Khulna University Studies **Volume 11 (1&2) and 12 (1&2): ??-?? : December 2013**

LIFE SCIENCE

PRODUCTION, MARKETING AND TRANSPORTATION OF MUD CRAB (*Scylla olivacea*): A STUDY ON KHULNA REGION OF BANGLADESH

Dipak Kamal, Md. Forhad Uddin and Mst. Muslima Khatun[1]

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

KUS: 08/33-210508

Manuscript received: May 21, 2008; Accepted: October 05, 2013

Abstract: Present state of the marketing and transportation of mud crab in Khulna region of Bangladesh was investigated through field survey from January to December 2001. Out of 9 *upazillas* in Khulna District, mud crab business was found in 5 namely, Paikgacha, Koyra, Dumuria, Batiaghata and Dacope. The crab depots were located mostly near the highways and on the bank of rivers. The crabs landed at depots were harvested from various sources including the Sundarbans mangrove swamps, tidal rivers and canals, and black tiger shrimp ponds (*ghers*). Supply of mud crabs was round the year with a peak during rainy season. The total production was estimated to be 1872.28 tons in Khulna district in 2001 of which 1228.73 tons were males and 643.55 tons were females. The highest production of mud crab was found in Paikgacha (75.59% of the total production). The maximum average price was found for XL grade followed by F1 grade. The harvested crabs were transported to depots by small wooden boats. Trucks and buses were used to transport crabs at night when the ambient temperature was low in order to reduce mortality. The mortality rate during transportation was higher in summer. The domestic market of crab was poorly developed in this region because of high price, and social and religious prohibition among the Muslim. Most of the harvested crabs were marketed in the foreign country. Major importers of mud crab are China, Singapore, Hong Kong and Malaysia, Thailand and Taiwan.

Keywords: Mud crab, marketing, transportation, grading, mortality, Bangladesh

Introduction

Mud crab, one of the most popular and costly seafood in the South-East Asian countries (Pripanapog and Tongdee, 1998), is widely distributed in the Indo-Pacific region (Macintosh *et al.*, 2002). Of 4 species of mud crab, the most important one is *S. olivacea*, one of the biggest crustaceans under the portunidae family, which may grow up to 1 kg in weight and 22-25 cm in carapace width (Piatek, 1981). In Bangladesh, *S. olivacea* is widely distributed (Ahmed, 1992; Khan and Alam, 1992). It is important in terms of energy transfer, nutrient trapping, substrate modification, and a food item (Khan and Alam, 1992).

Mud crab is almost entirely an export item. Mud crab export started in 1977-78 fiscal year and become a settled business in 1982 (SEAFDEC, 1998). In the past mud crab had a virgin stock, marketed locally at negligible quantities and price, and occasionally consumed by non-Muslims. Muslims, in general never accepted it on their table (Ahmed, 1992). Nevertheless, attitudes are gradually changing in the Muslim community. Of several crab species, the mud crab in Bangladesh holds the prime position in term of price and demand in the international market.

* Corresponding author: <muslima_khatun@yahoo.com>

DOI: https://doi.org/10.53808/KUS.2013.11and12.0833-L

The price of mud crab is higher than that of fish and mollusk in SE Asian countries (Azam *et al*., 1998) and live mud crab is exported mainly to these countries (Agbayani, 2001). This high demand and price for the species have resulted in the huge entry of new fishers in crab harvesting from coastal waters in recent years. Presently, the species is severely over exploited, which is an issue affecting sustainability of livelihood of coastal people. For example, the export earnings declined from US$ 55,35,000 in 1996-97 to US$ 2,83,000 in 1999-2000 (EPB, 2001). However, there is no information on the production, marketing and transportation of this potential aqua resource in Bangladesh. Therefore, the present study was undertaken with an aim to assess the production, marketing and transportation of mud crab from Khulna region of Bangladesh.

