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CONSERVATION FUTURE OF THE SALTWATER CROCODILE (*CROCODYLUS POROSUS* SCHNEIDER) IN INDIA¹

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(With four plates & a text-figure)

The conservation future of the Saltwater Crocodile in India is discussed together with reasons for the species' decline and conservation programmes already in progress. The Saltwater Crocodile is endangered in India at the present time due to inadequate steps being taken to ensure the long-term survival of its mangrove habitat. Whereas hunting was responsible for the earlier dramatic decline in the species' numbers habitat loss now poses the most serious long-term problem since the species is fully protected by law and effective protection can be provided in the field. Conservation programmes have operated since 1975 in Orissa, and 1976 in West Bengal and

Andhra Pradesh, and work commenced in 1979 in the Andamans. However, the Bhitarkanika Sanctuary in Orissa is the only successfully operating sanctuary for the species in India and its integrity is seriously threatened by encroachment. Much of India's coastal mangrove forests have been destroyed and the remnants are rapidly disappearing. Unless sanctuaries to effectively protect the mangroves, as well as the wildlife, can be set up and soundly managed to ensure their long-term integrity, the Saltwater Crocodile will become extinct. It is suggested that well-managed commercial utilisation of this valuable economic species could help to ensure the future of the sanctuary areas and with them the crocodile.

"No country has done more than India to conserve its crocodilian resources and nowhere has the effort met with such marked success" (Bustard, *in press*, a). Concerned about the future of India's crocodilians, particularly the gharial (*Gavialis gangeticus*).

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Government of India asked UNDP for assistance in carrying out a survey. The resultant report (FAO 1974), stated that the Gharial was on the verge of extinction, the saltwater crocodile (*Crocodylus porosus*) reduced to two pockets in its former strong-hold along the Bay of Bengal, and the mugger (*C. palustris*) a fast depleting species.

Following this Report, Government of India initiated a Crocodile Project, with FAO/UNDP assistance, and the senior author, who had carried out the 1974 investigation, became Chief Technical Adviser for the large scale Project which subsequently ensued and is still in progress. (The present project is scheduled to terminate in December 1980.)

An early account of the project development in Orissa, the first State to take up works under the Government of India Project, is given in FAO (1975). The gharial occurs only in the Indian region and its future was the subject of much international concern. The very critical situation facing the gharial (FAO 1974, 1975) led naturally to maximum efforts being directed to that species in the early years. This tended to overshadow the deteriorating status of the saltwater crocodile, and delayed realisation of the seriousness of its poor future conservation status as a member of the Indian fauna, although a project was initiated on this species in Orissa in 1975, and a further project commenced in West Bengal in 1976. Today, the very success of "Project Gharial" tends to hide the urgent steps that need to be taken to assure the future of the saltwater crocodile in India.

As recently as 1971, Neill was able to write of this species. "In spite of its wide range, the estuarine crocodile has not become well known" and,

"The activities of the adult estuarine croco-

diles, outside of nesting and of predation on man, are practically unknown."

Since then the species has been the subject of considerable research, particularly in Australia by Messel's group which followed on from Bustard's high-lighting of its conservation predicament in the Australian region (Bustard 1967, 1969 a, b, and c, 1970, and numerous inter-governmental reports) and in India as part of the Government of India Project on Crocodile Breeding and Management (FAO 1974, 1975, Bustard 1978, *in press*, b; Choudhury & Bustard 1980; Kar & Bustard, *in press*). The biology of the species is now sufficiently well known to plan sound conservation management.

GEOGRAPHICAL DISTRIBUTION AND PRESENT STATUS

The saltwater crocodile formerly had an enormous geographical distribution from Cochin in South-west India, eastwards to South China, and extending Southwards through Malaysia, Indonesia and the Philippines to New Guinea and Northern Australia. In India the species had its world Western distributional limits near Cochin and occurred along the Bay of Bengal in the States of Tamil Nadu, Andhra Pradesh, Orissa and West Bengal and the Union Territory of the Andaman and Nicobar Islands (Figure 1).

The species is now extinct on the Asian mainland east of Saigon. Throughout this extensive remaining distributional range the species must now be considered rare to endangered. It is listed as endangered in the RED DATA BOOK of IUCN (1975).

This species was still common in the immediate postwar years before large-scale hunting commenced. However, whole populations were wiped out in a matter of years. In

CONSERVATION OF THE SALTWATER CROCODILE

Papua-New Guinea it had become very rare by the early sixties (Bustard 1967), in Northern Australia by around the mid-sixties with the hunting effort in Western Australia taking place last (Bustard 1970).

India did not escape this large-scale hunting phase (FAO 1974). In 1974 no reliable information existed on the then status of the saltwater crocodile in India. Early writers frequently commented on its abundance. The

