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COMPARATIVE STUDY OF MUD CRAB (*SCYLLA OLIVACEA*) PRODUCTION IN THE SUNDARBANS AND IN TRADITIONAL SHRIMP *GHERS* OF BAGERHAT DISTRICT, BANGLADESH

Dipak Kamal, Momotaz Khatun*, Mst. Muslima Khatun, Md. Kamrul Islam and Md. Forhad Uddin

Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna 9208, Bangladesh

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Abstract: The comparative study of mud crab (*Scylla olivacea*) production between Sundarbans Mangrove Ecosystem and traditional shrimp *ghers* was conducted in three major landing centers namely Gona, Digraj and Vaga in Bagerhat region at monthly interval from January to December 2002. The maximum production of 1247.15 MT was estimated from Sundarbans mangrove swamp areas while 1016.30 MT from traditional shrimp *ghers*. The production of mud crab from the Sundarbans ecosystem was 10.20% higher and significant at 5% level than the traditional shrimp *ghers* of Bagerhat region in 2002. There were no significant differences in production at different landing centers, months and seasons. But the production of different grade sizes from the Sundarbans and traditional shrimp *ghers* in the region showed significant variation ($P<0.05$). The production from the Sundarbans was found to be consistent round the year, whereas it was seasonal (May to November) for the traditional shrimp *ghers*. Fishing closure for mud crab inside the Sundarbans should be enforced effectively in order to maintain the supply of mud crab seed for its production from the shrimp ponds throughout the coastal region of Bangladesh.

Key words: Mud crab (*Scylla olivacea*), the Sundarbans, traditional shrimp *ghers*, landing centers.

Introduction

The mud crab (*Scylla olivacea*), generally known as "Green crab" or "Mangrove crab" and locally called as " Habba kakra" or "Silla kakra" or "Kankra" is the most important coastal species after the tiger shrimp (*Penaeus monodon*) in Bangladesh due to its high demand and lucrative price in the international market (Kamal, 2002; Ahmed, 1992; Khan and Alam, 1992). The mud crab occurs throughout the coastal water of Bangladesh particularly in the estuaries, brackish water tidal rivers and canals, swamps of the Sundarban and traditional shrimp (*P. monodon*) *ghers* (Overton and Macintosh, 1997; Rahman *et al.*, 1996; Acharya and Kamal, 1994 and Shafi and Quddus, 1982).

A major part of the Sundarbans mangrove forest (5772.85/sq. km) is situated in Bagerhat District. Of the 107,961.59 ha traditional shrimp *ghers* (TSGs) in Khulna division, Bagerhat district alone

* **Corresponding author**:
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represents 47,710.38 hectares (44.19%) (Anon, 2002). The present study was taken up to estimate mud crab production from the Sundarbans and TSGs for a comparison.

Mud crab, one of the biggest crustaceans under the portunidae family, may attain 1 Kg in weight and 22-25 cm in carapace width (Piatek, 1981). It is widely distributed in the Indo-Pacific region as mangrove associated fauna (Macintosh *et al.*, 2002). It is one of the most popular and costly seafood in the South-East Asian countries (Pripanapong and Tongdee, 1998). In Bangladesh obviously bulk of mud crab production comes from the Sundarbans mangrove swamps. The mud crab fishery is absolutely based on wild catch from the the Sundarbans and TSGs along the coastal region of Bangladesh (Azam *et al.*, 1998; Overton and Macintosh, 1997; Achyara and Kamal, 1994; Ahmed, 1992; Khan and Alam, 1992). Once considered as a minor fishery, mud crab became an important export item in 1982, and ranked 3rd among the frozen food export earnings of Bangladesh (SEAFDEC, 1998).

The export of live mud crab from Bangladesh has increased many folds in the last decades (Anon, 2002). Income from this export has increased somewhat steadily from 2,000 US$ in 1977-78 to 2,83,000 US$ in 1999-00. A total of 702 people were involved in mud crab trading at landing centers of Khulna, Satkhira and Bagerhat districts in 2001 (Kamal *et al.*, 2003).

A few information on the biology, production and marketing of mud crab are available (Kamal *et al*., 2003; Khan and Alam, 1992;) from the Sundarbans and TSGs. The main objective of the present study was to compare the mud crab production from the Sundarbans and from TSGs. Other objective was to observe variation in different aspects in mud crab production at different landing centers.

