

## CONGENITAL DEFECTS IN THE GHARIAL *GAVIALIS GANGETICUS* (GMELIN)

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### SUMMARY

Twelve kinds of congenital defects, namely, absence of one or both eyes, corneal defect, unsmooth pupil, squint, bent neck, hunch back, bent tail, crossed snout, absence of palatal valve, bulged belly and wrong umbilical constriction were noticed for gharial eggs incubated under simulated ideal conditions, and are believed to be naturally occurring. It is believed that a "blind" gene is present in the gharial populations from Kali-Narayani-Gandaki and Karnali rivers in Nepal.

### INTRODUCTION

The biology of the gharial (*Gavialis gangeticus*) is virtually unknown (Neill, 1971). The only published data on congenital defects concern two blind gharial (Singh & Tandan, 1978; Subba Rao & Bustard, 1979). The literature on congenital defects in crocodylians is very sparse. Bustard (1969) noted an abbreviated and malformed tail in *C. novaeguineae*, Kar (1980) reported an instance of malformation at birth in *C. porosus* and Kar & Bustard (1982) reported a greatly abbreviated tail in *C. porosus*, all observations on hatchlings or full term embryos. Lynn & Ullrich (1950) described experimental production of shell abnormalities in chelonians.

In 1975 the Government of India commenced a large-scale conservation programme on the gharial (FAO 1975; Bustard, 1975). Under this programme we have incubated 1061 gharial eggs under simulated natural conditions in a hatchery designed for tropical conditions (Bustard & Singh, in press). This has given us the opportunity to study and record what we consider to be naturally occurring congenital deformities.

### MATERIALS AND METHODS

Gharial eggs collected from the Kali-Narayani-Gandaki river system (1975, 1976, 1977) and the Chambal river (1979, 1980) were incubated in brick-walled cells of river sand 1 m<sup>3</sup> in a predator-proof wire-mesh enclosure. This method provided a mean nest temperature of 30°C (range 29–32°C). Moisture content was maintained at around 8% water content in the medium (by weight) as recommended by Bustard

(1966). Yearwise incubation and successful hatching were as follows:

Year	Place of incubation	Total eggs	Total hatchlings	% hatchlings
1975	Tikerpada, Orissa	71	42	59.1
1976	Tikerpada, Orissa	230	65	28.2
1977	Royal Chitwan National Park, Nepal	590	438	74.2
1978	Royal Chitwan National Park, Nepal	—	—	—
1979	Tikerpada, Orissa	20	15	75.0
1980	Tikerpada, Orissa	150	114	76.0

In our experience gharial with congenital defects do not emerge themselves—they require to be helped out of the eggs. Our standard practice is to surgically open all unhatched but otherwise surviving eggs 3–4 days after normal hatching is complete. Using great care it is possible to remove undamaged, all living young, some of which may survive for years. At the same time we open all other eggs that have failed to hatch. Hence complete data are recorded on all embryos showing any development.

### RESULTS

Congenital defects were noticed in the Kali-Narayani-Gandaki hatchlings in all years. During 1975 and 1976 the defects were restricted to the eyes but in 1977 defects pertaining to the morphology of other parts of the body were also noted. No congenital defects were recorded in 1979 and 1980 in hatchlings from Chambal-laid eggs. Frequency and types of these congenital defects are presented in Table I and described below.

#### EYE DEFECTS

Eye defects recorded during 1975, 1976 and 1977 occurred in respectively 9.0%, 5.0% and 5.2% of the developing hatchlings. The various defects included blindness, defects in corneal colouration, squint and unsmooth pupil.

#### Blindness

Complete absence of both eyes was noticed to be the most common congenital defect and of consistent

TABLE I. Occurrence of congenital defects in *G. gangeticus*

Nature of defect	Number of instances	Total number of fertile eggs incubated	Remarks*
No eyes	2	44 (1975)	1, 6, 8, 9, 11
	3	140 (1976)	
	2	476 (1977)	
One eye present	1	476	1, 5, 8, 9, 11
Corneal defect	1	190	1, 7
Unsmooth pupil	1	44	1, 7
Unsmooth pupil (in one or both eyes)	1	44	1, 7
	3	190	
	11	476	
Squint	1	44	1, 7
Bent neck	21	476	3, 7, 8, 9
Hunch back	2	476	4, 10
Bent tail	11	476	1, 5, 8
Crossed snout	2	476	1, 7, 9
Mouth valve	1	476	1, 6, 10
Bulged belly	2	476	4, 10
Umbilical constriction	1	44	1, 6

