceylonica* may appear similar superficially but have remarkable differences. The overall average size (SL ranging up to 30 mm) and shape of the shell in *T. granulata* is larger and elongated (SL/SW ratio 1.85) while that in *T. ceylonica* is smaller (SL ranging up to 25 mm) and broadly ovate (SL/SW ratio 1.45). The spire is a little higher in case of *T. granulata* than *T. ceylonica*. The colour of the shell in *T. granulata* is whitish grey with dark brown to black at nodules as compared to *T. ceylonica* which has yellowish to whitish grey colour with brownish grey to black nodules. The infra sutural ramp (IR) in *T. granulata* is more sloping and smaller than *T. ceylonica* where it is much broader with delayed slope; this gives little broadly ovate shape to the later one. The teleoconch whorls are usually less in numbers in *T. Ceylonica* as compared to *T. granulata* here not showing much differences. Columella is

smooth and plain white in both with brownish purple patch on the upper part in *T. granulata* and blackish purple patch in *T. ceylonica*. In *T. ceylonica* the columellar lip is comparatively broader with remarkably strong anterior columellar single tooth. The aperture is a little larger and slightly tilted away from the central axis from the posterior end in case of *T. ceylonica*, this may be because of broader and less sloping IR. The aperture interior is purple whitish and outer lip with blackish to creamy white lustering texture in *T. granulata* while in *T. ceylonica* the aperture interior whitish to light purple brown and outer lip whitish cream. The outer lip is marked with 4 to 5 equal sized whitish cream denticles with blackish purple right ridge edge in *T. granulata* and in *T. ceylonica* there are 4 nearly equal sized whitish cream denticles with slight purple tinge in between on the right edge. The outer lip is a bit broader in *T. ceylonica* as compared to *T. granulata*. A prominent blunt parietal denticle is observed in *T. ceylonica* than *T. granulata*. Operculum is rigid in both cases with a nucleus basal towards the siphonal edge, slightly turned to the left side. Operculum colour is reddish brown in *T. granulata* and golden to dark brown in *T. ceylonica*.

The scanning electron microscopic (SEM) radular morphology is a highly important criterion in the muricid taxonomic studies. Many researchers have used it as a powerful tool for species allocation purposes. On the account of comparative observational studies of radular morphology in *Tenguella granulata* and *Tenguella ceylonica* a typical rachiglossate radula with 1+R+1 formula is observed in both. In *T. granulata* radular length is around 30% of the shell. A characteristic 3D rachidian tooth with a broader base and large protruding sickle shaped tapering pointed central cusp flanked by small narrow lateral denticles. Pointed triangular shaped lateral cusps which are half the length of the central cusp and give a remarkable 'V' shape to the rachidian tooth. The marginal area has tree clean marginal denticles and a bicuspid marginal cusp. Half-moon shaped lateral teeth with tapering pointed end. In *T. ceylonica* the length of the radula is a little larger, around 33 % of the shell length. Similar 3D rachidian tooth with sharply pointed conical protruding central cusp flanked with small narrow lateral denticles and pointed cone shaped lateral cusps with moderate length. The marginal area has two serrated unfledged marginal denticles with little outward blunt marginal cusps. The sickle shaped lateral teeth with broader base and pointed tip is observed.

The body pigmentation is differing notably in both species with whitish and greenish subcutaneous pigmented grains at foot sole and light to dark green, whitish and blackish pigmented grains at foot edge in *T. granulata*. Similarly in *T. ceylonica* the sole of the foot has whitish and yellowish subcutaneous pigmented grains and foot edges are marked by light to dark green, yellowish, whitish and blackish pigmented grains. The tentacles of *T. granulata* have greenish and whitish pigments at base and black to white pigmented bands surrounding the eyes. The eyes are black dots in black and white band. The tentacles of *T. ceylonica* have greenish, yellowish and whitish pigments at the base followed by blackish and white pigmented bands surrounding the eyes. The eyes are black dots in white band.

The penis of *T. granulata* is larger, muscular with curvature and having tapering single flagellum. The flagellum tip has a small connection like structure with slightly swollen base and blunt tapering end. The penis of *T. ceylonica* is also larger and muscular but with little higher curvature followed by single tapering flagellum. The flagellum tip here also has a small connection like structure where the swollen base is noticeably larger than *T. granulata* with a tapering blunt apex.

Tenguella granulata is a highly common species on Indian coasts. Rocky substratum with oyster bed co-inhabited by diverse gastropod snails is an ideal place for the growth and colony formation of carnivore *T. granulata*. Similarly for *T. ceylonica* the ecology of the present habitat is highly suitable. There were earlier known reports of this species from south-eastern India, Chennai, Tamil Nadu (Houart 2017). GBIF also shows certain reports from the Indian Ocean and Arabian Sea but their latitude and longitude data are not available. So, with reported records having lat long data it seems more than 1000 km range extension but actually it has occurred gradually but without proper study things goes unnoticed till date.

Different natural catastrophic events like tsunami, hurricanes etc. and anthropogenic activities like fishing, transportation, climate change etc. shows an unnoticed but drastic effect on the distributional patterns and habitat selection of marine organisms. So, there might be any natural or man-made cause for such range

extensions. This may also suggest that this *Tenguella ceylonica* species might be distributed widely from the south Indian coasts to western regions but a clear investigative taxonomic study needs to be done.

ACKNOWLEDGEMENTS

We are grateful to the Bombay Natural History Society for allowing present work as part of the PhD program of the first author. We are thankful to J. S. M. College, Alibag authorities for technical support. Images of *Tenguella granulata* are accessed from National Museum of Natural History, Paris, France; Collection: Molluscs (IM): Catalogue number: MNHN-IM-2000-777 (<http://coldb.mnhn.fr/catalognumber/mnhn/im/2000-777>) and that of *Tenguella ceylonica* from National Museum of Natural History, Smithsonian Institution, Washington D.C., U.S.A; Catalogue number: USNM 336197 (<http://n2t.net/ark:/65665/3838b8806-4755-4809-910e-c9b476e981e4>) and Roland Houart, 2017. The necessary permits were granted by the Maharashtra State Biodiversity Board, Government of Maharashtra.

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