Materials and methods

The present study was carried out through field survey at monthly interval from January to December 2002 in three landing centers namely Vaga, Gona Bridge and Digraj in Bagerhat district (Figure 1). The primary data on production from two wild sources namely the Sundarbans and TSGs were collected through a structured questionnaire survey from three randomly selected depots in each landing center. In addition, other information was collected through interviewing mud crab fishers and traders during field survey. Collected data were analyzed using MS-Excel (Version 0.5) and SPSS. The production at each landing center was calculated by multiplying the average production from three randomly selected depots with the total number of depots in corresponding landing center as follows:

$$P = D * Pi$$

Where, p = Production of mud crab in Kg;
D = Number of mud crab depots in a landing centers;
Pi = Average production of three randomly selected depots.

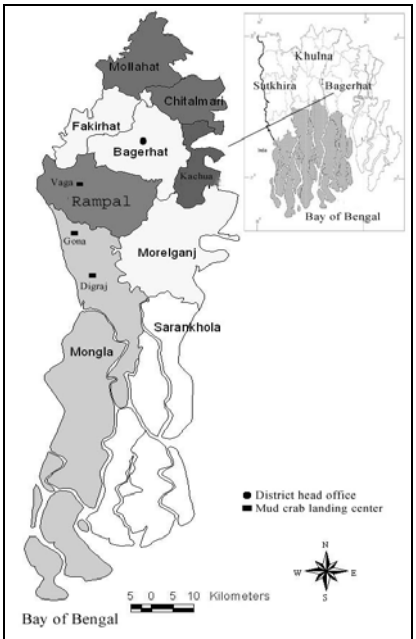

Fig.1: Location of mud crab sampling stations from three landing centers in Bagerhat.

In addition, the total production of mud crab from the Sundarbans and TSGs in Bagerhat region was calculated by multiplying the mean production from nine surveyed depots with total number of depots in the three landing centers of Bagerhat region.

Results

Production: The total number of mud crab landing depots at Digraj, Gona Bridge and Vaga were 10, 8, and 15 respectively. The total production of mud crab in Bagerhat district was estimated to be 2,263.45 MT in 2002 of which 1,247.15 MT (55.10%) production was obtained from the Sundarbans mangrove swamp areas and the rest (1016.30 MT ; 44.90%) from TSGs. Crab production from the two sources is summarized in the Table 1. A significant variation (P<0.05) in production was found between the Sundarbans and the TSGs.

Table 1: Total annual production (in MT) of mud crab from the Sundarban and traditional shrimp *ghers*.

Landing centre	Sample	Sundarban	%	Shrimp *gher*	%	Total
Gona (depot 8 nos.)	Depot-1	32.15	52.53	29.05	47.47	61.20
	Depot-2	31.83	52.35	28.98	47.65	60.81
	Depot-3	31.76	52.68	28.53	47.32	60.30
	Mean	31.92		28.86		-
	SD	0.21		0.28		-
Sub total (Mean production*8)		255.33		230.84		486.17
Digraj (depot 10 nos.)	Depot-1	54.98	75.73	17.62	24.27	72.59
	Depot-2	55.71	74.67	18.89	25.33	74.60
	Depot-3	56.34	76.98	16.84	23.02	73.18
	Mean	55.67		17.78		-
	SD	0.68		1.03		-
Sub total (Mean production*10)		556.75		177.80		734.55
Vaga (depot 15 nos.)	Depot-1	32.94	42.81	43.99	57.19	76.93
	Depot-2	26.42	39.28	40.83	60.72	67.25
	Depot-3	27.66	42.98	36.70	57.02	64.36
	Mean	29.01		40.51		-
	SD	3.46		3.66		-
Sub total (Mean production*15)		435.08		607.62		1042.70
Total		1247.15		1016.30		2263.45

Monthly and seasonal variation in production: The total production was found to be highest in January (172.97 MT) and the lowest in October (54.55 MT) from the Sundarbans mangrove forest. On the other hand, from TSGs the highest and the lowest production were in September (150.11 MT) and April (35.76 MT) respectively (Figure 2). However, the monthly variation in production of mud crab was not statistically significant (P>0.05).

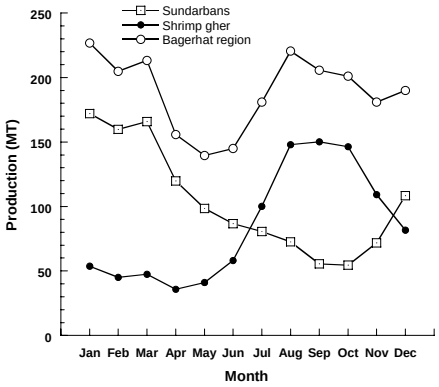

Fig. 2: Monthly production of mud crab (*S. olivacea*) from the Sundarbans and traditional shrimp *ghers*.