\* 1, persistent; 2, not persistent; 3, persistent in a few; 4, fatal; 5, dead but the defect may not be the cause; 6, may be fatal; 7, not fatal; 8, difficulty in swimming; 9, difficulty in feeding; 10, difficulty in respiration; 11, difficulty in vision.

occurrence in the hatchlings both at Tikerpada and Nepal. A total of seven such cases resulted from incubation of 42 fertile eggs. In all cases, both eyes were completely absent (Plate 1a) without any sign of development of the embryonic eye buds.

Only one case was recorded during 1977 of a hatchling with only one eye (Plate 1b). The corresponding area on the other side showed no trace of the eye. This hatchling had an additional deformity of the snout, which was horizontally arched and longer than normal.

#### Corneal defect

The normal colour of the iris in gharial is light brown. In one young individual, hatched during 1976, it was yellowish-red in colour. The cornea was depressed and the pupil did not open properly in the dark. When the animal reached a length of a metre, the colour changed to light yellow. Visual response of the eye appeared to be poor.

#### Unsmooth pupil

In many juveniles a persistent defect was noticed with the pupil. In dark, the pupil opens wide but in light it does not close properly. The constriction of the pupil in response to light, leaves an unsmooth and slightly round margin (Plate 1c and d).

#### Squint eye

Only one case was noticed in 1975 where the pupil of the right eye had been shifted to the front, forming a squint (Plate 1e).

#### BENT NECK

Twentyone of these hatchlings had bent necks at the time of hatching during 1977 (Plate 1f). The bends were 9:12 = right:left respectively. Within 1 month the defect had disappeared in all except four hatchlings.

#### HUNCH BACK

Two hunch back hatchlings were surgically removed from their eggs during 1977. These juveniles had a small hunched body, about 15 cm in total length. The head was also small and deformed. Both juveniles died within 24 hours of emergence.

#### BENT TAIL

In this condition the tail remains permanently bent to one side or is twisted (Plate 2a). This defect was noticed with 11 hatchlings in 1977. Such hatchlings naturally faced difficulty in swimming and thus kept mostly to shallow water in the rearing pools.

#### CROSSED SNOOT

Two hatchlings during 1977 had a crossed snout (Plate 2b). This defect was not pronounced when they hatched, but it became evident within the next five days. In this defect the upper jaw crosses over the lower jaw and, therefore, projects to the side. When the snout was still in its "quick growing phase" at 30 days old, treatment was resorted to in an attempt to correct the defect. The hatchlings were force-fed throughout the treatment period and after feeding both jaws were tightly bound together with gauze cloth or adhesive plaster. Following nine days treatment the defect was fully corrected in one individual but reappeared after two years. In the other hatchling, however, it reappeared after 24 hours and subsequent treatment never improved the condition.

#### MOUTH VALVE

One case with this defect was noticed in 1977. In the region where the mouth opens into the oesophagus, it is guarded by two palatal flaps one aligned to each jaw. The internal nares open behind the upper valve. In this defect the upper valve is completely absent and thus the internal nares become visible when the jaws are kept open (Plate 2c and d). Such a gharial cannot breathe in water with its mouth open and snout tip protruding above the surface. It died of drowning.

#### BULGED BELLY

In 1977 two cases were noticed where the hatchlings were only about 12-15 cm in length and had a large bulged-out belly. These juveniles failed to emerge from the eggs by themselves. The belly had occupied almost all the space within the egg. Both the hatchlings died within 2 hours of emergence.

