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CONTENTS

	PAGE
Notes on the ecology and behaviour of six species of Mexican anurans. By Peter Mundel and Robert G. Jaeger	221
Observations on the egg and hatchling of the American turtle, <i>Chrysemys picta</i> . By Carl H. Ernst	224
Loggerhead turtle movements. By H. Robert Bustard and Colin Limpus ...	228
Mating and Spawning of <i>Rana temporaria</i> under unusual circumstances. By Trevor Beebee	231
Surgery on captive Gaboon viper. By J. E. Cooper	234
Case report on a Corn snake. By E. Elkan	236
Letters to the Editor	236
Book Reviews	239

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NOTES ON THE ECOLOGY AND BEHAVIOUR OF SIX SPECIES OF
MEXICAN ANURANS

By

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(Received 9/10/70)

Recent studies on visual physiology and phototactic responses of anurans have provided information which allows the ecology and behaviour of many species of frogs and toads to be viewed in a new light. Muntz (1962, 1963) reported that adults of *Rana temporaria* respond most strongly to that area of the visible spectrum which humans see as blue and that this response develops ontogenetically from a strong response to green light in young tadpoles. Hailman and Jaeger (in prep.) showed, from a survey of over 100 species of anurans, that most species express one of two types of phototactic response: either the species is monotonically photopositive to white light and shows a strong preference for blue or the species is monotonically photonegative and fails to show a colour preference independent of intensity.

Such studies have made essential the acquisition of more data on the ecology and behaviour of even the most common species of anurans. For all but a few species, critical field and laboratory observations are rare. In part, this dearth of information is due to the convenience of studying anurans in breeding congregations. Breeding behaviour is usually highly specialised and often reflects little of the activity patterns of the animals during the remainder of the year or life cycle. Information on the temporal patterning of activity and foraging, for example, is difficult to find. Often when such information does exist there are conflicting statements in the literature as to whether a given species is diurnal, nocturnal, crepuscular or arrhythmic. Such basic knowledge is critical to the ecological interpretation of the two types of phototactic response found experimentally. Also additional information is needed for many species as to the non-breeding microhabitat, prey utilization, means of escape and predator defense. While this paper presents only a small amount of this type of data, it does give additional information on six species of anurans collected in Mexico during the summer of 1969 and used in phototactic experiments. The observations made here, then, will provide a partial basis for interpretations to be made in a later more detailed paper (Jaeger and Hailman, in prep.) on phototactic behaviour.

PACHYMEDUSA DACNICOLOR (Hylidae)

A large number of individuals of this species was observed in the States of Oaxaca and Nayarit. They occur in a variety of habitats but appear to be primarily concentrated in arid tropical scrub forests; Duellman (1961) also found them mainly in this habitat. We found males calling in vegetation on the ground and in low bushes. A single individual was found calling from a tree at a height of 6 m at sunset. Although we observed no egg-laying, Pyburn (1970) noted that eggs are laid in gelatinous masses on leaves and branches over water into which the larvae fall upon hatching. Movement occurs by a slow uninterrupted crawl, described as "lemuroid manner of climbing" by Duellman (1968), whether on the ground or climbing vegetation, and jumping seldom occurs. Protection from predators is probably afforded by the dark green dorsal colour which makes individuals almost invisible in the green foliage of trees. When disturbed, the frog tends to remain motionless, pressed flat against the substrate. Most activity was observed to be crepuscular to nocturnal. Pyburn (*op. cit.*) observed them breeding at night.

Captive specimens in the laboratory become active only at twilight. During the day they remain absolutely motionless, clinging flat against large green leaves. At night they slowly crawl among the vegetation, never descending to the ground. Adults feed on plant-dwelling animals of at least 1 cm in length, avoiding smaller prey. They apparently do not readily prey on terrestrial organisms and catch flying insects with difficulty. Orthopterans and small frogs, such as *Hyla staufferi*, are consumed in large numbers in the laboratory. When approaching the prey, these treefrogs slowly move from plant to plant as if stalking. When at a distance of 5 to 10 cm, the frog leaps, catches the food item, falls, then clings to the plant during ingestion.

ANOTHECA SPINOSA (Hylidae)

This apparently rare species was collected at Cuautlapan, State of Veracruz. The habitat is one of foothills covered with lush subtropical vegetation, quite wet during the time of collection. Bromeliads are absent at this altitude (670m) although abundant at higher altitudes in the surrounding hills where *A. spinosa* is apparently absent. The site of collection was a banana grove, and the frog was found in the leaf axils of banana trees (coexisting with another, far more abundant treefrog, *Smilisca baudini* as well as the plethodontid salamanders *Bolitoglossa platydactyla* and *B. rufescens*). The frogs were generally found at the base of leaves where pockets of water collect. Robinson (1961) stated that tadpoles of *A. spinosa* were found in a water-filled tree cavity about two feet above the ground. Although individuals were not observed during the night, we saw no sign of activity during the day.

In the laboratory, this species is strictly nocturnal. During periods of light, the frog remains motionless while clinging to any vertical object in a darkened place, such as under the shade of a leaf or in artificially provided cavities. Activity does not begin until darkness is almost complete and even then movement is confined to the more protected parts of plants, but never on the ground. Movement is usually restricted to a slow and deliberate crawl with jumping rarely occurring. Although this frog was quite active nocturnally, we could not induce feeding, with a variety of prey provided.

HYLA DENDROSCARTA (Hylidae)

Individuals of this species were observed and collected at Cuautlapan, State of Veracruz, at an elevation of 1340 m. The top of the mountain is heavily forested and bromeliads and mosses are abundant; however this habitat is ecologically isolated from surrounding areas. *H. dendroscarta* apparently is restricted to isolated habitats such as this. Individuals were found only in large, water-filled bromeliads in hardwood trees. These treefrogs were collected at a distance as high as 12 m up in the trees and probably occur much higher. The unusual, dorso-ventrally flattened tadpoles in all stages of development were found in the same bromeliads as the adults. Although adults occurred singly, tadpoles numbered from 10-15 per plant in which they occurred. Individuals of this species are sparsely distributed and occur only where bromeliads occur. The salamander *Pseudoeurycea nigromaculata* commonly coexists with *H. dendroscarta* in these bromeliads.

The activity pattern of this species, as observed in the laboratory, is one of diurnal foraging and nocturnal quiescence. During the day individuals move freely around the leaves and stems of plants feeding on a variety of winged insects. They seldom go to the ground and then only for short periods. These treefrogs sit for long periods of time without movement, lying close to the plant, but while foraging they are quite active, making long jumps. Activity decreases with darkness, and nocturnal foraging is absent.

HYLA EXIMIA (Hylidae)

Individuals of this species were taken near Ciudad Hidalgo, State of Michoacán. The habitat is an ecotone between mesquite-grassland and pine-oak woodland. This is similar to the habitat for specimens observed by Duellman (1961). The treefrogs were breeding in a temporarily flooded grassy ditch at the edge of a pasture and, less abundantly, in a flooded corn field bordered by grass. It was the only species of anuran present in the former area. Individuals were quite abundant, nestled among short blades of grass. Holman (1965) found individuals beneath boulders bordering a small pond in a pine-oak forest. Martin (1958) mentioned that while they are abundant during the rainy season in short grass near water, he found no trace of the species during the dry season.

In the laboratory, individuals of this species forage by day. They are very active, jumping frequently among leaves of plants and taking large numbers of winged insects, particularly dipterans. They often descend to the ground but do not remain there long. They are inactive at night.

ELEUTHERODACTYLUS RHODOPIS (Leptodactylidae)

This species was found at Huatusco, State of Veracruz, in a ravine at 1100 m altitude. The habitat is composed of a wet deciduous hardwood forest with many very large oak trees, abundant bromeliads and patches of grass in less shaded areas. The forest floor is wet, dark due to heavy shading and thickly carpeted with fallen leaves. Duellman (1960) also found this species in ravines of humid forests at the Isthmus of Tehuantepec. We found individuals of this species to be terrestrial and very abundant in shaded areas hopping on and amid the fallen leaves of the forest floor. Rand (1957) collected them from under stones and leaf litter. Their foraging activity is diurnal during which time they prey on small terrestrial organisms. Escape is made by rapidly hopping and then taking refuge among fallen leaves. An extreme variety of colour patterns was exhibited by the specimens collected, with no two individuals exhibiting the same pattern. This may be of great survival value since it prevents predators hunting visually from learning to identify individuals of a particular edible species, since each member of the species presents a radically different design. Massive polymorphism of this type was termed "reflexive selection" by Moment (1962).

