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MATING AND EARLY DEVELOPMENT OF *GASTROTHECA MARSUPIATA* (DUMÉRIL AND BIBRON) IN CAPTIVITY (HYLIDAE, ANURA, AMPHIBIA)

By

M. S. HOOGMOED

Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands

(*Received* 15/8/66)

INTRODUCTION

Duméril and Bibron (1841, p. 598) assumed that the function of the pouch in the female of *Hyla marsupiata* was to serve as a receptacle for eggs. They thought that, as in *Pipa*, the male placed the eggs on the back of the female who extended her cloaca, a view shared by Weinland (1854). Brehm (1869) however, suggested that the male brushed the eggs into the pouch after fertilisation had occurred. Recently Mertens (1956, 1957) finally cleared up the question of how eggs reach the pouch in *Gastrotheca ovifera* (Lichtenstein and Weinland, 1854) a relative of *G. marsupiata* from the Venezuelan Andes. In this species the female raises her cloaca by stretching the hind-legs, thence the eggs are transported to the pouch by means of gravity.

After Mertens' (1956, 1957) observations, Harrison Matthews (1957), Walker (1957), Brenner (1960), and Deckert (1963) described the amplexus of *G. marsupiata*, but only Deckert (1963) has described in detail the mating behaviour and deposition of eggs into the pouch. The hatching of tadpoles from the pouch was described by Grenard (1958), while Grenard (1958), Oeser (1959), Weiss (1960) and Brenner (1960) described tadpole growth. Only Kästle (1963) described the entire life cycle. No detailed quantitative data however are yet available, nor have colour changes in young frogs been described. The purpose of this paper is to present some further information on these features of development.

DESCRIPTION OF *Gastrotheca marsupiata*

Early in 1964 the Rijksmuseum van Natuurlijke Historie, Leiden, received from Mr. W. G. van Oyen a pair of living adult specimens of *G. marsupiata*. They originated from the neighbourhood of Quito, Ecuador, 2,000 metres above sea-level. Both specimens (the female is the larger) are beige coloured above, with two longitudinal dark brown stripes edged with black. Each stripe is preceded by a single patch of the same colour. The back is bordered by a white margin, leading from the tip of the snout to the top of the hind-legs; ventrally there is an irregular dark border. The frogs can change colour into either a lighter or darker tone of beige, but changes are not as spectacular as those in *Hyla arborea* (Linn.).

The female's pouch is recognized externally by a crescent-shaped opening situated rostrally and dorsally to the cloaca. Occasionally the rostral border of the pouch is visible as a ridge immediately caudally to the eyes. When the pouch is empty it has a wide opening, but when full of eggs the opening is considerably narrowed.

Nearly every evening and occasionally in the morning or at noon, the male emits a long note, followed by several shorter ones in rapid succession (something like wràààààh, krok, krok, krok). Sometimes the call consists only of a single long note.

OBSERVATIONS

Near the end of September 1964 the pouch of the swollen female was found to be full of eggs. The two specimens of *Gastrotheca* were thenceforth maintained in a terrarium, which also contained other amphibians (*Bombina*, *Bufo*, *Hyla*). Temperature varied between 5°C. and 25°C. Tadpoles hatched from the pouch early in the morning of February 23rd, 1965. They were immediately transferred to two oxygenated and permanently lighted glass aquaria, containing waterplants (*Salvinia*, *Elodea*). Water-temperature varied between 20°C. and 26°C.

The tadpoles were fed mainly with WAWIL (a finely crumbled fishfood, rich in albumin), powder of *Urtica dioica*, boiled fish and boiled yolk. Dead larvae were often cannibalised by living ones.

Hatched larvae were similar in size to halfgrown larvae of *Rana temporaria* Linn (about 15 mm.) and hind-limb buds were already recognizable. In *G. ovifera* larvae do not hatch until after metamorphosis.

a: *Larval development* (days from hatching)

11 days The foot-plate of the hind-limb is discernible.

20 ,, The knee and ankle are recognizable. When touched the legs are withdrawn. Beneath the operculum the fore-limbs are noticeable.

22 ,, Toes of the hind-limb can bend actively.

23 ,, Fore-limbs respond to touch.

24 ,, Elbows of fore-limbs bulge outwards within the operculum. Range in weight is 0.5 gm.-2 gm.

27 ,, In some specimens green patches are visible on the back. Adhesive pads on the toes of the hind-legs. Hind-legs are used in swimming.

29 ,, The hind-legs can be used for jumping.

35 ,, In some larvae a toe of the left fore-foot protrudes though the spiracle, which shape has changed from funnel-like to a more flattened aperture.

37 ,, Specimens with four externally visible limbs have now lost the horny sheath of the jaws; outlines of the frog-mouth are discernible. The left fore-limb always protrudes first, through the spiracle, the right through an opening in the wall of the operculum. The horny sheath of the lower jaw disappears first.

41 ,, Some specimens leave the water; tail vestige is still present. Thus practically completion of metamorphosis.

The changes in length have been compiled in graphic and tabular form. Both sets of measurements are recorded 5 days after hatching (Table 1, Fig. 1).

Date	a	b	c	Date	a	b	c
1-3-65	7.2	14.3		1-4-65	24.7	70.0	27.3
2	7.8	15.2		2	23.5	64.3	26.2
4	8.4	20.3		3	22.8	62.0	26.0
5	8.8	22.3		5	22.4	46.8	25.0
6	9.2	22.9		6		36.5	24.2
8	9.7	27.6		7		29.6	24.5
9	12.5	31.1		8		28.5	25.2
10	13.2	32.6		9		25.1	24.4
11	14.9	37.2		14		26.0	25.9
12	16.0	41.3		16			26.5
13	17.0	43.7		20			26.3
15	19.8	51.7		22			27.5
16	19.2	52.5		6-5-65			30.5
17	20.4	54.9		11			32.3
18	21.2	58.1		14			32.7
19	22.0	59.5		29-6-65			40.5
22	23.3	61.8					
23	25.5	66.2					
24	25.7	68.6					
25	25.8	68.4					
26	25.6	70.3					
27	25.0	69.8	26.8				
29	26.0	69.6	27.8				
30	25.2	70.8	27.7				
31	25.3	70.5	27.5				

Table 1; *see following page*

Table 1. Daily average growth of tadpoles of *G. marsupiata*
Each value was calculated from daily measurements of six living tadpoles.
a = length of head + body (mm.)
b = total length (mm.)
c = length from tip of snout to anus (mm.)

b: *Colour changes*

Colour variety I

The basic colour of the back is grass-green, which may change to dark green.

There are two longitudinal rows of patches, each patch green at the centre. Each green centre is separated from the grass-green colour of the back by a black band. From the top of the hind legs to the tip of the snout there is a cream coloured stripe, which continues over the eyes and on each side to the base of each fore-limb. Behind the eye a large, brown area surrounds the tympanum. The upper jaw is green. Belly grey, iris dark brown.

Colour variety II

The basic colour of the back is bright beige to dark red-brown. Patches have a green centre, surrounded by a dark band separated from the basic colour by a cream coloured band. The rest of the pattern of the second type is the same as in the first, except that all the green parts are brown.

The shape of the patches on the back is variable. In most animals two isolated patches are recognized in front, between the eyes. In some specimens, however, these patches are connected with the rest of the row. The pattern on the back may be formed either by two continuous stripes, or by two rows of patches in many combinations.

