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Co-occurrences of jellyfish in the shrimp fishing grounds of Palk Bay and the Gulf of Mannar and their implications in the commercial fishery

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Original Article

Abstract

The regular abundance of jellyfish in Palk Bay and the Gulf of Mannar during the Indian summer was studied in 2023. Experimental bottom trawling was carried out to assess the influence of jellyfish on fish and shrimp catches in the shrimp fishing grounds of the Gulf of Mannar and Palk Bay. The jellyfish that were caught in the gear were measured and quantified. Among fin fishes, about seven species of silverbellies were more prevalent in both regions' catches. In Palk Bay, *Lobonemoides robustus* is a common jellyfish, whereas three other jellyfish species were also found in the Gulf of Mannar, including *Cyanea nozakii*, *Rhopilema hispidum*, and *Chrysaora chinensis*. *C. nozakii* was shown to be the dominant and most numerous species in the Gulf of Mannar region. Using morphometric data, the relationship between bell diameter and weight for these jellyfish was determined. In general, the perception of fishermen is that there is less fish catch in the jellyfish areas, but in our experiment, the shrimp catch was normal despite the jellyfish abundance. Continuous monitoring can help to demarcate jellyfish occurrence areas as Jellyfish Focal Areas (JFA) for better management of commercial fishing operations in both the Gulf of Mannar and Palk Bay.

Keywords: *Jellyfish focal areas, shrimp fishery, bottom trawl, catch rate*

Introduction

The Gulf of Mannar and Palk Bay lie between India and Sri Lanka. Palk Bay is situated on the southeast coast of India, encompassing the sea between Point Calimere in the north and Dhanushkodi in the south (Kumaraguru *et al*., 2008). The Gulf of Mannar encompasses the territorial waters from Dhanushkodi in the north to Kanyakumari in the south (Kumaraguru *et al*., 2006). Jellyfish inhabit the world's oceans and estuaries, ranging from the surface to the deepest depths. Jellyfish swarms are widespread and frequent in coastal areas worldwide, and they are considered a menace due to their ecological and socioeconomic consequences (Stabili *et al*., 2020). During the pre-monsoon, an increase in temperature, along with a rise in salinity, favours the blooming of jellyfish in the coastal waters and adjacent estuarine and backwater areas along the southern Indian coastline.

Trawl fishing attempts in Palk Bay began in the twentieth century (Herdman, 1903). Palk Bay's shrimp fishery has grown since 1980 into a major industry that supports the largest coastal fisherfolk population along the Tamil Nadu coast. The green tiger shrimp, *Penaeus semisulcatus,* was the major species contributing to the shrimp fishery along the Mandapam coast of Palk Bay and Gulf of Mannar (Thomas, 1974; 1975). In the nineties, fishing vessels with a length range of 9.15–9.76 m and an engine power of 41–88 hp were commonly operated in Palk Bay (Maheswarudu *et al*., 1996; Krishnan, 2012). Due to increasing demand and fishing pressure, the overall length of the fishing vessel has increased to 18 m with 180 hp (Rajkumar *et al*., 2022). In Palk Bay only single-day fishing patterns are followed, and the cod end mesh size of the trawl net is maintained at 25 mm, which is contrary to the prescription of the Marine Fishing Regulation Act, 1983.

Jellyfish harm the fisheries sector. The jellyfish menace led to lower catches of *Metapenaeus dobsoni* in the estuarine stake nets operated off Kochi, Kerala (Sandhya *et al*., 2020). Scyphozoan jellyfish are generally known to affect the fishing industry, tourism, aquaculture, and pumping machinery (Richardson *et al*., 2009). Some jellyfish can also have ecosystem impacts, such as indirect effects on fisheries resources (Purcell *et al*., 2007). *Chironex indrasaksajiae*, a deadly species of box jellyfish, causes severe sting scars (Saravanan *et al*., 2024), and the extremely venomous genus *Chironex* has occasionally caused deaths in tropical and subtropical coastal regions across the globe. Despite this, jellyfish are important in stabilising the marine ecosystem by supporting nutrient cycling (Lebrato *et al*., 2012) and establishing symbiotic relationships with fish (Purcell and Arai, 2001). Carangid juveniles live in harmony with scyphozoan jellyfish (Rajkumar *et al*., 2014), and the survival rate of juveniles of some pelagic fish species depends on jellyfish in a big way, since pelagic fish rarely eat young individuals of these species that are associated with jellyfish (Nagabhushanam, 1964).

