

**HATCHABILITY PROBLEM OF *EX-SITU* CONSERVATION OF THE FRESHWATER CROCODILE *CROCODYLUS PALUSTRIS* (LESSON 1831) AT DULAHAZRA SAFARI PARK, COX'S BAZAR, BANGLADESH**

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**Abstract**

In this research hatchability problems of freshwater crocodile in Dulahazra Safari Park have been discussed. The findings focused on meteorological factors, lack of suitable habitat in semi-captive enclosures and some physiological factors which are mainly responsible for non-hatchability of freshwater crocodile in the park environment. The research emphasized on finding rationale that interrupts breeding failure of this crocodile in this park. The hatchability problem was identified with some influential factors which are main barriers to escalate and proliferate the reintroduce program in Bangladesh. The findings showed that the influential factors including high stock density in a small space, low water deepness and narrow sandy bank of the enclosure with lack of nesting materials, high temperature and heavy rainfall are mainly responsible for the failure of freshwater crocodile breeding potentiality.

*Key word:* Hatchability, Incubation, Courtship, Clutch, Stock, Viability

**Introduction**

Crocodiles have specific position in herpetology as a carnivore aquatic group which are somewhat distinct from other two groups, the lizards and serpents. Besides, this group plays a vital role in maintaining steady state condition of aquatic ecosystem as predator along with high economic value (Jayson *et al.* 2006). Crocodile skin has high market value for durability and use for luxurious leather products. Similarly, meat is delicious food to people of near Asia-pacific and the teeth are being used for various showpiece products in many countries. According to Khan (1990), illegal hunting for financial benefit, collection as specimens for laboratories and museum use are the prime threats to crocodile survivability in the natural environment.

Once three crocodile species: the saltwater crocodile, freshwater crocodile and gavial were available in Bangladesh in wild condition. But now, freshwater crocodile has been extinct from wild state and saltwater crocodile and gavial are survived with vulnerable condition (Khan 1982). Several individuals of freshwater crocodile in Bangladesh are

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surviving in captive and semi-captive conditions in Dulahazra Safari Park, the lake of Khan Jahan Ali Mazar in Bagherhat, Dhaka and Chittagong Zoos with miserable conditions. According to Whitaker (1987), freshwater crocodile has already been extinct from nature in many Asian countries. Once Mekong, Iraboti, Ganges and Sindu river were famous for freshwater crocodile distribution range. In some Southasian countries including Bangladesh, India, Pakistan, Nepal, Bhutan and Sri-Lanka along with Myanmar, Iran, Malaysia and Indonesia the species were broadly distributed in freshwaters (Felix 1983). The freshwater crocodile distribution range has been shrinking in most of Asian countries due to water pollution, unfavourable aquatic habitat, food scarcity and other anthropogenic pressures. Besides, increased national and international market demand for the valuable skin of freshwater crocodile are causing illegal hunting, poaching and smuggling. For example, Bangladesh, Nepal, Bhutan and Myanmar already lost their valuable freshwater crocodile species from nature (Rao and Chaudhury 1992). Public awareness, applying strict rules and regulations on habitat protection strategy can be a remedy for restoration of freshwater crocodile population in wild condition in most Asian countries.

Low breeding rate, non-hatchability and inbreeding problem in captive and semi-captive conditions are main drawback for freshwater crocodile to establish a viable population size in captive and semi-captive conditions. As the freshwater crocodile population is almost extinct from nature of Bangladesh, the wildlife conservation authority of Government of the Peoples' Republic of Bangladesh has taken initiative to received 40 freshwater crocodiles from India as a donation to restore and establish freshwater crocodile population in nature under reintroduction program.

### **Materials and Methods**

Freshwater crocodile breeding activities were observed in semi-captive Lake of Dulahazra Safari Park at Cox's Bazar during June 2007 to May 2008 and the data were recorded through frequent field visits. In addition, during the crocodile introduction in May 2004, breeding related data of freshwater crocodile (*Crocodylus palustris*) in Dulahazra Safari Park were collected from park staffs, officers and recorded documents. The list of the materials included note book, pen, pencil, eraser sharpener, a pair of binoculars (Bushnell, 10×50 coated lens), measurement tape, spring balance, a pair of scissors, thermometer (maximum-minimum), calculator, alcohol and formalin, protective cloth, jungle boot and sunglass, hand gloves, torch light, polythene bags, first aid box, etc.

