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Rapid Assessment of Coastal Biodiversity Post-2015 Chennai Flood, India

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Abstract

During late November and early December of 2015, Chennai city in the coastal state of Tamil Nadu experienced unprecedented rainfall that resulted in a flash flood. It was one of the worst affected coastal cities of southern India resulting in an alteration of the coastal environment. We was made an attempt to document the impact of the flood on coastal fauna following which a survey was conducted from the estuarine river mouths of Adyar to Cooum along the Marina beach. 177 marine species were identified, represented by 5 fishes, 15 crustaceans, 95 bivalves, and 57 gastropods. Other groups include echinoderm, coral, polychaete, anthozoan and bryozoan represented by a single individual. Presence of various freshwater species including various plastic components indicates that the heavy freshwater outflow from the rivers and canals have had a notable effect, calling for a long term assessment of the study area.

Keywords: Chennai flood; 2015; Precipitation; Coastal fauna; India

1. Introduction

With climate change being evident in the 21st century, extreme weather or tectonic conditions have become more unpredictable. Such conditions can lead to serious environmental impacts as seen previously. Coastal districts of eastern Tamil Nadu and Puducherry usually bear heavy rains during the northeast monsoon along with Andhra Pradesh which becomes prone to flooding with numbers of swelling rivers and wetlands. Between the years from 1943 to 2005 Chennai city had experienced five major floods alone causing particularly severe damage in the year of 1943 and 2005. Aside from this, unplanned and illegally urban development has caused many wetlands and natural sinks being built over artificially. In addition, aging civil infrastructures and poorly designed drainage systems have resulted in an increase in frequency of flooding (Seenirajan *et al*., 2017). Following the pursuit, the magnitude of heavy rain events has also witnessed a marked increase in the Indian Ocean indicating vulnerability towards the Indian subcontinent (Goswami *et al*., 2006; Roxy *et al*., 2017). The effect was observed in one such event where continuous rainfall ranging from 200-340 mm/d (max. 450 mm) occurred in Chennai, Tamil Nadu

(Figure 1) due to a northwesterly moving low-pressure system which initially formed over the southeastern Bay of Bengal (Singh *et al.*, 2018). Continuous rainfall resulted in a flash flood along certain parts of the coast (Chakraborty, 2015; Balakrishnan, 2016; Mishra, 2016). The coast, which accounts for 17% (approximately 1000 km) of the coastline of India consists part of the Bay of Bengal to a length of 355 km, the Palk strait 275 km, Gulf of Mannar 315 km and a certain part of Arabian sea amounting to 55 km. The city of Chennai was the worst hit as several sectors were severely affected as well as rivers and canals were overflowing.

Intertidal benthic fauna are bio-indicators of environmental stress (Lekshmi *et al.*, 2014). Due to very restricted movements and differential tolerance, they are among the most common organisms used to assess natural or anthropogenic impacts. With comparatively longer life spans and as key elements in the food web of aquatic systems, they can integrate the effects of the environment (Ansari and Ingole, 2002). During the early period, the interesting phenomenon of sudden and devastating mass mortalities in populations of marine fauna was investigated (Brongersma-Sanders, 1957). Mass mortalities of bivalves have occurred due to low salinity water from outflows from the river mouth (Murray-Jones and Johnson, 2003). Heavy deposition of fine sediment during disastrous events such as extreme rain and flooding can profoundly influence the function and structure of macrobenthic communities (Norkko *et al.*, 2002). Rajendran *et al.* (2005) have reported that only two earthquakes (1881 and 1941) have caused the tsunami run-up on the east coast of India. Furthermore, Altaff *et al.* (2005) highlighted that the previous historical events are meager in terms of the 2004 tsunami as it has caused extensive damage to the shore and foreshore area of the coastal system, resulting in greater physical damage. Severe biodiversity loss in the Nicobar group of Islands in the Indian Ocean post-tsunami was also reported by Porwal *et al.* (2005). The present work is carried out as a baseline data for biological elements that were identified and documented after the Chennai flood 2015.