#### UMBILICAL CONSTRICTION

During embryogenesis the ventral closing up of the skin in the umbilical region normally encloses the yolk

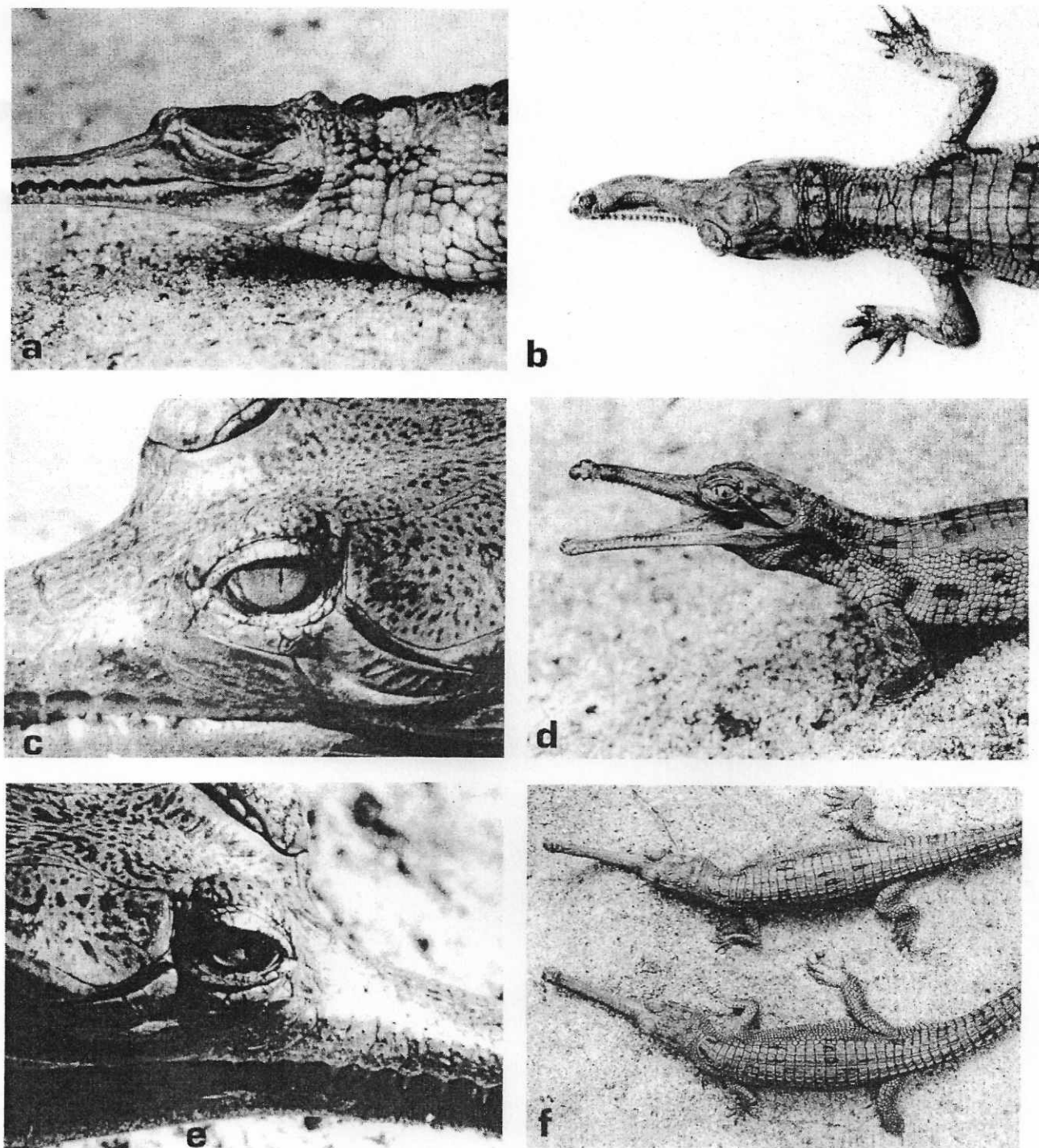


PLATE 1. (a) Blind gharial with both eyes absent. (b) Blind gharial with one eye absent. (c) Pupil of a normal gharial. (d) Pupil of a gharial showing the defect "unsmooth pupil". (e) Gharial showing squint eye. (f) "Bent neck".

mass within the abdomen. In one case in 1975 and in five cases in 1976 the skin closed on the wrong side, excluding the yolk mass. The 1975 hatchling died at about 3 months of age. All 1976 hatchlings were artificially force-fed daily after they were 5 days old. Three of these hatchlings died within 1 month while the other two survived. These were forced-fed till they were about 2 months old.

