

STUDY ON BREEDING AND NURSING OF CROCODILE



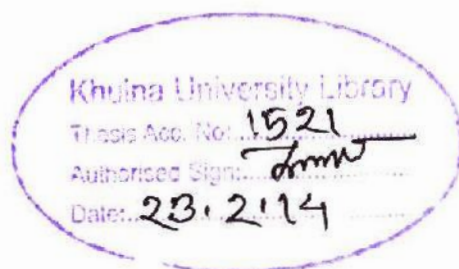
A Project Thesis

By

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Examination Roll No: MS-060613

Session: 2005-2006



**A project thesis submitted in partial fulfillment of the requirements
For the Degree of Master of Science in Fisheries and Marine Resource Technology**

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STUDY ON BREEDING AND NURSING OF CROCODILE

Approved as to style and content by



A handwritten signature in dark ink, appearing to be "A. Huq", written over a horizontal line.

Professor Dr. Khandaker Anisul Huq

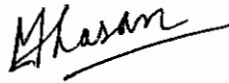
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Declaration

Study on breeding and nursing of crocodile

The results presented in the thesis with the above mentioned title are entirely of the candidate's own investigations and no part of the results has been accepted for any degree nor is it being concurrently submitted for any degree.



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DEDICATED TO

MY BELOVED PARENTS

Acknowledgement

All praises are to the Supreme Being, creator and ruler of the Universe Allah, whose mercy keeps me alive and enables me to pursue my education in Fisheries & Marine Resource Technology Discipline and to complete my project thesis for the degree of M. Sc. in Fisheries and Marine Resource Technology.

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I have received helps from my classmates, friends and junior students of Fisheries & Marine Resource Technology Discipline, Khulna University, Khulna.



Mehedee Hasan
Khulna University
August, 07

Abstract

The study on crocodile breeding and nursing was conducted in Chandpai Point of the Sundarban from 07 January, 2006 to 30 June, 2007. It was aimed to know the breeding, rearing and nursing system of a crocodile. Data was collected through field study and from the record book of Forest Department. Brood crocodile (*Crocodylus porosus*) was reared in a pond (1.7 ha.) with wide vegetated dike and pond was enclosed with 5 ft. high concrete wall. Out door cemented tanks were made for the nursing of hatchlings and yearlings. Fast growing fish species namely, tilapia, silver carp, mrigal were stocked 6 months prior of the stocking of brood crocodile. The number of brood crocodile in the pond was 8 (7 male and 1 female). Breeding season of *Crocodylus porosus* was found from March to June. Fecundity and hatching rate was depended on the age of brood. Fecundity was found 2, 18, 23, 26 and 38 at the age of 12, 13, 14, 15, 16 years, respectively. Egg hatching rate was found 0, 0, 4.30, 11.50 and 28.90 % for the age of 12, 13, 14, 15 and 16, respectively. Zero to three month aged hatchling was fed supplementary feed made of Australia. The dose of feed for the age of 1, 2, 3 and 4 years was 10, 12, 12 and 15% of the body weight, respectively and the frequency was 6, 3, 2 and 1 day/week, respectively. Hatchling growth rate was found 2.78 g/day and 16.11 g/day in first six month and next six month, respectively. Survival rate was found 76.66, 93.33, 100, and 100 % at the age of 1, 2, 3 and 4 years, respectively. The study concludes that to conserve the crocodile and also to introduce culture practice, it is necessary to improve the breeding and nursing technique.

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CHAPTER ONE

INTRODUCTION

Introduction

1.1 Background of the study

Bangladesh is fortunate enough having an extensive water resources scattered all over the country in the form of small ponds, beels, lakes, canals, rivers and estuaries covering an area of about 4.34 million hectare and enriched with diverse aquatic resources including fish, shrimp, prawn, turtle, crocodile, crab, mollusks, seaweed and others. Within the overall agro-based economy of the country, the contribution of fisheries sector has been considered to hold good promise for creating jobs, earning foreign currency and supplying protein and maintaining a steady rise in contribution to GDP. Fisheries have contributed 5.71% of the total export earning and 4.92% to GDP, about 12 million people are directly or indirectly involved in this sector. Labour employment in this sector has been increasing approximately by 3.5% annually (Matshay Pakkha, 2005). Only fish, shrimp and prawns are given priority in our country for culture but crocodile, turtle, crab, mollusks seaweeds etc are being neglected although they have greater potentials in our country.

Crocodiles are largest surviving species of the vertebrate class reptilia, and are one of the last living links with the age of the dinosaur (Bolton, 1986). Mugger crocodiles have several features that differentiate them from other crocodiles. They have the broadest snout of any member of their genus. They generally reach maturity between 1.7 and 2.6 meters between the ages of six years to ten years (Whitaker *et al.*, 1989). Like other crocodilians, this species is known to dig burrows and nest in holes.