Materials and method

Study area: A reconnaissance survey was conducted in all the 9 *upazillas* of Khulna district namely, Paikgacha, Dumuria, Batiaghata, Dacope, Rupsha, Koyra, Terokhada, Digholia and Fultala to identify the mud crab business centers or depots. Out of 9 *upazillas*, mud crab depots were found in five, namely, Paikgacha, Koyra, Dumuria, Batiaghata and Dacope. A one year survey work was carried out at monthly interval from January to December 2001 in these 5 *upazillas* of Khulna district.

Field visits and observation: At first, a total of 10 Focus Group Discussion (FGD) sessions with 10-15 people of mud crab fishers, traders and exporters were held to get an overview of mud crab production, marketing and transportation in Khulna district. Later, the primary data on various aspects of production, trading and transportation were collected through a structured questionnaire interview from 3 randomly selected mud crab depots in each *upazilla* through interviewing the mud crab fishers, traders and exporters directly. Finally, the collected data were cross-checked with key informants e.g. school teachers, local leaders, *upazilla* and district fisheries officers, fisheries extension officers and NGO personnel.

Data analysis: Collected data were analyzed with computer softwares such as MS-Excel, SPSS and Kaleida graph. The *upazilla* wise production was calculated from selected three depots and the total production in a depot in a as follows:

P= Mean production volume in 3 surveyed depots in a sub-district × Total number of depots in the sub-district.

Results

Geographic distribution of mud crab business: Out of 9 *upazillas* in Khulna district, the crab business was found to exist in 5 *upazillas* at 13 localities namely Paikgacha (Main Bazar, Minaz market, Mosque road, Shibsha Ghat and Kopilmuni), Koyra (Haiatkhali, Koyra Bazar and Katakhali), Dumuria (Dumuria Bazar, Noakathi Bazar and Chuknagar Bazar), Batiaghata (Batiaghata Bazar) and Dacope (Chalna Bazar). Most of the crab depots were located near the river and or roadside, from where the crab can be easily transported.

Physical condition of mud crab depots: The numbers of mud crab depots in 5 *upazillas* of Khulna districts were enumerated at 122 of which the maximum numbers (83) were located at Paikgacha and the minimum (5) at Batiaghata *upazilla*. In terms of physical condition, the depots were categorized into *katcha* (made of bamboo, bamboo-fence, and by Nipa-leafs with earthen floor), *semi-pacca* (made of bamboo, wood and tin roof with concrete floor), and *pacca* (made of bricks, cement). Number of *katcha*, *semi-pacca* and *pacca* depots were 36 (29.51%), 66 (54.10%) and 20 (16.39%) respectively in the study area (Table 1).

Table 1: The number and physical condition of mud crab depots at different sub-district of Khulna District in 2001

	Depot No.			Total depots	Manpower			Total manpower
	Katcha	*Semi-pacca*	*Pacca*		*Katcha*	*Semi-pacca*	*Pacca*	
Paikgacha	14	51	18	83	36	129	52	217
Koyra	10			10	17	-	-	17
Dumuria	5	9		14	13	18	-	31
Batiaghata	2	3	-	5	5	10	-	15
Dacope	5	3	2		13	7	7	27
Total	36 (29.51%)	66 (54.10%)	20 (16.39%)	122	84	164	59	307

Manpower in crab trading: The number of people involved with crab trading in Khulna district was estimated to be 307 of which the maximum (217) and the minimum (15) persons were found at Paikgacha and Batiaghata respectively (Table 1).

Depot size: The size of the depots varied from 40-900 sq. ft. However, the variation of depot size was found to be related with their physical conditions. The average sizes of *katcha, semi-pacca* and *pacca* crab depots were recorded at 165.11±75.39, 189.77±149.09 and 213.35±156.20 sq. ft. respectively.

Age structure and sex of depot workers: Most of the workers were young, between 18 and 40 years of age. Almost all the workers (96%) were male.

Source of fund in mud crab business: Mud crab business in Khulna was entirely dependent on borrowed money. The mean value of debt per depot in Khulna district was estimated at Tk. 63939±62704. However, the average debt was found to vary from *upazilla* to *upazilla* e.g. Tk. 112093±65060 in Paikgacha; Tk. 35500±10124 in Koyra; Tk. 36785±17387 in Dumuria; Tk. 58000±16807 in Batiaghata and Tk. 141260±109000 in Dacope sub-district.