Twenty-one days after metamorphosis (sixty-two days after hatching) in some specimens of colour variety I the borders between the patches and the basic colour of the back have disappeared so that the back of the animals is of nearly uniform colour. In some specimens of colour variety II the green centres of the patches have changed into brown, to give rise to uniform brown patches, separated by a black band from the basic colour of the back. Moreover, others have as a basic colour a mixture of brown and green.

By December 1965 in one animal the entire back was green, the outlines of the patches being only vaguely discernible. Most of the other animals had beige-coloured backs with either black-bordered brown or green patches and in a few cases the patches are green near the head and brown along the back.

Thus in ontogeny the proportion of different colour combinations may undergo quite considerable changes and one original type is almost completely replaced by another.

Eighty-five days after metamorphosis (126 days after hatching) young males were heard calling for the first time. The sound they produced did not even remotely resemble that of parental forms, for the sequence of notes did not always agree and the volume was weaker.

It would be of interest to record the call of males separated from older males from hatching, and to compare it with those of animals of the same age who had not been separated from older males.

Ninety-eight days after metamorphosis (139 days after hatching) in some animals an incipient skinfold had formed in the hinder part of the back. Fifty-nine days later it had extended and a small pouch had developed beneath the skin of the back.

The first female of this brood with a pouch full of eggs was discovered by the 15th. July, 1966.

c: *Mating behaviour*

On the 18th. June, 1965 at 17.15 the pair of *G. marsupiata* were in a scapular amplexus (Mertens, 1957). The next day at about 19.00 the cloacal opening of the female assumed a horizontal, even slightly sloping forward position, by twisting the hind legs and lifting the end of the body slightly (see photograph by Harrison Matthews, 1957). In this way the cloacal opening approached that of the male, and was now situated above the opening of the pouch.

About 20 minutes later the male moved his feet over the back of the female. Between the animals a considerable amount of fluid—probably including sperm—was produced at intervals by the male. By movement of the feet of the male this fluid reached the pouch of the female. As no further fluid was produced it is concluded that eggs are fertilized when they reach the pouch, when the sperm is already present. This "sperm-rubbing" lasted for nearly one hour. About half an hour later the first egg was extruded by the female and thence directed into its pouch by the male's feet. The rhythm in which eggs are produced is probably influenced by the male. The female only extrudes an egg when the male's feet approach her cloacal-opening.

The eggs are pure white in colour and about 2 mm. in diameter. They are extruded fairly regularly. The following lists show the time in seconds between the appearance of eggs. In brackets is the number of eggs which appeared simultaneously.

List 1

28-30-21-27-28(2)-29-27-26(2)-32-30-32-25-27(2)-23-40-45.

List 2

27-21-24(2)-30(2)-28(2)-27-27(2)-27-26-27(2)-23(2)-20(3)-30(2)-25(2)-30(2)
-30(2)-27(2)-28.

The pouch eventually became full of eggs. In both series after about every 30 seconds one or more eggs were produced. In the first series in only 3 out of 16 cases were two eggs produced simultaneously, while in the second series this ratio has changed to 2/3. It is possible therefore that during mating the average number of eggs produced simultaneously increases. Eggs were still being produced nearly one hour after the first egg was laid, but observations were then terminated.

The animals were in amplexus for about 30 hours; the entire process took place outside the water.

When the pair in amplexus was moved for clearer observation, the male behaved like species of *Rana* and *Bufo* by kicking violently with his hind legs in all directions.

After a month the swollen female was set apart in an aquarium in which the water was 10 cm. high. A tree-branch was provided as a resting place outside the water. One and a half months after fertilisation the first living tadpoles were found in the water. Thirty appeared during the night of August 1st. 1965, another 100 during the next night and during the night of the 3rd. 30 more. One further tadpole appeared during the night of August 4th. (night = the period between 17.15 and 9.15 of the following day). Each night also a number of dead tadpoles were deposited (50 in all).

Probably because of the more constant and higher temperature (25°C.) in which the female with the full pouch was kept after the second pairing, the tadpoles were deposited into the water within six weeks.

DISCUSSION

Comparison of the mating of *Gastrotheca marsupiata* with that of *G. ovifera* shows that in the latter the female raises its cloaca by stretching its hind legs (Mertens, 1957, Fig. 8, p. 123). In *G. marsupiata* the hind legs are twisted, so that the cloacal-opening is turned upward and forward (Deckert, 1963).

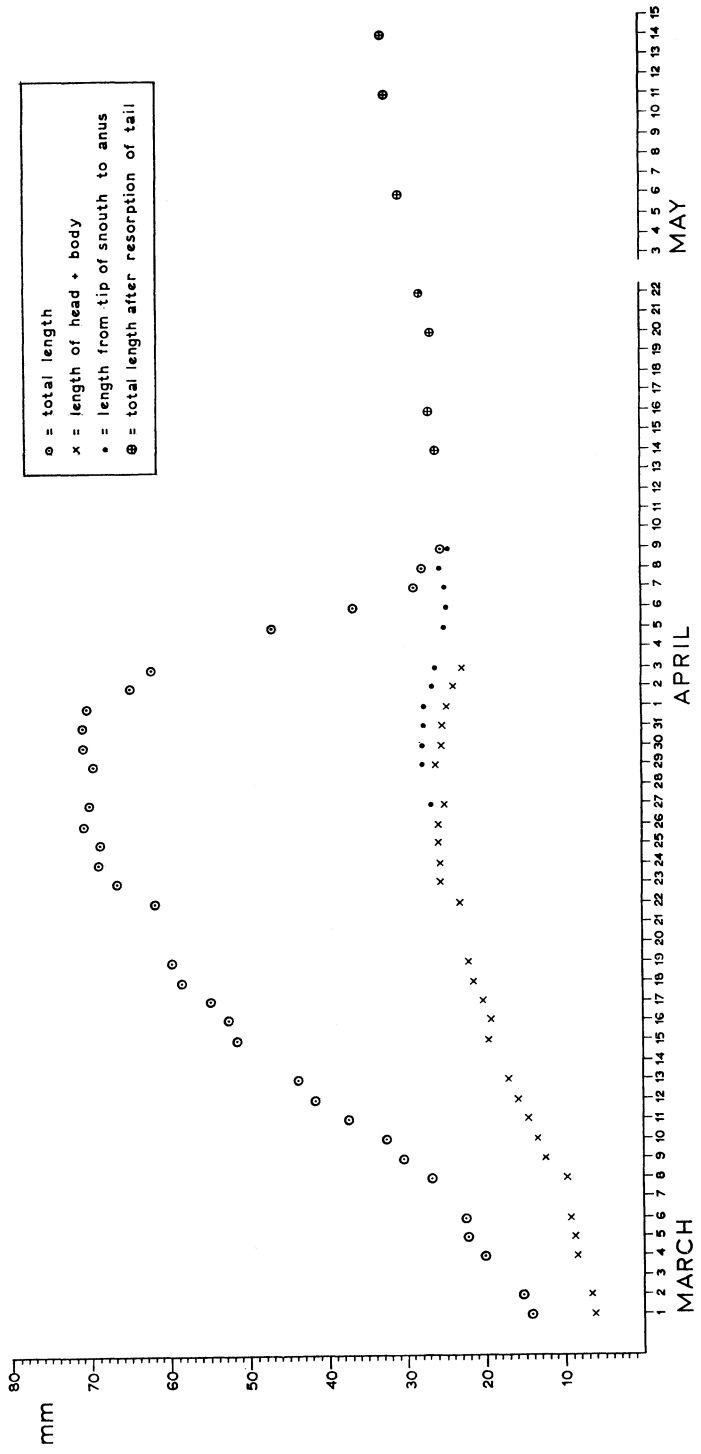

Fig. 1. Daily average growth of tadpoles of *Gastrotheca marsupiata*.

