ANALYSIS OF CATCHING EFFICIENCY OF COLLAPSIBLE SERIAL FISH TRAPS WITH TWO DIFFERENT FUNNELS[#]

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ABSTRACT

A study on the comparative efficiency of two types of serial collapsible fish traps differing rear end funnel opening was carried out. With respect to Type-1 trap having rectangular rear end funnel opening and Type-2 trap with elliptical rear end were fabricated. The experiment was carried out in fishing ground one nautical mile off the coast of Mandapam (Lat 09º 16.633'N, Long: 079º 08.992') February 2015 to June 2015. Significant difference was observed with respect to catch rate of different species caught irrespective of the design of traps (P<0.05). The difference in shape of rear funnel opening was found to be responsible for the significant difference in the catch rate of the experimental traps. The mean overall catch rate of Type-1 trap with rectangular rear funnel opening was about three times higher (17.1 Nos/ soaking day) than that of Type-2 trap with elliptical shaped rear funnel opening (5.9 Nos./ soaking day). The impact of seasonal variation on the catch rate was found to be insignificant (P>0.05). Though Psammoperca waigiensis was found to be the dominant species in both types of traps in terms of numbers, Epinephalus coioides ranked first in terms of weight and price per kilogram in both Type-1 and Type-2 traps. Irrespective of the types of traps tested, the higher catch rate, including all the species caught, and was observed during the month of February which directly increased the overall catch rate during February month. With respect to the behavior of different species caught in relation to the types of traps tested, Sarcocendrum rubrum was recorded only in Type-1 trap which had rectangular shaped rear funnel opening and Muraena sp was recorded only in Type-2 trap with elliptical shaped rear end of the funnel opening which served like a burrow and hence facilitated the entry of eel. Type -1 trap gave three times higher gross returns than Type-2 trap.

Key Words: Trap, Funnel opening, Catch rate

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INTRODUCTION

Trap is the earliest form of fishing gear mainly used in orients and later introduced in various parts of the world (Hornell, 1950). Trap is an impounding device into which fish is lured to enter and there after the escape is made difficult. A fish trap may have one or more chambers, to retain the catch. One of the indigenous methods prevalent in the Gulf of Mannar and Palk Bay is employing traps, locally called "*Koodu*". These traps have been primarily intended for catching percoid fishes which prefer localities with hard bottom formed of rocks and corals in the inshore waters of the Gulf of Mannar and Palk Bay (Prabhu, 1954). Trap designs have been evolved for many years to suit the local conditions such as the nature of ground, depth of water and strength of tide (Spence, 1989). Judiciously selected materials improve the efficiency of traps up to 10 times higher (Brandt, 1984). The metal pots would be the obvious solution to avoid losses of wooden pots every year while lobster fishing (Prudden, 1951). In the process of development, first non-return device was made with galvanized iron wire (Thomas, 1953). Metal traps could effectively replace the wooden traps (Webster, 1959). Floating pots have been designed to maximize the selectivity with as little modification of the original design as possible and minimize the chance of fish getting lost through the escape window when the pot was hauled (Stewart and Ferrell, 2003). The design and model of fish trap also have been reported to affect the capture success of Black sea bass (Shepherd *et al.*, 2002). Collapsible traps have the advantages of occupying less space in the boat. In recent years the use of collapsible trap is increasingly widespread because of its advantages over ordinary trap and other fishing gear (Slack-Smith, 2001). Design of the trap entrance and bait have been reported to be an important factors that decide the efficiency of the trap. Comparative studies have been carried out to analyze the efficiency of three types of traps and a hoop net. Among them, round pots yielded highest catch. They attributed the greater efficiency of round crab pots to the shape of entrance besides the higher number of entrances (4 Nos) which affect their ability to facilitate the entry and retention of organisms (Butcher *et al.*, 2012). The objective of the present study was to determine the shape of rear end opening of the funnel is ideal for the collapsible serial fish trap.

