6th Biennial Fisheries Conference & Research Fair 2014

26 -27 April 2014

Book of Abstracts

BFRF Bangladesh Fisheries Research Forum

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Bangladesh Agricultural Research Council

Dhaka, Bangladesh

Book of Abstract

Fish Biology
Fish Biodiversity
Fish Genetics
Openwater Fisheries Management
Aquaculture
Fish Nutrition
Fish Disease
Aquaculture Innovation
Product Development
WorldFish Researches
Fisheries Education

Bangladesh Fisheries Research Forum

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Book of Abstract

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Foreword

Bangladesh Fisheries Research Forum (BFRF) is a national, non-political and non-profit professional body with the memberships from the Universities, DoF, BFRI, BFDC, NGOs, private sectors, other departments involved and committed to fisheries and natural resources development. It envisions promoting action, innovative and adaptive research in all areas of fisheries for increased production, reduction of poverty and hunger, and improvement of livelihood of the rural and urban poor people.

As part of its commitment, BFRF has been organizing Biennial Fisheries Conference and Research Fair since its establishment in 2004. Similar to the past, there has been a great enthusiasm among the fisheries scientists, extension agencies and relevant stakeholders to present their scientific outputs and gather together to share and exchange current knowledge. We have received 120 abstracts this year for presentation in different scientific sessions. There will be awards for the best presenter, best poster as well as best scientific paper in this occasion. Among the presented papers, the valuable innovations will be published in the Proceedings as Advances in Fisheries- volume 2 as in the past. Besides this abstract book, we also feel encouraged through getting highly positive feedback for our half yearly magazine, Fisheries and Aquaculture News -Bangladesh "FAN". We will continue to publish it through the support of BFRF members and other interested partners and institutions.

We, from the editorial committee, sincerely appreciate the contributors to this book of abstracts and look forward to their presentations in the conference. We would very much acknowledge the assistance of the Government of Bangladesh and development partners, especially WorldFish and Katalyst, for their generous support for publication of the materials in this Biennial Conference and Research Fair 2014. We deeply acknowledge the hard works of many colleagues, especially Drs. Mostafa A. R. Hossain and M. Enamul Hoq, for making this publication possible.

Dr. Md. Abdul Wahab
President, Bangladesh Fisheries Research Forum
and
Professor, Bangladesh Agricultural University

Contents

Fish Disease

Aquaculture Innovation

WorldFish Researches

Fisheries Education

Posters

Aquaculture entrepreneurship development in Bangladesh

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The fisheries sub-sector of Bangladesh has been contributing immensely to the food basket of the country, with annual production levels of over 3.26 million tonnes of fish and shellfish from capture fisheries and aquaculture. The production from inland capture fisheries in the last two decades has grown by only 105% i.e. from 0.47 million mt in 1985 to 0.96 million tonnes in 2012, but the aquaculture sector has shown a tremendous growth of 1,294% in the same period, i.e. 0.13 million tonnes in 1985 to 1.73 million tonnes in 2012.

Most aquaculture takes place in freshwater environments and has continued to form a major share of the country's aquaculture production, with a contribution of about 89% in terms of quantity. Though the country possesses a large number of potential cultivable freshwater species, it is only the three Indian major carps catla (*Catla catla*), rui (*Labeo rohita*) and mrigal (*Cirrhinus cirrhosus*) and one Chinese silver carp (*Hypophthalmichthys molitrix*), which share as much as 1.2 million tonnes of fish production in 2012. A few other species like pangas (*Pangasianodon hypophthalmus*), tilapia (*Oreochromis* sp.), koi (*Anabas testudineus*) and shing (*Heteropneustes fossilis*) have also been brought into the culture systems, turning the freshwater aquaculture a growing entrepreneur activity across the country. On the other hand, shrimp (*Penaeus monodon*) and prawn (*Macrobrachium rosenbergii*) are the major produce of brackishwater aquaculture, with production over one hundred thousand tonnes in 2011-12, and fisheries export commodity earning about US$ 433 million in 2011-12.

With an annual growth rate of over 6% during the last decade, the fisheries sub-sector has evolved from the stage of a homestead activity to that of an industry in recent years, where aquaculture production has moved from being a traditional activity to being a well-developed commercial activity. Appropriate technologies on captive breeding, mass seed production and grow-out management, financial investments particularly in feed and other input, industry and entrepreneurial enthusiasm primarily account for this development. Recently, the national average aquaculture productivity of freshwater fish has gone up at a level from 500-600 kg/ha/yr to over 3,000 kg/ha/yr and that of brackishwater shrimp and prawn from 75 kg/ha/yr to over 700/kg/ha/yr. There are farmers and entrepreneurs achieving a high production levels of 30,000-60,000 kg/ha/yr for pangas and that 6,000-8,000/ha/yr for tilapia, koi and shing.

Establishing commercial-scale aquaculture in Bangladesh can contribute to economic development by providing employment opportunities throughout the value chain, especially in marketing. Although subsistence-level, non-commercial aquaculture has a role to play in providing fish to families and communities, small-scale aquaculture models have limited potential for profitability and there is a need to develop aquaculture in Bangladesh as an agribusiness activity. There is a consensus that modern aquaculture has a business orientation, similar to any small or medium-sized enterprise. Effective governance of modern aquaculture is required without which there will be misallocation of resources, and perhaps stagnation of the industry and irreversible environmental damage.

With the importance of aquaculture in Bangladesh in mind, it seems apparent that strategies for increasing fish production from aquaculture should be directed towards horizontal and vertical growth of the industry. The keynote paper provides an insight into aspects of the country's aquaculture production practices and trends and future prospects of developing entrepreneurship in aquaculture. The focus of discussions will be on the track record of aquaculture in the country in terms of its responsiveness to a number of issues related to small-scale vis-à-vis large scale industrial aquaculture and sustainability in the next few decades against the backdrop of stagnating food fish production from capture fisheries.

Jalmohal management for biodiversity conservation and livelihood development: Potentialities, challenges and management approaches

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Bangladesh is an ecotone between the India and Malayan sub-regions of the Indo-Malayan zoogeographic ream. This is the country of rivers and floodplains with high potentials of aquatic resources comprising 26,275 Jalmohals of 232,533 ha area. During 2011-12, only 9,57,095 mt (29.34%) fish production was contributed by 3.925 mill ha inland open water fisheries, but 7.741 mill. ha inland culture fisheries contributed about 17.361 mt (52.92%) fish of total fish catch.

This sector contributed 2.19% of the total fish production in the world and 2.45 % in Asia during 2010. Around 17.12 million peoples are directly or indirectly involved in this sector for their livelihood. The growth rate of fisheries sector over the last 15 years varied from 7.58 (1997-98) to 6.54 % (2011-12) with an average of 5.99% which revealed almost steady and encouraging growth rate.

Inland open water resources of Bangladesh bear 'Mother Fishery' with an excellent species richness and in early sixties inland fisheries contributed about 90% of total fish production of the country. Although over the last few decades, there has been a decreasing trend in the diversity and yield. Trend of last 15 years fish production shows that production from closed water bodies (aquaculture) has been increasing but yield in open water fisheries has been decreasing alarmingly. Open water fisheries are under great stress and their sustainability is in danger because of climate change and human Interventions.

Now out of 260 fish species living in Jalmohal 54 are endangered although fisheries sector contributed 4.37% to GDP and 23.37% to Agriculture in 2011-12 and still the fisheries is the second highest foreign currency earner. It is the need of the time to revise "Government Jalmohal Management Policy, 2009" to address leasing principles from ecological and social standpoints. On the other hand, Bangladesh is a signatory to a number of Multilateral Environmental Agreements (MEAs) and also some bilateral instruments, Reo Declaration, Convention on Biological Diversity (1992), and Convention on Wetlands of International Importance. Based on lesson learned from different development projects and revenue programme it can be said that multi-stakeholder or co-management approach is a very effective approach through which biological or ecosystem based Jalmohal management and livelihood development of poor beneficiaries can effectively be addressed. For effective co-management, promotion of multiple management tools need to be considered in Jalmohal management which includes- awareness rising, habitat restoration, re-introduction of disappeared and threatened species through stocking and beel nursery establishment, establishment of wetland sanctuary, wetland plantation, effort control and observation of fisheries norms, construction of fish pass, fish friendly regulator, spillway etc. depending on experiences of previously constructed such structures, adaptive cropping, capacity building for AIGA etc.

Government should take up policy to include Union council to different Ministries and their line agencies to play their due role in wetland management. The Department of Fisheries (DoF), Bangladesh with the leadership of the Ministry of Fisheries and Livestock (MoFL) should take necessary initiative for effective Jalmohal management as per their vision and mission. For the greater interest of natural resources management, biodiversity conservation and livelihood development of dependant resources users, the Ministry of Land (MoL) should provide adequate co-operation.

Involvement of environmental factors in the gonadal development of a tropical Damselfish, *Chrysiptera cyanea*

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Photoperiod and temperature are potent environmental factors regulating the annual reproductive activities in temperate fish. It is unclear whether fish in the tropical origin utilize these environmental factors for their reproductive activities. The aim of the present study was to examine the effect of photoperiod and temperature on the gonadal development of the sapphire devil *Chrysiptera cyanea*, which is a reef-associated tropical damselfish adapted to the subtropical environment. Monthly collection of individuals in the experimental region in Okinawa (26°42′N, 127°52′E) showed an increase in the gonadosomatic index (GSI) and appearance of vitellogenic oocytes in ovaries from March to August. Post-ovulated follicles and yolk-laden oocytes coexisted in some ovaries from May to August. These results suggest that the sapphire devil in Okinawa has a restricted reproductive season with repeated spawning. Rearing the fish during the resting phase (in December) under experimental conditions of a long photoperiod (LD 14:10) at 31°C for 15 days and at 25 or 31°C for 60 days resulted in a significant increase in the GSI and induction of vitellogenic oocytes, whereas a short photoperiod (LD 10:14) at the same temperatures failed to induce oocytes at the yolk stages. Long-term rearing at the higher temperature caused suppression of vitellogenic oocytes. Controlling temperature under natural photoperiodic conditions affected spawning frequency during the reproductive season. Repetition of spawning was observed in the pairs reared at 25 °C, but not at 20 or 30°C. It is concluded that photoperiod and temperature are involved in regulation of gonadal development in the sapphire devil and that a long photoperiod within a suitable range of water temperatures is required for the maintenance of reproductive activities.

Some aspects of the biology of *Gagata cenia* (Hamilton 1822) in the Padma River, Rajshahi

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Some biological aspects of the Indian gagata catfish, *Gagata cenia* (Haminton, 1822), collected from the Padma River near Rajshahi city, were studied for a period of seven months from May to November 2012. Length frequency distributions, length-length relationships, length-weight relationship, sex ratio, Fulton's condition factor and fecundity of *G. cenia* were studied. This is the maiden research conducted on *G. cenia* in Bangladesh. The highest mean total lengths were 66.51±10.28 mm (combined sex), 70.12±09.49 mm (female) and 61.08±09.45 mm (male) in the month of June. Maximum 39.78% female fishes were belonged to the length category of 55-60 mm, whereas 51.06% male belonged to 50-55 mm. Similar findings are also presented for standard length, fork length, body depth, dorsal length, pectoral length, pelvic length and anal length. Linear relationships were also studied among mentioned lengths. Strong positive correlations were observed in all cases. The highest mean body weight was 2.78±1.08 g (June) in combined sex, this value was 3.20±1.00 g in female (May) and 2.17±1.04 g in male June. Strong positive correlations were also observed between total length and body weight. Observed value of sex indicated that 66.43% specimens were female and remaining 33.57% were male. The value of chi square (χ^2) was 30.23 at 1 degree of freedom ($p<0.01$) strongly indicated that the observed sex ratio differs significantly from the expected ratio (1:1). Spearman's Rank test indicated that there was a strong, positive correlation between total length and condition factor, which was statistically significant ($r_s = 0.210$, $P = 0.044$) (two tailed, $p<0.005$). Whereas in case of male, there was no significant correlation between these two ($r_s = 0.167$, $P = 0.262$). The Mann-Whitney U-test showed that the female individuals had the highest condition factor (Mean rank is 79.76). There was a statistically significant differences in the Fulton's condition factor between males and females (Two tailed, Mann-Whitney U = 1324). The mean individual fecundity was calculated 1501.50±278.89. Significant positive relationships were also observed between fecundity, total length and body weight. The lowest relative fecundity (402) was recorded in the May whereas the highest fecundity (994) was measured in the same month. All these data may serve as baseline information for conducting further research on *G. cenia*. Further in depth research efforts regarding biology (e.g. gonadal cycle observation, breeding and others) of this species are recommended.

Life history traits of the Tank gobi, *Glossogobius giuris* (Gobiidae) in the Padma River, Northwestern Bangladesh

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This study furnishes some biological parameters including sex ratio, length-frequency distribution (LFD), length-weight relationships (LWR), condition factors (Allometric, K_A; Fulton's, K_F; Relative condition, K_R and Relative weight, W_R) and form factor ($a_{3.0}$) of *Glossogobius giuris* in the Ganges (Padma), northwestern Bangladesh. Samples were collected from fishermen catch landed at different fish landing centers located between Jahaj ghat to Godagari, Rajshahi during April 2011 to March 2012. For each individual, total length (TL) was measured to the nearest 0.01 cm, while wet body weight (BW) was taken on a digital balance with 0.01 g accuracy. The overall sex ratio was statistically different from the expected male: female ratio of 1:1 (χ^2 = 26.14, P> 0.001). The TL ranged from 5.70 cm to 22.00 cm, while BW varied between 1.62 g and 73.93 g. The TL frequency distribution showed significant differences between males and females. The allometric coefficient (*b*) estimated in this study for males (*b*= 2.679), females (*b*= 2.770) and combined gender (*b*= 2.712) indicated negative allometric growth. The results also indicated that there was significant differences in the intercepts (P< 0.001), but not in the slopes (P = 0.059) between the sexes. Also the Mann-Whitney *U*-test showed no significant differences in the Fulton's condition factor between males and females (P= 0.105). In addition, the W_R (actual median= 98.97) showed no significant differences from 100 for males (P= 0.519) and females (Wilcoxon rank tes, P= 0.854) in this study. Moreover, form factor of male and female *G. giuris* was calculated as 0.0062, and 0.0070 respectively. This study will provide an important baseline for future studies within the Ganges River and adjacent ecosystems.

Reproductive biology of long whiskered catfish, S*perata aor* in captivity

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The abundance of *S. aor* was very rich in Bangladesh in '70s. But it is now a declining fauna due to various anthropogenic reasons. The IUCN declared it is an endangered to critically endangered in Bangladesh. So, the study was investigated to understand the reproductive biology of *S. aor* in captivity in Jakigong fish farm, Sylhet for a period of one year from August-2012 to July-2013. The body surfaces of male broods during breeding season (July-August) were inflamed, reddish and secreted milky fluid or scum. On the other hand, the abdomen of the mature females were rounded and swollen, and the genital opening is rounded, protruded and reddish in color. The testes of males were bilobed and more or less elongated and denticular projected. The colors of denticular projections of immature testis were cream whitish during Sep. to April, while the mature testis (during July-August) looked whitish. On the other hand, the ovaries of females were rounded and reddish brown in immature stages (during September-June) and light yellowish in mature stages (during July-August). This species found to be nest builders during breeding season. The average diameter and depth of their nests were 99.67±1.83 and 24.63±2.04, respectively. While the average body length and body depth of the brood fishes found in the same ponds were 50.26±1.39 and 6.82±0.43, respectively. The gonado-somatic index was gradually increased from September and the highest value 3.00±0.02 was observed in August. The average fecundity ranges from 65736 to 68627 per kg body weight**.** The relationship between fecundity and total length, fecundity and body weight, fecundity and ovary weight of fish were linear and significant. Histological study of ovary of *S. aor* revealed the presence 4-8 stages of oocytes of different developmental stages and appeared to be a random mixtures of early perinucleolar, late perinucleolar, yolk-granule and Yolk-globule stages in a single ovary which indicated a group asynchronous ovary. Presence of numerous spermatocytes and spermatogonia in the testes indicated that egg fertilization can be performed for a long duration.

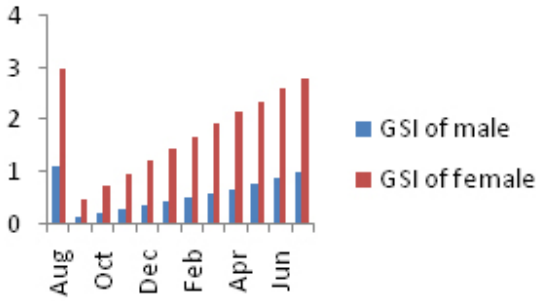

Fig.1. Monthwise GSI value of female *S. aor*

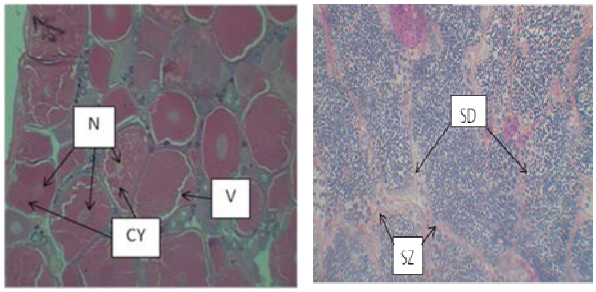

Fig. 2. Different stages of gonad development *S. aor*

Effect of dietary protein levels on reproductive development and distribution of amino acids in the body tissues of female *Pangasianodon hypophthalmus* (Sauvage 1878) broodstock in captivity

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The present study investigated the suitable level of dietary protein for the *P. hypopthalmus* broodstock development. Four experimental diets containing 25, 30, 35 and 40% of protein and a constant lipid level of 9% were added to feed prepared and presented in triplicate groups of fish. The fish (mean weight 770±17.23 g and 712±23.42 g for females and males, respectively) were stocked in outdoor canvas tanks (4 m x 1 m x 1 m) at a stocking density 20fish/tank with a sex ratio 4:1 of females and males, respectively. The fish were fed twice daily for 180 days. No significant changes were observed among the treatments in the survival, HSI index and individual egg weight. However, the final body weight gain, ovipositor diameter, GSI, fecundity, egg diameter and ripe egg were significantly (P<0.05) lower at 25% dietary protein level compared with the other treatments. Amino acids levels were higher in the muscle followed by the oocyte and liver in those fish fed at 35% and 40% protein diet treatments. Based on reproductive performance and biochemical composition of body tissues, a dietary protein level of 35% is recommended for the *P. hypophthalmus* broodstock development in captivity.

	Diets (%)			
Parameters	25	30	35	40
Initial weight(kg)	0.77±0.03	0.77±0.06	0.77±0.07	0.78±0.13
Final weight(kg)	$1.62±0.32^{a}$	$1.72±0.58^{b}$	$1.85±0.25^{c}$	$1.81±0.07^{c}$
Weight gain(kg)	$0.85±0.03^{a}$	$0.94±0.05^{b}$	$1.08±0.03^{c}$	$1.03±0.01^{c}$
Survival (%)	98.33±2.88	98.33±2.88	100.00±0.00	100.00±0.00
Ovipositor diameter(cm)	$0.27±0.03^{a}$	$0.42±0.08^{b}$	$0.52±0.03^{c}$	$0.47±0.02^{b}$
Ovipositor colour	pink & reddish	reddish	reddish	reddish
Condition factor	1.19±0.07	1.19±0.10	1.19±0.04	1.22±0.05
GSI	$4.73±0.64^{a}$	$6.76±2.10^{ab}$	$9.21±0.78^{b}$	$7.06±0.91^{ab}$
HIS	2.03±0.64	2.44±0.38	2.14±0.15	2.07±0.24
Fecundity (egg/kg) × 10^4	$6.51±4.2^{a}$	$14.67±4.05^{b}$	$16.89±2.93^{b}$	$13.24±1.14^{b}$
Oocyte weight(mg)	$0.47±0.08^{a}$	$0.47±0.03^{a}$	$0.56±0.07^{b}$	$0.53±0.02^{b}$
Oocyte diameter (mm)	$0.88±0.05^{a}$	$0.96±0.01^{b}$	$0.99±0.02^{b}$	$0.90±0.05^{a}$
Ripe egg (%)	$64.70±1.47^{a}$	$79.33±4.50^{b}$	$85.66±2.75^{c}$	$85.00±2.78^{bc}$

Different superscripts in each row indicate significant difference (P<0.05). Data expressed as mean ± SD.

Effects of cypermethrin and diazinon on haematology of *Labeo rohita*

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As pesticide pollution is very common in aquatic environment of Bangladesh, an attempt has been made to investigate the effects of cypermethrin and diazinon on haematology of *Labeo rohita*. In this study, same aged juveniles of *L. rohita* (Body weight 123±19.58 g) were exposed to two concentrations (low and high) of cypermethrin (0.15 and 0.30 μl/L) and diazinon (0.002 and 0.004 ml/L) for a period of 96 hours in 15 glass aquaria. The haematological parameters in terms of WBC, RBC, Hb, Ht, MCV, MCH and MCHC were analyzed using standard methods and these parameters of the fish exposed to pesticides were compared to control fish (not exposed to pesticides). During this study, water quality parameters (water temperature, dissolved oxygen and pH) were within the acceptable ranges for fish. The fishes exposed to pesticides decreased their food intake, exhibited frantic swimming and showed sluggish movement. A significant decrease in WBC, RBC, Hb and Ht level was found in the fish exposed to cypermethrin at both concentrations ($P<0.05$). MCV value was decreased at low concentration and increased at high concentration whereas MCH and MCHC values were increased significantly at low concentration and decreased at high concentration of cypermethrin as compared to the control fish ($P<0.05$). On the other hand, the number of WBC and MCHC values in diazinon exposed fish increased significantly with the increasing concentration of diazinon whereas the number of RBC, Hb level, PCV, MCV and MCH values decreased significantly at both concentrations as compared to the control fish ($P<0.05$). The present study concluded that short-term exposure to low concentration of cypermethrin and diazinon in aquatic environment might produce adverse changes in blood parameters of fish.

Effects of growout transplantation timing on growth and reproduction of Pacific oyster, *Crassostrea gigas* in Gamakman Bay, off the southern coast of Korea

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Pacific oyster, *Crassostrea gigas*, is the most important shellfish resources in Korea and has been widely cultured in numerous semi-enclosed bays along the south coast. In Korean oyster aquaculture, the spats are supplied mostly from wild and hardened for 9-10 months to secure high survival of the oyster during growout in the suspended long-line culture system. Previous studies have reported that the hardened oysters transplanted in the bay in May-June produced considerably small quantity of eggs during spawning in late summer, resulting in reduced larval recruitment in the bay. To understand the effect of growout transplantation timing on the growth and reproductive activity two populations of hardened oyster spats were differently transplanted into the Gamakman Bay in January and May 2009, and monitored for 12 months. The January transplanted oyster (JTO) reached a marketable size in August, while the oyster transplanted in May (MTO) became a marketable size in October. Histology revealed that JTO spawned from June to September, with single spawning pulse in July and MTO spawned mostly in September. During the spawning season the highest mean gonado-somatic index (GSI) was 28±6% for JTO and 11±7% for MTO (Fig. 1).The potential fecundity of JTO estimated prior to spawning in June was 27.92 million, approximately 6 times higher than that of the MTO. In November and December as the oysters are harvested, the meat weight and carbohydrate and protein levels in tissues of JTO were also significantly higher than those of MTO ($p<0.05$). The study clearly demonstrated that early transplantation of hardened oyster significantly enhances egg production, as well as to shorten grow out period (2 months). This study suggest that traditional grow out transplantation time needs to be re-evaluated for sustainable oyster aquaculture in the Gamakman Bay where oyster industry is facing a shortage of natural spat supply.

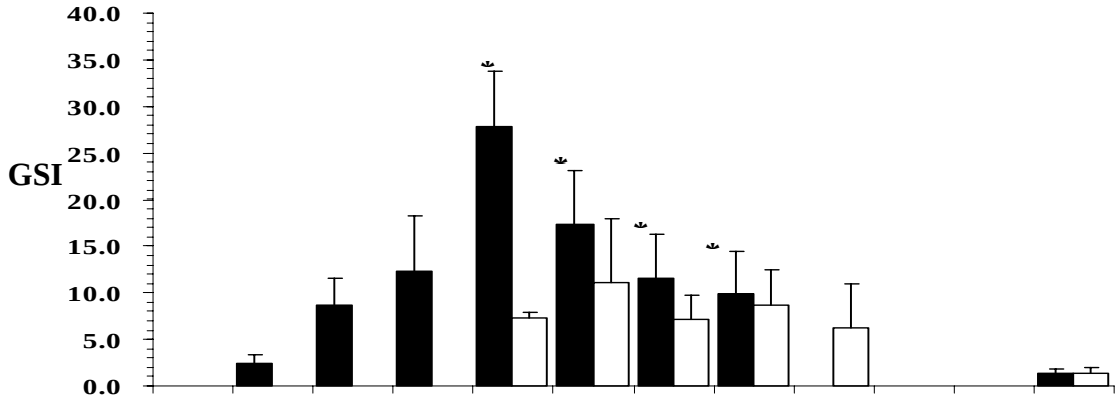

Fig.1. Monthly variations of GSI (%) of January (solid bar) and May (open bar) transplanted oysters during the study period from Gamakman Bay, Korea. The values are mean ±SD. The asterisk (*) indicates significant variation of the *t-test* at $p<0.05$.

Bamboo charcoal added feed boost Pangasiid growth and can reduce ammonia from pond

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A 50-day feeding trial was conducted to determine the effects of dietary bamboo charcoal (BC) on growth performance, body composition, and ammonia nitrogen excretion of Thai pangas, *Pangasius hypophthalmus*. Four levels of BC (0%, 0.5%, 1% and 2%) were supplemented to the diet composition and fed to fish (initial body weight 1.18±0.04 g) twice a day. At the end of the trial, mean of final weight (g), final length (cm), weight gain (g), length gain (cm), percent weight gain, percent length gain, specific growth rate (% per day), food conversion ratio (FCR), survival rates and water quality parameter i.e. NH_3, pH, DO and temperature were measured and found that fish fed 2% BC diet showed significantly (P<0.05) higher growth enhancement than those of fish fed the control diet (without BC). Ammonia concentration over the experimental period decreased with increasing dietary BC. Moreover, to detect the effect of BC upon the intestinal content of fish, intestines were collected and histology of those intestines were conducted and found that there was no significant difference among the intestinal content of fishes of different treatment. In conclusion, the diet supplemented with 2% BC was found to have a suitable level to fulfill the maximum growth performance and to decrease the ammonia concentration of *P. hypophthalmus*, under the conditions applied in this study.

Effect of pH stress on the embryonic development of zebra fish, *Danio rerio*

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Embryonic development of Zebra fish (*Danio rerio*) was studied under sub-lethal pH levels that showed significant differences in the hatching rates. Eggs were collected from the mature brood stocks and exposed to the high basic (10.5) and acidic pH (5.5) levels. Eggs were also collected from the fish that contained in the acidic medium but there was no egg from the high basic medium. Hatching time and hatching rates varied with the changes with pH. This study showed that hatching time and hatching rates were 72, 78, and 74 hours and 71%, 42% and 52% in the control (pH 7.0), acidic (pH 5.5) and high basic (10.5) medium, respectively. An increased blood glucose level (8.7 mmol/l) of Zebra fish was also found at high basic and acidic pH compared to the control (2.53 mmol/l).

Impact of sanctuary on fish biodiversity and production in the beels of Rajshahi and Naogoan districts of Bangladesh

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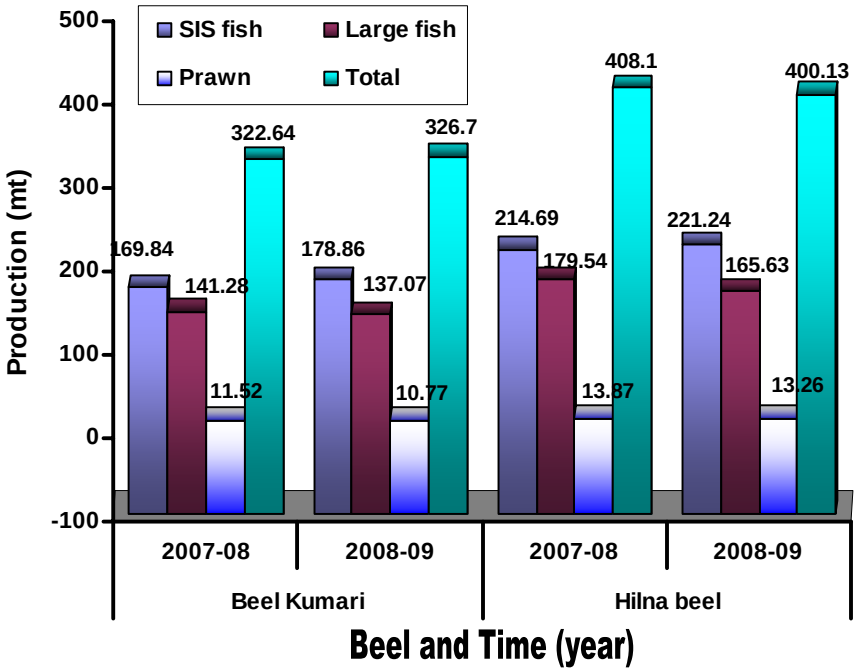
The study investigated the impacts of fish sanctuary on production and biodiversity of fishes in Rajshahi and Naogoan districts of Bangladesh. The experiment was conducted over 24 months during July 2007 - June 2009 in *Hilna beel* (Control) and *Beel Kumari* (Sanctuary established). The sanctuary area inside was *beel* Kumari (the beel area is about 996 ha in rainy season and 156 ha in dry season). The area of *Hilna beel* was 1500 ha in rainy season and 160 ha in dry season. Number of species increased from 88 to 92 viz. *Channa orientalis, Puntius gelius, Sperata aor* and *Somileptes gongota*. On the other hand, fish production also improved from 322.64 mt to 326.70 mt in the *beel Kumari* while in the *Hilna beel* the number of fish species declined from 88 to 85. Furthermore, fish production decreased from 408.10 mt to 400.13 mt in the *Hilna beel.* The present results suggested that fish sanctuary can be recommended for development of the *beel* fisheries management specially to improve conservation and increase fish production.



Finfish and shellfish biodiversity in the river systems of Chittagong and their conservation

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Biodiversity and habitat conservation are very important for the development of sustainable natural resources and to improve the livelihood of community people and enhancement of national economy. Bangladesh is a riverine country with a total of about 720 rivers, where 57 are transboundary, 54 with India and 3 with Myanmar. Chittagong river system plays a significant role in the national economy by providing large scale natural carp seed for country's aquaculture as well as fishery production. To know about the environmental health and fish biodiversity, a two years study during 2010 - 2012 was conducted on the fish and shellfish fauna and water quality of Chittagong River systems namely Halda, Karnaphuli, Sangu, Shikalbaha and Chandkhali. Species richness in the river systems of Chittagong was found to be 119 (101 finfish and 18 shellfish) belonging to 14 orders, 48 families and 93 genera. Three critically-endangered, nine endangered and eight vulnerable fish species (as in IUCN 2000) were observed in the population. Strong dominance was observed for the Clupeid. Three exotic species were also found. Although the water quality of the river systems was found to be suitable for fish but human interventions and climate change caused serious harm to the spawning ground and seed production of major carps (2470 kg fry in 1945 to 625 kg in 2012). Recommendations are given for conservation of biodiversity, endangered and endemic species and sustainable fish production.