There are two seasons of mud crab production in the study area i.e., dry season (November-April) and wet season (May-October). Seasonal variation in mud crab production was statistically insignificant at 5% level. In the annual production of mud crab of the Sundarbans and TSGs and seasonality of production have been presented in Fig. 3. In terms of combined production from the Sundarbans and TSGs no seasonality in production was observed, however production from either of the sources varied markedly.

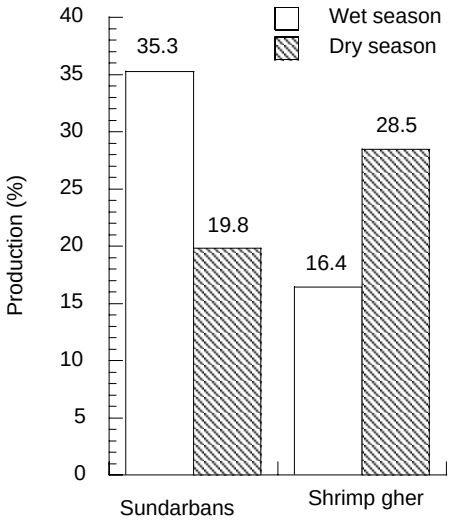

Fig. 3: Seasonal variation in the production of mud crab from the Sundarbans and traditional shrimp *ghers*.

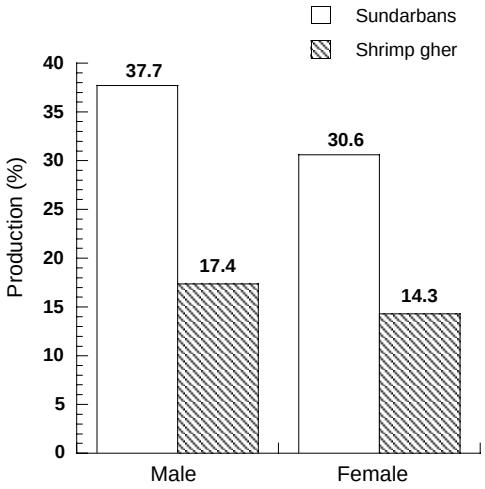

Fig. 4: Sexual variation of the production of mud crab from the Sundarbans and traditional shrimp *ghers*.

***Sexual variation in production*: O**f the total production male and female crabs contributed to 1546.01 (68.3%) and 717.44 (31.70%) MT respectively (Table 2). The production of mud crab for male was 853.68 MT (38.72%) and 692.33 MT (30.59%) and for female 393.47 MT (17.38%) and 323.97 MT (14.31%) from the Sundarbans and TSGs respectively (Table 2 and Figure 4). The mud crab production of male is significantly higher than that of female (P<0.05).

Table 2: Total annual production (in MT) of mud crab for both sexes from the Sundarbans and traditional shrimp *ghers*.

Landing centers	Depots	Male			Female			Total
		Sundarbans	Shrimp gher	Sub total	Sundarbans	Shrimp gher	Sub total	
Gona	Depot-1	22.47	20.17	42.64	9.68	8.88	18.56	61.20
(Total	Depot-2	22.28	20.03	42.31	9.55	8.95	18.50	60.81
depot No.	Depot-3	22.16	19.77	41.92	9.61	8.77	18.37	60.30
8)	Mean	22.30	19.99	-	9.61	8.86	-	-
	SD	0.16	0.21	-	0.07	0.09	-	-
*Sub total (MP*8)*		178.42	159.93	338.35	76.90	70.91	147.82	486.17
	Depot-1	38.01	11.40	49.41	16.97	6.22	23.19	72.59
	Depot-2	38.13	12.27	50.40	17.58	6.62	24.20	74.60
Digraj	Depot-3	38.56	10.93	49.50	17.77	5.91	23.68	73.18
(Total	Mean	38.23	11.53	-	17.44	6.25	-	-
depot No.								
10)	SD	0.29	0.68	-	0.42	0.35	-	-
*Sub total (MP*10)*		382.34	115.34	497.69	174.40	62.50	236.90	734.59
	Depot-1	22.34	30.36	52.70	10.59	13.63	24.22	76.93
	Depot-2	17.78	27.91	45.69	8.64	12.92	21.57	67.25
Vaga	Depot-3	18.46	25.14	43.60	9.20	11.56	20.76	64.36
(Total	Mean	19.53	27.80	-	9.48	12.70	-	-
depot No.								
15)	SD	2.46	2.61	-	1.00	1.06	-	-
*Sub total (MP*15)*		292.92	417.06	709.97	142.16	190.56	332.72	1042.69
Total		853.68	692.33	1546.01	393.47	323.97	717.44	2263.45