The main objectives of the paper are 1) to provide a comprehensive checklist of coastal biodiversity observed post-Chennai flood-2015. 2) To inform the presence of freshwater and terrestrial species due to an excessive outflow of fresh water. 3) Highlight the need for long term monitoring and management.

2. Material and Methods

2.1 Study area

Marina beach is the second longest beach in the world with a width varying from 150 to 600 m and has a length of approximately 5.6 km (Figure 2). It is a popular tourist attraction with more than a million tourists visiting every year (Pradhan *et al.*, 2018). Adyar and Cooum are the

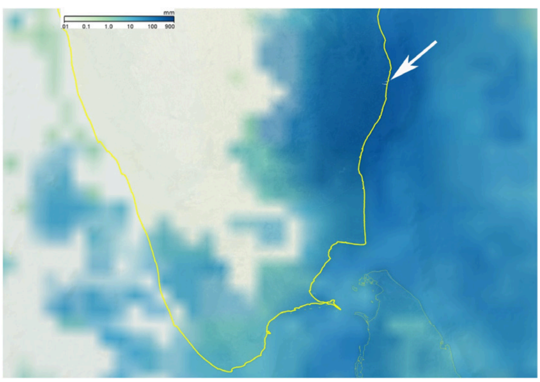

Figure 1. TRMM radiometric data shows the amount of rainfall over Chennai city (Arrow), east coast of India on the 1st December, 2015 overlaid on Google Earth.
(Original source: https://neo.sci.gsfc.nasa.gov/view.php?datasetId=TRMM_3B43M)

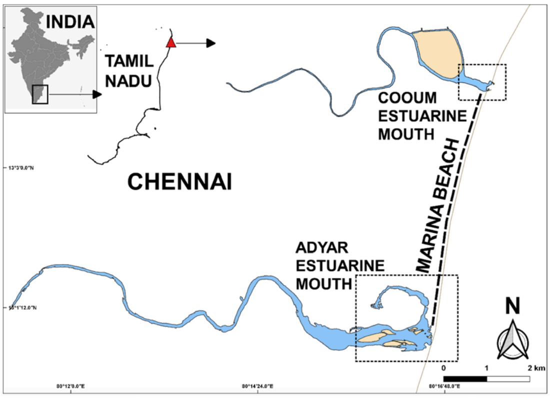

Figure 2. Study area (Marina Beach). Dashed lines indicate sampling area, rectangular boxes indicate estuarine mouth highlighted in Figure 3.

Figure 3. Pre and Post-rainfall scenario of estuarine mouth (A, B) Cooum River (C, D) Adyar River

two main non-perennial rivers that run across the city (Figure 2). The Cooum runs through the middle of the city from west to east and almost bisects the city into two halves while the Adyar is in the south. The estuarine region of these rivers remain closed for most of the year, however, the northeast monsoon during October to December opens up the river mouth (Ramanujam *et al*., 2014). The watercourses are polluted within the city limits which eventually find its way to the Bay of Bengal. They are used as open sewers due to the innumerable outfall of sewer-stormwater interconnection by Chennai the Metropolitan Water Supply and Sewerage Board (CMWSSB) at a number of points.

2.2 Methodology

Field observations were carried out between the Cooum estuary in the north and the Adyar estuarine mouth in the south (Figure 2). The survey was undertaken in the second week of December 2015 soon after the flood. Specimens representing different taxa were strewn across the beach. Shells, coral fragments and other calcareous matter were either hand-picked or documented in the field based on the Wildlife Protection Act (Regulations) India, 1972. The specimens that were not decomposed, were washed and their tissue was preserved in 10% formalin solution in plastic vials for future studies. The collected fauna was sorted into groups; counted, labeled