Study on water quality and planktonic biodiversity of Punarbhaba river in the North-west Dinajpur, Bangladesh

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The present study was designed to demonstrate some valuable information about the water quality and planktonic biodiversity of the river Punarbhaba in the North-west part of Bangladesh. The research was carried out during April 2012 - September 2012. Water samples were collected fortnightly from the river along eight points and analyzed. Sites were chosen in such a manner to provide for even distance for effective sampling. All water quality parameters (viz., water temperature, transparency, dissolved oxygen, pH, alkalinity, phosphate-phosphorus and water depth) varied significantly ($P<0.05$) among different sites. Significant negative correlations were observed between dissolved oxygen (DO) and temperature; transparency and DO; temperature and phosphate; water depth and temperature. A total of 45 genera of plankton were recorded belonging to Chlorophyceae, Bacillariophyceae, Cyanophyceae, Euglenophyceae, Crustacea and Rotifera. Chlorophyceae was the most dominant group in terms of biodiversity and Cyanophyceae was the least. Unplanned urban and agricultural activities are reported as major threat and responsible for destroying the overall ecosystem of the river. It is an urgent need to highlight the linkages between river ecology, biodiversity, livelihoods and sustainable development in order to protect the river for future generations.

Fish biodiversity of Ashura beel in Dinajpur, Bangladesh

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Bangladesh is a country of both seasonal and perennial wetland, which get interconnected, at least during the monsoon and eventually ensuring livelihood security of the Wetland people. A study has been carried out in *Ashura beel* in Dinajpur district under Nawabjong Upazila for a period of 8 months in order to observe fish with a focus on biodiversity conservation. It is one of the largest *beel* in Dinajpur district having an area of 251.78 ha. A total 16 samplings were conducted where a total of 38 fish species were found. Among the observed 38 fish species, 14 species are threatened of which most of are small indigenous fish species (SIS). The most abundant fish species were *Labeo rohita, Channa punctatus, Colisa lalius, Mastacembelus panculas, Mystus vittatus* and *Nandas nandus* during the study period. On the other hand, the least abundant fish species were *Ompak pabda, Osteobrama cotio* and *Channa marulius.* On the basis of the available data, the fishes were ranked under different categories developed by IUCN (2000). Some of the fishes were widely distributed while others were ranked as common, rare and very rare. Fish like *Amblypharyngodon mola, Wallogo attu* and *Puntius ticto* were common where as *Hara hara, Channa orientalis* and *Labeo boga* were very rare. Both the seasonal and perennial parts of the *beel* provide extensive support to the people living around the *beel*. However, agriculture activities in the lower and upper edges of the *beel* is the main reason for the gradual reduction of the potential size of *Ashura beel*.

Status of fish species diversity of Padma river Rajshahi, Bangladesh

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The study was conducted during May 2010 - November 2010 on the Padma River near Rajshahi. A total of 63 fish species of nine Orders and 21 Families were identified. On the basis of availability the species were categorized in four statuses that obtained as common (49.21%), less common (34.93%), rare (12.69%) and very rare (3.17%). Result of the study identified nine species as very rare which may extinct in near future. A number of causes both manmade and natural are responsible for this declining trend. The present work recommends preventing water pollution, ensuring water flow, developing fishermen's awareness, implementation of fisheries laws and declaration of fish sanctuary to save fish diversity of the study area

Diversity of adaptive fishing gears in Meghna river, Bangladesh

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A survey was conducted to study the fishing gears in the river Meghna during July 2010 - June 2012. Six types of nets under seven major groups, three types of trap, two types of hook and line, and one harvesting method were found in operation during the study period. For fishing purpose, a wide variety of nets such as gill nets, seine nets, drag.net, set bag net, lift net, cast nets were usually used. The fishing traps were *pangas chai, ichar chai, damphu* etc. For line fishing, long line (*hajari borshi*) was used.

Table 1. Detailed features of different kinds of net used in the Meghna River

	Local Name	Mesh Size cm	Avg. Length m	Catch kg /Haul (CPUE)	Target Sp.	Material	Season of Operation
Gill Net	Chandi	5-10	400	0.5-7	Ilish	PA multi	Year round
	Cord Phas/Pile	10-15	500	0-40	Pangus	Tire Cord	Nov-Apr
	Poma	2.5-4	500	0.5-8	Poma	PA multi	Nov-Apr
	Kajoli	2.0	200	0.5-3	Chewa	PA mono	Nov-Apr
	Phas/Current	2.0-4	200	0.5-3	Jatka, Ilish	PA mono	Year round
Seine Net	Katha Ber	0	500	10-15	Kaski	Zero mesh filter net	Year round
	Kona Ber	5-8	500	5-10	Hilsa	Tire Cord	Year round
	Angta	0.5-1	200	0.5-2	SIS	PA multi	Nov-Apr
	Ber	2-2.5	1000	10-40	SIS	PA multi	Year round
Set Bag net	Behundi	0-2.5	5-8	5-20	SIS, Shrimp, jatka	Tyre cord, PA Multi	Year-round
Drag Net	Moi	2-2.5	3	0.25-0.5	Prawn	Tyre cord, PA Multi	Year-round
	Chap	4-5	500	5-20	Catfish	Tyre cord	Nov-April

PA Multi- Polyamide Multifilament, PA Mono- Polyamide Monofilament, SIS- Small indegenous Species

Most of the gears used were nonselective except the gill nets Fishing gears like *behundi jal, chor ghera jal, katha ber jal,* are capable of capturing a wide variety of fish species thus those are harmful for the river biodiversity. Fish trap like *pangas chai* that catches undersized Pangas (*Pangasius pangasius*) is a severe threat for the existence of the species. During peak season (April- June) there are numerous incidences of killing more than 100 kg of pangas fry by a *pangas chai* in single haul of 8 to 10 hours.

Floodplain aquaculture: Impacts on ecology and biodiversity

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Floodplain appears as an important aquatic ecosystem that provides wide range of biodiversity and indispensable benefits to the people. This study was conducted to identify the aquaculture impact on biodiversity of non-stocked indigenous fish species (NIFS) and ecology of floodplain *beel*s (two cultured and one nonoculture) located in northwestern Bangladesh during July-December, 2013. To observe the present status of cultured and non-cultured *beel*s during fish harvest, direct observation methods were used. After intervention of fish culture, the total number of fish species was 29 (Including 9 cultured species) and 18 (including 7 cultured species) in *beel* Kola at Baghmara and *beel* Khosal at Mohanpur, respectively. Whereas at non-cultured floodplain *beel* Hatra at Mohanpur, 21 species were found. In *beel* Kola 31 and in *beel* Khosal 38 types of aquatic plants were found in the study period. 6 types of benthos and 5 types of other fisheries items were recorded in the study area. To increase the production of aquatic resources in these open waterbodies without interrupting the ecology and biodiversity, sustainable fishery management is required.

Spatial and temporal patterns of fish assemblages in the Rezu khal estuary, Cox's Bazar, Bangladesh

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Rezu Khal is an important river of Ukhia under Cox's Bazar district from the commercial and ecological viewpoint and supports diverse fisheries organisms. Present study was carried out to record the species composition, abundance and to assess the fish diversity status in both spatial and temporal scales. Fish samples were collected from three stations of the Rezu Khal estuary from December 2012 to November 2013. Findings showed that Rezu Khal estuary is the habitat of 45 species which belongs to 23 families. *Stolephorus* sp. 1 was counted for maximum individual species (6.75%) whereas *Dasyatis zurgei* was the minimum (0.312%) during study period. The highest number of species was represented by the family Engraulidae, Clupeidae and Gobiidae comprising 40.97% of the total fish abundance and each family with 5 finfish species. Analysis of similarity (ANOSIM) showed significant difference in species assemblage among the stations and seasons at the level of >1% and >5%. Similarity percentage (SIMPER) analysis implied the fact that samples analyzed based on seasons have more similarity than the stations. *Escualosa* sp., *Escualosa thoracata* and *Mugil* sp. 2, were dominant species in different seasons (temporal), whereas *Mystus gulio*, *Rogadius asper* and *Beleopthalmus viridis* were dominant species in different stations (spatial). *Rastrelliger kanagurata*, *Escualosa* sp., *Escualosa thoracata* and *Eleotris fusca* were the discriminator species in different stations and *Escualosa* sp., *Oreochromis niloticus*, *Rastrelliger kanagurata* and *Scomberomorus kuhli* were the discriminator species in different seasons.

Fish fauna of the Andharmanik river in Patuakhali, Bangladesh

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The fish fauna and their seasonal abundance in the Andharmanik River of Patuakhali district have been studied during March 2011 - February 2012. Specimens of fishes were collected from three different sites (S_1, S_2 and S_3) of the Andharmanik River; approximately between $21^o50'$-$22^o00'$ North and $90^o05'$-$90^o15'$ east. Specimens were collected using seine net of 1-2 cm mesh size. Collected fish specimens were examined and preserved in 10% buffered formalin solution in labeled plastic jars. Local names of specimens were noted on the sampling sites. A total of 53 fish species belonging to 10 orders, 27 families and 47 genera were collected and identified. The most dominant order of fishes was Perciformes (18 species) followed by Siluriformes (12 species) and Clupeiformes (9 species). Maximum 45 species were recorded in November whereas minimum 19 species in May. September was the peak (availability) month for majority 11 species. May was found to be the lean season for majority 14 species. Two critically endangered, 3 endangered, and 5 vulnerable fish species of Bangladesh were also recorded along with one exotic carp species.

Commercial finfish and shellfish of the Karnaphuli river, Chittagong, Bangladesh

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A five months study from September 2012 to January 2013 was conducted on the commercial fish and fishery of a section of the river Karnaphuli (from Kalurghat Bridge point to Shah Amanat Bridge point), to know the commercial finfish and shellfish fauna, their production and price, and fishing gears used to harvest them. The data and information were collected monthly by visiting the fishing boats, gears and by interviewing the fishermen and key informer. A total 24 finfish species belonging to 15 families under 6 orders (Clupeiformes, Cypriniformes, Channiformes, Perciformes, Pleuronectiformes, and Siluriformes) were recorded. Three species of shellfishes belonging to 1 family (Palaemonidae) under order Decapoda were also found during the study period. Among the fin fishes Perciformes showed the maximum (9) species under 9 genera. On the other hand Siluriformes, Clupeiformes, Cypriniformes, Pleuronectiformes, and Channiformes showed 7, 4, 2, 1 and 1 species respectively. Among the finfish and shell fish species in context of five months total production, *Setipinna phasa* occupied the first position by contributing 16.63 metric ton (mt), second position 7.38 mt by another clupeid *Tenualosa ilisha,* third position 1.8 mt by *Macrobrachium rosenbergii.* The most abundant and available fish throughout the study months was the *S. phasa* (300 kg/month to 5640 kg/month) followed by *M. rosenbergii* (155kg/month to 806 kg/month). *Cynoglossus* sp. and *Polynemus paradiseus* were found to be least abundant species (production 1.55 kg/month). In context of economic value during the five months study period *T. ilisha* occupied the first position by contributing total Taka 47.97 lacs for 7.38 mt fish, second position by *S. phasa* by contributing Taka 36.59 lacs for 16.63 mt fish and third position by *M. rosenbergii* by contributing Taka 12.61 lacs for 1.8 mt shellfish. The total fish production during the 5 months study period was 30.11 mt, which total price was Taka 94.76 lacs. Monthly lowest total fish production was found during the month of September 2012 (4.8 mt) and highest during October 2012 (7.4 mt). Systematic position, common name, morphology, habit and habitat, fishing gears and commercial production (daily and monthly) of finfish and shellfish species are presented. Four types of fishing gears were recorded, their particulars (length, width, mesh size, and gear materials) are provided. Suggestions are given for protection, conservation, and sustainable yield of commercial fishes in the Karnaphuli River.

Complete mitochondrial genomes and novel gene rearrangements in two dicroglossid frogs, *Hoplobatrachustigerinus* and *Euphlyctishexadactylus*from Bangladesh

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We determined the complete nucleotide sequences of mitochondrial (mt) genomes from two dicroglossid frogs, *Hoplobatrachustigerinus* (Indian Bullfrog) and *Euphlyctishexadactylus* (Indian Green frog). The genome sizes are 20,462 bp in *H. tigerinus* and 20,280 bp in *E. hexadactylus*. Although both genomes encode the typical 37 mt genes, the following unique features are observed: 1) the ND5 genes are duplicated in *H. tigerinus* that have completely identical sequences, whereas duplicated ND5 genes in *E. hexadactylus* possessed dissimilar substitutions;2)Duplicated control region (CR) in *H. tigerinus* has almost identical sequences whereas single control region (CR) was found in *E. hexadactylus* ; 3) the tRNA-Leu (CUN) gene is translocated from the LTPF tRNA cluster to downstream of *ND5-1* in *H. tigerinus*, and the tRNA-Pro gene is translocated from the LTPF tRNA cluster to downstream of CR in *E. hexadactylus*; 4) pseudo tRNA-Leu (CUN) and tRNA-Pro genes are observed in *E. hexadactylus*; and 5) two tRNA-Metgenes are encoded in both species, as observed in the previously reported dicroglossidmt genomes. Almost all observed gene rearrangements in *H. tigerinus* and *E. hexadactylus*can be explained by the tandem duplication and random loss model, except translocation of *tRNA-Pro* in *E. hexadactylus*. The novel mt genomic features found in this study may be useful for future phylogenetic studies in the dicroglossidtaxa. However, the mt genome with interesting features found in the present study reveal a high level of variation of gene order and gene content, inspiring more research to understand the mechanisms behind gene and genome evolution in the dicroglossid and as well as in the amphibian taxa in future studies. amorphosis.

Comparative study of breeding performances of three different broodstocks and their $F_1$and F_2generations of freshwater prawn *Macrobrachiumrosenbergii*

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Breeding performances of freshwater prawn *Macrobrachiumrosenbergii* was carried out with gravid females collected from the Haldariver (HB), Own developed (OB) and *Ghers* (GB) at Upakul Freshwater Prawn (UFWP) Hatchery, Sonapur, Noakhali. Own developed broods were produced from juveniles collected from the Bulla river of Noakhali with a formulated feed (32% crude protein) in earthen ponds by rearing for 135 days at Southern Agro Fisheries and Allied Limited (SAFAL) MatsyaKhamar, Noakhali. F_1PL produced from those broods were reared for 56 days supplemented with nursery CP food. Similarly PL of F_2 generations were produced from F_1 broods of Halda (F_1HB), Own developed (F_1OB) and *Gher* (F_1GB) but F_2PL of *Gher*broods died due to unknown disease outbreak in UFWP hatchery. Juveniles of F_1 and F_2 generations obtained from nursery phases were reared for 240 days in the same ponds supplemented with formulated feed. River water was used at every lunar cycle by pumping and passing through a fine meshed net so that no fish or any larvae can invade in experimental ponds. Fecundity of broods of Halda (HB), Own developed (OD) and *Gher* (GB) ranged from 85952- 106154; 82023-103545 and 14272-17544 respectively. In F_1 generations fecundity of broods of F_1HB, F_1OB and F_1GB ranged from 63539-92195, 60920-77567 and 23328-37292 respectively but fecundity was dramatically dropped to 26473-31539 and 29178-33617 in broods of F_2HB and F_2OB respectively where no significant differences were observed between generations of HB and OB (*P>0.05*). Relationships between fecundity and body weight in all the generations showed positive linear relationship but regression coefficients were very strong in HB and OB and their F_1 generations, and modest in F_2 generations. Hatching rate of eggs from HB and OB were 46.64% and 42.92% which increased to 49.54% and 50% in F_1 generation and 70.26% and 67.82% in F_2 generations respectively. The results of GB (20.23%) and F_1GB (29.01%) were always poor. PL conversion rate and juvenile conversion rate from broods of HB (23 and 65%) and OB (20 and 61%) were always higher than those of GB (13 and 35%). The results suggested that breeding can be performed well through production of quality broodstocks in captivity with a proper balanced diet (32% crude protein) provided with water management and sufficient shelters.

Genetic variation of cultured and wild broodstocks and their progenies of freshwater prawn *Macrobrachiumrosenbergii* revealed by microsatellite markers: implications for hatchery managers

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Farming of freshwater prawn (*Macrobrachiumrosenbergii*) plays an important role in the economy of Bangladesh. With the rapid expansion of farming, many freshwater prawn hatcheries were established in the country. Though the hatcheries prefer wild broodstocks for producing quality seeds, the supply is rather irregular. So, they have no alternative but using the broodstocks collected from traditional culture systems called 'ghers'. Moreover, there is a speculation among the farmers that the quality of hatchery produced post-larvae (PL) is low. To address all the issues the present study was conducted to assess genetic variation of wild and captive reared broodstocks and occurrence of changes of genetic variation in their progenies. For the study, broodstock of "Own developed" (OB) was produced by rearing juveniles of freshwater prawn collected from the Bulla river of Noakhali region in earthen ponds in Southern Agro-Fisheries & Allied Ltd. (SAFAL) of Noakhali by providing own formulated feed. Wild broodstock of prawn was collected from the "Halda river" (HB) and captive reared broodstock was collected from a "gher" (GB) of Bagerhat district. F_1 and F_2 progenies of each broodstock origin were produced at Upakul Freshwater Prawn Hatchery (UFWPH), Noakhali and reared in SAFAL farm. As all the larvae and PL produced from F_1broodstock of GB origin died due to unknown disease outbreak at UFWPH, genetic variation of three broodstocks (HB, OB, GB), their F_1 progenies, and F_2 progenies of HB and OB origin were assessed at eight microsatellite loci. Genetic variability in terms of mean number of observed and effective alleles per locus, mean allelic richness and observed and expected heterozygosity of parental broodstocks was highest which reduced gradually in F_1 and F_2 progenies. Though there was no significant (P>0.05) difference in genetic variation in terms of mean allelic richness, observed and expected heterozygosity between parental broodstocks and F_1 progenies, significant (P<0.05) difference was observed between parental broodstocks and F_2 progenies indicating high magnitude of loss of genetic variation in F_2 generation. Estimation of genotypic differentiation (F_{st}), AMOVA and factorial correspondence analysis also supports the genetic heterogeneity between broodstocks and their progenitor populations (F_1 and F_2). Pair-wise estimate of F_{st} (0.0075) between HB and OB was the lowest and insignificant (P>0.05) indicating close relation between them as both of them were of river origin. The result of 'Bottleneck Test' was significant only in GB and its F_1 progeny. So, freshwater prawn hatchery managers should not use broodstocks sourced from 'ghers'. They may use broodstocks produced by rearing wild PL or juveniles in earthen ponds as genetic variation of such developed broodstocks was equivalent to that of wild broodstocks as evident in the present study. Initiation of such practice will also be supportive for conservation of wild stocks. However, F_1 broods should not be used for production of PL in hatcheries as loss of genetic variation in F_2 generation was found high.

PG-Induced breeding of endangered spiny eel *Mastacembelusarmatus*(Lacepede 1800)

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Mastacembelusarmatus categorized as endangered is a highly potential species in Bangladesh. The experiment was initiated to establish an induced breeding technique. Two different trials were conducted on induced breeding of this species at Wet laboratory and Mini hatchery & breeding complex under the Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh during May to July 2013.In trial I, for standardizing PG dose in female *M. armatus*,fourdifferent doses of PG viz., 20, 40, 60 and 80mg kg^{-1} body weight were used in treatments I, II, III and IV respectively. Marked differences were observed in effectiveness of the four doses in inducing ovulation. Each of the doses of 40, 60 and 80mg $PGkg^{-1}$ body weight resulted in 100% ovulation. The percent fertilization of eggs was the highest in treatment II (93.00±2.00%) at 40mg $PGkg^{-1}$ body weight followed by treatment III (29.00±3.61%) at 60mg kg^{-1} body weight and the lowest fertilization rate (16.67±1.53%) in treatment IV (80mg $PGkg^{-1}$ body weight). The percent hatching of eggs was also the highest in treatment II (58.30±3.50%) followed by treatment III (12.30±1.50%) and the lowest hatching rate (6.67±1.53%) in treatment IV. The lowest dose of 20mg $PGkg^{-1}$ body weight resulted no ovulation. On the other hand, females treated with the highest dose of 80mg $PGkg^{-1}$ body weight although showed 100% ovulation, the fertilization rate was very low and subsequently hatching rate was negligible. This is ascribable to the fact that the lowest dose of PG failed to induce ovulation and the highest dose of PG resulted very high percentages of eggs on stripping including unripe ones. The best result was obtained from 40mg $PGkg^{-1}$ body weight in respect of ovulation rate (100%) of females and fertilization (93.00±2.00%) and hatching rates (58.30±3.50%) of eggs. The temperature in incubator ranged from 26 to 28^0C and latency period varied from 36 to 42h in treatments II & III and 30 to 32h in treatment IV during the experimentation.In trial II, the best dose *i.e.* 40mg $PGkg^{-1}$ body weight obtained from trial I was used. In this trial the variation in mode of injection was as follows: i) administration of the whole dose at a time (treatment I) and ii) administration of the dose by two different injections (treatment II) (30% & 70%) at 6h interval. In treatments I and II, 100% and 100% ovulation, 91.67±2.08% and 91.33±2.08% fertilization, and 57.00±3.61% and 58.33±3.51%hatching were achieved respectively. Statistical analysis revealed no significant difference among the females treated once (with the whole dose) or twice with divided dose of PG at the rate of 30% & 70% at 6h intervals in respect of ovulation rate of females and fertilization and hatching rates of eggs.

Genetic diversity and structure of wild populations of mrigal*Cirrhinuscirrhosus* revealed by microsatellite markers

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To assess genetic diversity and structure of wild populations (the Halda, the Jamuna and the Padma) of mrigal, *Cirrhinuscirrhosu*s six microsatellite markers namely *MFW1, MFW2, MFW17, Bgon17, Bgon22* and *Barb54* were analyzed in this study and all of the markers, except *Bgon17,* were found to be polymorphic (P_{95}) in all the populations. The average number of alleles was highest in the Halda population (2.8) while the Jamuna population contained the lowest number of alleles (2.4). The average observed heterozygosity (Ho) value in the Padma stock was the highest (0.400) followed by the Halda (0.383) and the Jamuna (0.377) populations. Similarly the expected average heterozygosity (H_e) value was highest in the Padma population (0.456) followed by the Halda (0.392) and the Jamuna (0.391) populations. Significant deviations from Hardy-Weinberg Equilibrium (HWE) were detected in 5 out of 15 loci and the Padma population (3 loci) deviated much among the three populations which occurred due to excess heterozygosity. The population differentiation (F_{ST}) value between the Halda and the Jamuna populations was the highest (0.026) and that of lowest (0.0143) between the Jamuna and the Padma populations. The Nei's (1972) genetic distance between the Halda and the Padma population was the highest (0.0370) and it was lowest (0.0195) between the Padma and the Jamuna populations indicating that the genetic distances are pronounced. The geological structures separate the Haldariver from the other stocks and may limit the gene flow between the Halda and any of the other two populations. The UPGMA dendrogram based on Nei's (1972) genetic distance resulted in two major clusters. The Halda population alone was in one cluster and remaining two populations (the Jamuna and the Padma) were in the other cluster. The microsatellite analyses of three wild populations revealed a low level of genetic variation among the populations which suggested that appropriate measures need to be taken for stock improvement and conservation of the stocks.

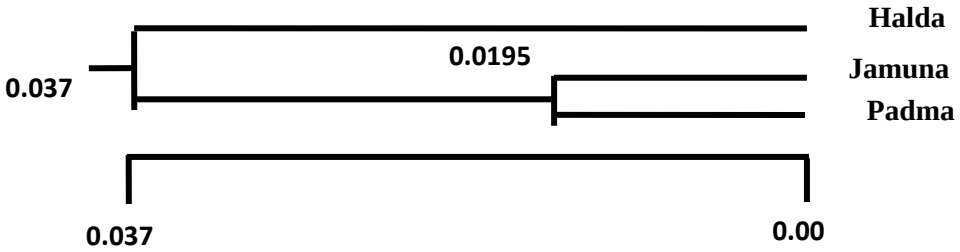

Fig. 1.UPGMA dendrogram based on Nei's genetic distance in *C. Cirrhosus.*

Landmark based morphometric and meristic variation of the endangered bata (*Labeobata*) population in the south western part of Bangladesh, using truss network system

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The morphological variations of endangered bata (*Labeobata*) was studied based on morphometric, meristic and landmark analysis to know the population status in the south western part of Bangladesh. Samples were collected from a hatchery, Chuadanga;Kirtonkhola River, Barisal and Boluhorpur*Baor*, Jhenidah. Univariate and multivariate analysis were performed along with the land mark of truss morphometric network. Morphometric characters in the present study were more discriminative than meristic characters. Significant variations were observed in 3 meristic characters (Number of Scales above lateral line, Fin rays in caudal fin, Fin rays in pectoral fin), 14 morphometric characters (Head length, Predorsal length, Standard length, Fork length, Eye diameter, Post orbital head length, Body depth, Length of the upper jaw, Height of the pelvic fin, Trunk length, Inter orbital, Length of base of the dorsal fin, Least depth of the caudal peduncle, and Length of the base of the anal fin) and 21 truss measurements (1-2, 1-9, 1-10, 2-3, 2-8, 2-9, 2-10, 3-9, 3-10, 3-4, 3-8, 4-5, 4-7, 4-8, 4-9, 5-6, 5-7, 5-8, 6-7, 8-9, 9-10) were found to be significant at varying degrees (*P < 0.05, **P < 0.01 and ***P < 0.001). For morphometric and landmark measurements, the first and second DF accounted 80.4 % and 19.6% among group variability respectively. The overall random assignment of individuals into their original group by the DFA was 100%. This suggested that there was very limited intermingling among populations and the populations of the species were separated. The dendrogram constructed in this study consist of two clusters: Hatchery and Boluhorpur in one and the Kirtonkhola is another. These all analysis supports that “Truss Network” is an effective tool for determining the population status of fish. The results of the study are useful as baseline information of L. bata populations for further studies both home and abroad.

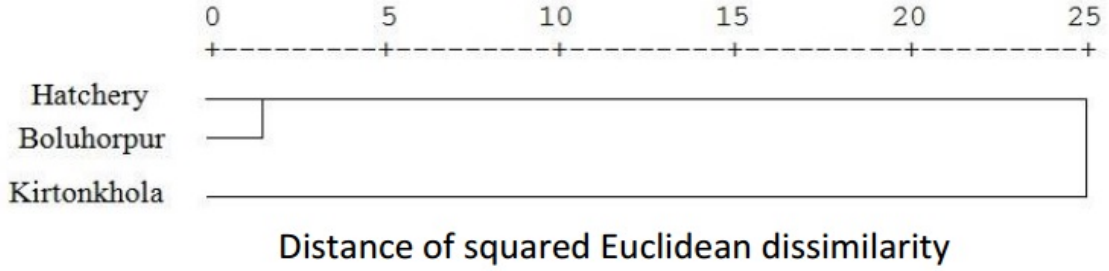

Fig. 1. Dendrogram based on morphometric characters and Landmark distances of the hatchery, theKirtonkhola and the Boluhorpur populations of *L. bata.*

Development of heterotic hybrids through crossing riverine stocks of rohu, *Labeorohita*

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Two of the approaches for improvement of growth performance in the aquaculture species are selection and hybridization. Depending upon breeding cycle of a species, selection program can always be time consuming, however, hybridization that exploits dominant genetic variation, production of F_1 hybrids is quicker and although nicking of dominant allelic action in hybrids is fortuitous, the program is worth trying. With this aim in view, six reciprocal hybrid crosses were made between three strains of rohu (*Labeorohita*) from the Padma, Halda and from a local Hatchery from Jessore, Bangladesh, together with control crosses of the three single strains. The participating broods were tagged intraperitoneally with digital tags and preserved in the pond facility of Bangladesh Fisheries Research Institute's, Jessore campus. The fishes of the different crosses were growth tested for length and weight for 18 weeks in ponds. The single strain, Padma × Padma showed the highest growth performance followed by one of the reciprocal crosses between Padma♀ × Hatchery♂. The lowest growth performance was observed in Hatchery × Hatchery crosses which was deemed obvious as poor performance of hatchery produced seed is variously claimed by the farmers. Growth results of the above crosses were vindicated through looking at DNA variation using RAPD and microsatellite markers. Three di-nucleotide microsatellite loci were analyzed to reveal genetic structure of the strains and all the loci were found polymorphic (*P95*). The strains were varied with respect to the number and frequencies of alleles where mean number of alleles varied from 4.667±0.882, 3.333±1.333 and 2.667±1.202 in Padma, Padma♀ x Hatchery♂ and Hatchery respectively; the strains were also varied with regard to mean heterozygosity in different loci. Strain differentiation *(F_{ST})* values among the Padma, the Halda and hatchery were insignificant *($p < 0.05$)*. Relatively high level of gene flow and low level of F_{ST} values were found between the Padma& Hatchery and Padma&Padma♀ × Hatchery♂ strain. The Unweighted Pair Group Method with Averages (UPGMA) dendrogram based on genetic distance resulted in two clusters; the Padma population was alone in one cluster whereas the Padma♀ × Hatchery♂ and Hatchery made another cluster. The results revealed a relatively low level of genetic variability in the river populations of *L rohita*in Bangladesh. Hybrid seed production is an established method in agriculture, in general. Thus the parents of strain crossed foregoing hybrid which were conserved with tag marks in Jessore campus of BFRI can be used for hybrid seed production in future.

