



A Review on Status and Conservation of Saltwater Crocodile (*Crocodylus porosus*) in India

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Introduction

The saltwater crocodile (*Crocodylus porosus*) is the largest of all crocodylians, and the largest reptile in the world (Daralyn, 2006) with unconfirmed reports of individuals up to an impressive eight to ten metres in length, although a maximum of five to six metres is more usual. Saltwater crocodiles are also called Indian mugger. The species has a relatively large head, with a pair of ridges that run from the eye along the centre of the snout. Adults are generally dark in colour with lighter tan or grey areas and dark bands and stripes on the lower flanks. The underside is creamy yellow to white becoming greyer along the tail. The juvenile is usually pale tan with black stripes and spots on the body and tail, which gradually fade with age, although never disappear entirely. Female saltwater crocodiles grow to a smaller size than males normally reaching a maximum length of 2.5 to 3 metres. With its long, powerful tail, webbed hind feet, and long, powerful jaws, the saltwater crocodile is a superbly adapted aquatic predator. As in all

crocodylians, the eyes, ears and nostrils are located on top of the head, allowing the crocodile to remain almost totally submerged when lying in water, helping to conceal it from potential prey, while a special valve at the back of the throat allows the mouth to be opened underwater without water entering the throat.

The saltwater crocodile is considered to be more aquatic than most crocodylians, and is less heavily armoured along the back and neck. *C. porosus* moves very fast in water, capable of swimming 12 to 15 miles per hour during short bursts and 2 to 3 miles per hour at a leisurely pace. To swim, the crocodile folds its limbs against its body and laterally undulates, using its tail and body to move through the water.

Classification

The scientific classification of the saltwater crocodile is as follows: –

Kingdom	.....	Animalia
Phylum	.....	Chordata



Fig-Saltwater Crocodile (*Crocodylus porosus*)

Class	.....	Sauropsida
Order	.....	Crocodylia
Family	.....	Crocodylidae
Subfamily	.....	Crocodylinae
Genus	.....	<i>Crocodylus</i>
Species	.....	<i>C. Porosus</i>

Distribution and Habitat

The saltwater crocodile has a wide distribution, due to its ability to travel long distances. Individuals of this species are most commonly found on the coasts of northern Australia, New Guinea and Indonesia (http://animaldiversity.ummz.umich.edu/site/accounts/information/Crocodylus_porosus.html). However, the distribution of *C. porosus* can range from Sri Lanka and the eastern coast of India in the west to the Caroline Islands in the east, and from Burma and Southeast Asia in the north to Australia in the south (Parks and Wildlife Service of the Northern Territory). Saltwater crocodiles remain in the northeast coastal region of mainland India and the Andaman Islands (Singh and Kar 2006). A restocking program in Bhitarkanika National Park (BNP), Orissa has released more than 2300 captive-reared juveniles (approximately 1 m long) between 1977 and 2009. Some have matured and several released females are now reported to be nesting successfully in the wild (Kar 2007a, 2009). The *C. porosus* population in BNP has been increasing since the reintroduction program started from 95 sightings in 1976/77 (relative density=



(Source: http://library.byways.org/view_details.html?MEDIA_OBJECT_ID=53733)

0.87/km) to 1596 sightings in 2009 [1484 individuals in the park (relative density= 13.5/km), and a further 112 in areas surrounding the park] (Kar 2009). Almost 74% of crocodiles are found in the Kanika Range. The number of nests has increased from around 55 in 2004 to 65 in 2009 (Kar 2009). This population increase has led to increased dispersal and human-crocodile conflict (HCC). Local fishermen are now employed to capture problem crocodiles and relocate them back to BNP (Anon 2008b). Recently, groups of captive-bred *C. porosus* were released by the Forest Department in the southern-most part of BNP, but primarily as a strategy for deterring human activities in the mangrove forest (Kar 2007b). In the Andaman Islands, crocodiles are widely distributed but population expansion through intrinsic breeding appears to be constrained by the lack of suitable breeding habitat (freshwater swamps). Human occupation is displacing crocodiles (Andrews and Whitaker 1994) and a recent study has examined HCC in this area (Whitaker 2008). Single crocodiles may even be found wandering in the open ocean some distance from their usual range, like in the Sea of Japan.

The saltwater crocodile, as evident by its name, can tolerate saline environments very well, that is why it is typically found in brackish water around coastal areas and in rivers (http://www.flmnh.ufl.edu/natsci/herpetology/brittoncrocs/csp_cpor.htm). It may also be found in swamps, freshwater rivers, and billabongs, depending on the season and the social status of the



crocodile. Between the dry and wet season, individuals will move between different habitats and juveniles will be forced out from the freshwater rivers where they were raised to make room for the breeding adults. During the wet season, the crocodiles are found in freshwater swamps and rivers, while during the dry season, they are found in estuaries ((http://www.flmnh.ufl.edu/natsci/herpetology/brittoncrocs/csp_cpor.htm).