Saltwater crocodiles are distributed throughout the coastal regions of northern Australia, from Broome in Western Australia to Rockhampton in Queensland. They are found

primarily along mangrove-lined tidal rivers (in brackish water) up to 200 km from the coast, and flood plain billabongs, creeks and freshwater swamps up to 100 km from the coast. They are found in higher densities in areas with a good food supply and abundant nesting areas, where recruitment into the population is higher. Adults can venture out to sea and swim around coastlines or between islands. Individuals have been found to travel over 1000 km by sea. *Crocodylus porosus* can also be found in substantial numbers in Papua New Guinea and Indonesia (Anon, 2007). In Bangladesh, saltwater crocodiles are reported to remain in the Sunderbans (the Ganges delta) (Cox and Rahman, 1994). Bangladesh was once an ideal country for the marsh crocodile or mugger and the other species of salt water crocodile and the gharial (Anon, 2000).

There is little chance that the fresh water crocodiles can survive in Bangladesh, unless something is done immediately. The only chance the gharial (*Gavialis gangeticus*) and marsh crocodile (*Crocodylus palustris*) have to survive in Bangladesh waters is if they are reintroduced into protected areas of quality habitat. The main problems are lack of adoption of crocodile culture, which accelerates extinction and nesting habitat destruction by human interference. There are only about two hundred salt water crocodiles left in the Sundarbans, a small population considering the capacity it could hold (Khan, 1996).

The leather and meat of crocodile have a high demand in the international market. The price of crocodile skin is about 15-20 dollar per square cm and meat is also very demandable in numerous countries as like Australia, Thailand, Malaysia, and Vietnam, Philippine, USA, Papua New Guinea, Zimbabwe etc. The price of meat is about 20 dollar per kg. Crocodile blood may yield powerful new drugs. The scientists hope to collect enough crocodile blood to isolate the powerful antibodies and eventually develop an antibiotic for use by humans.

The pattern of world trade has changed to some extent but France remains the leading importer of classic skins. Italy, Germany FR, Japan, Switzerland, Austria, Hong Kong, Singapore and the United States are also prominent importers of crocodilian skins (Hemley *et al.*, 1984)

1.2 Justification of the study

The study associated with crocodile and its farming practice in our country is very limited. Though human development has increased, the crocodile population has decreased due to degradation of habitat, dumping, siltation, industrial discharge, change of river flow, pouching and predation pressure of requit etc. Previously three crocodile species (*C. palustris*, *Crocodylus porosus* and *G. gangeticus*) were available in Bangladesh. Among them mugger and gorial are near to be extinct and salt water crocodile is strictly endangered. In this situation, to save those species, crocodile breeding and culture practice is essential for our country.

For this reason, the present study was undertaken with a view to justify the suitability of crocodile breeding and culture in Bangladesh. In spite of having some limitations, crocodile farming has huge prospects and opportunities. It can play economic role for our country besides other fisheries if we manage our natural water bodies as the breeding habitat and adopt culture technique in our country.



1.3 Objectives of the study

- To know the infrastructure of crocodile breeding and nursing farm.
- To know the rearing system of brood crocodile.
- To know the breeding, incubation, hatching and nursing system of crocodile.
- To find out the worldwide economic importance.

CHAPTER TWO

LITERATURE REVIEW

Literature Review

Britton (1995) studied on reproduction and found that during the breeding season males set up territories and the females approach the males for mating. After a fairly elaborate courtship, copulation takes place in the water. It would appear that the female is covered by more than one male. Mating starts some three months before laying, and continues up to the time of laying. The temperature in the nest is approximately 32°C. The eggs take approximately 90 days to incubate, depending on the nest temperature. The female remains near the nest, protecting it against predators. She lies on top of the nest at night and when it rains. The main predators of eggs are leopards, honey badgers, mongooses, baboons, and man.

Bustard (1974) reported that crocodile hunting was banned in India in 1972, but by that time all three species found in the country (the gharial, *Gavialis gangeticus*; the saltwater crocodile, *Crocodylus porosus*; and the mugger or marsh crocodile, *C. palustris*) were on the verge of extinction.

Whitaker (1994) studied on management of crocodilians in India and reported the mugger crocodile greatly decreased in number until the early 1970s. Killing of the species for skins was the primary cause of their decline in India. Saltwater crocodiles only remain in the northeastern coastal region, and in the Andaman Islands. A restocking program in the Bhitarkanika National Park in Orissa has been quite successful, with over 1,400 crocodiles released by 1993. Surveys in 1994 indicated at least 580 surviving individuals. This population is recovering under active management and protection.

Ortega *et al.* (1994) reported that saltwater crocodile populations and habitats are greatly reduced throughout the Philippines and no large populations are known. Remaining crocodiles appear to distribute as single individuals and small groups scattered through the remaining habitat. Particular areas of distribution include the island of Mindanao, the Liguasan swamp area, and numerous small rivers around Palawan and northeastern Luzon.

Bolton (1978) reported that swamps and wetlands cover a significant portion of the land area. In most of these areas the possibilities for economic development are limited. In many cases crocodiles constitute one of the only saleable resources. As a result, in the past, crocodiles had been exploited as a wild cash crop, which seriously depleted the resource. In addition, destruction of breeding-size animals, sale of undersized skins, poor skin preprocessing and inadequate marketing operations had combined to create a wasteful and declining industry.

Bolton (1986) in another study reported that the concept of captive rearing of crocodiles in Ethiopia is not new; the National Wildlife Conservation Organization has followed the progress of crocodile management schemes developed in other parts of the world since the early 1970s. However, uncertainty about the status of the resource and a lack of practical experience impeded the development of any significant efforts. In 1982, however, based on the clear successes of other programmes, including those discussed above and a national effort in Zimbabwe, the Government requested help from FAO in assessing wild crocodile resources and in identifying ways of deriving sustainable economic benefits from them.

