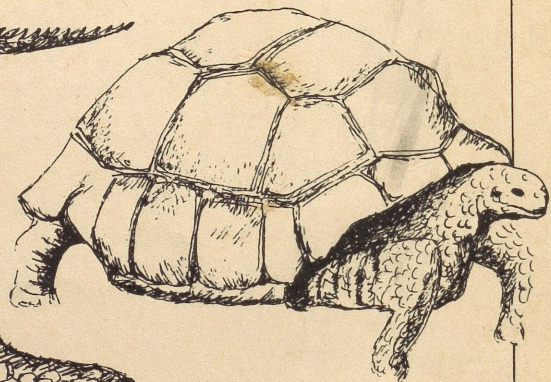
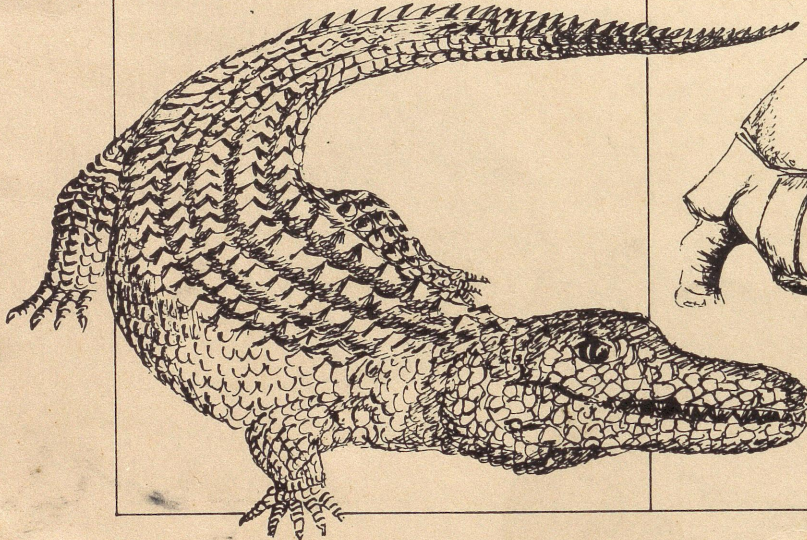
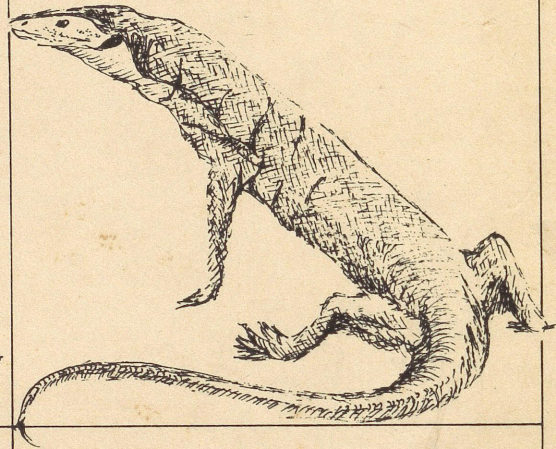
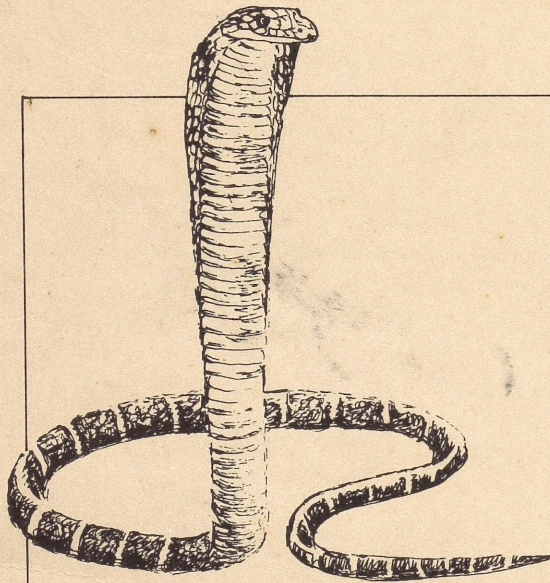


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# HERPETON

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## EDITORIAL

*We are happy about the success of the premier issue of **Herpeton**. It was produced with considerable caution and judging from positive response from the readers, we are confident in producing the current issue. The first volume owes its success to the unequivocal efforts put in by our staff and unparalleled assistance provided by eminent personalities in various fields. This in turn has also helped us to fulfill the aims and objectives set forth by Indian Herpetological Society. We have always aimed at eliminating the ambiguities in the comprehension of Herpetology. By publishing standard scientific literature on Herpetology we have managed to open newer avenues in the academic, social and applied fields of herpetological research. A major part of our job will henceforth also include organising various workshops, seminars and conferences on Herpetology to ensure smooth reciprocity of advanced techniques and updated knowledge of this science.*

*In spite of maneuvering our way through a number of adversities, we have been forced to amalgamate two issues of **Herpeton** in this volume. To enhance the quality of this Journal and to incorporate a planned methodology in reviewing and editing the articles, we sincerely hope that the **Instructions to Authors** will be keenly observed hereafter.*

ANIL KHAIRE

# Preliminary Photographic Record and Description of Various Developmental Stages of the Frog *Microhyla ornata* (Dumeril and Bibron)

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## Introduction

There are over 160 species of frogs and toads in India, representing about 91% of our total amphibian fauna (Inger and Dutta, 1986). There is, however, very scanty information about the biology of most of our species. Early embryonic development and metamorphosis of only a few species has been described. There is an early but brief description of some of the developmental stages of the frog *Microhyla ornata* (Mohanty-Hejmadi, Dutta and Khan, 1980). Descriptions of early developmental stages of the most common local frogs, namely *Rana tigerina* and *R. cyanophlyctis* have also been published (Ramaswami and Lakshman, 1959; Dutta and Mohanty-Hejmadi, 1976; Agarwal and Niazi, 1977; Mohanty-Hejmadi and Dutta, 1979). Development of another microhylid *Uperodon systoma* has also been described (Mohanty-Hejmadi, Dutta and Mallick, 1979).

We have described elsewhere the spawning behaviour, size and shape of the spawn and its related aspects in the frog *Microhyla ornata* (Padhye and Ghate, 1988). The purpose of this paper is to give preliminary photographic record and description of some of the developmental stages of this microhylid. Such information about *M. ornata* has not been published earlier.

## Materials and Method

Naturally fertilized eggs of the frog *M. ornata* were collected from a natural pond situated in Kothrud area, Pune. To collect freshly fertilized eggs, the pairs in amplexus were located in their natural environment and watched throughout the spawning-period. The spawning generally occurred around 2 to 3 a.m. Fertilized eggs were then collected and allowed to develop under laboratory conditions. The

temperature of the water varied between 24°C to 27°C, at least during first 96 hours of development. The tadpoles were fed with dried and ground lettuce as well as fresh plankton collected from the natural ponds until metamorphosis. The tadpoles were kept in aquaria with 40 litres of water per 20 tadpoles to avoid crowding.

In addition a semi-artificial pond was also prepared in the natural environment of the frog to study the development under natural conditions. This pond was lined with cement to prevent seepage and then covered with soil and vegetation to make it as natural as possible. At a time a single spawn was collected from natural pond and was released in it. Regular observations were made on the spawn developing under such conditions. Various developmental stages were collected from this semi-artificial pond and compared with those from laboratory aquaria. The different developmental stages were carefully observed under stereozoom trinocular dissecting microscope for the purpose of description. Different stages were preserved in 10% of formalin and photographed subsequently. Morphometry was done using stage and ocular micrometer. Since the magnification of each photograph (except figs. 29 to 39) is different, the exact morphometry of the different stages is given in the text.

## Observations

Following is the description of various developmental stages of the frog *Microhyla ornata*.

*Stage 1* (fig. 1 a - animal view, 1 b - vegetal view), age 30 min, diam. 0.70 mm, zygote stage, slightly flattened at the animal pole region. Animal end is pigmented. Darker pigment band is present at the periphery of the animal hemisphere. Vegetal pole area is creamy white in colour due to concen-

tration of yolk material. The egg is moderately telolecithal. Grey crescent, which is observed in many amphibians, is not very distinct.