Grading system: Marketable crabs were classified into several grades depending on sex, size and weight, shell condition and gonadal maturation. The grading system was different for local and foreign markets. After collection from local depots, exporters in Dhaka allocated a different grading system for international markets. Various grades of mud crab are presented in Table 2.

Table 2: Grading system of mud crab (*Scylla olivacea*) by sex and weight in local market.

	Male				Female			
Local Grading system								
Grade	XL	L	M	SM	F1	KS-1	F2	F3
Wt. (g)	>400	>300	>250	>200	>180	>180	>150	>120
Shell/gonad	HS	HS	HS	HS	FDG	PG	PG	IG

International grading system											
Grade	XXL	XL	L	M	SM	FF1	F1	KS-1	KS-3	F2	F3
Wt. (g)	>500	>400	>300	>250	>200	>200	>180	>180	<180	>150	>120
Shell/gonad	HS	HS	HS	HS	HS	FDG	FDG	PG	FDG	PG	IG

HS= Hard Shell, FDG= Fully Developed Gonad, PG= Partial Gonad and IG= Immature Gonadal condition.

Price of mud crab: The price of mud crab in local market was fixed by exporters, based on international market. However, the price varied with season and grade.

Price variation by season: The average maximum price was found as Tk. 167.50±45.81/kg in summer followed by winter (Tk. 148.25±10.55/kg) and rainy season (Tk. 145.00±9.32/kg). No significant seasonal variation was found in price ($P>0.05$).

Price variation by grade: Grade wise and seasonal variations in mud crab price have been presented in Table 3. The highest prices were Tk. 200/kg for XL male and Tk. 300/kg for F1 grade females. The grade wise price variation was found to be highly significant ($P<0.05$) at 5% level.

Table 3: Grade wise and seasonal variation in price of mud crab (*Scylla olivacea*) price in Khulna 2001

	Male				Female			
Season	XL[a]	L[b]	M[c]	SM[d]	F1[a]	KS-1[b]	F2[c]	F3[d]
Summer	154.25±17.57	65.00±6.07	38.50±3.03	21.15±2.85	167.50±45.81	87.50±30.93	42.10±3.74	23.50±2.35
Rainy	143.25±9.07	69.50±4.26	41.45±3.98	21.20±3.62	145.00±9.32	76.00±8.05	42.35±3.15	21.75±2.10
Winter	144.50±9.45	67.25±5.95	40.10±3.28	19.15±2.25	148.25±10.55	72.14±4.35	41.35±3.18	22.50±2.24
Overall	147.33±13.38	67.25±5.71	40.02±3.61	20.5±3.07	153.58±28.98	78.58±19.44	41.93±3.34	22.58±2.31

Production: The total production of mud crab in Khulna was estimated to be 1872.28 tons in 2001 with an average production of 15.35 tons per depot and 6.10 tons production per person per depots. The production was found to be related with lunar phase, being highest during spring tides of new and full moon. Mud crab production also varied depending on geographical location, season, sex and grade.

Table 4: Production (ton) of mud crab (*Scylla olivacea*) in different *upazillas* in Khulna in different seasons in the year 2001