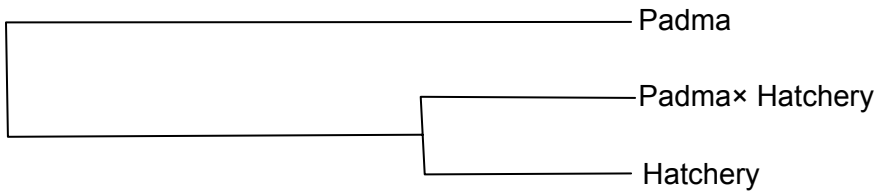

Fig. 1. Dendrogram based on Nei's (1972) genetic distance summarizing the differentiation among Padma, Padma×Hatchery and Hatchery populations of *L. rohia.*

Genetic variation in the stinging catfish *Heteropneustesfossilis* (Bloch) populations revealed by microsatellite DNA markers

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Catfish is one of the lower teleosts whose genome research is important for evolutionary genomics. As the major aquaculture species in Bangladesh, its genome research has also practical and economical implication. Three microsatellite loci (*Cba02, Cba19* and *Cba20*) developed from *Clariasbatrachus* were tested in the stinging catfish (*Heteropneustesfossilis*) to study the genetic variation. Samples were collected from two natural populations namely Mohongonj and Narsingdi and from a hatchery population located in Mymensingh of Bangladesh. All the three loci were found to be polymorphic (P_{95}) in the three studied populations. The average number of allele was almost the same in all the three populations (6.0-6.3). The average observed heterozygosity (H_o) value was the highest in Narsingdi population (0.80) followed by the Hatchery (0.70) and the Mohongonj population (0.67). Only Mohongonj population was significantly deviated from Hardy-Weinberg Equilibrium only in one locus. The population differentiation value (F_{ST}) between all the population pairs were insignificant. The highest genetic distance value (D = 0.47) was found between the Mohongonj and Hatchery populations while the smallest value (D = 0.34) was found between the Mohongonj and Narsingdi as well as Narsingdi and Hatchery populations. The UPGMA dendrogram based on genetic distance resulted in two major clusters: Hatchery stock alone was in one cluster and the remaining two natural stocks were in other cluster. The result would be useful in the study of population genetic structure of different catfish species. The present study revealed that the *Clariasbatrachus* microsatellite could be effectively used in the assessment of genetic structure of the stinging catfish *H. fossilis.*

Morphometric relationships and condition factors of two freshwater barbs, *Puntius sophore* and *Puntius ticto* from the river Padma of Bangladesh

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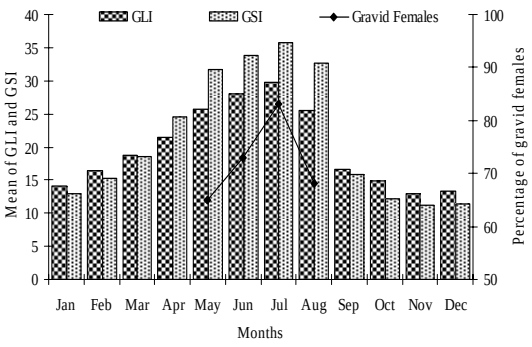
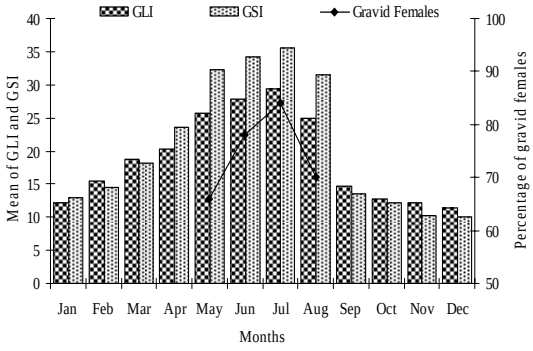
The present study was carried out length-length, length-weight relationships and condition factor of two freshwater barbs *Puntius sophore* and *Puntius ticto* in Rajshahi during the months January, 2011 to December, 2011. The length-length relationships with total length among different body lengths for *P. sophore* and *P. ticto* were found highly significant with all "r" values ranged from 0.888 to 0.997 for *P. sophore* and 0.897 to 0.996 for *P. ticto*. The interrelationships among the length parameters were also found highly significant ($P<0.01$) with all "r" values being >0.872 both for *P. sophore* and *P. ticto*. The length-weight relationship equations were obtained as $TW=0.00831TL^{3.015}$ for *P. sophore* and $TW=0.00647TL^{3.021}$ for *P. ticto* and found highly significant. The observed (K_o), calculated (K_c) and relative (K_n) condition factors showed little variation for both the species and maintained fairly same patterns among them. Findings of the present work would be helpful for fishery managers as well as the sustainable management of freshwater barbs of Bangladesh as well as other countries of the world.



Monthly variation in GLI, GSI and percentage of gravid females of *P. sophore*



Monthly variation in GLI, GSI and percentage of gravid females of *P. ticto.*

Impact of community based fisheries management (CBFM) on the livelihood of fisheries at Sherudanga *beel* in Rangpur district, Bangladesh

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Community Based Fisheries Management (CBFM) approach appears to be a worthy factor in managing fisheries successfully. We investigated and trying to evaluate the management practices and its impact on the livelihood of the fisheries community of Sherudanga *beel* in Rangpur district from March 2010 to February 2011. The study was carried out based on Community Based Fisheries Management (CBFM) practices, *beel* biodiversity, fish production, socio-economic and livelihood condition of the fishermen. The studied *beel* is 83 acre seasonal floodplain, which was mainly used by a community consisting of 80 families for their livelihood, and where the CBFM approach was introduced by the community. At pre CBFM, there was no controlled management system from any NGO or even Government for its proper management of the *beel*. Recently, community fishers leased out this *beel* from government in 2000 for 12 years and started to manage it. The CBFM project works for the development of fishery as well as fishermen and the people beyond. Sherudanga *beel* is rich in its fish diversity, where 7 stocked, 31 resident and 6 extinct species were identified in the catch of different type of fishing gears such as nets (*jhaki jal, current jal, thela jal*), trap (*darki*) and wounding gears (hook). The yearly gross fish production was about 4.7 times higher than pre CBFM period, implying that average abundance and fish biodiversity were significantly higher in the CBFM implemented *beel*. Majority of the fishermen had primary level education (37.5%) compared to 27.5% and 16.5% having secondary level and above secondary level education, while 18.75% of them could sign their name only, indicating the improvement of education level among fishers. About 43.75% of them had small size family, while 40.0% and 16.25% had middle and large size families. The prevalence of unconstructed house was the highest (77.5%) while few of them (22.5%) had semi constructed house. More than half of the fishers had their own tube well, while rest (37.5%) of them used to drink water from the tube well of others. About 8.75% of the fishermen had medium income, while 12.5% and 18.75% had small and large income. More than half (56.25%) of the fishermen received credits from different sources while rest (43.75%) of them did not get any credits. In conclusion, the overall findings showed that community based fisheries management has significantly increased annual fish production, lifted household income levels, improved access to credit from a wide range of sources, and enabled livelihood diversification.

Physico-chemical characteristics and accumulation of heavy metals in water and sediments of the river Dakatia, Bangladesh

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The study was conducted to know the status of water quality in the Dakatia river of Cahndpur district with particular emphasis on concentration of heavy metal in the water and sediment. Dakatia river is the first tributary that Meghna receives after entering Noakhali district. Various physico-chemical water quality parameters such as water depth, temperature, color and odor of water, transparency, conductivity, turbidity, TDS, dissolved oxygen, CO_2, pH, NH_3, alkalinity, hardness, BOD, COD were monitored during July 2012 - June 2013. Simultaneously concentration of heavy metal like Pb, Cd, Cr, Cu, Fe, Mn, Zn in water and sediment were monitored. Physical water quality parameters such as water depth, temperature, color and odor of water and transparency have been found to be suitable throughout the study period. The water pH was less than the standard i.e. slightly acidic (7.78), DO concentration was some time found below the acceptable limit and ranged from 2.67-7.28. Presence of NH_3 at an average rate of 0.21mg/l with average BOD and COD of 5.17 mg/l and 35.96 mg/l respectively, pretenses the threat of water pollution. Free CO_2, alkalinity, hardness, TDS, conductivity did not show any deviation from acceptable limit during the study.

Table 1. Geo-accumulation indices and Pollution load index (PLI) of heavy metals in Dakatia river bed sediments

Station	Pb	Cd	Cr	Cu	Mn	Zn	PLI
S1	-2.29	-1.21	-2.40	-1.47	-5.34	-1.79	0.28
S2	-2.50	-1.59	-5.57	-0.86	-3.23	-1.73	0.25
S3	-2.40	-1.59	-2.11	-0.78	-5.23	-1.76	0.30
Background (World surface rock average)	20	0.2	97	32	720	129	

Among the studied heavy metals (Pb, Cd, Cr, Cu, Fe, Mn and Zn), the most dominant metal was Fe, in both water and sediment. The degree of contamination in the sediments of the Dakatia river, for the metals Pb, Cd, Cr, Cu, Fe, Mn, Zn, has been evaluated using Pollution load index (PLI) and Geo-accumulation index (I geo) which did not exhibit any sign of heavy metal pollution in river sediment.

Table 2. Chemical properties of the water of Dakatia river

Station	Dissolve O_2 (mg/l)	Free CO_2 (mg/l)	pH	NH_3 (mg/l)	Total alkalinity	Total hardness	BOD (B) (mg/l)	BOD (N) (mg/l)
S1	2.78±1.10	6.21±1.83	7.15±0.65	0.41±0.28	125.24±20.26	126.41±46.33	3.96±0.51	5.03±0.98
S2	6.46±1.08	3.34±0.77	8.10±0.28	0.12±0.11	114.61±43.13	102.42±68.40	5.72±0.73	6.87±0.87
S3	7.29±1.04	3.18±0.79	8.25±0.35	0.10±0.14	132.98±16.23	164.16±21.51	5.85±2.50	7.69±1.62

Towards sustainable fisheries management of Tanguar haor: Status, problems and prospects of co-management organizations

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Tanguar haor is the second RAMSAR site of Bangladesh, producing 0.67% of the total annual fishery production. In the past few decades, due to agricultural drainage, faulty Jalmohal leasing systems, intense fishing pressure, over exploitation, siltation, soil erosion and hunting, the total environmental settings of the haor has degraded a lot. Recognizing the urgent need and utmost importance to restore and protect the natural environment and heritage of this large perennial wetland, government declared the haor as a Ecologically Critical Areas (ECAs) of the country. This study was conducted to examine and evaluate the performance (overall status) along with the major problems and challenges of CMOs in sustainable fisheries management of the TH. This article focus and represent a review of the present benefit sharing mechanism, prescribed guidelines and their implementation concerning the existing CMOs. I found that the present benefit sharing mechanisms is far better than the erstwhile three years *'Jalmohal'* leasing system ensuring more effective monitoring and the overall broad indicative impressions reflect that CMOs are functioning moderately (score 49.14%) which required Government and development partners nourishment to become sustainable. Vulnerability to flash flood along with negative impact of climate change and other natural disasters, intense fish pouching and illicit harvest (eg. use of current jal), high dependency on natural resources and its over exploitation, political obstacles with the dominancy of influentials, lack of intelligent and honest local leader, lack of support from GoB administration and UP, low literacy rate, poor health, hygiene and sanitation facilities are the major threats and challenges faced by the community (i.e. CMOs) in the Tanguar haor.

Table 1. Broad indicative impression and performance (overall status) of CMOs in sustainable fisheries management of the Tanguar haor, Bangladesh (after Khan 2010)

	Broad Indicators	**Full Marks**	**Obtained Score**
1.	Assessment of awareness and knowledge	10	4.60
2.	Organizational development of the existing CMOs	10	5.14
3.	Capital formation by CMOs	10	6.17
4.	Benefit sharing and conflict resolution by CMOs	10	5.40
5.	Development of self-reliance of CMOs	10	3.26
	Grand total	**50**	**24.57 (**49.14%)

Score (%): Indicative status- Less than 19: Critical, Between 20 and 39: Weak, Between 40 and 59: Moderate, Between 60 and 79 : Satisfactory/ well performing, Between 80 and 100 **:** Very well performing/ sustainable

Agro-ecological zone specific risks, vulnerabilities of climate change, disaster and climate change adaptation in fisheries sector of Bangladesh

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Bangladesh has been experiencing serious environmental degradation in recent years caused by climate change and a number of human induced factors. There are many dimensions of this environmental degradation. Ground water sinking and contamination (by arsenic, etc.), surface water squeezing and pollution, encroachment of rivers and other water bodies, deforestation, loss of open water space due to siltation, loss of bio-diversity, improper disposal of industrial, medical, and household waste are just a few examples. Considerable damage has already been done. With loss of wetlands and forests, Bangladesh is gradually losing its flora and fauna. Many aquatic species are becoming rare; some have already become extinct. The Bangladesh Climate Change Strategy and Action Plan (BCCSAP 2009) has considered fisheries sub sector as one of the most potential area to be targeted. National Plan for Disaster Management (NPDM 2010-15) suggested taking appropriate actions and demonstrating relevant adaptive measures, approaches and interventions that would build resilience to protect fisheries against climate change, coupled with other natural and manmade intervention both normal and extreme events. The present study was undertaken to identify the agro-ecological zone specific risks, vulnerabilities of disaster and climate change and farmer/fisher's innovated best practices of Climate Change Adaptation CCA) in fisheries and aquaculture sector of Bangladesh. The study thoroughly reviewed the literatures on climate change and fish sector, identified, assessed and listed the agro-ecological zones (Draught, Flood & River Erosion, Flash Flood & Haor and Saline-Coastal & Water Logged) specific risks and vulnerabilities of fisheries and aquaculture caused by climate change and disaster. The study also enlisted adaptive fishes and shellfishes in climate change scenario and the adaptation techniques with fish combination and mode of culture, that need to be followed in culture management. Finally, it suggested relevant adaptive measures, approaches and interventions that would build resilience to protect fisheries and aquaculture against climate change impacts.

Impact of various management systems on socio-economic status of fishing communities in four water bodies of Bangladesh

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Most of the inland water bodies in the country are owned by the government. Leasing is the only way to use the resources but unfortunately poor fishermen have been depriving to get the waterbodies leased. In recent past, these resources were abused by influential people. Government, different donor agencies and some NGOs were initiated few projects to ensure access rights of true fishermen, improve their livelihoods and bring sustainability in fisheries sector. Present study was undertaken to evaluate the impact of various management systems on socio-economic status and institutional sustainability of fishing communities in various locations. Four potential projects were selected from different management systems located in four geographical locations of Bangladesh. Data were collected through individual questionnaire interview, PRA tools such as transect walk and FGDs. Collected data were verified with key informant interviews. The data interpretation showed that most of the water bodies were used by influential people before project activities. Before the initiation of the projects the lease holders did not take any management initiative rather than only capturing fish. Out of four projects, the FFMDA got lease from district administration and switched to total aquaculture activities through releasing fingerlings, partial feeding and selective harvesting with the assistance from DFA and DoF. Daudkandi project received lease the water bodies from private owners and partially switched to aquaculture activities through stocking spawn, fry and fingerlings and fully harvest through dewatering the water bodies not keeping any population for conservation. On the other hand, Charer Beel which is and open ecosystem, was leased from DoF, spawns were released and fish harvesting was continued throughout the year. MACH project did not get lease of the water body, did not carry out any management practices except fishing. Out of the four projects, FFMDA participants have increased their income, improved level of education and housing and sanitation followed by Daudkandi project. On the other hand, Charer Beel and MACH projects did not show such impact on the socioeconomic status of the participants. As improved and sustainable activities were performed, the FFMDA project compared to other three projects although having some policy and management related threats, for aquaculture along with conservation in large close water bodies might be recommended to replicate in other open as well as closed water bodies in the country.

Length-weight and length-length relationships of some small indigenous fish species from the Brahmaputra river

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The present study describes the length-weight (LWR) and length-length (LLR) relationships for twelve important small indigenous fish species (SIS) from the Brahmaputra river. A total of 1424 specimens, representing *Ailia coila*, *Amblypharyngodon mola*, *Chanda nama*, *Channa punctata*, *Glossogobius giuris*, *Gudusia chapra*, *Heteropneustes fossilis*, *Lepidocephalus guntea*, *Mastacembelus aculeatus*, *Mystus bleekeri*, *Nandus nandus* and *Puntius sophore* belonging to eleven families used for this study, were caught by traditional fishing gear. All linear regressions of LWRs were highly significant ($r^2 > 0.94$; $p < 0.05$) for the analyzed species. The allometric coefficient (*b*) values revealed a positive allometric growth for *A. mola*, *H fossilis*, *L. guntea* and *N. nandus* ($b > 3.00$) and a negative allometric growth in *C. nama*, *G. chapra* and *M. aculeatus* ($b < 3.00$), whilst an isometric growth ($b = 3.00$) was found in the rest of the species (*A. coila*, *C. punctata*, *G. giuris*, *M. bleekeri* and *P. sophore*). A significant difference among species for the intercepts (*a*) and slopes (*b*) of the regression lines ($p < 0.05$). The results further revealed that all the LLRs of the twelve species were highly correlated ($r^2 > 0.92$; $p < 0.05$). To the best knowledge, this study presented the first reference on LWRs and LLRs for *C. nama*, *H. fossilis* and *M. bleekeri* from Bangladesh.

Assessment of water quality parameters from Mongla port and Karamjol area of the Sundarbans and its impacts on surrounding aquatic environment

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The study was conducted to investigate the water quality parameters - temperature, transparency, pH, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), electrical conductivity (EC), total dissolved solids (TDS), salinity, suspended solids, hardness, alkalinity, chloride and heavy metals concentrations as chromium (Cr), zinc (Zn), copper (Cu), and iron (Fe) from the Passur river in the Mongla port and Karamjol area under Sundarban mangrove forest. The water samples were collected from five sampling points of Mongla port area as P-1 (1 km upper from port), P-2 (port area), P-3 (tributary), P-4 (Mongla ferighat), P-5 (1 km down from port), and from three sampling points of Karamjol as P-6 (1 km upper from Karamjol), P-7 (Karamjol tourist area) and P-8 (1 km down from Karamjol) during high and low tide during six months from January to June 2013. pH values were slightly alkaline both in Mongla port and Karamjol area. The highest DO concentration (7.98 mg/l) was observed in Mongla port area and BOD (2.7 mg/l) was found in Karamjol area during Ma -June, respectively. In March and April almost all sampling points showed higher concentration of COD. The highest EC value 12339.16 µS/cm was measured at high tide in Karamjol area and lowest 10817.7 µS/cm at low tide in Mongla port area which are higher than the recommended concentration for Bangladesh. The average concentration of TDS were 5226.4 and 5583.8 mg/l at low and high tide, respectively in Mongla port area, while 5997.9 and 6003.25 mg/l at low and high tide, respectively in Karamjol area of the Sundarbans. The highest average total hardness (522.34 mg/l) was obtained in March at Mongla port area. The highest salinity concentration (11.0 ppt) in Karamjol area was observed in March. The sea water intrusion may contribute the high concentration of Cl- ions (4680 mg/l) in April at Karamjol area. The measured average temperature, transparency, salinity and heavy metals (Cu, Zn, Fe and Cr) of Passur river were well matched with standard levels. From the overall analysis, the study depicted that the water quality parameters of the rivers were low in May and June; however, moderate to high values of the parameters were appeared in February, March and April. The comparative study showed that most of the water quality parameters of the Passur river were suitable for fisheries and aquaculture though the water quality of the rivers becomes degraded due to port activities, tourism and other developmental activities. This deterioration not only harms the aquatic organisms but also affects entire ecosystem as well as the local people who depend on river water for their livelihood. Thus, to maintain the sound environment and healthy ecosystem of the river and the surrounding Sundarbans areas, proper management and monitoring of water quality of the river is needed.

Isolation of beneficial bacteria (*Lactobacillus* spp.) from shrimp(*Penaeusmonodon*) and possible use as probiotics

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The present study was conducted to study *in-vitro* the antagonistic effect of *Lactobacillus* spp. against the pathogenic bacterial *vibrioharveyi* on shrimp. For this purpose, shrimp samples were collected from three different Ghers at Batiaghataupazilla, Khulna from May to July, 2013. Gills and intestines were taken out from the samples to identify the load of *Lactobacillus* spp. and *Vibrio* spp. The results revealed that the load of *Lactobacillus* spp. was more than *Vibrio* spp. both in gills and intestines; the gills also contained higher load of *Vibrio* spp. than in the intestines. *V. harveyi*was separated from the isolated *Vibrio* spp. with different types of biochemical tests: Gram stain, Motility test, Indole test, VP test, MR test, Argininedihydrolase, Salt tolerance test, growth at different temperature ranges and Colony color on TCBS agar media. The isolated *V. harveyi*was subjected for *in-vitro* test. In *in-vitro* challenge test, the potential antagonistic effect of *Lactobacillus* spp. against *V. harveyi*was gradually obtained at 0, 4th, 8th, 12th hour of treatments. Interesting finding was that, with the time, the load of *V. harveyi was* reduced gradually and the lowest load was obtained after 12 hours of probiotic inoculation. The present study revealed an excellent *in-vitro* antagonistic probiotic effect of *Lactobacillus* spp. on *V. harveyi.* Therefore the result suggested that probiotic treatment may be an effective alternative to the use of antibiotics in treatments of bacterial diseases in shrimp aquaculture

Table 1. *In-vitro* challengetestand **e**numeration of *V. harveyi* load with and without probiotics

Time Interval	Sample No.	Without Probiotics		With Probiotics	
		Vibrioharveyi load (CFU/g)	Average load (CFU/g)	*Vibrioharveyi* load (CFU/g)	Average load (CFU/g)
0 hour	01.	2.01×10^3	4.69×10^3	2.01×10^3	4.69×10^3
	02.	1.18×10^3		1.18×10^3	
	03.	1.09×10^4		1.09×10^4	
4th hour	01.	1.89×10^4	2.30×10^4	9.45×10^3	1.16×10^4
	02.	1.76×10^4		8.00×10^3	
	03.	3.25×10^4		1.75×10^4	
8th hour	01.	3.50×10^4	2.36×10^5	6.40×10^3	7.41×10^3
	02.	1.92×10^5		8.32×10^2	
	03.	1.66×10^5		1.50×10^4	
12th hour	01.	4.32×10^5	4.24×10^5	1.50×10^3	1.13×10^3
	02.	3.71×10^5		2.49×10^2	
	03.	4.70×10^5		1.65×10^3	

Optimization of stocking density of Vietnamese climbing perch in cage at coastal region

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First growing stain of climbing perch Vietnamese Koi (*Anabas testudineus*) seed was imported from Vietnam at 2012. Presently, this strain is getting more popularity than our native and Thai Koistrain as the growth rate of Vietnamese Koi is much higher. An experiment was conducted from May 6 to September 6, 2013 to optimize the stocking density of Vietnamese climbing perch in cage at Patuakhali district. Nine cages were used for this experiment having size 2.5m × 1.8m ×1.3m. The experiment was designed with three treatments containing three replications assigned into a completely randomized design with various stocking density. The stocking density of different treatment was 50 (T_1), 75 (T_2) and 100 (T_3) fry per m^3, correspondingly. Mega floating koi feed was delivered at rate of 3-10% body weight twice a day. There was no significance difference among treatments for different yield parameters of Vietnamese Koi ($p<0.05$). Survival of fish was not significantly affected by the stocking density and ranged between 9.33 to 95.66%. The highest fish production (kg/m^3) was found in T_3 (13.32kg), followed by T_1(6.94 kg) and T_2(10.12kg). A simple economic analysis of the Vietnamese Koi cage culture showed that T_3 generated the maximum net profit Tk. 1052.02/ m^3/4 month followed by T_1(532.65 Tk.) and T_2(793.96 Tk.). This study revealed that highest stocking density (100/m^3) of Vietnamese Koi is most suitable in terms of production and economics in cage culture.

Table 1. Comparison of yields parameters (Mean ±Sd) of Vietnamese Koi among different treatment

Yield parameters	T_1	T_2	T_3	Level of sig.
Mean initial weight (g)	0.25^a± 0.03	0.27^a± 0.04	0.24^a± 0.03	NS
Initial length (cm)	2.18^a± 0.08	2.21^a± 0.10	2.17^a± 0.06	NS
Mean final weight (g)	145.26^a± 12.26	143.98^a± 12.65	142.71^a± 15.80	NS
Final length (cm)	20.35^a± 0.337	19.81^a± 0.30	19.06^a± 0.29	NS
Mean weight gain (g)	145.01± 12.23	143.71± 12.22	142.47± 12.23	NS
% Weight gain	58004^a	53325^a	59363^a	NS
Average daily gain (g)	12.084^a	11.975^a	11.872^a	NS
SGR (% per day)	5.30^a	5.23^a	5.32^a	NS
Survival (%)	95.66^a± 4.37	93.80^a± 5.85	93.33^a± 2.33	NS
FCR	1.93^a	1.96^a	1.97^a	NS
Yield (kg/m^3)	6.94^a	10.12^{ab}	13.32^b	*
Net profit (Tk/ m^3)	532.65^a	793.96^{ab}	1052.02^b	*

*Indicate significant ($P<0.05$) and NS indicate not significant.
a,b and ab, superscript; means with the different superscript within the same row are significantly different ($P<0.05$)

Effects of stocking density on cage culture of Thai sharpunti (*Barbonymusgonionotus*) in Kaptailake

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Thai sharpunti(*Barbonymusgonionotus*) were reared at four different stocking densities in 50 cages in Kaptai lake to evaluate the effects of stocking density on growth, survival rate and food conversion ratio. The sizes of the each cage were 3m x 3m x 2m. Fingerlings (average initial weight 15g) were stocked in four different densities as 30, 50, 70 and 90 fish/m^3 with three replicates. The growth trial was conducted for 120 days from April 2013 to July 2013. Bulk and individual weights of fish in each cage were recorded fortnightly. Feeding was done regularly usingpelleted semi-buoyant feed @ 5% of body weight, twice daily for all treatments. The final mean weights (±SD) of the fish stocked at densities of 30, 50, 70 and 90 fish/m^3 recorded as 91.33±1.40, 83.67±1.53, 74.67±1.41 and 66.33±1.72 g. The corresponding SGR values were 1.51, 1.47, 1.32 and 1.26 % /day. The water quality parameters were optimum and no deviation was found among the treatments. The feed conversion ratios were estimated as 2.77, 2.85, 3.06 and 3.28 and cumulative survival rates were calculated as 77.50, 72.80, 71.80 and 70.14 % respectively. The results revealed that the stocking density of 30 fish/m^3 can be recommended for the cage culture of Thai Sharpunti in Kaptai lake, although commercial culture of this species is not be profitable because of high FCR value.

Table 1. Growth and survival rate of Thai Sharpunti (*Barbonymusgonionotus*) in different stocking densities

Stocking density (fish/m^3)	Initial		After 120 days		Survival rate (%)	SGR (%)	FCR
	Length (cm)±SD	Weight (g) ±SD	Length (cm)±SD	Weight (g) ±SD			
30	9.72±0.35	14.85±0.58	16.67±0.82	91.33±1.40	77.50	1.51	2.77
50	9.46±0.52	14.40±0.65	15.79±1.00	83.67±1.53	72.80	1.47	2.85
70	10.01±0.46	15.40±0.72	14.71±1.13	74.67±1.41	71.80	1.32	3.06
90	9.62±0.28	14.70±0.54	14.43±1.09	66.33±1.72	70.14	1.26	3.28

Tiger shrimp (*Penaeusmonodon*) farming using probiotics at different stocking density and its impact on production and economics

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Shrimp aquaculture production in much of the world is depressed by disease. So probiotics farming has tremendous scope for controlling various diseases. Determination of suitable stocking density of shrimp for probiotic farming is very necessary because of profit. In this present study different stocking densities ponds were cultured by using various probiotics and compared them with each other. The production cost were lower in 10 pcs/m^2 compared with 5 pcs/m^2 and 15 pcs/m^2 per kg. FCR was low (1.3) in 5 pcs/ m^2 densities and high (1.6) in 15 pcs/ m^2 densities. Survival of 5 pcs/ m^2 densities shrimps were 70%, 10 pcs/ m^2 densities shrimps were 60% and in 15 pcs/ m^2 densities shrimps were 48%. By cost benefit analysis of this culture, it is easy to say which density culture is most profitable and suitable. This present study showed that 10 pcs/ m^2 densities were most profitable (159010 Tk, profit 63%), 15 pcs/ m^2 densities were not so profitable (124013 Tk, profit 37%) because of slow growth and 5 pcs/ m^2 densities were not so profit (68295 Tk, profit 40%) because of high production cost and low production. So we can easily conclude that 10 pcs/ m^2 cultures were most profitable in semi-intensive probiotic shrimp farming

System.

Pond Area (Ha)	Density (Pcs/M2)	Production (Kg)	Survivality
0.29	5	435	75%
0.32	5	499	80%
0.31	5	445	70%
0.42	10	845	61%
0.39	10	852	64%
0.44	10	870	56%
0.52	15	1115	49%
0.55	15	1075	48%
0.54	15	1085	48%

Fig. 1. Production performance in different pond.

Importance of indigenous knowledge of adivasi fisher's communities on production biology of cuchia and its effect on their livelihood in northern Bangladesh

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The studywas conducted in kokraduba beel surrounding two adivasi fisher's villages Chitolia and Shampur; district Mymensingh to collect information about ecosystem health of Kokraduba beel, habitat, food and feeding habit and reproductive biology of cuchia (*Monopteruscuchia*)by interviewing adivasi fisher's indigenous technical knowledge (ITK) method. Primary and secondary data was collected by direct interviews with adivasi respondents, Department of Fisheries and internet sites. According to the ITK method of adivasi fisher's, total production of the koraduba beel was recorded 14395.0 kg and 13208.0 kg between the year 2012 and 2013 respectively. About 8.25% production was decreased between 2012 and 2013. According to (78.57 -88.01)% fisher's blocked water flow and shallow depth of the beel, expansion of agriculture and aquaculture, use of chemicals, fertilizer and pesticide, infrastructure development and fishing pressure in breeding season were main causes of destruction the natural habitats and reducing production of cuchia in kokraduba beel. Three fishing methods physical (by hand), line (hook) and traps (bair) methods were identifyed in the survey area. According to the ITK method, food and feeding habit, male and female identifying characteristics, breeding behavior, fecundity and larvae development, mother care, cannibalism characteristics identified and 64.24% adivasi fisher's recognized that Chitro to Joisto bangla mash was breeding period of cuchia. Updated adivasi's ITK method with science based knowledge on habitat, food and feeding habit, reproductive biology, management of hatchlings, fry and fingerling production, alternative income generating activities and developed value chain; it will be a new horizon to develop ecosystem health and production of cuchia in the kukraduba beel through community based co-management aspect.

Impact of mola,*Amblypharyngodonmola* culture with carps in ponds and pond connected rice fields on biodiversity, production, consumption and income of associated and non-associated households

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WorldFish, Bangladesh has recently disseminated culture technology of micro-nutrient rich small fishes specially mola*Amblypharyngodonmola* with carps in the ponds and pond connected rice fields in some districts of north-west and southern part of Bangladesh. Present research has been carried out to assess the impact of this mola culture on biodiversity, production, consumption and income of intervened and non-intervened households in the project area of Dinajpur district. For this purpose, seven communities (Para) were selected for survey in the Mominpur union of Parbatipurupazilla. Recall data were collected through individual interviews, field observations and other participatory rural appraisal (PRA) tools such as focus group discussion (FGD), case study, trend analysis etc. Survey results showed that, production of mola from the ponds of intervened households was higher in several folds after project intervention than before which ultimately increased family consumption and income from the fish. The intervened households who have pond connected rice fields reported that production of mola increased upto double or more than those of the households having ponds but not connected to rice fields. More space and suitable environment for breeding and nursing in the holding water of rice fields are responsible for rising the production. It is noteworthy that the farmers stopped or reduced to use pesticides in the rice field with their own initiatives when they started to use rice field for production of mola which obviously has positive effect on the environment. Cultured mola of the households were not only used for their own consumption but also were serves as gift to their neighbors and relatives. Even many of the non-intervened households released mola to their ponds getting inspiration from increased production of the intervened households. Another interesting finding was that the culture of mola with carps was found as a useful strategy to safe the carp species from harvest in smaller size and gets more time to grow them to large size for getting best price from the market. An amazing finding was obtained when data was collected from fishermen of the study area who lead their lives only by fishing from open water and wet lands. They reported that the natural production of mola increased several folds from open rice fields, canals, beel (Kanmuchuri, Modhura and Dolbari) and rivers (Isamoti and ChotoJamuna) surrounding the study area which count almost 50 sq km. Escaping of mola from cultured ponds and rice fields through flood water during wet season, and prolific breeding behavior of the fish are responsible for such production in surrounded natural water bodies. Positive effect of mola culture was also found on the biodiversity of other aquatic animals beside fish. As for example, presence of water snakes, herons and kingfishers increased around the culture ponds after project intervention. Farmers even took initiatives to protect the fish from those predators. Such experience may motivate to find the way of ecosystem restoration for regaining fish diversity and sustainable production of endangered small indigenous fishes in our aquatic environment.