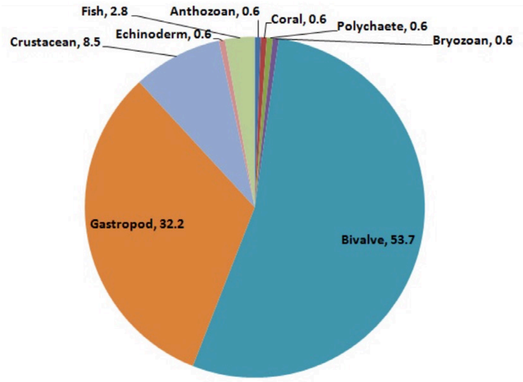

Figure 4. Percentage contribution of coastal fauna collected and observed in the study site

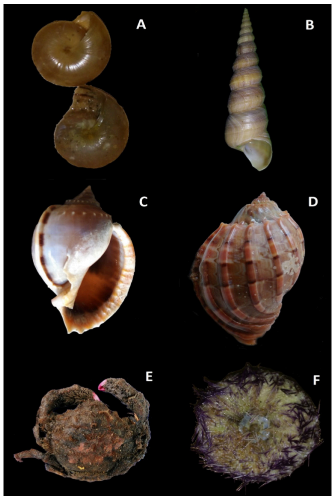

Figure 5. Some of the species observed during the study (A) *Kaliella aspirans* (B) *Turritella duplicata* (C) *Phalium glaucum* (D) *Harpa davidis* (E) *Dromia* sp. (F) *Salmacis virgulata*

and preserved in plastic containers. In the case of molluscs, dry preservation was also carried out. The specimens were segregated group-wise and identified using standard taxonomic references following Day (1967) for polychaetes, anthozoans Raghunathan *et al.* (2014); bivalves Sathyamurthi (1956), and Huber (2010; 2015), gastropods Franklin and Laladhas (2014); Apte (2014), and Raheem *et al.* (2014); crustaceans Ng *et al.* (2001), and FAO (1998); echinoderms Raghunathan *et al.* (2013), and fishes Venkataraman *et al.* (2007), and Murugan *et al.* (2010). The identified species names were validated using World Register of Marine Species database (WoRMS). Google earth archived satellite imagery was georeferenced using QGis 3.0.1 for pre and post-flood visualization of the Adyar and Cooum river mouth (Figure 3). Microwave radiometric data for precipitation was obtained from Tropical Rainfall Measuring Mission (TRMM) and was modified accordingly (Ghosh *et al.*, 2016) (Figure 1).

3. Results and Discussion

Periods of high river discharge (Murray-Jones and Johnson 2003) followed by extreme flooding lead to increased deposits of sediments leading to mortality of macrobenthic communities in coastal areas (Norkko *et al.*, 2002). This was witnessed during the Chennai floods of 2015 which was caused by incessant rains, followed by the release of excess water from the reservoirs leading to the inundation of low lying areas and spillover from rivers. This is the worst ever recorded incident in Chennai, post 1943 (Frederick, 2011). As per the report of the National Remote Sensing Centre (NRSC, 2016), the flood water level exceeded more than 5 m in height in several localities, severely damaging property of thousands of families. Flooding of Cooum and Adyar rivers, the major draining points for Chennai lead to the inundation of low-lying areas. Excess water outflow also temporarily modified the geomorphological features of the estuarine mouth (Figure 3).