*Stage 2* (fig. 2 - animal view), age 1 hour, diam. 0.70 mm, late 2 cell stage, second cleavage has just started from animal pole, the cleavage furrows are prominent in animal hemisphere.

*Stage 3* (fig. 3 - animal view), age 1 hour 20 min., diam. 0.70 mm, 4 cell stage, second cleavage completed, the cells show dark pigmentation in the animal pole region.

*Stage 4* (fig. 4 a - equatorial view, 4 b - animal view), age 2 hrs. 15 min., diam. 0.70 mm, 8 cell stage, third cleavage is latitudinal, animal pole cells are distinctly pigmented and smaller in size while vegetal pole cells are creamy white and larger in size.

*Stage 5* (fig. 5 a - animal view, 5 b - vegetal view), age 3 hrs., diam. 0.70 mm, the embryo is about 64 cell stage. Black micromeres and whitish megameres can be distinguished by size and pigmentation. Micromeres are more in number, indicating rapid cleavage at the animal pole.

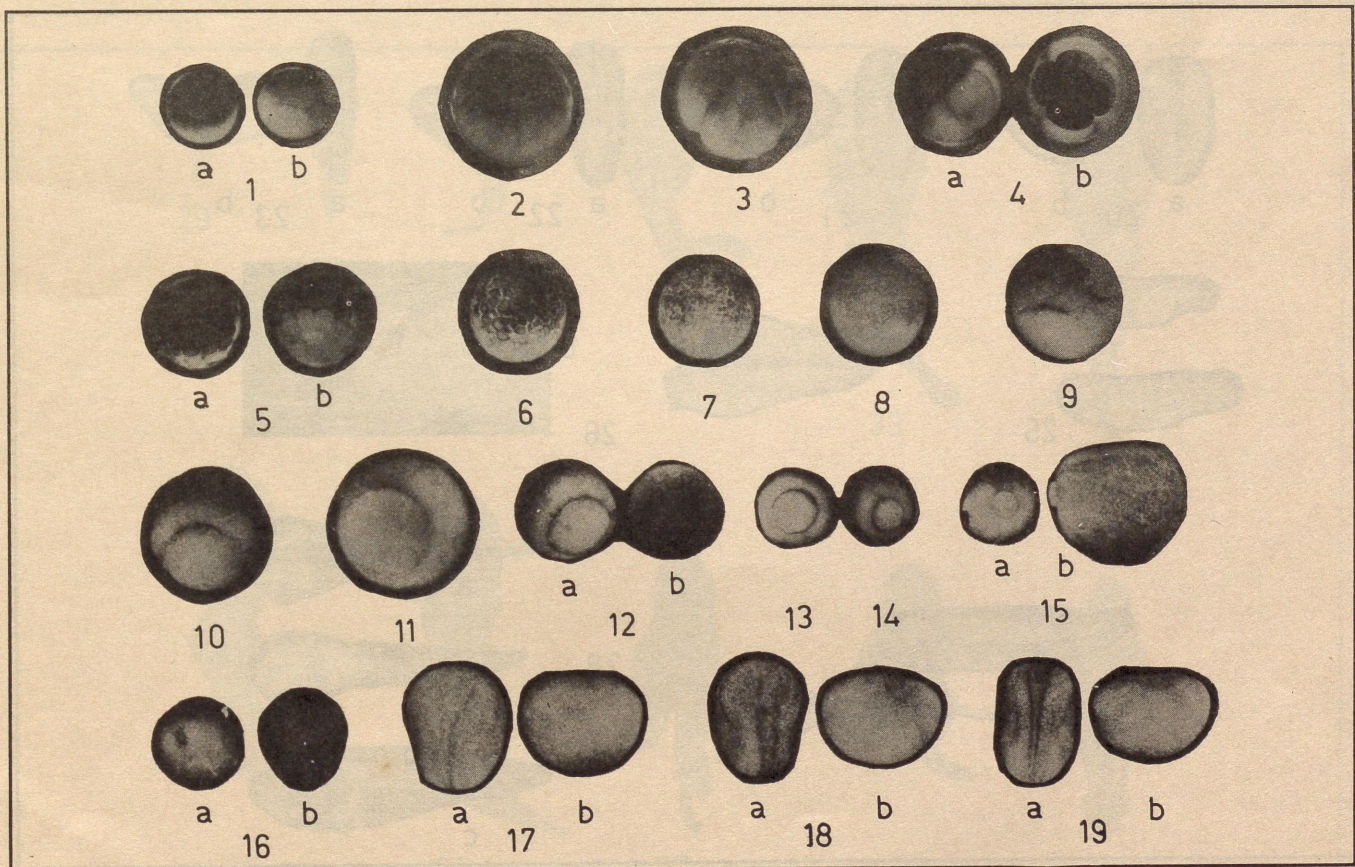
*Stage 6* (fig. 6) & *Stage 7* (fig. 7) - animal views, age 3 hrs. 45 min. and 4 hrs. 30 min. respectively, diam. 0.75 mm, late cleavage stages, pigmented micromeres are distinct.

*Stage 8* (fig. 8 - equatorial view), age 5 hrs., diam. 0.75 mm, blastula stage, pigmented micromeres can be seen to be spreading over vegetal hemisphere indicating beginning of the epiboly.

*Stage 9* (fig. 9 - equatorial view), age 6 hrs. 30 min., diam. 0.75 mm, early gastrula stage, dorsal lip is marked from where the process of invagination has started, epibolic movements are also evident.

*Stage 10* (fig. 10 - equatorial view), age 7 hrs. 30 min., diam. 0.85 mm, well formed dorsal-lip stage, even the lateral lips are about to be formed. The shape of the embryo has also started changing.

*Stage 11* (fig. 11 - equatorial view), age 8 hrs. diam. 1.0 mm, lateral lips stage, ventral lip is about to be formed. Large mass of vegetal pole cells is yet seen on the surface, the epiboly is evident as the pigmented cells appear to be gradually spreading towards the blastopore.



*Stage 12* (fig. 12a - equatorial view, 12 b - animal view), age 8 hrs. 45 min., diam. 1.0 mm, circular blastopore stage, a mass of yolky cells protruding out of blastopore, forming the so called yolk plug, can be seen. The stage can be conveniently called as midgastrula.

*Stage 13* (fig. 13) & *Stage 14* (fig. 14) - equatorial views age 9 hrs. 30 min. and 10 hrs. respectively, diam. 1.0 mm, mid-gastrula stages, yolk plug is reduced in size.

*Stages 15* (fig. 15 a - posterior view, 15 b - lateral view), age 10 hrs. 20 min. length 1.1 mm, late gastrula/early neurula, very small yolk plug, dorsally flattened elongated embryo. The embryo is slightly narrower posteriorly, neural plate cells are getting arranged dorsally.

*Stage 16* (fig. 16 a - posterior view, 16 b - dorsal view), age 10 hrs. 45 min., length 1.15 mm, neural plate can be faintly delimited, yolky cells completely invaginated, blastopore lips constricted showing a very small blastoporal opening.