A preliminary investigation on the production performance of Vietnam koi*Anabas testudineus* in cage culture in Bangladesh

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A four month long experiment was conducted to evaluate the production performance (growth and survival) of cage culture of Vietnam koi *Anabas testudineus*which is newly introduced in Bangladesh. The cages were set in an earthen pond at Sher-e-Bangla Agricultural University (SAU), Dhaka. Major water quality parameters (temperature, pH, dissolved oxygen and transparency) were recorded throughout the study period and found within the suitable range. Three stocking densities i.e. 100, 150 and 200 fishes/m^3 cage were used and designated as Treatment-I, Treatment-II and Treatment-III, respectively. Each treatment had two replicates. All of the fish were of same age group having mean length and weight of 4.37 cm and 2.03 g, respectively. Experimental fish were fed with commercial pelleted feed (30% protein). The result of study showed that the fish in treatment-II stocked at the rate of 150 fish/m3 significantly showed increase in individual length and weight followed by treatment-I and III. There was not much variation among the survival rates of fish which ranged between 58 and 52%. The net production in different treatment were 5.48, 11.04 and 12.96 kg/m3/120 days for treatment-I, II and III, respectively. The result of the present study indicated that the best individual growth of *A. testudineus*was obtained at a density of 150 fish/m3. Further trial is necessary to determine natural survival rate and production in cage since mortality was occurred by bacterial disease due to water pollution during experiment.

TABLE 1. Growth parameters of the climbing perch *Anabas testudineus* with different treatment reared in cages at SAU, Dhaka.

Parameters	Treatment-I	Treatment-II	Treatment-III
Mean initial length (cm)	4.1	4.29	4.7
Mean final length (cm)	16.40	16.40	16.90
Length gain (%)	300	282.29	259.58
Mean initial weight (g)	1.92	1.77	2.38
Mean final weight (g)	105.35	118.62	112.67
Weight gain (%)	5386.98	6601.70	4634.04
Survival rate (%)	52	62	57.50
Production (kg/m^3/120 days)	5.48	11.04	12.96

Cage culture of stinging catfish *Heteropneustesfossilis*: effect of introducing mud and plastic pipe substrate inside cage

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Stinging catfish (*Heteropneustesfossilis*) is very popular in Bangladesh. It has high market value. A number of attempts have been taken in different study to develop culture systems of this fishes in cages but the survivability was not satisfactory which ultimately decreased production. In the present study, we attempted to develop sustainable cage culture technique providing natural environment for the species inside cage to increase survival rate as well as production. For this purpose, we provided mud on the bottom of the cage with hanging plastic pipes horizontally inside since the fish naturally dwell in the bottom mud and prefer to hide inside substrate. Survival and growth of fish inside this modified cage were compared with the fishes reared in ordinary cage.

TABLE 1. Growth parameters of the stinging catfish, *Heteropneustes fossilis* with different stocking densities reared in cages in SAU, Dhaka.

Parameters	Ordinary cage		Modified cage	
	100 fish/m^3	150 fish/m^3	100 fish/m^3	150 fish/m^3
Mean initial length (cm)	6.69	6.88	6.86	6.92
Mean Final length (cm)	12.45	13.09	15.33	15.84
Length gain (%)	86.10	90.27	123.47	128.91
Mean initial weight (g)	2.22	2.24	2.34	2.35
Mean final weight (g)	12.16	13.96	21.85	25.82
Weight gain (%)	447.75	523.22	833.76	998.73
Survival rate (%)	68	72	82	86
Production (kg/m^3/120 days)	0.83	1.51	1.80	3.33

The experiment was conducted for a period of 120 days. Fish fries with a mean weight of around 2.5 g and length of about 7 cm were stocked at 100 and 150 fish per m^3 floating cage with two replicates each in a large earthen pond at Sher-e-Bangla Agricultural University (SAU), Dhaka. Commercial pellet feed was given to caged fish thrice daily at a rate of 50% body weight initially per day and later feeding rate was adjusted based on body weight sampling. Important water quality parameters (dissolved oxygen, pH, temperature, transparency, ammonia, phosphate and nitrite) were recorded weekly throughout the culture period and found within the suitable range for fish culture.Survival was 82% and 86% in the modified cages for the density of 100 and 150 fish per m^3 cagerespectively where the mean final weight of fish was found 21.85g and 25.82g respectively. In case of ordinary cages, survival rate was 68% and 72% for the density of 100 and 150 fish per m^3 cage, and the mean final weight was 12.16g and 13.96g respectively. So, results showed that net yield was relatively higher in the cages with mud and plastic pipe substrate than those of ordinary cages. This experiment demonstrated the potential of *H. fossilis* production through new technique of cage culture system but more research is needed with higher stocking density and, setting mud and substrate separately inside cage.

Some preliminary observations on growth and adoption of hilsa fry, *Tenualosailisha* (Hamilton) in a freshwater pond at Barisal, Southern Bangladesh: a DoF-WorldFish collaborative research initiative to hilsa aquaculture

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Hilsa, *Tenualosailisha* (Hamilton): clupeidae comprises the largest single openwater fishery in Bangladesh with high local and global demand as food fish for its delicacy. In recent days it is facing crucial problems in continuing its natural production in conventional ways due mainly to implications of climate change, habitat destruction, restricted recruitment and overfishing. It is imperative to conserve and promote this fishery through natural conservation and population management as well as to explore aquaculture potentials through diverse research on various interventions. Adoption and adaptations to different habitats, lotic and lentic, in captivity with different feeding regimes and stocking densities, are some major concerns in this regard. With this, growth and adoption of hilsa fry in captivity were investigated under the present initiative.

Some 20,000 fry of hilsa were collected from the nearby river and stocked in a well-prepared nursery pond in Barisal and nurtured for four months in order to observe their growth and adoption in captivity. The pond was treated with urea and phosphate fertilizers and no supplementary feeds were used. Samples were taken at every fortnight and growth rate through total length, standard length, fork length, girth length were monitored and computed for condition factor. Graphs obtained showed continued linear growth with uniformity in length-weight relationships with average survival rate of 87%. Physico-chemical parameters viz., DO, pH, TDS, Salinity, temperature, turbidity were recorded followed by gut content analyses and photosensitivity to sunlight with means of and longevity of the species to transportation.

Water quality and plankton composition in mola (*Amblypharyngodonmola*) pond stocked at different density

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An experiment was conducted to study the water quality and plankton composition in fed mola (*Amblypharyngodonmola*) pond stocked at different density during the period of 09 July to 09 October, 2011, at the Field Laboratory complex, Faculty of Fisheries, BAU, Mymensingh, Bangladesh. There were three treatments, each with three replications. Nine earthen ponds were used with an average depth of 1.5 m. Selected ponds were followed by proper management system including removal of unwanted species, liming, fertilization and feeding. Ponds of three treatments T_1, T_2 and T_3 were stocked with mola at the density of 145,000; 73,000 and 36,500 individual ha^{-1}, respectively. Feeds were supplied twice daily for mola and feeding rates were 10% of body weight at the start of study (up to 15 days), and reduced to 8% after this till the last month. Water quality parameters such as water temperature, transparency, total alkalinity, pH and dissolved oxygen were measured weekly. Nitrate-nitrogen, nitrite-nitrogen, ammonia-nitrogen, phosphate-phosphorus and chlorophyll-*a* of the ponds water were measured monthly. Plankton samples were collected once in a month. Water quality parameters (except transparency, chlorophyll-*a*) did not vary significantly (P>0.05) among the treatments. The lowest PO_4-P and chlorophyll-*a* concentration were observed in treatment T_1 where 145,000 individual ha^{-1} of mola was stocked. A total of 38 genera of phytoplankton and 13 genera of zooplankton were identified of which Chlorophyceae (20 genera) in phytoplankton population and Crustacea (9 genera) in zooplankton population were dominant. The mean value of total plankton population ($\times 10^3$ cells L^{-1}) were 158.42±53.33, 191.17±62.24 and 240.17 ±93.37 in T_1, T_2 and T_3 treatments, respectively and contributing to the production according to their availability and abundance within the treatment.

Table 1. Mean values of water quality parameters (mean ± recorded from different treatments

Parameters	Treatments			Level of significance
	T_1	T_2	T_3	
Temperature (^oC)	27.65± 0.85	27.65± 0.90	27.46± 0.91	NS
Transparency (cm)	48.76± 2.98[a]	46.67± 3.44[b]	40.64± 4.71[c]	*
p^H range	7.53± 0.25	7.54 ± 0.23	7.62± 0.21	NS
DO (mg l^{-1})	7.46± 1.49	5.75± 1.40	6.29± 1.21	NS
Total alkalinity	74.27±13.26	81.00±14.36	74.36± 13.35	NS
NH_3-N (mgl^{-1})	0.23 ± 0.25	0.27 ± 0.21	0.18 ± 0.16	NS
NO_3-N (mgl^{-1})	0.04 ± 0.04	0.02 ± 0.02	0.02 ± 0.02	NS
PO_4-P (mgl^{-1})	0.33 ± 0.32	0.20± 0.17	0.31 ± 0.29	NS
Chlorophyll *a* (μgL^{-1})	102.10±50.10[b]	118.60±40.15[ab]	143.51±45.58[a]	*

NS= Means are not significantly different (P>0.05)* Mean values with different superscript letters in the same row

Messages for shrimp and prawn farmers in the form of calendar: fresh lesson producing aquaculture dissemination material for seafood production and trade in Bangladesh

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The SEAT project (www.seatglobal.eu) project funded by EU investigated the sustainability issues affecting seafood value and volume being produced and traded from Bangladesh to European countries. Over the last four and half years, 13 European and Asian partners of SEAT worked with several issues and found out important messages for the farmers and other value chain stakeholders in terms of seafood farmers' practices in Bangladesh and seafood consumers' behaviours in Europe. Out of several important messages derived from different research partners, 12 messages were emphasised to be disseminated in the form of calendar to inform the farmers and other value chain stakeholders. The first 6 messages of the calendar from January to June useful directly to the farmers were of 1) avoiding health risk in handling chemicals and other inputs; 2) adopt good aquaculture practice to increase farm productivity; 3) necessary measures during disease outbreak in the farm; 4) avoiding poultry and other animal feed; 5) proper and recommended use of chemicals in the farm; and 6) use of Pangasius pond sludge for vegetable production. The other 6 messages from July to December related to the attitudes of the Europeans on seafood consumption were of 7) dependency of the Europeans on seafood supply from Asia; 8) changes of social reality and food consumption behaviours of the Europeans; 9) Europeans' believes on seafood as healthy food; 10) diversity of food behaviours between and within European countries; 11) importance of food safety; and 12) seafood information flow to the Europeans and related confusion.

Making the message understandable to the farmers was a big challenge. To overcome the challenge, the messages were converted into the pictorial forms with special inputs of hired cartoonist. Having systematic effort (July – November 2013), field-test of the disseminating material at the farmers' level and several times of editing, the visual illustration in the form of calendar was made. This calendar was designed for 2 years (2014-2015) integrating both English and Bangla calendar together so that farmers do not leave the calendar after 1 year rather use for 2 years, and uptake the messages to a greater extent. The calendar would be distributed to 2500 farmers and other value chain stakeholders in 20 communities by the beginning of January 2014 where SEAT worked for the last four and half years.

This work gave fresh experience first time, particularly to the Bangladeshi partner, to produce dissemination materials in the form of calendar for aquaculture farmers, which is likely to impact on the current practices of shrimp production and trade in Bangladesh. Moreover, there is a plan of the SEAT local partner, BAU to monitor and assess how the farmers using the message in terms of knowledge and practices. This dissemination effort is likely to have scale out impacts in the seafood production region of Bangladesh. A project working under WorldFish, Bangladesh has shown interest to multiply this dissemination material for wider coverage in the southwest Bangladesh for a large number of stakeholders.

A survey on carp culture practices in Rajshahi district

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A study was conducted in nine Upazillas of Rajshahi district for a period of one year during April'2012 to March'2013 to examine the stocking density and production level in three types of culture pattern likely nursery, rearing and grow-out ponds. Data were collected from 90 fish farmers through questionnaire development method. From the survey it was found that three species of Indian major carps such as, Rohu (*Labeorohita*), Catla (*Catlacatla*), Mrigal (*Cirrhinusmrigala*); five species of Exotic carps such as, Silver carp (*Hypophthalmichthysmolitrix*), Bighead carp (*Aristichthysnobilis*), Grass carp (*Ctenopharyngodonidella*), Crucian carp (*Cyprinuscarpio* var. *specularis*) and Common carp (*Cyprinuscarpio*var. *communis*) were widely cultured in Rajshahi. According to fish farmer average stocking density of sac fry in nursery pond was 0.0198kg/decimal, whereas the stocking density of fry to rearing pond was 0.5878kg/decimal and in case of grow-out pond it was 14.487 individuals/decimal of 50-1000g wt. varying with species. Average production was revealed 7.95kg, 10.57kg and 24.52kg per decimal in nursery, rearing and grow-out pond respectively. The study indicated significant relationship between investment and production.

Effects of fry stocking densities on growth, survival rate and production of *Hypophthalmichthysmolitrix, Cyprinuscarpio*var. *Specularis*and *Labeorohita*in earthen ponds at Natore fish farm, Natore

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The experiment was conducted to determine the effects of fish population density on the growth and production of carps fries (Silver carp, mirror carp and rui) in polyculture for a period of 90 days in earthen ponds. Mean individual stocking wt (g) of the fry of silver, mirror and rui were 0.10, 0.103 and 0.08 under treatment-I and were 0.17, 0.142 and 0.11 under treatment-II. In ponds under both treatments, inorganic and supplementary balanced feed (50% per body weight) was used to cultured ponds for spawn to fish fingerlings. During the experimental period, the ranges of water temperature (26 to 34°C), transparency (28 to 41 cm), dissolved oxygen (2.45 to 5.5 mg/L), pH (7.0 to 8.5), total alkalinity (130 to 182 mg/L), and ammonia nitrogen (0.12 to 0.3 mg/L) found were within the productive limit and more or less similar in all the ponds under treatment-I and II. The survival rate of silver carp was 38.60% and 66.48% under treatments I and II, mirror carp was 31.20% and 45.50% under treatment I and II and in rui it was 31.51% and 53.35% under treatment I and II, respectively. The calculated net fish production of the ponds under treatment-I was 1905.13±141.95 kg ha-1 90d-1 whereas it was 3831.74±411.35 kg ha-1 90d-1 in treatment-II. It was found that net fish growth, survival rate and productions was better in treatment-II than treatment-I. Finally it is concluded that the growth, survival rate and production of fry up to fingerlings would be better by intervention of proper stocking density of various fish species in pond fish culture.

Effects of seasonal variation on growth performance of mirror carp (*Cyprinuscarpio ver. specularis*) in nursery earthen ponds

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The experiment was conducted to determine the effect of seasonal variation on growth performance of fish fry of *Cyprinuscarpio* in six earthen ponds during December 2011 to June 2012 with covering winter (WS) and summer season (SS). This study was done with three replications for each season. Stocking density was 6250 per decimal with a mean weight of 0.192±0.002 (g). During the WS, the mean value of water temperature 16.78±2.17, transparency 32.67±1.9 cm, dissolved oxygen 5.88±2.18 mg/l, pH 8.24±0.49, total alkalinity 184.72±22.72, and ammonia nitrogen 0.21±0.05 was found whereas the mean value of water temperature 30.56±1.51, transparency 30.61±1.71cm, dissolved oxygen 4.3±1.37 mg/l, pH 8.33±0.24, total alkalinity 274.95±6.73 mg/l, and ammonia nitrogen 0.16±0.05 mg/l in SS. Mean value of survival and specific growth rate was 58.94±0.95 and 2.45±0.03 in WS, whereas in SS it was 67.85±4.27 and 4.00±1.03, respectively. Mean gross and net production in WS was 1581.94±71.55 kg $ha^{-1}60$ d^{-1} and 1285.03±69.84 kg $ha^{-1}60$ d^{-1}, whereas in SS, gross and net production was 4262.74±147.81 kg ha^{-1} 60 d^{-1} and 3964.74±145.74 kg ha-1 60 d^{-1}, respectively. This study concluded that mirror carp fish fry production was better in SS than WS.

Effects of inclusion of predatory fishes on the production and economics of farmer managed aquaculture in floodplain

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An experiment was conducted to study the effects of inclusion of predatory fishes on the production and economics of farmer managed aquaculture in floodplain. Fishes (Carps and predatory fishes with a mean stocking weight of 0.23 kg) were grown for a period of six months from October, 2012 to March, 2013 under feed and fertilizer based aquaculture in floodplains of Bagmara and Mohonpurupazilla under Rajshahi district. The experiment was conducted under 3 treatments of predatory fish inclusion to the total stocked fishes (T_1: control i.e. no inclusion of predatory fishes, T_2: inclusion of 3.5% predatory fishes and T_3: inclusion of 7.0% predatory fishes), each with 2 replications. Water quality and fish growth parameters were monitored monthly. Mean value of water temperature, transparency, pH, DO, alkalinity and NH_3-N varied from 18.75±1.49 (T_2) to 19.24±1.79ºC (T_3), 15.45±1.25 cm (T_2) to 18.87±1.67 cm (T_1), 7.78±0.12 (T_2) to 8.23±0.07 (T_3), 7.84±0.16 (T_3) to 8.27±0.11 mg/1 (T_1), 96.91±2.58 (T_2) to 105.92± 1.26 mg/l (T_1) and 0.19±0.01 (T_3) to 0.23± 0.01 mg/l (T_3), respectively. Mean final weight (kg), weight gain (kg), SGR (% bwd^{-1}), survival rate (%), SIS yield (Kg/ha/6 months) and total yield of the stocked fishes (Kg/ha/6 months) varied from 1.09±0.10 (T_2) to 1.28±0.24 (T_1), 0.84±0.12 (T_2) to 1.10±0.21(T_1),0.91±0.13 (T_3) to1.09±0.06 (T_1), 75.85±2.87 (T_1) to 86.71±1.36 (T_3), 7.00±3.00 (T_3) to 40.00±9.00 (T_1) and 335.00±15.00 (T_3) to 437.50±12.50 (T_1), respectively. Total cost (Tk/ha), total income (Tk/ha), net profit (Tk/ha) and CBR varied from 30914.00±3416.00 (T_1) to 32129.00±2065.00 (T_2), 60175.00±4365.00 (T_3) to 67300.00±1140.00 (T_1), 28736.00±3124.00 (T_3) to 36386.00±4556.00 (T_1) and 0.91±0.06 (T_3) to 1.20±0.28 (T_1), respectively.

One mother one tank: A way to produce WSSV free shrimp post larvae (PL)

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In 2011-12, Bangladesh exported 92,479 mt fisheries product and earned BDT 4,704 crore of which 48,007 mt was frozen shrimp worth of BDT 3,640 crore(DOF 2013). The contribution of shrimp was about 77 % in export basket. About 8,33000 farmers have been farming shrimp in 2 75,232 ha areas with a production rate of 713 kg/ha. The shrimp sector has been struggling to survive since 1994 due to outbreak of White Spot Syndrome Virus (WSSV) of tiger shrimp (*Penaeusmonodon*). When WSSV outbreak occurs in hatchery or farm, entire crop is destroyed within a few days. Sixty one shrimp hatcheries of Bangladesh coast have suffered from scarcity of WSSV negative shrimp brood and PL. Usually hatchery owners stock 40-50 broods (either WSSV positive or negative) into a brood maturation tank. Then they select 30 gravid spawners and stock in a 6000 L spawning tank. After spawning about 20-25 million eggs are stocked in a hatching tank and 3-4 million nauplii stocked in a larval rearing tank (28000 L size) and 1.5-2 million PL in a nursing tank (28000 L size) until the PL are sold to the shrimp farmers.

In the currently practiced hatchery systems, is huge possibility of contamination of WSSV negative nauplii/PL by WSSV positive ones. Department of Fisheries has given a circular on 24 December, 2012 under rule 9(4) of Hatchery Act 2011that all the shrimp hatcheries must produce virus free PL and declare the PL produced in their hatcheries as “virus free ”. However, present hatchery structures are not suitable to produce WSSV free PL. In October 2012, Zamzam Hatchery, Kolatali, Cox’s Bazar has constructed a system to produce PL using one WSSV negative brood/mother keeping into one tank. In 18 February 2013, Zamzam hatchery received 95 brood for Batch-1, in 23 February received 105 for Batch-2, in 20 June received 85 for Batch-3 and in 2 September received 75 brood for Batch-4 to produce shrimp PL. After receiving the brood from the Bay of Bengal, they were kept in a quarantine tank and sorted out better spawner observing the physical appearance and transferred to another quarantine tank and conducted 1st& 2nd PCR test with the help of WorldFish/BFRI. It was found that there was only 55% shrimp brood as WSSV negative in B-1, 33% in B-2, 25% in B-3 & 25% in B-4.. On average, 65% broods were found contaminated by WSSV. Only 16% broods were selected for hatching. The selected WSSV negative brood has transferred to spawning tank (500 litter size). After spawning, 56,25,000 eggs from B-1, 27,44,00 from B-2, 12,82,000 from B-3 and 13,33,000 from B-4 were obtained. Samples of stocked eggs of a single brood maintained in individual hatching tank (500 litter size) were sent for 3rd PCR test. After hatching, the nauplii of a single brood were stocked into individual larva rearing tank (7500 L size) and at PL stage 3, 4th PCR test was conducted. At day 17 and 23, 5th and 6th PCR tests were conducted. This way 100% PCR negative PL were ensured. After rearing for 24 days, Zamzam Hatchery sold 32,40,000 PL from B-1, 15,80,000 PL from B-2, 7,28,000 PL from B-3 and 6,50,000 PL from B-4 to a contract farmer who had earlier booking for the PL. Contact farmer reported that he got average 92% survival after harvesting the shrimp.

Status of fish culture in Joypurhat district

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The study was carried out for a period of seven months (January 2006 to July 2006) from 50 farm owners and 50 local people near the farms of different upazilla in Joypurhat district. The study indicated that most of the farms (46%) were established within last ten years. Fifteen different fish species were cultured. Three types of farm were observed, such as own (48%), leased (38%) and both (14%). Fish farming (58%) was the major income source for farm owners. Most of the (72%) farms depend on underground water. Various types of chemicals and toxic substances like rotenone (16% farm), phostoxin (10% farm), bleaching powder (6% farm), disel/kerosin (22% farm) and sumithion (4% farm) were used. Among all the farms 32%, 56% and 34% were affected by tail and fin rot, oxygen deficiency and disease, respectively. Lime (76% farm), salt (34%) and sumithion (18%) were widely used as antibiotics for disinfection, prevention and control of fish disease. Total fish productions have gradually been increased in all the farms. The benefits of fish farm owners were increased in income (92% farm owners), social status (74% farm owners), employment opportunity (58% farm owners), ingestion of fish (42% farm owners) and poverty alleviation (70% farm owners).

Production and economic performance in three stocking and management regimes of carps and mola in North-west Bangladesh

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An on-farm experiment was carried for 240 days during April-December 2012 in the North-west region of Bangladesh to ensure increased production of small fish with carps. Effect of culture period intervention on growth and production performance of Indian major and minor carps with nutrient- rich mola was evaluated. Household ponds (200-600 m^2) were stocked with the fingerlings of rui (*Labeorohita*), catla (*Catlacatla*), mrigal (*Cirrhinuscirrhosus*), silver carp (*Hypophthalmichthysmolitrix*), grass carp (*Ctenopharyngodonidela*), bata (*Labeobata*), and mola (*Amblypharyngodonmola*) at a rate of 10, 6, 10, 8, 2 and 4, respectively in number and 150g per 40 m^2.. There were three treatments, early stocking, T_1 (April-December, 240 days), seasonal stocking, T_2 (July-December, 150 days) and traditional stocking, T_3 (April-December, 240 days). All water quality parameters varied significantly t ($p<0.05$) among the treatments except transparency and DO. Among all the carps, silver carp was the fast growing and bata was the slowest. The total fish production was the highest (3783.30 kg ha^{-1}) in early stocking ponds, T_1 and the lowest (2836.61 kg ha^{-1}) in traditional stocking, T_3 treatment. Total small fish production (55%) was higher in T_3 ponds than T_2 and T_1 ponds. The highest SGR and the rate of survival of carps were higher in T_2than other treatments. An economic analysis showed the highest BCR of mola (3.29) t in T_1

Gender drive to improve labor compliance: the case of female workers engaged in the shrimp processing industry in Bangladesh

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Fair wage and labor rights situation across the shrimp processing industry in Bangladesh has been the key area of concern from various national and international labor rights organizations as well as from the US Trade Representatives in the recent past. The tragic incident of building collapse killing thousands of garments worker at Dhaka in April 2013 accelerated the suspension of GSP facility for Bangladesh in The US markets.The shrimp and seafood industry has been very promising economic sector from where Bangladesh receives her second largest foreign exchange earningswas blamed for use of child labor and other labor non-compliance affecting especially the female workers for which GSP withdrawal complain was lodged originally against the country in 2007. The inability of the industry to respond to the evolving needs of social compliance and implementation of labor rights, the United Nations Industrial Development Organization (UNIDO) joined with the Bangladesh government and the export industry in developing customized training manuals, training of trainers on the labor laws and their implementation, assessing compliance and interviewing female workers over their condition.This paper attempts to assess the outcomes of the gender focused drive to improve implementation of Bangladesh Labor Laws 2006 throughproject interventions fromBetter Work and Standards Program (BEST) - Better Fisheries Quality (BFQ) Component, UNIDO. The assessment revealed number of positive outcomes including significant reduction in child labor and better acceptance of theproject interventions both by the industry and by the government departments.Efforts towards institutionalizing the compliance activities for sustainability includeappointment of Compliance officers and adoption of own training program on labor laws by the processing factorieslikely to benefit millions of poor workers and staffs engaged across the shrimp value chain. The assessment further suggests that the replenishment of work place safety and labor standards are considered to be very crucial for sustaining the current economic growth from the shrimp and seafood sector.

Morphometry, breeding and larval development of mola, *Amblypharyngodonmola* (Hamilton 1822) from different regions of Bangladesh

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Mola (*Amblypharyngodonmola*), a micronutrient rich small indigenous fish of Bangladesh contains higher micronutrients such as; vitamin A, calcium, iron, zinc as compared to large fish or other animal source food. Under the collaboration of WorldFish, BFRF and Bangladesh Agricultural University, Mymensingh, the present program has been designed for a PhD study. The research has started since July 2013. Induced breeding techniques were applied at Dolphin Hatchery, Rangpur to develop the artificial breeding protocol of mola. PG as inducing agent with different dose, natural spawning techniques (also stripping), various spawning and hatching devices (tank, tray and aquarium) were employed. Green water as phytoplankton, mashed zooplankton and Tubifex were used for larval rearing at tray and aquarium up to 1 month. Molabroodstock were developed through collection of mature fish from three districts (Rangpur, Dinajpur and Nilphamari) and reared properly with mono culture before using in artificial breeding program. The study on reproductive biology (gonad development, fecundity, breeding season and sex ratio), embryonic and larval development are on going at the laboratory of Fish Biology and Genetics, Bangladesh Agricultural University, Mymensingh. The study outcome will reveal the breeding performance, fecundity, sex ration, fertilization rate and hatching rate of mola. The specific results of the research and the outcomes obtained would bring a positive change in small fish domestication in the country, which will lead to alleviate undernourishment of millions of rural poor people in Bangladesh.

Comparative productivity of integrated multi-trophic aquaculture and non-culture pond producing freshwater Snail (*Viviparusbengalensis* Lamarck)

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The growth and production of freshwater snail (*Viviparusbengalensis*, Lamarck) in integrated multi-trophic aquaculture (IMTA) pond and non-culture pond was studied for a period of 3 months during peak summer (May to July, 12) and 3 months during peak winter (November 12 to January 13) on the pond bottom in 4 experimental ponds located in Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymensingh. There were two treatments (T_1 and T_2) each with four replications and each pond was stocked at the rate of 250g snail/decimal. The individual pond area was of 1 decimal in size. Treatment 1 (T_1) and Treatment 2 (T_2) were considered as IMTA and non-culture pond, respectively. During the experimental period, compost was applied at the rate of 1.70 kg/decimal fortnightly. For measuring growth and production of snail, sampling was done at 30 days interval from all the treatments. In IMTA, average length of a snail was 2.36±0.09 cm and 2.35±0.35 cm in summer and winter, respectively and in non-culture pond was 2.26±0.07 cm and 2.16±0.20 cm, respectively. In IMTA, average weight of a snail was 2.56±0.49 g and 3.75±0.05 g in summer and winter, respectively and in non-culture pond was 2.38±0.23 g and 2.77±0.09 g, respectively. In summer and winter, average production of snail was 18,731±1,473 nos./decimal and 5,990±424 nos./decimal in IMTA, respectively; 15,246±1,026 nos./decimal and 3,158±217 nos./decimal in non-culture pond, respectively. In summer, highest production was 19,619±62 nos./decimal in May at T_1 and lowest was 14,482±23 nos./decimal in June at T_2. In winter, highest production was 6,279±21 nos./decimal in November at T_1 and lowest was 3,158±42 nos./decimal in January at T_2. Overall the production of snail was higher in IMTA pond compared to non-culture pond.

Diet composition and feeding intensity of wild zigzag eel, *Mastacembelusarmatus*

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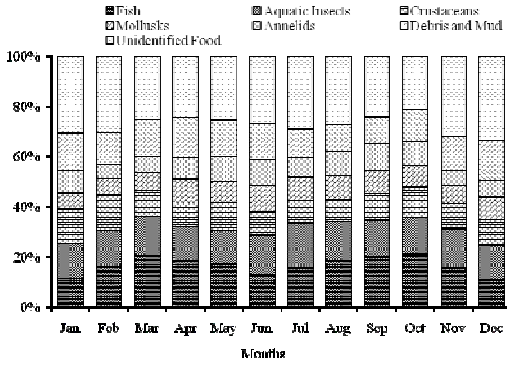
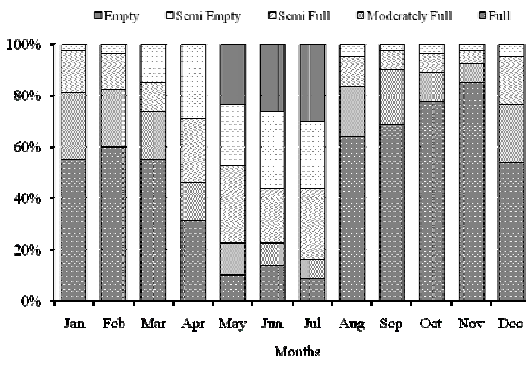
Mastacembelusarmatus is a commercially important, large sized, popular freshwater fish. The dietary composition and feeding intensity of the fish was observed for a period of 12 months. The fish fed on varieties of food items *viz.* fish, aquatic insects, crustaceans, molluscs, annelids, debris and mud that respectively obtained as 16.60, 14.75, 10.78, 8.50, 8.28, and 13.52 percent in average. During the study period 80.94% fish showed active feeding. In case of categorized feeding intensity 48.54% stomachs were found full, 16.14% were moderately full, 16.25% were semi-full, 12.40% were semi-empty and 6.67 % were empty. The fish also showed monthly variation in feeding intensity.



Monthly variation in diet composition of*M. armatus*.



Monthly variation in feeding intensity of*M. armatus*.