		Grade									
Sub-district		XL	L	M	SM	F1	F2	KS1	F3	Sub total	Total
Paikgacha	Summer	178.42	47.09	19.64	21.74	73.24	5.12	11.29	20.39	376.91	
	Rainy	283.49	76.67	24.43	29.74	166.88	8.50	11.90	30.45	632.07	
	Winter	211.54	49.26	13.89	12.23	85.97	6.22	10.72	16.48	406.30	1415.29
Koyra	Summer	7.71	1.70	1.57	1.04	4.93	1.47	2.11	1.23	21.76	
	Rainy	12.76	2.71	2.23	1.56	6.69	1.04	3.21	2.09	32.30	
	Winter	20.29	4.61	2.80	2.42	14.41	1.72	4.90	1.42	52.56	106.62
Dumuria	Summer	15.90	3.16	1.81	1.94	8.78	1.14	1.90	1.49	36.12	
	Rainy	38.84	4.53	2.71	4.13	26.38	3.86	5.67	2.14	88.26	
	Winter	15.25	1.66	1.75	1.77	10.40	1.68	2.01	0.96	35.48	159.86
Batiaghata	Summer	8.25	1.56	1.04	0.88	5.45	0.87	2.02	0.72	20.78	
	Rainy	17.76	1.96	1.34	1.23	10.56	1.33	2.60	0.87	37.67	
	Winter	9.10	0.60	0.99	0.72	5.47	0.69	1.03	0.53	19.13	77.58
Dacope	Summer	14.40	5.20	2.83	2.35	12.57	2.51	4.39	0.73	44.98	
	Rainy	12.92	5.27	2.70	3.77	11.05	4.56	4.24	2.35	46.85	
	Winter	6.56	1.96	1.02	1.32	5.16	2.32	2.14	0.62	21.10	112.92
Total		853.19	207.95	80.74	86.85	447.93	43.03	70.12	82.47		1872.28

Variation in mud crab production among different upazillas: Mud crab production in Paikgacha was significantly higher than the other four *upazillas* ($P<0.05$). The production was estimated to be the highest (1415.29 tons, 75.59%) in Paikgacha followed by Dumuria (8.54%), Dacope (6.03%), Koyra (5.69%) and Batiaghata (4.14%) (Table 4).

Seasonal variation: The seasonal variation in the production of mud crab was found to be statistically non-significant ($P>0.05$; Fig. 1).

Sexual variation: The production of male crab was higher (1228.73 tons, 65.63%) than the females (643.55 tons, 34.37%) (Table 4, Fig. 2).

Production variation by grade: Production of XL grade for male (45.6%) and F1 for female (23.9%) were significantly higher than other grades (Table 4, $P<0.05$). However, the lowest production was estimated for M grades (4.3%) for male and F2 grade (2.3%) for female.

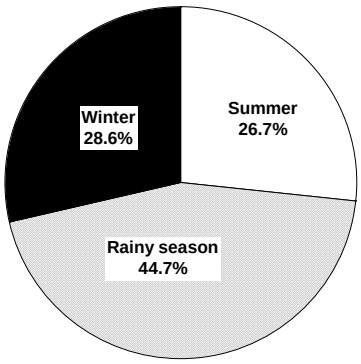

Fig. 1: Mud crab production by season in 2001

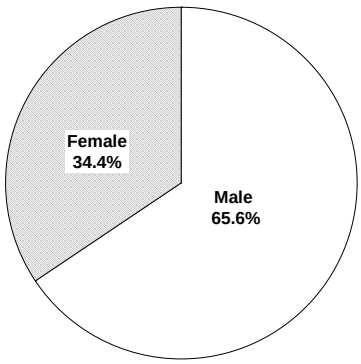

Fig. 2: Mud crab production by sex in 2001

Marketing: The mud crab fishermen harvest crabs from various sources, namely, the Sundarban mangrove swamps, tidal rivers and canals outside the Sundarbans (SRF) and shrimp ponds (*ghers*) in Khulna (Fig. 3). Fishers sometimes sell their harvest directly to the nearby crab depot. However, most of the fishers are bound to sell their products at a lower price to the *dadondars* (money lenders) from they borrowed money. Most of the depot owners provide *'Dadon'* to selected fishers in advance to purchase or repair their fishing crafts and gears and also for food and bait. The exporters purchase crab directly from the supplier located at *upazilla* level. Sometimes, exporters purchase crabs directly from the catchers by employing agents at major crab trading centers at *upazilla* level. Finally, mud crabs are exported to foreign countries by air.