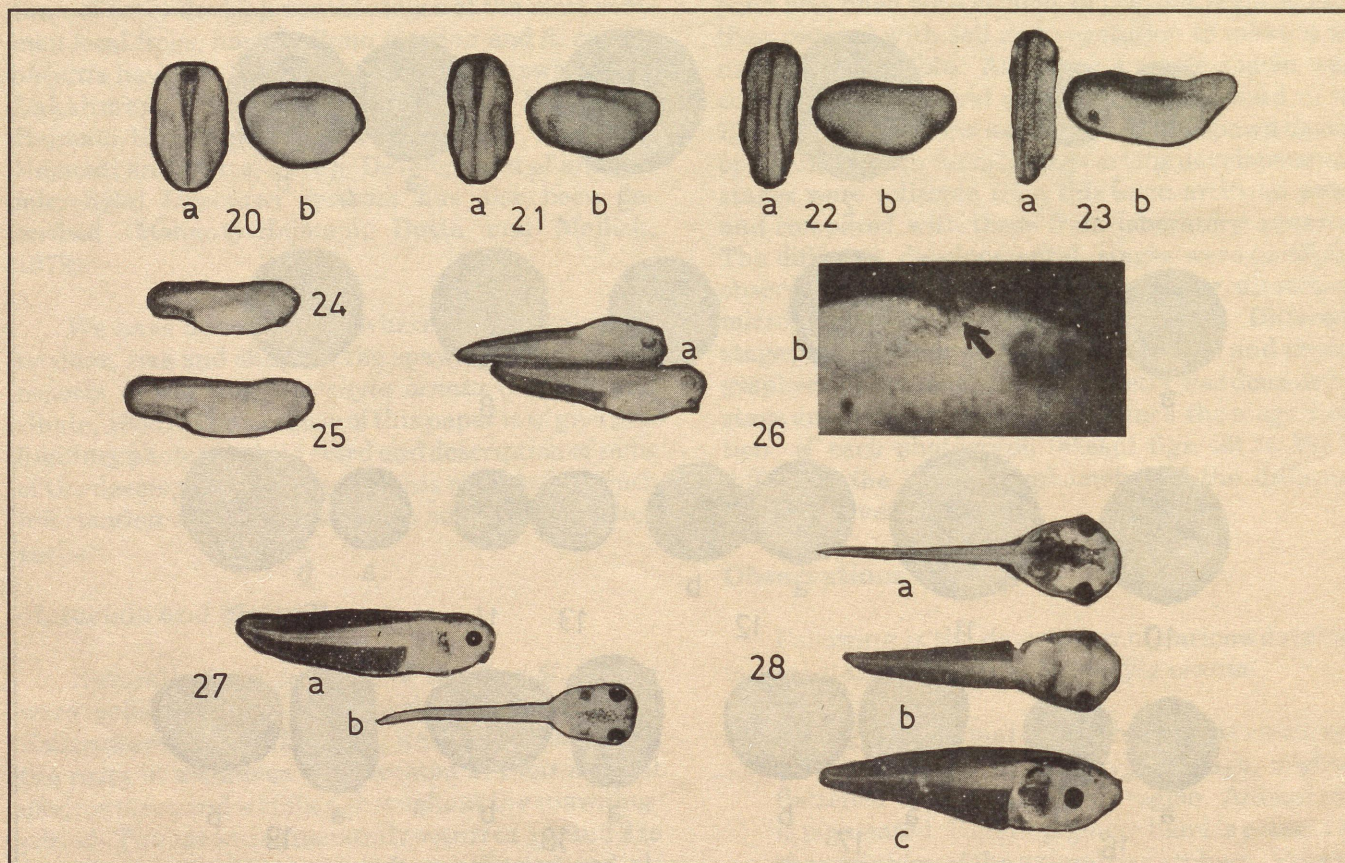
*Stage 17* (fig. 17 a - dorsal view, 17 b - lateral view), age 11 hrs. 15 min., 1.15 mm, neurulation stage,

neural plate is slightly elevated. It is convex anteriorly and flattened posteriorly. Caudal part of the neural groove is just appearing. Neural folds not prominent.

*Stage 18* (fig. 18 a - dorsal view, 18 b - lateral view), age 12 hrs. length 1.15 mm, rising neural folds are prominent, especially in the anterior parts. Posteriorly the developing neural folds approach the lateral lips of the blastopore.

*Stage 19* (fig. 19 a - dorsal view, 19 b - lateral view), age 12 hrs. 30 min., length 1.30 mm, deep neural groove stage. Neural folds are fully raised and very close to each other posteriorly. Neural groove is very deep and prominent in the central and posterior parts. Anteriorly the neural folds are still away from each other leaving a wide, shallow gap in between.

*Stage 20* (fig. 20 a - dorsal view, 20 b - lateral view), age 13 hrs., length 1.45 mm, initiation of neural tube closure in the posterior region. Neural folds are touching each other forming dense pigmented streak in the posterior part. Anteriorly the folds are close to each other. Flattening of mid-dorsal and postero-dorsal parts of the embryo initiated indicating further differentiation



of head and trunk regions.

*Stage 21* (fig. 21 a - dorsal view, 21 b - lateral view), age 13 hrs. 30 min., length 1.50 mm, posteriorly closed neural tube, open only in the cranial region. Initiation of tail-bud formation, prominent flattening of mid-dorsal and posterior most parts of the embryo. Appearance of faintly pigmented areas on anterior side in the ventrolateral region. This area marks the future position of the ventral suckers. Lateral compression of the embryo is also evident.

*Stage 22* (fig. 22 a - dorsal view, 22 b - lateral view), age 14 hrs. 15 min., length 1.65 mm, tail-bud stage, neural tube completely closed, prominent tail-bud as a result of flattening of posterior-most and mid-dorsal areas of the embryo. Pigmented areas which appeared in earlier stage are distinct. Embryo is markedly elongated and laterally compressed. Muscular twitching movements started.

*Stage 23* (fig. 23 a - dorsal view, 23 b - lateral view), age 15 hrs. length 1.90 mm, differentiation of head, trunk and tail regions is prominent, embryo elongated. Sharply defined, densely pig-

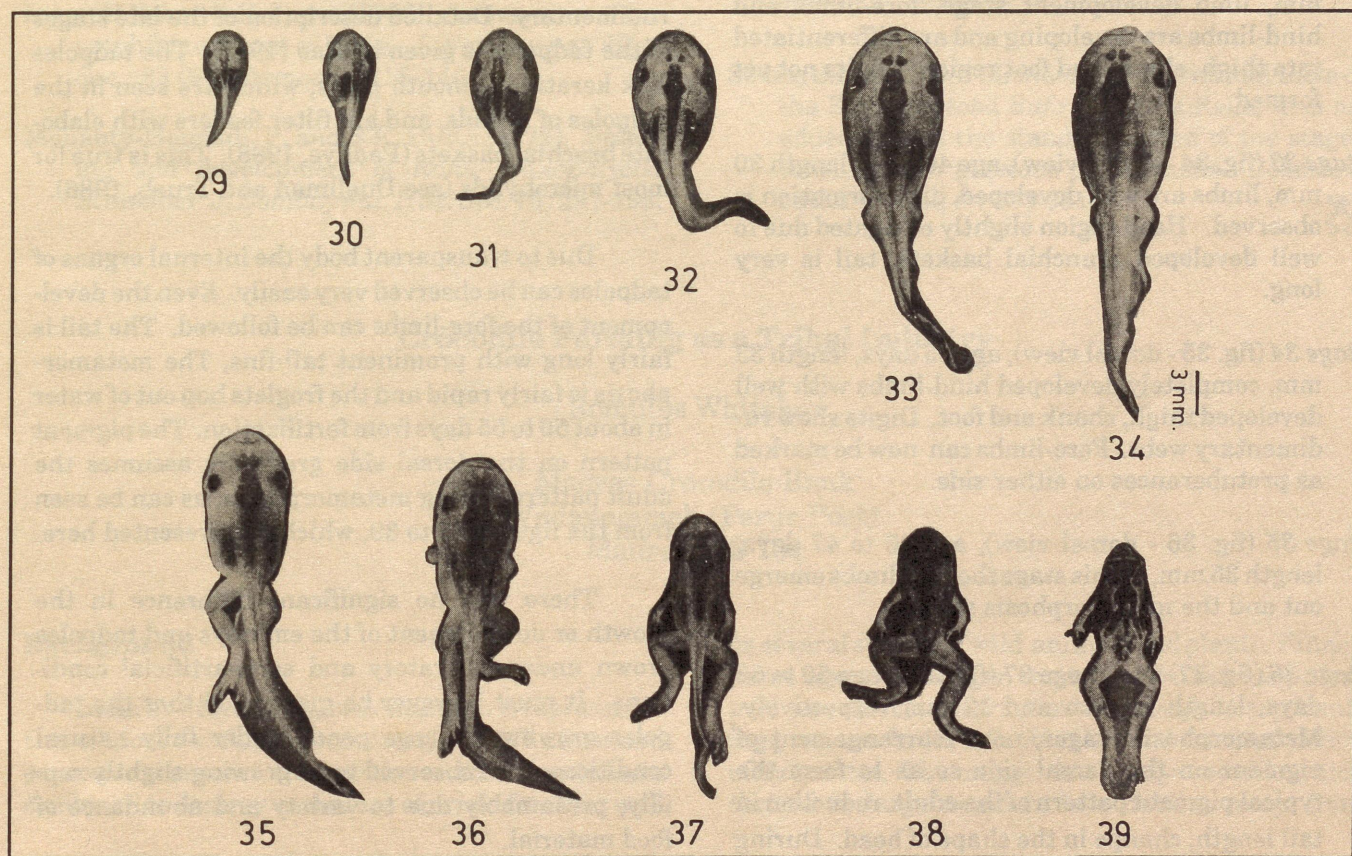
mented sucker spots.