Mitchell (1988) reported that by the end of 1989, four large commercial crocodile farms had been established, and several others are in various stages of development. For example, at

Dabra there are three crocodile rearing operations, one of which, P.T. Reptilindo Ekapratama, currently has nearly 4000 crocodiles. Good records and stock checks indicate that the animals are healthy and that their skins are in good condition.

Messel *et al.* (1989) studied on ecology of crocodile and found that crocodiles are typically found in brackish water in tropical estuaries, rivers and swamps. Feeding is to be done about 15-20% total body weight per month. To avoid cannibalism crocodiles are never to be kept hungry. Feeds were placed in wide plastic trays kept at several points along the marginal shallow area, which are good feeding places. The regular observation of the feeding trays helped the operator in estimating the exact feeding rate, water quality, health of croc.

Peucker *et al.* (2005) studied on range of crocodile reproduction and disease topics including nutrition, disease, genetics, animal capture, economics and extension practices.

Magnusson (1982) studied on mortality of eggs of the crocodile *Crocodylus porosus* in northern Australia and found that most mortality of eggs of *C. porosus* in northern Australia is caused by flooding. Floods are of two types, short-term caused by the interaction of rainfall and tidal movements, and long-term caused by heavy rain. The duration of inundation necessary to kill eggs in laboratory experiments is longer than that normally experienced during tidal flooding, but less than that experienced during long-term flooding. Nests beside rivers are more likely to be flooded than those in swamps. Predation by varanids and humans causes fewer losses but this is probably because floods kill eggs in most years before predators have a chance to take them. The presence of an adult crocodile at the nest appears to deter varanids. Aboriginal hunters apparently are less efficient at finding nests in swamps than nest along rivers.

CHAPTER THREE

MATERIALS & METHODS

Materials and Methods

3.1 Study area

The study was carried out in Koromjol of Chandpai Point. Koromjol is well known tourist spot of the country for wild life sanctuary. A few years ago some infrastructure development was initiated for the breeding and nursing of crocodile. At present rearing of breeding population and nursing of hatchling, yearling practice is continuing successfully.

3.1.1 Infrastructure description of farm

1) Two single stored houses were made – one for storing necessary materials and another for the accommodation of workers and technicians.

2) Major component of farm

- Breeding stock pond
- Outdoor cemented tank

3) Equipment

- Grinding machine
- Generator
- Water pumps
- Medicine
- Harvesting kit

3.2 Duration of the study

The study was conducted from 07 January, 2006 to 30 June, 2007.