Thus in *G. ovifera* eggs move towards the pouch by means of gravity, while in *G. marsupiata* eggs are deposited on the female's back and are then directed to the pouch by the male, who brushes eggs into the pouch with his feet. In *G. ovifera* the mechanism of fertilisation was not established. Mertens assumed that it occurred when the eggs disappeared under the male. In *G. marsupiata* sperm is introduced into the pouch before the first eggs appear. Thus fertilisation probably occurs when eggs enter the pouch.

In *G. ovifera* the male is rather passive, merely moving his feet occasionally. In *G. marsupiata* he is continually active, first rubbing sperm and later on brushing eggs into the pouch.

Mertens assumed that eggs of *G. ovifera* were quickly transported into the pouch by suction exerted by the dorsal skin of the pouch, combined with that of the ventral region of the male. In *G. marsupiata* eggs are pressed into the pouch by the male's hind feet. Perhaps the slight movement of the feet in the male of *G. ovifera* has the same effect. In *G. marsupiata* there is no trace of an extended uterus stated to occur by Walker (1957). From the notes of Brenner (1960), Deckert (1963) and Kästle (1963) on mating of *G. marsupiata* it is clear that the males behaved in the same way as the male observed by the present author.

According to Mertens (1957) in *G. ovifera* the male calls the female, remaining stationary, and the female moves towards the male. In *G. marsupiata*, however, the male was active in the terrarium, calling and attempting to mate either with the female *Gastrotheca* or with some *Bufo bufo* L. males. When not inclined to mate, the female *G. marsupiata* ejected the male from her back by bending her head downwards and creeping backwards. The males of *B. bufo* squeaked vociferously when mounted by the male *G. marsupiata*, a noise which revealed the whereabouts of the latter quite clearly. Nevertheless it is possible that this "wandering" is the result of restriction in the small terrarium (60 cm. × 40 cm. × 40 cm.) and that had there been more space, the male would have behaved like the male of *G. ovifera*.

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A MECHANISM FOR GREATER PREDATOR SURVIVAL DURING COLD TORPOR IN GEKKONID LIZARDS

By

H. Robert Bustard

Queen Elizabeth Fellow, Department of Zoology, The Australian National University, Canberra

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Loss of the tail by autotomy (a process which occurs at a predetermined plane of weakness across a vertebra (Bellairs, 1957)) is common in lizards belonging to families such as Lacertidae, Scincidae and Gekkonidae. These lizards are able to lose and regenerate the tail many times. It is generally accepted that autotomy is of great survival value since the predator is preoccupied with the tail, which writhes around actively while the lizard makes its escape.

Werner (1964) has shown, in the Israeli gecko *Stenodactylus sthenodactylus*, that when the tail is grasped the threshold to autotomy is lowered with rise in temperature from 25°C. to 31°C.; a result to be expected with ectotherms due to the Q_{10} effect (Wright, 1952). Furthermore, it is known that autotomy is brought about, at least in part, by stimuli which evoke escape reactions, since specimens accustomed to being handled show a greatly increased threshold to autotomy (Bustard, unpublished observations).

During a large scale ecological study (extending over several seasons), of the Australian gecko *Gehyra variegata*, the author collected numerous data on tail autotomy.

Winter in inland Australia is characterised by cold nights and warm, sunny days. The temperature is often about 4°C. at 7-8 a.m. rising to about 20°C. by mid-day. Contrary to expectation, it was found that at these low, early morning temperatures geckos (which had not been able to raise their body temperatures above that of their surroundings) practised autotomy much more readily than at normal activity temperatures reached later in the day.

Hand capture, by skilled collectors, results in about 5-10% of *G. variegata* autotomising part of the tail at temperatures of about 20-30°C. However, at about 4°C. I recorded approximately 50% autotomy at capture.

It is known that in certain species the gecko's tail need not be touched for autotomy to occur (Waite, 1929). However, under normal activity temperatures (20-30°C.), *Gehyra variegata* very rarely autotomises unless the tail is grasped. But when geckos, in cold torpor, at about 4°C. were caught, autotomy frequently took place even without the tail being touched.

The data for *G. variegata* are based on more than 500 captures. On the basis of more limited data it would appear that the geckos *Heteronotia binoei* and *Oedura ocellata* also autotomise more readily when in cold torpor.

It may be suggested that at low temperatures, when the geckos can move only very slowly due to cold torpor, the markedly reduced threshold to autotomy has

important survival value. If exposed to predation the gecko is unlikely to be able to move away in time, and rapid autotomy, even without the tail being grasped, will enhance the probability of its escape. Under these conditions autotomy of all or most of the tail was observed, in contrast to a process of economy in autotomy (Woodland, 1920; Werner, in press), in which only the smallest portion of tail loss compatible with escape takes place. This complete tail autotomy may occupy a predator long enough for the sluggish gecko to move further into a crevice and so escape. At normal activity temperatures the gecko is usually agile enough to take shelter, and thus there is a selective advantage in (a) not autotomising the tail unless this is grasped, and (b) if it is grasped in practising economy of autotomy.

In view of the above data, and that of Werner (in press), it appears that the autotomy threshold in relation to temperature may not be a straightforward linear relationship. The mechanism for ready autotomy at low temperatures may be quite distinct from that operating over the range of normal activity temperatures.

Further studies on the survival value of autotomy under different ecological conditions are in progress and will be published elsewhere.

ABSTRACT

During cold torpor the threshold to autotomy of the tail is lowered in *Gehyra variegata* and the whole tail may be autotomised without it being touched. It is suggested that this adaptation has evolved because it increases the probability of the gecko's escape under temperature conditions adverse for an ectotherm.

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THE GREEN TURTLE (*CHELONIA MYDAS JAPONICA*) THUNBERG IN THE SEYCHELLE ISLANDS

By

René E. Honegger

Zoological Gardens, Zurich, 8044 Zurich, Switzerland

Director: Prof. Dr. H. Hediger

(*Received* 28/6/66)

During a short stay in the Seychelles Territory (December, 1963—March, 1964) some new information was gathered on the Green or Edible Turtle, which was once abundant in the waters around the Mahé Group (the Granitic Islands: Mahé, Praslin, La Digue, Curieuse, Frégate and Silhouette), but has now practically disappeared from this region. Only on rare occasions are females observed around the Granitic Islands. One was found by a plantation manager digging a nest on Curieuse Island in December 1963, but did not complete it because it was disturbed.

Around the plateau upon which the Granitic Islands are based, especially near Praslin and Curieuse, there are extensive shoal waters with an abundance of so called "Turtle grass", *Cymodocea sap*, which could provide grazing for the vegetarian adult Green Turtle. However, few of them are recognized there today. If one appears in

the waters around Mahé, the Seychellois harpoon it. It is considered that the heavily populated islands and especially the beaches of Mahé, Praslin, La Digue, etc., are no longer suitable for breeding. Formerly there were three breeding sites on Mahé: St. Anne Island, Anse Police and Anse Nord Quest.