Effect of commercial probiotics on growth performance of fresh water prawn *Macrobrachiumrosenbergii* (de Man 1879)

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This study was carried out in order to evaluate the production performance of fresh water prawn (*Macrobrachiumrosenbergii*) by applying locally available probiotics. There were four treatments named without probiotic (Control T_1), Zymetin (T_2), Super PS (T_3) and Both Zymetin and Super PS (T_4). Twelve ponds with three replicates for each treatment group and the control group were used and the stocking density was 2/m^2. Initially at the time of stocking average body weight of prawn was 1.04 g. After 4.5 months, at the time of harvesting average weight increased to 24.93 g in control pond, 30.48 g in Zymetin treatment pond, 36.27 g in Super PS and 40.06 g in combine application of Zymetin and Super PS pond. The production of control pond was 397 kg/ha where as 492 kg/ha for only Zymetin treated pond, 582 kg/ha for only Super PS treated pond and 656 kg/ha for both Zymetin and Super PS treated pond. Probiotics treated pond production was always higher than control pond. The mean weight and length of each treatment groups was significantly different ($P<0.05$) from that of the control. There was no significant difference of water and soil parameters among treatments. Water pH was 7.76-7.85 while temperature was 25-30 ^{o} C in dry period, and 12.5-18.5^{o}C in winter, salinity 0.5 ppt, hardness 380-450 mg $CaCO_3$/L, alkalinity 180-240 mg $CaCO_3$/L, dissolved oxygen 4.5-5.3 ppm, transparency 40-60 cm ammonia and nitrite were 0.3-0.8 ppm and 0.2-0.7 ppm respectively. The soil pH was 6.7-7.7, while organic carbon was 1.067 to 1.32 % Ca, 0.13 to 0.17%; Mg 0.08-0.09%; phosphate 0.02-2.67%; electrical conductivity (EC), was 2.3to 6.91 ds/m. Maximum microbial load was found in non probiotic treated pond water ($5.3x10^5$ CFU/g)while minimum in Super PS treated pond ($3x10^4$ CFU/g).

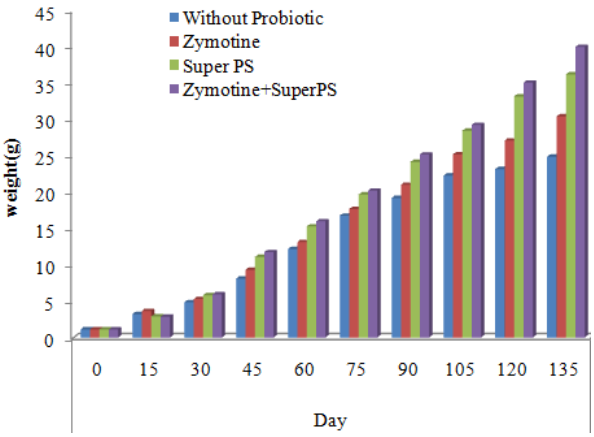

Fig. 1. Average prawn weight (g) in fourtreatments

Nutritional status of feed used in fish and shrimp culture at south-west region of Bangladesh

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The importance of commercial aqua feed is increasing with the intensification of fish culture. Fish production fully depends on quality feed. Traditionally extensive and semi-intensive fish farmer use different types of industrial feeds and supplementary feeds. Use of fish feeds extensively used, depends on its low cost, nutritional quality and easy availability. The nutritive value fish feeds vary in different branded feeds. But the farmers do not know the actual nutritive value and its variation in different branded feeds. So it is necessary to investigate the actual nutritive value of fish feeds, ingredients and its variation among different branded feed. Growth performance is deeply related with nutritional composition of used feeds. For this reason nutritional composition of collected feed were determined and analyzed.

A total 160 samples were collected which included 38 samples of shrimp feed, 27 samples of fish feed, 22 samples of poultry feed and 74 samples of feed ingredients (poultry litter and snail samples (dried shell whole, dried shell crushed and live form). Results of nutritional analysis for 160 samples were obtained from Laboratory of Nutrition, Bangladesh Agricultural University. Results indicate 70% samples were found of poor quality and the rest 30% are of good quality in terms of recommended protein content. In Bagerhat district, among the feeds and feed ingredients collected from Fakirhat, Chitalmari, Mollarhat, Rampalupazilla, 14 out of 42 (33%) samples were found of good quality. In Khulna district 11 samples were of good quality among the total 35 samples (31%) collected from this region. In case of Jessore district, 13 samples were found good quality among 35 samples (37%). In case ofGazipur and Mymensingh district, 3 out of 24 (13%) and 8 of 24 (33%) were of good quality respectively according to protein content, as standard set by the Lab. of Nutrition, BAU and Akiyama *et al.* 1992. All feed samples collected were found as in satisfactory level for Lipid, Ash, Carbohydrates, and Moistures. But in terms of protein content most of feed samples were found to be in poor quality.

Table 1. Nutritional status of feed and feed ingredients used in study area: cumulative and area-wise percentage

Cumulative		Area wise percentage		
Good Quality Feed	Poor Quality Feed	District	Good Quality Feed	Poor Quality Feed
30%	70%	Bagerhat	14(33%)	28(67%)
		Khulna	11(31%)	24(69%)
		Jessore	13(37%)	22(63%)
		Mymensingh	3(13%)	21(87%)
		Gazipur	8(33%)	16(67%)

Effects of replacing mustard oil cake with *Spirulina* on the growth and carcass composition of common carp (*Cyprinuscarpio* var. *specularis* L.)

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A growth trial was conducted to evaluate the effects of replacing mustard oil cake (MOC) with *Spirulina* on the growth and carcass composition of common carp (*Cyprinuscarpio*var. *specularis* L.). Four experimental diets were formulated by replacing 0, 20, 30 and 40% MOC in conventional fish feed (mixture of rice bran and MOC in 1:1) with *Spirulina* treated as T1 (Control), T2, T3 and T4, respectively. One hundred-eighty common carp fingerlings (mean weight 11.09 ± 0.49g) were randomly allocated into 12 glass aquariums (15 in each aquarium). Water quality parameters, proximate composition of feed, growth parameters and carcass compositions of fish were analyzed by using standard methods. During this study, water quality parameters were within the acceptable range for the fish growth. The growth of fish in terms of body weight gain and specific growth rate were significantly higher in T3 than T1, T2 and T4 ($P<0.05$). Significantly higher carcass protein was determined in T3 as compared to T1, T2 and T4 ($P<0.05$). Carcass lipid, glycogen and ash contents were decreased significantly with increasing levels of *Spirulina*($P<0.05$). The results of this study indicate that 30% *Spirulina* can be substituted for mustard oil cake in mustard oil cake-based feed for better growth and quality carcass of common carp.

Effect of oxytetracycline on bacterial load of *Labeorohita* in culture pond

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The study was aimed to outline the antibiogram profiling of oxytetracycline against usual ecological bacterial flora of culture ponds of *L. rohita.* After applying pelleted feeds treated with oxytetracycline (OTC) at 2gm/kg the physicochemical parameters of water like temperature, pH, dissolved oxygen, alkalinity, ammonia and nitrate were recorded weekly: 28.99 to 31.09°C, 7.58-7.95 ppm, 5.36-5.86 mg/L, 86.31-111.99 mg/L, 0.20-0.30 mg/L and 0.11-0.17 mg/L, respectively. The total viable counts of bacteria were found $4.9\pm1.03\times10^{3}$- $5.75\pm1.0\times10^{3}$cfu/mL in pond water, $5.62\pm1.0\times10^{7}$- $6.60\pm1.02\times10^{7}$cfu/g in sediments, $6.77\pm1.0\times10^{6}$-$7.57\pm1.0\times10^{6}$cfu/g in gills, $6.02\pm1.02\times10^{7}$-$8.32\pm1.0\times10^{7}$cfu/g in gut of *L. rohita*in control ponds. After OTC treatment the total viable count of bacteria ranged from $3.1\pm1.19\times10^{3}$-$3.1\pm1.20\times10^{3}$cfu/mL in water, $3.1\pm1.13\times10^{6}$-$4.27\pm1.10\times10^{6}$cfu/g in sediment, $2.82\pm1.25\times10^{5}$-$3.09\pm1.19\times10^{5}$cfu/g gill, $2.69\pm1.12\times10^{6}$-$4.68\pm1.12\times10^{6}$cfu/g in guts of *L. rohita*respectively, indicating reduction of overall bacterial load below 1 log in sediment, gills and guts of *L. rohita*significantly ($P<0.005$).

Enumeration of beneficial bacterial load in the gut content of freshwater prawn (*Macrobranchiumrosenbergii*) from probiotic treated and non-treated pond

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The use of probiotics in the culture of aquatic organisms is increasing with demand for environment friendly aquaculture practice. A study was conducted to enumerate the beneficial bacterial load (*Streptococcus faecialis*) in the gut content of freshwater prawn (*Macrobranchiumrosenbergii)* from control (T_1), probiotic treated at hatchery, nursery and grow out level (T_2) and probiotic treated at grow out level (T_3) ponds. The result of the present study demonstrated that the total bacterial loads in the gut content of the freshwater prawn were found to be $(7.350.08)\times10^4$, $(8.30\pm0.23)\times10^4$ and $(8.03\pm 0.38)\times10^4$ CFU/g in T_1, T_2 and T_3 respectively. Higher amount of total bacterial loadswere found in T_2 and T_3 compared to T_1. The beneficial bacterial(*Streptococcus faecalis*) loadwas enumerated from fresh water prawn sample by using KF streptococcal agar media. The beneficial bacterial (*Streptococcus faecalis)* load was found to be $(0.350\pm.02)\ x10^4$, $(2.93\pm0.13)\ x10^4$ and $(2.88\pm0.15)\ x10^4$ CFU/g in T_1, T_2 and T_3 respectively.

A confirmation test of *Streptococcus faecalis*was done by using SF (*Streptococcus faecalis*) medium (broth) and it showed the presence of *Streptococcus faecalis*in the prawn sample. The result of the study demonstrated that significant differences were there in the beneficial bacterial (*Streptococcus faecalis*) loads of the two treatments T_2 and T3than in the control treatments T_1 at 0.05 levels of significance. The highest beneficial bacterial (*Streptococcus faecalis*) load was found in the gut content of two probiotic treated prawn (T_2 and T_3) than the prawn cultured in the control pond. It could be concluded that the gut content of freshwater prawn in control ponds had the least beneficial bacterial load than in the gut content of the prawn treated with probiotic.

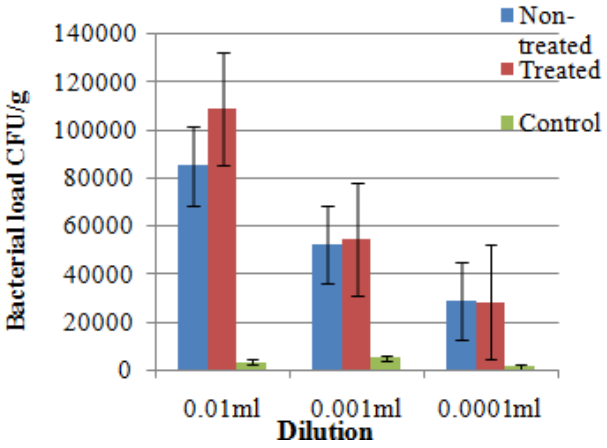

Fig 1. Significance test of beneficial bacterial load at probiotic treated and non-treated *M. rosenbergii.*

Development of production technique for black soldier fly larvae as alternate tilapia feed

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Aquaculture provides more than 60% animal protein for human consumption in Bangladesh. Adulterated and low quality feed creates environmental hazards and reduces profitability. An attempt made to overcome these problems throughprotein, fat and minerals containing non pest insect, BlackSoldierFlyLarvae(BSFL) rearing technique to reduce fish feed cost, boost up production and tackle environmental hazards. The wild BSF attracted to lay eggs which then hatched and larvae emerged. Newly hatched larvae consumed voraciously the putrescent wastes. Three experimental diets were formulated by replacing 0, 25 and 50% fish meal with BSFL and only dehydrated BSFL used to rear tilapia fry in hapa and feed formulated without BSFL as control. Data interpretation showed that the BSFL production fluctuated with temperature and stopped in less than 15^0 C. The proximate composition of BSFL is 62% moisture, 7% lipid, 16% protein, 3% ash, 3.2% crude fiber and 9% carbohydrate on live weight basis. Among the four formulated feeds 50% BSFL containing feed performed best followed by 25%, control and 100% dehydrated BSFL. The survival rate of tilapia fry was alike in all the treatments but fish production was 40.4, 36.1, 31.9 and 33.1tons/ha/90 days in 50 and 25% fish meal replaced by BSFL based feed, 100% dehydrated BSFL and control feed respectively. The feed conversion ratio was the lowest i.e. the best (1.65) with 50% fish meal replaced feed and highest feed conversion ratio (2.18) was with dehydrated BSF larvae. Further research needed to develop the captive breeding of BSF for sustainable fish production.

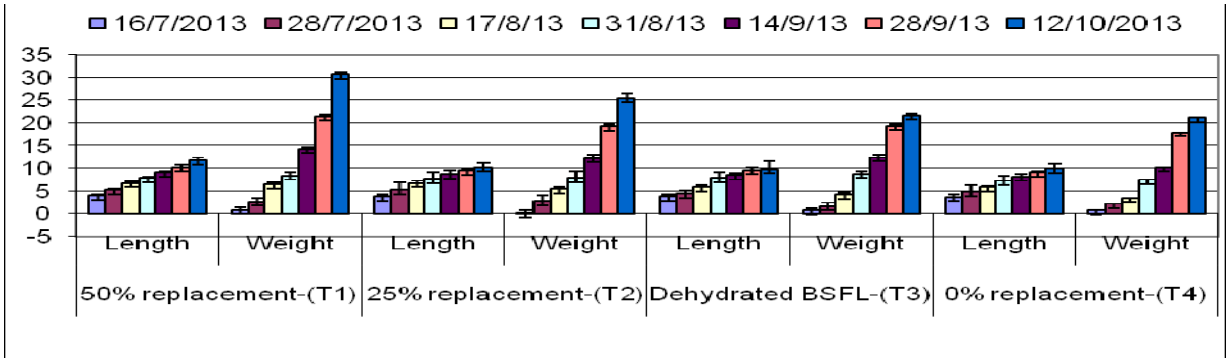

Fig.1. Tilapia fry response to black soldier fly larvae based feed in different treatments.

Effects of feeding frequency on the growth performance of indigenous catfish, *Clariasbatrachus* (Linnaeus 1758) in ponds

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A 180-days feeding trial was conducted to investigate the effects of feeding frequency on the growth performance of indigenous cat fish, *Clariasbatrachus* (Linnaeus, 1758) in pond condition under three treatments each with three replications. Three feeding frequency once daily (T_1), twice daily (T_2) and thrice daily (T_3) were used. Stocking density among the treatments was same. The fish were initially fed at a rate of 8% of their body weight with 28% protein diet and the feeding rate was reduced to 5% gradually. The water quality variabilities were monitored at 15 days intervals and they were more or less similar in three treatments and remained within the suitable ranges for aquaculture. The mean weight gain 41.14±0.15, 44.49±0.78 and 56.10±0.86g and specific growth rate (SGR %) of 1.29±0.002; 1.33±0.01 and 1.44±0.01 % per day were recorded in T_1, T_2 and T_3 respectively. The survival rate was highest in T_2 (96.23±0.76%) and lowest in T_1 (95.32 ±0.76%). The lowest i.e. the best FCR (1.65±0.12) was observed in treatment T_3 with three time feeding frequency and the highest i.e. the worst FCR value (2.14±0.15) was recorded in T_1, with the feeding frequency of once a day. Among the treatments, the highest production of fish was observed in T_3 (3559.27±85.95 kg/ha/180 days), which was significantly higher than that of other treatments (2677.48±26.68 kg in T_1 and 2919.54±267.11 kg in T_2).The production of *C. batrachus* was found to be highest with the feeding frequency thrice daily. From the feeding trial it is evident that feeding at thrice per day effective for optimum result in the growth of *C. batrachus* in ponds.

Reproductive performance of freshwater prawn *Macrobrachiumrosenbergii* (de Man 1879) broodstocks grown on different diets

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An experiment was carried out during April to September 2013 to compare the reproductive performance of freshwater prawn, golda (*Macrobrachiumrosenbergii*) broodstocks fed on four diets including 3 commercial (Mega -F1, SABINCO- F2 and CP- F3) and a laboratory formulated test feed (F4). Post larvae (PL) were collected from the river Kocha of district Pirozpur in April 2012 and nursed initially in the hapa (net cage), and then reared in the earthen ponds at the Fisheries Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh. The broods were fed with selective feeds since their PL stage. The feeding was continued till their maturity of both male and female upto berried females. The proximate composition of the feeds, F1 were crude protein 33.49%, lipid 5.38%, carbohydrate 30.31%, F2-crude protein 26.70%, lipid 5.50%, carbohydrate 34.34%, F3- crude protein 38.90%, lipid 8.09%, carbohydrate 25.37% and treatment F4-crude protein 33.00%, Lipid 11.13%, carbohydrate 25.43%. Feeds were supplied at 5% body weight twice at dawn (5:30-6:00 am) and dusk (5:30-7:30 pm) till the end of the experiment. The variation in most water quality parameters, temperature, DO, NH_3-N, NO_2-N, NO_3-N, PO_4^{-3} and depth were insignificant; while parameters pH, transparency, TDS, conductivity and chlorophyll-a, were found to vary significantly ($p<0.05$) among treatments. Brood observation was carried out by dragging a sine net or/and hand picking carefully so that the eggs in egg chamber remained intact. The male and female ratio was estimated 1:2.8, 1: 2.4, 1: 2.4 and 1: 1.7 in the treatments F1, F2, F3 and F4, respectively. The weight of the berried females were 56.33±19.55 g, 85.50±14.85 g, 73.67±23.09 g and 94.50±51.62 g, and total weight of eggs were 7.61±1.86g, 7.04±0.69g, 10.26±1.41g and 6.15±1.20 g in treatments F1, F2, F3 and F4 respectively. The estimated numbers of eggs were 53,889±10,541, 37,555±1,217, 59,640±5,270 and 36,017±7,790 in treatments F1, F2, F3 and F4 respectively. The weight of berried females with eggs (g), weight of total eggs (g) and estimated number of eggs were significantly ($p<0.05$) different among treatments. In the experiment, females fed with commercial feed F3 (CP) was found to produce maximum number of eggs (59,640/female) followed by commercial feed F1 (Mega). The findings of this study may contribute to the better broodstock management of freshwater prawn and the production of higher number of eggs.

Effect of replacement of fishmeal protein by a mixture of meat and bone meal and protein concentrate in the diet of climbing perch *Anabas testudineus* (Bloch 1792)

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A 70-days growth trial of *Anabas testudineus*was conducted to evaluate the effects of replacing fish meal protein with equal ratio (1:1) of meat and bone meal (MBM) and protein concentrate (PC) on growth, digestibility and economic performances. Four iso-nitrogenous (40% crude protein) and iso-energetic diets were formulated by replacing 0 (D_1, control), 70 (D_2), 85 (D_3) and 100% (D_4) fish meal with a mixture of MBM and PC (1:1). Fish were stocked in triplicate groups @300 decimal^{-1} in 12 experimental ponds. At the beginning, fish were fed at 15% of their body weight which was gradually reduced to 5%. After 70 day's growth trial, 10 fish from each replicate pond were transferred into 12 indoor glass aquarium (0.243 m^3 each) to determine the digestibility of the experimental diets. Chromic oxide (0.5%) was used as a marker to the previous feed formulation to prepare diets for the digestibility trial. The result showed that the ($P<0.05$) final weight, % weight gain, SGR and final yield among the treatments were significantly higher in fish fed D_1. Apparent dry matter digestibility and protein digestibility was significantly higher ($P<0.05$) in fish fed with D_1. Similarly, no significant difference for apparent dry matter digestibility and protein digestibility was found between fish fed D_2&D_3 and D_3&D_4. No significant difference ($P>0.05$) was found in lipid digestibility among the treatments. Although all these growth and digestibility parameters were higher for D_1. ForD_2 & D_3 all these parameters were near about performance found in D_1 and all parameter were lower in D_4. On the other hand, feed cost for D_1 was highest among all diet. Based on the overall performances and considering fishmeal availability it can be concluded that upto70% to 85% fishmeal protein could be replaced with a mixture of MBM and PC (1:1) in practical diets for pond culture of *A. testudineus.*

Table 1. Growth, production performance and digestibility of *A. testudineus*fed with experimental diets

Parameters	Diet 1	Diet 2	Diet 3	Diet 4
Initial weight (g)	0.80 ± 0.04	0.80 ± 0.02	0.80 ± 0.03	0.80 ± 0.02
Final weight (g)	48.3 ± 1.31 a	36.3± 1.10 b	33.3 ± 1.00 c	24.7 ± 0.51 d
Weight gain (g)	47.5	35.5	32.5	23.9
Percent weight gain (%)	5941.7 ± 163.14 a	4441.7 ± 137.7 b	4056.3 ± 125.5 c	2992.1 ± 67.3 d
Survival (%)	75.1 ± 2.2 a	77.9± 1.5 a	76.6 ± 3.7a	72.3± 3.2 a
Final yield (kg/treat.)	10.89	8.49	7.64	5.37
Final yield (kg/ha)	2689.46±77.84a	2096.60±56.57b	1887.07±129.91b	1326.69±87.28c
Dry matter digestibility (%)	69.62± 1.81a	61.71±2.03b	57.00±2.43bc	54.64±2.80c
Protein digestibility (%)	87.54±1.59a	82.65±1.69ab	78.34±3.18b	71.57±1.84c
Lipid digestibility (%)	85.42±1.05a	82.76±0.84a	73.09±1.45b	74.38±1.25b

Harmful bacterial loads in soil, water and gut contents of freshwater prawn (*Macrobrachium rosenbergii*) from probiotics treated and non-treated pond

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The giant freshwater prawn (*Macrobrachium rosenbergii*), locally known as 'Galda', a leading export item, plays an important role in the economy of Bangladesh by earning valuable foreign exchange, generating employment and raising protein food production. Despite the development of culture techniques, a number of challenges for sustainable development of prawn farming need to be addressed. For evaluating the microbiological quality of prawn, an investigation was carried out to enumerate the coliform bacteria (total coliform and faecal coliform) and to detect the pathogenic bacteria, *Salmonella* sp. and *Vibrio* sp. in cultured prawn by applying probiotic in the pond complex of Khulna University campus from August, 2012 to March, 2013. Twenty seven prawn samples were collected from nine experimental ponds under three treatments viz control pond without any probiotic (T1); animals treated with probiotics throughout the nursery and grow-out period (T2) and animals treated with probiotics at only grow-out stage (T3).

The samples were analyzed in Molecular Biology Laboratory of Fisheries and Marine Resource Technology Discipline in Khulna University. The average number of total coliform was observed 1.8 MPN/g, 0.8 MPN/g and 1.4 MPN/g in prawn gut contents; 2.2 MPN/g, 1.2 MPN/g and 1.87 MPN/g in soil samples and 1.87 MPN/g, 1.0 MPN/g and 1.6 MPN/g in water samples in T1, T2 and T3, respectively. In all three treatments total coliform was almost negligible, no faecal colifoms observed in any of the three treatments. The Total coliform in the three treatments were within the acceptable range (<100 MPN/g). *Salmonella* sp. and *Vibrio* sp. were absent in all the three treatments. Based on the results reported here in, it was concluded that the prawn samples were safe for human health and of better quality from the microbiological point of view and good enough for export purpose.

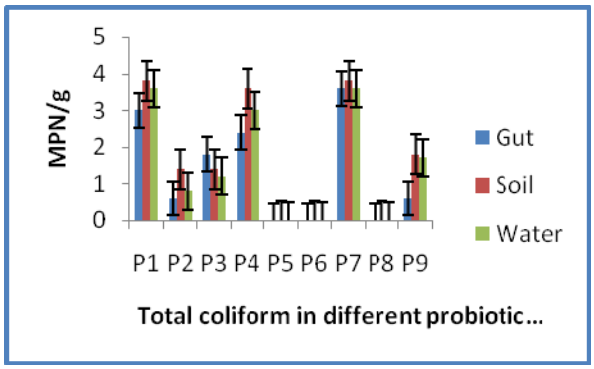

Fig. 1. Test of significance of the treatment

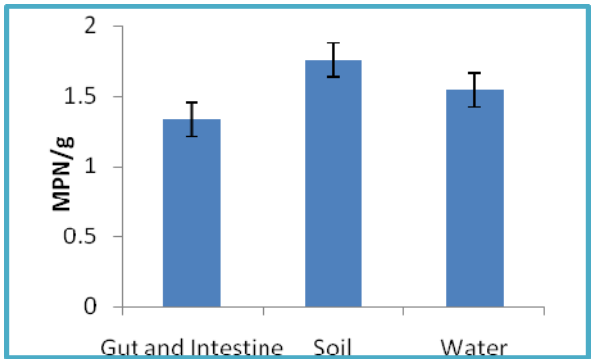

Fig. 2. Number of total coliform bacteria in the animals, soil and water of the experimental ponds

Probabilistic quantitative risk assessment of formalin treated fish in local market of Bangladesh

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In Bangladesh, formalin (FA) is widely added preservatives by the fish traders while transporting to domestic marketing chain which is highly health hazardous and risk factor to the consumer. Thus, the objective of the present study was to establish quantitative risk assessment (QRA) model for formalin treated fish in Bangladesh. The probabilistic QRA of formalin treated fish was performed based on available primary data. FA concentration in fresh and cooked fish, and national average fish consumption included 3 different scenarios (average consumption, 2 and 4 times of average consumption) were used for exposure analysis using @Risk program version 6.0. QRA model reveals that FA intake under scenario1 and 2 was lower than acceptable daily intake (ADI) thus lower risk for both fresh and cooked fish. However, scenario 3 revealed that 0.01 % population was at risk (FA intake higher than ADI) upon the fresh fish consumption, where cooked fish consumer remains safe at the same scenario. The result confirmed that cooking has significant effect to reduction of formalin. Unavailability of local data and variation of average fish consumption and formalin contamination might lead to uncertainty and underestimate of the result. Consequently, concentration and consumption data from local studies are highly recommended to be carried out and support the QRA in Bangladesh. Implementation of food safety management system (FSMS), international food safety standards, traceability, up gradation of food safety regulation and strategy based on farm to fork approach, mass awareness abuse of formalin, proper official control, monitoring and sampling plan throughout the supply chain could be worth to identify and control strategy for this risk. Therefore, probabilistic quantitative risk assessment model could characterize and provide important risk information to the risk manager (government) which could be applied to establish risk management strategy efficiently and effectively in Bangladesh.

Table 1. Probabilistic analysis of estimated formaldehyde intake (minimum, maximum, mean, and percentiles, mg/ kg body weight/day) from fish by Bangladeshi population

Scenario	Formalin intake (mg/ kg body weight/day)							
	Min.	Max.	Mean	SD	95%	97.5%	99.9%	exposed≤ADI
Fresh Fish-1	$2.97x10^{-03}$	$5.34x10^{-02}$	$7.73x10^{-03}$	$3.81x10^{-03}$	$1.50x10^{-02}$	$1.80x10^{-02}$	$3.30x10^{-02}$	100%
Fresh Fish-2	$5.94 x10^{-03}$	0.11	1.5410^{-02}	$7.61x10^{-03}$	$3.01x10^{-02}$	$3.58x10^{-02}$	$6.61x10^{-02}$	100%
Fresh Fish-4	$1.19x10^{-02}$	0.21	$3.09x10^{-02}$	$1.52x10^{-02}$	$6.02x10^{-02}$	$7.16x10^{-02}$	0.13	99.998%
Cooked Fish-1	$4.28x10^{-04}$	$2.34x10^{-02}$	$2.10x10^{-03}$	$1.59x10^{-03}$	$5.15x10^{-03}$	$6.36x10^{-03}$	$1.28x10^{-02}$	100%
Cooked Fish-2	$8.43 x10^{-04}$	$4.69x10^{-02}$	$4.20x10^{-03}$	$3.18x10^{-03}$	$1.03x10^{-02}$	$1.27x10^{-02}$	$2.56x10^{-02}$	100%
Cooked Fish-4	$1.67x10^{-03}$	$9.38x10^{-02}$	$8.39x10^{-03}$	$6.36x10^{-03}$	$2.06x10^{-02}$	$2.54x10^{-02}$	0.051	100%

Early mortality syndrome (EMS) in shrimp: Lessons learnt from the experience of global aquaculture alliance

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Early mortality syndrome (EMS) or Acute Hepatopancreatic Necrosis Syndrome (AHPNS) is an epidemic disease that damages the digestive system of shrimp and causes death, often within 30 days of stocking. This was first detected in China in 2009, then to Vietnam, Malaysia, Thailand, then remarkably jumped all the way to Mexico in 2013, and it is feared to have presumptive outbreaks in India, while in Bangladesh is yet to be reported. The disease originated with infected postlarvae and quickly spread throughout the ponds to 'clean' shrimp. The diseased animals become lethargic and anorexic. Upon simple dissection, the hepatopancreas organs of the shrimp may appear atrophied and whitish with black streaks. Other signs include a soft, generally darker shell and mottling of the carapace. The Pacific white shrimp, *Litopenaeus vannamei* are particularly susceptible to this disease. The causative agent is identified as *Vibrio parahaemolyticus*, a strain demonstrated not to contain human toxin, hence pose no human health concerns. The agent is transmitted orally, colonizes the shrimp gastrointestinal tract and produces a toxin, only when they reach a density of 10^5 to 10^6 cfu, which causes tissue destruction and dysfunction of the shrimp digestive organ, the hepatopancreas. The ability to produce toxin by this relatively common bacterium, *V. parahaemolyticus* is thought to be achieved once they are infected by a virus known as a phage. The bacteria tend to stick to surfaces, found in the bottoms of ponds, and have a quorum sensing capability. The infected shrimp exhibited abnormal behavior that led to cannibalism by non-infected shrimp, hence triggering their mortality rapidly. This is considered a major mechanism for transmission of AHPNS in ponds. Environmental factors appeared to have a role in the manifestation of the disease. Striking by EMS is likely to occur at salinity above 5; and at 10 the problem is very much at full strength. It peaks during warm season. The disease is manifested only when a given environmental parameter, pH, is within a specific range of 8.5 to 8.8, usually caused by algal bloom. Control of EMS infection needs pond preparation, disinfection, use of probiotic, PL stocking and so forth. Trial with black tiger shrimp however was never infected with EMS even when raised beside ponds that have infected vannamei, as demonstrated by GAA. Implementing vannamei production here in Bangladesh therefore demands critical consideration before the control strategy is ensured.