Most species of jellyfish lack commercial value due to non-consumption, but in recent years, reports from Sri Lanka and India have indicated export of processed bells and oral arms of *Crambionella* species, *Lobonemoides, Catostylus perezi* and *Rhopilema hispidum* to South Asian countries (Kumawat *et al*., 2023; Karunarathne *et al*., 2024). Some other species, like *Cassiopea andromeda*, are used in aquaria and zoos (Karunarathne *et al*., 2020). Traditional trap fisheries operating along the same coastline used species like *Acromitus flagellatus* and *Lychnorhiza malayensis* as live baits to capture demersal fish species (Karunarathne *et al*., 2021).

Huge jellyfish entrapment hinders shore-seine fishing activity in Palk Bay and the Gulf of Mannar, where fishermen employ manual labour to drag their nets. This causes considerable economic loss to fishermen operating the shore seine for shoaling fish, and they invariably get jellyfish in their nets during these swarming months (Saravanan *et al*., 2016). The scyphozoan jellyfish most often reported in the coastal waters of Palk Bay and the Gulf of Mannar include *Mastigias papua, Netrostoma coerulescens, Cassiopea xamachana, Chrysaora caliparea,* and *Rhopilema hispidum*. The present study aims to investigate jellyfish co-occurrences in the shrimp fishing grounds of Palk Bay and the Gulf of Mannar, as well as their implications on the commercial fishery.

Material and methods

Experimental bottom trawling was conducted in two locations *viz*., the Gulf of Mannar on June 6, 2023, and Palk Bay on June 9, 2023, in the shrimp fishing grounds (Fig. 1) with two hauls