Today the only green turtles which can be seen on Mahé are in the pool alongside Long Pier. Here mainly males are kept until they are slaughtered. They originated mainly from Aldabra.

Originally it was planned to go to Aldabra for at least four weeks and to stop for a few days on Assomption, Cosmoledo and Astove, but due to bad weather and transportation difficulties a much shorter time was available on these outlying islands. Each person interviewed here repeated the same story; the number of Green Turtles coming ashore to deposit their eggs is decreasing year by year.

OBSERVATIONS

Astove: Small settlement, guano deposits. Average yearly maximum catch 250 turtles, obtained mainly by turning them on their backs on the beach, or by harpooning them. There is a small pool to keep them alive before transfer to Mahé's Long Pier Pool.

Cosmoledo Atoll: On its various islands, Menai, Wizard, Grand Polyte and South East, turtle hunters have built hunter-camps of small simple huts. On Grand Polyte we found about 23 carapaces, the remains of turtles of a recent hunt which had been butchered and their meat taken to the main island, Menai, for salting and drying. The whole area was covered with scavenging Land-hermit Crabs (*Coenobitidae*) and Robber Crabs, *Birgus latro*. Large beaches for nesting sites. No data available on numbers caught per annum. Meat and calipee* shipped to Mahé.

Assomption: This is the largest of the Guano Islands. About 50 to 60 settlers live here, fishing and turtle hunting, mainly for local consumption. Dried meat shipped to Mahé.

Aldabra: This large atoll is the main nesting site for Green Turtles in the entire Indian Ocean (Hornell, 1927; Parsons, 1962); about 70 to 80 people live here temporarily. There is some agriculture; mainly coconuts. The main industry is fishing and some turtles are caught. Mangroves are harvested for shipment to the Granitic Islands. Turtles are harpooned from pirogues throughout the year. During the breeding season, from December to April, the outlying sites are visited regularly by hunters, who might turn up to 30 turtles in a single night. Instead of 500 turtles permitted by the Government, some 1,500 or more are killed and processed for export. Our small schooner loaded 50 male turtles, of which 47 arrived alive in Mahé after the five-day trip. They were sold locally: a whole male turtle for Rp. 110; a female turtle, Rp. 140; butchered turtle: meat, Rp. 1.25/kg.; calipee, 1.50/kg.; mixed meat and calipee, 1.00/kg. (1 Rp. =£0/1/6).

In February and March, fresh tracks and signs of nesting activities were recognized on most of the beaches. Sand crabs (*Brachyura sp.*) and Robber Crabs (*Birgus latro*) dig out eggs for food some days after they are laid. *Birgus latro* is very common on Aldabra, Assomption and Cosmoledo, and is considered one of the greatest predators of hatchling Green Turtles, and baby Giant Tortoises (*Testudo gigantea*) on Aldabra.

The endemic Aldabra Ibis, *Threskiornis aethiopica abbotti*, is said to destroy an entire nest. Other animals on Aldabra which devour turtle eggs or hatchlings either on their way to or in the sea are: domestic Dogs, Rats (*Rattus norvegicus*), the Frégate bird (*Fregata minor aldabrensis* and *F. ariel iregalai*), Flamingo (*Phoenicopterus ruber antiquorum*), Grey Heron (*Ardea cinerea*), Black and White Crow (*Corvus albus*), Sand Crabs (*Brachyura*), Hermit Crabs (land and marine forms), Vara-Vara (*Lutianus bohar*), Carangue-les-dents (*Caranx ignobilis*) and various species of Sharks and Barracuda. It is estimated that unprotected nests may have up to 100% losses; fish are waiting to eat any hatched survivors.

Because of storms, females were not seen to come ashore to deposit eggs, but males and females, some of them mating, were observed offshore. One nest of eggs, laid on January 2nd. 1964, was transferred from its original site on the beach at Aldabra to Picard Island (near the manager's house) where it was covered with wire. The turtles hatched on March 1st. after 59 days of incubation. 111 hatchlings from that nest were measured just after hatching (Table 1); the egg tooth was still present. Carapace length ranged from 45 mm. to 53 mm.; width between 36 mm. to 46 mm. Its colour, though not uniform, varied between dark grey and light brown. The plastron was whitish to dark grey.

right	left	Number of turtles	% of turtles
Marginalia			
11	11	104	93.7
12	12	3	2.7
12	11	3	2.7
11	12	1	0.9
Costalia			
4	4	104	93.7
5	5	2	1.8
5	6	1	0.9
6	5	1	0.9
4	3	1	0.9
4	5	2	1.8
extra Supracaudalia (more than one pair)			
none		111	100
Vertebralia			
5		101	91
6		10	9

Table 1.—Shield variations of 111 newly hatched green turtles from Picard Island, Aldabra. All counts are made from the dorsal aspect.

right	left	Number of turtles	% of turtles
Marginalia			
11	11	40	100
Costalia			
4	4	40	100
extra Supracaudalia (more than one pair)			
none		40	100
Vertebralia			
5		38	95
6		2	5

Table 2.—Shield variations of 40 juvenile green turtles, hatched April, 1963, Picard Island, Aldabra and measured on March 4th. 1964.

right	left	Number of turtles	% of turtles
Marginalia			
11	11	15	100
Costalia			
4	4	15	100
extra Supracaudalia (more than one pair)			
none		15	
Vertebralia			
5		15	100

Table 3. Shield variations of 15 adult male green turtles, collected around Aldabra (harpooned) during February, 1963.

In turtles of Table 2, carapace length ranged between 149 mm. and 204 mm., and width between 132 mm. and 176 mm. The colouration was a brilliant brown with a beautiful slightly brighter star-like pattern.

In specimens of Table 3, carapace length ranged from 950 mm. to 1,120 mm., the width from 840 mm. to 1,010 mm. One specimen had the left hind flipper missing, but the others were uninjured. Travis (1959) stated that he has seen many turtles with only one hind-flipper, almost certainly due to attacks by sharks. Two large specimens (carapace lengths 1,020 mm. and 1,070 mm.) had their plastrons covered with barnacles.

CONSERVATION

Green turtles of the Seychelle Islands, as in many parts of the tropics, are over-harvested. If no immediate steps are taken for their protection they may soon totally disappear.

A programme, similar to that carried out in the Caribbean Sea under the Caribbean Co-operation Scheme could well be established in the Seychelles. In Costa Rica, in 1960, 20,000 baby green turtles were hatched (Parsons, *op. cit.*). For the Seychelles protection could include the establishment of fenced-in areas on Aldabra, preferably on Picard Island (Settlement), where eggs could be incubated safely. These could be collected from the various beaches by teams of workers and transported to Picard Island in wooden crates or buckets, with layers of grass or cedar-needles between them. Incubation would take place in holes in the sand fenced in with chicken-wire to prevent attacks by crabs. Fencing would also keep out dogs, pigs, goats and female turtles seeking nesting-sites. The fragile eggs could also be left in the original turtle nests but fenced in. Hatchlings should be collected at daily intervals and maintained in large concrete or wooden tanks on Picard Island. A small powerpump would be necessary to supply clear water into small ponds for growing baby turtles which should be fed with fresh fish (see Harrisson, 1955). In order to protect the rearing ponds from the extreme heat and predators overhead, a simple roof of mangrove poles and palm leaves can be constructed. The next habitat for the small turtles should be in natural "tanks" in corals in suitable sites close to the lagoon; closed with concrete and coralstones but so constructed that seawater could enter. Here, turtles may be liberated into the lagoon when about 140 mm. to 170 mm. in length, marked, either with small plastic or steel tags, similar to those used for cattle (Harrisson, 1956). The laws should be strictly controlled by a Government officer on Aldabra and the close season for females on the sea and beaches enforced.