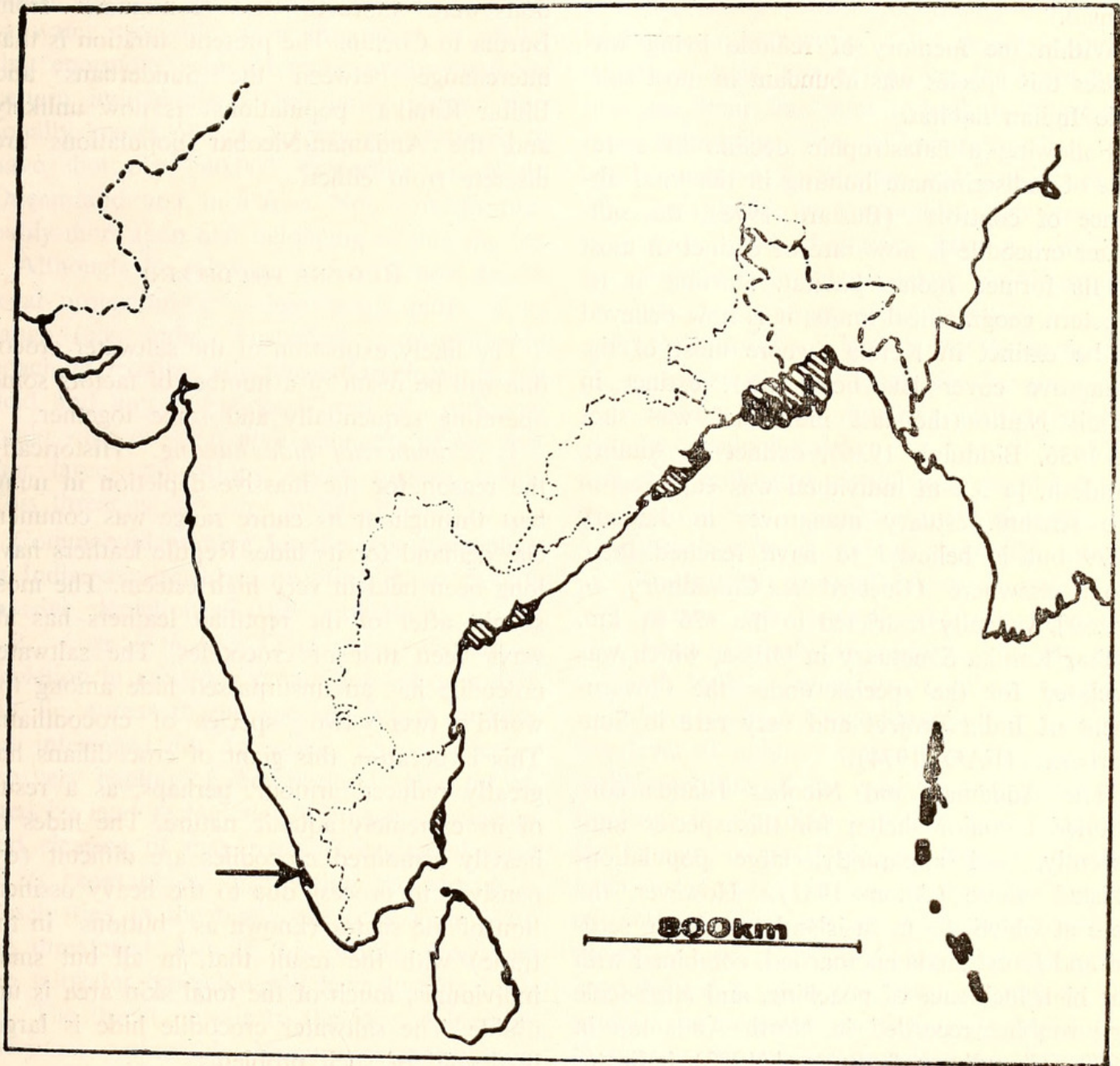


Fig. 1. Distribution of the Saltwater Crocodile in India today. Mangrove areas are indicated by diagonal lines and the occurrence of Saltwater Crocodile by solid black areas. The arrow indicates the location of Cochin, the former Western distributional limit of the species. The scale indicates 800 km.

distinguished herpetologist Günther (1864) wrote, "This is a very common species along all the rivers of the East Indian Continent and Archipelago."

More recently Deraniyagala (1939) noted: "It flourishes along the shores of the Bay of Bengal."

Within the memory of reliable living witnesses this species was abundant in most suitable Indian habitat.

Following a catastrophic decline as a result of indiscriminate hunting in the total absence of controls (Bustard 1978), the saltwater crocodile is now rare or extinct in most of its former Indian habitat. Starting at its Western geographical limits, it is now believed to be extinct in Kerala (where most of the mangrove cover has been lost), extinct in Tamil Nadu (the last individual was shot in 1936, Biddulph 1936), extinct in Andhra Pradesh, [a 3.2 m individual was captured in the Krishna estuary mangroves in January 1979 but is believed to have reached there from elsewhere (Bustard & Choudhury, *in press*)], virtually restricted to the 176 sq. km. Bhitarkanika Sanctuary in Orissa, which was declared for the species under the Government of India Project and very rare in Sundarbans, (FAO 1974).

The Andaman and Nicobar Islands constituted a major shelter for this species until recently, and apparently, large populations existed there (Anon. 1931). However, the rate at which the main islands are being settled and forest lands encroached, combined with the high incidence of poaching, and large-scale egg robbing recorded in North Andaman in 1978 (Choudhury & Bustard 1980) indicates that these populations have an uncertain future.

Two pockets of the saltwater crocodile still occur, therefore, on mainland India (in Oris-

sa and West Bengal) together with much reduced populations in the Andaman and Nicobar islands. The latter populations presumably have had some interchange with those in Burma, and in the case of the Nicobars, with Sumatra. Similarly, the coastal populations were more or less contiguous from Burma to Cochin. The present situation is that interchange between the Sunderbans and Bhitarkanika populations is now unlikely and the Andaman-Nicobar populations are discrete from either.

REASONS FOR DECLINE

The likely extinction of the saltwater crocodile will be result of a number of factors some operating sequentially and some together.

1. *Commercial hide hunting.* Historically the reason for the massive depletion in numbers throughout its entire range was commercial demand for its hide. Reptile leathers have long been held in very high esteem. The most sought after of the reptilian leathers has always been that of crocodiles. The saltwater crocodile has an unsurpassed hide among the world's twenty-two species of crocodilians. This is because, this giant of crocodilians has greatly reduced armour, perhaps, as a result of its extremely aquatic nature. The hides of heavily armoured crocodiles are difficult (expensive) to process due to the heavy ossification of the scutes (known as "buttons" in the trade) with the result that, in all but small individuals, much of the total skin area is unusable. The saltwater crocodile hide is largely devoid of such problems.