In addition to the above description of major defects, at least 200 out of the total of 438 1977 hatchlings had

their tail tips curled upward (Plate 2e and f) at the time of hatching. This defect disappeared in the more vigorous of the hatchlings within 3 months of hatching, and all were very healthy. At the end of the sixth month it persisted in none of the hatchlings.

Furthermore, a juvenile of 1977 was noticed to face difficulty in walking immediately after hatching. The limbs of the right side appeared to be defective at that time. Before the third day of hatching the defect disappeared by itself.



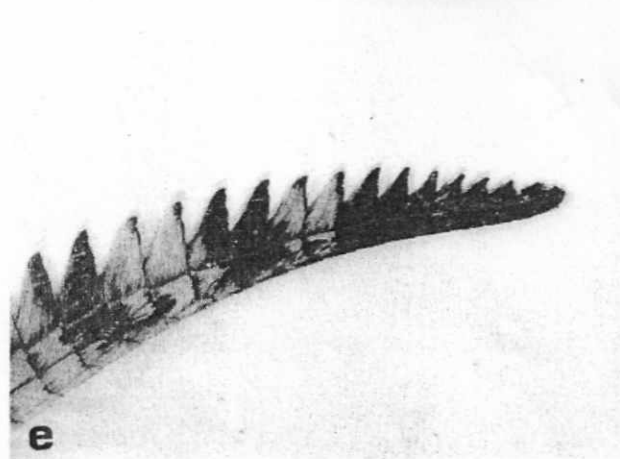
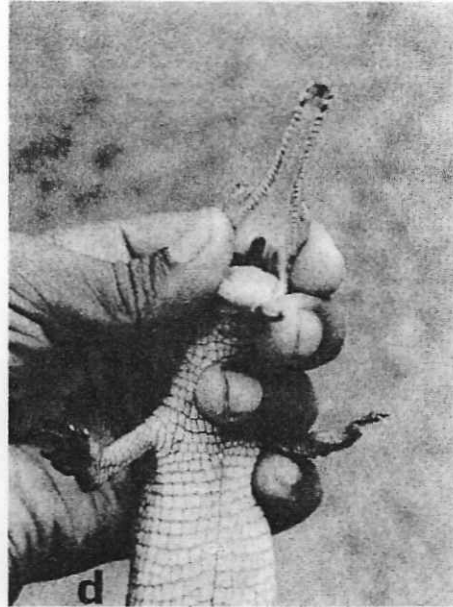
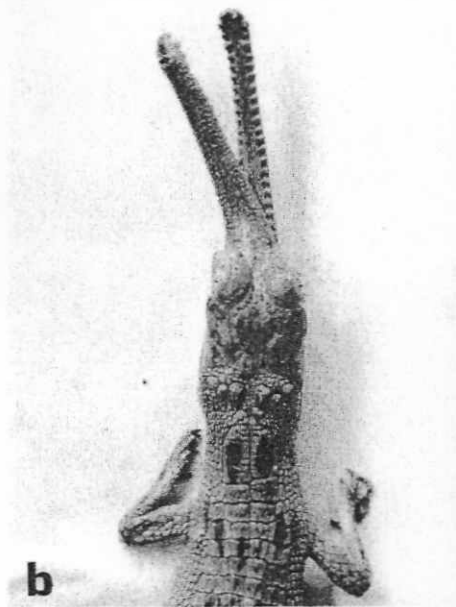
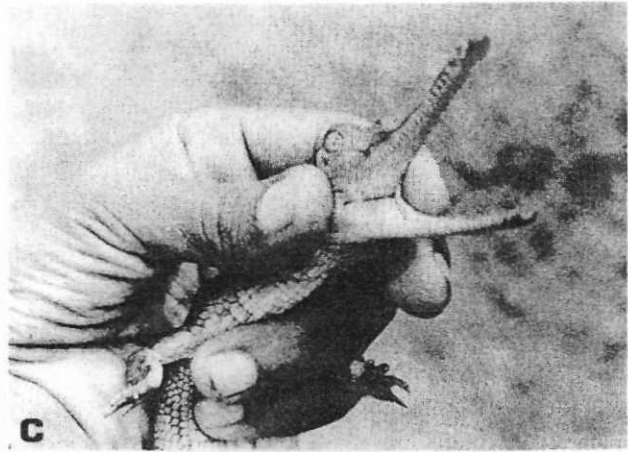
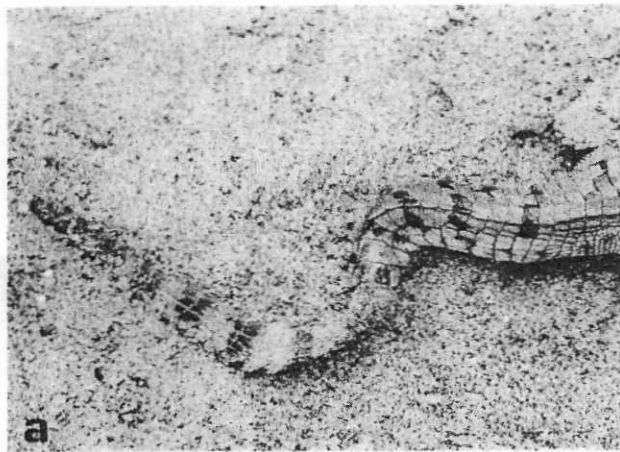