ACKNOWLEDGEMENTS

The observations were made during a visit to Aldabra, where the Giant Tortoise population was surveyed. The trip was financed by The World Wildlife Fund, The Goethe Stiftung zur Förderung von Kunst und Wissenschaft, Zurich, The Zoological Society, London and The Zoological Garden of Zurich, Switzerland. On the Seychelles assistance and advice were provided by the Department of Agriculture and various individuals. I am very grateful to Mr. Werner Noth of Zurich, who accompanied and assisted me.

* Calipee and calipash are the unossified parts of the bellyplate and the backbone. The term "calipee", apparently of West Indian origin, was at first applied to the belly, or underside of the turtle, while the "calipash" was the upper side or carapace. By the nineteenth century these terms had come to be applied specifically to the delicately flavoured gelatinous substance that comprises much of the lower and upper shells (Parsons, 1962).

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CONGENITAL MALFORMATIONS IN SNAKES

By

L. RUBIN, A. d'A. BELLAIRS and S. V. BRYANT

Hull College of Education, and St. Mary's Hospital Medical School

(*Received* 23/8/66)

Remarkable malformations have been observed in a number of new born American water snakes (*Natrix sipedon*). These were kindly sent to us, preserved in alcohol, by Dr. Robert L. Rausch who states that they were apparently born at term. The scales are well differentiated and pigmented.

All 5 specimens are very short and thick; their bodies flexed in a single tight coil, and they have a grotesque, ball-like appearance (Fig. 1). In some cases the skin of the flank on the inner aspect of the coil is folded to form one or more protruberances. The ventral scutes are distorted and in places irregular; it is impossible to count them accurately. A mass of intestine protrudes through the umbilical opening and the tail is very short. The upper jaw is shorter than the lower, a fairly common congenital anomaly in lizards and snakes (Bellairs, 1965), but otherwise the head and front of the neck appear relatively normal.

Dissection of one specimen shows that the neck region is comparatively little affected and that the trachea, oesophagus, tongue sheath and main blood vessels are not markedly abnormal. The heart also seems to occupy a relatively normal position, about one-third of the way down the body. The stomach and liver, however, are shorter and thicker than normal, while the liver and certain other viscera such as the right lung and kidneys, occupy atypical positions.

The largest specimen measures only about 6 cms. from snout to tail, whereas hatchlings of *Natrix natrix*, a smaller species, are 16-19 cms. long (Smith, 1964). Both the liver and the lung extend further cranially in relation to the heart than might be expected in a normal natricine snake. The vertebral column was exposed in 3 specimens and was found to follow the curve of the body, passing down the mid-dorsal line of the back in the normal fashion. This fact is of interest since it shows that the malformation could not have resulted from lateral fusion of adjacent coils during embryonic life. The number of pre-caudal vertebrae was estimated as about 75 in two specimens; to judge from Boulenger's (1893) figures for the ventral scutes, this is about half the normal number in the species now called *Natrix sipedon*.

The way in which these malformations developed is difficult to envisage. It seems probable, however, that early in embryonic life these specimens failed to lengthen and to develop multiple coils in the normal fashion of snake embryos. Such an arrest would probably have taken place at about the time when the branchial arches were beginning to become externally visible, at a stage comparable with stage 18 in Zehr's table (1962) for the garter snake *Thamnophis* (Fig. 2). The spinal cord and vertebral column have remained relatively short and the viscera, cramped by the truncated body-cavity, have become widened and displaced. These changes have been most severe in the caudal two-thirds of the body, which has apparently remained too short to accommodate the mid-gut region of the intestine. The latter has therefore retained its primitive embryonic position outside the body cavity. It is possible that the skin and superficial tissue has grown in excess of the rest of the body; this would account for the presence of the large cutaneous folds on the flank of the embryo.

Addendum:—The abnormal young of *Natrix maura* described by R. J. Riches in the next article of this issue perhaps show similar, though less severe and more localised malformations.

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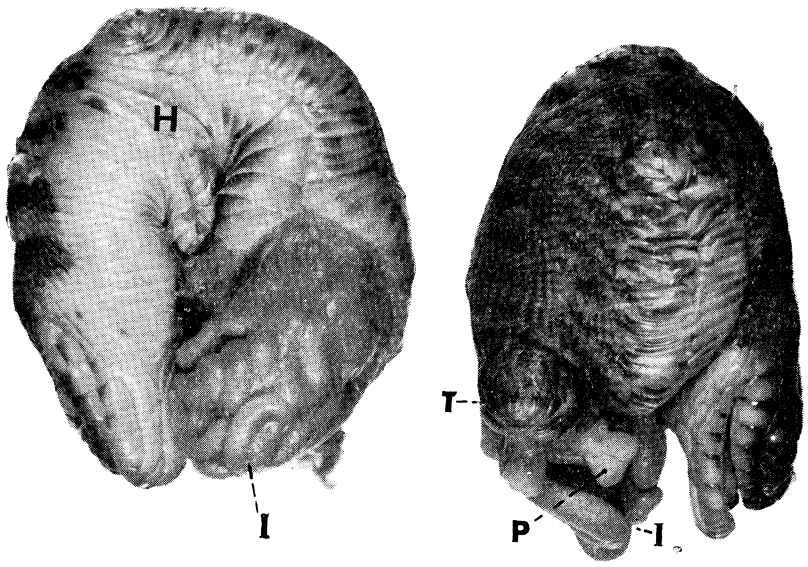


Fig. 1. Two of the malformed specimens of *Natrix sipedon*. That on the right shows marked shortening of the upper jaw. It differs from the rest in having the body flexed in the dorsi-ventral instead of the lateral plane; the ventral scutes on the adjacent surfaces of the coil are fused. ×1.6
H, approx. position of heart. I, protruding intestine. P, hemipenis. T, tail.

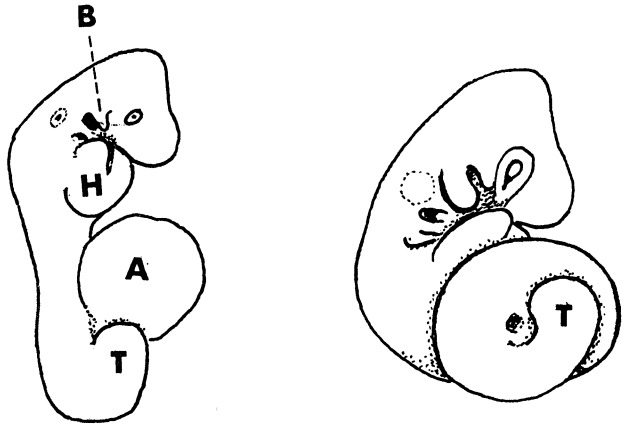


Fig. 2. Stages 18 (×12; on left) and 20 (×22; right) in normal embryonic development of *Thamnophis* showing appearance of coils. After Zehr (1962). A, allantoic sac (not shown on right). B, branchial arch region. H, heart region. T, tail.