*Stage 24* (fig. 24 - lateral view), age 16 hrs. 30 min., length 2.50 mm, head, trunk and tail well defined, suckers making appearance as elevated dark spots.

*Stage 25* (fig. 25 - lateral view), age 18 hrs. 30 min., length 3.00mm, tail elongated, suckers prominent, head region showing elevation of eye region, belly creamy white, a few somites can be distinctly seen.

*Stage 26* (fig. 26 a - lateral view, 26 b - close up external gills), age 28 hrs. 45 min., length 3.50 mm, external gill stage. Embryos showing well developed tail with transparent tail-fins, short white belly, head region with well developed suckers and beginning of the eye formation is evident, external gills are present laterally in the cleft between head and trunk. External gills are in the form of three buds. Dorsal side of the head shows some pigmentation. Note close up of external gills in fig. 26 b (indicated by arrow).

*Stage 27* (fig. 27 - lateral view, 27 b - dorsal view), age 55 hrs., length 4.4. mm, hatching stage. It shows well developed suckers, eyes, tail with tail-fins



and tail musculature. Faint pigmentation on the dorsal side of the head and trunk. Non-feeding stage without mouth opening.

*Stage 28* (fig. 28 a & Fig. 29 - dorsal view, 28 b - ventral view, 28 c - lateral view), age 100 hrs., length 5.75 mm, transparent tadpole, typical pigment pattern on the dorsal side, mouth opened, feeding started, suckers not seen, coiled intestine present in a pigmented sac.

*Stage 29* (fig. 30) & *Stage 30* (fig. 31) age 10 days and 15 days respectively, length 10 mm and 15 mm resp., active feeding stage, filter feeding mechanism well developed, no gross morphological changes than increase in size. Eyes, heart, lungs, digestive system and branchial baskets (filter feeding apparatus) well developed.

*Stage 31* (fig. 32 - dorsal view), age 20 to 25 days, length 22 mm, limb-buds stage. Fore-limb as well as hind-limb buds seen, fore-limb buds are internal, between branchial basket and the intestinal coils, but are visible due to transparent body. Hind-limb buds are situated at the base of the tail, just above the vent.

*Stage 32* (fig. 33 - dorsal view), age 30 days, length 25 mm, limb development stage, fore-limbs and hind-limbs are developing and are differentiated into thigh, shank and foot region. Digits not yet formed.

*Stage 33* (fig. 34 - dorsal view), age 40 days, length 30 mm, limbs are well developed, digit formation is observed. Head region slightly elongated due to well developed branchial baskets, tail is very long.

*Stage 34* (fig. 35 - dorsal view), age 45 days, length 33 mm, completely developed hind-limbs with well developed thigh, shank and foot. Digits show rudimentary webs. Fore-limbs can now be marked as protuberances on either side.

*Stage 35* (fig. 36 - dorsal view), age 46 to 47 days, length 35 mm, at this stage the fore-limbs emerge out and the metamorphosis sets in.

*Stage 36* (fig. 37) and *Stage 37* (fig. 38) - age 50 to 53 days, length 20 mm and 12 mm respectively. Metamorphosis stages, note rearrangement of pigment on the dorsal side so as to form the typical pigment pattern of the adult, reduction in tail length, change in the shape of head. During

these stages disappearance of the branchial baskets and widening of the mouth is observed.

*Stage 38* (fig. 39 - dorsal view), age about 55 days, length (snout-vent) 10 mm, freshly metamorphosed froglet. Note typical pigment mark on the dorsal side, pigment bars on the limbs, absence of the tail, reduction in size. Jaws are well developed with a wider mouth.

## Discussion

The pattern of development in *Microhyla* is very similar to that described for other anurans (Agarwal and Niazi, 1977; Sedra and Michael, 1961). The tadpoles are completely transparent and possess a typical pigment mark on the head, almost throughout the entire development and metamorphosis. The previous description of early development of this frog, as given by Mohanty-Hejmadi, Dutta and Khan (1980) is very brief as compared to the information presented here; besides the different stages are not adequately illustrated. The development appears to be quite rapid because the hatching usually takes place in 48 hours. The external gill stage is very transient in this frog and even the gills are almost rudimentary. Detailed description of the late stages of the tadpoles is given by Rao (1917). The tadpoles lack keratinous mouth parts, which are seen in the tadpoles of Ranids, and are filter feeders with elaborate brachial baskets (Padhye, 1988). This is true for most microhylids (see Duellman and Trueb, 1986).

Due to transparent body the internal organs of tadpoles can be observed very easily. Even the development of the fore-limbs can be followed. The tail is fairly long with prominent tail-fins, The metamorphosis is fairly rapid and the froglets hop out of water in about 50 to 55 days from fertilization. The pigment pattern on the dorsal side gradually assumes the adult pattern during metamorphosis, as can be seen from the figures 35 to 39, which are presented here.

There was no significant difference in the growth or development of the embryos and tadpoles grown under laboratory and semi-artificial conditions. It must however be mentioned that the tadpoles growing in large ponds under fully natural conditions were observed to be growing slightly rapidly, presumably due to variety and abundance of food material.

## Acknowledgements

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## Crocodile Farming as a Tribal Industry

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## Background

India's natural resources situation is representative of most developing countries, where human and economic pressures along with vested interests have combined to destroy vast areas of prime forest as well

as several species of wild animals and plants. Fifteen years ago, the mugger crocodile (*Crocodylus palustris*) was almost exterminated through heavy hunting pressure for its valuable skin and the destruction of its habitat. The mugger is a hardy crocodile which thrived in large numbers in a habitat range from

reservoirs and ponds to streams and even estuaries. Today it is found in comparable numbers only in the island nation of Sri Lanka (Whitaker and Whitaker, 1979).

Between 1972 and 1975, this author undertook, on behalf of the Madras Snake Park and Conservation Center, several surveys throughout the country to evaluate the present distribution and status of the three species of crocodilians extant in India, the mugger, the saltwater crocodile (*Crocodylus porosus*) and the gharial (*Gavialis gangeticus*). It was found that the mugger was much depleted in numbers but still holding its own in some protected areas, and that the other two species has been hunted almost below recoverable numbers. In 1975 the Government of India, with the technical aid of the Food and Agriculture Organisation of the United Nations, started Project Crocodile, a programme which sought to rehabilitate the dwindling numbers of crocodiles and to establish protected reserves for them (Bustard, 1974).

Because there are a number of suitable protected habitats (national parks and sanctuaries) where there are no human populations, the Government's programme has been fairly successful. The operation is based on the collection of eggs from the remaining wild nests, and the rearing and release of the young. Over 2000 crocodiles have been released into wild areas and over 6000 are being reared in captivity at the present time (Singh and Choudhury, 1984). The time has come for a systematic evaluation, both of the success of the project as well as the future trends for crocodile conservation and the management of crocodiles as an industry in India.

### Justification

Firstly, it must be stated that the introduction of large numbers of crocodiles into the wild can become a sensitive issue with local human populations. Habitats where human activity is non-existent are limited and nowhere is it easy to protect, encourage or re-introduce an unpopular predator. Crocodiles have one of the worst (albeit largely undeserved) reputations as man-eaters. In actual fact, crocodiles are an intrinsic part of natural aquatic ecosystem and contribute to environmental quality by virtue of their predator/scavenger habits. Studies in Africa have shown that crocodiles are beneficial to commercial fisheries interests, as they prey on the predatory fish which in turn depleted commercially valuable species.