Extensive collections carried out during the second week after the flash flood indicated that while some taxa had living representatives, most of the collected fauna were dead and in a decomposed condition. The marine taxa documented included dead coral, sea anemone, polychaete worms, crustaceans, bivalves, gastropods, echinoderm, bryozoan and fishes (Table 1). The percentage contribution of coastal fauna collected from the study site is given in (Figure 4). Only a single representative of coral (*Truncatoflabellum* sp.), sea anemone (*Heteractis* sp.), polychaete (*Sabellides* sp.), echinoderm (*Salmacis virgulata*) and a bryozoan colony occurred. A total of 15 species of crustaceans was recorded among which, commercially important species like *Scylla serrata* (estuarine form) and *Charybdis natator* (marine form) were present. Phylum *Mollusca* had the maximum representation with 53.7% bivalves and 32.2% gastropods (Figure 4). Besides, empty shells, 5 species of freshwater/terrestrial gastropods namely *Pila globosa*, *Bellamya dissimilis*, *Achatina fulica*, *Ariophanta bistrialis*

Figure 6. (A) Removal of plastic garbage from beach after the flood near river mouth, (B) Plastics deposited on the Marina beach post flood, (C) Remains of excess flood and rainwater, (D) Machines to restructure damaged areas, (E) Local community collecting edible *Donax cuneatus* post flood, (F) Water receding as the sea calms post flood

Table 1. Species recorded from Marina beach post flood

Sl. No.	Group	Family	Species
1	Anthozoan	Hormathiidae	*Heteractis* sp.
2	Coral	Flabellidae	*Truncatoflabellum* sp.
3	Polychaete	Sabellidae	*Sabellides* sp.
4	Bryozoan	–	Unidentified sp.
5	Bivalve	Anomiidae	*Anomia ephippium* (Linnaeus, 1758)
6	Bivalve	Anomiidae	*A. achaeus* (Gray, 1850)
7	Bivalve	Arcidae	*Anadara antiquata* (Linnaeus, 1758)
8	Bivalve	Arcidae	*Arca navicularis* (Bruguière, 1789)
9	Bivalve	Arcidae	*Arca* spp.
10	Bivalve	Arcidae	*Anadara inaequivalvis* (Bruguière, 1789)
11	Bivalve	Arcidae	*A. chemnitzii* (Philippi, 1851)
12	Bivalve	Arcidae	*A. notabilis* (Röding, 1798)
13	Bivalve	Arcidae	*Anadara* spp.
14	Bivalve	Arcidae	*Tegillarca rhombea* (Born, 1778)
15	Bivalve	Arcidae	*T. granosa* (Linnaeus, 1758)
16	Bivalve	Arcidae	*Mosambicarca* sp.
17	Bivalve	Arcidae	*Barbatia lacerata* (Bruguière, 1789)
18	Bivalve	Cardiidae	*Fulvia australis* (G. B. Sowerby II, 1834)
19	Bivalve	Cardiidae	*Vasticardium assimile* (Reeve, 1844)
20	Bivalve	Cardiidae	*V. asiaticum* (Bruguière, 1789)
21	Bivalve	Cardiidae	*V. coronatum* (Schröter, 1786)
22	Bivalve	Cardiidae	*Maoricardium setosum* (Redfield, 1846)
23	Bivalve	Cardiidae	*Maoricardium* sp.
24	Bivalve	Cardiidae	*Acrosterigma cygnorum* (Deshayes, 1855)
25	Bivalve	Carditidae	*Cardita variegata* (Bruguière, 1792)
26	Bivalve	Chamidae	*Chama* sp.
27	Bivalve	Condylocardiidae	*Carditopsis* sp.
28	Bivalve	Corbulidae	*Corbula taitensis* (Lamarck, 1818)
29	Bivalve	Corbulidae	*Corbula* sp.
30	Bivalve	Donacidae	*Donax scortum* (Linnaeus, 1758)
31	Bivalve	Donacidae	*D. cuneatus* (Linnaeus, 1758)
32	Bivalve	Donacidae	*D. faba* (Gmelin, 1791)
33	Bivalve	Donacidae	*Donax* spp.
34	Bivalve	Glycymerididae	*Glycymeris undata* (Linnaeus, 1758)
35	Bivalve	Glycymerididae	*G. decussata* (Linnaeus, 1758)
36	Bivalve	Glycymerididae	*Glycymeris* spp.
37	Bivalve	Glycymerididae	*Cyrtodaria* sp.
38	Bivalve	Limidae	*Ctenoides annulatus* (Lamarck, 1819)
39	Bivalve	Lucinidae	*Anodontia edentula* (Linnaeus, 1758)
40	Bivalve	Lucinidae	*Monitilora bonneti* (Cossmann, 1923)
41	Bivalve	Mactridae	*Oxyperas lentiginosa* (Gould, 1852)
42	Bivalve	Mactridae	*Mactra violacea* (Gmelin, 1791)