Observations in the laboratory show that individuals remain under leaf litter or objects on the ground for several months when subjected to artificial light approximating normal daylight and apparently forage there successfully. However, they forage on the surface of the ground when lighting is dim. A wide variety of terrestrial organisms is consumed as well as a few winged insects. Foraging is both nocturnal and diurnal under conditions of dim light.

HYPOPACHUS OXYRRHINUS (Microhylidae)

Members of this species were collected at La Venta, State of Jalisco in a semi-dry habitat combining thorn forest and cultivated fields. Shannon and Humphrey (1958) described the species' habitat as deciduous mesic jungles. Our specimens were calling at night when collected and were found well-concealed in areas of grass near the water's edge at a flooded corn field.

Laboratory observations indicate that individuals of *H. oxyrrhinus* remain in excavations under objects on the ground during the day but leave these burrows at twilight to forage on the surface. Each individual returns to the same burrow before morning. Being lethargic in movement, predation is apparently restricted to terrestrial organisms which are slow to move, such as various insect larvae and adult coleopterans.

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OBSERVATIONS ON THE EGG AND HATCHLING OF THE AMERICAN TURTLE, *CHRYSEMYS PICTA*

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The following observations were made while the writer conducted an ecological study on the painted turtle, *Chrysemys picta*, at the White Oak Bird Sanctuary, 3 miles north of Manheim, Lancaster County, Pennsylvania, U.S.A. The study was in progress from mid-May, 1965 to mid-August, 1967. All measurements were made to the nearest 0.1 mm with dial calipers and all weights were recorded on a calibrated triple beam balance.

Fifteen clutches numbering 71 eggs were examined. The number of eggs per clutch ranged from 4 to 6 with a mean of 4.73. The literature reveals the following ranges of eggs per clutch for the four subspecies of *Chrysemys picta*: *C. p. picta*—2 (Lynn and von Brand, 1945, based on oviducal eggs from a Maryland specimen) to 11 (Wilcox, 1933, Long Island, New York and Powell, 1967, Nova Scotia, Canada); *C. p. dorsalis*—2 to 7 (Cagle, 1937, Tennessee); *C. p. marginata*—3 (Blanchard, 1928, Michigan) to 10 (Cahn, 1937, Illinois); and *C. p. bellii*—4 (Breckenridge, 1944, Minnesota) to 20 (Carl, 1944, British Columbia, Canada). The records of Carl (*op. cit.*) of 20 deposited eggs and Smith (1956) of 15 for *C. p. bellii* seem extremely high and are

considered doubtful. Legler (1954) has observed a Minnesota *C. p. bellii* laying 11 eggs, and Mahmoud (1968) reported a clutch size of 11 from Wisconsin, and it seems more reasonable to record this as the greatest number deposited, since neither Carl or Smith give supporting evidence for their high numbers. Cagle (1954) stated that repeated observations of two females depositing in the same or connecting nests indicate caution in use of such data as above. Cagle (1954) also reported that females collected in May, June and early July and containing oviducal eggs, usually had large ovocytes still present. He assumed that these enlarged ovocytes represented second or third broods that would be deposited in one season. Personal examinations of female reproductive tracts revealed enlarged ovocytes throughout the year, and since there have been no second layings ever recorded in *C. picta*, Cagle's assumption is believed in error. Powell (1967) stated that *C. picta* in Nova Scotia produce a clutch each year and some may lay two clutches per year. He reported that females of *Chrysemys picta* in more northern populations lay larger clutches possibly compensating for the presumed fewer number of clutches laid by them. Agassiz (1857) believed *Chrysemys picta* only deposited one clutch of eggs each year. He interpreted the size groups of ovocytes to represent clutches that would be deposited in later years, and suggested these groups were associated with the need for two matings a year for four successive years to stimulate ovulation. This is doubtful. The number of oviducal eggs found in dissected females ranged from 3 to 6 (mean 4.8).

There seemed to be a slight positive correlation between plastral length and number of eggs in the seven depositions observed. The following are the plastral lengths of the seven females and the number of eggs each deposited: 123.8 mm, 4 eggs; 125.1 mm, 4 eggs; 129.3 mm, 5 eggs; 130.5 mm, 5 eggs; 130.9 mm, 6 eggs; 133.5 mm, 5 eggs; and 135.4 mm, 5 eggs. There was no correlation between the size of the eggs, or the number of eggs in the clutch and the plastral length.

The 71 deposited eggs and 24 oviducal eggs were examined. The shells of the deposited eggs were white to cream in colour, and had smooth, slightly pitted surfaces. The texture was calcareous but flexible when first laid, becoming more firm as water was absorbed. The shapes were variable but normally appeared elliptical. The oviducal eggs were pinkish white and slightly translucent but became white shortly after their removal. Their shapes did not vary significantly from deposited eggs. The deposited eggs ranged in length from 28.8 to 35.1 mm (mean 32.1) and in diameter from 17.6 to 22.2 (mean 19.2). Fourteen were weighed and gave a range of 6.1 to 9.1 g (mean 7.2). The 24 oviducal eggs removed in the laboratory ranged in length from 23.1 to 33.0 mm (mean 28.4), in diameter from 15.4 to 20.1 (mean 17.5), and in weight from 5.3 to 6.8 g (mean 5.9).

It has been previously reported that turtle eggs increase in size and weight during development (Cunningham and Hurwitz, 1936; Cunningham and Huene, 1938; Lynn and von Brand, 1945; Legler, 1960). To test this, 38 eggs (14 deposited and 24 oviducal) were placed between two layers of moist cotton in shallow dishes, as suggested by Legler (1956) and incubated at 24 degrees. Each dish was numbered and held a different clutch, and the individual eggs were marked for identification with different colours of vegetable dye. The eggs were weighed and measured weekly and showed a slow steady increase in weight and size. The weight increased approximately 35%; the length, 16%; and the diameter, 18%. Cunningham and Huene (*op. cit.*) reported an average weight increase from 70 to 75% in *Chrysemys picta* eggs, and Lynn and von Brand (*op. cit.*) reported an increase of only 15%. Cunningham and Huene (*op. cit.*) listed the functions of absorbed water as: (1) used by embryos for body fluids; (2) keeps the shell fully distended and

avoids pressure on the embryo; (3) the rapid increase in absorption at the end of the incubation period is a device for rupturing eggs. Lynn and von Brand (*op. cit.*) also measured the oxygen uptake of *Chrysemys picta* eggs and found that it increased regularly during the first 40 to 50 days and later irregularly. They stated that this was probably due to muscular activity of the embryos. They found that advanced embryos had about the same rate of oxygen consumption as hatchlings.

The incubation periods of the artificially incubated eggs ranged from 65 to 80 days (mean 76) and those naturally incubated in the nest 72 to 80 days (mean 76). The earliest hatching in nature took place on 14 August and the latest on 29 August. Oviducal eggs took several days longer to hatch than deposited eggs when removed. Lynn and von Brand (*op. cit.*) reported artificially incubated *Chrysemys* eggs hatched in 58 to 68 days, and Legler (1954) 69 days (but did not fully emerge until the 75th day). Records in the literature of the natural incubation period of *Chrysemys picta* include: Wilcox (1933), 75 days; Finneran (1948), 69 to 81 days; Pope (1939), 74 days; and Smith (1956), 72 days. Legler (1960) found the incubation period of *Terrapene ornata* to be longer at lower temperatures, but Cagle (1950) found no distinct differences in length of incubation period for *Chrysemys scripta* eggs at different temperatures within the range tolerated by the eggs. Because of the small number of eggs incubated no attempt was made to determine this during the current study.