Furthermore, as pointed out by Neill (1971) the large average size, as well as the reduced armour, assures the hide-hunter of a handsome profit. Neill stressed; "Man is the great-

est enemy of the estuarine crocodile and the species is rapidly being exterminated."

The coastal mangrove-fringed tidal swamps and associated river systems favoured by this species, are in general inhospitable to man and in most parts of the world people formerly entered this ecosystem only to hunt the saltwater crocodile. It is important to realise that enormous sums of money were made by certain individuals. The senior author personally knows of one shooter who claimed to have shot over 40,000 crocodiles in North Queensland and in Papua New Guinea probably more than half belonging to this species.

Although the saltwater crocodile now enjoys legal protection in at least some parts of its range (e.g. India, Australia) prevention of poaching requires effective enforcement in the field and any sustained level of poaching could wipe out the small remnants of the former large populations which survive today. This threat is still very much alive.

Commercial hunting for the hide took place in India, as elsewhere, resulting in an equally massive depletion of the population.

2. *Loss of habitat.* The phase of massive depletion in crocodile populations is now past, but the threat to the species' future survival has intensified not decreased. This is because the very habitat of the species is now threatened by land reclamation/drainage of swamps and clearing of mangroves. Throughout most of its geographical distribution the species is closely tied to the mangrove ecosystem. With the threatened loss of this whole ecosystem the saltwater crocodile will have lost its habitat. The threat now is to the very vulnerable survivors—vulnerable because their numbers have shrunk so drastically as a result of the hunting phase, and with this their average size, threatened because the habitat is contracting rapidly—nowhere more so than in

India.

Habitat destruction in India has been very much worse than the mean situation elsewhere in the geographic range. This, in part, reflects the massive depletion of India's forests in the last three decades, as a result of the ever increasing timber requirements for fuel and house construction of the rapidly expanding population. The mangroves have not been immune from this, and indeed, have proved most vulnerable. This is because:

- a. mangrove forests are not considered to be valuable in economic timber terms in India, and, therefore, have a low protection and management priority with the State Forest Departments,
 - b. the alluvial soil built up by the mangrove ecosystem is extremely fertile, and when reclaimed high quality cultivation land is obtained, and
 - c. the ecological significance of the mangroves—as a barrier to cyclone damage, beach erosion and as a natural spawning/nursery ground for many species of marine fish, prawns and crabs has not been properly appreciated. So the loss of India's mangroves continues today.
3. *Animosity.* Crocodiles suffer from a low level of public esteem. The saltwater crocodile, because of its very large size, and its existence in a habitat which is itself frightening to man, is greatly feared. There have also been instances of attacks on humans, mostly by nest-guarding females (Bustard & Choudhury, *in press*). These, greatly exaggerated, have helped to turn the hand of man firmly against the species. There was no legislation to protect the species anywhere in its world-wide range until the massive depletion had already occurred.
4. *Use as food.* The saltwater crocodile is hunted as food in various parts of its range.

This subsistence hunting, when not associated with commercial hide-hunting, is not usually dangerous to the population and has existed as part of the species' ecology since time immemorial. The natural increase of the population is well able to cope up with such losses in the absence of commercial hide-hunting provided there is not an explosion in the population of the hunters.

There is little eating of cocodile meat in India, apart from some tribal groups, however, the eggs are widely eaten. These are a good source of nourishment, particularly valuable where hens' eggs are rare or expensive—as in the Andamans.

5. *Medicinal uses.* In India, there have been additional, subtle pressures on the species not found in many parts of its non-Indian range. These include medicinal demand for parts of the crocodile and/or its eggs. The liver, spleen and particularly the gall bladder and also the fat of the crocodile, are highly esteemed medicinally. The gall bladder is believed to cure eye diseases such as cataract, the liver and spleen bronchitis, and the fat to be remedial for rheumatism. In some areas the eggs are also believed to have medicinal value resulting in enhanced egg hunting (Choudhury & Bustard, *in press*).

CONSERVATION PROGRAMMES

The first conservation programme for the saltwater crocodile started in Papua New Guinea following Bustard's Report to Government in 1967 (Bustard 1967, 1969). This has now grown into a large-scale project, tied in to the commercial economy of the swamplands. This Project, now receiving assistance from UNDP/FAO, will have major conservation impact if it succeeds in combining the conservation of saltwater crocodiles with successful village farming as proposed by Bustard.

In Australia, the first legislation to protect the saltwater crocodile was gazetted by the Government of Western Australia in 1971 as a result of Bustard's (1970) report on the status of the species in the State. Western Australia also gazetted the first sanctuary anywhere in the world specifically for the saltwater crocodile in 1971. Meanwhile, conservation studies aimed at commercial production of skins, and a sound conservation programme by tribal aborigines were commenced by Bustard at Edward River, Cape York, North Queensland, Australia. This work continues on a small pilot research basis but has not reached the commercial phase of Papua New Guinea. Bustard's highlighting of the conservation status of the saltwater crocodile in Australia (see earlier references) has resulted in very extensive studies on the species by Messel's group (Messel *et al.* 1977, 1978), which are bound to have a useful impact on its conservation at least within Australia.