Secondly, it is to be argued whether preservation oriented conservation is justifiable in economically handicapped countries such as India. Once a commercial valuable species such as the crocodile is numerically safe and adequate population exist in the wild, the animal should be allowed to 'pay its way' through a carefully planned and monitored system of exploitation on a sustained-yield basis. Unless this is done, the already tenuous justification for crocodile survival in a country of historically unprecedented human pressure, will fail to save the reptile for long. It is axiomatic that unless wildlife proves itself an economic asset, it is unlikely to survive; this is especially true in the case of predators such as crocodiles which allegedly compete with man for fish and which on occasion attack livestock and rarely, humans.

A third argument for the controlled farming of crocodiles for the skin trade is the existence in India of many groups of tribal people who are among the most economically depressed people in the world with an average per capita income of under US \$100. Many of these groups are hunter-gatherers whose needs were at one time fulfilled by the land, but who are now unable to continue their hunter-gathering activities for a variety of reasons such as restrictive wildlife legislation, conversion of hunting lands into Reserve Forests, and depletion of wild flora and fauna. Some, such as the Irulas of Tamil Nadu State in south India, once hunted the crocodile for its skin and meat.

The subject of this paper is the proposal that the tribals be permitted to farm crocodiles commercially and that this be classified as a 'Reserved' occupation for these traditional hunters, since they have little or no opportunity for gainful employment in mainstream society. Co-operative societies could be formed to operate the farms and the high and sustained value of crocodile skins in the international market, combined with the low maintenance costs and quick growth of the animals, will ensure a profitable trade. At the end of three years of captive growth, each crocodile's skin and by-products will earn over US \$125.

### Establishment and Operation of a Crocodile Farm

#### Introduction

Crocodile farming is now recognized as an integral part of wildlife and natural-resource utilization, and countries which are now farming local species

for the skin market include Australia, the United States and Indonesia. Models and techniques for commercial crocodilian rearing have been discussed in the literature for Papua New Guinea (Bolton 1981), USA (Joanan, 1972) and elsewhere but no design has been offered for commercial farming in India. Crocodiles remain totally protected in India but it is anticipated that the paucity of suitable habitat for further re-stocking in the wild, and the considerable success at breeding crocodiles in captivity at several centres, will soon result in an official status shift and policy adjustment.

Contrary to popular belief, crocodiles require professional care and maintenance, and their needs do not stop at an enclosed space, feed and water. They are easily susceptible to stress and the lack of hygiene, and many aspects such as the land-water ratio have to be taken into account in order to prevent disorders as wide-ranging as fungus-based diseases and social stress. The first step in the development of a crocodile farm is the choice of well-watered land and further the preparation of a carefully laid out scheme of pen design, water supply and drainage. Pens must be regularly and thoroughly cleaned with running water to avoid the kind of die-outs from coccidiosis, salmonella and other bacterial diseases, which poorly maintained crocodiles suffer from.

An economical feed-source calculated to eventually feed the maximum number of crocodiles is another prerequisite. On the east coast of south India, the location of the crocodile farm proposed in this paper, feed is available at 20 cents per kg. (Rs. 2.50) and includes the trash fish bycatch from trawlers and shore seines, cheap backwater fish, buffalo, waste entrails from chicken farms, and rats, frogs and crabs collected by tribals and local village people.

Pen construction must be worked out carefully and several factors taken into account, including the digging and climbing abilities of crocodiles. Some species succeed in escaping from supposedly foolproof enclosures and for these an adequate wall foundation and high smooth walls are necessary. Water in the pools must be maintained at a suitable depth and slope; for example, breeders will need deep pools, while hatchlings need suitable sloped designs to allow them easy access to land.

## **Project Outline**

### **Objective**

To establish a medium sized commercial croco-

dile farm owned and managed by a co-operative run by Irula tribals for the production of over 1000 crocodile skins per year.

## **Sources of Crocodiles**

The Madras Crocodile Bank is producing over 500 hatchling crocodiles per year and other state government projects produce comparable numbers. The Irula Tribal Crocodile Farm would, provided current legislation was altered, have adequate sources for the purchase of crocodile stock.

## **Land and Water**

There are several government schemes for tribal welfare and self-help projects which could be tapped for the crocodile farming programme. The Adi Dravide (Tribal) Welfare Department of Tamil Nadu State has stated that if suitable land is identified, it can be procured by Government and given at no cost to the Irulas. Well watered land with enough leeway for expansion, would have to be located.

## **Pen Design and Construction**

The technical services of the staff of the Madras Crocodile Bank (India's largest crocodile facility) are available to aid in the establishment of the Irula Tribal Crocodile Farm. Similarly, staff for the commercial farm can receive training at the Crocodile Bank.

The pens should have enough upper vegetation to shade at least 50% of the area and sufficient ground cover to allow the hatchlings and juveniles to hide or shelter from the heat. Small, cement-lined ponds are easy to keep clean by scrubbing and frequent water change, though larger, rammed-earth organic ponds can also be used. Stocking rates for different pen and pond sizes can be standardized to suit the various rearing schemes. It should be pointed out that crocodile husbandry has several features in common with farming other commercial species, for example poultry. One of the basic principles applicable to both is the segregation of stock based on size and course species. A well managed crocodile farm will continually sort the animals in order to maintain compatible size groups together and thus eliminate equal competition for feed and territory, which is detrimental to growth.

## Feed

As mentioned earlier, feed sources for large numbers of crocodiles exist in and around Madras city in the form of marine and fresh water organisms as well as the waste entrails from abattoirs and broiler chicken farms. In the expense/profit breakdown, feed costs form a major part of the overheads of a crocodile farm and new ways to keep these costs down must continually be examined.

As with many species of newborn animals, learning initial acceptance of feed in a particular spot and sometimes even at a particular time of day, is critical to the success in rearing healthy hatchlings. In the wild, hatchlings feed on a variety of creatures including insects, small fish, frogs and crabs. It is worth investing manpower and funds during the first few months of rearing to ensure an adequate supply of the best feed available for captive young. The size of food offered is an extremely important aspect and one which is often overlooked. Small crocodiles generally do not tear up prey items but swallow them whole; the size of food pieces should obviously vary with the size of crocodile (Bolton, 1981).

## Breeding

If obtained at the optimum age of 3-5 years, mugger will gain maturity in 2-4 years. During this period they will become acclimatized to their new group-mates in enclosures with the recommended sex ratios. As breeding stock they should be fed whole food (such as rats, frogs and fish) or the equivalent whenever possible and in particular prior to and during the breeding season. This will ensure the assimilation of adequate calcium and other nutrients. At this stage it is also important to have an understanding of mugger social behaviour, particularly just before egg-laying when extreme territoriality on the part of some animals can inhibit the breeding potential of subordinate ones. Larger crocodiles with a tendency to 'bully' may have to be isolated or removed from the enclosure.

The egg-laying period in South India is between February and April. The female mugger digs a hole in the embankment above water level at night, deposits her eggs and covers them with the excavated earth. Once covered, the nest is not easily located except by an experienced eye, and it is worthwhile to

have enclosure watchmen during the nesting season, to note the identity of the female and mark the nest spot.

There are two time periods in which the eggs may be collected; within 24 hours of laying, or after 35 days have elapsed. In between, the embryo is too delicate and moving the eggs may rupture the delicate blood vessels that attach it to the shell. The eggs should either be transferred to a hatchery or left in the natural nest for most of the incubation period. There are advantages in both systems and initially both are worth trying and evaluating.

Temperature and humidity patterns are the key factors during the 60-70 day incubation period. Simple incubators, set to maintain the optimum temperatures (28° - 33°C) and humidity (80 - 90%), can be constructed to exercise significant control over the incubation. Findings in recent years seem to prove that incubation at marginally higher temperatures (32°C plus) in the first half of the period will produce a majority of males, while at lower temperatures (29°C and below) females will predominate (Lang and Whitaker, in preparation). This factor offers interesting implications in the commercial use of crocodiles, since a higher percentage of females is desirable as egg-layers in the formative stages of a farm, but males grow faster and are thus more economical to grow for skins.