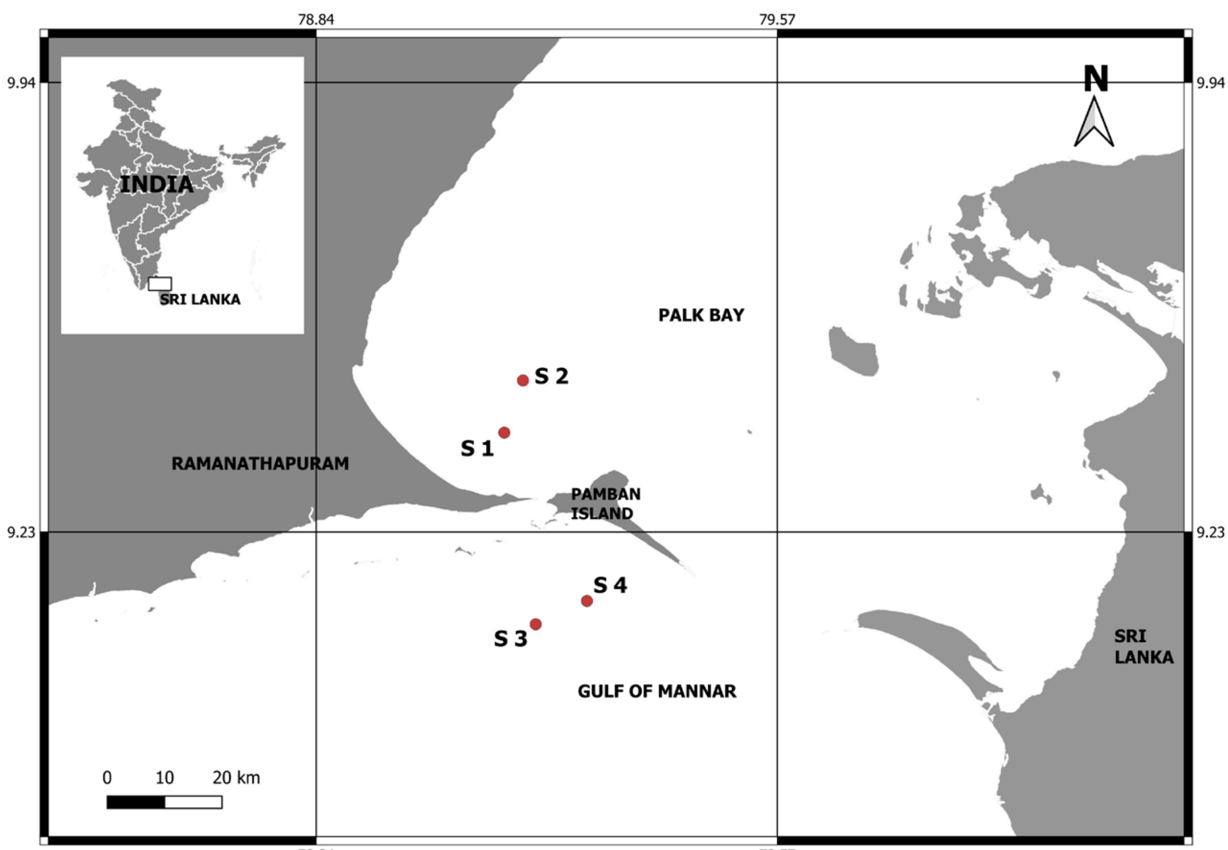

Fig. 1. Sampling locations (red dotted) in the Palk Bay and Gulf of Mannar

in each location to assess the co-occurrence of jellyfish. An onboard GPS (GARMIN 420 S) was used to locate and record the sites during the study. A trawl net with 20 mm cod-end mesh was used during the experimental trawl fishing operation. The standard operating procedure was followed for the shooting and hauling of nets during the entire fishing operation. The specifications of the trawler (stern bottom trawler) and trawl net (shrimp trawl attached to an otter board) used for experimental fishing are provided in Table 1. The primary species targeted in both areas was the shrimp *Penaeus semisulcatus*. Each haul went for 120 min in the Gulf of Mannar and Palk Bay. The catches were segregated, and the species were identified. The jellyfish caught in the gear were measured and weighed.

The biomass quantification of jellyfish was done by the swept area method using the following formula (Sparre and Venema, 1992).

$$a = D * h * X_2$$

where, 'a' is the swept area in square nautical miles (NM^2), 'D' is the distance covered by trawl in NM (calculated using exact positions of the start and end of the haul), 'h' is the length of the head-rope (30 m), 'X_2' is the fraction of the head-rope length or wing spread ratio (0.4 to 0.6 for Southeast Asian bottom trawls but optimum 0.5 was taken for the study). The biomass is estimated as follows (Sparre and Venema, 1992)

$$b = \frac{\frac{(cw}{a)}}{X_1}$$

where, 'b' is the biomass kg/NM^2, 'a' is the area swept by trawl, 'cw' is the catch in weight of a haul (in Kg), X_1 is the fraction of the biomass in the effective path swept by trawl, which is retained in the gear

The length-weight relationship (LWRs) and condition factor were also derived for some of the jellyfish using the formula given by Le Cren (1951),

$$W = aL^b$$

Table 1. Specifications of trawler and trawl net used for experimental fishing

Craft details		Gear details	
Craft type	Trawl	Gear type	Trawl net
Overall length	12 m	Head rope length	65 m
Beam	3.5 m	Foot rope length	70 m
Draft	2.0 m	Otter board type	Rectangular and flat
Power	120 hp	Length of trawl net	37 m
		Cod end Mesh size	20 mm

where W = total weight in grams, L = Bell diameter in centimetres, and 'a' and 'b' are the allometric growth constants.

The correlation coefficient 'r' was calculated to determine the strength and pattern of association between the two variables. The condition factor was calculated by the formula (LeCren, 1951),

$$K = W/(aL^b)$$

where, K = Condition factor, W = Weight (g), L = Bell diameter (cm), 'a' and 'b' are constants.

Results and discussion

The jellyfish catch first and second hauls in the Gulf of Mannar were 350 kg and 90 kg respectively, and the catch rate was 73 kg per hour. The biomass of jellyfish was estimated to be between 106 and 416 kg/NM^2 for the first and second hauls. The average biomass was 211 kg/NM^2. In Palk Bay, the jellyfish catch in the first and second hauls were 32 kg and 43 kg respectively, and the catch rate was 12.5 kg per hour. The biomass of jellyfish was estimated to be 41 and 208 kg/NM^2 for first and second hauls, respectively. The average biomass was 69 kg/NM^2.

In both regions, among the 35 varieties of finfish resources (Table 2), silverbellies were more abundant in the catch. In the Gulf of Mannar, the catch rate of *P. semisulcatus* was 6.3 kg/h, and three species of jellyfish, *viz. C. nozakii*, *R. hispidum*, and *C. chinensis,* were found in the depth range of 22–24 m (Fig. 2

Table 2. Species recorded in the experimental trawling

Groups	Species	Size range (TL) (mm)	weight range (g)	Biomass (kg)	Catch (%)
Teleost	*Alectis indica*	73-105	1.93-55.62	0.43	0.10
	Alepes kleinii	50-134	1.6-45	0.11	0.03
	Apistus carinatus	64-87	4.5-10.85	0.15	0.04
	Jaydia ellioti	73	8.35	0.01	0.00
	Arothron immaculatus	266	305	0.34	0.08
	Bathycongrus nasicus	237-340	9.72-29.84	0.10	0.02
	Carangoides coeruleopinnatus	125	48.07	0.05	0.01
	Cirrhitichthys bleekeri			0.00	0.00
	Cynoglossus arel	235-292	70.82-146.87	1.08	0.26
	Cynoglossus dispar	41-230	2.03-20.58	0.53	0.13
	Cynoglossus puncticeps	64-101	3.06-8.82	0.03	0.01
	Epinephelus areolatus	141	38.62	0.04	0.01
	Gazza minuta	80-139	10.18-39.44	8.74	2.11
	Gerres longirostris	91-131	15.52-63.79	0.36	0.09