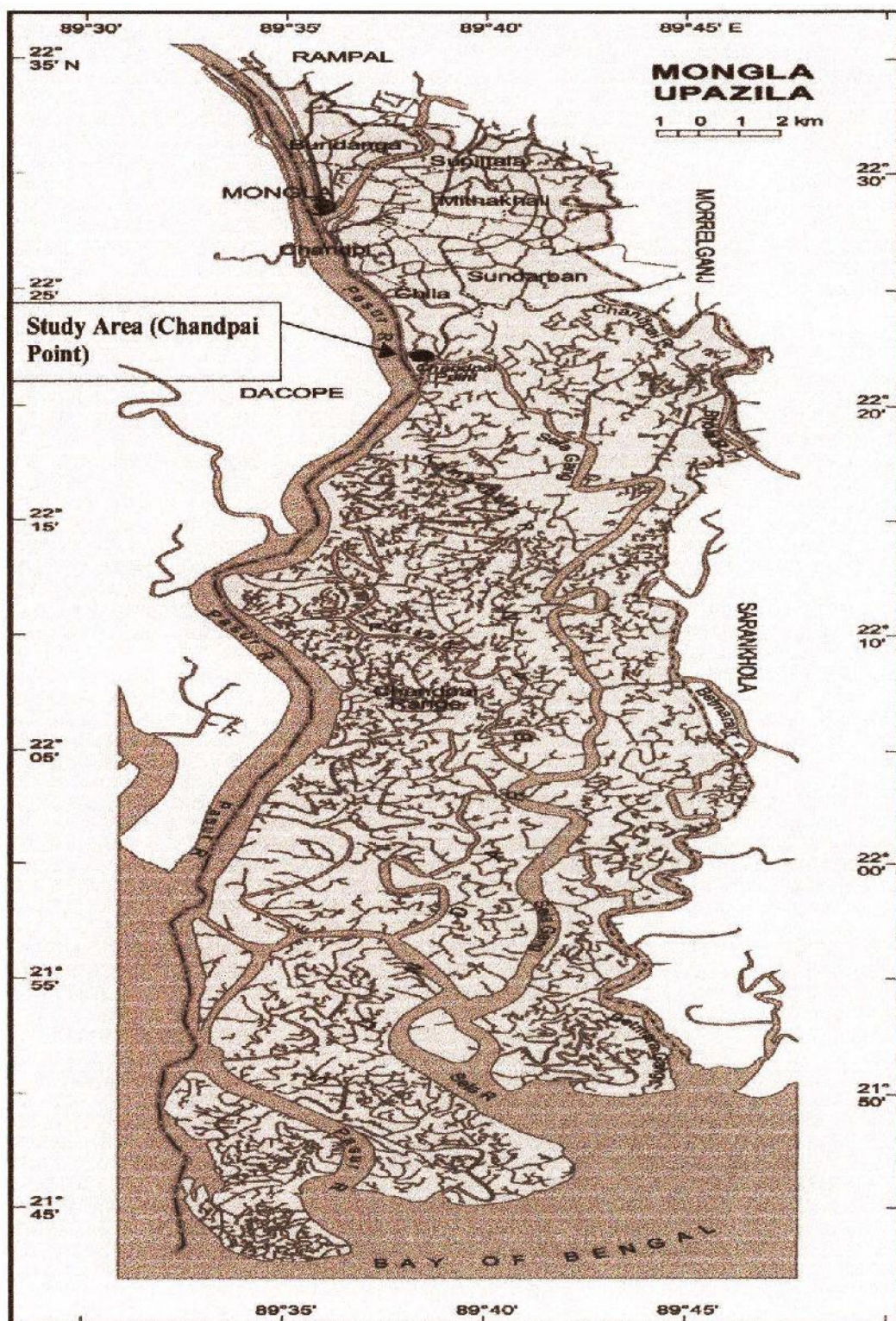


Fig. 1. Map of Mongla upazilla locating the study point

3.3 Data collection

Various physical conditions of the ponds such as types of soil, dike, depth of water, color of the water, presence or absence of aquatic weed, etc. were collected at the beginning of the study from the farm technician. Monthly body weight, length and belly width of hatchling and yearling and other data related to stocking, supplementary feeding, monitoring etc were collected from record book of technician.

3.3.1 Brood crocodile rearing

3.3.1.1 Pond description

Breeding stock reared in a pond enclosed with wall and wide dike. Dike of the pond was well vegetated with shrubs and grass to facilitates nesting during breeding season. Total area of pond was 1.7 ha. (Including 10ft.x10ft dike). Depth of water body maintained at least 2 meter. A 5ft. high concrete wall was constructed surrounding the pond.

3.3.1.2 Stocking management

(1) Source of brood

Breeding population was collected from wild habitat (Sundarban).

(2) Stocking of fast growing fish species

Before stocking the crocodile breeding population some fast growing fish species was released into the pond for live food supply of crocodile. For the live food supply of crocodile fast growing fish species namely, tilapia, silver carp, mrigal was stocked 6 months before stocking of breeding population. Stocking ratio of the pond was 1 female and 7 male.

(3) Feed and feeding

Crocodiles require only small amounts of food to survive and grow, relative to warm-blooded animals such as birds and mammals. Supplied feed was used occasionally.

Area 16-1521,
Sundarban

Breeding stock mainly reared with live food. During breeding period some food was supplied from the outside. This includes dead chicken, fish etc.

3.3.2 Nursing practices of hatchling and Yearling

(1) Tank description

Three types of rectangular cemented tank were used for nursing. Each tank comprises 60% land and 40% water area. 70% of each tank was covered by plastic made shed.

Table1: Nursing and rearing tank distribution

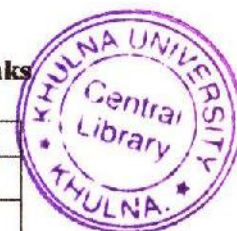
Type of Tank	Number of Tank	Dimension (L x W x H)m	Stocking capacity/Tank
Hatchling	4	4x3x2	40
Yearling	4	5x4x2	30
Raising	2	6x5x3	15

(2) Stocking

Before stocking of hatchling tank was disinfected by 10% KMnO₄ solution. Stocking was done after seven days of disinfections.

Table 2: Stocking Composition in nursing and rearing tanks

Type of Tank	Age group	Number of individual
Hatchling	Below 1 year	30
Yearling	1 year	20
	2 year	15
	3 year	15
Raising	4 year	7



(3) Food and feeding

Hatchling and yearling were feed with supplied feed. Hatchlings were supplied mainly manufactured feed (imported) and little amount live food like shrimp fingerling, small trash fish and small insects were also given to the hatchling. Yearling mainly feed on live fish,

dead fish, dead chicken, crabs and shrimps. Size of this live feed depends on the age of yearling.

Table 3: Ingredients composition of hatchlings food

Types of food	Percentage of food
Kangaroo meat	75%
Chicken head	20%
Calcium(DCP)	2%
Vitamin	1%
Phosphate	2%

The above foods were mixing with each other and by using grinding machine. Paste like food was supplied to the hatchling for easy digestion.

(4) Growth and health management

Monthly growth was checked. Length, weight and belly width were taken carefully. Hatchlings are susceptible to disease which results mortality. Regular water change was practiced and tanks were disinfected by 3% KMnO₄ solution 2-3 times in a week to avoid contamination of infectious.

3.4 Data analysis

Collected data were sorted, categorized and analyzed using different statistical packages, Microsoft Excel, SPSS. Results are presented in the form of table and figures.