Young turtles from eggs laid late in the season (July and August) would not have the opportunity to emerge from the nest before the colder weather of autumn sets in. Such young apparently overwinter either in the egg, or as hatchlings in the nest. Overwintering of *Chrysemys picta* hatchlings is well known, and has been reported from Minnesota (Woolverton, 1961, 1963), Michigan (Hartweg, 1946; Sexton, 1957), Illinois (Williams, 1957), Long Island, New York (Nichols, 1933), and Nova Scotia, Canada (Bleakney, 1963). Abundant evidence was found that some painted turtle hatchlings overwintered in the nest at White Oak. Each year during late May and early June, a number of hatchlings were collected. This was too early in the laying season for them to be from that year's eggs. All had measurements corresponding to late summer White Oak hatchlings, and those given by Carr (1952) and Cagle (1954) for hatchlings. None showed evidence of new growth or growth annuli, and all had unhealed or recently healed yolk scars. Cold weather might not have been the only cause of overwintering in the nest, as the extremely dry summers and falls of 1965-66 dried the earth rock hard and this could have prevented hatchlings from digging out. Overwintering of hatchlings is apparently a protective mechanism well established in painted turtles.

Fertility and prenatal mortality were studied in the 38 eggs incubated in the laboratory. Of these 29 were fertile and 21 hatched successfully, although several hatchlings died soon after. Of the 14 eggs removed from nests 9 were fertile and 4 hatched, giving a percentage hatched of 28.6. Twenty of the 24 oviducal eggs were fertile and 17 hatched for a 70.8% of the total. These percentages are very similar to those given by Legler (1960) for *Terrapene ornata*. Of the 57 eggs left in the nests, 13 were laid during 1967 and had not hatched by the time the study ended in mid-August; however, 15 of the remaining 44 eggs hatched. Laboratory incubation conditions were probably more nearly optimum, and this accounts for the greater percentage of hatchlings. Egg predation was not noted during this study, but a severe drought in 1966 destroyed many eggs.

Observations of laboratory hatchlings showed that all the eggs of one clutch did not hatch simultaneously, but ruptured individually over a period of from 26 to 92 hours. The young remained in the shell for periods of 23 to 49 hours before totally freeing themselves. The eggs first split along the end

which covered the head and forelegs. The first slit was occasionally made by the caruncle, but usually by the forefeet and head movements. Cunningham and Huene (1936) reported that *Chrysemys picta* eggs split as often at the posterior as at the anterior region of the embryo. They attributed the splitting to rapid absorption of water near the end of incubation. Once the shell split the hatchling broke the embryonic membranes with its head and forefeet and took a long gasping breath. The struggles then stopped for a period of from one to four hours, during which pumping motions were made with the head. Cagle (1950) reported similar motions in *Chrysemys scripta* and thought they probably aided in the slow retraction of the yolk mass through the umbilical opening into the body cavity. After the greater portion of the yolk was absorbed, the hatchlings resumed their struggles until completely free of the shell. Cagle (1950) reported fragments of the hardened outer layer of calcium often fell away from *Chrysemys scripta* eggs prior to actual splitting. This did not occur on any *Chrysemys picta* eggs.

When the hatchlings emerged from the egg, their shells were misshapen from fitting the contours of the confining egg shell. Their marginals were pliable and folded inward, and a deep crease existed across the abdominal plate. Many showed evidence of a keel. Most were generally round in shape and had long tails. The head and eyes were large in proportion to body size when compared to adults. The pigmentation and patterns of the shell and skin were brighter and more pronounced than in adults.

Normally, about 7 to 10 days were needed for the shell shape to set and the hatchlings to reach their maximum size before the initiation of actual growth. During this time the yolk mass was retracted and the young changed in body proportions. Yolk retraction was accompanied by a lengthening and widening of the carapace and a reduction in height. Cagle (1950) reported similar changes occurred in *Chrysemys scripta* hatchlings. Eighteen hatchling *Chrysemys picta* survived 10 days or longer and increased in carapace length 0.8 to 1.0 mm (mean 0.83); carapace width 1.5 to 2.5 mm (mean 2.1); plastron length 0.2 to 0.3 mm (mean 0.26); and plastron width 0.1 to 0.7 mm (mean 0.50); but decreased in height 1.5 to 2.2 mm (mean 1.93). Cagle (1954) reported similar changes in size in two *Chrysemys picta* hatchlings he measured. After 10 days the 18 turtles gave the following measurements: carapace length 23.0 to 30.6 mm (mean 25.9); carapace width 21.0 to 28.2 mm (mean 24.9); plastron length 20.1 to 30.4 mm (mean 25.7); plastron width 10.5 to 13.9 mm (mean 12.5); height 10.4 to 13.0 mm (mean 11.5); and weight, 4.8 to 6.1 g (mean 5.3).

Chrysemys picta hatchlings had yolk masses ranging from 10 to 25 mm in diameter (mean 18.6). Only 14 of 42 turtles had completely retracted the yolk before leaving the egg. The yolk mass persisted in some turtles for as long as 14 days after hatching. Cagle (1954) stated that the mass of yolk retained at hatching varies, and is apparently related to the temperature levels and changes during incubation. The yolk seems to be of little value and may even be a hindrance to motion and escape from the egg and nest (Legler, 1960). Cagle (1950) reported finding 16 of 108 hatchling *Chrysemys scripta* imprisoned in the eggs when the shell became adherent to the carapace or yolk. The umbilical scars of all captive young were closed by the end of two months. The caruncle disappeared in most young by the fifth day after hatching, but one individual retained it until the sixteenth day.

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LOGGERHEAD TURTLE MOVEMENTS

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Loggerhead turtles (*Caretta caretta* (L.)) are known to move very considerable distances from their nesting grounds. The sparse data were summarised in Bustard and Limpus (1970).

The present note records a second long distance movement by an Australian tagged loggerhead turtle. This is the first record of a turtle tagged in central Queensland rounding Cape York peninsula (Fig. 1) despite tagging operations extending over six years in which 3831 green turtles and 1216 loggerhead turtles have been tagged.

The loggerhead in question, tag number 2967, measured 89 cm in length (over the curve of the carapace). Tagged female loggerheads varied from 86 to 120 cm in carapace length so that 2967 was at the lower end of the size distribution for breeding females. It was tagged at Mon Repos beach near Bundaberg in south-central Queensland (Fig. 1) on 28th December, 1968 when nesting. It was seen again on 12th January, 1969 at Moneys, a nearby beach, again nesting. It was not seen subsequently.

In March, 1970 a fisherman, Mr. Bill Buse, trawled up a tag, number 2967, in a depth of ten fathoms north-west of Duyfken Point, which is in north-west Cape York peninsula (Fig. 1). Whether the tag, which was in perfect condition, was lost from the turtle following its death, either as a result of natural causes or predation, or had been insecurely affixed in the first instance will never be known. However, the last possibility seems extremely unlikely on two counts. Firstly, the turtle was seen again subsequent to initial tagging. At such times any defective tags are noted and replaced. Secondly, further evidence that the tag was properly affixed is provided by the fact that it remained in place during a very lengthy migration.

Since the monel metal tag would not be carried by water currents, the turtle must have migrated from the vicinity of Bundaberg to the Gulf of Carpentaria. The shortest route between the point of tagging and recovery of the tag is 1350 miles. Bustard and Limpus (1970) recorded recapture of a tagged loggerhead 1100 miles in a straight line from the point of tagging (plotted on Fig. 1). However, the present case is of particular interest not only because of the distance involved but because the turtle rounded Cape York peninsula indicating that there may be some degree of interchange between turtles which nest in south-central Queensland and populations in the Gulf of Carpentaria.

We are indebted to Mr. Bill Buse for collecting the tag and to Mr. Ray Walker for returning the tag together with the above data.

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FIGURE 1.

Map of Queensland showing the migration involved in the recapture reported here and also the recapture recorded by Bustard and Limpus (1970). The lines do not necessarily indicate the routes taken by the turtles.