The major importing countries include Singapore, Hong Kong, Malaysia, Thailand and Taiwan. A big share of the profit from mud crab trading goes to middleman or brokers who operate between fishers and suppliers. Rejected crabs (under-grade and broken claws or legs) are

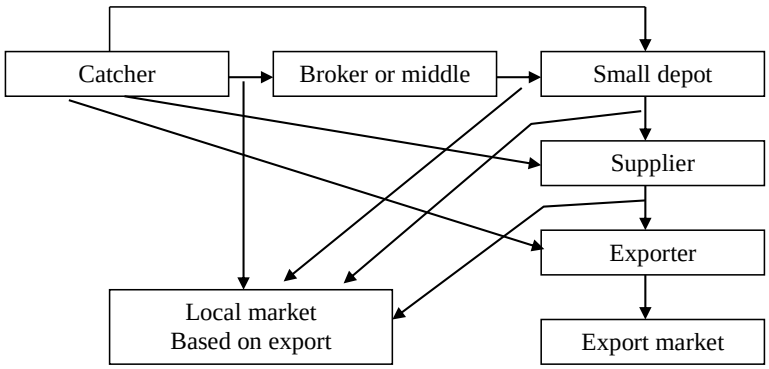

Fig.3: Marketing channel in mud crab business in Khulna

sometimes sold to the local market for domestic consumption at low price. Many depot owners fatten the under-grades in small ponds. Sometimes local poor people purchase rejected grades from the depot at low price and fatten them for high prices.

Transportation of mud crab

Transport to Depots: Mud crabs harvested from tidal rivers and mangrove swamps were transported to depots in small wooden boat, trawler, etc. From shrimp *ghers*, crabs were carried in bamboo basket, jute bags, etc. on bicycles or tri-cycle vans.

Transport to Dhaka: Long necked bamboo baskets covered with jute sack were used to transport mud crabs from local depots to Dhaka. There are two sizes of baskets - small basket contains 60-80 kg crabs, while large basket contains 80-100 kg crabs. A layer of wet betel-nut leaf was placed at the bottom of the baskets to provide cooling and prevent dehydration. Crabs of different sexes and grades were placed in the basket randomly. Crabs were transported to Dhaka by bus or pick-up van at night, when the ambient temperature is low. After reaching Dhaka, crabs were graded again according to the international standard within 2-3 hours and were packed in woven bamboo basket, each containing 15 kg of crabs. The bottom of the basket was covered with polythene sheet to avoid leakage. The baskets were stacked one over the other.

Transportation mortality: The average mortality during transportation from catching to depots, packaging in depots and depots to Dhaka were estimated as 26.60%, 41.70% and 16.92% respectively. However, the mortality of crabs on transport was found to be related with season (Fig. 4). The highest mortality during handling and transportation up to Dhaka was observed during summer (34.50%) followed by rainy season (25.72%) and winter (25%) season (Fig. 4).

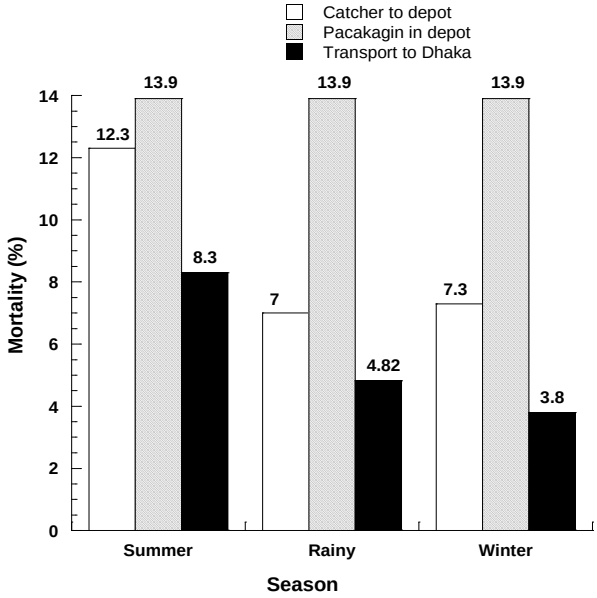

Fig. 4: Seasonal variation in mortality of mud crabs during handling and transportation in Khulna.