## Hatchlings

When the hatching crocodile is fully formed and ready to leave the egg, it provides a vocal cue for the female parent to excavate the earth covering the eggs. The average clutch of mugger eggs numbers around 30, and a chorus of high-pitched grunts signal the 'ripeness' of a clutch. The outer, brittle layer of shell flakes off around this time enabling the hatchlings to emerge by slitting open the leathery inner shell with its 'egg tooth' (caruncle) on the snout tip. In artificially incubated nests the crocodile farmer must stand in for the female, scrape earth away and if required, assist some hatchlings by opening the egg. Care must be taken not to remove a baby prematurely. The usual practice is to keep the hatchlings in shallow plastic tube with an inch of water until the yolk sac is completely absorbed, before releasing them into their pools. This generally takes twenty-four hours but may take longer in the case of some animals.

## Handling

It is found that crocodiles are easily susceptible to stress and crocodile farm staff must be properly trained in handling to avoid injuries and deaths. Rough and frequent capture and excessive disturbance will retard growth in young crocodiles. It has been seen that very young crocodiles in captivity respond well to individual attention and gentle handling. Crocodiles upto 80 cms in length can be caught and held by one person, but larger ones may require more help. While catching meter-long animals, the jaws should be secured with a rubber band (strips of motorcycle inner tubing are ideal).

## Skin Production

It takes an average of four years for a crocodile to grow to 1.25 to 1.50 metres in length. At this size, the belly skin is 13 to 18 inches in width; this is the unit of measure generally used by dealers. If the average-sized skin is unscarred and well cut, it is worth US \$ 100 to 150, raw and salted, indicating a profit of 50% or more after deducting overheads of feeding and maintenance.

During cropping exercises, selected animals are noosed or hand caught, jaws secured and the animal quickly killed with an axe or knife cut to the top of the neck just behind the skull. The animal is then washed and placed on a clean non-abrasive surface for skinning. Skinning is a technical skill which can be performed by a number of experienced Irulas. A single knife hole or gash can reduce the skin to Grade II level, reducing the value by 25%, and several holes or an improper cut makes it Grade III, 50% less than full value. Meat and fat must be completely flayed from the skin in preparation for salting (Whitaker, 1984).

Fine, crushed salt should be used for preserving hides. The salt is rubbed into all parts of the well flayed inner surface of the skin which is then folded and rolled for storage. Within 48 hours the salt which has by then drawn much of the surface moisture from the skin, should be shaken off and discarded, and the skin completely resalted. Antibacterial preservatives such as a simple mixture of one per cent naphthalene and one per cent boric powder should be mixed with the salt for both applications. The skin can then be re-folded and rolled for storage in a cool, dark place, secure from rodents, for several months if necessary (Bolton, 1981).

Raw, salted skins are preferred by the European and Japanese tanneries for 'quality reasons' but this means that the country of origin gets the minimum income from its product. The feasibility of producing export quality finished skins should be examined.

Because many crocodile species are endangered and thus internationally protected under the Convention for International Trade in Endangered Species, and also to minimize the chances of illegal skins from the wild entering the market, each skin would be tagged with a one-use plastic tag. These are being utilised in the crocodile and alligator skin programmes in Papua New Guinea and the United States. The skins would be sold to the highest bidder; Japan and France currently pay the highest prices. Each consignment of skins would be inspected by a representative from the Wildlife Department.

## Tribal Occupations

The profitability and suitability of crocodile farming by the Irula tribals can be assessed by comparing it to commercial fish farming, which also seem an appropriate occupation for Irulas. The main constraints of fisheries include seasonal water shortages (in comparison crocodiles can, if necessary, survive out of water for months), fairly intense management, possible high capital investment and relatively low returns in relation to the time and money input.

For example, in one fish farming feasibility study utilizing 2 acres of land, the capital investment for pond construction, water supply and purchase of stock is US \$ 25,000. The projected annual recurring costs are US \$ 5,000. Profits after the first few years to clear capital costs would average US \$ 5,000. Ten persons would be employed (State Fisheries Department pamphlet). Compared to the income from a crocodile farm, fish farming is only a fraction as profitable. Even more important is the time and management effort that has to be invested for the much smaller return. It must be remembered that Irulas lack animal husbandry experience and have no tradition of agriculture. Therefore it is difficult for them to adapt themselves to complex, new occupations.

Other alternate employment prospects available to Irulas include road digging, root excavation in tree plantation clearance, crop harvest and odd jobs, all of which are temporary, low paid and a waste of their skills.

## Summary

It becomes increasingly obvious that the total protection approach cannot be applied to the wildlife resources of the third world, given the escalating human pressures. Crocodile farming is an ideal activity and an appropriate industry for hunter-gatherer tribes such as the Irulas of south India.

Mugger crocodiles have made a dramatic comeback in India, where they were an endangered species until recently. Crocodiles are suitable animals for farming; they are hardy, highly efficient converters of food, require minimum care and can be fed largely with animals not generally used for human consumption. The basic details of the management of a crocodile farm and its economics are summarized and the profitability demonstrated.

The economics of crocodile farming is compared to that of fish farming, another potential industry for tribals. It can be concluded that crocodile farming for skins is the most profitable animal-based industry and an appropriate one for the Irulas, who traditionally hunted the crocodile for meat. Other employment available to Irulas is unacceptable as it does not offer a sustained income.

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## Conservation and the Amateur Herpetologist

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**ABSTRACT:**- The state of reptile conservation today should be apprehended by everyone involved in the various aspects of conservation efforts.

### Introduction

Although conservation and ecological concern has become a popular area of endeavour in our society, the preservation of herpetological species has been grossly neglected. Specialists in our discipline have tried to forward these efforts; but in such today's the situation requires a 'grass roots' movement, in

which the most experienced professional must join ranks with the rank amateur to protect these fascinating and ecologically vital creatures.

Due to the space limitations, I won't go into the reasons why reptile and amphibian conservation is so vital. We have all been lectured about ecological niches and balance, while the value of reptiles to man

has been discussed by Murthy (1988). What I wish to narrate is the subject of what we, the amateur herpetologists, can do for further conservation efforts.

### Conservation Ethics

The most important service we can give for reptile and amphibian preservation would be to follow the first rule learned by surgeons; "First, do no harm". Overcollecting has drastically reduced population of the spectacled caiman (*Caiman crocodilus*), while the San Francisco garter snake (*Thamnophis sirtalis tetrataenia*) and the Eastern indigo snake (*Drymarchon corais couperi*) have been endangered species in parts because of over-collecting.

The Society for the Study of Amphibians and Reptiles, The Herpetologists League and The American Society of Ichthyologists have published (1987) a very good treatise on herpetological ethics for field research, which not only include the guidelines for collection, but also for the returning of specimens to their habitat after the research work.

### Education

Recently, a friend of mine came to see me while I was handling my Burmese python. Although he was an experienced outdoorsman, he nearly had to be revived after such a close encounter with a snake. When he regained his composure, he told me some of the most outlandish stories I've ever heard - and some pretty off-the wall stories. My own parents, when faced with a snake that invaded their garage, advocated the death penalty for the offending animal. This just goes to show how little the general public knows about these misunderstood creatures. The first time I handled the python around my assistant, she was so afraid of it that I had to do so in a separate room. That is how maligned these animals are.

The education of the general public does not entitle as much as it would seem to. Some, like our facility, have developed a normal lecture and delivered it to the local social groups, Audubon Society Chapter and schools. But you can aid in this aspect of conservation by telling your friends about herps, or offering suggestions to your local herpetological chapter in the form of information exchanges or formal papers. I am not advocating that you become an exhibitionist with your herps; but I do say that the attitude of the general public shouldn't inhibit you either.

### Legislation

Finally, we can differentiate as activists. As a rule, legislators are not concerned with herpetological conservation. We form a special interest group, and can not only suggest actions to our respective representatives, but also to inform them of current situations. We must remember that the members of our respective government are no more knowledgeable about herps than anyone else, and rarely comprehend the importance of the matters put before them.