NOTES ON A CLUTCH OF EGGS OF THE VIPERINE SNAKE (*NATRIX MAURA*)

Early in June, 1965 a very large gravid female Moroccan viperine snake was obtained from a continental dealer. Its length of 34½ inches (862 mm.) was almost the maximum size for this species for females may reach a length of nearly one metre (Hellmich 1962). The supplier advised that this snake was of a size seldom available.

The snake's head was very large and swollen at the temples, especially seen when the head and neck were spread out preparatory to striking, which happened frequently for a few weeks until it became accustomed to handling. Strikes were, however, invariably made with the mouth closed.

Bearing in mind the remarks made by Steward (1958) on causes of egg-binding in the closely allied Dice snake (*Natrix tessellata*) the vivarium was kept at a daily temperature of about 85°F. dropping only slightly at night. Damp grass was piled in one corner for egg deposition. On a dry vivarium floor eggs would probably become dehydrated.

EGG LAYING

At 10.00 a.m. on the 11th. of July a mass of eggs was carefully removed from the damp grass without disturbing the snake. They were easily separated as the secretion holding them together was still moist. During the remainder of the morning three more eggs were laid, the last one at approximately 12.30 p.m. The entire clutch numbered twenty-four. Four discarded infertile eggs each with a thin almost transparent shell were misshapen and yellowish in colour. Of the remaining twenty, one of doubtful fertility was preserved. The largest egg measured 34 mm. long and 19 mm. wide, and the smallest 27 mm. × 18 mm. Average size was 31 mm. × 18 mm.

INCUBATION

Twelve eggs were half buried in a container of damp sand and the remainder placed between layers of damp paper tissues in a separate container. Both containers were immersed in water and thermostatically maintained at 80-84°F., apart from a forty-eight hour period when the thermostat failed and the temperature rose to 94°. However, Blackwell (1952) incubated eggs of this species at 95°F. with no ill effects on the developing snakes.

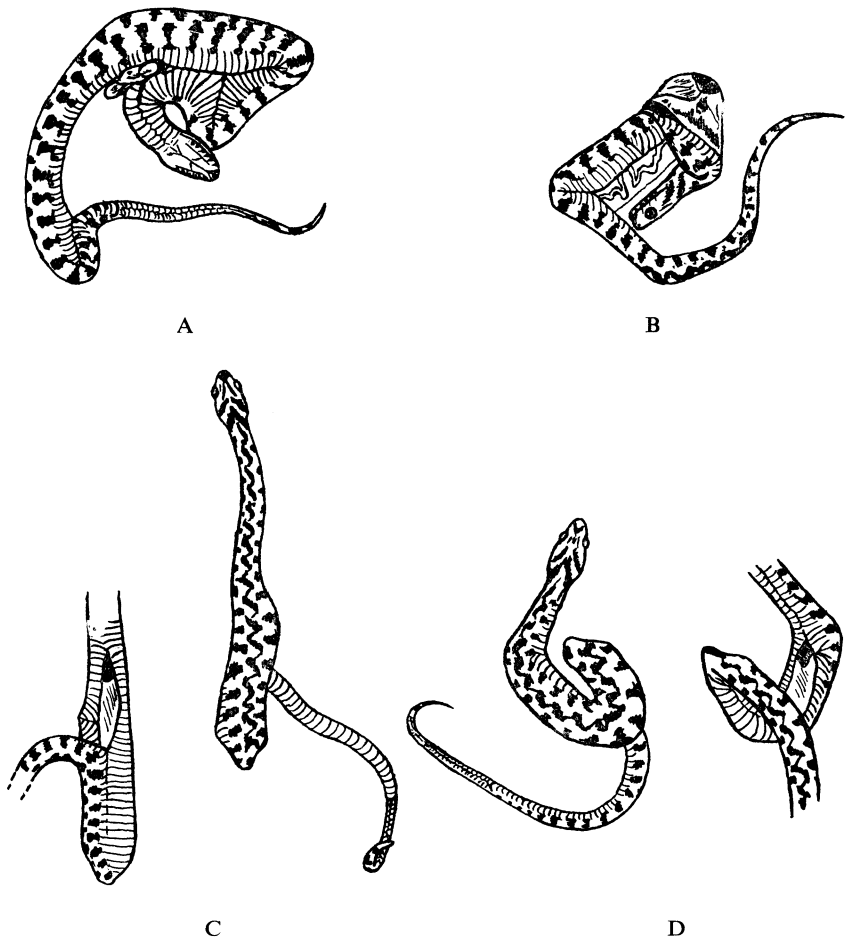
The doubtful egg was opened on the 16th. of July. It contained watery fluid only as did three more eggs opened between the 29th. of July and 4th. of August. One egg opened on the 9th. of August, of greasy appearance and with an almost transparent shell, contained a living embryo 105 mm. in length. Its skin lacked pigment, the scaling was clearly visible and the head was highly domed with large distinct eyes. Pulsation of the heart accompanied by weak wriggling motions of the body continued for 15 minutes until the snake was immersed in formalin.

Between the 12th. and 15th. of August six eggs were infected with fungus. All contained small snakes between 50 and 75 mm. long in various stages of decomposition. One was misshapen with a flattened head and contorted body.

The nine eggs which remained were thenceforth maintained in a container of damp paper tissues to which small quantities of water were added to prevent dehydration. Most of the eggs in damp sand had perished, although in previous years sand was found to be a most reliable incubation medium, particularly with the eggs of Grass snakes (*Natrix natrix helvetica*). In this instance the sand may have been too wet thus encouraging the growth of fungus.

HATCHING

On the 31st. of August after 51 days of incubation hatching commenced. At 8 a.m. three eggs were found with long slits in their shells through each of which protruded the head of a young snake; quickly withdrawn on being disturbed. They were transferred to a small vivarium whereupon one snake immediately hatched and burrowed into some moss. By 12 noon the others were free although one still had



Abnormal species of *Natrix maura*

much yolk firmly attached to it. During the evening all three were handled, the yolky one now having freed itself. When held two of them flattened their heads and bodies and struck repeatedly at fingers, each strike accompanied by a sharp hiss. Unlike the parent they struck with wide open mouths.

Another egg with a semi-transparent shell contained a coiled active snake. The egg was opened during the evening but it contained a dead and deformed specimen (Fig. A).

On the 1st. to the 3rd. of September further abnormal specimens were removed from their eggs (Figs. B, C, D). Specimen C was surprisingly strong and active. A normal snake also hatched on the 2nd, but bled profusely after tearing itself from the yolk sac. The minute length of its attached cord was carefully tied with cotton

to stop the bleeding. Of the last two eggs hatched on the 54th. day of incubation one of them was the abnormal D and hatching was assisted; the other of normal appearance had little control over its head and neck movements and tended to roll over on to its back.

ABNORMAL YOUNG

The four abnormal specimens (A, B, C, D), especially specimen A with a protruding lower jaw, gave the appearance of the body being folded back along itself and then stitched in this position. Specimen A could not escape from the egg as its eggtooth on the upper jaw could not be brought into contact with the shell.