Groups	Species	Size range (TL) (mm)	weight range (g)	Biomass (kg)	Catch (%)
	Heteromycteris oculus	76-99	4.66-11.88	0.02	0.00
	Hilsa kelee	140	31.77	0.03	0.01
	Johnius borneensis	11-109	2.03-23.6	0.21	0.05
	Karalla daura	95-120	2.59-26.6	0.36	0.09
	Karalla dussumieri	54-125	1.25-53.87	109.36	26.44
	Lactarius lactarius	204	93	0.10	0.02
	Lagocephalus lunaris	90-176	16.19-130.47	0.16	0.04
	Equulites lineolatus	12-110	0.18-40.1	6.74	1.63
	Lepturacanthus savala	49-146	2.63-39.53	0.69	0.17
	Lethrinus lentjan	101-370	15.94-460	3.95	0.96
	Leucosia anatum	9-18	1.73-5.04	0.06	0.01
	Ellochelon vaigiensis	145-156	36.94-46.32	0.18	0.04
	Lutjanus fulviflamma	190	100.75	0.11	0.03
	Lutjanus lutjanus	110	20.35	0.02	0.01
	Muraenesox bagio	501	121.58	0.13	0.03
	Nemipterus japonicus	102-163	19.06-69.61	1.01	0.24
	Netuma thalassina	349	448	0.49	0.12
	Nibea maculata	122-172	42.22-92.11	0.24	0.06
	Nuchequula gerreoides	21-116	3.76-41	4.08	0.99
	Otolithes ruber	117	14.33	0.02	0.00
	Pampus chinensis	155.0	177.0	0.19	0.05
	Parastromateus niger	75-152	12.28-116.95	0.61	0.15
	Pelates quadrilineatus	60-173	5.24-78.23	0.45	0.11
	Pellona ditchela	21-134	8-29.16	0.20	0.05
	Paramonacanthus nipponensis	81	12.81	0.01	0.00
	Photopectoralis bindus	95	15.49	0.02	0.00
	Platycephalus indicus	51-195	2.32-66.01	0.78	0.19
	Plotosus lineatus	65-132	1.77-13.61	2.67	0.64
	Psettodes erumei	80-170	10.27-62.38	0.23	0.05
	Pseudorhombus elevatus	71-77	4.59-5.72	0.01	0.00
	Pseudorhombus malayanus	32-105	1.26-40.72	19.94	4.82
	Pseudorhombus triocellatus	92-113	13.68-22.92	1.61	0.39
	Pterois russelii	130-183	31.86-88.06	0.13	0.03
	Rastrelliger kanagurta	75	3.37	0.00	0.00
	Richardsonichthys leucogaster	64-95	7.86-16.25	0.06	0.01
	Sardinella albella	129-134	23.48-25.15	0.05	0.01
	Saurida micropectoralis	11-275	9.53-148.04	3.13	0.76

Groups	Species	Size range (TL) (mm)	weight range (g)	Biomass (kg)	Catch (%)
	Scomberoides commersonnianus	201	64.01	0.07	0.02
	Scomberomorus commerson	140-203	21.8-60.55	0.53	0.13
	Leiognathus ruconius	80-139	10.18-39.44	23.07	5.58
	Selaroides leptolepis	11-151	9.25-38.52	2.86	0.69
	Siganus canaliculatus	60-162	10.39-72.91	0.70	0.17
	Sillago sihama	75-204	3.67-124.06	1.72	0.42
	Sphyraena pinguis	125-273	53.71-135.8	0.30	0.07
	Sphyraena flavicauda	190-220	59.2-72.46	0.21	0.05
	Stolephorus commersonnii	51-125	1.64-16.28	0.20	0.05
	Stolephorus indicus	49-76	0.99-3.97	0.09	0.02
	Strophidon sathete	555	75.73	0.08	0.02
	Telatrygon zugei	119-199	28.72-265	1.62	0.39
	Terapon puta	17-125	4.66-91.12	2.21	0.53
	Thryssa mystax	60-146	1.59-31.82	1.16	0.28
	Thryssa setirostris	76-178	3.41-17.7	0.17	0.04
	Trachinocephalus myops	71-231	3.62-57.35	0.71	0.17
	Trypauchen vagina	141	38.62	0.01	0.00
	Upeneus sundaicus	60-190	10.01-61.15	10.36	2.51
	Upeneus tragula	95-172	12.58-64.8	1.70	0.41
	Upeneus margarethae	95-172	12.58-64.8	3.69	0.89
	Scomberomorus commerson	39-55	200-300	0.50	0.12
Elasmobranchs	*Brevitrygon imbricata*	71-272	13.99-226	0.77	0.19
	Gymnura poecilura	246-277	131.96-209.42	0.38	0.09
	Torpedo sp.	70	27.36	0.03	0.01
	Glaucostegus granulatus	276-291	63.69-72.44	0.15	0.04
Cephalopods	*Uroteuthis (Photololigo) duvaucelii*	78	29.71	0.03	0.01
Shrimps	*Alpheus lobidens*	44-60	2.51-4.06	0.02	0.00
	Metapenaeopsis barbata	60	2.4-3.77	0.01	0.00
	Metapenaeopsis stridulans	54-67	1.66-3.01	0.02	0.01
	Metapenaeus moyebi	59-95	1.31-6.84	0.05	0.01
	Kishinouyepenaeopsis maxillipedo	35-94	4.23-14.68	1.59	0.38
	Penaeus indicus	75	2.64	0.00	0.00
	Penaeus latisulcatus	105-135	8.84-23.47	0.06	0.01
	Penaeus semisulcatus	22-222	8.29-90.9	12.32	2.98
	Megokris granulosus	45-166	1.02-5.68	0.18	0.04
Crabs	*Aethra scruposa*	74	54.01	0.06	0.01
	Albunea occulta	23	4.5	0.00	0.00

