

Full Length Research Paper

First record of mugger crocodile *Crocodylus palustris* (Lesson, 1831) from the Rajaji National Park, North India

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First record of mugger crocodile *Crocodylus palustris* (Lesson, 1831) from Rajaji National Park, north India, is described and illustrated. This is the first record of the order Crocodylia and genus *Crocodylus* for Rajaji National Park. On 8th and 9th of December 2010, two mugger crocodiles were observed basking in sandy bed of Ganges near to Bhimgora barrage (Haridwar city) on the very edge of Rajaji's boundary adjoining to Haridwar forest division. We used ground survey method to identify new potential habitats of the animal and to examine the distribution and presence of the species from December 2010 to February 2011. Field observations indicated that the distributional range and upward movements of mugger crocodile is increasing in river Ganges. Besides, their movement range was found increasing in adjoining areas of Haridwar and in the Rajaji National Park. Still no any record is available, which confirms the presence of this crocodylian species near to Haridwar city and in Rajaji National Park and based on this evidenced study, one more reptilian species – mugger crocodile *Crocodylus palustris* can be added to the list of reptilian fauna of the Rajaji National Park. This new record of mugger crocodile's presence in some pockets of Rajaji National Park, Haridwar forest division and in higher elevation of Ganges towards Rishikesh requires further investigations.

Key words: Mugger crocodile *Crocodylus palustris*, new record, basking behaviour, Rajaji National Park, Haridwar, conservation.

INTRODUCTION

Of the three species of crocodiles found in India, the most common and widely distributed is the mugger crocodile *Crocodylus palustris*, which inhabits all kinds of fresh water habitats such as rivers, lakes, reservoirs, hill streams and village ponds. The broad-snouted mugger crocodile is restricted to the Indian sub-continent (India, Nepal, Pakistan, Iran and Sri Lanka) and is categorized under vulnerable category in 'IUCN Red List of Threatened Species' and protected under schedule I of Wildlife Protection Act 1972 (WTI, 2003; Da Silva and Lenin, 2010).

Available historical records suggest that in Bangladesh, the wild population of crocodile was extinct and only two wild crocodiles were known to live in community ponds (except in zoos); similarly in Bhutan, mugger crocodiles are considered to have become extinct in the 1960s and in Myanmar last record of the species was observed in 1867 to 1868 (Da Silva and Lenin, 2010). Increase in population and intensification of agricultural practices, construction of dams and diversion of water channels for irrigation purpose are considered to be major reasons for shrinkage of the population of marsh crocodiles in Pakistan however, presence of this species is limited to certain area of Sindh and coastal areas of Balochistan (Javed and Rehman, 2004). In India, mugger crocodiles are reported from over ten states and the wild