Translationally Controlled Tumor Protein (TCTP): A molecular target in protection of shrimp from White Spot Syndrome Viral (WSSV) infection

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Translationally controlled tumor protein (TCTP), also known as Fortilin, is a highly conserved and multifunctional protein. It was initially isolated from human tumor cell as a factor implicated in cell growth. Later on TCTPs homolog were isolated across different species and characterized diverse functions. Among its diverse functions, the protection of shrimp against WSSV infection is very significant in the context of aquaculture and fisheries. The WSSV is a common pathogen that causes significant production losses in the shrimp industry around the world. In our laboratory, TCTP homolog was isolated, expressed and characterized from shrimp, *Penaeus monodon* and named as *Pm* Fortilin. The injection of purified *Pm* Fortilin solutions to the shrimp after challenged with WSSV inoculation showed higher survival rate compared to the group which was not injected with *Pm* Fortilin. Though the survival rate of the *Pm* Fortilin injected shrimp increased significantly, the detail mechanism involved in the interaction is yet unknown. In the present study, we investigated the three dimensional (3D) structural variation of TCTP proteins and interaction mechanisms in detail by a number of *in silico* analyses. Homology Modeling was used to construct the 3D structure of TCTP protein from different groups of organism, and finally docking simulation was performed to predict the interaction sites with other molecules. The SWISS-MODEL server which is fully automated protein structure homology modeling server, accessible via the ExPASy web server was used for 3D structure construction. Auto Dock Vina (version 1.1.2) was used to predict the interaction of TCTP with probable a small fragment of the target proteins or ligands. The result of the 3D structure modeling showed significant structural variation among TCTP of different groups of organism which may provide the binding sites of interaction with other molecules. Among the different interactions of TCTP and other molecules, the interaction of *Pm* Fortilin to FBP1 (Fortilin Binding Protein 1) molecule is significant during WSSV infections to shrimp and the self interaction (interaction of TCTP-TCTP) properties may be the key reason for its multifunctional nature.

Probiotic technology for sustainable disease management of prawn aquaculture

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Macrobrachium rosenbergii, the giant fresh water prawn is one of the most important commercially-produced crustaceans in Bangladesh. A significant limitation to the industry is loss of productivity owing to the emergence of a large variety of pathogenic bacteria and viruses, and their resistance to chemotherapeutic drugs resulting in mass mortality and consequent crop failure. Finding a public health- and environment-friendly alternative is therefore a burning question to ensure sustainability of this industry in Bangladesh. Probiotics – the friendly bacteria with a host of benefits work by competitive exclusion of pathogenic bacteria can be a suitable alternative. This study aims to test probiotic bacteria able to inhibit growth of pathogenic bacteria that caused prawn mortality. Following a disease outbreak in prawn hatcheries of southwest coastal districts of Bangladesh during May 2012, samples were collected immediately from dead prawn larvae, culture water and prawn feed in order to isolate and characterize the pathogenic bacteria. The antibiogram of the isolated pathogens was conducted before they were challenged to compete with probiotic bacteria, *Lactobacillus* spp isolated from indigenous environment. The bacterial count on prawn samples was found significantly higher ($p<0.05$) than that of the water and feed samples. The dead prawn harbored heavy loads of pathogenic bacteria, and were identified principally as *Vibrio* spp, based on the pathogens' morphological, biochemical and physiological characteristics. The isolated pathogens, in a simulated environment caused mortality to prawn post-larvae, indicating that the mass mortality in the hatcheries were due to the bacterial infections. Twenty six antibiotics were tested to study the drug-resistance pattern of the isolates. Virtually all the tested isolates (thirty six) showed moderate resistance state to the drugs tested, and the highest sensitivity of the isolates (75%) was recorded to Doxycycline. In an *in vitro* attempt to control pathogen's growth on solid media, the cell-free supernatant (CFS) of the two-day old *Lactobacillus* spp, soaked in blank discs clearly produced at least 15 mm zone of inhibition. In broth cultures, CFS, collected in different day's intervals produced a dose- and age-dependent reduction, down to zero of bacterial count. The inhibition of bacterial growth could be attributed to some extracellular substances released from *Lactobacillus* spp, demonstrating its potential to be an excellent probiotic candidate for possible applications in prawn aquaculture. If successfully translated in culture ponds, this will be an eco-friendly approach to counter bacterial infections without compromising the prawn quality, thereby ensuring food safety in prawn industries of Bangladesh.

Investigation of heavy metal contamination in water, fishes and sediments from the Passur river at Mongla port near Sundarban mangrove of Bangladesh

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The study was conducted to investigate the heavy metal contamination in water, fishes and sediment from the Passur River in the Mongla port area near Sundarban mangrove during the period from January to June 2013. The water samples were collected fortnightly from five different sampling stations as St-1 (1 km upper from port area- upstream), St-2 (port area), St-3 (1 km lower from port area- downstream), St-4 (tributary), St-5 (1 km lower from tributary) for six month considered as dry season (Jan-Mar) and wet season (Apr-Jun) at both the high and low tide period. The heavy metal as Copper (Cu), Zinc (Zn), Iron (Fe) and Chromium (Cr) in water were determined with the help of Atomic Absorption Spectrophotometer (AAS, UNICAM, 969) in the Regional Office of the Department of Environment (DoE), Khulna, Bangladesh.

The fish (*Liza parse*) and shrimp (*Penaeus monodon*) samples were collected from two stations as St-1 (Katakhali) and St-3 (Amtola) monthly for three months in January (winter), March (pre monsoon) and May (Monsoon). Before analysis, a bit of muscle, the whole liver and two gill arches from each fish and shrimp were removed. Samples of tissues from each fish and shrimp were removed, weighed and dried. A microwave digestion system was used to prepare the samples for analysis. After digestion residue diluted with 25 ml 2.5% HNO_3. The water used was deionized and distilled. The metal analyses of samples (Cd, Cr, Cu, Pb and Zn) were carried out by using UNICAM-929 atomic absorption spectrophotometer (AAS) in SGS Bangladesh Limited, Dhaka-1205, Bangladesh. The sediment samples were collected from three sampling stations as St-1, St-2 and St-3 for six months during the study period. Sediment samples were air dried, sieved with 230 mesh (600 μ) stainless screens to separate larger particles and pebbles and digested with 4:1 mixture of nitric acid and perchloric acid. The volume was again made up to 10 ml with 0.1N HNO_3 and both the samples were analyzed by AES in SGS India Limited, Behala Industrial Complex, Kolkata-700034, India.

The concentrations of heavy metals as Copper (Cu), Zinc (Zn), Iron (Fe) and Chromium (Cr) were measured in the water. The concentrations of heavy metal (Cu, Zn, Fe and Cr) were found from water much lower than the permissible level. Among the heavy metals studied Cd, Cr, Cu, Pb and Zn were detected in fish and shrimp species were within acceptable limits by FAO standards. The concentrations of five heavy metals (Cr, Cu, Ni, Pb and Fe) were identified in the sediment sample. The levels of Fe were found at 23481.61 to 15339.4 mg/kg. Other metals were much lower and little difference during the different months. The results of this study indicated that a general absence of serious pollution in the Passur River is due to heavy metals; whereas the concentrations of elements found could mainly be attributed to geological sources. In this regard, to maintain the water and sediment qualities as well as the sound aquatic environment of the river need proper monitoring and management.

Filming experience gathered from sustaining ethical aquaculture trade (SEAT) project: leading to aquaculture journalism

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The Sustaining Ethical Aquaculture Trade (SEAT) Project has been working over the last four and half years in Bangladesh with other Asian countries such as China, Vietnam and Thiland. The main purpose of the project was to analyze the sustainable issue regarding seafood production and trade between Asia and Europe. In this project the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh as representative partner of aquaculture producing country worked with 13 European and Asian partners in an interdisciplinary research framework. In this project, the authors were involved in various research activities including research design, data collection, data recording, data analysis, interpretation and production of communication materials in printed and audiovisual forms.

As part of producing communication materials, a work package of Bergen University, Norway has produced two video documentaries; the first one on European consumers' attitudes to seafood and the second one on Bangladeshi seafood producers' attitudes. The documentaries were produced by a European film crew, hired by the University of Bergen and particularly, the segments of Bangladeshi producers covering how the farmers produce seafood and what are the opinions and perceptions of other value chain stakeholders. In the filming process of seafood production/aquaculture scenario, the first author learnt different kind of technicalities such as taking snaps, organizing the frame and story, and editing the video which is particularly not common in journalism in Bangladesh. Based on this experience, the first author got a job opportunity to work as a staff correspondent of Mymensingh District for a private television channel, Channel 9. This experience would lead the author to produce such kind of documentary of aquaculture system in Bangladesh in the coming days. This is because the greater Mymensingh region is the heart of aquaculture production in Bangladesh hence a new area of journalism in fisheries and aquaculture is likely to be developed. This all would lead to develop the knowledge dissemination process among the stakeholders which in turn contribute to the process of the improvement of sustainable aquaculture and trade.

Feasibility study of commercial cage fish farming in Mahananda river at Chapai Nawabganj, Bangladesh

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A three months (September-November, 2013) trial was conducted to study commercial feasibility of cage fish farming in the river Mahananda at Chapai Nawabganj in norther bangladesh. Nine Battalion of Border Guard of Bangladesh (BGB) sponsored the project. Chapai Nawabganj is a drought prone district where fish culture ponds suffer from lack of water and very low water depth in dry season. As an alternate and prospective tool of fish culture this endeavor was undertaken ever first in north-west Bangladesh. A unit of ten cages made of nylon net was established for this trial. Size of each cage was 6 m × 3 m × 1.5 m. Mesh size of the net was 1.9 cm. Frame was made by bamboo. Monosex tilapia (*Oreochromis niloticus*) was stocked in all the cages. Three replications of three stocking densities (*viz*., 700, 800 and 900 per cage) were designed. Initial weight of each fingerling was 26 g. Floating pellet feed was used. Up to 100 g weight of fish feeding was done three times a day. Fish were fed twice a day as they reached an average weight of 100 g. Feed was applied from @8.5% to 2.5% of the total body weight. Sampling was done fortnightly to evaluate growth performance in each cage. Fortnight physicochemical parameters *viz*., water current, temperature; pH, dissolved oxygen and total hardness were also monitored.

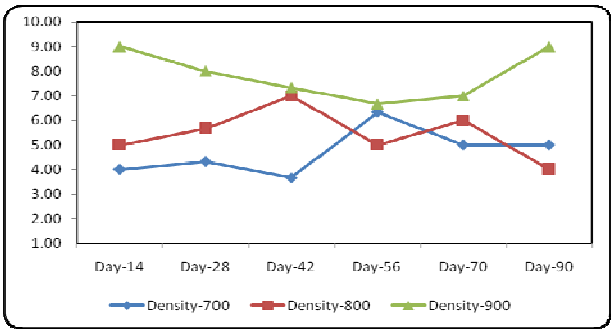

Fig. 1. Growth performance in different treatments

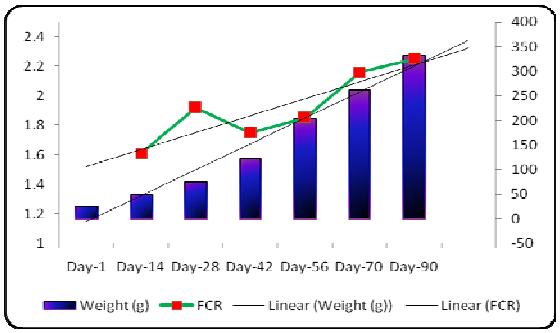

Fig. 2. Average weight (g) and FCR at different time intervals.

FCR showed higher trend with lowering water temperature. Overall FCR was 1.97. Best growth performance was observed in treatment-3 where stocking rate was 900/cage. The cages were arranged at the parallel direction of water current so that fish can always get fresh water - a reason of higher growth rate. In 90 days fish in this stocking density attained 362.83 ± 22.01 g whereas overall average growth was 331.72 ± 18.81g. Total production was 2,255.69 kg. In this method taka15,000/month can be earned.

Fig.3. A view of the project

The trial suggests that improving feeding efficacy can effectively reduce operational cost. The trial also reveals that cage fish culture in flowing river can open a new window of commercial aquaculture and also can create an alternate employment opportunity.

Aquarium fish business in Jessore district, Bangladesh

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This study was conducted in Jessore district of south-western Bangladesh with a view to assess the present status of aquarium fish business for a period of six month during September 2012 - February 2013. Only three aquarium shops were recorded and all were located at the heart of Jessore city. Owners of 3 others shops already closed their business. Only 17 varieties of ornamental fish were recorded to be sold in the surveyed shops belonging to 3 orders- Cypriniformes (52.94%), Perciformes (23.53%) and Siluriformes (23.53%). No fish was found to be sold during winter months *i.e.* January and February; and retailers diverted to other subsidiary business this time. All aquarium species were exotic and brought from Katabon area of Dhaka city. The highest retail price was found for large silver shark (BDT 123.33±40.41 / pair) followed by goldfish (BDT 106.67±11.54 / pair) and black moor (BDT 105.00±39.05 / pair). Shop owners fetched highest profit (BDT 38.33±02.89 BDT/pair) from large sucker mouth catfish. Production of ornamental fish locally, inclusion of native ornamental species as aquarium fishes are recommended for a sustainable and profitable aquarium fish business.

A preliminary investigation into river *Kole* as new non-traditional water body potential for aquaculture in dry season in the northwest Bangladesh

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Fish culture in non-traditional waterbodies - river *kole* in dry season is a recent attempt in the Northwest Bangladesh. The river Padma is one of the largest rivers become shrinked and most of the river beds are dried up in dry season leaving some depressions (water pockets) along its narrow stream/water flow. These depressions look like small lake or large ponds are locally know as '*kole* or *damosh'*. Water retains in the *koles* only for 5 to 6 months and remains uninundated till next rainy season offering vast water area potential for aquaculture. Very recently unemployed youths and fishers living close-by the the river *koles* were found to use these potential waterbodies for fish culture in Chapai Nawabganj Sader Upazila (Sub-district). A preliminary investigation was carried out during January – July, 2012 to assess the feasibility and to identify the problems and prospects of *kole* fish culture.

Data from three selected *koles* were collected and personal observations on fish culture practices were made. The farmers were not instructed to follow any kind of management technique. The largest *kole* water area was 15 ha in December that gradually reduced to 7.4 ha in May-June and the smallest *kole* area varied between 3.5 to 1.75 ha. Initial average depth was 3.5 m which finally reduced to 2.5 m. *Kole* water were found to remain mostly transparent (Secchi disc reading >45 cm) before fertilization. In most cases, *koles* were prepared for fish culture through eradication of predators by repeated netting and with the application of lime and fertilizers. A total of 33 fish species were found in the *koles,* - carps (3), minnows (6), catfishes (10), eels (3), gobies (1), loaches (1), featherback (2), gars (1), perches (3), murrels (3) and prawns (2). Sometimes snails were also found. Stocking of *koles* with carp yearlings (juvenile) (@300kg/ha) was completed during January-February that took nearly 15-20 days to finish. Supplementary feeds like mustard oil cake, rice bran, and sometimes feed pellets were used as well.

Stocking and harvesting details of *kole* fish culture

	Species name	Stocking (nos/ha)		Individual stocking wt (g)		Individual harvesting wt (g)	
		Min	Max	Min	Max	Min	Max
1	Silver carp	280	320	140	400	800	2000
2	Big head	160	190	150	380	900	2200
3	Catla	130	170	110	390	500	1500
4	Rui	180	225	150	225	450	1050
5	Mrigal	80	120	130	240	425	900
6	Common carp	275	325	270	370	1000	2900
7	Grass carp	10	20	300	400	1100	2100
Total		1115	1370				

Sudden rainfall was found to make fish harvesting difficult expanding water area, increasing water depth and disrupting communications. It could also allow fish to escape. Fish harvesting was usually done in the month of June and sometimes early in July that took almost a month to complete. Within 4 to 5 months culture period, average 767 kg / ha fish (including 42 kg non stocked wild fish) was produced with an average net profit of Taka. 38,000 / ha of *kole*. It was also revealed that all the cultured species used except mrigal were suitable for *kole* fish culture considering their growth performance. With introduction of appropriate culture techniques through training and motivation, the present production as well as net profit from *kole* culture can be increased at least 2 to 3 folds easily.

Integrated floating cage-aquaponics systems (IFCAS) in shaded ponds for enhancing production and households' nutrition in Barisal region, Bangladesh

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Rural households' ponds in Barisal region were constructed digging soil for making bedrock of homestead. Traditionally the ponds are used as trap ponds for wild fish with little stocking of carps fry which is mainly limited to subsistence consumption. In this context, taking integrated aquaculture agriculture approach, to improve household nutrition, the Agriculture Nutrition Extension Project (ANEP) supported by European Union (EU) is being implemented in Barisal District of Bangladesh. The WorldFish as a partner is implementing the aquaculture component of the ANEP in collaboration with others. Characteristically, the pond dykes in the region are commonly used for tree plantation that provides cooking fuel, fruits and timber for sale. Trees on the pond dyke create shadow affecting sunlight penetration to the water around the dykes. This impacts negatively on fish production in pond water and vegetable production on pond dykes. However, there is a potential of growing vegetable in the sunlight exposure areas of pond water. Considering the shaded nature of pond dykes and sunlight exposure area in the water, an action research with a new specialized water based aquaculture systems, IFCAS (Integrated Floating Cage Aquaponics System) is being carried out. Giving an initial training to participatory 9 farmers, an IFCAS was designed. A 9 m^2 rectangular iron-bar made frame was constructed having four grooves in its four corners for holding floats. Locally available plastic containers were used as float in the IFCAS structure. In between two floats in the width edge of structure, a pit was made to put dried pond sludge mixing with cowdung and other organic manure. The whole bottom of the structure was surrounded by similar size of a rectangular net to get the shape of a large cage. On the upper surface the structure, a scaffold was made using bamboo split for vegetable climbing on the whole structure. The climbing vegetables as per farmers' preference were planted on the pit of the structure which is attached to pond water underneath being able to absorb nutrient from the pond. In the net cage, mono-sex tilapia fry was stocked at the rate of 100/m^3 feeding with floating feed. Apart from IFCAS, the remaining area of pond is used for farming of carps as per usual carp culture technique. At the beginning of first cycle (Jul – Oct 2013) of action research with 9 households, the participation of women was found encouraging. All the IFCASs were set in the sunlight exposure area of pond by the farmers. The height of scaffold was elevated from the original design by the farmers themselves to grow long vegetable like snake gourd. Farmers as per their own preference have planted various type of climbing vegetables such as cucumber, snake gourd, spinach, bitter gourd and bean. The growth of fish and vegetable in semi-shaded ponds was higher than that of deeply shaded ponds. The range of vegetable consumption among the participating households was 5-22Kg/household over 3 months of trial. During that time, homestead vegetable production was almost none due to heavy rainfall and muddy ground. The average estimated production of tilapia in the cage of IFCAS was 31 kg and 52 kg/9m^2 for deeply shaded and medium shaded ponds, respectively. The poor growth was attributed to poor water quality parameters, particularly NH_3 and NO_2 was found toxic at the deeply shaded ponds, possibly due to decomposition of organic matter (plant leaves) in the deep ponds with lack of water turbulence, no removal of sludge etc. This action research will be continued until March 2014. It is expected from this participatory research, a new technology of integrated aquaculture-agriculture for resource poor farmers going to be emerged from ANEP.

The Pros and Cons of commercial aquaculture development in Bangladesh: Preliminary understanding

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Commercial aquaculture is the rearing process of aquatic organisms which is profit oriented and primarily by the private sector, contributes to food security, directly by producing food fish, and indirectly by generating employment, and thus, income for the purchase of food. There is wider level of criticism on commercial aquaculture in terms of social and environmental sustainability, however, commercial aquaculture can be sustainable because it depends on private, rather than public funds that are usually lacking or scarce in the developing countries. The main commercial fish species being cultured in Bangladesh are *Pangasius*, Tilapia and Koi (perch). The aim of this study is to provide an in-depth analysis of the culture practices of these species with special emphasis on the identification of opportunities and challenges towards sustainable commercial aquaculture development in Bangladesh.

The study area was divided into 4 zones/clusters: i) Greater Mymensingh, ii) North Bengal – Bogra iii) Southeast – Comilla, and iv) Southern Bangladesh – Barishal district. These four zones covering four parts of the country those have been identified due to considerable development of aquaculture practices for favorable biophysical resources and climatic conditions, including the availability of ponds and low-lying agricultural land, warm climate, fertile soil, and abundant labor. The questionnaire survey along with a number of participatory rural appraisal (PRA) tools and secondary literature review is being used for the study. Until middle of December 13, data collection from greater Mymensingh and Barisal region has been finished. However, data collection from the remaining areas was not possible due to countrywide political unrest. As part of preliminary understanding it was found that increasing feed cost, increasing labor cost of salaried staff of farm, lower profit margin are the major constraints. By region, feed cost is relatively higher in Barisal area because no development of feed mill and multiple business there. Even there is no any use of small-scale pellet machine because its manufacture is only concentrated in Mymensingh region. In terms of species, the profit margin was found higher in *Pangasius* farming compared to tilapia and Koi. For this reason, the population size of *Pangasius* farmers is larger than other farmers. A commercial aquaculture project is being piloted by the WorldFish under its FtF project to promote super intensive commercial aquaculture in Amtoli Upazila under Barguna District following the practice in the Mekong River Delta, Vietnam. Initially, it seems the project is successful technically in terms of growth, production and productivity of pond connected to tidal freshwater river. However, the profits margin was not satisfactory due to higher price of feed, poor marketing infrastructure of cultured *Pangasius* in the wild fish dominated area and very high initial investment. To sustain this sort of commercial aquaculture, other input supply facilities such as seed and feed supply needs to be developed around, and export trade should be linked. This research is still under field level data collection, however it is expected that at the end of March 2014, the comprehensive results of pros and cons of commercial aquaculture would be derived that will in turn contribute to developing strategy of sustainable commercial aquaculture in Bangladesh.

Land use change detection for aquaculture planning through remote sensing image analysis using GIS tools in Mymensingh region

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The land has gone through tremendous changes over the decades in Bangladesh. The present study conducted to detect the land use changes using Remote Sensing (RS) images and Geographical Information Systems (GIS) tools for aquaculture planning in Trishal Upazila, Mymensingh. Landsat TM Image of 1999 and Google image of 2012 were used in the study. Normalized Difference Vegetation Index (NDVI) was prepared using NIR, MIR and blue bands for discriminating the vegetation in the images. Cluster image prepared with 5% linear stretch for unsupervised image classification. The NDVI image were reclassified into four land use classes as water, bare land, low vegetation, high vegetation and cluster image were classified into four categories as bare land, water body, field crops and homestead vegetation. The unsupervised Landsat TM image of 1999 interpretation showed that total bare land and water body were 212 and 8 km^2, respectively. However, the bare land has decreased to 115 from 212 km^2 and the water body increased 74 km^2 which was 8 km^2 that means bare land has decreased 28% and the water body increased 19% due to ponds created sporadically for fish culture in the region. By contrast, the vegetation has increased 10% in NDVI Google image of 2012 than the Landsat TM image of 1999. Therefore, it is evident that 66 km^2 (28%) of water body has increased in 2012 Google image than the 1999 Landsat TM image, that means land use has changed tremendously in the study area over the fourteen years. It is also noted that vegetation has increased in the area due to water availability round the year in the region due to presence of fish ponds. Conversely, we have to be cautious to agricultural land conversion to fish ponds as we need rice to feed our people. Conversion of agricultural land will only be permitted when follow the planning rules and integration of fish with agriculture is done.

Floodplain aquaculture: Impacts on ecology and biodiversity

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Floodplain land appears as an important aquatic ecosystem that provides wide range of biodiversity and indispensable benefits to the people. This study was conducted to identify the aquaculture impact on biodiversity of non-stocked indigenous fish species (NIFS) and ecology of floodplain *beel*s (two cultured and one non-culture) located in northwestern Bangladesh from July, 2013 to December, 2013. To observe the present status of cultured and non-cultured *beel*s during fish harvest, direct observation method was used. After intervention of fish culture, the total number of fish species was 29 (Including 10 cultured species) and 18 (including 7 cultured species) in *beel* Kola at Baghmara and *beel*Khosal at Mohanpur, respectively. Whereas at non-cultured floodplain *beel*Hatra at Mohanpur, 21 species were found. In *beel* Kola 31 and in *beel*Khosal 38 types of aquatic plants were found in the study period. 6 types of benthos and 5 types of other fisheries items were recorded in the study area. To increase the production of aquatic resources in these open waterbodies without interrupting the ecology and biodiversity, sustainable fishery management is required.

Aquaponics: A promising technique for sustainable food production in saline affected coastal region of Bangladesh

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Aquaponics is a bio-integrated system linked to re-circulating aquaculture with hydroponic vegetable production. The objective of the present research was to evaluate whether aquaponics can produce fish and vegetable in saline affected zone in coastal Bangladesh. Chalna of Dacope Upazilla, Khulna was selected as study site. Fifteen farmers were purposively selected with electricity facilities in the area. A typical aquaponics unit was set in each farmer's yard with a fish tank of 800 liters and three plastic bath tub of 60 liters for media based vegetable growing. Fish tank waste water was irrigated to the vegetable media where nitrogenous compounds converted to nitrates by denitrifying bacteria which used as fertilizer by the vegetables and filtered water returned to the fish tank. Monosex tilapias were used as the experimental animal in the system. The farmers were introduced with the aquaponics to handle the system smoothly. Water quality, and growth of fish and vegetables were monitored fortnightly. Data analysis revealed that pH and dissolved oxygen ranged between 6.8-8.7 and 2.8-7.68mg/l which was acceptable. The initial length and weight of fish were 3.5±08 cm and 1.0±0.02 g which grown to 16.04±0.62 cm and 212.94±0.35 g at the end of the experiment. Vegetable production from the system was also promising. The five-point Likert-scale assessment showed that majority (86.67%) of the participants strongly agreed that the aquaponics system was suitable for fish and vegetable production in the region, produced vegetables were palatable (100%), and any members of the family could take care of the system (93.33%). The aquaponics system can be replicated to other disaster prone areas of the country for sustainable fish and vegetable supply.

Table 1. Illustrates farmers' perception on aquaponics system based on five-point Likert-scale

Sl. No.	Statements	Extent of Agreement				
		SA	A	U	D	SD
1	Aquaponics system is suitable for fish and vegetable production	86.67	13.33	0.00	0	0
2	The technology is easy to use	66.67	33.33	0.00	0	0
3	Provides more outputs with little inputs	46.67	46.67	6.67	0	0
4	Requires minimum intercultural operations	80.00	20.00	0.00	0	0
5	Any members of the family can take care the system	93.33	6.67	0.00	0	0
6	Vegetables and fishes produced by the system are palatable	100.00	0.00	0.00	0	0
7	Increases beauty of the homestead	80.00	20.00	0.00	0	0
8	The technology is satisfying to use	60.00	33.33	6.67	0	0
Strongly agreed (SA)=5, Agreed (A)=4, Undecided (U)=3, Disagreed (D)=2 and Strongly disagreed (SD)=1						

Cage farming of tilapia (*Oreochromis niloticus*) at different stocking densities in the river Mahananda

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Water quality, production and economics were studied for cage farming of tilapia, *Oreochromis niloticus* in the river Mahananda of Chapai Nawabganj district, Bangladesh. Fishes (mean stocking weight of 35.2 g) were grown for a period of four months from August to November, 2012 in floating cage (2 m x 2 m x 1m). The experiment was designed with 3 treatments of tilapia stocking densities like T_1 (150 fishes / $m^{3)}$, T_2 (200 fishes / m^3) and T_3 (250 fishes / m^3), each with 3 replications. Fishes were fed with 28% protein rich floating pellet. Water quality parameters were monitored fortnightly and the growth parameters were monitored monthly. Mean water temperature (°C), transparency (cm), pH, DO (mg/l), CO_2 (mg/l), alkalinity (mg/l) and NH_3-N (mg/l) varied from 29.03±1.61(T_3) to 29.06 ± 1.61(T_1), 32.86 ± 0.26 (T_1) to 33.01 ± 0.29 (T_3), 7.50 ± 0.07 (T_3) to7.51 ±0.06 (T_1), 5.56 ±0.13 (T_1) to 5.58 ± 0.03 (T_3), 3.23±0.04 (T_3), to3.25±0.04 (T_1), 73.26±0.55 (T_3) to 73.34±0.57(T_1) and 0.23±0.03 (T_1) to 0.24±0.02 (T_3), respectively. The mean final weight (g), monthly mean weight gain (g), specific growth rate (SGR, % bwd^{-1}), survival rate (%) and yield (kg/ m^3 /4 months) varied significantly ($P<0.05$) from 153.07±0.07 (T_3) to 170.00±0.00 (T_1), 29.47±4.15 (T_3) to 33.70±4.78 (T_1), 1.22±0.46 (T_3) to 1.32±0.51 (T_1), 93.67±0.17 (T_3) to 97.44±0.06 (T_1) and 18.87±0.01 (T_1) to 27.04±0.06 (T_3), respectively. Total cost (Taka /cage /4 months), total return (Taka /cage /4 months), net benefit (Taka /cage /4 months) and CBR varied significantly ($P<0.05$) from 5,341 ± 2.02 (T_1) to 6,980 ± 2.89 (T_3), 14,510 ± 2.77 (T_1) to 17,510 ± 2.77 (T_3), 9,168 ± 3.00 (T_1) to 10,530 ± 2.89 and 1.51 ± 0.01 (T_3) to1.71 ± 0.003 (T_1), respectively.

Juvenile carrying capacity and life cycle of ovoviviparous freshwater snail, *Viviparus bengalensis* produced in IMTA (integrated multi-trophic aquaculture) ponds

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Life cycle and juveniles carrying capacity of freshwater snail (*Viviparus bengalensis*, Lamarck) grown in IMTA (Integrated Multi-Trophic Aquaculture) ponds were studied for a period of 90 days from 4th July to 1st October, 2012. Nine experimental IMTA ponds situated in the south-west side of the Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymensingh were taken under this study. There were three Treatments (T_1, T_2, and T_3) each with three replications. Each pond was 1 dec in size and stocked with 80 carps/dec and 100 stinging catfish (*shing*) per cage of 1 m^3. In T_1, snail was not stocked, T_2 and T_3 were stocked at the rate of 250 g snail per decimal. For life cycle observation of snail, two *hapa* were set in T_2 and T_3 ponds. Sampling was done at 7 days of interval using Ekman Dredge in the ponds. It was found that an adult snail carried approximately 30-40 juveniles. In T_1, juveniles carrying capacity per snail was found 39±4 and, in T_3 it was found 40±3. The highest snail production was estimated in T_3 (no. of juveniles 66,868±2994/decimal, and no. of adult 9303±1006/dec), where IMTA was complete with carps in ponds, *shing* in-cage-in-ponds and floating aquaponics on the pond surface. The lowest production was found in T_2 (no. of juveniles were 65,122±1644/decimal and no. of adult snails were 8140±1007/decimal). It was also observed that life cycle of snail was completed within 40-42 days. Adult snail released eggs after 15 days, and embryos and juveniles have taken 7 to 8 days to be reached at young stage. Finally, it was found that a complete life cycle of freshwater snail requires 5 - 6 weeks. The physico-chemical parameters of the ponds under three treatments were found to be more or less similar. However, significantly difference ($P<0.05$) was found in case of pH and dissolved oxygen and other factors (biological, environmental etc.) but the ranges were within acceptable limits for fish and mollusks culture. Finally, it could be concluded that IMTA for growing snail along with fish showed potential for increasing productivity of freshwater ponds in Bangladesh.