Groups	Species	Size range (TL) (mm)	weight range (g)	Biomass (kg)	Catch (%)
	Arcania erinacea	2-5	4-5	0.04	0.01
	Arcania heptacantha	18	5.43	0.01	0.00
	Calappa bilineata	46-90	16.19-137.8	0.76	0.18
	Calappa clypeata	35	6.26	0.01	0.00
	Calappa gallus	36	14.65	0.02	0.00
	Calappa lophos	34-65	7.35-85.98	0.80	0.19
	Charybdis (Charybdis) natator	44-66	20.27-102.97	0.28	0.07
	Charybdis (Charybdis) variegata	36	14.65	0.02	0.00
	Charybdis (Charybdis) granulata	22-25	1.86-2.72	0.01	0.00
	Doclea canalifera	20-35	1.31-16.14	0.06	0.01
	Dorippe frascone	10-22	1.91-4.77	0.02	0.00
	Dorippe quadridens	20-31	3.21-11.67	0.05	0.01
	Enoplolambrus pransor	19-28	7.93-14.54	0.08	0.02
	Ixa cylindrus	19-51	0.54-4.78	0.05	0.01
	Matuta planipes	10-26	1.95-13	0.04	0.01
	Myra fugax	16-25	3.38-5.06	0.04	0.01
	Pagurus kulkarnii	20-110	0.73-29.41	0.53	0.13
	Portunus pelagicus	50-70	110-150	0.43	0.10
	Eodemus hastatoides	19-34	1.02-8.21	0.20	0.05
	Portunus sanguinolentus	10-54	18-115	5.62	1.36
	Monomia gladiator	17-71	1.02-49.8	0.59	0.14
Stomatopods	*Cloridopsis immaculata*	55-94	2.28-48	0.09	0.02
	Erugosquilla woodmasoni	64-169	2.73-46.73	0.29	0.07
	Oratosquillina gravieri	35-127	1.04-90.04	1.07	0.26
	Oratosquillina quinquedentata	45-96	1.47-7.77	0.23	0.06
Gastropods	*Babylonia spirata*	34-51	4.76-24.81	0.45	0.11
	Babylonia zeylanica	22-46	2.17-21.64	0.05	0.01
	Bufonaria crumena	20-75	1.14-32.55	0.60	0.15
	Chicoreus virgineus	28-64	2.38-21.76	0.04	0.01
	Conus amadis	31-45	2.94-9.11	0.02	0.01
	Conus araneosus	41-51	8.72-23.45	0.07	0.02
	Conus monile	38	7.61	0.01	0.00
	Hastula raphanula	37	2.4	0.00	0.00
	Ficus ficus	63-67	12.9-79	0.14	0.03
	Fusinus colus	62	2.93	0.00	0.00
	Gemmula vagata	30-69	1.0-11.59	0.05	0.01
	Gyrineum natator	42	5.77	0.01	0.00
	Harpa major	65-79	36.54-49.19	0.15	0.04