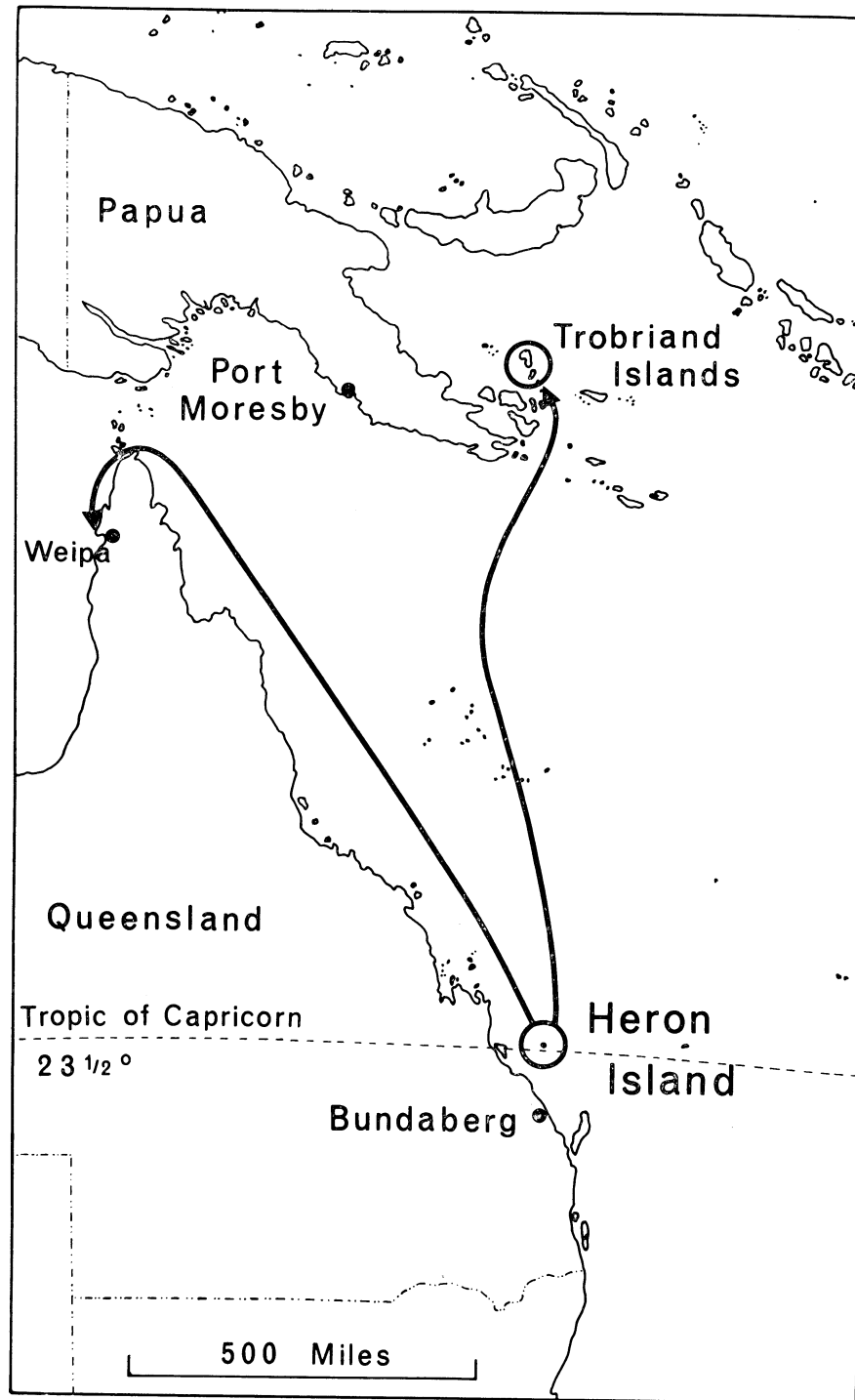
MATING AND SPAWNING OF *RANA TEMPORARIA*
UNDER UNUSUAL CIRCUMSTANCES

By

TREVOR BEEBEE

School of Biology, University of Sussex, Falmer, Brighton.

(Received 3/2/70)



During the autumn of 1968 serious storm damage to a section of the Basingstoke canal between Ash and Aldershot provided a unique opportunity to study the breeding of frogs during the following spring. *Rana temporaria* is now no longer a common species in Northwest Surrey, but in previous years this section was the spawning site for a colony of over 1,000 frogs. This part of the canal is banked above the surrounding fields to a height of 15-20 feet. In the autumn of 1968 storm water caused a section of bank to collapse completely emptying nearly a mile of canal. A dam was erected to prevent further drainage east of the breach, and an old lock served the same purpose to the west (Fig. 1). The drained section included the zone where all breeding by *Rana temporaria* occurred in previous years.

Observations were begun in the spring of 1969 to study the effects of the breach on the breeding colony. Frogs were first seen on March 14th at the point marked BREEDING SITE (Fig. 1), which region corresponds to that used previously when the canal was filled with about 24" of water.

Counting was done directly in the case of spawn and frogs, the latter hardly moved when accustomed to my presence. Three counts were made for each total of large concentrations (one count every 30 minutes) and the average taken. The variation was never greater than 12 and usually less than 5. The smaller migrations were easily followed merely by observations without tagging.

This spring, however, the only water present was a tiny stream flowing from a makeshift dam over the mud, nowhere deeper than 3", rarely more than a foot wide and completely devoid of vegetation. Flow was fairly slow and dependent entirely on day to day rainfall. On the 14th 8 adult males were seen; on the 15th 35, including 2 females in amplexus. On the 17th 480 were recognised on the mud and in the water, including 45 mating pairs. Croaking had begun but no spawn was present. Frogs were rarely observed migrating to the site and the only three seen along the canal were probably atypical of the general population. It seems unlikely that hibernation occurred in the canal because few were seen migrating along it. Such a high emergence rate after hibernation would be unlikely if the adults had been in the canal after the breach and consequently exposed to frost. The nearby River Blackwater seems a likely area for hibernation and will be subsequently investigated.

On the 19th 700 frogs were counted at the site; over 100 clumps of spawn had been deposited. Due to the lack of space many clumps were either on the mud or partially out of the water. On the 20th though the total number of frogs was about the same, for the first time adult males and pairs in amplexus were seen moving away from the main colony eastwards along the stream. About 8 frogs had reached the dam by afternoon and by the following day only one male had found a way round into deeper water.

By noon of the 21st some 15 frogs, including 6 pairs, were below the dam. One solitary female also arrived and resisted attempts at mating, apparently by croaking. Deliberate rejection of a mate in this manner may not yet have been reported. Although behavioural characteristics should not be judged from a single example, the observation does suggest that the

female role involves more than passive acceptance. This particular female remained unmated for four days below the dam, and on the 26th when lifted over into deeper water, accepted amplexus within two minutes.

Between the 20th and 29th 40 frogs migrated to the dam; 34 were known to have come from the original site. Only 4 males crossed the dam unaided, the rest were carried over by hand. Spawning occurred immediately on the other side of the dam. Fifteen clumps of spawn were deposited between the 25th and the 31st. Although all the frogs which arrived at the dam were permitted to remain for at least 48 hours or even much longer before being carried over, only one female spawned on the dry side. Males, females or pairs made no efforts to climb the dam and most of the frogs continued to arrive and spawn on the original site.

Between the 23rd and the 25th about 75 frogs moved west from the main colony to a point some 50 yards downstream, where the stream widened to form a shallow puddle. On the 29th 28 clumps of spawn were counted here when only a few lone males remained. By April 2nd only a few males remained at the original site and 632 clumps of spawn had been deposited here in and around the stream. At the end of March torrential rain carried many of these downstream. They spread out and became dry when the water subsided. At this stage many of these were moved to deeper water by the dam where other frogs had spawned but most were lost. On April 16th thousands of tadpoles were seen in the stream near the main site in company with a few smooth newts. The fate of the tadpoles is not known; however the stream dried up completely for some time during the summer.

An estimated 1,400 frogs were present at some time during the breeding season. Apart from the catastrophic loss of probably 90% of their progeny at an early stage, predation on the adults was high. Situated in the centre of the canal base on open mud, with no vegetation and little water the frogs were exceptionally vulnerable. Brown rats (*Rattus norvegicus*) were seen many times devouring adult frogs at the site, and even water voles (*Arvicola amphibius*) which are very common along the canal and quite unperturbed by humans dragged adult frogs away.

Smooth newts (*Triturus vulgaris*), the only other species of amphibian found in this section of the canal, also migrated east and over the dam though no attempt was made to assess numbers.

A few small froglets are known to have been seen in the vicinity of the dam in June 1969.