Diet

Saltwater crocodiles take a wide variety of prey, although juveniles are restricted to smaller items such as insects, amphibians, crustaceans, small reptiles and fish ((http://en.wikipedia.org/wiki/Crocodylus_porosus). The larger the animal grows, the greater the variety of items that it includes in the diet, although relatively small prey still make up the majority of the diet even in large adults. Prey items including crustaceans (e.g. mud crabs) and vertebrates (e.g. turtles, goannas/lizards, snakes, shore and wading birds). Large adults occasionally take much larger preys including buffalo and domestic livestock, wallabies, wild boar, monkeys etc. (http://en.wikipedia.org/wiki/Crocodylus_porosus)



(Source:- http://dangerous-animals-pets.blogspot.in/2011_08_01_archive.html)

Communication and Behaviour

The saltwater crocodile is one of the most intelligent reptiles, in terms of its ability to communicate with other members within its species. They communicate through vocalizations, or "barks," each of which means something different. It is thought that the saltwater crocodile has four different calls. The first is a distress call which is typically barked by juveniles when

they are endangered. It consists of several highly pitched short barks. The second is a threat call which is performed when it may be defending its territory, since these animals usually compete to acquire the territory in the first place. It is heard as a coughing or a hissing sound. The third type is a hatching call, performed by newborns; it consists of just one short bark. The fourth is a courtship bellow, which is heard as a long low growl.

In addition to vocalizations, the saltwater crocodile also uses body postures and head slapping at the water surface to communicate with others. A crocodile will mark its territory by loudly slapping its head or snapping its jaws at the surface of the water (<http://animaldiversity.ummz.umich.edu/site/accounts/information/Crocodylia.html>) dominance can be displayed by the level in the water at which an individual is swimming. For example, a dominant crocodile will swim higher in the water and the subordinate one will swim lower in the water. Fighting between two adults for dominance typically will involve banging of the sides of their heads together or biting.

The crocodile will also secrete scents from scent glands under the throat or at the base of the tail to communicate. For example, during courtship, a male will rub a female's head with his chin, spreading his musky scent (secreted from glands under his throat) on top of her.

The saltwater crocodile is ectoderms and spends much of its time thermo regulating to maintain its body temperature. In response to heating or cooling, a crocodile can either enter water or bask in the sun. Animals going from a cool to warm environment will increase their heart rate to increase heat convection and cooling rates. Conversely, animals going from warm to cool environments will decrease their heart rate and decrease cooling rates (Seebacher and Franklin, 2004).

Reproduction Hatching and Parental Care

The saltwater crocodile typically breeds during the wet season, between November and March in freshwater areas. Breeding territories are marked and defended by males. Female crocodiles reach sexual maturity before males at 10 to 12 years old compared to



16 years old for males. The female normally lays 40 to 60 eggs which was confirmed in a study in nests made from grasses and mud which are then buried. Larger females typically produce larger eggs. that egg width is restricted by the diameter of a female's pelvic canal, which means that older (and thus, larger) females will be able to produce larger eggs (Isberg *et al.*, 2005). The eggs of *C. Porosus* exhibit temperature-dependant sex determination (TSD) in which the sexes of the hatchlings are directly related to the nest temperature. If the temperature of the nest is about 31.6 degrees Celsius, males will be produced; if the temperature is a few degrees above or below this number, then females are born.

When they are ready to hatch, the young will make chirping sounds, which triggers the female to dig the hatchlings out from the nest. This usually occurs after around 90 days. She then carries them in her mouth to water, where they will mature and grow. There is a very high mortality rate of saltwater crocodiles from egg to maturity; only 25% of eggs that are laid will hatch and only 54% of the young will survive to one year (Parks and Wildlife Service of the Northern Territory). Researchers studying juvenile survival of *C. porosus* found that there is a high mortality rate during the first 400 days of a juvenile's life (Isberg *et al.*, 2005). After the first year, mortality rates decrease. Overall, only 1% of hatchlings will survive to reach maturity. Flooding is the main cause for egg mortality, however they are also eaten by predators like turtles, other species of crocodiles, and even males of the same species (Parks and Wildlife Service of the Northern Territory). Females of *C. porosus* exhibit more parental care than males. For example, females usually make the nests and then watch over it, splashing water onto it if it gets too dry (which is uncommon). As mentioned above, females are also the ones who dig their young out from the nest when they are ready to hatch and then carry them safely to water where they look after them until they learn how to swim.