MATERIALS AND METHODS

The trap frames were fabricated using light weight material of PVC pipes and, additionally, it is a non-corrosive material which can withstand very well in seawater. The PVC pipe of 25 mm diameter was used to fabricate the two types of experimental traps viz. Type -1 trap and Type- 2 trap. Commercially available 20 feet length PVC pipe was purchased and cut into four pieces, two pieces with a length of 90 cm and two pieces with a length of 60 cm). The four pieces were joined together using the four elbow joints which gave a rectangular shape to the frame_Four different types of frames were prepared with different level of filling of cement mortar mix to assess the floating and sinking performances of frames which helps to avoid experimental error during fishing. The following four types of frames were prepared viz., (i) Without filling, (ii)

Completely filled, (iii) filled only at the base pipe and (iv) filled at the base pipe and half of the vertical pipe. Cement mortar mix was prepared by mixing the cement and sand with in the ratio of 1:2 respectively and water was added at the rate of 500 ml per kilogram mixture. The floating and sinking performances of the above mentioned frames were tested in a circular cement tank of 2m diameter having 500 liters of sea water. It was found that frames filled with cement mortar both at the base and vertical pipe showed both sinking and vertical erection of frame. The fourth type of frame was found to be more suitable which was weighed around 2 Kg.

Eleven frames were used for making combined Type-1 and Type-2 serial trap assembly so as to have five chambers per type of trap. A black colored nylon (Poly Amide) webbing having 330 meshes in length and 230 meshes in breadth with 50mm meshes were joined length wise by folding their ends together so as to form a long bag with a help of a nylon twine having a specification of 23 Tex / 2/ 3. A total of eleven frames were inserted in to the bag one by one and laced with a help of a nylon twine with the specification of 23 Tex/3/3. The inter distance between two frames was maintained as 0.73 m with 30 meshes. The front face of the trap had 36 meshes in length and 23 meshes in height. Further, two polyethylene webbings having the dimensions of 100 meshes along length and 118 meshes along the height and with mesh size of 50mm was seamed to form a cylindrical bag resembling rod end of the trawl. Two such bags were made and attached on either side of serial trap assembly as fish collection bags (Fig. 1). Two additional frames were fixed one on each side of the cod ends of the trap assembly after a distance of 40 meshes from the extreme frame (*i.e.,* 1st and 11th frame) to facilitate free movement of fish inside the trap.

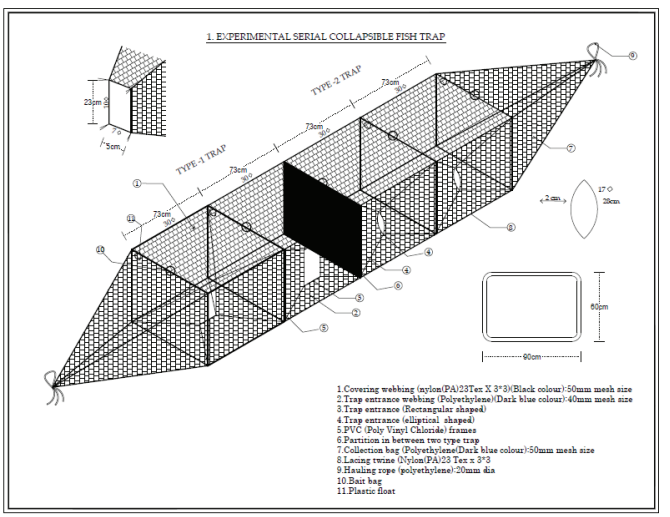

Fig. 1. Experimental collapsible serial fish trap assembly

The rear ends of the bags were closed with help of cod end knots commonly used for closing the cod end of trap so as to serve as collection bags. Both the ends were secured tightly with polyethylene twine of 12mm thickness by passing through the end meshes. The front face of each of the trap units were cut and removed on alternative side so that each of the adjacent trap units had the entrance on opposite side alternatively. In this experimental serial collapsible fish trap Type-1 trap consisted of 5 chambers, each of which was fitted with a funnel having rectangular rear opening. While Type-2 trap consisted of 5 chambers, each of which were fitted with a funnel having elliptical shaped rear opening.

Funnel of Type-1 trap

The funnel had three panels. The funnel of Type 1 trap was made from polyethylene webbings of 40mm mesh size fabricated with the twine of 0.75mm thickness The first panel had 100 meshes in length and 10 meshes in depth while the second panel had 50 meshes in length and 7 meshes in depth. Both first and second panels were joined with take up ratio of 2:1. The third panel had 34 meshes in length and 5 meshes in depth and it was joined with the second panel with take up ratio of 3:2. Joining of three resulted in a trapezoidal piece. The lateral edges of the trapezoidal funnel piece were folded and laced with a polyethylene twine of 0.75 mm diameter to get the funnel. After lacing, the stretched circumference of rear end funnel opening was 56cm. The rear end funnel opening was made rectangular with the help of a bolch line of polyethylene twine of 2.5mm. Further, the bolch line had the base width of 5 cm accommodating 7 meshes and a height of 23cm accommodating 10 meshes. The funnel was made by tying the corners of rectangular rear end opening of the funnel the respective opposite frame corners with help of a twine having 2.5 mm thickness