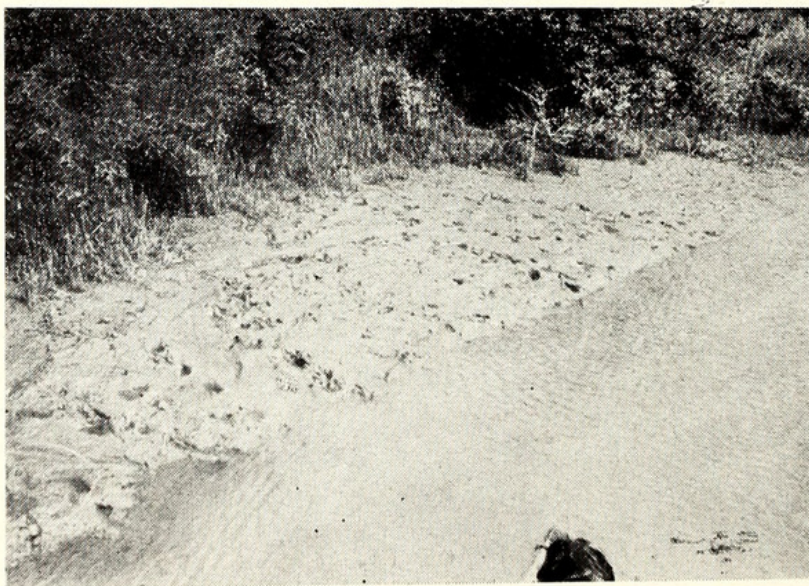
In India the Wildlife (Protection) Act, 1972, which listed the saltwater crocodile together with India's two other species of crocodilians in Schedule I (fully protected at all times) was a most significant step. This legally banned all crocodile hunting in India. Similarly, Export Instruction No. 46/73 forbade the export of crocodiles and gharial, their hides or products therefrom. This Government of India Act was taken up by all States in India. Enforcement of the Act became a problem and has been overcome with varying degrees of success. The initiation of even a small-scale project on the species has enormous conservation effect, since the presence of even a very few dedicated workers in India has been found to be an effective deterrent to poaching.

The present conservation status of the species is presented below on a State by State



Above: Large male Saltwater Crocodile (over 6.5 m) in one of the typical basking situations in the Bhitarkanika Wild Life Sanctuary, Orissa. Such large individuals are extremely rare in most of the species' distributional range today.

Below: A typical 'blank' (Siddhu 1963) in the mangroves of Coringa Reserve Forest (now Coringa Wild Life Sanctuary), Godavari delta, Andhra Pradesh. These result from clear felling in the past and show little/no mangrove regeneration.



Above: Spoor marks of a large male Saltwater Crocodile (over 5 m) the hind foot impressions are seen on the left and on the right the massive rut left by the tail. The hind foot impressions, from which total length was established, measured 40-45 cm. *Below:* Preferred basking area of a 3.5-4 m Saltwater Crocodile. The many foot imprints and the semi-circular slide mark should be noted. At high tide this individual will be basking in the grass like the male shown in Plate I.

basis.

1. ORISSA. The entire remaining mangrove forests of the Brahmini-Baitarani delta, known as Bhitarkanika, and comprising 176 sq. km, was declared a sanctuary in May 1975. In the same month, fishing was banned within the sanctuary. This latter action was essential as all poaching activity was carried out by people from inter-state visiting the area under the pretext of fishing. Furthermore, crocodiles readily become entangled in fishing nets and drown or are clubbed to death. Clear-felling had been practised on an extremely short rotation cycle and was threatening the very future of the mangrove forests. Subsequently (1976) the State Government of Orissa completely ceased mangrove felling operations in the entire sanctuary area.

The sanctuary area comprises part of the ex-zamindari lands of former Raja of Kanika. Rajasaheb Kanika has long been extremely interested in saltwater crocodiles and is very knowledgeable about them. Although he allowed hunting under licence, this was organised so that the species would be preserved. The massive depletion in numbers took place later in the 1950's and early sixties. At the end of 1976 the census carried out by Mr S. Kar, Research Scholar working on saltwater crocodile under the senior author through the State Forest Department Crocodile Project, gave a total of thirty-five adults and only six in the age classes about to recruit to the breeding population. It is interesting that following twenty months of conservation-research-management of the area there were 61 young crocodiles between 1-1.4 m—hatchlings of the 1974 season. (Kar and Bustard, *in press*). This contrasts markedly with the situation facing the young of the previous year (1973), which by late 1975, had "virtually all disappeared, presumably as a result of poach-

ing activities prior to the declaration of the sanctuary" (FAO 1975). Clearly, the greatly enhanced survival observed at the end of 1976 is a result of the ban on fishing and the protection afforded to the sanctuary area.

The Orissa Project, following the "rear and release" technique described in FAO (1974), proposes to increase the breeding population to several 100 adult individuals and, thereafter, to manage the population at around this optimal level. This is being done by collecting all available natural nests as soon after egg laying as practical for safe hatching incubation and subsequent rearing of young to a release size of 1 metre. First releases back into the wild took place in 1977 (15 animals). And this, combined with the excellent survival of juveniles in the wild described above, boosted the potentially recruiting segment of the population over twelve times. This is an excellent illustration of the ease with which a population can begin to recover, if afforded stringent protection. The 1978 release (of 80 crocodiles) has boosted the recruiting segment over 25 times, since 1975.⁴ The conservation programme will ensure that these released crocodiles have every opportunity to recruit to the breeding cohort of the population without the risk of being killed by poachers. The definitely recorded survival of the 1977 releases was 80 per cent after two full years had elapsed (it may, of course, have been even higher).

2. WEST BENGAL. A project for the saltwater crocodile was taken up by the State Forest Department in Sunderbans in 1976. One nest was collected from the wild for captive incubation and rearing of young. Excellent survival was obtained and the immature crocodiles will be released during winter

⁴ A further thirty were released in January 1980.

1978/79.⁵ Sunderbans is the largest mangrove area in the world. A large part of it is in Bangladesh but the Indian portion extends to 200,000 hectares (Blasco 1977). A portion of this is already included in the State Project Tiger Reserve, protection should be good and the potential for the saltwater crocodile excellent.