Table 1. Species recorded from Marina beach post flood (continue)

Sl. No.	Group	Family	Species
43	Bivalve	Mactridae	*M. antiquata* (Spengler, 1802)
44	Bivalve	Mactridae	*M. achatina* (Holten, 1802)
45	Bivalve	Mactridae	*Mactrinula* sp.
46	Bivalve	Mactridae	*Mactra* spp.
47	Bivalve	Mesodesmatidae	*Atactodea* sp.
48	Bivalve	Myida	*Pholas orientalis* Gmelin, 1791
49	Bivalve	Mytilidae	*Perna perna* (Linnaeus, 1758)
50	Bivalve	Mytilidae	*P. viridis* (Linnaeus, 1758)
51	Bivalve	Mytilidae	*Modiolus modulaides* (Röding, 1798)
52	Bivalve	Mytilidae	*Modiolus* sp.
53	Bivalve	Ostreidae	*Crassostrea bilineata* (Röding, 1798)
54	Bivalve	Ostreidae	*C. gryphoides* (Schlotheim 1813)
55	Bivalve	Ostreidae	*Crassostrea* spp.
56	Bivalve	Ostreidae	*Saccostrea cucullata* (Born, 1778)
57	Bivalve	Pectinidae	*Mimachlamys sanguinea* (Linnaeus, 1758)
58	Bivalve	Pectinidae	*Volachlamys tranquebaria* (Gmelin, 1791)
59	Bivalve	Pharidae	*Siliqua radiata* (Linnaeus, 1758)
60	Bivalve	Pholadidae	*Barnea candida* (Linnaeus, 1758)
61	Bivalve	Pholadidae	*Pholas* chiloensis Molina, 1782
62	Bivalve	Pholadidae	*Barnea birmanica* (Philippi, 1849)
63	Bivalve	Pinnidae	*Pinna bicolor* (Gmelin, 1791)
64	Bivalve	Pinnidae	*P. muricata* (Linnaeus, 1758)
65	Bivalve	Pinnidae	*Atrina vexillum* (Born, 1778)
66	Bivalve	Placunidae	*Placuna placenta* (Linnaeus, 1758)
67	Bivalve	Psammobiidae	*Hiatula diphos* (Linnaeus, 1771)
68	Bivalve	Pteriidae	*Isognomon* sp.
69	Bivalve	Spondylidae	*Spondylus nicobaricus* (Schreibers, 1793)
70	Bivalve	Spondylidae	*S. layardi* (Reeve, 1856)
71	Bivalve	Spondylidae	*Spondylus* spp.
72	Bivalve	Tellinidae	*Pristipagia subtruncata* (Hanley, 1844)
73	Bivalve	Tellinidae	*Bosemprella incarnata* (Linnaeus, 1758)
74	Bivalve	Tellinidae	*Hanleyanus immaculatus* (Philippi, 1849)
75	Bivalve	Tellinidae	*Tellina* spp.
76	Bivalve	Tellinidae	*Serratina capsoides* (Lamarck, 1818)
77	Bivalve	Tellinidae	*Arcopagia* sp.
78	Bivalve	Veneridae	*Chione* sp.
79	Bivalve	Veneridae	*Meretrix meretrix* (Linnaeus, 1758)
80	Bivalve	Veneridae	*M. casta* (Gmelin, 1791)
81	Bivalve	Veneridae	*Protapes gallus* (Gmelin, 1791)
82	Bivalve	Veneridae	*Circe scripta* (Linnaeus, 1758)
83	Bivalve	Veneridae	*Timoclea habei* (Fischer-Piette and Vukadinovic, 1977)
84	Bivalve	Veneridae	*T. imbricata* (Sowerby II, 1853)