Courtship, pair formation, and mating behavioral activities were noted including specific time of breeding season. Nest sites were marked and the length and breadth of nests were measured along with counted nest number. The nests materials were also identified during the field investigation. The egg laying time and clutch size were recorded to compare with previous egg laying time and clutch sizes. Randomly, the weight and



length of ten eggs were taken to find out the reason of hatchability problem. The incubation period was recorded to compare with the length of previous incubation period. Weather related data including temperature, humidity and rainfall were also recorded. The data were analysed statistically where needed.

### Results and Discussion

*Courtship, pair formation and mating behaviour:* The breeding season of freshwater crocodile in Dulahazra Safari Park was recorded from November to August based on male's and female's observed breeding activities. Males usually take initiative to bond pair and participate mating through courtship behaviour as a sign of generation continuity. A dominant male gets more priority than other males based on their hierarchy. The dominating male shows power and strength by jaw slapping and roaring on water. Some incredible breeding behaviour from both male and female were recorded during breeding season. Firstly, the male showed encircle swimming surround of female with hitting water surface by tail and continuous production of sound unless get approval from the female. Secondly, the female agreed pair formation by soft biting on the head of male. During mating, the male was found to draw attention of female by physical contact and some aggressive behavior on surface water. Suddenly, male becomes very close to female and set copulatory organ to female's cloaca and slowly both go under water from surface. The mating time was recorded to be from 5 to 20 minutes comparing in different couples.

*Nesting, egg laying time and incubation:* During the study period, eight nests were found in loose soil eroded bank of crocodile enclosure including three in the east and five in the south which were selected and made by female crocodile (Table 1). The nests were apart from each other at a certain distant. The observed nests were tube-shaped with average 46.12 cm deep, 32.5 cm at the top and 35.12 cm at the bottom (Table 1). Nests materials included dry plant leaves, roots, grasses and climbers (*gilalata*, *assamlata*, *Entada phaseoloides* and *Eupatorium odoratum*). Three nests were found to complete in one day, two in one and half day and others in two days. The freshwater crocodiles of Safari Park prefer to construct nest during morning and evening except night. During the research work, the freshwater crocodiles of Safari Park were found to lay eggs between 9 and 22 April in 2008 (Table 2). They preferred mid-night and mid-day to lay eggs and took 3 to 6 hours after completion of the nest. The first female laid eggs on 9 April 2008 at 1345 hours (Table 2). The average clutch size was 48.37 (range 35-70, N=8) (Table 1). The eggs were little bit elongated-oval in shape with rough texture. The randomly selected egg-lengths were 60-90 mm and weight 80-130 g (Table 3). The significant correlation was found between the length and weight of eggs ( $r = 0.95$ ,  $t = 8.35$ ,  $df = 8$ ,  $p < 0.05$ ). The eggs are white to light brown but abnormal eggs were milky white. After 90 days of incubation period, no hatchling was found. When some eggs were broken, those were found to be rotten with immature embryo. Total 29 individuals were released in semi-

captive condition of Dulahazra Safari Park to establish a viable population size by rearing and hatching.

From the introduced year 2004, the freshwater crocodiles (9 males, 16 females and 4 juveniles) were in breeding problems although male and female combination was satisfactory. The analyses on breeding indicates that the influential factors behind the breeding failure are high stock density in a small space, low water deepness and narrow sandy bank of the enclosure with scanty of nesting materials, high temperature and heavy rainfall. Besides, newly habituated in new place might be counted as breeding failure factor which influence the physiological and hormonal system interruption for a certain period of time.

Table 1. Length, breadth (Top and Bottom) and clutch size of eight nests.

SN <sup>o</sup>	Length (cm)	Breadth (Top)	Breadth (Bottom)	Clutch size
1	42	29	32	36
2	45	31	35	48
3	50	34	38	64
4	48	33	36	35
5	39	28	33	52
6	44	30	34	70
7	49	32	35	45
8	52	35	38	37

Table 2. Egg laying period and hatchability of freshwater crocodile in the Dulahazra Safari Park.

Year	Egg laying period	Egg laying time by 1 <sup>st</sup> female	Egg laying duration (H)	Number of female laid eggs	Total number of eggs	Hatchability (%)
2006	12-24 April	22.00 H	4	6	260	0
2007	10-20 April	23.00 H	6	7	320	0
2008	9-22 April	13.45 H	4	8	387	0

Table 3. Length and weight of randomly selected ten eggs.