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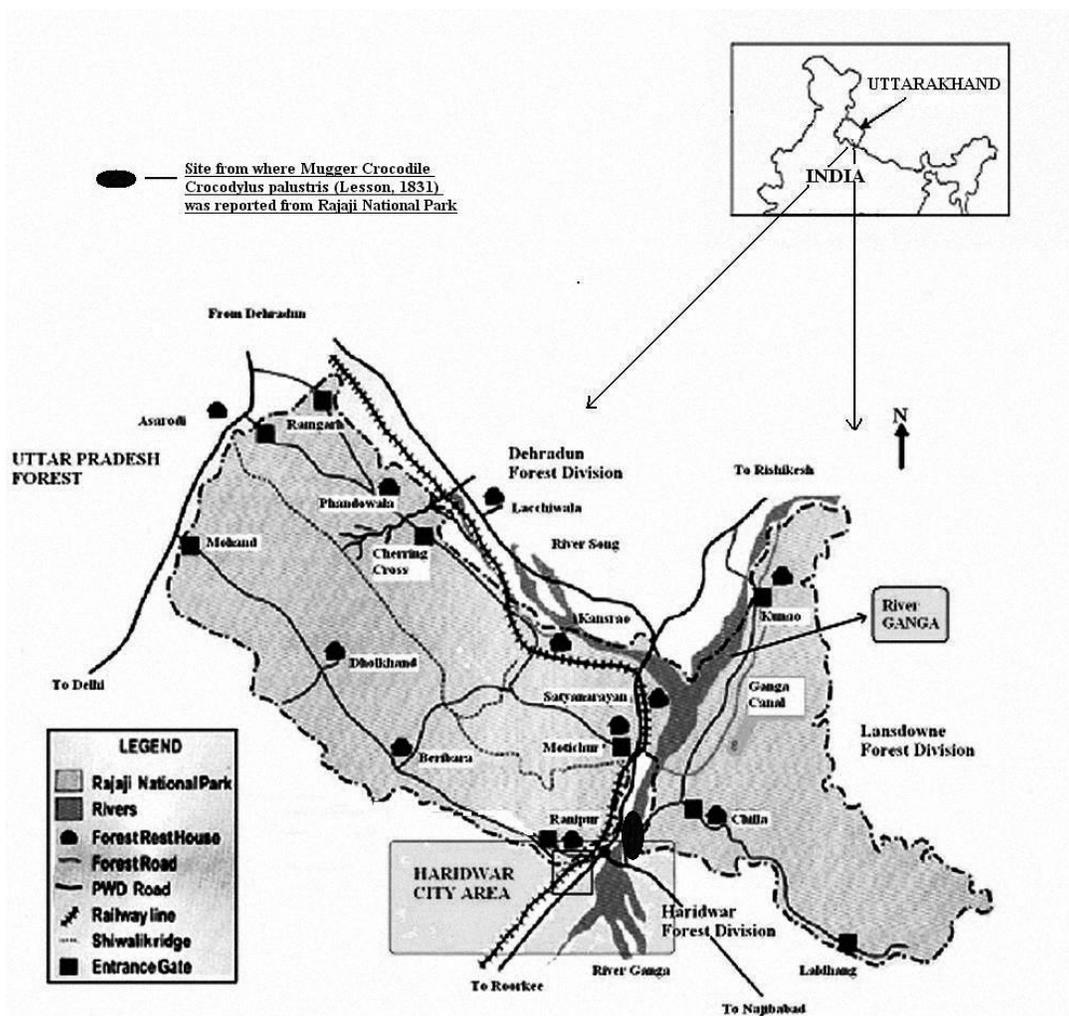


Figure 1. Map of Rajaji National Park showing location from where muggers crocodile *C. palustris* has been observed.

population is tentatively estimated as 2500 to 3500 non-hatchlings (Whitaker and Andrews 2003). In Uttarakhand state, this highly threatened wild species is known to be found in Corbett Tiger Reserve (Ram-Ganga River and Sonanadi reservoir) and in Baan-Ganga wetland (Laxar area, district-Haridwar) adjoining to river Ganges. But still no any such record exists, which confirm the presence of crocodile near to Haridwar city and in the Rajaji National Park in river Ganges.

Study area

The Rajaji National Park (Figure 1) in north-west India (29°15' to 30° 31' North Latitude, 77°52' to 78°22' East Longitude, elevation 250 to 1100 m above MSL) was created in 1983 to protect Asian elephant's habitat, which presently comes under Elephant Reserve No. 11. RNP is spread over an area of 820.42 Km² in and around the

Shivalik foothills, which lies in the lesser Himalayas and the upper Gangetic plains and has been designated as a reserved area for the "Project Elephant" by the Ministry of Environment and Forests, Government of India with the sole aim of maintaining the viable population of Asian elephants. The Shivalik foothills offer the most prominent geomorphic features of this tract and the river Ganges has cut across these hills at Haridwar.

METHODS

After observing the specimen, the entire riparian corridor was walked on foot and searched for crocodiles' presence in other adjoining areas. After the assessment of ground-based data and reporting the confirm presence of muggers crocodile in Rajaji National Park area, in-depth observations were conducted on both the specimens during day hours (0900 to 0500 h) and data were collected during 8th of December 2010 to 5th of February 2011. The data collected were as part of the animal monitoring activities



Figure 2. Extending home range: First author (Ritesh Joshi) confirms the presence of *C. palustris* basking in bank of Ganges.

and the daily record was based on direct sighting of animals and indirect evidences like footprints and body impression signs. Besides, dwellers of adjoining areas, Gujjars (where available), staff of forest department other individuals working on this problem, were also interviewed. Field binocular was also used for observing their activities and behavioural responses without disturbing the animal from an adequate and safe distance.