During the spawning period the weather was mild and wet. Rainfall did not correlate either with the initial or later migrations, which were steady and continuous, irrespective of weather. The stream was always present, and during the actual spawning period fluctuations in water volume due to rainfall were negligible.

DISCUSSION

The results raise questions regarding the conservation and behaviour of *Rana temporaria* in the area described. At present there are no definite plans to repair the breach to the canal bank, although the authorities are under pressure from local interests and the situation may eventually be remedied. The behaviour of the frogs suggests that desire to propagate in an old-established site outweighs any possible "instinct" to provide a more viable future for their offspring. Only 3% of the adults failed to spawn in their "ancestral home" although another 5% did at least spawn in a more promising part of the stream. Over 90% of the population however continued to breed at the original site. As little is known about the lifespan of these frogs and the number of times they breed, it is impossible to state a time within which the breach would need to be repaired for the main population

to survive. The increased predation and presence of immature frogs will also doubtless influence population total. Failing repair the future existence of the colony depends on their ability to modify breeding behaviour patterns, features difficult to check in the future even by observation. Dwindling numbers at the primary site would more likely represent the annual mortality rate than a change of site.

These observations are compatible with the hypothesis that frogs are attracted to their breeding ponds by the scent of volatile oils exuded by specific algae. The water in the stream and from the canal from which it originated are the same with respect to their algal flora. Why, however, do the frogs breed at this particular site? Perhaps the frogs travel directly to the stream from their hibernating quarters and this section is the first aquatic area they meet. This would imply that virtually all frogs hibernated together and that the winter quarters, rather than the actual spawn site, are ancestral. The frogs travel directly to the site at 90° to the canal, a fact which suggests that the river Blackwater provides the Winter quarters. This does not explain why a small population of the breeding population separates later during breeding. One can postulate some sort of algal concentration gradient in the stream as a cause of the migration to the source but why are some frogs affected and not others? Two possible explanations are (a) random wandering of individuals and (b) some additional or better developed faculty possessed by only 3% of the population.

Random wandering seems less likely since the movements observed were not entirely haphazard and no migration was seen other than along the stream. Wandering within the confines of the water may possibly explain the utilisation of the secondary site to the west, but the distances travelled by the frogs moving east—over 1,000 yards—makes it an improbable explanation in this case.

If on the other hand there were some physiological differences between the frogs, then a better developed sense of smell by the minority might explain the later migration. The difference may well be one of degree rather than a new development.

1970 OBSERVATIONS

In March 1970 frogs spawned at a site immediately beneath (west of) the dam, in a pool formed by growth during the previous summer of obstructing vegetation. None were seen at any other site, numbers were much reduced and merely 200 clumps of spawn were observed. Time did not permit observation of frog migration or subsequent development of tadpoles. No progress has been made in repairing the canal breach.

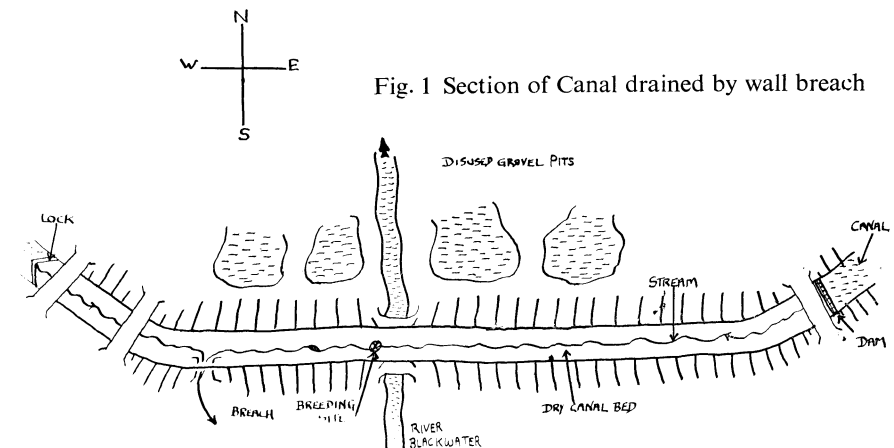


Fig. 1 Section of Canal drained by wall breach

SURGERY ON A CAPTIVE GABOON VIPER

By

J. E. COOPER

Veterinary Research Laboratory, P.O. Kabete, Kenya.

(Received 10/3/71)

SUBJECT

An adult male gaboon viper (*Bitis gabonica gabonica*), approximately 90 cm long (including tail).

HISTORY

This snake arrived at the Nairobi Snake Park on 13th March, 1970, from Kakamega Forest in W. Kenya. It had been attacked with a large knife ("panga") in an attempt to kill it. As a first aid measure its wounds were sprayed with a solution of oxytetracycline and gentian violet. When examined the following wounds were noted:—

(1) A deep wound about 3 cm posterior to the cloaca. This had severed the vertebral column and bone fragments could be seen. The tail was attached to the body only by the lateral muscle and skin on the snake's left side. The wound contained clotted and free blood.

(2) A deep wound about 15 cm anterior to the cloaca on the right hand side. This wound was a deep (5 cm) cavity and contained blood but there was no obvious damage to the internal organs.

(3) A wound about 12 cm posterior to the head, again on the snake's right hand side. This wound was not so deep but wider (5 cm diameter) and was partly covered by a flap of skin. It again contained blood.

SURGICAL PROCEDURE

In view of the value of a gaboon viper to the Nairobi Snake Park (only two or three are received per year) it was decided to operate. The snake was anaesthetised using ether. Surgical anaesthesia took nearly 15 minutes (probably on account of the large volume of the anaesthesia box) and was characterised by flaccidity and the disappearance of the "righting reflex".

Before surgery commenced the snake was given 20 cc glucose saline intraperitoneally in order to counteract dehydration and shock. The two anterior wounds were cleaned, debrided and scarified. The skin surrounding each was sutured using number 1 nylon and leaving a hole for drainage. The posterior wound was cleaned and the tail amputated. Haemorrhage was controlled using Spencer-Wells artery forceps; the smaller vessels were ligated by pressure, the larger with catgut ligatures. There was not sufficient skin available to close the wound completely so number 0 catgut was used for deeper sutures and nylon used where apposition of epithelium was possible. All wounds were sprayed with oxytetracycline/gentian violet and this was repeated daily for 5 days.

During surgery anaesthesia was maintained using a pad of ether in a face mask. Recovery was rapid following removal of the ether pad.

RESULTS

A week after the operation the snake was re-examined. All wounds were healing and the snake was fairly active but still not feeding. The snake was not examined again until 11 days later; it was then noted to be very active and it struck at a grab-stick. Closer examination revealed that the wounds were healing well but that the tail stump was oedematous and, probably as a result of the oedema, one hemipenis was extruded. No attempt was made to

replace this hemipenis and when examined a month later it was no longer visible and the oedema had disappeared. Six weeks after the operation the snake ate for the first time.

The snake was re-examined on November 4th nearly 8 months after the operation. It had increased in size and now measured 97 cm in length. It was active and aggressive. All wounds had healed well and there was skin covering them. The snake had sloughed a few weeks previously and there was some adherence of slough to the surgical wounds. The remaining skin sutures were removed.

An X-ray taken on December 1st showed several broken ribs at each of the anterior wounds and two damaged vertebrae in the area of the deeper wound. In addition there was one broken rib on the left hand side, about 30 cm posterior to the head.

DISCUSSION

Surgery of reptiles is now becoming more commonplace, especially in zoological collections (Wallach, 1969). For the present case described, ether was used as an anaesthetic; in our experience volatile anaesthetics are more reliable than barbiturates and recovery is quicker. Ether is cheaper than halothane but the latter is non-inflammable and is the anaesthetic of choice when thermo-cautery is used.

At the Nairobi Snake Park we have had disease problems in snakes due to *Aeromonas* and *Pseudomonas* bacteria (Cooper and Nares, 1971). These organisms can persist in cages and pits and may infect wounds, sometimes resulting in a bacteraemia. For this reason all wounds in snakes are cleaned thoroughly and either a quaternary ammonium disinfectant or a suitable broad spectrum antibiotic is applied daily for 4-5 days. Surgical cases are confined in a separate clean cage until healing has taken place.