### Breeding

Although professional research has uncovered a vast amount of information regarding the natural history of herptiles, it is still the amateur pet keeper that develops the most effective methods for keeping and breeding herps. We are at the vanguard of this area of our science, and the result of our efforts - even if they're unsuccessful - lead to new, better techniques in herpetological husbandry. There are a number of sources to which you should report your findings and results, the most prominent of them are:

The Hydra, 1340 Highway 8, Business #V80, Lakeside, CA 92040 U.S.A. - a captive breeding society that depends on reports of breeding attempts, whether or not they are successful, to assimilate information that will aid in future attempts.

Frank L. Slavens, P.O. Box 30744, Seattle WA 98103 U.S.A. - a noted American compiler of information regarding herp collections, as well as a source for finding subjects for breeding attempts. His Inventories (Slavens, 1983-87) are valuable reference to the would-be breeder.

### Conclusion

Ours is an important position in the herpetological community, despite the fact that, that as amateurs, we occupy its bottom rung. We are the lifeblood of the efforts to conserve herptiles, and inactivity on our parts could lead to drastic consequences, especially to the species that are literally dependent on our efforts for survival. Without our efforts, there may be mass extinction of amphibians and reptiles in the next twenty years.

### Acknowledgements

I am especially indibted to my assistant, Dora M. Martin, for her assistance and support in my studies;


and to the librarians at E.G. Fisher Library in Athens, Tennessee, whose help in procuring materials used in this research was invaluable.

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Dr. Douglas H. Taylor, Publications Secretary, Department of Zoology, University of Ohio, Athens, OH 45056 U.S.A.

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## The Food of Common Garden Lizard *Calotes versicolor* in Captivity With Notes on its Feeding Behaviour

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Successful maintenance of captive reptiles depends on different factors with proper food being one of the most important. Correct feeding leans on familiarity of habits in free-living specimens and additionally may be worked out during keeping the animal in terrarium. The food of common garden lizard is generally known. It consists of primarily insects and ants, although small birds, nestlings, frogs and small vertebrates are also occasionally taken (Daniel, 1983). Examination of stomach contents of 35 adult *C. versicolor* (of varied size and sex) showed that these lizards feed mostly on black ants, *Camponotus compessus* (Subba Rao, 1975). He listed also the following food items - beetles, lepidoptera larvae, gastropod shells, eggshells, grasshoppers, dragon flies, spiders, centipedes, earwigs, one lizard, millipedes and earthworms. Plant material (seeds, twigs etc.) and stones may pass accidentally into the stomach.

Observations presented here deals with one specimen only collected as juvenile in Agra in November 1986, however after two years in my terrarium it seems worthy to publish them in order to improve our knowledge in keeping lizards of this species in captivity.

The list of food items is presented in the table 1. As an addition to it cockroaches and mealworms of laboratory origin were commonly used. It is seen that *C. versicolor* is not fastidious about food and can take practically all kinds of invertebrates. What is interesting is that very unpleasantly smelling insects are

eagerly eaten, e.g. Pentatomids as well as large Carabids like *Carabus violaceus* (about 32 mm) and *C. coriaceus* (about 40 mm). A large part of supplied invertebrates consisted of snails, earthworms, wasps, honeybees, naked and hairy caterpillars and various butterflies (excluding those with big ocelli on wings). Newborn mice are also eaten, however juvenile lizards *Lacerta agilis* and frogs *Rana temporaria* were refused. At last small pieces of beef were taken from the tweezers to complement the food during winter.

The lizard got used to European invertebrates immediately, depending chiefly upon sight in catching them, not protruding its tongue. Dead insects or dead weaned mice, sometimes containing vitamins inside, were also accepted. It extremely needs as vast range of supplied invertebrates as possible. Providing with one kind of food in greater quantity caused immediate refusing of eating. Water is licked from leaves. It is still very shy and feeds only in calm surroundings.

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**Table 1.**

Invertebrate diet composition of captive *Calotes versicolor*

Oligochaeta	-	<i>Lumbricus terrestris</i>
Malacostraca	-	Isopoda - <i>Oniscus asellus</i>
Arachnida	-	Araneae
Myriapoda	-	Glomeris, <i>Lithobius forficatus</i>
Gastropoda	-	<i>Succinea putris</i> , <i>Cepea nemoralis</i> , <i>Monachoides vicina</i> , <i>Bradybaena fruitcum</i> , <i>Arion subfuscus</i>

Insecta	-	Orthoptera - Acrididae, Gryllidae, Tettigonidae (Tettigonia, Pholidoptera, Roeseliana) Trichoptera Dermaptera - <i>Forficula aurifularia</i> Heteroptera - Pentatomidae ( <i>Mesocerus marginatus</i> , <i>Pelomena</i> ) Coleoptera - Elateridae, Cerambycidae ( <i>Rhagium</i> , <i>Stragalia quadrifasciata</i> ), Carabidae ( <i>Pterostichus</i> , <i>Carabus violaceus</i> , <i>C. coriaceus</i> , <i>C. cancellatus</i> ), Scarabeidae (Amphimallon) Diptera - Tipulidae, Muscidae Hymenoptera - Apidae ( <i>Apis mellifera</i> , <i>Bombus</i> ), Vespidae ( <i>Vespa</i> ), Lepidoptera
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### Abnormal Diet of the Indian Bull Frog (*Rana tigerina*)

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The Indian Bull Frog is usually the first vertebrate introduced for dissection in many parts of our country. While studying this animal for gonadal development, I came across an animal with abnormally distended stomach. Further dissection showed a full grown garden lizard, *Calotes versicolor*, in the stomach. This lizard was in fact, seen on the previous day in the enclosure where live frogs were kept. The lizard was obviously a recent prey; even its tail was still in the oesophagus. The frog was of a medium size with snout-vent length 140 mm. The snout-vent length of the lizard was 75mm. (Fig. 1).

Survey of the relevant literature revealed that such abnormal food items have been often found in *R. tigerina*. Many small notes have appeared in the Journal of the Bombay Natural History Society in the past. Not all the previous reports could be located but a few that were found gave an interesting list of such food items. The list is given in table 1.

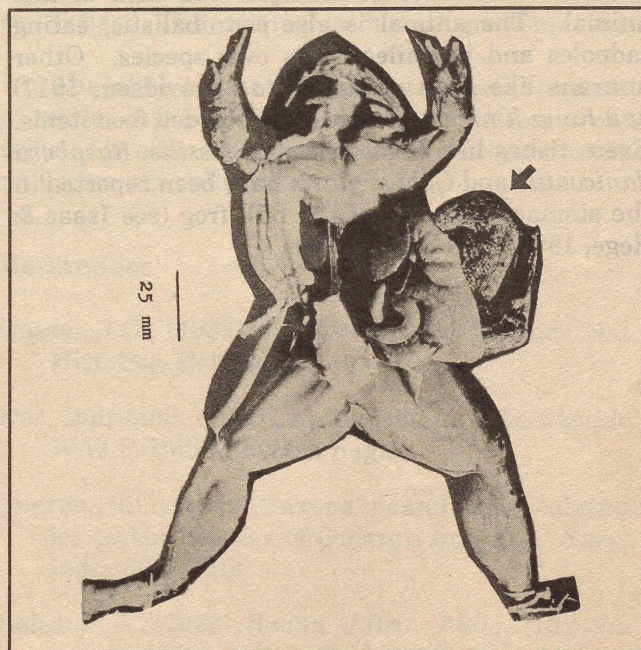


Table 1.

Reptiles :

<i>Uromastix sp.</i>	(Ishwar Prakash, 1953)
<i>Hemidactylus sp.</i>	(Wadekar, 1963)
<i>Calotes versicolor</i>	(Joshee, 1968)
<i>Mabuya carinata</i>	(Issac & Rege, 1975)
<i>Zaocys mucosus</i>	(Sundara Raj, 1914)
<i>Natrix stolatus</i>	(Joshee, 1968)
<i>Xenochrophis piscator</i>	(Isaac & Rege, 1975)
<i>Amphiesma stolata</i>	(Isaac & Rege, 1975)
<i>Lycodon aulicus</i>	(Isaac & Rege, 1975)

Mammals :

Rat	(Zutshi, 1962; Joshee, 1968; Isaac & Rege, 1975)
Mouse, <i>Mus sp.</i>	(Wadekar, 1963)
<i>Suncus murinus</i>	(Joshee, 1968; Isaac & Rege, 1975)

Feathers of birds have also been reported by Wadekar (1963). In fact the frog was observed catching a fledgeling of spotted munia that had accidentally fallen in the pond (Tyabji, 1982).