PLATE 2. (a) "Bent tail". (b) "Crossed snout". (c) Opened jaws of a gharial showing upper and lower palatal flaps intact. (d) Same showing absence of the upper flap (mouth valve defect). (e) Tail tip of a normal gharial. (f) Tail tip of a gharial showing "curling".

#### DISCUSSION

Only 6.1% of the total of 1061 eggs incubated showed any kind of congenital defects. This constitutes 8.2% of the fertile eggs (789) incubated. Out of the 65 instances of congenital defects there were 25 (38.4%)

with eye defect(s), 34 (52.3%) with axial skeletal defects (bent neck, hunch back and bent tail), two (3.0%) with head skeleton defects (snout) and four (6.1%) of non-skeletal type (mouth valve, bulged belly and umbilical constriction).

It is interesting to note that eye defects of some kind

occurred every year in eggs collected from the Kali-Narayani-Gandaki river systems originating in Nepal. An instance of a blind gharial has been recorded for eggs collected from the Girwa river gharial population (Singh & Tandan, 1978). This hatchling is similar to those reported by us above, in that there was no development of eyes whatsoever. Singh & Tandan (ibid.) record the absence of the eyeballs together with the optic stalks and optic chiasma. They explain this abnormality in terms of a deleterious gene in the genome. In this instance the young had hatched from eggs collected at Girwa river in extreme northern Uttar Pradesh, a river entering India from Nepal where it is known as the Karnali. It is believed that a "blind" gene causing the absence of one or both eyes is present in some individuals in the populations from the Kali-Narayani-Gandaki and Karnali-Girwa river systems of Nepal.

The defect involving an unsmooth pupil may be associated with defects in functioning of the ciliary muscles.

Partial desiccation of the eggs during incubation may cause skeletal distortions as is recorded for chelonians by Lynn & Ullrich (1950), in the case of gharial commonly in the form of bent necks. This problem could also be due to wrong positioning of the embryo in the egg. Choudhury (Pers. comm.) recorded instances of bent necks in hatchlings from Chambal eggs but the defect disappeared in most in due course. Minor muscular distortions, causing temporary limb defects leading to clumsy walking, may have similar causes. Only one such case was clearly noted, but gait was normal after the third day.

Bustard (1969) thought that a stunted tail in *C. novaeguineae* may have been caused by high temperature egg incubation (38°C) and recorded similar results in gekkonid lizards whose eggs were incubated at high temperatures. Similar congenital defects in *C. porosus* (Kar, 1980; Kar & Bustard, 1982) do not appear to have a temperature origin and may have been due to desiccation. We consider that the 11 individuals with bent tails (all in the 1977 sample) could be the result of desiccation. Desiccation, if present, was present during only the last 4 weeks incubation.

The defects noted in this paper were observed with young which developed from eggs incubated under simulated ideal natural conditions. The defects divide into two categories: those that are genetically determined and those that are environmentally determined. It is expected that the latter category of defects also

occurs in nature, and that the frequency of these environmentally determined defects may be higher in nature than those here reported because of widely varying climatic conditions in nature compared to the provision of a more stable incubation environment in the hatchery used here.

#### ACKNOWLEDGEMENTS

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