Groups	Species	Size range (TL) (mm)	weight range (g)	Biomass (kg)	Catch (%)
	Unedogemmula indica	55-90	4.79-11.57	0.12	0.03
	Neodilatilabrum marginatum	27-49	1.31-11.25	0.04	0.01
	Monetaria annulus	42	5.77	0.01	0.00
	Murex tribulus	22-70	0.9-10.11	0.07	0.02
	Nassaria pusilla	15-26	0.83-2.59	0.03	0.01
	Nassarius glans glans	39	2.92	0.00	0.00
	Nassarius stolatus	28-32	1.18-4.35	0.01	0.00
	Naticarius canrena	20-24	1.8-2.79	0.01	0.00
	Tanea picta	15-18	1.63-2.15	0.00	0.00
	Natica vitellus	16	0.78	0.00	0.00
	Neverita didyma	30-45	5.83-17.41	0.10	0.02
	Notocochlis gualteriana	19	2.61	0.00	0.00
	Oliva reticulata	29-49	2.84-12.83	0.21	0.05
	Oliva sericea	19-46	0.57-11.03	0.11	0.03
	Phalium glaucum	29-68	4.04-91.79	0.55	0.13
	Polinices mammilla	7-8	1.43-1.5	0.00	0.00
	Mammilla melanostoma	22-23	1.4-1.41	0.00	0.00
	Rapana rapiformis	19-65	1.66-34.5	0.25	0.06
	Semicassis bisulcata	34-45	3.86-11.51	0.03	0.01
	Tanea lineata	15-25	0.97-2.59	0.01	0.00
	Tonna dolium	14-97	0.21-58.33	0.56	0.13
	Turbinella pyrum	29-111	1.44-175.72	0.59	0.14
	Turritella terebra	79	12.73	0.01	0.00
	Vexillum acuminatum	24-25	0.94-1	0.00	0.00
	Volegalea cochlidium	29-97	1.64-152.18	0.65	0.16
Bivalves	*Tegillarca granosa*	36	6.44	0.01	0.00
	Anadara inaequivalvis	9-34	0.73-14.62	0.94	0.23
	Cardites bicolor	8-26	1.32-8.04	0.16	0.04
	Cucullaea labiata	22-58	3.64-51.54	1.33	0.32
	Latona cuneata	11-33	0.35-2.49	0.01	0.00
	Donax faba	19-34	1.02-4.18	0.01	0.00
	Donax incarnatus	6-11	0.47-1.32	0.00	0.00
	Marcia opima	25	6.1	0.01	0.00
	Meretrix casta	9-56	0.44-40.17	0.92	0.22
	Paratapes textilis	8	2.34-2.31	0.01	0.00
	Pinctada fucata	32	4.25	0.00	0.00
	Pinctada sugillata	33	2.6	0.00	0.00
	Pinna bicolor	141	4.91	0.04	0.01
	Placuna placenta	14-79	0.18-8.08	0.17	0.04

Groups	Species	Size range (TL) (mm)	weight range (g)	Biomass (kg)	Catch (%)
	Solen strictus	51	1.16	0.00	0.00
	Macomangulus tenuis	22	2.46	0.00	0.00
	Vepricardium asiaticum	14-46	1.27-25.57	0.49	0.12
	Volachlamys tranquebaria	27-33	1.77-4.25	0.01	0.00
Echinoderms	*Brissus unicolor*	55-64	11.35-34.98	0.05	0.01
	Sculpsitechinus auritus	35-94	4.23-14.68	0.07	0.02
	Salmacis virgulata	14-87	1.05-49.81	0.20	0.05
	Ophiactis savignyi	45-50	1.1-5.2	0.01	0.00
	Archaster typicus	29-170	1.12-11.71	0.07	0.02
Barnacles	*Balanus*	11-16	0.29-0.39	0.00	0.00
Jellyfish	*Cyanea lamarckii*	105-490	110-7400	142.26	34.39
	Rhopilema hispidum	140-210	180-506	4.96	1.20
	Chrysaora chinensis	46-112	15-65	0.31	0.08
	Lobonemoides robustus	45-215	30-560	7.21	1.74
	Sponge	61-115	14.97-62.64	0.42	0.10
	Chank egg	11	1.1	0.00	0.00

and Fig. 3). Among these, *C. nozakii* was found to be the dominant and most abundant species in the Gulf of Mannar region. In Palk Bay, very minor quantities of shrimp (0.9 kg/hour) and jellyfish were caught at 10 m depth. *L. robustus* is an abundant jellyfish in this area. (Fig. 4). The Sea Surface Temperature (SST) and salinity recorded were in the range of 28.6-30.2 ^{0}C and 33-34 ppt in the fishing grounds of Palk Bay and the Gulf of Mannar. The size distribution of jellyfish in the Gulf of Mannar and Palk Bay is depicted in Fig. 5, and the length-weight relationship of jellyfish is depicted in Fig. 6. The morphometric values of jellyfish are given in Table 3. The relationship between bell diameter and wet weight was highly significant (r^2>0.9; p<0.01) for *C. nozakii*, *C. chinensis,* and *L. robustus*.