Table 1. Species recorded from Marina beach post flood (contunue)

Sl. No.	Group	Family	Species
85	Bivalve	Veneridae	*T. ovata* (Pennant, 1777)
86	Bivalve	Veneridae	*Timoclea* spp.
87	Bivalve	Veneridae	*Sunetta scripta* (Linnaeus, 1758)
88	Bivalve	Veneridae	*S. meroe* (Linnaeus, 1758)
89	Bivalve	Venerida	*S. donacina* (Gmelin, 1791)
90	Bivalve	Veneridae	*Sunetta* spp.
91	Bivalve	Veneridae	*Chioneryx grus* (Holmes, 1858)
92	Bivalve	Veneridae	*Dosinia areolata* Römer, 1870
93	Bivalve	Veneridae	*D. prostrata* (Linnaeus, 1758)
94	Bivalve	Venerida	*Dosinia* sp.
95	Bivalve	Venerida	*Dosinia contracta* (Philippi, 1844)
96	Bivalve	Veneridae	*Marcia opima* (Gmelin, 1791)
97	Bivalve	Veneridae	*Paratapes undulatus* (Born, 1778)
98	Bivalve	Veneridae	*Gafrarium divaricatum* (Gmelin, 1791)
99	Bivalve	Veneridae	*Periglypta fischeri* (Récluz, 1852)
100	Gastropod	Achatinidae	*Ariophanta bistrialis** (Beck, 1837)
101	Gastropod	Achatinidae	*Ariophanta* sp.
102	Gastropod	Achatinidae	*Achatina fulica** (Férussac, 1821)
103	Gastropod	Ampullariidae	*Pila globosa** (Swainson, 1822)
104	Gastropod	Architectonicidae	*Architectonica laevigata* (Lamarck, 1816)
105	Gastropod	Babyloniidae	*Babylonia spirata* (Linnaeus, 1758)
106	Gastropod	Bursidae	*Bufonaria crumena* (Lamarck, 1816)
107	Gastropod	Bursidae	*B. echinata* (Link, 1807)
108	Gastropod	Bursidae	*B. rana* (Linnaeus, 1758)
109	Gastropod	Calyptraeidae	*Ergaea* sp.
110	Gastropod	Calyptraeidae	*Desmaulus extinctorium* (Lamarck, 1822)
111	Gastropod	Calyptraeidae	*Ergaea walshi* (Reeve, 1859)
112	Gastropod	Carditidae	*Cardites bicolor* (Lamarck, 1819)
113	Gastropod	Cassidae	*Phalium glaucum* (Linnaeus, 1758)
114	Gastropod	Chilodontidae	*Euchelus asper* (Gmelin, 1791)
115	Gastropod	Conidae	*Conus figulinus* (Linnaeus, 1758)
116	Gastropod	Conidae	*C. amadis* (Gmelin, 1791)
117	Gastropod	Conidae	*Conus* sp.
118	Gastropod	Chronidae	*Kaliella aspirans** (Blanford, 1861)
119	Gastropod	Cypraeidae	*Erosaria lamarckii* (J.E. Gray, 1825)
120	Gastropod	Cypraeidae	*E. ocellata* (Linnaeus, 1758)
121	Gastropod	Ficidae	*Ficus variegata* (Röding, 1798)
122	Gastropod	Ficidae	*F. ficus* (Linnaeus, 1758)
123	Gastropod	Fissurellidae	*Diodora ruppellii* (G. B. Sowerby I, 1835)
124	Gastropod	Harpidae	*Harpa davidis* (Röding, 1798)
125	Gastropod	Janthinidae	*Janthina janthina* (Linnaeus, 1758)
126	Gastropod	Littorinidae	*Littoraria coccinea* glabrata (Philippi, 1846)