RESULTS AND DISCUSSION

On 8th of December 2010 (09.00 am), when we were documenting the winter migratory avian species across the river Ganges (Neeldhara area to Jhabargarh/Dudhia/Dogadda forest of the Rajaji National Park; 8 km long riparian stretch), we came across a juvenile mugger crocodile (nearly 1.5 m in length), who was basking on a sandy river bank near to Bhimgora barrage and adjoining to Haridwar city (Figure 2). This area exist on the edge of Rajaji's boundary and falls under Chilla forest beat (Hazara block, compartment No. 7) of the Chilla forest range (29°94.958' North latitude, 78°18.040' East longitude, elevation 274.7 m above MSL). We observed the specimen for whole day (08 h) and noted its activity (that is, minor movements, use of water, impact of its presence on winter migratory avian species and the behavioural responses). On next day (9th of December 2010), we started a search operation to cross-check crocodiles' presence in other parts. Surprisingly, we encountered an adult specimen (early 2.5 m long; 29°94.816' North latitude, 78°17.927' East

longitude, elevation 269.2 m above MSL) basking over to a huge sandy bed present some 200 m far from the spot, where we sighted the juvenile specimen first. This site is adjoining to the forest of Rajaji National Park and Haridwar forest division. Sporadic sightings sometimes over to rocky substrate, bare soil, sandy river bed, while on pre-bask phase and basking phase were continuously occurred during next two months (5th of February 2011; Figure 3). During 12th to 23rd January 2011, several winter rains and extreme cold weather conditions made the animals to bask more frequently during day hours and it made easy for us to observe their behaviour sharply. Temperature regulation is a dynamic process that involves behavioural and physiological adjustments in order to maintain body temperature within a range. Fluctuating environmental conditions that differ from thermal preferences of reptiles increase the time required to thermoregulate (Venugopal and Prasad, 2003).

Basking is a seasonal phenomenon taking place during the colder months of the year and therefore, we still continued our observations and monitoring the activities of the animals for reaching to a further firm conclusion. During the course of this investigation, it was revealed that animal's sense was quite sharp although we were observing them from a safe distance and without disturbing them even though, sometimes they sensed our presence and reacted provisionally and returned back inside the water. The crocodile's sense of sight, hearing and smell are well developed and the animal remains very alert while basking on land (Daniel, 2002). As per



Figure 3. New habitat: Juvenile crocodile basking over to a sandy/muddy base of the Rajaji National park adjoining to Ganges.

the results of an study carried out on the basking behaviour of a wild population of marsh crocodiles in Baghdarrah lake (Rajasthan, India), in the winter season, specimens were observed basking from 09.00 am to 04.00 pm; both young and old specimens were encountered more frequently away from the water line while basking (Mahur et al., 2010).

Habitat

One site from where specimen was documented falls under Rajaji National Park and the other one is well connected and adjoined to Rajaji National Park and Haridwar forest division (both are protected habitats and same biological area) on one axis, whereas the other side has the wider stretch of Ganges (200 m broad) and there this city Haridwar is situated. One habitat is a small with deep water reservoir (size 150×60 m) and another is a running channel of ganges, which is having a small and deep water reservoir in it (size 50×20 m). Interestingly and notably both the habitats observed are channalized with flowing fresh water besides, entire stretch is a potential integrated unit with vast water reservoir, flowing water channel, a portion of river bed with sandy/muddy

base and flowing water and on one side completely covered with protected forest. We kept our sharp observations on both the sites as animal can migrate anywhere else (shift themselves to another favourable habitats) with the onset of summer as natural water was observed to decrease slowly during very hot period.