The seasonal fishing ban on the east coast starts from April 15th to June 14th to avoid the breeding season of most of the fishery resources of this coast. After the ban, shrimp fishing is at its peak in both the Palk Bay and the Gulf of Mannar region. This preliminary study determined the influence of jellyfish co-occurrences in the shrimp fishery. Jellyfish play a vital role in the ecosystem. Lynam and Brierley (2007) said that young (0-group) gadoid fish that have been hiding under the umbrellas

Fig. 2. Jellyfish caught in trawl in the Gulf of Mannar (haul-1). A. Unloading of catch from the cod end, B. Catch, C. Sorting of catch and measuring jellyfish

Fig. 3. Jellyfish caught in trawl in the Gulf of Mannar (haul-2). A. Catch, (Arrow shows jellyfish) B. *Cyanea nozakii*

Fig. 4. Experimental trawl catches in Palk Bay. A. Catch (haul-1, arrow shows jellyfish), B. Sorting of the catch onboard, C. Holding a specimen of *Lobonemoides robustus,* D. Catch (haul-2)

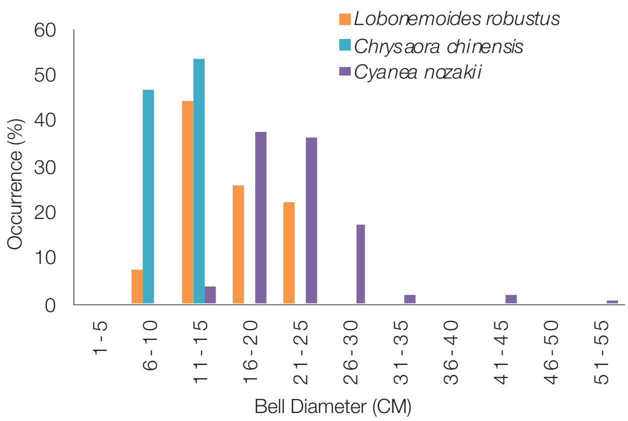

Fig. 5. Size distribution of Jellyfish catches in the Gulf of Mannar and Palk Bay

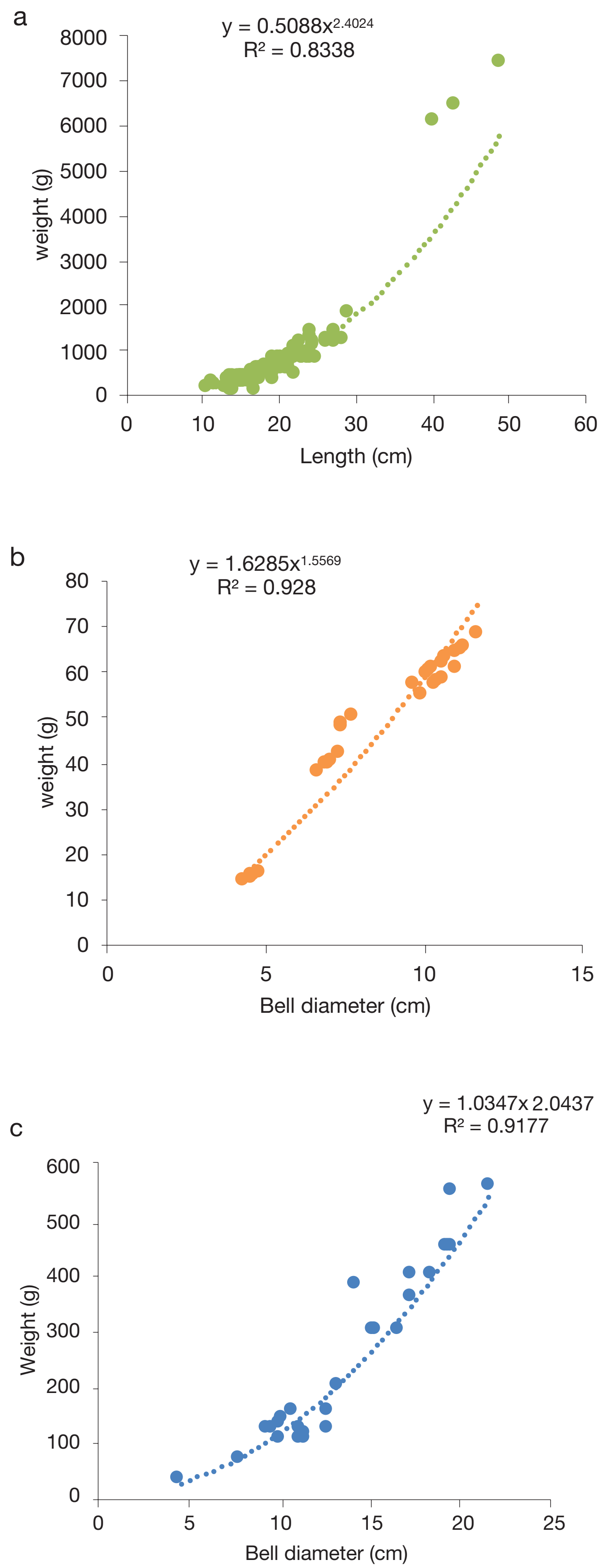

Fig. 6. Length-weight relationship of Jellyfish in the Gulf of Mannar and Palk Bay. A. *Cyanea nozakii,* B. *Chrysaora chinensis* C. *Lobonemoides robustus*