Export: All the harvested crabs were exported by air from Zia International Airport in Dhaka. Major export market of mud crabs includes Singapore, Hong Kong, Malaysia, Thailand and Taiwan. Besides, a small amount of crabs were also exported to UK, Japan, Germany, Belgium, China, France, Korea, South-Africa, the Netherlands, Saudi Arabia, India, Austria, Qatar, Kuwait, Mexico, UAE, Uganda, Oman, Bahrain, Honduras, Malawi (Source: EPB, 2002).

Discussion

Mangrove swamps, tidal rivers and intertidal shrimp ponds are the major sources for mud crab fishery. Khulna district has large water areas, mangrove forest and intertidal shrimp ponds, which suitable habitat for mud crabs. However, out of 9 *upazillas*, the crab business was found only in five namely, Paikgacha, Koyra, Dumuria, Batiaghata and Dacope. The absence of mud crab depots in 4 other *upazillas* was due to absence of shrimp ponds and tidal rivers.

Most of the crab depots were located on the river bank for easy landing of harvested crabs. The depots were also connected with roads and highways to carry harvested crabs to Dhaka for export.

The maximum number of crab depots and manpower engaged with crab trading were observed in Paikgacha *upazilla* due to its proximity to large number of shrimp ghers and good communication with the Sundarbans through tidal rivers and canals. And the minimum number of depots and manpower were found at Batiaghata *upazilla* due to fewer numbers of shrimp *ghers* and its distant location from the Sundarbans. The number of *semi-pacca* depots was higher followed by *katcha* and *pacca* types that can be attributed to the volume investment and business

throughout the year. The negative relation between production and depot size reveals that the depot owners are not aware of maximum utilization of space or lower construction cost triggered depots owners for making larger size depots.

The fishermen receive debt from the depot owners or *dadondar* or from the local agent of exporters. The mud crab fishers receive a lower price for their harvested crabs from the money lenders. This has pushed the mud crab fishers into persistent poverty. Alternative source of money by the Government or NGOs can contribute significantly in enhancing profitability of mud crab business. The physical structure of depot (*katcha*, *semi-pacca* and *pacca*), marketing channel (lot of intermediaries), grading (different grading in local and international market) and local financing conditions in mud crab business have remain unchanged over the years in the region (Zafar and Ahsan, 2006; Khatun, 2008, Khatun et al., 2009). However, the number of depot has increased to 135, which are now classified as small depot and large depot (Zafar and Ahsan, 2006).

The production of mud crab varied with location, season, sex, and grade. The production of mud crab was the highest during rainy season because in this season, crabs were harvested from shrimp *ghers*, the Sundarbans and tidal rivers, whereas during summer and winter, collection of crab was restricted only to the tidal rivers and the Sundarbans. In fact in the rainy season, major part of the crab came from shrimp ghers. In 2005-2006 fiscal years, the total production of crab from shrimp farms was estimated to be 4250 MT. Average production of crab in typical extensive shrimp farm is 25 kg/ha which are exported and locally consumed (Anon, 2007). Moreover, mud crab harvesting is restricted inside the Sundarbans during winter months (December to February) (Rouf, 2001). Edwards and Early (1998) stated that the crab move into deeper offshore water in winter, returning inshore in spring with the main fishing season during March to September, with a peak in May and June. Sastri (1950) also reported that May-June months are the peak-fishing season for crab in West Bengal. In Malaysia, rainy season (June to August) is also the peak season for crab production (Ferdouse, 1990). Macintosh (1984) noticed that mud crab move out from the mangrove forest to spawn offshore during November and December in Malaysia.

In this study, the highest price was observed in summer, which is contrast with the study of Khatun et al. (2009) where the highest price was observed during winter. However, the market demand and price of crabs in Bangladesh is almost similar to that in the Philippines (Balio *et al*., 1999) and Queensland (Lee, 1992). Price of crabs in the Philippine and Queensland is high during Christmas.