Behavioural responses

For the maximum time adult specimen was found in basking phase whereas juvenile was found to bask in diminutive contact with water (prebask phase) and surface bask was not observed at all. Of the 47 observations made, on 34 occasions orientation of the mouth was found away from water line and on 13 occasions, the specimens were found with their mouths oriented towards the water line and parallel to water. On seven occasions, animal sensed our presence and after a while returned back quickly inside the water. Literature and some previous studies suggests that crocodiles sometimes keep their mouths open while basking for regulating their body temperature but during the course of investigation no such phase has been observed. The number of crocodiles in the basking phase was observed



Figure 4. Mugger crocodile that have been captured by forest officials from Chandighat area (very close to Haridwar city) during September 2009. The individual was later released in Rawasan River-a tributary of river Ganges.

higher than those in the other phases, during January to February, however by the end of March, those in surface bask category were higher and only at 1700 h, the number of crocodiles were found more in the basking phase thus, there was a change in the choices of basking phase, from land basking to basking in contact with water (Venugopal and Prasad, 2003).

Feeding habits

During most of the observations, both the specimens were found basking but on four occasions, an animal (adult) was found feeding on fishes. Additionally, several species of winter migratory avian species were also observed moving near to the animals but noticeably no stern encounter was observed between both the species.

Previous significant and confirm records of crocodile's presence in the area

In November 2007, the first author noticed a specimen for the first time on the sandy bank of Ganges near to Tatwala village and Haridwar forest division (Chiriapur

forest range), while denoting the movement signs of elephants in the forest adjoined to river Ganges. It was an adult individual basking with its half tail remained in the water. Notably, during January 2008, local people had seen an adult specimen early in the morning on Haridwar-Chilla-Rishikesh motor road near to old checkpost of civil police very closed to Bhimgora barrage. After receiving the information, the first author made a detailed survey of adjoining areas and riparian corridors of Ganges in Chilla forest of the Rajaji National Park and observed the presence of only an individual. However, movement signs were remarked for short duration. Again during January 2009, a juvenile individual was observed basking along the Ganges on an island (Shyampur forest) that falls under Haridwar forest division.

Surprisingly and evidently during September 2009, two individuals were seen randomly in the water channels flowing in between the Haridwar city (Birla ghat and Chandi ghat area; Figure 4). This incident happened in the city area (near to famous Har ki Pauri area and in pilgrim bathing spots) has caused tremendous rumour and panic among devotees. As both the area act as bathing sites for devotees, therefore, caused a severe problem for administration specially at the time when

Maha-Kumbh 2010 fair have to start from January 2010.

Some reports of crocodile's presence were highlighted earlier sometime 40 years back (near to 1970s) in Rishikesh, Ganga Bhogpur village (situated in between Haridwar and Rishikesh across river Ganges and adjoining to Rajaji National Park) and Jagjeetpur village (4 km far from Haridwar towards Laxar). Additionally, in some areas villager's complaints about crocodile's presence came forward from time to time and currently these reports are increasing notably (V.P. Upadhyay, Himalayeya Ayurvedic Medical College, Uttarakhand, India, personal communication).

Humans and crocodilian conflict

In Laxar and its adjoining areas (Ban Ganga wetland, Pathri area and village's stretch situated along the Ganges) human–crocodile conflict is increasing rapidly. Cases of crocodile's presence inside the villages (in small marshy ponds) and attacks have increased the level of this severe conflict. However, till date no such case has been reported from Haridwar area.

Conservation efforts in state

Limited work has been carried out on mugger crocodile in Uttarakhand state and still needs some favourable field-based studies, which can explore their geographical distribution in the state. Currently, protected habitats of Corbett Tiger Reserve (some parts of Jim Corbett National Park and Sonanadi Wildlife Sanctuary) and Ganges stretch from Baan-Ganga wetland to Laxar area are considered to be their potential habitats in state but a need is felt to conduct the ground-based survey in Sharda River to work out the presence of this crocodilian species. Both Corbett Tiger Reserve and Baan-Ganga wetland falls under protected habitats whereas some pockets of Laxar and its adjoining areas exist partially under reserve forest, therefore, needs proper monitoring specially during February – June, which is supposed to be their egg-laying and hatching occurring time.