Healing of wounds in snakes may take a long time, especially if the snake is in poor condition or refuses to feed. We often give multiple vitamin injections since deficiency of certain vitamins will retard the healing of tissues. In some cases force-feeding may be carried out but we refrain from this where possible, as it can result in damage to the snake. In view of the slow healing of reptile tissues we generally leave skin (nylon) sutures in place for several weeks; only if there is evidence of inflammation round them are they removed sooner.

Damaged snakes are frequently dehydrated on arrival and for this reason are usually immediately given glucose-saline by intraperitoneal injection. Such injections may be repeated if necessary during and after surgery.

Surgery of snakes is justified when a specimen is required for display purposes or for venom production. Much remains to be learned about anaesthesia and surgery in reptiles and in collections with educational responsibilities surgical cases usually prove of considerable interest to visitors.

Acknowledgements

I am grateful to Dr. D. Röttcher of the Faculty of Veterinary Science, University of Nairobi for taking the X-ray and to Mr. R. Leakey, Director of the National Museum, and Dr. I. E. Muriithi, Director of Veterinary Services, for permission to publish this paper.

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CASE REPORT ON A CORN SNAKE

The Corn Snake, *Elaphe guttata* is a preferred pet of American herpetologists because of its tameness, its attractive colour pattern and its tendency to do well in captivity provided it is given a mouse from time to time, the only food it will accept. Two specimens can at present be seen at the London Zoo. I was given the present snake by a member of our New York sister Society in June 1970 because it had developed a tumour, about 2½ in. long and ½ in. thick in the cervical region. It had not eaten for a long time and grave doubts were expressed about its future. The snake travelled safely in a drawer of my well-furnished cabin on the "France" and landed eventually on the operating table of the London Zoo Hospital where Mr. Himes most skilfully removed the tumour under Halothane anaesthesia. The skin was so carefully sown up that it would be difficult to locate the scar now. Whatever the snake thought of the procedure, it took it another 68 days before it accepted the first mouse. Since then it has eaten many others but at very irregular intervals. It is more regular in shedding its skin about once a month. The tumour proved to be histologically unusual and special staining methods were needed to show that it had developed in response to a fungus infection. Since it is impossible to diagnose a fungus from sections and since the snake is still alive and no fresh fungus-infected material is available, we are left to speculate on the nature of the fungus and the way by which it got into the neck tissues of the snake. The next step in this investigation will have to wait until the snake dies and lands—this time for *p.m.* dissection—on the operating table again.

E. ELKAN,
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Pinner, Middx.
(Received 19/3/71)

LETTERS TO THE EDITOR

The letter which you published (*Br. J. Herpet.*, 4, 192, 1970) from M. Peaker of the Agricultural Research Council, cannot be allowed to pass without comment. While the general trend of his criticism of Nickerson's method, and that of his consequent advice, are most certainly in the right direction, he has nevertheless attacked Scylla only to be engulfed in the slightly less perilous Charybdis. As he very rightly states, the injection of water (the "absolute" hypotonic fluid) into the muscles of live reptiles is undoubtedly both painful and highly destructive to the tissues, but it must be recognised that his "remedial" suggestion of substituting what he calls an "isotonic" aqueous solution of 0.9% NaCl is not very much better. He is in fact advising us to inject preferably a hypertonic solution of NaCl, which will also prove destructive to the tissues (through osmotic dehydration and shrinkage). It is, of course, 0.6% aqueous saline solution that is isotonic for reptiles and amphibians—(0.9% NaCl solution is isotonic only for a number of mammals, including man). It seems rather strange that this fact should not be known to the Institute of Animal Physiology. With regard to the problems mentioned, as to the sterilisation of syringes and needles, these can surely quite simply be obviated nowadays by the use of the expendable, sterile, plastic syringes (with needle) that are generally obtainable from pharmacists. Finally, on the basis of my personal experience of administering to large numbers of reptiles (snakes and lizards) intraperitoneal injections (of barbiturates, hormones, etc.), I do not agree that the preliminary swabbing with spirit of the "skin" (i.e.,

scales) is necessary. If, however, this serves to reassure the person who is giving the injection, it will no doubt prove in some degree beneficial to the operator, and the patient will certainly not object (as he will to the subsequent introduction of the needle), nor will it in any case do him any harm.

(Dr.) R. H. AHRENFELDT
9 Lea Road,
Heaton Moor,
Stockport, Cheshire.
(Received 7/4/71)

COURTSHIP OF PELOMEDUSA GALEATA

In a recent comprehensive survey of communication among amphibians and reptiles, Blair (1968) concludes that vocalisation and visual signals, supplemented by scent production, may comprise the chief forms of display among chelonians. He does not mention tactile stimulation although this appears to play a part in the pre-copulatory courtship of the helmeted terrapin *Pelomedusa galeata* (J. D. Schoepff). In this species, the male and female face one another under the water which, in nature, may well be muddy (thereby prohibiting the use of visual signs). Then they touch noses and sides of their faces, as though kissing. These actions may be repeated for some minutes before mating takes place, also under water.

REFERENCE

BLAIR, W. F. (1968). Amphibians and reptiles. pp. 289-310 in Sebeok, T. A. (ed.) *Animal communication*. Bloomington: Indiana Univ. Press.

J. L. CLOUDSLEY-THOMPSON,
Dept. of Zoology,
University of Khartoum.
(Received 14/2/71)

I am anxious to obtain a new or second-hand copy of "The Principal Diseases of the Lower Vertebrates" by H. Reichenbachklynke and E. Elkan, Academic Press (1955). I am writing to ask if any member of the Society has a copy of this book for sale. I shall, of course, be very happy to refund all postage and other costs involved.

I should also like to mention that amongst other duties here in Kenya I do the Veterinary Work (Clinical and *Post-Mortem* Examinations) for the Nairobi Snake Park. A number of interesting cases have been encountered and it is hoped to publish some of the findings in the herpetological and veterinary literature. I should be most interested to correspond with others who have experience of reptile diseases.

JOHN E. COOPER,
Veterinary Services Division,
Veterinary Research Laboratory,
P.O. Kabete.
(Received 14/10/71)

FROG POND DESECRATED

Canon Slade Grammar School, Bolton.

Early in March this year great publicity by both television and press was given to "Operation Frog Lift" devised by the Youth Wildlife Service, whereby thousands of school children were asked to collect frog spawn from

ponds containing large amounts and to either transfer it to ponds without any, or to take it to their schools and rear the tadpoles there so as to increase the distribution, and it was hoped, the numbers of frogs in the various areas. An excellent idea but unfortunately it would appear that several factors were overlooked.

(1) Children are full of enthusiasm, and energy, and will gladly contribute their services invited or not.

(2) Supervision in such an undertaking as this must be available.

(3) In the North, spawning takes place either immediately before or during the Easter vacation when Schools are about to be or are closed.

(4) Leaving the children entirely to their own devices and no matter how keen the teacher may be or how often he or she is on the premises, she cannot be there all the time.

As readers are aware a continued and detailed survey of frogs has been taking place at this pond ever since 1965 and it is now most disheartening to realise that, having carefully nursed it through contamination, it would appear that the pond may also be one of the casualties of this Operation which has proved disastrous to a few other breeding colonies in the area.

This year 317 frogs were checked and among those marked 32 dated back to 1965. Spawning took place just as our School term ended and a nearby Headmaster telephoned to enquire whether we could do with "a sack of some 200 frogs, which a boy had brought in to his school to save them"! I requested they should be replaced where collected; as soon as possible.

Then came the children from the Council and other estates of the area with jars, tins, three with large household plastic buckets and our protective task was indeed great. We are also in a period of drought so that water levels continued to go down adding to our troubles.

Under these circumstances we removed the remaining spawn and every tadpole we could find; some were kept indoors as controls, the vast majority were placed into a very deep and dangerous pond entirely fenced, the "Top Pond" situated beyond the railway line on the map, in school property.

Then came the junior boys from the two neighbouring schools heaving stones of the pond in their search for mature frogs. Some of these frogs were extracted from boys' trouser pockets only this morning, two of them bearing the 1965 clip. After a protracted discussion I then attempted, with these boys' assistance, to round up some of the frogs that have been removed in this way and which were scattered round various "estates" (already well inhabited by hundreds of cats and dogs), a few greenhouses and sheds, wells, walls, etc. — a virtually impossible task. So what price seven years of serious study?