Dried fish production, trade and consumption in Bangladesh through the social wellbeing lens

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Dried fish makes an important contribution to the material and cultural dimensions of livelihoods and food security in Bangladesh. This paper addresses the production, trade and consumption of dried fish, using social wellbeing as an analytical lens. In doing so, we examine its material, subjective and relational dimensions, as they apply to producers and consumers of dried fish products, paying particular attention to social identity, labour and gender. Materially, dried fish is disproportionately important to poorer consumers by virtue of its easy divisibility into small portions with low nominal prices, and accounts for a significant fraction of total fish consumption in the north and east of the country. Fishing and fish drying make important economic contributions to the livelihoods of large numbers of people, with perhaps half of marine landings being dried, mainly by women, many of whom are highly marginalised *Rohingyas* displaced from Myanmar. Marine fishing is characterized by high levels of insecurity due to widespread piracy. Subjectively, there is a strong cultural affinity for the consumption of dried fish products, as evidenced by buoyant exports to Bangladeshi expatriates in the UK and Gulf states. Relationally, domestic trade is characterized by highly unequal patron-client dynamics between traders and producers. Low caste Hindu and hereditary Muslim fishers and fish traders experience social exclusion but, conversely, this status also supports the retention of control over parts of an often lucrative business. Labour relations are highly gendered and frequently exploitative, but are also characterised by complex moral economies.

Effects of bitter-melon, *Momordica charantia* against fly infestation on dry fish products

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The present study was conducted to investigate the effects of bitter-melon (*Momordica charantia*) extracts against fly infestation in traditional sun dried fish products during May to November 2012. The fish bombay duck (*Harpodon nehereus*), which is an ideal fish for drying, was used in this experiment. Bitter-melon was collected from local market, splitted and dried, and then extracted by cold extraction method. Six treatments (concentrations 50, 100, 150, 200, 250 and 300 ppm) each having two replications were tested. Fresh fish were dipped in extract solution for about 10 minutes and then traditional sun drying method was followed. During drying, flies assembled randomly on all the treated samples as well as on the controlled samples indicating that there was no instant resistance of bitter-melon extract against fly. The organoleptic qualities of the dried fish were excellent and moisture content ranged from 9.75 to 21% (Fig. 1), which reflects dried process was ideal. Dried fish were stored after packed in gunny bags and were checked at every 15 days interval. At first 15 days dried products remain more or less unchanged and after 30 days little fungal attack found on the dried fishes. Profound fungal attack was observed after 45 days of storage and the attack was more prominent in control. Little fungal attack in extract treated fish was due to the antimicrobial action of bitter-melon extract. During this short period of storage, no insect infestation was observed both in controlled and treated samples. Therefore, it is not clear whether there is any effect of bitter-melon against insect infestation or not? In panel test of the samples, only 15% panelists reported very little bitter taste in the treated samples (Fig. 2). As bitter-melon possesses some antimicrobial constituents and safe for human consumption, therefore, further studies with higher concentrations and long storage period should be conducted to know the effects of bitter-melon against fly and insect infestation.

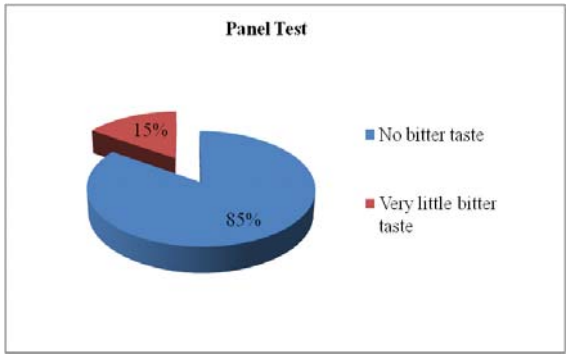

Fig. 1. Moisture contents of dried fish products

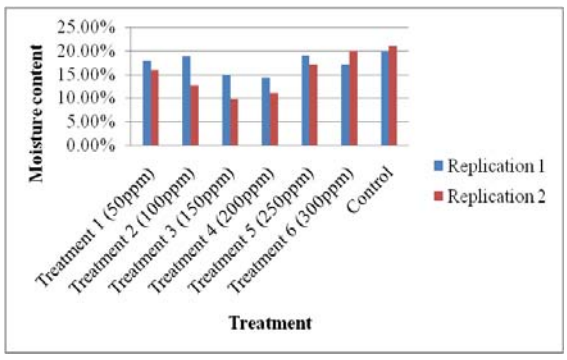

Fig. 2. Percentage of bitter taste in treated products

Marketing of formalin treated fishes in domestic markets at Khulna city in Bangladesh

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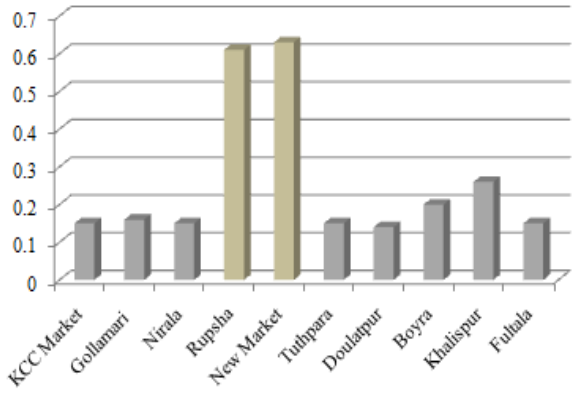
A survey was conducted in ten selected fish markets in different locations of Khulna city to determine the presence of formalin in fish from February to April 2013. Formalin was detected by Z-300 Formaldehyde Meter. In the most of the markets formalin in fish was found at different levels of concentration. In this study, it was observed that marine fishes contained higher level of formalin than fresh water fish. The formalin ranged for marine fish was 0.4-1.09 ppm. The marine fish specially parshe (*Liza persia*) (1.09±0.33), bele (*Glossogobius giuris*) (0.79±0.5), tengra *(Mystus vittatus*) (0.56±0.32) and some of the fresh water fishes such as tilapia (*Oreochromis mossambicus*) (0.5±0.44), sarpunti *(Puntius sarana*) (0.47±0.29) and mola (*Amblypharyngodon mola*) (0.77±0.58), contained higher level of formalin compare to others fishes. It was also found that the presence of formalin in different fish was higher in Rupsa Fish Market and New Market than other fish markets. Formalin concentration in rohu (*Labeo rohita*), catla (*Catla catla)*, kalibaus (*Labeo calbasu)*, koi (*Anabas testudineus)*, shing (*Heteropneustes fossilis)*, magur (*Clarias batrachus*), chital (*Notopterus chitala)*, and silver carp (*Hipothylmicthis molitrix)* were within acceptable range (> 0.5 ppm). However, formalin level in tilapia sarpunti, mola, khoira, bata, bain were little higher than the acceptable range (0.5 ppm). Parse (1.09±0.33 ppm) and bele (0.79±0.5 ppm) contained the highest range of formalin than other marine species. On the other hand, koi, shing, magur and taki (*Channa punctatus)* contained almost zero formalin in all the fish markets in Khulna city.



Extent of Formalin used in different market in Khulna city

Effect of temperature on the quality of smoked tilapia (*Oreochromis niloticus*) stored at ambient and refrigeration temperature

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Organoleptic characteristics, quality and shelf-life of ready-to-eat smoked tilapia (*Oreochromis niloticus*) were evaluated in laboratory condition. For this purpose a locally made improved smoking kiln was used. Sixteen fresh experimental tilapia (*O. niloticus)* used for the smoking experiment were obtained from BAU market, Mymensingh. T first, the fillets were dipped for 30 minutes in brine. The samples were then divided into two equal parts as treatments A and B. Treatment A was processed at 60ºC temperature for 2 hrs and B was processed at 80ºC temperature for 1.5 hrs under laboratory condition. The quality of smoked fish in both treatments was evaluated at ambient temperature and refrigerated temperature during which the sensory, biochemical and bacterial evaluation was done. Organoleptic evaluation showed that the smoked fish stored at ambient temperature had an acceptable shelf-life of 6 and 2 days in treatments A and B, respectively. However, the products of the two treatments stored at refrigerated temperature (4ºC) showed a longer shelf-life of 65 and 45 days, respectively for A and B. The smoked fish which was prepared at 60ºC in treatment A had the longer shelf-life with all its sensory attributes and quality within an acceptable condition. Biochemical assessment in smoked product showed that protein, lipid and ash contents increased due to loss of moisture during smoking. However, there was found no significant change in moisture, protein, lipid and ash content in both the two treatments A and B during the storage conditions. TVB-N content increased with time up to rejection level with the progress of storage period in both ambient and refrigerated storage condition. Considering all the quality parameters it showed that the hot smoked products prepared at 60ºC had a longer shelf-life of 65 days.

Utilization of processed fishes and other fisheries items

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A total seven species of fishes and other fisheries items such as *Cirrhina reba*, *Mastacembelus pancalus*, *Mastacembelus armatus*, *Xenentodon cancila*, *Glossogobius giuris*, *Hypophthalmichthys molitrix* and small prawns (*Macrobrachium malcolmsoni*, *Macrobrachium lamarrei*, *Macrobrachium dayanum*) were studied. The average total lengths of *C. reba* was 157.5 mm, *M. pancalus* was 135.25 mm, *G. giuris* was 104.5 mm, *M. armatus* was 199.20 mm, *X. cancila* was 190.45 mm, *H. molitrix* was 238.75mm and small prawns were 44.07 mm. The average after dressing and washing weights were 22.95 g (*C. reba*), 12.21 g (*G. giuris*), 16.58 g (*X. cancila*), 40.97 g (*M. armatus*), 13.00 g (*M. pancalus*), 410.50 g (*H. molitrix*) and 1.05 g (small prawns). The highest percentage after dressing (ADW) weight and washing weight of *M. pancalus* was 85.20% and lowest in *H. molitrix* which was 62.49%. In small prawns, the highest percentage of waste weight (WW) per kg was 91.79% and the lowest in *X. cancila* which was 79.88%. On the other hand, percentage of powder per kg the highest value was found in *X. cancila* (20.12%) and the lowest in small prawns (8.21%). Different parameters were also found. The lowest duration of day was needed in *C. reba* and *X. cancila* (4 days) and the highest duration (7 days) was needed in *M. pancalus* and *M. armatus*.

Micronutrients in commercially important seaweeds of Bangladesh

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Seaweeds or algae are marine plants that form the basis of a complex food web involving all the organisms living within a marine ecosystem. It is used as industrial raw materials and edible item for human in many countries. There are more than 140 species of seaweed found in the coastal water of Bangladesh especially in Cox's Bazar. About 50 seaweed species were collected, identified and preserved, of which about 20 are commercially important. Considering nutritional and medicinal values of seaweed and its potential of being used as human food, 6 most abundant species from Bakkhali-Moheskhali Channel and Saint Martin Island were studied for micronutrient contents (Table 1).

Table 1. Micronutrient contents in selected seaweed of Bangladesh

Seaweed	Type	Ca (ppm)	Fe (ppm)	K (ppm)	Na (ppm)	Zn (ppm)
Enteromorpha intestinalis	Green seaweed	5,935.84	5,570.34	16,234.27	65,824.82	14.91
Hypnea musciformis	Red seaweed	3,329.61	3,690.61	60,679.44	27,807.15	20.05
Sargassum oligocystum	Brown seaweed	14,761.52	3,795.04	88,846.89	30,798.54	13.42
Padina tetrastromatica	Brown seaweed	183,155.46	14,160.95	23,839.61	21,058.95	15.66
Hydroclathrus clathratus	Brown seaweed	21,196.92	24,334.55	5,404.13	34,267.38	439.16
Porphyra sp.	Red seaweed	9,140.44	2,465.21	22,175.86	45,948.35	67.89

Ca, Fe, K and Na content in all seaweeds are found to be high. The highest Ca was in *P. tetrastromatica* and lowest in *H. musciformis*. Highest Fe content was found in *H. clathratus* and lowest in *Prophyra sp.* Moreover, highest K concentration was in *S. oligocystum* and lowest in *H. clathratus*. The seaweed industry in Bangladesh is in its initial stage and very few people consume seaweeds. However, high micronutrient present in the seaweeds of the country might open a new window to supplement nutrient deficiency of poor people of Bangladesh.

Fish drying in Naziraratek, Cox's Bazar

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Nazirartek is one of the largest fish drying centres in Bangladesh, located in the Cox's Bazar district. More than five hundred khola (fish drying unit) is now located in Nazirar Tek. Nearly all of the marine fishes, shellfishes are sundried here. Important marine fish that dried are loitya, chhuri, lakhua, chanda, ichhiri, poa, potka, chapila, pahisaa, pata, hangor, shrimp, squids and crabs. Fish drying generally starts in October and ends in April. Depending on species, and size (thickness), fish takes 2-4 days to be fully dried. During March 03-10, 2014 eight marine fishes namely lotya, phaisha, chanda, ichhiri, olua, poa, pata, and chhuri (2 sizes) were experimentally dried in Nazirar Tek to monitor the weight loss during drying. To produce 1 kg of dried lotya, ichhiri, small chhuri, pata, large chhuri, tak chanda, phaisa, poa and olua 5.97, 4.24, 3.17, 3.06, 3.00, 2.69, 2.68, 2.17 and 1.92 kg kg fresh fish was needed. Entire process of drying (washing, salt use etc.) for important species along with price of fresh fish (purchase) and dried fish (sale), number of labours worked and amount of dried fish produced were also recorded.

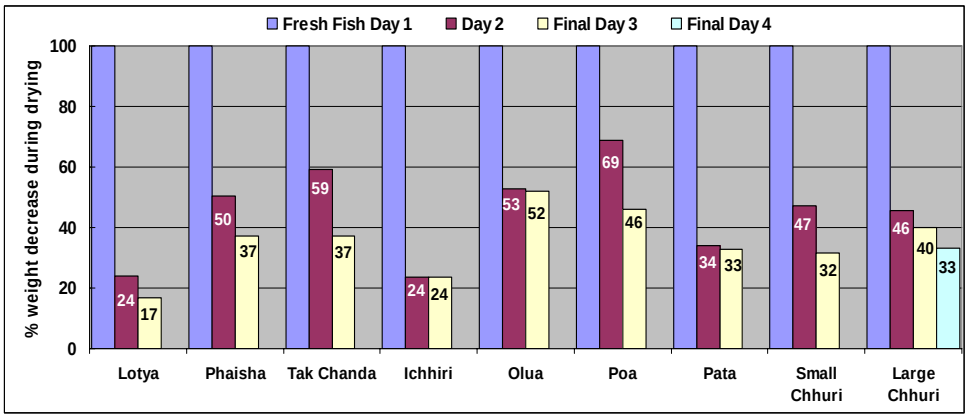

Table 1. Price of fresh fish and dried fish in Nazirar Tek during 2013-14

Name of fish\Size	Price of fish (Taka/Kg)					
	Small		Medium		Large	
	Fresh	Dried	Fresh	Dried	Fresh	Dried
Loitya	25-30	180-200	35-38	240-250	40-45	290-300
Chhuri	35-40	140-150	85-90	430-450	110-120	600-800
Phaisha	30-35	120-130	40-45	150-160	50-55	180-200
Poa	35-40	110-120	45-50	180-200	55-60	280-300
Olua	35-40	110-120	55-60	140-150	70-80	180-200
Ichhri	25-30	200-210	35-40	290-300	55-60	385-400
Tak Chanda	20-25	95-100	30-35	120-130	45-50	140-150
Chapila	30-35	120-130	40-45	135-140	50-55	140-150
Rita	65-70	130-140	90-100	140-150	140-150	290-300
Pata	30-35	75-80	40-45	120-130	50-55	145-150
Perki (squid)	20-25	45-50	30-35	70-80	40-45	90-100

Potential of value-added products of sea weeds in Bangladesh

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Seaweeds are macrophytic marine algae which are a primitive type of plants lacking true roots, stems and leaves. Being rich in protein, amino acids, vitamins, minerals and bioactive substances, seaweeds are called medical food of the 21st century. These marine algae reduce high blood pressure, cholesterol, and prevent strokes. They are used as medication for rheumatism, diarrhea, and for controlling the growth of tumors. Seaweeds have been used as a human food since ancient times, particularly in China, the Korean Peninsula and Japan. Now these are being commercially cultured and consumed by the populations of many countries like Philippine, Thailand, Fiji, Canada, Chile, etc. In Bangladesh, seaweeds are found in coast line of Ukiya, Teknaf, St. Martin's Island, and Sundarban mangrove forest. However, seaweeds are not so popular in the country as a food item. Considering the benefits of seaweeds on human health, the "Jahanara Green Agro" has been conducting research since 2010 to develop different value-added products including food and cosmetics items from these marine algae, and promoting those products to make popular to the people. A list of different products that we developed from seaweeds is given in Table 1. If Government takes initiative to make aware the people about the food value and benefits of seaweeds, it may open a new avenue in the economy of the country by creating demand of value-added products of seaweeds in the market.

TABLE 1. A list of different food and cosmetics products of seaweeds developed by Jahanara Green Agro, Cox'sbazar.

Products	Items	
1. Shampoo	a. Sea weed amla shampoo b. Sea weed hena shampoo c. Sea weed joba shampoo	d. Sea weed menda shampoo e. Sea weed copi shampoo
2. Soap	a. Sea weed copi soap	b. Sea weed jafran soap
3. Cleanser	a. Sea weed tea cleanser b. Sea weed tishi cleanser	a. Sea weed stivia cleanser b. Sea weed wheat leaf cleanser
4. Face wash and lotion	a. Sea weed olive lotion b. Sea weed face pack	c. Sea weed face wash d. Sea weed copi face wash
5. Food items	a. Sea weed milk shake b. Sea weed soup c. Sea weed snacks d. Sea weed cakes	e. Sea weed chips f. Sea weed salad g. Sea weed jam h. Sea weed noodles
6. Other products	a. Fertilizer	b. Animal food

Effects of formulated diet on growth of sea bass *Lates calcarifer* in freshwater condition

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A study was carried out on the growth performance of sea bass (*Lates calcarifer*) to evaluate the effect of a formulated diet in freshwater experimental ponds at Patuakhali Science and Technology University campus for a period of 6 months from June to November, 2013. The study was conducted in 9 ponds with three treatments, T1 Trash fish containing 30.62% protein (control), T2 Mega feed containing 25% protein and T3 Formulated diet containing 37% protein. Each treatment having three replications was assigned following a completely randomized design (CRD). The sea bass fry were collected from the natural sources and stocked in different pre-prepared treatment ponds at stocking density of 50 fry per decimal with an initial length and weight of 3.00±0.12 cm and 0.73±0.11 gm. Monthly sampling was done to record the length and weight of sea bass to observe the growth performance. Water quality parameters were also monitored during culture period and there was no significance differences observed among the treatments. A significant difference both in length and weight were observed between the treatment T1 and T2 and also between T2 and T3, but no significant difference was found between T1 and T3 ($p>0.05$). The result was demonstrated the future possibilities of sea bass aquaculture in freshwater using artificial feed.

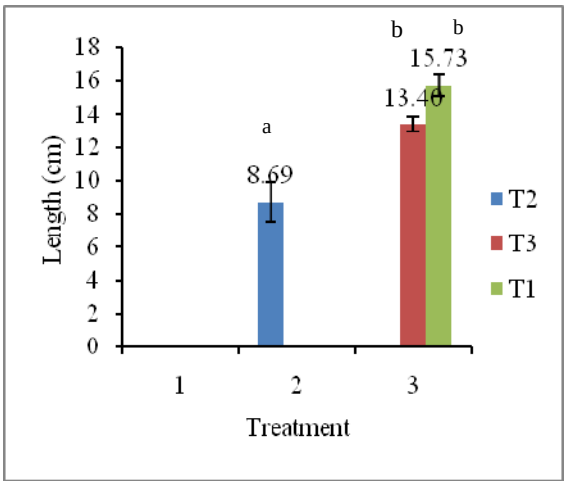

Fig. 1. Shows length of Sea Bass

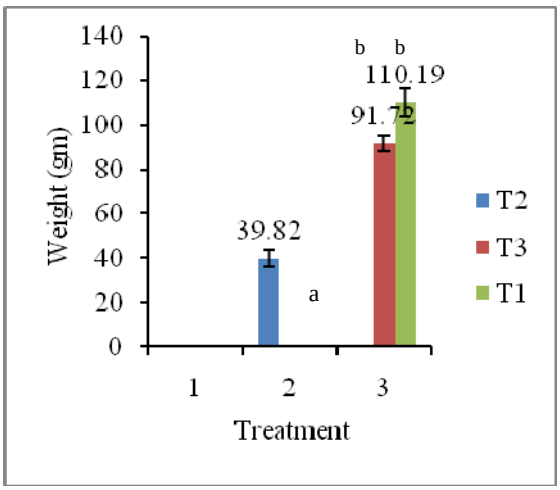

Fig. 2. Shows weight of Sea Bass

Effect of dipping time in brine on the quality of smoked silver carp (*Hypophthalmichthys molitrix*) stored at ambient and refrigeration temperature

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This experiment was conducted to evaluate the effect of dipping time in brine on the shelf-life of the hot-smoked Silver carp (*Hypophthalmichthys molitrix)* stored at ambient (23-26ºc) and refrigeration (4 ºC) temperature. The fish in two treatments named A and B were salt-dipped for 15 and 30 minutes respectively in a saturated brine solution (25% NaCl). The fish were then smoked at 75ºC in an improved traditional smoking kiln followed by cooling. After sealing in polythene bags the smoked products were stored separately at ambient (23-26 ºC) and refrigeration (4 ºC) temperature. Four major analysis and microbial analysis viz. sensory assessment, initial and final proximate analysis, chemical analysis and microbial analysis were carried out from the samples. According to sensory assessment the 30 minutes brine dipped smoked fish kept at ambient temperature (23-26 ºC) should a higher shelf-life of four days. On 5th day, appearance of fungus on the product of treatment B confirmed its acceptability up to 4 days. Similarly the sample of two treatments A and B stored at refrigeration temperatures (4 ºC) showed a longer shelf-life of up to 41 and 48 days respectively. The rate lipid deterioration and protein breakdown were found gradual and not significant. In all cases ash content increase slightly. No appreciable changes in proximate composition in two treatments during storage condition were observed. Values of TVB-N in the sample kept at ambient temperature (23-26ºC) showed more rapid increase to 34.65/100g on 4th day of observation in contrast to 35.95 mg/100g on 49th day in fish kept at refrigeration temperature (4ºC). However, 30 minutes brine-dipped hot-smoked Silver carp (treatment B) maintained its excellent quality up to 14 days of storage, and continued as acceptable for 41 days and was just to satisfactory level for 48 days under refrigerated (4 ºC) condition.

Organoleptic and bio-chemical changes of tilapia (*Oreochromis mossambicus*) stored in ice and at ambient temperature

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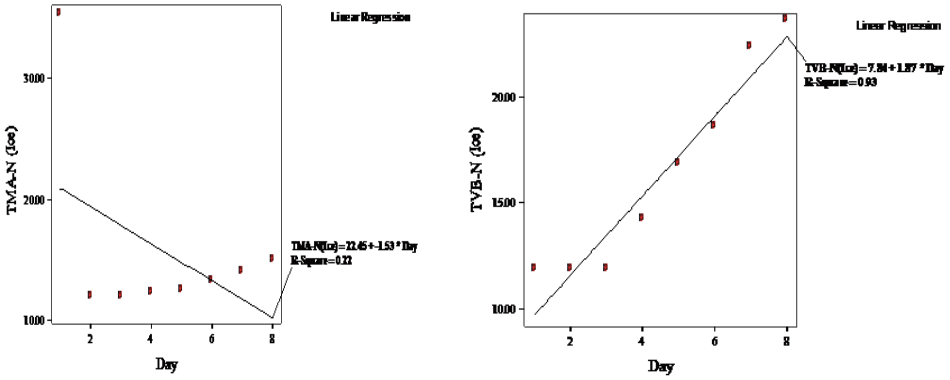
A study was carried out to evaluate the organoleptic and bio-chemical changes of Tilapia (*Oreochromis mossambicus)* stored in ice for a period of 8 days and at ambient temperature for a period of 24 hours. Fish samples were collected from a local fish farm and were kept in insulated boxes with crushed ice at a ratio of 2:1 and in plastic tray at ambient temperature. In ice condition, the value of total volatile base nitrogen (TVB-N), trimethyle amine nitrogen (TMA-N), and pH were ranged between 11.73 to 23.46 mg/100 g, 35.18 to 14.73 mg/100 g and 6.1 to 7.5, respectively. At ambient temperature TVB-N, TMA-N and pH values were 35.34 to 117.82 mg/100 g, 11.78 to 47 mg/100 g and 6.2 to 7.4, respectively during the period of 0-24th hrs storage where the figures reached just unacceptable limit during 18th hrs storage and that time TVB-N, TMA-N and pH values were 58.46 mg/100g, 12.23 mg/100g and 7.2, respectively.

Fig. 1. Changes of TVB-N and TMA-N content in *O. mossambicus* stored in ice



The results revealed that all values increased as spoilage advanced. The TVB and TMA contents obtained increased gradually under both storage conditions but on 2nd and 3rd days, the TVB and TMA values were found as same in iced storage condition. All values determined were correlated with storage time under both storage conditions. Significant statistical differences between storage time and values obtained were observed under both storage conditions. The value of TVB-N and pH were also found as an indicator for freshness/ spoilage indicator. The comparative study indicated that fish spoiled faster at ambient temperature than in ice storage condition.

Determination of formaldehyde by spectrophotometric method in some important freshwater and marine fishes

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The present study was conducted to evaluate the formaldehyde content in some important freshwater and marine fishes spectrophotometrically using Nash reagent in conjunction with TCA extraction. The freshwater fish and marine fish from markets and from freshly caught samples were evaluated for determination of formaldehyde conc. Formaldehyde conc. obtained in fishes from three different wet markets of Mymensingh Sadar ranged between 1.4 and 7.35 µg/g. On the other hand, formaldehyde conc. in fresh fishes- rohu, tilapia and Thai koi collected from ponds of Freshwater Station, BFRI, Mymensingh showed natural formaldehyde in their muscle having values of 1.45; 1.85 and 2.60 µg/g respectively. The marine fish *viz.* loyitta and chhuri collected from the landing center of BFDC at Cox's Bazar and investigation in frozen condition showed to contain naturally occurring formaldehyde as 3.9 and 1.55 µg/g, respectively. Spectrophotometrically determination of formaldehyde conc. showed highest value of 7.35 µg/g in market sample of kachki, and naturally occurring formaldehyde conc. showed higher conc. of 2.6 µg/g in Thai koi from freshwater and 3.9 µg/g in loyitta fish from marine source. Hence the present study suggested that fish from wet market contained a certain amount of formaldehyde and fishes from both freshwater and marine sources shows to contain natural occurring formaldehyde in their muscle at different conc. Further study needs to be done to highlight this thing more elaborately.

Fishery resources assemblage and management in the river Titas of Brahmanbaria, Bangladesh

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This paper presents the results of analysis of the fish assemblages in the river Titas of Brahmanbaria district in Bangladesh. Catch monitoring data from January 1997 to December 2000 covering 47 months were utilized for community structure analysis using TWINSPAN (Two-way Indicator Species Analysis) and DCA (Detrended Correspondence Analysis) techniques. Both techniques separate the monsoon from dry season. During monsoon 34 number of species contributed 41% of the production and the most dominant species were Jatputi (*P. sophora*), Kaikla (*X. cancila*), Gol chanda (*C. nama*), Foli (*N. notopterus*) Meni (*N. nandus*) and Boal (*W. attu*). During dry season 24 number of species contributed 51% of the production and dominant species were Ruhu (*L. rohita*), Bajari tengra (*M. tengara*), Gura Icha (*N. tenuipes*), Chapila (*G. chapra*), Tara biam (*M. aculeatus*) and Kackhi (*C. soborna*). Kachki the highest contributed species followed by Jatputi and Chapila contributed 12.95%, 11.44% and 11.02% respectively of the total overall catch in the river. In DCA plot major species within group 'A' were Kackhi (*C. soborna*), Jatputi (*P. sophora*), Chapila (*G. chapra*), Gura Icha (*N. tenuipes*), Gol chanda (*C. nama*), Kaikla (*X. cancila*), Bajari tengra (*M. tengara*) and Tara biam (*M. aculeatus*). Similarly and major species within group 'B' were Ruhu (*L. rohita*), Meni (*N. nandus*), Boal (*W. attu*) and Foli (*N. notopterus*). Species in cluster group 'A' contributed 82.22% and in cluster group 'B' contributed 17.71% of total abundance in the river.

Fish in complementary feeding among children aged 6-24 months in the households participating in a "Fish and Nutrition" intervention in Dinajpur, Rangpur and Sumanganj

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The IFAD funded "Fish and Nutrition" project was implemented among 1,500 small-scale, poor farming households in northwest Bangladesh (Dinajpur and Rangpur) and 500 fishers households in the *Haor* basin (Sunamganj) in northeast Bangladesh during 2011-2013. Complementary feeding practices with low food diversity and late introduction are major causes of childhood malnutrition in developing countries, including Bangladesh. Inappropriate and inadequate complementary foods are low in animal-source foods and micronutrients - vitamins and minerals. Fish is an important animal-source food which can supply animal protein as well it is a good source of various micronutrients such as vitamin A, iron, iodine, zinc, calcium and essential fatty acids. As part of the above project, complementary feeding practices among children 6-24 months were evaluated following the quantitative and qualitative research methodologies. The study focused on the provision of fish and perceptions of adding fish to the diet of young children. A questionnaire was developed and administered to mothers of children of 6-24 months, in 60 households. Among the study population, 57% of mothers started giving their children complementary foods at 7 months of age, and 45% of children were given fish at this age. Both small and large fish were given in the same amount, 19 g/child/meal. Among the respondents 73% mothers thought that large fish was most suitable to give a child whereas 26% mothers thought that small fish also suitable. Nearly two third of the respondents (68%) gave large fish to young child and 32% respondents gave small fish. Most of the respondents (88%) were found to prepare fish in the same way for the young child as to the rest of the family. Most mothers were found to serve fried fish and fish curry with vegetables to young children. Although fish was fed to many young children in the study sites, some misconceptions about including fish in a child's diet were reported. Mothers commonly believed that fish was not able to be digested by young children and would cause worms and diarrhea. In some Hindu households (10%), mother introduced fish to their child only after 1 year. Mother- in -law and other older family members prevented from giving fish to young child and they believed that if the children are given fish before 1 year, the child will have a larger appetite when they grow up. It was also perceived that among Muslim families that should not give fish, and in particular small fish to mothers for 40 days post-partum and they perceive that the bones of fish will go through mother's breast milk to child's belly and cause illness. Inclusion of fish in complementary feeding of young children can increase the intake of animal protein and may aid in meeting micronutrient requirements. Behaviour change communication regarding complementary feeding and nutrition education to raise awareness and understanding of the importance of fish in complementary feeding are key elements to be included in interventions of promoting fish production and fish consumption in order to improve nutritional status and combat malnutrition among young children.

Fisheries diploma education by Department of Fisheries

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Fisheries Diploma Institute under Chandpur Fisheries Training Institute was established in 2008, under a project named 'Fisheries Diploma Course Implementation Project'. Organizations like BFRI, BFDC, Nationalized banks, private sector, different GOs and NGOs now can easily utilize and appoint skilled manpower – the fisheries diploma holders to develop fisheries sector. If it is possible to provide skilled manpower, total production of fish sector of the country would be increased both qualitatively and quantitatively. There also have scopes to export the skilled and trained manpower in the international labor market. The Department of Fisheries, under a project, established Fisheries Diploma Institute in Chandpur with the objectives of producing skilled technical manpower for fisheries sector (Government and Non-governmental organizations) through offering Fisheries Diploma Course**.** To date, construction academic buildings and boy's and Girl's hostels have been completed. According to the curriculum of Bangladesh Technical Education Board (BTEB), there is a provision of 54 text books and 4 syllabi under the Fisheries Diploma Courses. The books and syllabus have been formulated and printed. There have been series of workshops/ seminar on fisheries diploma course and curriculum, and on the mode of teaching and learning under the. Stipend of Taka 750 (seven hundred fifty) per month for each student and Honorarium of guest lecturer have been provided during the course period. An organogram of 39 manpower (Principal, senior instructor, Instructor, computer operator and other employees) is waiting for the approval of Ministry of Finance for this diploma institute.