Table 1. Species recorded from Marina beach post flood (contunue)

Sl. No.	Group	Family	Species
127	Gastropod	Melongenidae	*L. undulata* (Gray, 1839)
128	Gastropod	Littorinidae	*Volegalea cochlidium* (Linnaeus, 1758)
129	Gastropod	Muricidae	*Purpura bufo* (Lamarck, 1822)
130	Gastropod	Muricidae	*Drupa* sp.
131	Gastropod	Muricidae	*Murex carbonnieri* (Jousseaume, 1881)
132	Gastropod	Muricidae	*M. ternispina* (Lamarck, 1822)
133	Gastropod	Muricidae	*M. trapa* (Röding, 1798)
134	Gastropod	Nassariidae	*Bullia vittata* (Linnaeus, 1767)
135	Gastropod	Nacellidae	*Cellana radiata* (Born, 1778)
136	Gastropod	Nacellidae	*C. rota* (Gmelin, 1791)
137	Gastropod	Olividae	*Oliva tigrina* (Lamarck, 1811)
138	Gastropod	Potamididae	*Telescopium telescopium* (Linnaeus, 1758)
139	Gastropod	Potamididae	*Pirenella cingulata* (Gmelin, 1791)
140	Gastropod	Ranellidae	*Gyrineum natator* (Röding, 1798)
141	Gastropod	Ranellidae	*Gutturnium* sp.
142	Gastropod	Ranellidae	*Cymatium* sp.
143	Gastropod	Ranellidae	*Linatella caudata* (Gmelin, 1791)
144	Gastropod	Terebridae	*Cinguloterebra commaculata* (Gmelin, 1791)
145	Gastropod	Tonnidae	*Tonna dolium* (Linnaeus, 1758)
146	Gastropod	Trochidae	*Gibbula swainsonii* (Adam, 1851)
147	Gastropod	Turritellidae	*Turritella duplicata* (Linnaeus, 1758)
148	Gastropod	Turritellidae	*T. attenuata* (Reeve, 1849)
149	Gastropod	Turritellidae	*T. acutangula* (Grateloup, 1845)
150	Gastropod	Turritellidae	*T. columnaris* (Kiener, 1843)
151	Gastropod	Turritellidae	*T. terebra* (Linnaeus, 1758)
152	Gastropod	Turritellidae	*T. terebra cerea* (Reeve, 1849)
153	Gastropod	Turritellidae	*Turritella* sp.
154	Gastropod	Viviparidae	*Bellamya dissimilis** (Mueller, 1774)
155	Gastropod	Xenophoridae	*Onustus indicus* (Gmelin, 1791)
156	Gastropod	Xenophoridae	*Xenophora corrugata* (Reeve, 1842)
157	Crustacean	Alpheidae	*Alpheus malabaricus* (Fabricius, 1775)
158	Crustacean	Balanidae	*Amphibalanus variegatus* (Darwin, 1854)
159	Crustacean	Balanidae	*A. amphitrite amphitrite* (Darwin, 1854)
160	Crustacean	Balanidae	*A. reticulatus* (Utinomi, 1967)
161	Crustacean	Balanidae	*Megabalanus tintinnabulum tintinnabulum* (Linnaeus, 1758)
162	Crustacean	Calappidae	*Calappa lophos* (Herbst, 1782)
163	Crustacean	Dromiidae	*Dromia* sp.
164	Crustacean	Epialtidae	*Doclea ovis* (Fabricius, 1787)
165	Crustacean	Lepadidae	*Lepas anserifera* (Linnaeus, 1767)
166	Crustacean	Majidae	*Schizophrys aspera* (H. Milne Edwards, 1834)
167	Crustacean	Matutidae	*Matuta planipes* (Fabricius, 1798)
168	Crustacean	Ocypodidae	*Ocypode platytarsis* (H. Milne Edwards, 1852)