Specimen B was virtually inside out. Most of the vital organs were outside the body and contained in a fragile membranous sac. The heart could be observed beating but respiration was spasmodic and apparently difficult as the snake opened its mouth wide in efforts to gulp in air.

Specimen C was a much stronger snake which although successful in cutting through the shell with its eggtooth was prevented by the contorted shape of its body from emerging completely. It moved actively although with difficulty. The heart and part of the stomach were visible through a gap in its ventral surface. It suddenly became weaker on the 6th. of September and died the next day.

Specimen D was also able to cut its way through the eggshell but had been unable to emerge completely. The internal organs were more easily visible than those of C in view of the wider gap on its undersurface. It lived for only three days.

NORMAL YOUNG

These five snakes each measured just over seven inches in length. They displayed dark grey markings on a light grey background which shaded to salmon pink on the sides. They sloughed for the first time between the 11th. and 14th. of September and after this accepted small pieces of minnow, but refused earthworms.

The young snake which lacked control over its movements fed well and was the only one to readily accept pieces of raw cod. When five months old it was quite bulky and almost fourteen inches long.

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ROBERT J. RICHES
17 Deerhurst,
Kingswood, Bristol.

(*Received* 5/9/66)

EARLY MATURITY IN GARTER SNAKES
(*THAMNOPHIS ELEGANS ELEGANS*)

Thamnophis species in their natural state usually become sexually mature at two and a half years, the females giving birth to their first litters when approximately three years old. If enough growth is attained young may be produced in the second year (Carpenter 1952). These observations involved the three Michigan species *Thamnophis sirtalis sirtalis*, *Thamnophis butleri* and *Thamnophis sauritus sauritus*, but it is reasonable to assume that similar criteria apply to other species and subspecies in the genus. Prevention of hibernation under captive conditions does not

inhibit breeding activity or prevent a female from producing young at the age of two years (Riches 1962). Sexual maturity depends on size attained rather than age.

From a litter of *Thamnophis elegans elegans* born in the author's collection on the 25th. of August, 1965, a male and female specimen attained sexual maturity in just over eight months after being kept active and feeding through their first winter. Mating, which involved actual coupling for a period of one hour and forty-five minutes, occurred on the 6th. of May, 1966. According to Blanchard (1942) observaitons on *Thamnophis sirtalis sirtalis* revealed the duration of attachment varied from five to thirty minutes, although unusually short copulations did not produce young.

At the date of mating the male snake measured 525 mm. (body length 381 mm.) and the female 587 mm. (body length 447 mm.), the latter's tail being incomplete with approximately 12 mm. missing.

Eight young were deposited on the 18th. of August, one week before the parents were twelve months old. Four were stillborn although fully developed and another merely a minute decomposed embryo, yet far enough advanced to show traces of skin pigmentation. The smallest full-term snake measured 138 mm. and the largest 164 mm. The litter born in 1965, which included the parent snakes, had consisted of twelve young whose sizes ranged from a minimum of 200 mm. to a maximum of 230 mm. There is considerable difference among broods of *Thamnophis sirtalis sirtalis* in the average length of newborn snakes (Blanchard 1942). This evidently also applies to *Thamnophis elegans elegans*.

The three living snakes were quite weak and two died within twenty-four hours. The survivor, believed to be a male, is still thriving at the time of writing (October 1966).

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Robert J. Riches
17 Deerhurst,
Kingswood, Bristol.

(*Received* 26/10/66)

AN UNUSUAL CASE OF SNAKE BITE

The following account records a case of injury inflicted upon the author by an African Rock python (Python sebae), *on June 20th.* 1965.

The six foot female snake was housed indoors in a heated cage. On the day in question she was rather ill-tempered due to skin sloughing—the eyes appeared opaque and she hissed violently when disturbed. Despite her condition it was necessary to move her in preparation for a short journey the next day. The snake was therefore lifted carefully from the cage and held at arms' length prior to being placed in a portable container. At this stage she struck at the left eye, the sharp teeth being felt as they entered the eyelids. The snake released her grip immediately and as a result of the pain and shock she herself was dropped on to the floor. The eye, now closed, was bleeding profusely from the upper lid. Examination at hospital showed three deeply penetrating wounds of the upper lid, one of which had lacerated the lid margin. The cornea also was found to have been penetrated

near its centre, a 3 mm. laceration extending obliquely upwards and entering the anterior chamber, with a 2 mm. linear opening. There were also two smaller corneal lacerations which did not penetrate the corneal layers. All three lacerations appeared to be directed upwards and medially. There was no evidence of any lens damage, but a thick fibrinous exudate was adherent to the area of endothelial damage.

Treatment consisted of a week's convalescence in hospital with topical and systemic antibiotics, and topical atropine. The lid was sutured under local analgesia and a booster dose of tetanus toxoid was given. The corneal wound sealed itself and the exudate in the anterior chamber was absorbed within 24 hours. Recovery was uneventful.

It was evident that the severe lid injuries had been inflicted by teeth of the snake's upper jaw, while a tooth of the lower jaw had penetrated the cornea.

This case is of interest on account of the unusual and dangerous site of the injury. It is well known that a usually good-tempered snake will become irritable and prone to strike during the sloughing process. Vogel (1963) mentions that the bite of a big snake "bleeds copiously and heals with difficulty", and he also states that "I have already mentioned several times that the big snakes have a propensity for biting. Some, however, only snap in warning or do not strike far enough to reach the intruder. Another time they will open their jaws as wide as they can and push the objects of their annoyance away . . . . if a snake really wants to bite, it contracts its facial muscles, moves its jaws as if to swallow, the tip of its tongue protruding through a depression at the point of the lower jaw and hisses often and viciously".

I am indebted to Dr. J. S. Cooper, who loaned me a python skull for examination and to Dr. W. J. Rich of the Bristol Eye Hospital, for his interest in the case.

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John E. Cooper
'Quantocks', New Wokingham Road,
Crowthorne, Berks.

THE CONVENIENT USE OF A LURE IN NOOSING SMALL LIZARDS

By

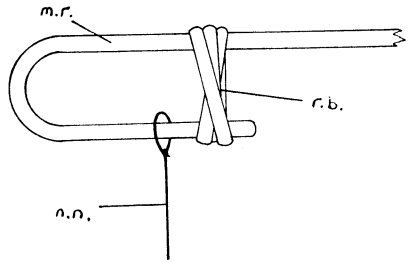
Malcolm and Stephanie J. Peaker

Department of Zoology, University of Hong Kong, Hong Kong, B.C.C.

Received 16/7/66

When considering the need for easily transportable field equipment an arrangement was devised which inadvertently led to the regular use of a lure in capturing small lizards.

The apparatus consists of a thin steel rod (m.r.) approximately 60 cms. in length, the end of which is bent back so as to be parallel with the rest of the rod. Small nooses of nylon fishing-line (n.n.) can be slipped onto the rod and held in place by a rubber-band (r.b.) wrapped around the bent end (Fig. 1). Replacement is simple and spare nooses of several lengths can be carried in small cans or packets ready for use.



Coloured rubber-bands of red, yellow and white were found to act as a lure. Basking lizards show an interest in the band and raise their heads (presumably taking it to be an insect). The noose can then be slipped over the raised head. Raising of the head was not seen when using a similar arrangement which did not have a brightly coloured lure.