The exporters deprived local depot owners by offering them a grading system different from the international grading regime. For instance, they offer XL and F1 grade at >400 g and >180 g crabs for male and female respectively for depot owners, whereas they make XXL and FF1 grade with crabs >500 g and >200 g for male and female respectively during export. The difference in price of crabs between XL and XXL, and F1 and FF1 sometimes reached Tk. 40 and Tk. 60 per kg respectively.

Although the prices of mud crabs vary by grade, location of market and season, the price is always fixed by the exporters based on the demand from international buyers in absence of local market. The domestic market for mud crab has not yet developed mainly due to its high price and religious belief among the Muslim.

The marketing channel of mud crab business is uniform in the all *upazillas*. Paikgacha ranks first as the marketing place among all the *upazillas* in Khulna district because of its suitable geographic location. Sometimes, the exporter engages agents to collect crabs directly from the fishermen or middlemen. As a result, conflicts arise between the local suppliers (depot owners) and exporters.

About 30-45% of the harvested crabs are lossed due to mortality (Kamal, 2003). This higher mortality of crab during handling and transportation is mainly due to high temperature in summer months, and sometimes due to prolonged transportation period. This result closely agrees with Gillespie and Burke (1991) who reported that crabs can survive for about ten days at 16-20^{0}C temperature but survive only 6-7 days at higher temperatures.

Conclusion

Mud crab business is a highly potential aqua-business although running uncontrolled. Paikgacha is the main trading center for mud crab business in Khulna district. The overall organization of mud crab business is at a rudimentary stage in the region. There is no institutional setup to look after this potential sector. In addition, there is no management regime for the mud crab fishery by the Department of Fisheries. There is no self-organized transportation system from the depots to Dhaka. Although association of mud crab traders exists, price of crabs is absolutely controlled by the exporters. Hence, in order to achieve success in mud crab marketing and transportation, research and management issues should be taken in consideration.

References

Ahmed, M.K. 1992. Mud Crab (*Scylla olivacea*) a Potential Aqua-resource of Bangladesh. In:Angell C.A. (ed.). The Mud Crab: A report on the *Mud crab Culture and Trade*. Surat Thani, Thailand, November 5-8, 1991, The Bay of Bengal Programme Report no.: BOBP/REP/51, Madras, India.

Agbayani, R.F. 2001. Production economics and marketing of mud crabs in the Philippines. *Asian Fisheries Science*, 14:201-210.

Anonymous, 2007. Brachishwater Aquaculture and shrimp farming. Annual Report (2005-2006). Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh.

Azam, K.; Kamal, D. and Mostafa, M. 1998. Status and potential of mud crab (*Scylla serrata*) in Bangladesh. pp.150-160. In: Rahman, M.A.; Shah, M.S.; Murtaza, M.G. and Matin, M.A. (eds.), Proceedings of the National Seminar on *Integrated Management of Ganges Floodplains and Sundarbans Ecosystem*. Organized jointly by Khulna University, Bangladesh Argicultural Research Council and Department of Agricultural Extension, held in Khulna University, Bangladesh.

Balio, D.D.; De Los Santos, M.A. and Franco, N.M. 1999. Pen culture of mud crab in mangroves. Aquaculture extension manual no. 26. SEAFDEC, Philippines.

Edwards, E. and Early, J.C. 1998. *Catching, handling and processing crabs*. Torry Advisory Note No. 26 (revised). FAO Corporate Documentary.

Export Promotion Bureau (EPB). 2001 & 2002. Export details of mud crab from Bangladesh, Ministry of commerce, Dhaka, Bangladesh.

Ferdouse, F. 1990. Live mud crab-a Malaysian favourite. *INFOFISH International*, 6:55-57.

Gillespie, N.C. and Burke, J.B. 1992. Mud crab storage and transport in Australian Commerce. pp. 207-209. In: Angell C.A. (ed.), The Mud Crab: A report on the Seminar convenced in Surat Thani, Thailand, November 5-8.