(1) Growth rate

Growth rate was determined in terms of weight (g). The growth rate of the hatchling was calculated following Mahmud et al. (1993):

$$\text{Growth rate (g/month)} = \frac{W_2 - W_1}{T_2 - T_1}$$

Where, W_2 = Weight (g) at time T_2

W_1 = Weight (g) at time T_1

T_2 = Date of last sampling

T_1 = Date of previous sampling

Here, $T_2 - T_1 = 30$ days

(2) Survival rate

The survival rate was calculated by using the following formula:

$$\text{Survival rate} = \frac{\text{Number of live individual}}{\text{Number of individual stocked}} \times 100$$

Survival rate of hatchlings and yearlings were also calculated by above mentioned formula.

CHAPTER FOUR

RESULTS & DISCUSSION

Results and Discussion

4.1 Status of breeding

4.1.1 Sex ratio

Total number of mature crocodile was 8 and male female ratio of the breeding population was found 7:1, respectively.

Smith *et al.* (1981) reported that an enclosure of 0.48 ha contained a pool of 0.28 ha. The pen held 100 alligators (presumably captive bred) with a sex ration of approx. 1 male to 3 females (26:74). In 1980 twenty-eight nests were found with a total of 1079 eggs. The hatchling rate was 57%.

Whitaker (1980) founded that the greatest number of *Crocodylus porosus* kept together at Moitaka government farm near Port Moresby in Papua Newguine was seven (1 male, 6 females) in a pen of 78 x 36 m with a pool of 24 x 15 x 1+ m deep.

Suvanakorn *et al.* (1981) found that maximum density a breeding pond of 0.2 hectare holds about 250 crocodiles with a sex ratio of 1 male to 3 females. The pools are concreted and have a concrete border which helps to keep the surrounding soil out of the water. The main pools are never drained but clean water is pumped in and the discharge is carried away through an overflow pipe as necessary. The depth of water is maintained at approximately 1.5 metres.

4.1.2 Fecundity

Fecundity of the brood crocodile was found 2, 18, 23, 26 and 38 at the age of 12, 13, 14, 15, 16 years, respectively.

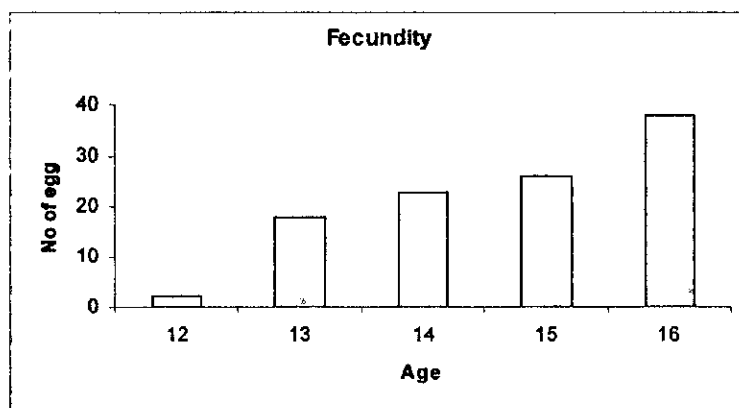


Fig. 3. Age wise fecundity of crocodile

Britton (1995) found that female Females reach sexual maturity at around 10 to 12 years old. Males, on the other hand, do not reach sexual maturity until the age of 16 years. The female crocodile normally lays 40 to 60 eggs, but she can lay up to 90 eggs.

Peucker *et al.* (1997) found that breeding takes place in the wet season, from late October to the end of May or early June. Under farm conditions females mature at 8-10 years, males at 10-12 years. Nest sizes for mature females range from 30 to 60 eggs per nest.

Anon (2007) reported wild female saltwater crocodiles will reach sexual maturity at around 12 of age (2.3 metres) and males around 16 years of age (3.35 metres). Between 40 and 60 eggs is normally laid (mean of 50), depending on factors such as the size of the female and age. Laying takes an hour.

4.1.3 Egg size

Average egg size of the crocodile was found 69, 74.5, 77.3, 81.9 and 105.3 g during the age 12, 13, 14, 15 and 16 respectively.

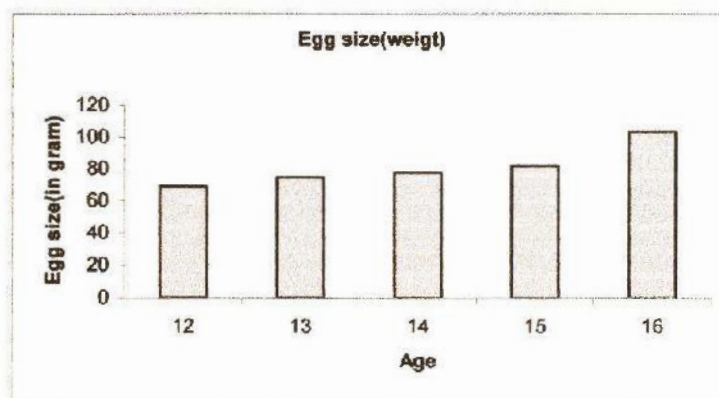


Fig. 4. Age wise average egg weight of brood crocodile

Anon (2007) reported that crocodile in captivity, when a female first reproduces, the number and size of the eggs is small. However, after three or four breeding seasons, the number of eggs, egg size, fertility and embryo survivability increases substantially. Eggs weigh around 113 grams and measure 80 mm x 50 mm. Within several hours of being laid, the embryo attaches to the eggshell and a white spot appears on the eggshell ("banding"). Over the next couple of weeks, the band expands and covers the entire egg as the embryo grows.