Funnel of Type-2 trap

The funnel of Type – 2 trap had elliptical shaped rear end opening. The funnel design of Type 1 –trap resembled exactly with that of Type -2 trap. However, the rear funnel opening of Type-2 trap was made as elliptical with mid width of 2cm and the stretched circumference of 56cm. Elliptical a shape in the rear end of the funnel could be achieved with the help of a bolch line of polyethylene twine of 2.5mm. Each arc of the elliptical bolch line was 28cm long which accommodated 17 meshes. The rear opening of the funnel of Type -2 was maintained as elliptical by tying its upper corner to the midpoint of the upper frame rod and lower corner to the midpoint of the lower frame rod respectively with the help of twines having of 2.5 mm thickness. Bait bags were made up of nylon webbing with mesh size of 50 mm. Each chamber of both type -1 and type- 2 traps had bait bags. The design details of experimental collapsible serial fish trap is shown in Fig.1.

RESULTS

Operational methodology

The present study was carried out at Mandapam fishing village of Ramanathapuram district of Tamil Nadu.

The traps were operated from a *Vallam* with the Overall Length (OAL) of 5 m, beam of 2 m and the depth of 2-5 m. The experimental traps were operated for five months from February 2015 to June 2015 in fishing grounds one nautical mile off the coast of Mandapam (Lat: 09^0 16.633'N; Long: 079^0 08.992' E).The total soaking duration of the trap was kept as 18 hrs for all fishing trials. Four species of fish such as *Psammoperca waigiensis, Epinephelus coioides, Sarcocendrum rubrum, Muraena sp* were found to be caught in the experimental traps during the study period (Fig. 2). Among the four species *S. rubrum* was caught in Type-1 trap and *Muraena sp* was caught only in Type-2 trap.

Performance of Type - 1 Collapsible serial fish trap

During the experimental period, three species of finfishes viz. *Psammoperca waigiensis, Epinephalus coioides*, *Sarcocendrum rubrum* were caught in the Type -1 trap. Month wise total fish catch details of Type-1 experimental trap is given in Table 1.The total catch of Type-1 trap was found to be 342 fishes for 20 soaking days with mean catch rate of 17.1 Nos/ soaking day (Table 1). Regarding the species wise overall catch rate, *P.waigiensis* was the species that showed highest representation in Type-1 with the catch rate of (8.8Nos/ soaking day) during the experimental

a. *Psammoperca waigiensis*

b. Psammoperca waigiensis

c. *Muraena sp*

d. Sarcocendrum rubrum

Fig. 2. Fishes caught in experimental traps

period. The highest catch rate of *P. waigiensis* in terms of weight was recorded during the month of February (2.50 kg/ soaking day) while lowest catch rate was being recorded (1.25kg/ soaking day) during June. Regarding the length distribution of catch during different months, highest mean length of 26.5cm was recorded for *P. waigiensis* during the month of February and lowest mean length of 23.5cm during May. With regard to monthly catch rate also, *P.waigiensis showed* its dominance with peak representation during the month of February (10Nos/ trap/ soaking day). It's lowest catch rate was recorded during month of June (7Nos/ trap/ soaking day).

In the case of *E.coioides* highest mean length of *E.coioides* of 36 cm was recorded during the month of February while the lowest mean length being 28cm recorded during June. Further, *E.coioides* was found to be the second dominant species and it also showed its dominance during the month of February as in the case care of *P. waigiensis* with the mean catch rate of 6Nos/trap/soaking day and the lowest catch rate during June (3Nos/ trap/ soaking day). *Sarcocendrum rubrum* was found to be the least dominant species with overall catch rate of the 3.3 Nos/ soaking day in Type-1 trap. Further, *E. coioides*, was caught with the overall mean catch rate of 5 Nos/ soaking day (Table 1). With respect to size of fish caught, *E. coioides* was the biggest species recorded in Type 1 trap (TL=36 cm) with the weight of 1.3kg The highest catch rate of *E. coioides* in terms of weight was also recorded during the month of February (2.13 kg/soaking day). On the other side, the lowest catch rate (1.38 kg/ soaking day) was noticed in the month of May.