MP= Mean Production

Variation in production of different landing centers: The estimated amount of mud crabs landed at Digraj, Gona and Vaga were 734.59 (32.45%), 486.17 (21.48%) and 1042.69 (46.07%) MT respectively in 2002 (Figure 5) among which the highest production was found in Vaga. There was no significant difference in production of mud crab in different landing centers of Bagerhat in 2002. Contribution of the Sundarbans and TSGs in mud crab production at Vaga has been presented in Figure 6.

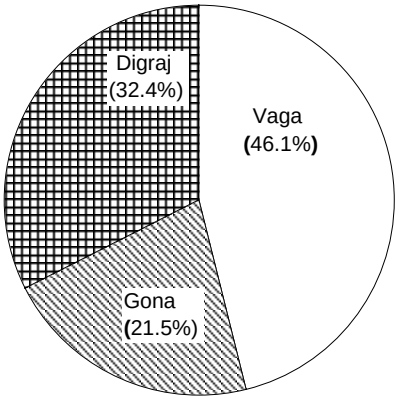

Fig. 5: Production variation of mud crab in different landing centers.

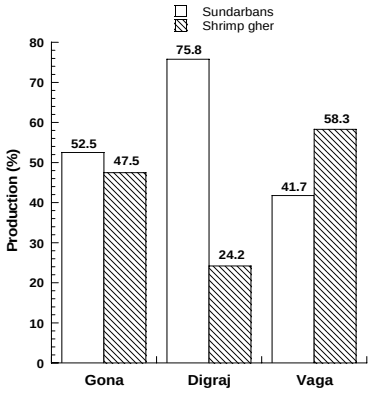

Fig. 6: Production variation of mud crab from the Sundarbans and traditional shrimp *gher*s accumulating from different landing centers.

Variation in production by grade: Marketable crabs are classified into several grades depending on sex, size, weight, shell condition and gonadal maturation. The grading system was different for local and foreign markets. There were 4 separate grades for female and 6 grades for male crabs. The grading system has been presented in Table 3.

After collection from local depots the exporters in Dhaka allocate a different grading system for international markets. They allocate one extra grade for male crab as XXL (body weight greater than 500g). But the WXL and WL male crabs were not accepted for the export. There were two extra grades for female crab FF1 (body weight >200g with full gonad) and KS-3 (body weight under 180g in weight with full gonad) shown in Table 3.

Table 3: Grading system of mud crab (S. olivacea) by sex and weight in local market and International market.

	Male							Female					
Local grading system													
Grade	-	XL	L	M	SM	WXL	WL	-	F1	F2	F3	KS-1	-
Weight (g)	-	>400	>300	>250	>200	>400	>300	-	>180	>150	>120	>180	-
Shell / gonad	-	HS	HS	HS	HS	SS	SS	-	FDG	PG-2	IG	PG-1	-
International grading system													
Grade	XXL	XL	L	M	SM	-	-	FF1	F1	F2	F3	KS-1	KS-3
Weight (g)	>500	>400	>300	>250	>200	-	-	>200	>180	>150	>120	>180	<180
Shell/ gonad	HS	HS	HS	HS	HS	-	-	FDG	FDG	PG-2	IG	PG-1	FDG

HS= Hard Shell, SS=Soft Shell, FDG= Fully Developed Gonad, PG-1= Partial Gonad, PG-2=poor Developed Gonad and IG= Immature Gonadal condition.

The highest and lowest production of the male crab of the Sunderbans and TSGs were estimated as 694.58 and 55.23 MT for XL and WL respectively and the other grade sizes of L, M, SM,WXL were 260.3, 220.31, 178.16, 137.44 MT respectively. In case of female mud crab, the highest and

lowest production was estimated as 366 and 77.9 MT for F1 and KS-1 and were 185.46 and 88.13 MT for F2 and F3 respectively (Table 4). There were no significant differences in production from the Sundarbans and TSGs (Figure 7, $P>0.05$). But the production in different grade sizes from the Sundarbans was significantly higher than from TSGs ($P<0.05$). The production of XL is significantly higher than other grades.