SN <sup>o</sup>	Length (cm)	Weight (g)	SN <sup>o</sup>	Length (cm)	Weight (g)
01	6	80	06	6.2	94
02	6.5	90	07	7	98
03	7	98	08	9	130
04	8	110	09	7	100
05	6	92	10	7	95

The breeding season recorded in the study area from August to November, but breeding season little bit extends in India such as November to June (Whitaker and Whitaker 1989), even in Chittagong Zoo in Bangladesh from November to July (Rahman 1990). During breeding season, dominant male takes initiative through courtship to get advantage for mating purpose (Das and Whitaker 1993). From November to December the courtship and mating activities were recorded in Dulahazra Safari Park but these type of behaviour recorded in Chittagong Zoo was from late November to January (Rahman



1990). During present work in Dulahazra Safari Park, nest building activities by female were found four months later especially in April. Freshwater crocodile usually likes to build nests beginning of the dry season in February in India (Whitaker and Whitaker 1989). Reddy (1993) described that mugger crocodile likes to select nesting sites near water in loose soil under shadow place. In Dulahazra Park only females were found to participate to build nest at certain distant from each other's nests but in India, Sri Lanka and Iran it was recorded that one or more crocodile took part to build nest with adult and sub-adult (Whitaker and Whitaker 1984 and Mobaraki 2002). In Dulahazra Safari Park, the built-up nests were tube-shaped, average 46.12 cm deep (39-52cm) but nests length varied from 35 to 56 cm considering ambient temperature to ensure survive of hatchlings in harsh environment (Lang 1987, Whitaker and Whitaker 1989 and Whitaker *et al.* 2007). The field recorded data have shown that there was no nesting material in two nests out of eight and the rest of the nests held few nesting materials due to scarcity of nesting materials in nest sites although nesting materials play significant role to control nest temperature for good hatchability (Felix 1983). The average clutch size was found to be 48 (range 35-70, N=8), while Rahman (1990) had reported clutch size of freshwater crocodile to be 25 to 40. According to Whitaker and Whitaker (1984), in captivity some muggers laid two clutches in a single year but in wild it has never been recorded. During the study, the longevity of incubation period was noted to be 91 days with non-hatchling condition while mugger crocodile's incubation period length is around 80 to 90 days in Madras crocodile bank, India even 55 to 75 days some parts of India recorded (Whitaker and Whitaker 1984, Whitaker 1987 and Sagar and Singh 1992).

*Meteorological investigation:* Some meteorological factors including temperature, humidity and rainfall were found to be closely related to natural breeding of freshwater crocodile. Sex diversity of most reptiles is controlled by temperature during incubation period. Proximate temperature is crucial part during natural incubation for vigorous hatchlings but recorded temperature in this park area was 28.4° to 43.9 ° and average 35 ± 0.5° C during study period (April - June 2008) especially in incubation time. Therefore, recorded temperature was quite high near nesting site of park area. Humidity also plays a significant role during incubation period to maintain eggs inside liquate quality and balance for success of incubation. Naturally 75% relative humidity level is appropriate for incubation but recorded humidity level was 49% to 98%, with an average of 68%. Minimum level of rainfall was good during incubation period, but heavy rainfall mostly created drawback during incubation period. Excessive rainwater indulged nesting sites and destroyed eggs hatchability quality. The recorded rainfall was heavy during the incubation period.

Since the freshwater crocodile has become extinct from the natural habitat, the reintroduction program is only the solution by rearing in captive and semi-captive conditions and back to nature by proper scientific process regarding the conservation viewpoints (Whitaker and Andrew 2003). Some provinces of India have successfully

reintroduced freshwater crocodile in nature by supporting rearing and hatching in captive and semi-captive conditions. Similarly, many Asian countries like Bangladesh is trying to success reintroduction program by supporting a viable and good composition stock in Dulahazra Safari Park in semi-captive condition from the year 2004. But non-hatchability has been shown to be a major barrier to promote and execute the reintroduction program in Bangladesh. During the present work on freshwater crocodile breeding in Dulahazra Safari Park some reasons of non-hatchability have been identified including water volume and water quality, feeds, space and inadequate of nesting materials in nesting sites, temperature and heavy rainfall. During the study period, it was noticed that 29 freshwater, 16 saltwater crocodiles and 2 gavial species live in congested conditions in semi captive enclosure. The water deepness was not appropriate in entire semi-captive enclosure along with shortage of space according to per crocodile demand. At least 12 to 170 meter square space need per crocodile and water deepness should be three or more feet everywhere of semi captive enclosure for successful breeding (Joanen and Mcnease 1971 and King and Dobbs 1975). The high density of crocodile in a small volume of waterbody and absence of facilities of water flow continuously were identified as unsuitable quality in the semi-captive enclosure. Besides, the park authority mostly provides poultry meat as crocodile feed which influence fat deposition in genital organ of female crocodile. Moreover, poor water quality is not suitable for crocodile for breeding activities and supplied food creates problem. So, freshwater crocodile in Dulahazra Safari Park is facing problem in breeding activities.

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