Table 1. Month wise total catch details of Type-1 experimental trap

SI. No	Name of the Species	Month										Total		
		Feb		March		April		May		June				
		Nos	Kg	Nos	Kg	Nos	Kg	Nos	Kg	Nos	Kg	Total no's	Total no's/ soaking day	kg
1	*Psammoperca waigiensis*	40	10	33	7.5	35	8.0	38	6.3	30	5.0	176	8.8	36.8
2	*Epinephelus coioides*	25	8.5	20	6.2	22	6.5	18	5.5	15	7.0	100	5	33.7
3	*Sarcocendrum Rubrum*	17	1.5	12	1.0	15	0.5	10	0.5	12	0.25	66	3.3	3.75
	Total	**82**	**20**	**65**	**14.7**	**72**	**15.0**	**66**	**12.3**	**57**	**12 .25**	**342**	**17.1**	**74.25**

Table 2. Month wise total catch details of Type-2 experimental trap

SI. No	Name of the species	Month										Total		
		Feb		March		April		May		June				
		Nos	Kg	Nos	Kg	Nos	Kg	Nos	Kg	Nos	Kg	Total Nos	Total no's/ soaking day	Kg
1	*Psammoperca waigiensis*	20	4.7	12	3.0	7	2.5	11	2.0	15	1.5	65	3.25	13.7
2	*Epinephelus coioides*	12	3.0	8	2.2	5	1.75	3	2.0	5	1.5	33	1.65	10.45
3	*Muraena sp*	1	3.0	0	0	0	0	0	0	0	0	1	1	3.0
	Total	**33**	**10.7**	**20**	**5.2**	**12**	**4.25**	**14**	**4.0**	**20**	**3.0**	**99**	**5.9**	**27.15**

Further, *Sarcocendrum rubrum* was the smallest fish among the three types of fishes caught with total length of 11.5 cm weighing 110 g in Type-1 trap. As far as *S. rubrum* was concerned, it ranked third in the catch in terms of number. It's highest mean length of 15cm was recorded during the month of February while the lowest mean length was being 11.5cm which was recorded during the month of May. There existed coincidence between highest mean length and highest occurrence of *S. rubrum* in Type -1 trap. Accordingly, the highest catch rate of *S. rubrum* was recorded during the month of February (4Nos/ trap/ soaking day) while the lowest catch rate was recorded during the month of May (2Nos/ trap/ soaking day). In terms of weight, the highest catch rate of *S. rubrum* was recorded during the month of February (0.38kg/ soaking day) and the lowest catch rate was observed during the month of June (0.06 kg/ soaking day).It could be observed that irrespective of the various species caught in the Type-1 trap, their highest catch rate was recorded during the month of February revealing the fact that February was the peak fishing month during the experimental study. However, the species differed from each other with respect to the month of occurrence and the lowest catch rate in different month.

Regarding the overall mean total catch rate of the fish**,** Type -1 trap of *P. waigiensis,* represented as much as 52% of the catch. *Epinephalus coioides* contributed 29% followed by *S. rubrum* with the contribution of 19% of the fish during the experimental period (Fig. 3).There was a general decline in catch rate from the beginning to the end of the experimental period. Notable difference in the catch rate between the three species could be observed throughout the study period during different months ($P<0.05$) (Table 3).

Table 3. Analysis of variance on the impact of design and season on catch rate of different species of fishes

Source of variation	Degrees of freedom	Sum of square	Mean sum of square	F ratio	F table		P value
					1 %	5%	
Species	2	1055	527.5	4.68	8.65	4.46	P < 0.05
Month	4	153	38.3	0.34	7.01	3.84	P > 0.05
Error I	8	901	112.6				
Source of variation	**Degrees of freedom**	**Sum of square**	**Mean sum of square**	**F ratio**	**F table**		**P value**
					1 %	**5%**	
Design	1	856	856	8.2	9.33	4.75	P < 0.05
Interaction	2	62	31	0.3	6.93	3.89	P > 0.05
Error II	12	1258	104.8				