Table 4: Production (in MT) of mud crab by grade.

		Male						Female				Sub total
		XL[a]	L[c]	M[c]	SM[c]	WXL[d]	WL[d]	F1[b]	F2[d]	F3[c]	F4[d]	
Sundarbans production (MT)												
Gona	Wet	18.98	12.28	10.91	8.92	4.35	2.52	11.50	2.81	9.78	3.75	85.80
	Dry	57.18	18.65	15.39	13.05	11.66	4.52	25.89	6.18	12.38	4.62	169.52
	Sub total				178.42					76.90		255.33
Digraj	Wet	76.96	27.46	22.22	17.97	14.79	6.08	40.37	8.32	18.32	11.30	243.81
	Dry	98.93	34.05	31.08	26.69	18.88	7.22	53.27	10.89	19.92	12.02	312.94
	Sub total				382.34					174.40		556.75
Vaga	Wet	28.56	16.75	14.58	10.30	6.12	2.91	16.83	3.77	13.63	5.47	118.91
	Dry	104.31	33.90	26.64	21.44	20.14	7.26	55.13	11.31	24.40	11.65	316.17
A		384.92	143.09	120.82	98.37	75.94	30.51	202.99	43.28	98.43	48.81	1247.16
Sub total					292.92					142.16		435.08
Total					853.68					393.47		1247.15
Shrimp ghers production (MT)												
Gona	Wet	47.03	16.14	14.01	12.25	9.51	3.84	22.46	5.15	12.60	3.86	146.85
	Dry	20.28	11.50	10.44	7.72	4.73	2.48	11.42	2.71	9.18	3.53	84.00
	Sub total		159.93					70.91				230.84
Digraj	Wet	37.12	10.96	8.76	5.95	7.28	2.26	19.93	3.98	9.72	5.36	111.32
	Dry	18.48	8.29	7.27	3.84	3.80	1.34	10.57	2.24	7.56	3.14	66.53
	Sub total		115.34					62.50				177.84
Vaga	Wet	122.43	43.23	36.97	32.50	22.78	9.23	63.79	12.88	27.61	14.61	386.01
	Dry	64.32	27.09	22.04	17.53	13.40	5.57	34.84	7.66	20.36	8.82	221.61
B		309.66	117.21	99.49	79.79	61.5	24.72	163.01	34.62	87.03	39.32	1016.35
A+B		694.58	260.3	220.31	178.16	137.44	55.23	366	77.9	185.46	88.13	2263.51
	Sub total				417.06					190.56		607.62
Total					692.33					323.97		1016.30

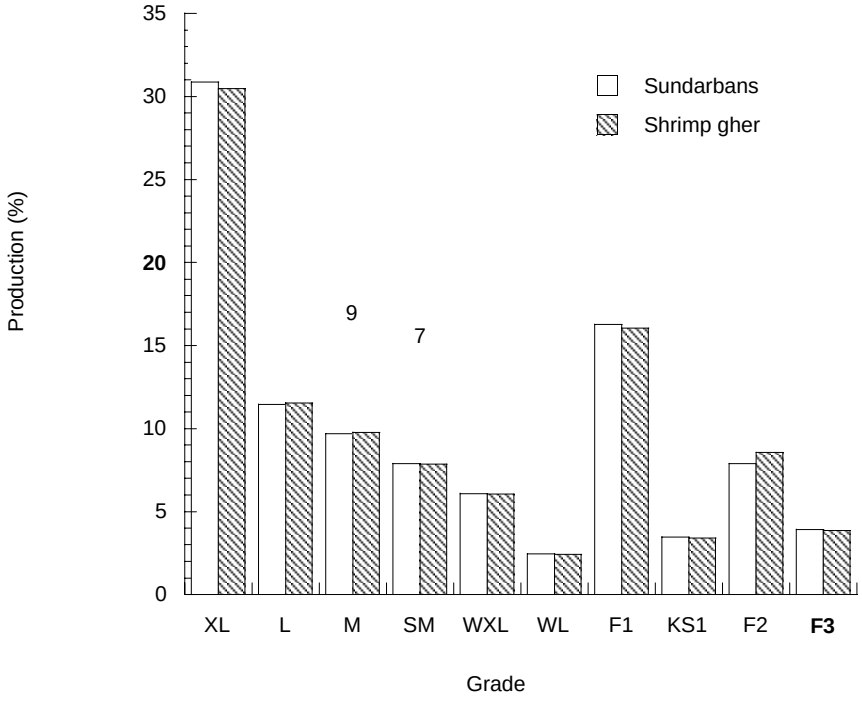

Fig. 7: Size wise production variation of mud crab between the Sundarbans and traditional shrimp *ghers*.