3. ANDHRA PRADESH. The major remaining mangrove area in the State, Coringa Reserve Forest, in the Godavari delta, was declared a sanctuary (Coringa Wild Life Sanctuary) in July 1978 with the aim of rehabilitating the saltwater crocodile, extinct in Andhra Pradesh. This is being done by egg collection in the Andaman Islands and captive rearing at Hyderabad in order to build a stock of the species. Three 1.2 m crocodiles hatched from eggs collected from the Andamans, were released into this area in March 1978. Further releases are planned.

4. TAMIL TADU. The sole remaining mangrove area is Pitchavaram in the Cauvery delta. This area has been suggested as a rehabilitation site for the saltwater crocodile in Tamil Nadu. However, the area is extensively fished and it may not be possible to reconcile the conflicting requirement of crocodile and fishermen.

5. ANDAMAN AND NICOBAR ISLANDS. Virtually nothing is known about the quantitative status of the saltwater crocodile in this Union Territory. Chatterjee (1977) noted that the saltwater crocodile; "is widely distributed and is found in almost all the islands of the Andaman and Nicobar groups. Unrestricted persecution of these animals by local people in the past has greatly reduced their numbers. Much destruction is also caused by collecting

their eggs whereby the entire brood is wiped out. The slaughter of these animals has been greatly reduced since the implementation of the Wildlife (Protection) Act."

Whitaker and Whitaker (1978) highlighted the need to carry out detailed surveys to determine the crocodile population and currently available habitat, a conclusion with which we concur. They also advocated better enforcement of protection by posting adequate field staff.

The Government of India Crocodile Project has been interested to extend conservation work to the Andamans and to have the Andaman Forest Department as a full member of the Project by initiating a Government of India-assisted Crocodile Project in the Territory.

The Andaman Forest Department has allowed the Project to collect eggs since 1976. However, due to logistic difficulties, it was not possible to undertake a full egg collection until 1978 when this was carried out by the Andhra Pradesh State Project by one of us (Bustard & Choudhury *in press*). In 1979, the Andamans Forest Department started their own project with the construction of a holding capacity and the collection of eggs.

IMMEDIATE PROBLEMS FACING THE SPECIES IN INDIA

1. *Habitat loss.* Doubts about the continued survival of the mangrove habitat, both on the mainland and in the Andamans, gives rise to serious concern for even the medium-term future of the saltwater crocodile. The model rehabilitation programme being operated by the Orissa Forest Department at the Saltwater Crocodile Research and Conservation Centre at Dangmal, within the Bhitarkanika Wildlife Sanctuary declared for the

⁵ Forty 1976 hatchlings were released in May, 1979.

species under the Project, will be of no avail unless the habitat can be effectively protected against encroachment. This problem is political and applies equally to other projects under initiation or planned.

2. *Large-scale egg robbing in Andamans.* Choudhury & Bustard (1980) have indicated the very high level of nest predation by settlers (84%) on North Andaman. They also noted five instances of nest-guarding females being killed at the nest during the 1978 nesting season. This represents a loss of 17% of the nesting females in a single season. Clearly under such a regime, in a species which does not commence breeding until it is at least 10 years old, the population will soon become extinct. This could be effectively stopped by extending the Government of India Crocodile Project to the Territory.

NEED FOR NEW INCENTIVES IF THE SPECIES IS TO SURVIVE

Now that India has adopted suitable legislation—the Wild Life (Protection) Act, 1972—it is necessary as a second step to see that it is fully implemented. Bustard (1969 c), in a world-wide review on problems of crocodile conservation, wrote; “Few Governments have suitable *conservation legislation* for crocodiles. Where legislation does exist no attempt is being made to enforce it.” This legislation should be complemented by the creation of good National Parks or Sanctuaries for crocodiles. It should be noted that, as pointed out by Bustard (1971), National Parks and other categories of refuges are not, and can never be, any more than tools in crocodile conservation. Bustard (1971) concluded that the creation of National Parks as an act in isolation would be of little help to crocodile conservation.

The third step in India is to ensure that the

National Park and sanctuary areas are inviolate—both against legal and illegal encroachment and all kinds of poaching activity. This requires active co-ordination at the Central level and staffing by a cadre of motivated and specially trained protection staff.

The various saltwater crocodile habitats in India are discussed below in the light of the requirements set out above.

ORISSA

1. Ten per cent of the sanctuary area was reportedly encroached during the year 1977/78 (de Waard 1978). The ex-zamindari forests which comprise the sanctuary have to be clearly demarcated to prevent encroachment.
2. The many villages within the sanctuary have to be carefully demarcated to prevent encroachment, which will otherwise obviously take place increasingly with population growth.
3. Adequate supplies of timber for fuel purposes will have to be maintained at a number of conveniently located timber depots within and around the sanctuary (Kanungo 1976).
4. Protective staff will, of course, have to be maintained as an effective deterrent to poaching activities.
5. The research husbandry unit will have to provide continuously updated figures on the status and break-up of the crocodile population within the sanctuary, so that proper assessment of the performance can be made and future requirements planned on a sound scientific management basis.
6. In order to retain the co-operation of the local people, so essential for a project of this kind, the crocodile management programme should result in real material

benefit to the people. This would be possible by tying conservation in the sanctuary to commercial crocodile farming at the village level.

7. Putting such an economic price tag on the sanctuary may be the most effective method for ensuring its future integrity.

WEST BENGAL

There is need for the crocodile project in West Bengal to gather momentum. Otherwise there are at present no measures specific to this area which require implementation. It will, of course, be essential to completely ban fishing in the crocodile rehabilitation sanctuary areas.