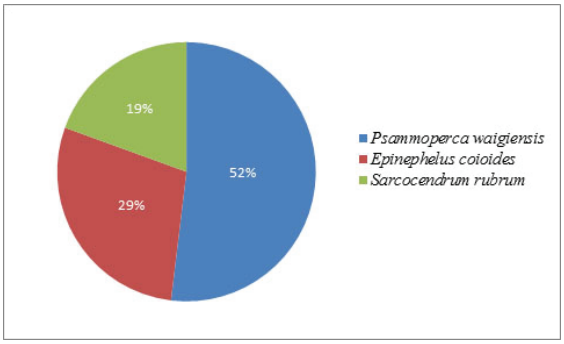

Fig. 3. Species wise catch composition of Type-1 experimental trap

Performance of Type- 2 experimental collapsible serial fish trap

During the experimental period, three species of finfishes such as *Psammoperca waigiensis, Epinephalus coioides* and *Muraena sp* were caught in the Type- 2 trap. The total catch rate of *Psammoperca waigiensis* in Type- 2 trap was found to be 99 Nos/ 20 soaking days with mean catch rate of 5.9 Nos/ soaking days (Table 2). Regarding the overall catch rate, *P. waigiensis* showed highest representation (3.5 Nos/ soaking day) during the entire experimental period. *Psammoperca waigiensis* was caught with the highest mean length of 28cm during the month of May and with the lowest mean length of 20.5 cm during June. As in Type-1 trap *P. waigiensis* was the most dominant species based on the monthly catch rate which showed its peak representation during the month of February(5 Nos/ trap/ soaking day) and its lowest catch rate was recorded during the month of April (2 Nos/ trap/ soaking day). *Psammoperca waigiensis* was the smallest species recorded in the Type-2 trap with the length of 20.5cm weighing 200g. The highest catch rate of *P. waigiensis* in terms of weight, was recorded during the month of February (1.12 kg/soaking day) and lowest catch rate was observed during the month of June (0.38 kg/month) (Table 2).

Table 4. Monthly returns

S. No.	Species	Month					Total (Rs)
		February (Rs)	March (Rs)	April (Rs)	May (Rs)	June (Rs)	
a. From Type – 1 experimental trap							
1.	*Psammoperca waigiensis*	1800	1100	1340	1360	1015	6,615
2.	*Epinephalus coioides*	2180	1700	1640	1020	720	7,260
3.	*Sarcocendrum rubrum*	360	240	240	120	240	1,200
				Gross returns			**15,075**
b. From Type – 2 experimental trap							
1.	*Psammoperca waigiensis*	660	470	230	600	480	2,440
2.	*Epinephalus coioides*	850	620	400	280	350	2,500
3.	*Muraena sp*	50	-	-	-	-	50
				Gross returns			**4, 990**

In contrast to *P. waigiensis*, the highest mean length of *E. coioides* was recorded during the month of April (36 cm) and the lowest mean length of 31cm during May. As in the case of *P. waigiensis,* the highest catch rate of *E. coioides* was record during the month of February (3 Nos/ soaking day), while the catch rate was low and remained same during the remaining months of experimental period (1No/ trap/ soaking day). Regarding the overall catch rate, *E. coioides* was caught with the catch rate of 1.65 Nos/ soaking day. The highest catch rate of *E. coioides* in terms of weight *was* recorded during the month of February (0.75 kg/ months) while the lowest catch rate was observed during June (0.3 kg/months). *Muraena sp* was recorded only once with the length of 110cm during the month of February and hence it was found to be the rarest species recorded with rate of 1 No/ soaking day during the experimental study. With respect to size of fish caught, *Muraena sp* was the biggest species recorded with the length of 110 cm with the weight of 3 kg recorded only in Type- 2 trap. Further, it was recorded only during February which was found to be the peak fishing month irrespective of the species caught.

Percentage composition of catch in Type-2 experimental trap is shown in Figure 4. Regarding the overall catch rate, *P. waigiensis* could be observed as much as 66% in Type-2 experimental trap. *Epinephalus coioides* contributed 33% and *Muraena sp* was the least dominant species which contributed only 1% of the catch of Type-2. There was slight decline in catch rate from the beginning to the end of experimental period. Notable difference in the catch rate between the three species could be observed throughout the study period during different months (P>0.05) (Table 3). As in the case of Type-2 trap peak catch rate was observed during the month of February, the fish catch accounted for 28% of the total catch of Type-2 trap.