Table 1. Name of the departments and subjects of the Fisheries Diploma course

Name of Departments	Name of Subjects
Fisheries Biology & Genetics	Aquatic Ecology, Ichthyology, Fish Physiology, Genetics & Breeding
Aquaculture	Closed-water Aquaculture, Open-water Aquaculture, Integrated Fish Farming, Shrimp Farming
	Fish Disease & Parasitology (Part I & Part II), Fish Feed & Nutrition (Part I & Part II)
Fisheries Management	Fisheries Resources & Prospects, Aquatic Bio-diversity Conservation & Management, Fresh-water Ecology, Physico-chemical Limnology, Biological Limnology
	Nursery Management, Fish Hatchery Management, Shrimp Hatchery Management
	Marine Fisheries Resources, Fisheries Resources Management & Planning,
Fisheries Technology	Fisheries Microbiology (Part I & Part II), Fish & Fish By-products, Fish Harvesting, Handling & Preservation, Fish Processing, Fish Inspection & Quality Control
Fisheries Extension & Environment	Fisheries Extension, Fisheries Economics, Husbandry of Domestic Birds, Homestead Gardening
	Soil & Soil Management, Environmental Science
Basic Science	Mathematics (Part I & Part II), Physics, Chemistry (Part I & Part II)
Arts & Social Science	Bengali, English (Part I & Part II)
	Physical Science
	Biometry & Statistics, Self-employment & Entrepreneurship Development
	Marketing & Cooperatives, Accounting
Computer Science & Aquaculture Engineering	Computer Applications (Part I & Part II)
	Aquaculture Engineering (Part I & Part II)

Internship programme for growing fisheries graduates in Bangladesh: the need of time

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Bangladesh is predominantly characterized by higher population density (1250/km^2), higher proportion (90%) of small and marginal landholdings (<1ha), indiscriminate loss of arable lands (1% per year), higher level of agricultural dependency, surplus rural labour, rice-fish based diet, food insecurity and increasing threats of climate change. Moreover, due to lack of mineral resources, heavy industrial development avoiding external input dependency would not be possible. Therefore, agricultural economy ranging from rural household food security to industrial food processing and trade is critical for sustainable development. In this context, the production of skilled graduates is the major challenge of the universities offering agricultural education. Over the last few years, government initiated agricultural education at primary and secondary level. Earlier at the tertiary level, agricultural education was only given by the Bangladesh Agricultural University (BAU), later a number of public universities started offering it. The major institutional change of behaviour is to adopt Fisheries discipline by 50% of the total public universities (32). Currently apart from BAU, 3 agricultural (SAU, SAU & BSMRAU), 5 science & technology (HSTU, PSTU, JSTU, MBSTU & NSTU) 4 general, 1 veterinary university, and 1 BAU affiliated college are offering Fisheries education. The massive uptake of Fisheries discipline by the number of public universities occurred in the last decade (Table 1) without any need assessment by the central authority (e.g. UGC). This reflects the questions of poor quality issues of teaching and a large number (approx. 1000) of graduates being produced per year. This is mainly because of poor laboratory facilities available for practical classes which is an intrinsic technical part of agricultural education. The available practical facilities are inadequate to make the students understood about the real world problems. Aquaculture (being perceived as an embedded part of Fisheries in Bangladesh) is the fastest growing food producing sector globally and locally, demanding skilled manpower which is not possible in university campus. Therefore realizing this gap, as with other disciplines, internship of Fisheries and Aquaculture is increasingly being adopted by several universities in Asia and Europe. Generally, internship consists of the exchange of services for experience between the student and organization which might be work experience or research internship; and paid or non-paid internship. The Faculty of Fisheries (FoF), BAU experienced a pilot of aqua-internship that supported post-graduate students of European and Asian institutions working with Aquaculture and Fisheries industries in Asia. Some agricultural disciplines, Veterinary Science and Animal Husbandry (e.g. in BAU) already adopted compulsory internship programs for the students. However, its all impacts regarding improved skills of the graduates and on the hosting organizations were not assessed. The FoF, BAU adopted new course-curricula adopting internship at the undergraduate level which is necessary for other universities as well. However, its need proper design, funding support, hosting support, implementation process, harmonization with other local and international universities/intuitions are the critical issues.

Local Knowledge Centre (*Gyaner Haat*): experience of Practical Action on operational model

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De-centralsied knowledge service is vital for empowering the knowledge deprived poor people. Aiming to create diverse entities for de-centralsied knowledge service, Practical Action Bangladesh promotes grass root Knowledge Centre in various locations called *Gyaner Haat*. Based on its experience on working with rural technology extensionist for 10 years, rural ICT or technology centre for 4-5 years and managing farmers technical inquiry service for many years Practical Action adapted a model of grass root knowledge centre attached with NGO, Union Council and high school over last 3 years. This paper describes experiences on operational model of knowledge centre from 2-3 Practical Action projects and one on going action research.

With varied start up investment cost from Taka 200,000 (around US$ 2,500) to Taka 1,000,000 (US$ 12,820) a centre can run by its own if it earns Taka 10,000-15,000 per month. One of the unique character of the centre is its local expert pool of around 20 self-employed rural technology extensionists linked with one self-employed knowledge entrepreneurs having one assistant in each centre for local knowledge service. They are govern by a local multi-stakeholder committee and are well connected with Govt., other NGOs and Practical Action's experts. The centre served range of farm and non-farm technology booklets, leaflets, CDs and fact sheets of local problem solving answers to its clients. The center is also well-equipped with internet resources, connected with the Bengali website (http://www.practicalaction.org) and other similar websites. The operational model does not require project based support and in the long run can run independently following a cost recovery method and local institutional support. It was recorded that each *Gyaner Haat* responded around 1,800 enquires per year, reached around 2,500 households covering 15 villages. Services at the centre such as computer compose & training, digital photo printing, knowledge material distribution, audio-visual show, distribution of various Govt. forms, photocopy was found useful. However, slow internet connectivity, poor electricity supply were the key constraints.

The *Gyaner Haat* was capable to serve mostly low and medium well-being category people. However, the approach didn't completely exclude the richer. Finally it was learnt how knowledge worked for its clients. It was found that only advice has less to do with the knowledge seekers as there is scarcity of necessary inputs and lack of skill and services to act. Therefore, an effective working model combining with advice (information, knowledge), input (e.g. quality seed, vaccine) and service (pushing vaccine, animal treatment) made a big difference in knowledge services. Sustainability of such centre lies with the capacity of local drivers, suitable legal and institutional arrangement and local ownership of the centre. Subsidy may require running such centre in very remote locations.

Fisheries education style at University level: Global vs Bangladesh- where we stand

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Knowledge unlocks human potential and seeking education for gaining knowledge is so important to live life. The objectives of education are diverse: charting the future, bringing benefit to life, building character and career, and meeting challenges of today and tomorrow. The fisheries education systems, along with other disciplines have got various styles at the university level in different parts of the world. The aim of this report is to compare the mode of fisheries education style in different universities of the world with that in Bangladesh. The education styles of five universities, including one from Bangladesh were studied. Questionnaire survey and personal communication were performed for gathering the required information on education system emphasizing teaching and learning methods. Distinct differences in styles were observed in different universities teaching fisheries at undergraduate and graduate entries. Comments have been made on semester structures, how national cultures shape each academic calendar, learning methods, student behavior, available resources, examinations and student evaluation, blind marking systems, external review committees to assess standards, and employment opportunities. The survey findings could help teaching staff and fisheries students with upgrading the semester curricula of different universities of Bangladesh and to update them with advanced teaching and learning techniques.

Fisheries education in Bangladesh in school and colleges: How to make it more practical oriented

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In Bangladesh, the school and colleges have 12 years of educational year, starting from January to end at December each year. The level of education is characterized in to primary (class 1-5), high school (class 6-8), school secondary (class 9-10) and the higher secondary (class 11-12) level. The National Curriculum and Textbook Board (NCTB), Dhaka is the sole authority to create the curriculum by experts and to execute in the matter of furnishing books for the students. For almost a decade the government is providing books for free from primary to secondary school level. For colleges (class 11-12) books were written by outsourced authors with the guidelines from NCTB. The fish or fisheries are totally absent from primary education. At present fish and fisheries are represented only under the subject agriculture. The subject is available from class six and above, but as optional. That is why many students may not be aware of the fisheries education at all. Even though, a few chapters on fish and fish culture sporadically present in different classes or levels. Fish as a natural resources, conservation and nutritional security perceptions need to be added. The present paper deals with the present status of fisheries education in school and colleges in Bangladesh and proposes possible modifications need to be made for the school and college students to make it more practical oriented.

Fisheries education in Bangladesh: A comparative assessment of the graduate curricula and courses followed and necessity for improvement

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Fishery is now a rapidly expanding program of education in Bangladesh. The first-ever formal Fisheries education in this part of the world was started in 1957-58 under Zoology discipline in Dhaka University, however, the real breakthrough in fisheries education occurred with the opening of the first-ever Faculty of Fisheries in the subcontinent at the then East Pakistan Agricultural University, Mymensingh, now the Bangladesh Agricultural University. The education in the form of four year B.Sc. Fisheries (Honors) is now being followed in 12 out of the 35 public universities and a private college in the country with annual turnover of about 700 graduates. As obvious the curricula and courses are being provided in four major fisheries heads *viz*., biology, aquaculture, management and post-harvest technology and the minor/extra head comprising different relevant subjects. A comparative analysis has been made on the credit loads distribution of the subjects under these different major and minor heads of 11 of these universities. There has been a wide ranging variability in the credit load distribution in the major heads of subject of the universities. This has been due both to variation in the number of subjects included and the amount of credit assignment in the respective subjects. There was heterogeneity in the institutional nomenclature; number of departments operated, the degree given and the system of the academic programs run in the universities. There were variations in the distribution of the courses in different levels of the graduation program; so also were there variation in the number of courses included in the different major heads. The percentage distribution of credit loads in biology, aquaculture, management and post-harvest technology were ranged from 15-40, 11-72, 20-35 and 0.05-27 respectively in the universities. A wide range of variation was also there in the distribution of the courses into theory and practical; the range of the ratios of theory and practical were seen to exist between 2:1 – 5:1. Other than the subjects of fisheries under the different major heads, it was also interesting to see for the subjects included in the minor/extra head. The subjects taught under the minor head of the graduation program actually provide a base for professionalism of the graduates produced but painful was that there also were seen to exist a wide variations between the universities in the number and kind of subjects included. In the minor head the percentages of credit loads were seen vary from 14-51 in the different universities. Curricula and courses followed are not the only indices of a valued education; trained manpower and improved physical facilities are but the prime determinants. Some amount of variability in the program with respect to all the indices can be there, however, to a large extend, a sustained fisheries education and development in country like ours would entail a homogeneous curricula and courses and to bring a homogeneity in the program it needs concerted efforts by the acting universities.

Nutrient film technique: a potential aquaponics system for fish and vegetable production

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A new and innovative fish and vegetable production system 'nutrient film technique' of aquaponics has tested to produce water spinach at BAU first time in the country to address food safety and security. Four inch diameter three 6 ft long plastic pipes joint together with seven holes in each pipe. Healthy water spinach sapling was planted in brick lets in a perforated plastic glass and placed in the holes. Three treatments were used with seven replications. Treatment T_1 sprayed with molasses, treatment T_2 sprayed with compost tea and treatment T_3 with no spray as control. Tilapia used as the test animal in the study. Fish tank waste water was irrigated using a 12 watt submersible pump and tank water was aerated with air pump and stones. The water passed through the pipe and denitrifying bacteria converted nitrogenous compound to nitrites and then nitrates which used by plants as food and clean water returned to the fish tank. Plant and fish growth was monitored fortnightly; evaporated and lost water was replaced with supply water. The data analysis showed that the T_2 performed best followed by compost tea (T_1) and control (T_3). Fish and water spinach production were 133.13 and 171,901tons/ha/105 days respectively. Water quality parameters such as pH and temperature were within the permissible limit but dissolved oxygen was bit lower than the standard level. The system can be well incorporated in urban and peri urban agriculture to increase fish and vegetable production from barren land and enhance food safety and security.

Fig.1. Demonstrated nutrient film technique of aquaponics water spinach production

Artificial breeding of the Indian Bullfrog (*Hoplobatrachustigerinus*): A case study on reproduction and conservation

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We attempted artificial breeding of an endangered Indian Bullfrog, *Hoplobatrachustigerinus*, in the laboratory using specimens collected from the field in Bangladesh. A total of 10,332 eggs were obtained from two females and fertilized with the sperm of one male. The developmental stages of *H. tigerinus*were observed at a water temperature of 23 °C. The results showed that the first cleavage started around 80 min after fertilization. The tail bud was observed at 24 h and hatching at 48 h after fertilization. The tadpoles were fed boiled smashed spinach from day 5 after fertilization. They were then reared for around 2 weeks in Petri dishes in an incubator before being transferred to concrete tanks in a green house. Metamorphosis started around day 42 after fertilization. Of the total eggs, 89% cleaved normally, 70% attained the tail-bud stage, 56% hatched normally, and 46% developed into normal feeding tadpoles. Finally, however, only 10% of the total eggs metamorphosed normally. A strong cannibalistic nature was observed among the tadpoles, which led to a reduced metamorphosis rate. In addition, an unidentified fungal infection and lower water temperatures due to the strong winter also contributed to the reduced rate of metamorphosis. The fecundity of *H. tigerinus* was excellent, but the mass production of *H. tigerinus* specimens failed. To ensure mass production and conservation of *H. tigerinus* in future experiments, we recommend strict regulation of water temperature in all stages preceding metamorphosis.

Chemical hazard in fishes of Bangladesh: a food safety issue in local and global market

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Bangladesh is one of the highly dense populated (160 million), developing and agricultural based country in the world. The daily food menu for the Bangladeshi people is rice and fish for which they known '*Mache–Vate Bengali*' in English '*The Nation who lives on Rice-Fish'*. Additionally, the processed fish and fishery products are the second largest exportable item which contributing to the national gross domestic production (GDP) and earning a lot of foreign currency. However, the main problem now in Bangladesh is most of the foods i.e fishes, vegetables and fruits are adulterated by chemicals at different steps from farm to consume. Among the agricultural food items fishes are highly risk of chemical hazard in both local and global market. In fish, locally formalin is used in domestic fish marketing chain as preservative to extend the shelf life of fish, and different chemicals are used in fish/shrimp feed and farm as an antibiotics or antimicrobial agent. Extremely harmful formalin is used to preserve fish that totally damage the nutritional values of the fish especially protein. Beside these, Bangladesh is also losing the international export market by rejection of processed shrimp/fish consignment and banned of export to EU countries/foreign buyers due to the presence of nitrofuran and chlorphenichol compounds. These chemicals are reported as carcinogenic and also caused of different incurable diseases like respiratory and neurological problems, liver cirrhosis, kidney, lung, allergy, asthma and other health hazards for the consumers. In spite of legislation and international standard enforcement initiatives accomplished by the government still it is a challenging issue for public health, food safety and improvement of national economy by earning foreign currency. Therefore, the different chemical hazard in fish of Bangladesh and its effects on consumer is an emerging food safety issue on local and global market.

Productivity of water for boro rice crop production: study on floodplain beels in Rajshahi, Bangladesh

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Water productivity is considered as an important indicator of agricultural productivity because of the scarcity of freshwater. More yield or output against same or less amount of water has become the global interest. This study measures the productivity of water on the floodplain land in terms of Boro rice crop cultivation for two floodplain *beels* in Bangladesh. In the floodplain area, the land used for agricultural production only in the dry season and the rest of the year it is covered by flood water. For this study, the production and market price data were collected by direct observation based on 30 samples in the year 2006-07. This study found gross water productivity of rice yield as 0.47kg m^{-3} in beel Mail and 0.43kg m^{-3} in *beel*Chandpur. In monetary value, water productivity per cubic meter irrigation water were TK 5.65, TK 3.42 and TK 2.64 based on gross return, net return considering cash costs and net return considering full costs in *beel* Mail. In *beel*Chandpur these values were TK 5.19m^{-3}, TK 2.87m^{-3} and TK 2.14m^{-3}, respectively. The usage of average irrigated water in the *boro* rice farms were estimated 10730.05m^{-3} and 11236m^{-3} with an average production of yield 4992.95kg and 4783.20kg in *beel* Mail and *beel*Chandpur. Statistical result shows that keeping irrigation water constant, a 1% increase of *boro* rice yield will increase water productivity at 0.916% in *beel* Mail and 0.972% in *beel*Chandpur. The water productivity in *beel* Mail was 4.65% higher than *beel*Chandpur due to the intervention of community based fish culture management. The findings of this study will help to govern and improve production by proper utilizing floodplain lands.

Status of water quality parameters from the Padmariver near Bheramaraupazila of Kushtia in Bangladesh and its impact on aquatic environment

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The study was conducted to investigate the status of water quality parameters in the Padmariver and its temporal changes over pre-monsoon, monsoon and post-monsoon seasons as affected by physicochemical factors during the period of eight months from April to November 2013. The water samples were collected for laboratory analysis from five different stations as station-1 (Hardinge bridge), station-2 (Ferrighat), station-3 (Pump house ghat), station-4 (Baromileghat), and station-5 (Majharghat) during pre-monsoon (April to May), monsoon (June to September) and post-monsoon (October to November) seasons, respectively from of the Padma river near Bheramaraupazila of Kustia district. The physicochemical parameters as transparency, temperature, electrical conductivity (EC), pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), total dissolved solid (TDS), alkalinity and total hardness were determined with the help of Secchi disc, Thermometer, EC meter, pH meter, DO meter, Titration method, TDS meter, Titration and EDTA Titration methods, respectively in the Laboratory of the Department of Environmental Science and Resource Management, MawlanaBhashani Science and Technology University, Tangail-1902, Bangladesh.

The result of the study showed that water transparency (43.6cm) of the river exceeded the standard level during the pre-monsoon season in all stations. The water temperature (31.5 ^{o}C) was slightly higher than the standard level i.e. slightly warmer during the monsoon season, where the electrical conductivity (233 µS/cm) and total hardness (70.7 mg/l) were lower than the standard level during all the seasons in all stations. This could be due to lack of sufficient water in the river during all the seasons, over exploitation of fisheries resources, riverbank erosion and human activities like faulty agricultural activities near and adjacent to the bank of the river. The result of the study also investigated that the level of pH (7.6), DO concentration (7.2 mg/l), BOD (2.4 mg/l), TDS (146 mg/l) and alkalinity (168 mg/l) were within the standard limit as well as suitable for aquatic lives and environment. The study showed that most of the water quality parameters of the river were suitable for aquaculture and openwater fisheries management. Therefore, the ecosystem of the river and the surrounding wetlands need to monitor though proper management as well as to improve the quality of water for aquatic lives.

Socioeconomic constraints for natural resource management atTanguarhaor in Sunamgonj district of Bangladesh

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Bangladesh is a gift of nature consists of low-lying deltaic plains which formed by the confluence of Ganges-Brahmaputra-Meghna rivers and their tributaries. The tropical monsoon climate has made it a unique hydro-ecological characteristic that provides various habitat for aquatic and terrestrial biodiversity and recognized it biologically hot-spot zone in the world. It possesses enormous area of wetlands including rivers and streams, freshwater lakes and marshes, haors, baors, beels, water storage reservoirs, fish ponds, flooded cultivable fields and estuarine systems with extensive mangrove swamps. The total area of these wetlands was variously estimated at between seven and eight million hectares i.e. about 50% of the total land surface. These wetlands are the homes of hundreds of different wildlife species of aquatic biodiversity. The Tanguarhaor is an unique wetland ecosystem of national and international importance and the Government of Bangladesh has declared it as an Ecologically Critical Area in 1999 due to gradually consequences of its natural resources overexploitation and degradation. The global importance of this wetland has made it to declare the second Ramsar Site of Bangladesh in 2000. The study was conducted in the Tanguarhaor to investigate the causes of natural resources degradation and management prospects for biodiversity conservation through ensuring sustainable livelihood during the period from March 2011 to February 2012. Both primary and secondary data were collected through different types of methods such as interview, observation, key informants interview, FGD, eye sight visitation, content analysis and secondary data from the study areas. The collected data were analyzed for further comments.

The study found almost 50% of the people were hard poor and basically fishing (30.1%) was the principal occupation and other major professions were farmer (12.9%), livestock (8.6%) and business (8.6%). The poverty were leading for poor health and sanitation as a result of more than half of total population was used to paved (48.5%) and hanging (22.6%) latrine as well as shallow tube-well (74.2%) where rest of people (17.2%) drink river or haor water. Local communities were dependent on three major resources of Tanguarhaor namely fisheries (58.1%), forestry (24.7%) and land (11.8%). Forest was provided daily fuel to half portion (50.5%) of the haor household because of their using grasses and branches of Hijal and Karos (30.1%) for cooking. The pesticides (35.5%), hanging latrine (35.5%), burned oil (17.2%) and coal washing (11.8%) were the main causes for environmental degradation in the haor area that was adversely affecting the socio-economic status (66.7%), health problems (29.0%) and environmental disturbance (4.3%). Flashflood is a common phenomenon in this area occurring for excessive rainfall (52.7%) and climate change (8.6%). Consequently, agriculture (54.8%), damage of home (32.3%), diseases of livestock (10.8%) and health problems (2.2%) regularly hurting haor's people and suffering from diseases like diarrhea (38.7%), cholera (31.2%), typhoid (17.2%) and fever and cold (12.9%) during the flood (54.8%), after flood (22.6%) and before flood (17.2%). Tanguarhaor has great ecological and socio-economic importance and this research will help to ensure sustainable management of the haor.

Snakehead murrel (*Channastraita*) breeding and intensification of its culture techniques for the fish farmer and unemployed youths

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The snakehead murrel (locally called, shoal) *Channastriata*(Bloch, 1793) is one among the highly priced freshwater air breathing fish species in Bangladesh. An experiment was conducted on the induced breeding of the snakehead Murrel, *C.striata*during April to June 2013 in a backyard hatchery building located in the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, Bangladesh. The present study explicated the embryonic and larval development of snakehead *C.striata*from fertilization until metamorphosis. The snakehead was successfully bred in the laboratory with the treatment of injecting synthetic hormones ovaprim (0.5 ml/kg body weight), SGnRH (0.4ml/kg body weight) and Luteinizing hormone releasing hormone analogue (LHRHa+Pimozide 50µg+5mg).When compared to the LHRHap and ovaprim, the latency period was long in SGnRH(26-29h) treated fish. In the SGnRHinjected *C. striata,* the percentage of fertilization was the lowest (68-73%) followed by LHRHap (75-81%) and ovaprim (91-98%).The fertilized eggs were floating, non-adhesive and straw yellow in color. The average diameter of fertilized eggs ranged from 1.20-1.45 mm. In terms of fertilization (91-98%) and hatching, ovaprim yielded better results. The captive bred larvae was supervised to evaluate the growth and survival of larvae of this species fed with different feed *viz.* zooplankton, fish paste and commercial fish feed for 21 days. The study revealed that significantly higher survival rate (73%) was recorded in zooplankton fed groups followed by fish paste (65%) and commercial fish feed (61%), respectively. Significantly the specific growth rate (SGR) was higher in larvae fed on zooplankton (5.82 %) followed by fish paste (5.41%), whereas minimum SGR (5.22%) was observed in commercial fish feed fed groups. Similarly highest percentage weight gain (1,567.65 %) was also observed in zooplankton fed groups and least performance recorded in commercial fish feed fed groups. The present study showed that early larvae of *C. striata*could be reared in captive conditions for attaining higher growth and survival.The overall breeding performances of *C. striata*were found to be satisfactory for the commercial production of this fish in Bangladesh.

Effect of bamboo charcoal and bamboo vinegar added feed on nitrogenous waste and growth of Vietnam koi (*Anabas testudineus*)

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Climbing perch (*Anabas testudineus*), locally called 'koi' is a delicious, high quality meat species. This species with accessory respiratory organs could be farmed at high stocking density and in relatively poor water quality. The native fish of this species is slow growing and less available. Recently *A. testudineus* of Vietnam has been introduced to Bangladesh for the increase of production. Bamboo charcoal (BC) is known as a universal adsorbent and has been drawing more and more attention for its numerous benefits as an environment friendly natural substance. For raising animals, adding BC powder into feed or drinking water can control foul odors in land animal farms. Our research work was undertaken in 12 glass aquaria (average capacity 40L) for 30 days. An adequate level of dissolved oxygen in each aquarium was maintained through artificial aeration during the experimental period. 20day old fry of Vietnam koi was collected from Swarnolata Agro-fisheries. Two fish per liter stocking density and three aquaria were used for each treatment. Different recommended dose of BC and bamboo vinegar (BV) was mixed with a commercially available feed. Four types of feed were prepared containing 0%BC/BV, 2%BC, 2%BV and 1%BC+1%BV. Fish fry were fed with experimental diets twice daily in the morning at 9.00 am and in the afternoon at 5.00 pm throughout the study period. Fry of koi in each aquarium were fed daily at the rate of 10% of their body weight. Every 15 days interval fishes were sampled by using scoop net and weight of the fries were recorded. At the end of the experiment our result showed that better growth performance by feeding 2%BV and better performance of NH_3 elimination in 1%BV+1%BC.

Aquaponics: a promising technique for food safety and security in the country

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The ever increasing population is creating tremendous pressure which resulting acute shortage of land resources and hampers development of the country. Impact of climate change has worsened the situation. To overcome these problems and increase organic food from the backyard a new and innovative food production system 'aquaponics' has adopted at BAU for last three years first time in the country. Various aquaponics techniques have adopted such as floating and gravel bed system, nutrient film technique and vertical aquaponics to reduce pressure on land and produce organic food at home. Plastic bottles, pipes, bathtub, water tank, wooden rack, brick lets, gravels and coconut fibres have used as media to grow vegetables. Tilapia used as the test animal in the research. A range of vegetables have tested in the system such as, arum, long bean, lettuce, okra, egg plant, tomato, water spinach, chili, papaya, pudina etc. Fish tank waste water irrigated through the gravel media where denitrifying bacteria break down the nitrogenous compound to nitrites then nitrates which used by plants as food and clean water recycled to the fish tank. The data analysis showed that the nutrient film technique performed better than all other aquaponics system followed by gravel bed and vertical aquaponics. The floating bed system gave the least production due to befouling by algae and other periphytic organisms. However, gravel bed system is easy to handle by the aquaponics beginners. Water spinach, tomato, lettuce, pudina and okra suited well in the system. The system can be well incorporated in urban agriculture to improve public health and food safety.

Fig.1. Illustrates of tomato and harvested fish from the gravel based aquaponics system

Development of black soldier fly larvae production technique alternative to fishmeal for fish farming

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Aquaculture has become one of the promising agricultural sub sectors in the country. However, fishmeal scarcity, price hick and adulterated feed have made the sector vulnerable and degraded the aquatic environment. Concomitantly, the demand for alternative low cost protein sources by the fish feed industry has sharply increased. A technology that effectively transforms organic wastes into valuable feed is therefore a timely need. Larvae of the non-pest black soldier fly (BSF, *Hermetiaillucens* L.) may be used as fish feed to solve the problems. Concurrently, the larvae convert organic waste into high protein pre-pupae which can partially fulfill the demand in aqua-poultry feed industry. As component of a complete diet, found to support good growth in chicks, ducks, rainbow trout, channel catfish and tilapia. An attempt made to address these problems through high protein, fat and minerals containing BSF larvae rearing technique to reduce feed cost, boost up fish production and tackle environmental hazards. Special chambers have made with plastic and cemented bucket having egg lying and larvae harvesting facilities where kitchen wastes and rotten fruits and vegetables placed to attract wild BSF to lay eggs which then hatched and larvae emerged. Upon hatching the larvae consumed voraciously the putrescent wastes and reached length up to 0.75 inch in size and migrated to turn into pre-pupae. The dried BSF pre-pupae contain 42 % protein, 35 % fat and in live weight basis 44 % dry matter which can easily be stored for long periods. Adoption of BSF larvae rearing technique by farmers can remove fish and poultry feed scarcity and bring sustainability in the rural Bangladesh.

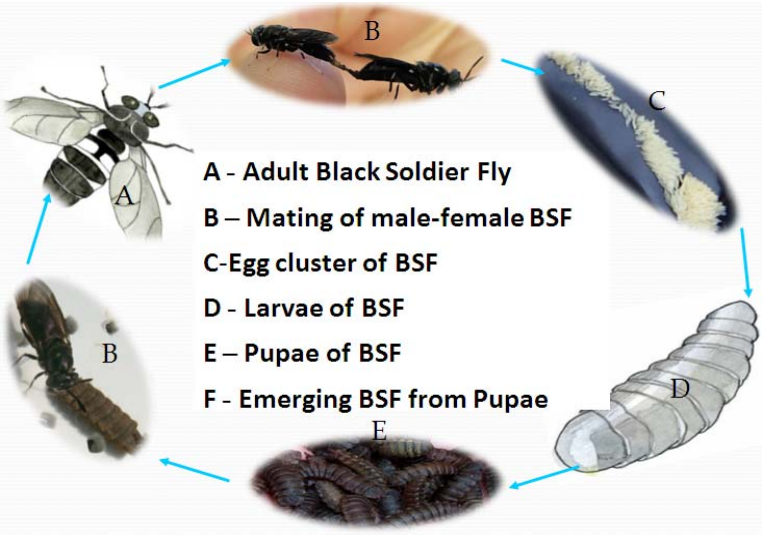

Fig. 1. Life cycle of Black Soldier Fly.

Evaluating the successes and challenges of integrating marine education Into the B.C. classroom curriculum: A seaquaria in schools case study

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For more than 12 years, Seaquaria in Schools has connected British Columbian students and educators with their local marine ecosystems through interactive aquaria containing local marine-life. Each of 35 schools hosts a unique aquarium paired with integrated lesson plans. Together, these promote experiential learning and encourage an holistic understanding of human-ecosystem interactions. Recently, the program has expanded so quickly that we find it difficult to support the diverse and dynamic needs of all of our participants. Yet these needs must be understood in order to allocate resources and offer support in an appropriate and sustainable manner. Thus, we are re-visiting the successes and challenges that teachers have experienced with the Seaquaria program, some of which prevent them from using this resource to its full potential. To that end, we have devised an interview process that includes qualitative feedback and quantitative measures of teachers' experiences and responses to this program. These are being carried out with Seaquaria educators and volunteers who work with students of a wide range of ages, abilities, and social demographics. One focus of the interview process is to consider the role that tools such as simple video technology can play in enhancing the Seaquaria experience. We are also examining case studies of schools with exceptional Seaquaria programs, to determine the common elements that have contributed to their success. In this poster, the results of these interviews and case studies will be compiled and analyzed to determine the most commonly experienced challenges and successes. These results will then be presented, discussed and evaluated in a series of participative "Think Tank" workshops, which will play a decisive role in planning how the Seaquaria program will be supported in the future.

The poster description can be found here:http://www.pacname.org/2012-AK/2012_poster.shtml