This kind of result was obvious to anyone well-acquainted with the younger generation of the industrial North who enter into everything so wholeheartedly.

Surely the obvious approach to the frog problem would be for school children to mount guard over EXISTING sites where frogs are known to breed successfully; where the water is still sufficiently uncontaminated for the tadpoles to metamorphose, thus to ensure their safety? Teachers are well aware that the majority of tadpoles in classrooms die young. It would therefore appear to me that we have already interfered with the frogs, at all stages of their development, a great deal too much.

ELLEN HAZELWOOD,
44 Rigby Lane,
Bradshaw,
Bolton, Lancs.

(Received 15/4/71)

FURTHER REPORT, June 1971

The tadpoles in the Top Pond are developing well and remain unmolested. Even in this deep pond the water level is lower than has previously been known following severe drought conditions in this area, and a number of large ponds, including the School Pond, and overflow channels of the local brooks have dried out completely so that there has been 100% tadpole mortality.

E. H.

AMPHIBIANS on the Dunes at AINSDALE, Lancs.

" OBITUARY "

Building on the sand continues; the dunes reduced and dried yet further are now, aided by the drought, completely dry. Dogs of every shape, size and hue are everywhere, with or without their owners, and the litter of human habitation continues to accumulate. The decline of these dunes as an area of wonderful natural history has rapidly accelerated during the last five years, gathering momentum each succeeding year.

Sand Lizards and newts are already absent.

During the latter part of March, 1971, frog spawn was deposited in the small pools of water scattered over the dunes, some clumps of which consisted of eggs fully swollen to a diameter of 8mm (whose controls indoors are developing normally), whilst other clumps were perfectly normal in size. On March 25th common toads were in amplexus, gathering round the few remaining pools; females were scarce and in one instance nine males formed a ball with, on and over a single female. Perhaps 100 would be a fair estimate of the total breeding population.

May 25th has always been an approximate date for the spawning of the natterjack toads so I tramped Ainsdale dunes on the 23rd from 9.30 a.m. to 4.30 p.m. and located two males and one female, two *B. bufo* and one frog aged two years. On the 26th four of us searched from 5.0 p.m. to 8.0 p.m. the normal and other spawning areas and located two natterjacks. All these five animals were singles and widely separated. Not a "croak" could be heard whereas in years gone past the entire dunes echoed with their noise. The silence hung heavily on our ears.

The entire dunes had dried out so that all the frog and toad tadpoles had suffered 100% mortality. The ditch which cuts right across the dunes still held patches of water, but not an amphibian or its tadpoles were present.

The Death of the Ainsdale Dunes has occurred.

ELLEN HAZELWOOD,
44 Rigby Lane,
Bradshaw,
Bolton, Lancs.

(Received 11/6/71)

BOOK REVIEWS

VENOMOUS ANIMALS AND THEIR VENOMS. W. Bücherl, E. Buckley and V. Deulofeu (eds). Academic Press, New York and London. Vol. I, 1968, pp. 707, Price \$34.00. Vol. II, 1971, pp. 687, Price \$35.

For the time being the editors plan to issue three volumes. Of the poisonous vertebrates the 24 authors in Vol. I cover *Platyptus*, the Insectivores and part of the poisonous snakes. The remaining snakes, saurians, Batrachia, Fishes and Invertebrates will be dealt with in the remaining volumes to be published.

So far as biochemistry and toxicology is concerned this volume puts under one cover all that is at present known on the subject and is therefore a most useful book of reference for any future worker in this field. The title suggests that the book deals with "Venomous Animals and Their Poisons" but while it does deal extensively with the latter, i.e. the poisons, it says very little indeed about the former, i.e. the animals. Anybody, for example, wishing to find anatomical or histological descriptions of the poison glands of ophidian species will be disappointed. On the other hand he may find 42 pages, devoted to snake chromosomes, entirely unrelated to the title of the book. The space thus occupied might have been better used to give the references *in extenso* instead of giving the journals and pages only. This practice wastes the time of those who have to plough such pages of references in ignorance of the title they are eventually to encounter. I would not insist that snake diseases should, by necessity, have a place in this book, but if they are to be mentioned they surely deserve more than one page. These shortcomings apart, the book is a mine of information, mainly on snake toxicology and is, as such, to be recommended for the use of laboratories specialising in this field.

The second volume of this encyclopaedic work deals with the toxicology of the remaining snakes, the Gila monster, the Batrachia and the Fishes. Naturally, since there are more poisonous snakes and since their poisons are more potent than those of other vertebrates, they occupy the largest space in both volumes, and of this the greater part is, understandably again, allotted to pure biochemistry. It will be a help to biochemists to have all now known on this obscure subject available in one work, but it must be understood that the biochemistry of animal toxins is extremely complex, that many gaps in our knowledge have yet to be filled in and that new complex substances with new names are constantly appearing and confusing the general public.

Our only poisonous Saurian, *Heloderma*, has received sympathetic and knowledgeable treatment by E. R. Tinkham. The book would have gained if other papers had been supplied with similarly instructive illustrations. The histological pictures of urodele skins included in W. Luther's paper have suffered too much from ill-treatment by the printers to be of any real value. Small omissions here and there might be filled in: the description of the batrachian mucous glands makes no mention of the interesting myo-epidermal cells and of the genus *Limnodynastes*, the most interesting species *dorsalis*, which has a large parotoid gland on the thigh, is not mentioned. Chapter 37 contains a welcome up-to-date checklist of the genus *Bufo* to the detriment of the other Anura whose skin secretions may not be as harmless to other vertebrates as would appear from the small space allotted to them.

The ichthyological part brings a few illustrations which might be more instructive if they had been more carefully printed. Just as in so many books of this kind, the absence of colour printing must be deplored.

No change has been made in the bibliographies attached to each chapter, which mention only the bare references without giving the titles of the works referred to.

Even so, if this book is too "heavy" for the general reader, it is indispensable for all laboratories dealing with toxicology, particularly that of the lower vertebrates. A third volume, dealing with the invertebrates, is in the Press.

E. ELKAN

GRASSE, PIERRE P. (ed.) 1970. *Traité de Zoologie*. Vol. XIV. Reptiles, Parts II and III, pp. 1,428; 2 plates in colour; 984 illustrations in black & white. Masson & Cie, Paris. Price Pt. II, 225 F; Pt. III, 240 F.

The long-awaited reptile part of the multi-volume Grassé special Zoology has at last been published. We still have to wait for the Amphibia which will constitute Pt. I of Vol. XIV. Although nearly 200 zoologists contribute to the work as a whole, the reptile part is almost entirely due to Prof. J. Guibé of the Museum of Natural History in Paris who has written 22 out of the 34 chapters. Part I contains the general features and the anatomy; Part II accounts of the endocrine glands, the embryology, systematics and a detailed chapter by Ginsburg on reptile palaeontology. Although each volume is equipped with a subject index the chapter indices one would expect to find following the title pages are missing. Among the many black and white illustrations we find, as one would expect, a few old acquaintances but there is also much new and interesting material and the bibliographies attached to each chapter alone will make this work indispensable to anyone wishing to be informed about the state of our knowledge on the reptiles in 1970. The price of the work will place it out of the range of the average reader who will have to find it in the nearest zoological library. English readers at home will, in most cases, be satisfied with Bellairs' *Life of Reptiles*, which covers the same ground in a more popular if less extensive way.

E. ELKAN

OLDHAM, J. C., SMITH, H. M., and MILLER, S. A., 1970. *A Laboratory Perspective of Snake Anatomy*. Stipes Publ. Co., Champaign, Ill.

It seems that in some parts of the U.S.A. snakes are in such ample supply that, in spite of their aberrant anatomy, they are being used for class work. A good dissection guide would certainly be useful for the students but the present one cannot compare with others that have been published before. Compared, for example, with Harris' *Anatomy of the Rainbow Lizard*, this is a poor production. Many of the Plates are dilettantish in their composition, badly printed, supplied with scale marks with no indication of what the marks represent and with guidelines the meaning of which the student is supposed to guess from the text. The book may at best be a help if supplemented by the teacher. As an adjunct to home study for beginners it cannot be recommended.