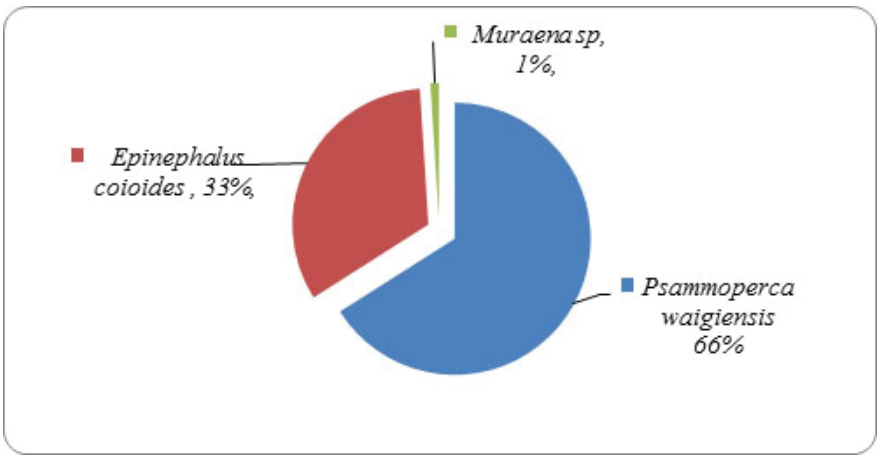

Fig. 4. Species wise catch composition of Type-2 experimental trap

Comparative price details of different length group of various species caught and monthly returns from experimental traps

No notable deviation in the prices of fish caught by Type-1 trap and Type-2 traps could be observed. Though no notable deviation with respect to size distribution of species caught in two different types of traps tested, remarkable difference in the monthly returns between the two types experimental traps could be observed. The gross monthly returns through the sale of different species of fish caught in Type-1 trap was Rs.15,075 and it was Rs.4990 for Type-2 trap (Table 4). Apart from the gross returns for the whole experimental period, the monthly returns were higher invariably during all the months for Type-1 trap. Further, another interesting observation that could be made was that *P. waigiensis* ranked first in terms of catch rate in both the types of traps and *Epinephalus coioides* ranked first in terms of monthly returns of both the experimental traps.

DISCUSSION

In the present study higher catch rate of Type-1 trap than that of Type- 2 tarp may attributed to higher visibility of bait through rectangular shapes entrance besides easy entry that could be possible through rectangular entrance rather than elliptical entrance. Similar observation have been made in an experiment conducted involving crab traps, reported that the rectangular shaped entrance of collapsible trap caught 127 crabs while only 13 crabs were caught in narrow gaps with ellipse shaped entrance. The reason was attributed to the higher visibility of bait through the rectangular shaped entrance (Gondo Puspito, 2013). In present study also Type-1 trap with rectangular shaped entrance caught 342 fishes in 20 soaking days against 99 fishes in 20 soaking days by Type-2 trap with elliptical shaped entrance. Change in the shape of rear funnel opening of the traps did not show any notable impact on the size distribution of the fishes caught in the traps as evidence through the size range of fish caught in both type of traps. The stacked volume of Type-1 trap with 5 trap units was estimated 2.7 m^3 while its total operational volume was estimated to be 9.7m^3. It is estimated that 30 Type-1 trap each containing 5 units would be ideal for commercial operation from a FRP *vallam* of 5m overall length by two fishermen. The design of the entrance was found to be of great importance for the catching efficiency of the pots (Furevik and Lokkeborgl, 1994). In the present study, the entrance of Type 1 trap with rectangular shapes found to produce the highest catch rate than that of Type 2 trap with elliptical shaped funnel. Prajith and Remesan (2018) reported that the narrow funnel in tubular traps prevents the escapement of fishes from the trap during fishing. In this study also Type 2 trap was fabricated with elliptical funnel to stops the fishes from getting outbreaks. Comparative study on the efficiency of three different types of crab pot in ice land fishing ground was carried out by Cruz and Olatunbosun (2013) and also reported that the spider crab was the most represented species in the catch with an average catch between 5.4 crab per pot in Conical pot to 9.6 crab per pot in Collapsible type pot. The rock crab was the second most abundant species with an average catch of 1.0 crab/pot in conical

pot to 3.6 crab/ pot in collapsible type pot. The green crab had the lowest average catch of 0.2 crab/pot in conical pot to 1.5 crab/pot in collapsible type pot. The present study revealed that, *S. waigiensis* was recorded with catch rate of 8.8 no's/soaking day in Type 1 trap and 3.25 no's/soaking day in Type 2 trap. *E. coioides* was recorded with catch rate of 5 no'/soaking day in Type 1 trap and 1.65 no's/soaking day in Type 2 trap. Non collapsible fish traps with oval shaped entrance operated in Enayam at Kanniyakumari coast found the dominance of Siganidae family species during October and November, while the rest of the months, from December to March, fishes belonging to the family Scaridae dominated the catch (Beenamol, 2017). The studies also revealed that *S. waigiensis, E. coioides and S. rubrum* dominated during the month of January in both Type 1 and Type 2 traps.

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