Discussions

The Sundarbans mangrove ecosystems (tidal rivers, canals, swamps, etc.) and the TSGs were the main sources of mud crab production in the study area. In Bagerhat region, there are large areas of mangrove forest and TSGs. All of the mud crab landing centres in the study area were situated on the highway side for easy transportation of harvested crabs.

The production of crab from shrimp farms in Bangladesh was estimated to be 4250 MT. This occupies only 3% of total production of shrimp, fish and crab in shrimp farm in 2005-2006 fiscal years. Average production of crab from one hectare typical extensive shrimp farm is 25 Kg which are exportable and locally consumed (Anon, 2007). In 2002, a total of 2263.45 MT of mud crabs was produced from the Bagerhat region of which 55.10% and 44.90% came from the Sundarbans and TSGs respectively. In addition, Khan and Alam (1992) reported that the total production from Bagerhat District was 535.6-605.8 MT in 1990-91. Ahmed (1992) mentioned that the total production from the Southwestern region of Bangladesh was 1200 MT in 1991. From the Sundarbans mangrove forest, the maximum production of mud crab was estimated in January which sharply decreased in October and again the production was increasing by November. Generally May to October is the optimal period for shrimp cultivation and so maximum production of mud crab was recorded from TSGs on that period.

The overall production of mud crab from the wild sources was estimated with two peaks; one in January and second in August. May to June was the peak for mud crab fishing season in West Bengal, India (Nandi and Paramanik, 1994) and June to August was the peak fishing season for

mud crab in Malaysia (Ferdouse, 1990). During the dry season (November to April) the production of mud crab from the TSGs was lower than that during the wet season due to drying out of the shrimp ponds for the next crop which starts in the early wet season (May). Macintosh (1984) noticed that the crab moves out from the mangrove forest to spawn offshore during November to December in Malaysia.

Significant variation in the production of mud crab was found between the male and female crab. The male crab showed comparatively higher production than the female crab from both the Sundarbans and TSGs. This may be attributed to fishing methods i.e. gear selectivity and due to cannibalistic nature of male crabs.

The highest production of mud crab was recorded in Vaga (1042.69 MT) followed by Digraj (734.58 MT) and Gona (486.16 MT). The Vaga station is located near the river bank and road access from both Sundarbans and Shrimp *ghers*. Vaga is under Rampal *Upazila* of Bagerhat district and most of the shrimp *ghers* in Bagerhat district were located in Rampal *Upazila*. So the maximum productions from the TSGs are landed in Vaga. On the other hand, Digraj is located in Mongla *Upazila*, in close proximity to the Sundarbans Mangrove swamps in comparison to Gona and Vaga. It is also located near the river bank so the maximum production from the Sundarbans was landed in Digraj.

The contribution of production of mud crab from the Sundarbans and TSGs has been compared in terms of sex, season, landing centers and size grade. In terms of landing center the production from the wild sources was insignificant but in terms of sex and size grade the production variation was significant (P>0.05).

Before the start of fattening practice with rejected crabs from landing centers both the rejected male (WXL and WL) and female (KS-1) crabs were sold in the local market at a cheaper prices. But now all the rejected or immature crabs are collected by the fishermen having fattening ponds to return into the market and so the wastage of mud crabs is being reduced.

Conclusion

The production of mud crab from the Sundarbans is significantly higher (10.20%) than the production from the TSGs. It was found that the production of mud crab from the Sundarbans mangrove ecosystem carried out throughout the year, although Sundarbans Forest Department prohibited mud crab fishing during the periods December to February and May to June. The enforcement of fishing prohibition inside the Sundarbans Reserve Forest area during closed season and practice of fattening of female mud crab may induce higher production of mud crab in TSGs. Awareness of traditional shrimp farmers should be developed in order to increase the production of mud crab per unit area as the second crop to target *P. monodon*. Government should take responsive training program for the fattening pond owners for better cultivation of rejected male and female crab through aquaculture like tiger shrimp.

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