Crocodile Breeding in Indian Zoos

In the last decade, the Indian zoological parks have been successfully breeding crocodiles from mere six zoos in 1980 breeding only the mugger crocodile (Bustard, 1980). Today, there are over 32 zoological parks



Fig- This is a couple caught in the act while in captivity. Though copulation normally takes place under the surface, and can hardly ever be seen by humans, this pair lives in a shallow pond with clear water.



Fig- The two male crocodiles fighting in the open water. This violent dance will end in one of them backing down and swimming away, while the other becomes king of that territory



Fig- A close up on a female laying and burying her eggs.



Fig- A picture of a salty on her nest.



Fig- One of the safest places for young crocodiles is on the back or head of their mothers.



Fig. A picture of a baby hatchling right after it breaks out of its shell



Fig- Some believe that the parental care of crocs is limited to protecting from predators. In this picture though, it seems like the adult croc is bringing food for its young.

in the country breeding all three Indian crocodilians species. Technical personnel - trained specifically in crocodile breeding and management put in their skills into breeding crocodilians in captivity.

Zoological Parks in India breeding Indian crocodilians

1. Jawaharla Nehru Biological Park (Bokaro, Bihar)- Mugger
2. Sanjay Gandhi Biological Park (Patna, Bihar)- Mugger
3. Tata Steel Zoological Park (Jamshedpur, Bihar)- Mugger
4. Alipur Zoo (Calcutta, West Bengal)- Mugger
5. Nandankanan Zoological Park (Bhubaneswar, Orissa) - Gharial, Mugger & Saltwater Crocodile
6. Nehru Zoological Park (Hyderabad, Andhra Pradesh)- Mugger
7. Indira Gandhi Zoological Park (Vishakhapatnam, Andhra Pradesh)- Mugger & Saltwater Crocodile
8. Vanvigyan Kendra (Warangal, Andhra Pradesh)- Mugger
9. Arignar Anna Zoological Park (Vandalur, Chennai, Tamil Nadu)- Mugger
10. Madras Crocodile Bank (Mammalapuram, Tamil Nadu)- Gharial, Mugger & Saltwater Crocodile
11. Chennai Snake Park Trust (Chennai, Tamil Nadu)- Mugger
12. Mini Zoo, (Port Blair, Andaman & Nicobar Island)- Saltwater Crocodile
13. Sri Chamarejendra Zoological Garden (Mysore, Karnataka)- Gharial & Mugger
14. Banerghatta Zoo (Bangalore, Karnataka)- Mugger
15. Bondla Zoo (Panaji, Goa)- Mugger



16. Mahatma Gandhi Rastriya Udyan (Sholapur, Maharashtra)- Mugger
17. Pune Snake Park (Pune, Maharashtra)- Mugger
18. Sayaji Baug Zoo (Baroda, Gujarat)- Mugger
19. Sakkarbaug Zoo (Junagarh, Gujarat)- Mugger
20. Balbhavan Children's Dreamland (Rajkot, Gujarat)- Mugger
21. Kamala Nehru Zoological Gaeden (Ahmedabad, Gujarat)- Mugger
22. Surat Municipal Zoo (Surat, Gujarat)- Mugger
23. Indroda Nature Park (Gandhi Nagar, Gujarat)- Mugger
24. Jaipur Zoo (Jaipur, Rajasthan)- Gharial and Mugger
25. Jodhpur Zoo (Jodhpur, Rajasthan)- Mugger
26. Udaipur Zoo (Udaipur, Rajasthan)- Mugger
27. Van Vihar National Park (Bhopal, Madhya Pradesh)- Mugger
28. Prince of Wales Zoological Garden (Lucknow, Uttar Pradesh)- Mugger
29. Kanpur Zoological Park (Kanpur, Uttar Pradesh)- Mugger
30. Kukrail Gharial Rehabilitation Centre (Lucknow, Uttar Pradesh)

Gharial, Mugger and Saltwater Crocodile

31. National Zoological Park (Delhi)- Mugger
32. Mahendra Chaudhury Zoological Park (Chhat Bir, Chandigarh)- Mugger
33. Kurukshetra Crocodile Centre (Kurukshetra, Haryana)- Mugger

Conservation Status : There are approximately 200,000-300,000 saltwater crocodiles in the world. According to the IUNC Red List, they are at low risk and of least concern. They are widely distributed and numerous in Australia and Papua New Guinea, but practically depleted elsewhere. Before 1971, hunting of the Crocodile was unregulated. This brought the population to the brink of collapse. Since then, the hunting has been controlled and the populations have shown a massive recovery. Trade of the Crocodile is hard to control because of their wide distribution. The commercial value of their hides is very high. Still, illegal

trade and poaching is not a significant problem for these animals. The biggest enemy they have are humans. People fear these Crocodile because of their size and their reputations of being man-eaters. Though they do attack humans, it is usually due to the people's ignorance. In Australia, where they have huge programs that perform research and educate people about the Crocodile, there have only been 14 deaths in 27 years. In most cases, the victim was swimming in areas where they shouldn't have been.