*R. tigerina* usually feeds on insects and land crabs are known to be a major food item in this animal. The animal is also cannibalistic, eating tadpoles and juveniles of its own species. Other anurans like *Bufo melanostictus* (Davidson, 1917) and *Rana limnocharis* are also recorded food items. Even fishes like *Heteropneustes fossilis*, *Rasbora daniconius* and *Gobius giuris* have been reported in the stomach contents of the bull frog (see Isaac & Rege, 1975, for a detailed list).

Thus it is evident from this brief note that *R. tigerina* consumes a variety of animals other than the ones which form normal diet and it might be interesting to study the strategy employed by the frog in capturing such unusual prey animals. It may also be noted here, that, as an addendum to the note of Ishwar Prakash (1953), the Editor of the Journal had listed following unusual dietary animals reported earlier in case of this frog : mouse, young ground thrush, full grown sparrow, chicken, snipe, pitta, land crab, toad, juvenile rat snake, scorpion and caterpillar of psychid moth with its case of babool thorns

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## Distribution of the Ganges Softshell Turtle

(*Trionyx gangeticus*: Cuvier) In Gujrat

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Today most of *Chelonians* are on the decline in India due to destruction of habitat by pollution, deforestation and also indiscriminate killing of chelonians as delicacy, use of eggs as food and also use of shells and skins for making fashionable luxury items.

### Background

References are vastly found in scientific literature about the Ganges softshell turtle *Trionyx gangeticus*. The hitherto published literature gives an idea about its distribution over a wide area which include River Indus, River Ganges and River Mahanadi systems and lower Bengal, (Smith, 1933; Daniel, 1983) Bihar, Madhya Pradesh, Orissa, Punjab, Rajasthan and Uttar Pradesh. Its occurrence in River Narmada and River Tapi (Das, 1985) has also been reported. Its existence in Dang district of Gujarat has been noted by Sharma (1980), but this species has hitherto been unreported in other parts of Gujarat State.

### The first encounter with *T. gangeticus*

A report from local villagers was received, stating that there were many big Kachaba (turtles) in River Mahi which surfaced where half burnt remnants of human bodies along with coconuts were thrown in the river.

To ascertain the facts the author accompanied by John Frazier and Susana Frazier visited River Mahi on 25th Feb. 1987 at a locality called Sindhrot. Sindhrot is about 25 kms away from Vadodara (Baroda) on the left bank of River Mahi.

After reaching the banks of Mahi we hired a flat bottom boat and went down-stream for about 2 kms. 4 to 5 big turtles were observed as they broke the surface for intake of air. About two hours were spent at this spot for observations. During this period these turtles repeatedly came out for breathing. Then due to intense activity of local people the turtles were disturbed and moved away.

During the return journey two empty nests of turtles were observed. One was right on the bank of

the river while the other was about 20 metres away from the flowing water. The information gathered from the local people revealed that these nests were prepared during the previous breeding season, October 1986. A few broken shells were found around these holes. Though the dimensions of both these nests were the same, the depth varied. The locals also informed that this part of the river termed as MiniNadi and is being polluted due to the contiguity of a chemical industry which has become dangerous for turtle *T. gangeticus*. This species has also been sighted in River Vishwamitri, Dhadhar, Vatrak and Sabarmati as well as small lakes like Sursagar, Sarasia, RajaRani Ajawa and temple tanks of Dakor and Sidhnath.

### Conclusion

*T. gangeticus* is found in many rivers of Gujarat State, but there is likely-hood of this species dying out due to the pollution and excessive killing by men. Besides, turtles in temple tank do not breed due to the lack of proper breeding grounds.

During this study a few specimens were observed which have no marking on carapace and three stripes on the head. The carapace is blackish green in colour.

The inhabitants of Vadodara city testify to plenty of turtles in River Vishwamitri, but these are now reduced to a limited number due to heavy industrial and sewerage pollution.

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## Review

### BREEDING TERRARIUM ANIMALS

by Elke Zimmerman

English Translation

by U. Erich Friese

TFH Publications Incorporated

New Jersey, USA

384 pages, illustrated (1986)

On the back cover of this book the publishers write, "Breeding Terrarium Animals is essential reading if you are even thinking of making the jump from just keeping an amphibian or reptile to actually breeding it". And while I cannot honestly go that far in praise of this book, I can say that this is the reference that I recommend to anyone who has just obtained their first herptile, and wants to know what to do to care for it. Many of the problems that bedeviled me when I first began keeping and breeding herptiles are touched upon in this book; some such as food-animal breeding and maintenance in considerable detail. And perhaps best of all, Ms. Zimmerman has presented it in a style that both the rank amateur and the seasoned professional will find quite readable.

The author describes in intricate detail the conditions needed to breed over a hundred different species of reptile and amphibian, and provides lists of some 250 other species that can be maintained in similar conditions. There are also general chapters covering the diseases of herptiles, nutrition and housing; as well as a fairly brief (24 pages) overview that is an essential foundation for anyone who intends to continue on to the specific accounts. All in all, the material is presented in a concise, yet well-organized and comprehensive form.

This is not to say that this book is without any faults. Written originally in German (under the title *Das Zuchten von Terrarientieren*), there are a few injustices of translation, and the reader must be mindful of cultural differences (for instance, the title itself seems to connote a broader field than Ms. Zimmerman intended). Occasionally, Ms. Zimmerman seems to assume too little capability on the part of the reader (such as recommending that a veterinarian be consulted before administering a suflamethazine bath, or eye ointments); while at other times, she is too vague in her instructions for any but the most experienced professional). But I agree with one review (Fugitt, 1988) that these faults arise mainly because of the broadness of the field she is trying to cover. I still believe that this book is an asset to any herpetoculturist; and I would fervently recommend it to anyone interested in this fascinating field of study. To go even further in praise of this book, it is the main reference I use in teaching my class in herpetoculture, and a valuable reference for my lectures.

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## Review

### THE SNAKE BOOK OF INDIA

by T. S. N. Murthy

International Book Distributors

9/3, Rajpur Road, Dehra Dun 248 001

Prices Rs. 150.00 (US \$15.00), Pages 101

Line Drawings - 10, Monochrome Photoplates - 27, Hard Bound (1986)

The snake book of India appears to have been prepared to serve as a field guide for identifying Indian Snakes. The language and terminology used in the book is user oriented and an attempt has been made to do away with the unnecessary scientific jargon that confuse the common reader.

This book begins with the general facts about the snakes. In this chapter there seems to be ambiguity about the number of species of the snakes. The number quoted in the general facts is 238, while the check-list describes 236 species. According to Khaire & Khaire the number is 239. Also the number of species of venomous snakes seems to be controversial.

The point of identification of sex need to be added since the sexes are separate, the reader will be interested to know how to identify them.

Cobra venom possess both the properties of cardiotoxicity and neurotoxicity while the Viper venom is cardiotoxic. Properties of Krait venom need to be added. Also it will be better to elaborate the venom information.

To the best of our knowledge the only treatment for venomous snake bite is intravenous injection of antisnake venom serum.

The snakes play major role of biological control over the rodents, amphibians and other animals but in no case are they voracious feeders.

In the checklist the author says that the olivaceous keelback (*Atrretium schistosum*) is found throughout India, actually this species has not been reported for its occurrence in Maharashtra.

A great number of spelling mistakes, some grammatical mistakes are also found which are expected to be corrected in the next edition. Also the plate no. 3 and plate no. 26 are printed upside down. Such printing mistakes are expected to be omitted.

It is good that usual museum piece photographs have been replaced by black & white photographs of live animals in their natural environment. It would have been much better with the coloured photographs since colouration is an important factor for identification. I hope that the next edition will take care of it.

This book will be useful as a handbook. A beginner in the field of herpetology is particularly advised to read this book for precise introduction to snakes. The author has taken great pains to bring out the book at the right time when there was a need for a recent book on Indian snakes.

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Pune - 411 007.

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