4.1.4 Fertility and Hatching rate

Fertility was found 0, 0, 17.40, 26.90 and 42.10 % at the age of 12, 13, 14, 15 and 16 respectively. Whereas, hatching rate was found 0, 0, 4.30, 11.50 and 28.90 % at the age of 12, 13, 14, 15 and 16, respectively.



Table 4. Age wise fecundity, fertility and hatching performance of brood crocodile

Age	Fecundity	Fertility	Hatching
12	2	0	0
13	18	0	0
14	23	4	1
15	26	7	3
16	38	16	11

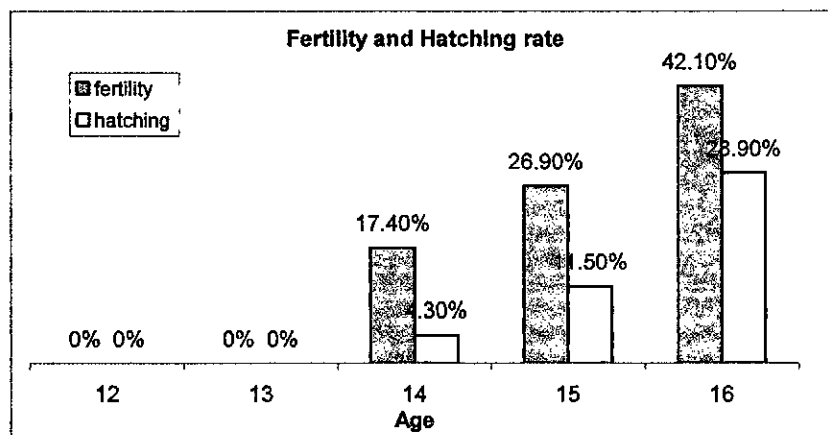


Fig. 5. Age wise fertility and hatching performance of crocodile

Anon (2007) reported that fertility is generally poor and survivability of any resultant hatchlings is reduced in first reproduction. However, after three or four breeding seasons, the number of eggs, egg size, fertility and embryo survivability increases substantially.

4.2 Nursing and rearing

4.2.1 Observation on feeding

4.2.1.1 Types of feed

Supplied feed was provided depending on age, size of the crocodile. Types of feed were categorized into three classes namely hatchling, grower/ juvenile and adult.

Table 5. Types of natural and supplementary feed used in different age group of crocodile

Life stage	Feed used in culture
Hatchlings	Imported feed, red meat and chicken heads, supplemented with a vitamin and mineral premix
Grower/ Juvenile	Poultry and red-meat based diets Insects, amphibians, crustaceans, small reptiles and fish
Adults	Poultry (defeathered), fish, pig and beef. Mudcrabs, vertebrates (e.g. turtles, goannas, snakes were provided in live condition.

Coulson *et al.* (1983) found that a diet of whole fish is perfectly satisfactory for rearing stock. This is because fish protein contains all the essential and non-essential amino acids in similar proportions to those found in crocodile tissues. Everything needed for rapid crocodile growth is present in near optimal amounts

Sah *et al.* (1996) reported that stomachs of hatchlings and juveniles contained crabs (Ocypodidae), prawns (Atyidae), insects and small fish (Hemiramphidae).

Britton (1995) found that young *Crocodylus porosus* is restricted to smaller prey like insects, amphibians, crustaceans and small fish and reptiles. When they become an adult,

they feed on larger prey such as mud crabs, turtles, snakes, birds, buffalo, wild boar, and monkeys

Peucker *et al.* (2005) reported that twenty years ago little scientific investigation had been undertaken into commercial crocodile production. Virtually no progress had been made on feeding manufactured diets despite the attention of the international research community. Considerable effort had been made in Zimbabwe and South Africa with little to show for those efforts. No one had identified the barrier(s) to the successful initiation of pelleted feeding. Further, no on-farm feed manufacturing equipment had been developed. Neither was there any technology available to show clients how to successfully manufacture pellets.

Anon (1992) reported that hatchlings are usually fed ground, minced or chopped food. 'Chunks' of food seem to be preferred, but grinding/mincing allows the efficient mixing of supplements.

Anon (2007) reported that hatchlings contain a good yolk supply, on which they can survive for days and even weeks if necessary, although they have sharp teeth and will begin feeding almost immediately. Juveniles take a wide variety of small prey items such as insects, other arthropods, crustaceans and small fish. Larger animals take bigger versions of these prey items, plus amphibians, reptiles, birds and small mammals. In the wild, very large animals will take almost anything including dingos, wallabies, shore birds, other crocodiles, large reptiles, domestic animals, cattle and even people

4.2.1.2 Doses of supplementary feed

Table 7. Doses of feed supplied to the crocodile

Age of crocodile	Doses of supplied food (days per week)	Body weight %
Upto 1 Year	6	10
2 Year	3	12
3 Year	2	12
4 years	1	15

Anon (1992) reported that Intervals between feeding should changes as an animal grows. Hatchlings are best fed once each day, juveniles of 1.2m once every second day. A typical juvenile crocodilian will consume about 15–20 percent of its body weight in food every week at a constant temperature above 32o C. However, in outdoor pens, food consumption will vary greatly depending on ambient conditions and season

Joanen *et al.* (1971) found that different feeding regimes could be tried though have concluded that a rate of 7-8% of body weight per week is optimal for breeding stock.