Table 1. Species recorded from Marina beach post flood (contunue)

Sl. No.	Group	Family	Species
169	Crustacean	Portunidae	*Scylla serrata* (Forskål, 1775)
170	Crustacean	Portunidae	*Charybdis natator* (Herbst, 1794)
171	Crustacean	Xanthidae	*Liagore rubromaculata* (De Haan, 1835)
172	Echinoderm	Temnopleuridae	*Salmacis virgulata* L. Agassiz in L. (Agassiz and Desor, 1846)
173	Fish	Gerreidae	*Gerres methueni* (Regan, 1920)
174	Fish	Gerreidae	*G. oblongus* (Cuvier, 1830)
175	Fish	Gerreidae	*G. erythrourus* (Bloch, 1791)
176	Fish	Muraenidae	*Gymnothorax* sp.
177	Fish	Uranoscopidae	*Uranoscopus affinis* (Cuvier, 1829)

*Freshwater species

and *Kaliella aspirans* (Figure 5) were also documented all along the study area in large quantities. These gastropods usually inhabit freshwater areas like ponds, tanks, etc. and were deposited on the beach as the result of their flushing by flood waters. The terrestrial gastropod, A. fulica is also an invasive species in India. Among the macrofauna assessed, *Donax cuneatus* (bivalve) and *Turritella* spp. (gastropod) dominated the flood-affected regions. These species are typical representatives of sandy beach and prefer low wave energy with exposed surf beaches. Fisherfolk women inhabiting the Lighthouse area of Marina beach were involved in the collection of wedge clams (*Donax cuneatus*) after the floods. Inquiries revealed that clams were consumed locally and the shells were used for ornamental purposes (Figure 6E). Among fishes, 5 species were recorded, including 3 representatives of Family *Gerridae* (*Gerres erythrourus*, *G. emthueni* and *G. oblongus*) that inhabit estuarine areas and are of commercial importance. Altogether bivalves and gastropods accounted for over 85.9% of the collected specimens. Apart from biological fauna, high amount of plastic debris was also observed in certain areas of the beach (Figure 6B). A threefold increase in microplastics were reported post-Chennai floods, especially near the Adyar and Cooum river mouths (Veerasingam *et al*., 2016) with a report indicating that the flood swept around 0.1 million tons of debris (Pradhan *et al*., 2018). These components can have a long-lasting effect on the coastal ecosystem.

Salinity is the major factor for fauna washing ashore (Lazarus and Sreenivasan, 1977). According to Brongersma-Sanders (1957), mass mortality of marine organisms occurs whenever there is a great inflow of freshwater due to heavy rainfall. On the other hand, a severe cyclonic storm in 1972 caused a large-scale death of *Lingula* due to the cyclonic turbulence combined with high spring tide (Ramamoorthi *et al*., 1973). Disturbance in meiofauna was reported in the same geographic location post 2004 tsunami due to the alteration of various physio-chemical parameters including salinity (25.86 to 30.53) during the initial 7 days (Altaff *et al*., 2005) however, long term observation also revealed that these species are resilient (Grzelak *et al*., 2009). Similar variation in environmental parameters can be expected during, or post Chennai flood.

Our survey further indicates that the seawater influx and the river discharge had an impact on the coastal and marine biodiversity along the coast of Chennai. The occurrence of deep water coral of the genus *Truncatoflabellum* in the shore points out towards the extent of impact on the continental shelf region of Chennai. Further, with the advent of climate change and the rise in SST, such natural hazards are expected to be more frequent in the future and the coastal cities must be prepared to minimize the degree of damage caused to the environment, properties or human life. This baseline data on the fauna encountered post floods provide environmental planners the level of damage that can occur for living resources when a natural disaster like flooding occurs and calls for regular and long term monitoring of the study area.

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