Lizards caught with this arrangement include *Lacerta muralis*, *L. sicula*, *L. melissellensis*, *Algyroides nigropunctatus* and several species of gecko.

HEATING SMALL CAGES FOR SMALL AMPHIBIA

Let us assume that somebody sends you, in the depths of winter, some small frogs from a tropical country and that, contrary to all expectations, these arrive alive. Apart from the worry of how to feed them, you will want to provide them with an atmosphere as close to their natural one as possible.

You can—assuming you have the space—rig up a Terra-Aquarium and heat this with one of the low wattage economy lamps now available. This, however, has grave disadvantages. First of all you produce as much light as heat and in the case of nocturnal animals the light is not wanted at all. Secondly the heat you produce rises to the top of the cage while the soil and the water remain cold. It is a better idea to heat the cage from below without, at the same time, producing any light at all. This can be done in the following way (see Fig. 1):

Make a perforated platform from any non-corroding metal (zinc, brass, galvanized steel) with three of four legs as long as convenient. To the bottom of this platform, which should fit easily into the cage, covering the whole floor, fit two clips, made from the same metal. One of these is to hold a 50 watt aquarium heater, the other an aquarium thermostat. The wires to go over the edge of the cage. On the platform put one thin layer of P.V.C. foam, now easily obtainable at Woolworth's, then fill the tank with water up to the level of the platform. The heater-thermostat combination will keep the tank at the desired temperature at all times. The heat will rise, no light but that of the little pilot lamp incorporated in the thermostat, is produced and the atmosphere is constantly water-saturated. Care must be taken when making the lid for the cage, to allow just enough room for the electric wire. A small dish to serve as a water bath must be provided. The rest may safely be left to the imagination of the herpetologist-handyman.

E. ELKAN
62 Woodhall Gate,
Pinner, Middlesex

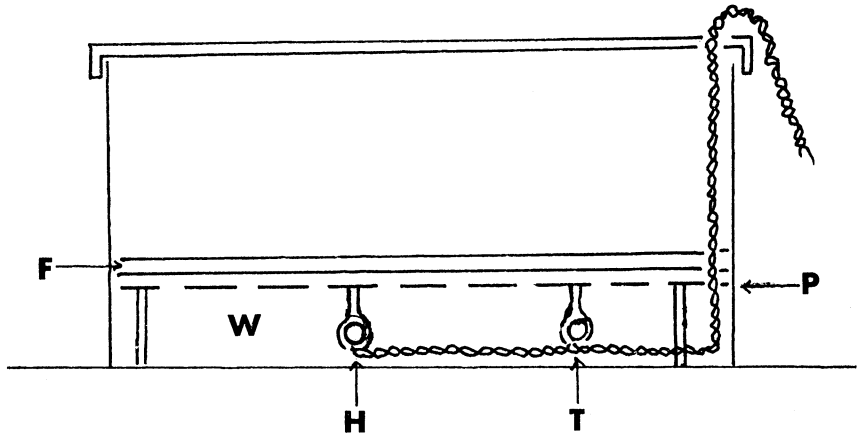


Fig. 1. Electrically heated small cage for tropical amphibian
F, Layer of P.V.C. foam; H, Aquarium heater, 50 W; P, Platform with legs; T, Thermostat; W, Space filled with water.

A CASE OF *ANGUIS FRAGILIS* DEVOURING NEWLY BORN YOUNG

A gravid blue-spotted slow worm caught in Penzance, Cornwall, in August 1966, gave birth to 8 young on the 5th September 1966, between 1.30 p.m. and 8 p.m.

The same evening she was observed to seize and devour one of the young ones. Immediately after eating it she was seen in the act of attacking another one, which was rescued and transferred along with the others remaining, to another cage.

The evening before the same female was seen eating 3 large earthworms and 2 slugs. She seized her young in the same manner as slow worms do when attacking earthworms.

As there seem to be no references in the literature describing such behaviour in this species, the case is presumably worthy of record.

M. DAVIES
10c Tevery Close,
Stapleford, Nottingham

OBSERVATIONS ON EGG DEPOSITION BY A SAND LIZARD

At noon on a warm sunny June day, near Frensham Common, a gravid female sand lizard was recognised near a vegetable patch on open sandy soil, where no lizards had been seen before. The lizard seemed to be searching the ground with its flicking tongue for insects or spiders. At the rim of a small plot she commenced to burrow using her feet. She emerged from the cavity several times to look around and rest, but finished digging within 20 minutes, so that the cavity was large enough for her to turn around completely, except for 1½ in. of tail protruding outside.

At 12.30 p.m. the tail twitched from time to time; presumably signs of egg deposition. On our return 45 minutes later the lizard had gone. The burrow had been carefully covered over though the spot was still recognizable.

The animal showed a complete disregard for the presence of three observers within a foot of her labours, though without doubt she must have been aware of them.

H. O. MUNRO
195 Park Lane, Wembley

ANNOUNCEMENTS

TSCHUDI: *CLASSIFICATION DER BATRACHIER*

A facsimile reprint of this herpetological classic (originally published in Neuchâtel, 1838; 120 pages, incl. 6 pls.; 7 × 10 inches) is scheduled for publication in Summer, 1967, by the Society for the Study of Amphibians and Reptiles. This reprint includes a 5-page introduction by Robert Mertens, with a portrait and bibliography of Tschudi. Price post paid, $4.00 paper bound ($2.00 to S.S.A.R. members); cloth bound copies $2.00 extra. Address orders to Joseph T. Collins, Secretary-Treasurer, S.S.A.R., 5807 Montgomery Road, Cincinnati, Ohio 45212. A complete list of S.S.A.R. *Facsimile Reprints in Herpetology* may be obtained from the Publications Secretary, Dr. Henri C. Seibert, Department of Zoology, Ohio University, Athens, Ohio 45701.

PARTHENOGENESIS IN *LACERTA*

Dr. Ilja S. Darevsky, Curator of Herpetology at the Academy of Sciences, Leningrad, recently published a major paper entitled "Natural Parthenogenesis in a Polymorphic Group of Caucasian Rock Lizards Related to *Lacerta saxicola* Eversmann" (in *Jour. Ohio Herpetol. Soc.*, **5**(4): 115-152, pl. I (coloured), 1966); this is the first time that a complete account of this important work has been made available in English. Single copies may be obtained, post paid, from Dr. Henry C. Seibert, Ohio University.

THE ZOOLOGICAL RECORD

Section 16, *Amphibia* and 17, *Reptilia*

Herpetologists are invited to write for the leaflet and broadsheet which explains the purpose and working method of *The Zoological Record* and illustrates specimen columns.

The Zoological Record, founded in 1864, is an international bibliography and three-way reference system for zoologists and those in related sciences. Volumes, published annually, consist of twenty sections: eighteen record a year's literature relating to a Phylum or Class of the animal kingdom; another section is devoted to Comprehensive Zoology, and the final section lists new genera and subgenera. Each section is divided into an Author Index, a Subject and a Systematic Index, and is designed for easy reference and retrieval.

Those wishing to have quick access to Sections *Amphibia* and *Reptilia* may obtain these sections singly at £1 each for Volume 100 (1963 literature) and Volume 101 (1964 literature). Postage and packing extra.

The broadsheet and further information may be obtained from: The Publications Dept. (B.H.S.), The Zoological Society of London, Regent's Park, London, N.W.1, England.