4.2.2 Growth

Hatchling and yearling growth rate (in weight) were found 7.98 g/day and 21.91 g/day, respectively.

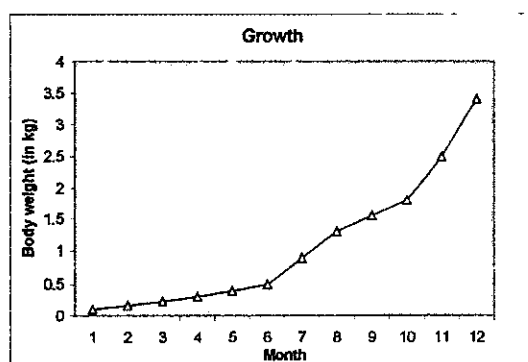


Fig. 6. Growth (in weight) of crocodile hatchling

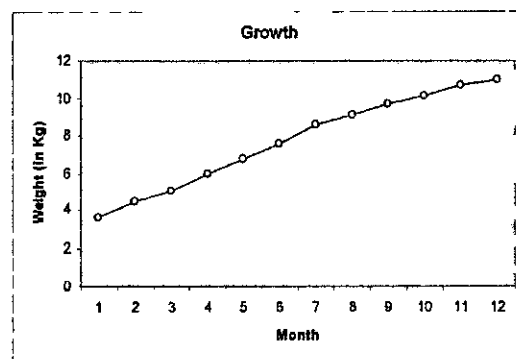


Fig. 7. Growth (in weight) of crocodile yearling

Sah *et al.* (1996) found that the hatchlings had growth rates between 0.3 and 1.5 g/day, while larger juveniles grew at least 2.7-2.9 g/day.

Peucker *et al.* (2005) worked on developing feeding strategies to grower crocodiles is also continuing. Growth rates of 16 grams/crocodile/day are being achieved. So far researchers have established that it is possible to manufacture on-farm, cold pressed, pelleted feed that crocodiles will eat. In addition, manufactured feed offers a 2.4:1 ratio over offal diets on a dry matter basis. This advantage translates into ingredient, transport and storage savings for producers.

Blake (1982) found that the low winter temperatures in Zimbabwe captive Nile crocodiles grow almost as fast as fish-fed *C. novaeguineae* in the farms of Papua New Guinea. The Nile crocodiles are fed on game meat (mainly elephant) with bone meal, vitamins and trace elements. Growth rates of 40-50 cm (increase in total length) per year can be achieved during the first three or four years. Fish-fed saltwater crocodiles reared in outdoor pens in Papua New Guinea averaged 2 metres in length and weighed 37 kg after 4 years. During this period they had consumed about 260 kg of food.

Anon (2001) found that with good sanitation a very fast growth rate can be reached. At Mr. Rachmat Wiradinata's farm (Ekanindya karsa, Crocodile Integrated Farm - Cikande, Serang), crocodiles slaughtered at 24 months of age have an average total body length of 155 centimeters and commercial belly width of around 15 inches. This farm uses poultry offal (dead chicken carcasses) for crocodile feed.

4.2.3 Survival rate

Survival rate was found 76.66, 93.33, 100, and 100 % at the age upto 1, 2, 3 and 4 years crocodile, respectively.

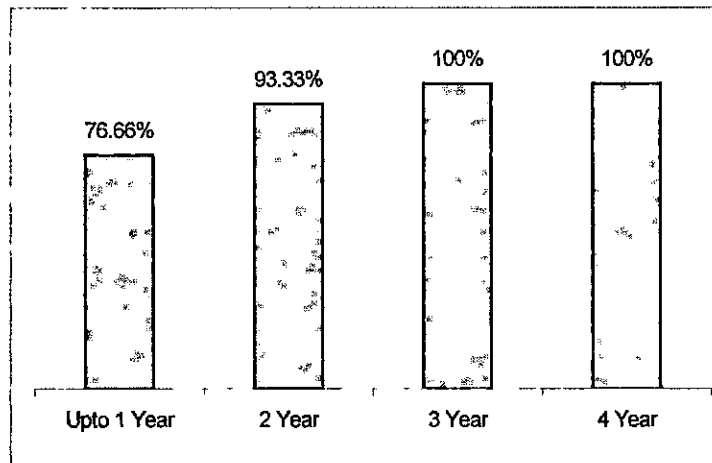


Fig. 8. Survival rate of different age group

Hyde (2000) found that survival rate of farmed crocodiles is much higher than in the wild, so the operation is supported by both the Aboriginal communities and the conservation groups. In the wild, up to 97 per cent of eggs and hatchlings are lost due to flooding of (crocodile) nests and predators. On the farm, we lose less than five per cent.

Anon (2007) reported that when a female first reproduces, the survivability of any resultant hatchlings is reduced. However, after three or four breeding seasons, the number of eggs, egg size, fertility and embryo survivability increases substantially.