Kamal, D.; Tapadar, S. and Uddin, M.F. 2003. Production, marketing and transportation of mud crab (*Scylla olivacea*) from the southwestern region of Bangladesh, pp. 123-143. In: Murtaza, M.D. (ed.), Proceedings of the seminar on *The Sundarbans, the Largest Mangrove Forest on the Earth: A World Heritage Site*. June 25-26, 2003, Khulna University, Bangladesh.

Formatted: Indent: Left: 0", Hanging: 0.6", Line spacing: single

Formatted: Font: 10 pt, Complex Script Font: 10 pt

Kamal D; Uddin M.F and Khatun M.M. (2013). Production, Marketing and transportation of mud crab (Scylla olivacea): A study on Khulna regions of Bangladesh. *Khulna University Studies* Volume 11 (1&2) and 12(1&2) : ??-??

Khan, M.G. and Alam, M.F. 1992. The mud crab (*Scylla olivacea*) fishery and its bio-economies in Bangladesh. pp. 29-40. In: C.A. Angell (ed.), *The Mud Crab: A report on the Mud crab Culture and Trade*. Surat Thani, Thailand, November 5-8, 1991, The Bay of Bengal Programme Report no.: BOBP/REP/51, Madras, India.

Khatun, M.M.; Kamal, D.; Ikejima, K. and Yi, Y., 2009. Comparisons of growth and economic performance among monosex and mixed-sex culture of red mud crab (*Scylla olivacea* Herbst, 1796) in bamboo pens in the tidal flats of mangrove forests, Bangladesh. *Aquaculture Research*, 40:473-485.

Khatun, M.M. 2008. Mud crab resource development in Bangladesh: A review. M.Sc. thesis submitted to Fisheries and Marine Resource Technology Discipline, Khulna University, Bangladesh.

Lee, C. 1992. A brief overview of the ecology and fisheries of the mud crab, *Scylla serrata*, Queensland. pp. 65-70. In: Angell, C.A. (Ed.), the mud crab. Report of the seminar on the mud crab culture and trade. Bay of Bengal Programme, Madras, India.

Macintosh, J.D. 1984. Ecology and productivity of Malaysian mangrove crab populations (Decapoda : Brachyura), IN: Proc. Asian Symp. on *Mangrove Env. Res. and Mgnt.* Soepadmo. E., Rao. A.N. and Macintosh, D.H. (eds), univ. of Malaya and UNSCO, pp. 354-357.

Macintosh, D.J.; Overton, J.L. and Thu, H.V.T. 2002. Confirmation of two common mud crab species (genus *Scylla*) in the mangrove ecosystem of the Mekong Delta, Vietnam. *Journal of Shellfish Research*, 21(1): 259-265.

Rouf, M.A. 2001. Towards a strategy for sustainable fisheries management and livelihood of fishing communities in the Sundarban coastal area, Bangladesh. M.Sc. Thesis, Asian Institute of Technology, Bangkok, Thailand.

Sastri, B.N. 1950. *The wealth of India: A dictionary of Indian raw materials and individual products.* Vol. II. Council of Scientific & Industrial Research, New Delhi, India.

SEAFDEC. 1998. SEAFDEC Newsletter, vol. 21, No.1, pp. 6. Retrieved on January 10, 2008,WebPagesaddress: <http://www.spc.org.nc/Coastfish/News/Fish_News/85/NIAR_4.htm>

Zafar, M. and Ahsan, M.N. 2006. Marketing and value chain analysis of mud crab (*Scylla* sp.) in the coastal communities of Bangladesh. In: Islam, M.A., Ahmed, K. and Akhteruzzaman, M. (eds.) Value chain analysis and market assessment of coastal and marine aquatic products of Bangladesh. Bangladesh Fisheries Research Forum, Dhaka, Bangladesh, pp. 25-53.

Formatted: Font: 10 pt, Complex Script Font: 10 pt

Formatted: Font: 10 pt, Complex Script Font: 10 pt

Formatted: Font: 10 pt, Complex Script Font: 10 pt

Formatted: Font: 10 pt, Complex Script Font: 10 pt

Formatted: Font: 10 pt, Complex Script Font: 10 pt