of scyphozoan and hydrozoan jellyfish may find safety from predators by hiding among the tentacles of medusae. This would help the survival of juvenile gadoids where there are lots of medusae. Most trawl fisheries discard most of the caught species, with estimates of the ratio of bycatch and discards to the total catch ranging from 45 to 50% (Tudela, 2004). According to Bailey (1989), large-sized jellyfish accounted for 86.9% of the weight of midwater trawl catches, with juvenile Pollock coming in second (11.6%). A moon jellyfish affects the size distribution and catches efficiency of horse mackerel in the midwater trawl fishery of the Black Sea. It has been found that moon jellyfish make up 33% of the total catch (Özdemir, 2014).

According to a study by Behera *et al.* (2022), the relationship between length (diameter) and weight is negative allometry for *Crambionella annandalei* (b = 2.547–2.601) and *Chrysaora* spp. (b = 2.34–2.981). The present study also recorded similar results with b values less than three and showed negative allometry for *C. nozakii* (2.402), *C. chinensis* (1.556), and *L. robustus* (2.043).

Generally, fishermen perceive 1–3 kg of green tiger shrimp per hour of operation as good in normal circumstances, however when jellyfish co-occurs; the catch is reduced, but our experimental trawl revealed a normal shrimp catch despite the jellyfish abundance, mainly because of the ban on commercial fishing operation and our experimental fishing is done with special permission to assess jellyfish abundance in shrimp fishing ground during the ban period. The experimental trawling data show that the Palk Bay and Gulf of Mannar shrimp catches differed during the same period. Rajkumar *et al.* (2023; 2024) asserted that the higher shrimp catch rates in Palk Bay were attributed to its productive fishing grounds, which are relatively shallow, whereas fishing in the Gulf of Mannar occurs in comparatively deeper waters. However, in the present investigation, the catch is higher in the Gulf of Mannar than in Palk Bay due to the ban period and monsoon changeover period. Jellyfish are a free-swimming medusa stage and mostly distributed in the pelagic

Table 3. Morphometric values and condition factor of the jellyfish

Species	n	Bell diameter (cm)		Weight (g)		Length-weight relationship			Condition factor		Relationship
		Range (Min-max) cm	Mean±SD (cm)	Range (Min-max) (g)	Mean±SD (g)	a	b	R^2	Range (Min-max)	Mean±SD	
Cyanea nozakii	104	10.5-49	19.1±5.9	110-7400	607.4±1067.3	0.5088	2.402	0.942	0.291-1.698	1.000±0.251	Negative allometry
Chrysaora chinensis	28	4.37-11.76	8.25±2.46	14.25-68.25	43.16±17.74	1.6285	1.556	0.9187	0.810-1.280	0.982±0.146	Negative allometry
Lobonemoides robustus	27	4.5-21.5	12.95±4.28	30-560	194.17±160.96	1.0347	2.043	0.9332	0.654-1.622	1.000±0.214	Negative allometry

*SD-standard deviation

and columnar coastal waters and the benthic nature of shrimp does not interact much to affect each other but its predation effect on benthic jellyfish polyp is poorly known. However, jellyfish may have considerable influence on the pelagic resources, zooplankton, fish eggs and larvae. Thus, continuous monitoring can help understand the long-term implications of the jellyfish abundance on zooplankton, fish eggs and larvae and their influence on recruitment of commercially important fishery resources along the Tamil Nadu coastline. Further demarcating jellyfish occurring areas as 'Jellyfish Focal Areas' (JFA) for better management of commercial fishing operations in both the Gulf of Mannar and Palk Bay is put forth.

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Author contributions

Conceptualisation: MR; Methodology: MR, RS; Data Collection: MR, ST, KS; Data Analysis: MR, RS, ST; Writing Original Draft: MR; Writing Review and Editing: MR, RS, SJK; Supervision: AKA

Data availability

The data are available and can be requested from the corresponding author.

Conflicts of interest

The authors declare that they have no conflict of financial or non-financial interests that could have influenced the outcome or interpretation of the results.

Ethical Statement

No ethical approval is required as the study does not include activities that require ethical approval or involve protected organisms/ human subjects/ collection of samples/ protected environments.

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