ANDHRA PRADESH

1. The recently declared sanctuary will have to be staffed and become operational.
2. If the sanctuary is to be of any use, fishing will have to be banned throughout the entire sanctuary as was done in the Bhitarkanika Saltwater Crocodile Sanctuary, Orissa, immediately following declaration.
3. Felling of mangroves has ceased in the sanctuary. This action must be maintained for the following reasons:
 - a. the mangroves are not regenerating well following clear-felling on a twenty year rotation cycle. Even cursory examination shows that in many areas there will not be a further crop after twenty years.
 - b. furthermore, the clear-felling practice used in mangrove areas encourages encroachments—there is a strong tendency for people to move into the felled areas and take up cultivation.
 - c. finally, the amount of disturbance caused by clear-felling is quite incon-

sistent with a small sanctuary like this.

4. Proper protection should be given to the total land area of the sanctuary so that the mammal fauna—especially the ungulates—can recover. These form an important part of the diet of adult saltwater crocodiles, and as in the case of tiger, healthy populations of deer and wild pigs are the best guarantee against predation on domestic stock. In the Bhitarkanika Wildlife Sanctuary the chital herds have responded excellently to the protection and wild pigs have increased to such an extent as to become a nuisance on adjacent agricultural lands.

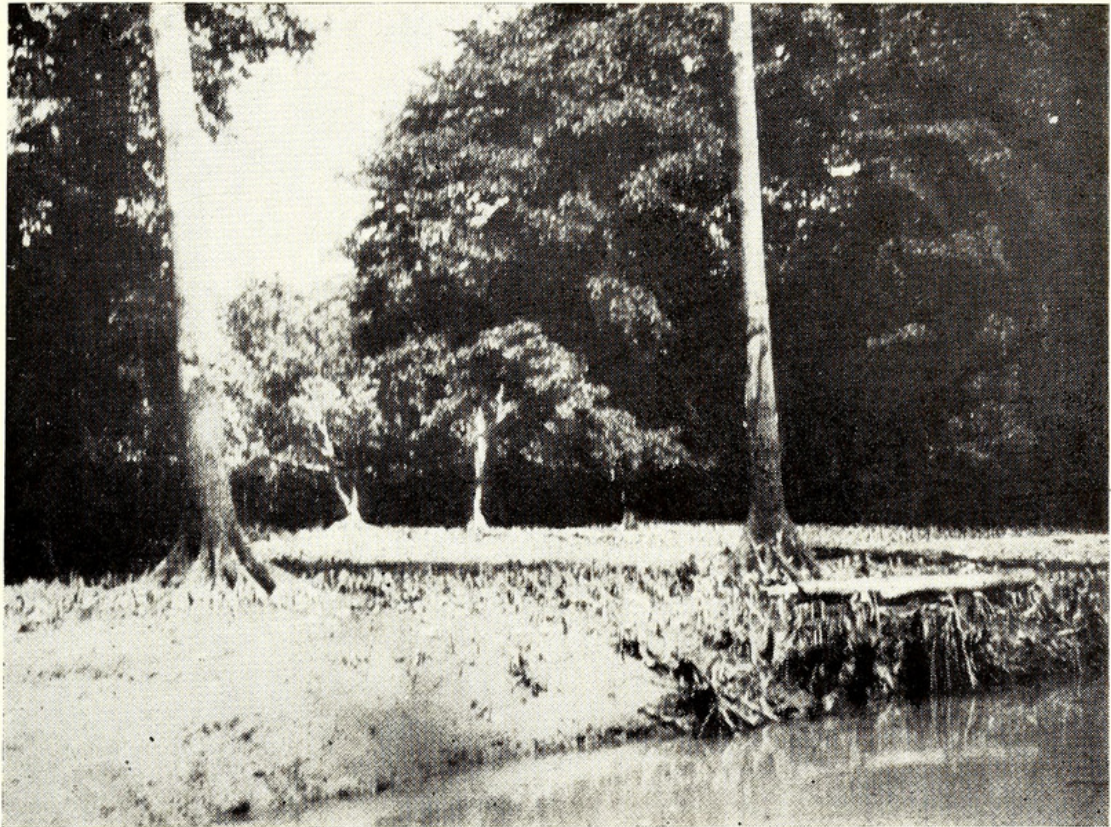
TAMIL NADU

Before a rehabilitation programme could be taken up in the Cauvery delta mangrove, it would be essential to ascertain that it would be possible to completely prohibit fishing throughout the proposed sanctuary area. This matter is under investigation.