Available records on mugger crocodile indicated that significant work has been carried out in southern India and some other parts of the country but still studies are required to be carried out in northern India, which will be helpful in sketching a conservation-oriented action plan for this threatened crocodilian species. Remarkably, some work on the breeding ecology of *Gavialis gangeticus* Gharial or long-snouted crocodile is ongoing at Ramganga River and adjoining reservoirs in world famous Jim Corbett National Park/Corbett Tiger Reserve (Wildlife Chronicles, 2010). As far as Rajaji National Park is concerned only a study and literature is available on distribution and presence of reptilian fauna (ZSI, 1995) but mugger crocodile was not included and mentioned in the list as was not reported earlier to this documentation.

Although in the current management plan of the Rajaji National Park, which is for the period of 2000-2001 to 2009-2010 (Pandey, 2001), only seven species of snakes belonging to four families were documented whereas any crocodilian species is not mentioned in it.

Based on these recent observations and evidences, we put on record the presence of the mugger crocodile *C. palustris* in Ganges flowing near to Haridwar city and confirm its presence in Rajaji National Park. However, a major threat was observed to its surviving population is presence of Bhimgora barrage, which is restricting its frequent upward movements. This barrage was constructed during 1970s together with Chilla hydro-electric power plant located some three kilometers far from barrage. Mining during previous years, shrinking of small watersheds/reservoir, decreasing rate of stones and increasing rate of silt in Ganges could be the reason for their upward movements. We are continuously making our efforts in locating its distribution upward and downward movements to reach some further favourable conclusions and to draw some more recommendations regarding to their long-term existence and survival in Ganges and in the 'Shivalik landscape's paradise' – the Rajaji National Park.

RECOMMENDATIONS

1. Proper base-line assessment and monitoring of crocodile's population in river Ganges especially of banks and reservoirs should be done to collect the accurate information about their presence and range utilization. Nesting and basking sites should be identified and mapped and potential ecosystems need to be restored scientifically.
2. Community based conservation efforts should be initiated and participation of stakeholders (people living in mugger areas, relevant Government departments-Forest, wildlife, irrigation, fisheries, research institutions, NGOs) should be ensured; additionally, their favourable views about conservation should be involved in policy making.
3. Checking of anthropogenic activities which have National Park for providing permission for research work on elephant's behaviour during previous years. Thanks negative impacts on the habitat range of crocodiles.
4. In some areas, habitat monitoring programmes need to be carried out, which could be also helpful in knowing the scientific reasons for altitudinal variations in their distribution.
5. As females are known to lay eggs in sandbanks between February and April, and hatching occurs between April and June, therefore, proper monitoring of habitat should be done on regular basis.

Conclusions

Field observations indicated that the distributional range

of the mugger crocodile is increasing in Ganges. Additionally, their movement range was found increasing in adjoining areas of Haridwar city and in the Rajaji National Park area. Study revealed that their upward movement in Ganges was occurs more frequently after the huge floods during monsoon of 2010, when Ganges water was found to flow above 294.60 m above MSL range (225000 cusec). Although 294 m above MSL range was supposed to be dangerous zone and thus, the administration declares 'high alert' during this said period. Both the specimens were observed in naturally made reservoirs of Ganges and for the maximum time they were found in basking phase. Currently, there is no collation of field data to suggest whether the overall wild *C. palustris* population is increasing or decreasing in Ganges and its adjoining habitats and ranges. To date no single literature is available, which confirms the presence of mugger crocodile near to Haridwar city and in Rajaji National Park. Based on the evidence from this study, one more reptilian specie, the Mugger Crocodile *C. palustris* (Lesson, 1831) can be added to the list of reptilian fauna of the Rajaji National Park. Additionally, this new record of mugger crocodile in some pockets of Rajaji's area and higher altitudes of Ganges requires further research. Additional detailed studies are urgently required, which may be helpful in strengthening knowledge about the presence and distribution of mugger crocodiles in Ganges flowing in between Rajaji National Park and Haridwar forest division, especially in adjoining pockets of Haridwar city.

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