E. ELKAN

DEVELOPMENTAL PROCESSES IN HIGHER VERTEBRATES. By Ruth Bellairs, pp. 366, 8 plates, 78 text figs., Logos Press Ltd. Price £6.00.

There are three reasons why this book should be reviewed in the *British Journal of Herpetology*. Firstly, in a lighter vein, the authoress is the wife of the well-known herpetologist, Professor Angus Bellairs, an ex-editor of this Journal; secondly she has previously researched on reptiles, indeed the authoress was probably the first to culture reptile embryos *in vitro* (*Nature*, 167, 1951); thirdly, and the most important, this book deals, in part, with developmental processes in reptiles.

Twenty-five years ago, just after the war, embryological research was still very concerned with the formal embryogenesis; the blastula, gastrulation and neurulation, organogenesis and the effects of yolk on cleavage in embryos. Though ideas on developmental mechanisms were still cluttered up with the vague concepts of gradients (whatever they were supposed to be) emphasised by Child's work, a great deal was already known about fundamental embryonic

cellular processes in both invertebrate and vertebrate forms. Embryologists were particularly interested in the chemistry of induction for they were still excited about the organiser, described previously by Spemann and Mangold in amphibian embryos, the vital staining of embryos by Vogt and the experimental work by Ross Harrison, Waddington, Horstadius and Fell, to name just a few. However, though DNA and molecular biology were in the wind (for Watson and Crick were still to come) and the first signs of serious immunology were soon to be apparent with the work of Medawar and McFarlane Burnett, yet the investigation of so many problems in developmental embryology was hindered by the absence of suitable techniques or satisfactory intellectual concepts.

This type of book on amniotic development could hardly have been written then, not even more than 10 years ago. Indeed, a random sample from about 20 of the pages of references (there are, incidentally, more than 1,000 publications listed) showed that over 70% of the references were published in the 1960's. So much has happened during this time to make a general account of the current state of affairs of much value. The authoress is well fitted for this task as seen by the list of some of her research papers in the bibliography.

There are some chapters dealing with fertilisation, embryonic development and induction, organogenesis, special aspects of development in different groups, embryonic biochemistry, teratology, immunology and control of growth. In the appendix a list of "Tables of normal development" of different amniotes is included. We see from this that the term "Embryology" is perhaps too abstruse, rather like the vague term "Zoology". The field now includes a set of new specialisations: immunology, molecular biology, biochemistry, biophysics, cytogenetics, ultrastructure or tissue culture, etc., each one an important discipline in itself. Old-fashioned embryology is dead; it has, however, risen, or better still, metamorphosed, from its ashes into new, highly skilled perhaps even scientific forms — long live embryology. Specialists in these fields are now helping to solve many of the problems first posed by the earlier "classical" embryologists.

I thoroughly enjoyed reading this book. It was refreshing to read about things I already know, to remind myself of things I had forgotten, and to learn much about work of which I was hardly acquainted. If one has to criticise then it could be that the book is too short and accounts in some of the chapters could have been dealt with in more depth. Of course, when whole volumes, and even current journals, are now exclusively devoted to subjects like individual cell organelles or tissues (recently I noticed 2 massive volumes which dealt only with lysosomes and another 2 with collagen), books on aspects of vertebrate development could well stock an entire library. This one is mainly a general introduction to the subject and should stimulate further reading of particular topics. It is ideal for undergraduates and for research workers who might wish to engage themselves in other fields. Certainly libraries and institutions should buy it, though I've no doubt a second edition, embracing new discoveries, will be necessary within 5 years. Apart from a few typographical errors the book is well presented. I wish, however, that the publishers had produced it on nice rich shiny paper, as with, say, the *Traité de Zoologie*, edited by P. Grassé (1970). They should have done so because it is rather expensive.

Ruth Bellairs indeed deserves our congratulations on her achievement.

H. Fox

LIVES OF BRITISH LIZARDS. By C. Simms, Goose & Son Ltd., Norwich, England. pp. 128, 4 colour plates. Price £2.75.

This book is written by a member of the British Herpetological Society, and the Foreword is by Dr. G. F. D. Frazer, the Society's President. It is fitting, therefore, that the book is reviewed in this Journal.

The author has studied British lizards, in the field, in Lancashire, Yorkshire and Dorset, for a number of years. His book includes an account of the activities of himself and of *Lacerta agilis* (sand lizard), *L. vivipara* (common lizard) and *Anguis fragilis* (slow worm) — the first on British lizards since G. B. Leighton's book in 1903. The "Introduction" deals with the methods used; then there is an elementary account of lizards generally and descriptions of lizard habitats. The lizards themselves are considered from page 50 onwards for about 70 pages, sometimes in quite charming prose. There is a brief "Appendix" providing a key to lizard recognition; a "Bibliography" giving the titles of 7 books and 4 shortish papers in the *Br. J. Herpet.* (without dates) and a 1-page "Epilogue" pleading for lizard preservation. There are 4 colour plates of the different species; the less said about the black and white illustrations the better.

On page 12 Mr. Simms writes that lizard studies prompted him to write this book "instead of a series of scientific papers I had intended". This book surely can't really be a substitute to be read by the professionals. In the text where very briefly he mentions viviparity, then at the very least the reader could have been referred to the work by Claire Weekes and the review by Bauchot; on courtship there is Noble; sloughing Maderson; colouration Cott; phylogeny Underwood and the illustrious Romer; reproductive cycles and endocrinology St. Girons, Guibé, Dufaure and Raynaud in France, among others, and Tinkle, Mayhew, the late Wade Fox, Licht, Lofts, Miller, and so many others, mainly in the U.S.A.; on parthenogenesis there is Darevsky and the recent review by Grassé. It wouldn't have hurt also to have mentioned J. Z. Young's *Life of Vertebrates*; the series "Biology of the Reptiles" (Eds: C. Gans and T. Parsons) and *Traité de Zoologie* (Ed. P. P. Grassé). No, I am afraid the book is not for the professionals. I suppose the author may well have intended it for those interested amateur naturalists and schoolchildren. Perhaps it would have been better if Mr. Simms had exercised patience and later on included his present work (so I believe) on snakes, so as to produce a more substantial volume.

Finally, I strongly deprecate the use of American-type spelling for words like favour, favoured, vigour and colour, etc. No favor, vigor and color for me, please, for we are not yet an offshore state of the U.S.A. This feature is indeed disgraceful — and published in Norwich, Norfolk, too.

If you are really particularly enthusiastic about lizards and have surplus money to spend then you will purchase a copy.

H. Fox

HANDBUCH DER PALAOHERPETOLOGIE — Encyclopedia of Paleoherpetology. Edited by Oskar Kuhn. Gustav Fischer Verlag, Stuttgart.

The following parts are now available, published in soft covers:

PART 6: Cotylosauria — Orders Captorhinomorpha, Procolophonomorpha, Promillerosauria. 1969, pp. 87. In German: By O. Kuhn (DM-48).

PART 9: Proganosauria, Bolosauria, Placodontia, Araeoscelidia, Trilophosauria, Weigeltisauria, Millerosauria, Rhynchocephalia, Protosauria. 1969, pp. 72. In German: by O. Kuhn.

PART 14. Saurischia—Suborders Theropoda, Sauropodomorpha. 1970, pp. 87. In English: By Rodney Steel. Also PART 15. Ornithischia by R. Steel (see review by L. B. Halstead, in *Br. J. Herpet.* 4, No. 6, 159 (1970)).

PART 5A. Batrachosauria. (a) Anthracosauria. 1970, pp. 84. In English: By A L. Panchen (DM-48).

PART 18. Ichnia Amphibiorum et Reptiliorum fossilium. Feet structure and locomotion of the Subclasses Lepospondylia, Labyrinthodontia, Amphibiosauria, Urodelomorpha, Cotylosauria, Araeoscelomorpha, Synapsida, Lepidosauria, Archosauria and Chelenomorpha. 1971, pp. 124. In German: By H. Haubold.

This extensive and highly detailed compilation of reptilian palaeontology—with contributions from a number of experts in their various fields—continues to be published in appropriate parts with unfailing regularity. They are expensive but no doubt will be purchased mainly by recognised Libraries and Institutions. Research workers especially should find particular sections of inestimable value.

H. Fox