4.2.4 Observation on nursing of crocodile in different age class

Table 7. Nursing performances of the farm

Parameter	Upto 1 Year	2 Year	3 Year	4 Year
Stocking dens (nos/i)	30	30	20	15
Retrieval	23	28	20	15
Survival %	76.66%	93.33%	100%	100%
Duration of rearing	12 month	12 month	12 month	Unlimited

4.3 World wide economic importance of crocodile culture

Salt water crocodiles are considered better than fresh water crocodiles because they have pretty skin, no bones, and are a lot softer. Sometimes more scales are required which is usually dictated by fashion. Australia has a relatively small role to play in this luxury industry. Countries like Papua New Guinea produces more than 10,000 skins a year.

About 80 percent of income derived from skins and the remaining 20 percent from meat. The principal markets for Australian saltwater crocodile skins are Japan, France and to a lesser extent Singapore and Italy. Australia primarily exports raw or 'green' skins for the purposes of processing and manufacturing into high-quality leather goods. 'Classic' skins as they are known, are traded in two forms, belly skin and horn-back.

Skin value

Prices are determined by belly width and the amount of damage to this area. Prices for a 34 cm belly are approximately \$AU355 for 1st grade, 2nd grade \$266 and \$177 for 3rd grade. Overseas fashion trends, the Australian dollar exchange rate, market supply and value adding influence the export trade. The supply of crocodile meat is dictated by the demand for skins and for this reason processing of the meat can be irregular.

Meditative value

Crocodile blood may yield powerful new drugs Scientists in Australia's tropical north are collecting blood from crocodiles in the hope of developing a powerful antimicrobial drugs for humans, after tests showed that the reptile's immune system kills HIV. The crocodile's immune system is much more powerful than that of humans, preventing life-threatening infections after savage territorial fights that often leave the animals with gaping wounds and missing limbs.

"They tear limbs off each other and despite the fact that they live in this environment with all these microbes, they heal up very rapidly and normally almost always without infection," said U.S. scientist Mark Merchant, who has been taking crocodile blood samples in the Northern Territory.

Initial studies of the crocodile immune system in 1998 found that several antibodies in the reptile's blood killed bacteria resistant to penicillin, such as *Staphylococcus aureus*, Australian scientist Adam Britton told Reuters on Tuesday. It was also a more powerful killer of HIV than the human immune system. "If you take a test tube of HIV and add crocodile serum it will have a greater effect than human serum," Britton said from Darwin's Crocodylus Park, a tourism park and research center. The scientists hope to collect enough crocodile blood to isolate the powerful antibodies and eventually develop an antibiotic for use by humans. "We may be able to have antibiotics that you take orally, potentially also antibiotics that you could run topically on wounds, say diabetic ulcer wound," said Merchant. However, drugs derived from the crocodile's immune system may need to be synthesized for human consumption. "There is a lot of work to be done. It may take years before we can get to the stage where we have something to market," said Britton.

As Food

Crocodile is consumed in some countries such as Australia, Ethiopia, Thailand, South Africa and also Cuba (in pickled form). It can also be found in specialty restaurants in some parts of the United States. The meat is white and its nutritional composition compares favourably with that of more traditional meats. It does tend to have a slightly higher cholesterol level than other meats. Crocodile meat has a delicate flavour and its taste can be complemented by the use of marinades. Choice cuts of meat include backstrap and tail fillet. Meat retails for between \$22 and \$27/kg. Demand for crocodile meat exceeds production to the extent that Australia imports meat from Papua New Guinea. Export markets exist in Great Britain, Denmark, Switzerland, China, Japan, Korea and New Zealand.



CHAPTER FIVE

RECOMMENDATION

Recommendation

From the understanding of present study following recommendations are suggested-

- Modern farm establishment and artificial breeding technique of crocodile should be developed in the Sundarban area by creating artificial environment with the help of fencing.
- Though crocodile farming has great potentially in Bangladesh, it could be farmed commercially in coastal region and fresh water region, which can create a chance for the contribution of our national economy as well as open a new door of tourism.
- It is necessary to identify economically important species of crocodile and their reproductive behavior, food and feeding habit and culture system development related extensive research conduction.
- It is necessary to take effective scientific management for improving habitat and nesting site development.
- Commercial crocodile farming solely depends on the fry produced by artificial breeding and supplementary feed. So, for making popular of crocodile farming system it should be given priority of artificial breeding, huge fry production and balance diet preparation technique.
- In Australia, America, Philippine, Malaysia, Papua New Guinea etc crocodile is cultured commercially. With the concerned research institute of those countries BFRI can make joint research planning and for implementation necessary steps should be taken up. As a result with crocodile farming, conservation and management technique, effective manpower will be made.

CHAPTER SIX

CONCLUSION

Conclusion

There is a great opportunity for the development of crocodile fishery in Bangladesh. This potential crocodile fishery could be developed through implementing proper breeding and culture practices. Crocodile skin, meat and other by products have huge demand in the international market. Bangladesh has available area for crocodile culture. Considering the demand and importance of crocodile, it is needed to create awareness among the policy makers of the government and non-government organization. Crocodile is now on the way of extinction due to environmental disruption and indiscriminate exploitation. By developing crocodile breeding and culture systems, natural population could be protected from the extinction and also can create some employment opportunity in our country.

CHAPTER SEVEN

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