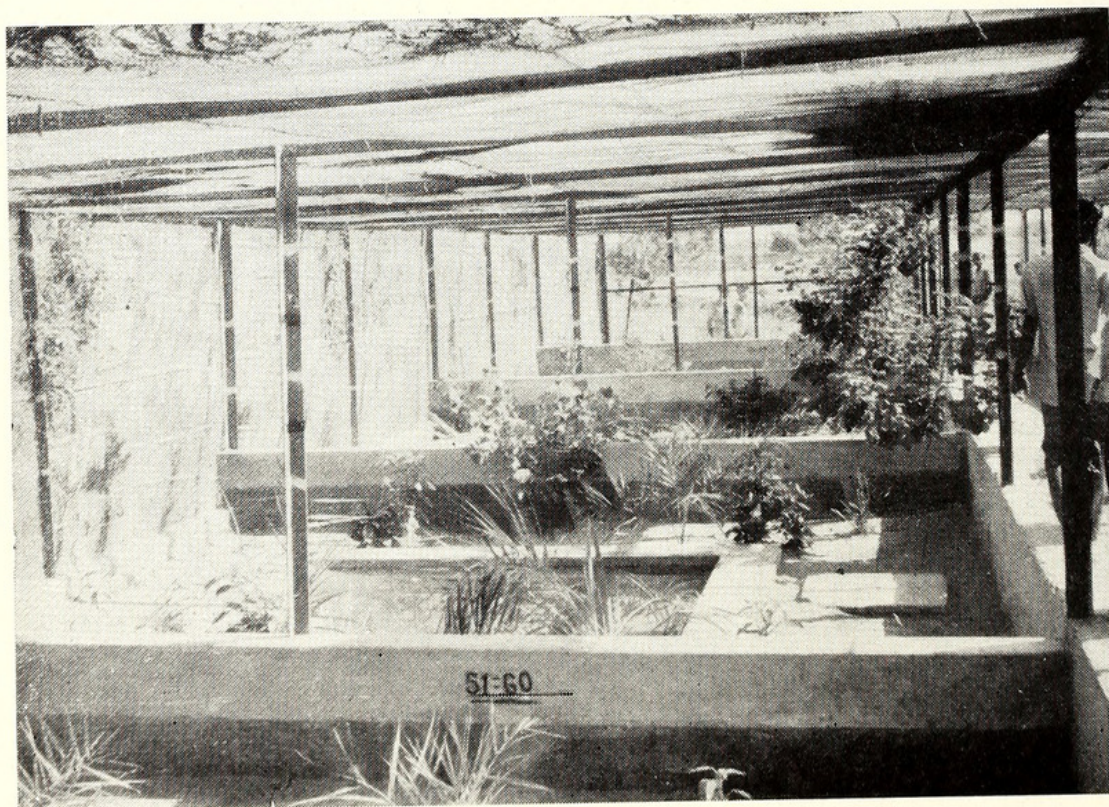
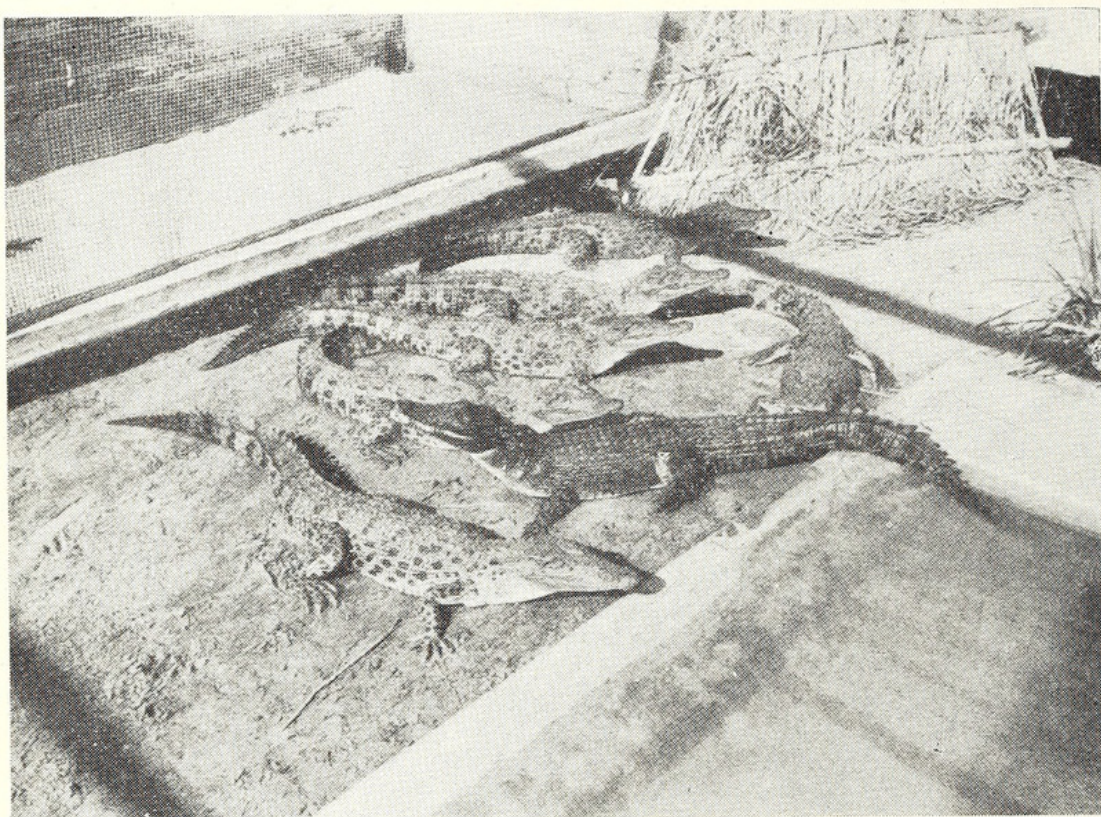
THE ANDAMAN AND NICOBAR ISLANDS

1. A crocodile project should be taken up in this Union Territory under the Government of India Project, Crocodile Breeding and Management, receiving technical assistance from FAO/UNDP.
2. In order to implement such a project it will be essential to strengthen the Wildlife Wing of the Andamans Forest Department. The sequential tasks of the Project would be:
 - a. to carry out surveys of the Andaman-Nicobar Group in order to establish the location of the best remaining saltwater crocodile populations and relate these to areas where the creation of sanctuaries will be feasible.
 - b. to take up conservation/husbandry

Bustard & Choudhury: Saltwater Crocodile



Above: Felling of mangroves for fuel-wood and house construction.
Below: Clearing for cultivation along the sweet-water creeks used for nesting by the Saltwater Crocodile. Note the bamboo fencing erected to keep out ungulates.



Above: Eighteen month old juvenile Saltwater Crocodiles (mean 1.1 m in total length) in the Bhitarkanika Research and Conservation Centre, Dangmal, Orissa.
Below: A general view of one part of the above hatchling pool complex.

work *within* the sanctuaries as they are gazetted.

- c. to assist the Wildlife Wing of the Andamans Forest Department in reducing nest-robbing and other poaching activities.
3. It is *urgent* to locate and gazette suitable sanctuary areas prior to increased settlement.