Currently, *Crocodylus porosus* is not listed as threatened species under the Environmental Protection and Biodiversity Conservation Act 1999 (*Parks and Wildlife Service of the Northern Territory*). The future of this species is under no immediate threat in part due to its wide distribution around the world. The northern three states of Australia (Western Australia, Queensland, and Northern Territory), are home to at least 100,000 to 150,000 crocodiles (Webb, GJW & Manolis, SC., 1989). Other populations of *C. porosus* around the world do not number so high only reaching in the hundreds or the few in areas like India, Sri Lanka, and Thailand. Populations in some areas have drastically declined over the years due to habitat loss from the development of coastal areas. *C. porosus* may live for over 50 years, however, they are often hunted for their hide, which is very valuable, or killed out of fear (*Parks and Wildlife Service of the Northern Territory*).

Saltwater crocodile leather products are also very valuable, with skins fetching prices in the thousands. The major countries that import Australian saltwater crocodile skins are France, Japan, Singapore, and Italy (Mac Namara *et al.*, 2003). In fact, it is not difficult to find companies selling crocodile leather products online made from farmed crocodile skins. Farms exist, such as the one I found in Queensland, Australia called Universal Enterprises Pty. Ltd, specifically to raise crocodiles until they are old enough to be skinned to make leather products. For a single crocodile that is farmed, 80% of its total product value is derived from the sale of its skin, 15% is derived from the sale of meat, and 5% is from the sale of by products such as the backstrap, head/skull, and feet (Isberg *et. al.*, 2005).



Conclusion

Crocodylus porosus is the largest and one of the most powerful and intelligent reptile species living today. Crocodiles, as a whole, have existed on earth for millions of years, demonstrating that their unique physiology and hunting abilities have made them very successful at surviving changing environmental conditions over time. Their importance to biodiversity lies in the key role that they play as predators at the top of the food chain. The saltwater crocodile is a true predator, which is why it may sometimes pose a risk to human lives.

Due to increasing habitat destruction, the coastal areas where *C. porosus* is normally found are disappearing, resulting in the dispersion of the species to find new homes. In this situation, it may accidentally encounter people and mistake them for predators (or even prey). Therefore, education and awareness of this species will become increasingly important in the future, in order to ensure the safety of both humans and crocodiles.

Although as of now *C. porosus* is not an endangered species, current programs and laws to protect the saltwater crocodile already in effect, should be maintained. If populations of the saltwater crocodile should ever start to decline, then further action such as banning crocodile farming should be taken. We can all do a little something to protect the future of this species and ensure its survival for many years to come. All it takes is a little education, making the decision not to buy crocodile skin products, and supporting conservation efforts to protect their habitat.

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Saltwater crocodile facts

- The Saltwater Crocodile is the world's largest reptile and the most likely to eat a human.
- Crocodiles can smell food or water from hundred of metres.
- A large adult crocodile can stay submerged for over 2 hours
- Lifespan: Over 70 years.
- Large male crocodiles will patrol their stretches of water protecting their territories from intruding males.
- Saltwater crocodile can travel over a thousand kilometres by sea but needs dry land to reproduce.
- The brain of the salt water crocodile can comprise as little as 0.05% of the body weight.
- Because of its broad body and the low number of armor plates on the neck, the saltwater crocodile was earlier believed by some to be an Alligator rather than a true crocodile.
- The commercial value of the hide is very high, a fact that is now taken advantage of by sustainable use program in Australia and Papua New Guinea. The salt water crocodile has the most expensive hide of all crocodilians , chiefly due to its size , the shape of its belly scales, and the absence of ventral osteoderm.
- In India, saltwater crocodile restocking programme in Bhitarkanika National park in Orissa have been successful. Throughout the rest of India the species is still very rare.

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Fig. on page 144-145 (Source: http://w3.shorecrest.org/~Lisa_Peck/MarineBio/syllabus/ch9vertebrates/reptilesandbirds/repbirdwp/barbara/repro.html).