MASTER PLAN FOR THE FUTURE

The master plan for the future combines the creation, management, and operation of a net-work of specially gazetted sanctuaries/ National Parks with the creation of a cadre of highly trained and motivated wildlife staff. Commercial utilisation is seen as an important tool in the crocodiles' conservation.

A. SANCTUARIES

MAINLAND

1. The future integrity of the Bhitar Kanika Sanctuary must be guaranteed.

The Bhitar Kanika population of saltwater crocodile is remarkable in still having quite a number of very large individuals in the population. In most of the species range these large individuals were wiped out many decades ago. Ninety-three per cent of the adults in this sanctuary measure more than 3.5 m and ten per cent exceed 6 m (Kar & Bustard, *in press*). The sanctuary also has the distinction of being the habitat of the largest crocodile of any species in the world known to scient (Daniel and Hussain 1974, Bustard *in press*, c). Bustard, on the basis of measurement of the intact skull, estimated this crocodile to be 7.35 m.

In view of this, and the excellent conservation management programme being operated by the Wildlife Wing of the Orissa Forest

Department it is essential that this population be preserved for posterity. The threat to the population arises from the threat to the sanctuary itself. To ensure the survival of this unique population of a critically endangered species, Government of India should assume responsibility for the territorial integrity of the sanctuary. This might best be achieved by making the sanctuary a National sanctuary as has been done in case of the gharial (*Gavialis gangeticus*) in a tri-state sanctuary (U.P., M.P. and Rajasthan) on Chambal river.

The size of adults of the Bhitar Kanika population is very much larger than the population studied on North Andaman (Choudhury & Bustard 1980). Discussion with a number of crocodile hunters, on the basis of large samples killed a decade or more ago, confirms that the Bhitar Kanika population even then consisted of very much larger crocodiles than those of North and Middle Andamans.

In any conservation programme for the saltwater crocodile in India the Bhitar Kanika sanctuary will be a lynch-pin. This is because this is the only scheme for the saltwater crocodile in India which has been fully implemented. It will still be essential to ensure the territorial integrity of this area even if the embryonic scheme in Sunderbans becomes a success. This is in part because it is most unwise to place total reliance for a species survival on the animals within one single sanctuary.

2. A viable population of saltwater crocodiles, should be built up in Sunderbans within the Project tiger reserve where they can be assured of good protection.

ANDAMAN AND NICOBAR ISLANDS

The importance of the Andamans for the saltwater crocodile lies in the following con-

siderations:

- a. there may still be good populations in less accessible areas of the Group
- b. if these areas are located quickly it should be possible to gazette sanctuaries in virgin mangrove forests, prior to encroachment. Clearly, it is much easier to manage a sanctuary without human settlement within it
- c. the Andamans is the home of the most isolated population of saltwater crocodiles in the Indian region. North Andaman lies at a distance of 896 km south-east of the mouth of the Hoogly and 1300 km East of the nearest area of the mainland. In the case of the Andamans, urgent action is essential because of rapid rate of settlement and consequent encroachment. It is important to gazette at least one large sanctuary and preferably two, for the species in this Union Territory.

B. COMMERCIAL UTILISATION

The saltwater crocodile is an ideal species for economic management. Exploitation, provided it is on sustained yield basis or from farms in which all products are produced from eggs laid in the farm, in no way conflicts with conservation. On the contrary this can provide an important tool for the conservation of the species resulting in a good level of management in the sanctuaries. If the sanctuaries and associate rearing farms can give good revenue to government then the integrity of the sanctuary areas is assured and with that the saltwater crocodile.

C. STAFF TRAINING

The Government of India Project, Crocodile Breeding and Management, under technical assistance from FAO/UNDP, has establish-

ed a Central Institute—the Crocodile Breeding and Management Training Institute—charged with the training of Forest Department personnel. The training programme covers not only all aspects of crocodile husbandry and management but also sanctuary and wildlife management. This Institute was created because of the obvious need for a cadre of well-trained management personnel without which even the best planned sanctuary programme of government could not hope to succeed.

The senior author has also been providing highly technical training of seven Ph.D Research Scholars recruited at post-M.Sc. level. Their contribution to the Project has been substantial and the junior author of this paper is one of them.

SPECIES WORLD-WIDE SURVIVAL PROSPECTS

Neill (1971) concluded his account on this species with these words: "In the 1950's and 1960's with the price of crocodilian leather skyrocketing, hundreds of thousands of estuarine crocodiles, were killed annually and its disappearance from all parts of its ranges is to be expected within a very few years."

It is our task to ensure that this gloomy prognosis does not prove accurate—at least for India. Neill considers that probably all the living crocodilians are doomed to extinction. The Crocodile Breeding and Management Project of the Government of India has shown that this need not be the case. The gharial is well on the way to being saved and if proper decisions are taken now the saltwater crocodile can look forward to a secure future within India, even if it is doomed to extinction throughout most of its range.

MAJOR RECOMMENDATIONS

The following recommendations are sug-

gested in order to implement the proposed Master Plan:

1. Bhitarkanika Sanctuary, Orissa should become a National sanctuary (100 per cent Central funding for both capital and recurrent costs).
2. The Government of India, FAO/UNDP assisted Project, Crocodile Breeding and Management should be extended to the Union Territory of the Andaman and Nicobar Islands with immediate effect. Once again this will have to be on the basis of 100 per cent Central financing. The reason a scheme has not been initiated already is lack of staff in the Wildlife Wing of the Andamans Forest Department. This Department faces special difficulties not being a service department.
3. Every effort should be made by the Gov-

ernment of India Project to encourage State schemes (under the Central assistance programmes to National Parks and Sanctuaries) in order to rehabilitate the saltwater crocodile elsewhere. It may not now be possible to do anything in Kerala, but Andhra Pradesh should be encouraged and possibilities in Tamil Nadu should be investigated.

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