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Contributions should be addressed to the Editor, A. d'A. Bellairs, St. Mary's Hospital Medical School, London, W.2. Articles should be typed in double spacing on one side of the paper only. Figures should be drawn in Indian ink on plain white paper.

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## EDITOR'S NOTE

The Editor would welcome more articles on the keeping of reptiles and amphibians in captivity, and on general topics such as hibernation.

OBSERVATIONS ON THE EGGS AND YOUNG OF THE  
WALL LIZARD (*LACERTA MURALIS*) IN CAPTIVITY

by

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The Wall Lizard (*Lacerta muralis*) is a common and widely distributed species in Europe and has been imported into this country in large numbers for many years. Smith (1954) describes the several unsuccessful attempts to introduce this species into this country and concludes that climatic factors have been the main reasons for the failures. He states, however, that two small colonies of the Wall Lizard have been established in Surrey for over twenty years and breed regularly in both localities, proving that breeding in our climate is possible. Rollinat (1934) has described the breeding of these lizards in captivity in France, and White (1957) has observed the breeding of captive Green lizards (*Lacerta viridis*) in England.

An outdoor vivarium 5½-ft. x 8½-ft. was constructed with vertical glass walls (see Plate). A small section was also roofed with glass, but the remainder left open. A variety of cover was provided with rock-work and plants and shelters made of wood and bark. Wall Lizards were first introduced into the vivarium in August in 1956 and the total stock at the beginning of the 1957 season was seven females and two males. They mated freely in the latter half of April and May, and during the summer between 50 and 60 eggs were laid. None of these had hatched in the outdoor vivarium before the onset of winter.

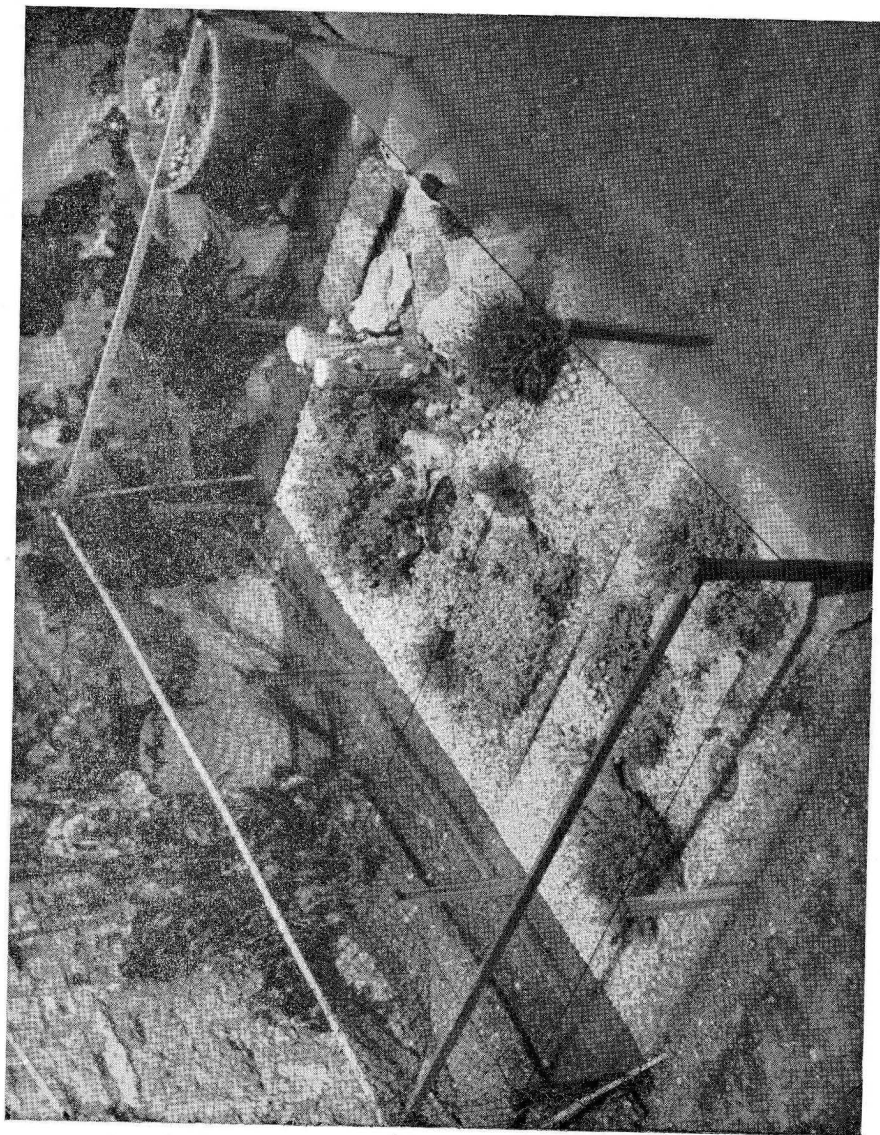
It must here be mentioned that in the same season and vivarium conditions, the viviparous Lizard (*Lacerta vivipara*) brought forth young normally in mid-July, and in the middle of June Sand Lizards (*L. agilis*) laid eggs which hatched in the middle of August.

The following account commences with the deposition of the eggs, and gives details of the eventual hatching of some of the Wall Lizards eggs, and the rearing of the young, with the aid of a heated vivarium indoors.

## DEPOSITION OF EGGS

The gravid females would take no food for about ten days before laying, becoming very thin. They were restless and furtive, exploring every corner of their quarters and digging small holes in many places with the fore-feet. Finally, the digging was sustained in one spot and a burrow made extending obliquely into the ground until the lizard had disappeared from view. It was later ascertained that a larger chamber was formed at the bottom of the burrow to accommodate the eggs.

Having laid her eggs, the mother emerged, filling in the burrow as she did so. The soil was well compressed with the feet, so that it was after-



Vivarium for Wall Lizards

wards difficult to distinguish the replaced soil from the undisturbed ground. The female Wall Lizard has remarkable ability to disguise the site of her "nest" and to leave the surface of the overlying soil exactly as she found it. One of the lizards dug her burrow in ground covered with an inch of coarse gravel, and after the eggs had been laid and the burrow filled in, the gravel was replaced on the top. The laying of the eggs and their concealment occupied a number of hours and the work often extended into the night.

The digging of the burrows was observed a number of times. On one occasion, the lizard was noticed soon after she had started to dig, and several hours later the burrow was evidently complete, as the head, with the tip of the tail alongside, could be seen at the bottom of the sloping shaft, facing towards the entrance. During the next two hours, the creature moved gradually nearer to the entrance, and towards dusk, I alarmed her as she was about to come out, whereupon she fled to another part of the vivarium. The next morning, the surface of the soil had been perfectly restored. Evidently, the lizard had returned to finish her work in the night.

After finishing their task, the females were very active and ate and drank copiously. They were very thin with a loose fold of skin along the flank

#### Eggs

The seven females produced a total of thirteen clutches of eggs during the season from June 1st to August 6th as shown in the following table. The lizards were individually recognisable and were numbered from 1 to 7.

<i>Lizard</i>	<i>Dates of Laying</i>
1	June 17th and July 18th
2	June 21st and July 19th
3	June 1st
4	June 3rd
5	June 6th
6	June 14th and July 5th and August 6th
7	June 12th and July 2nd and August 4th.

The eggs were deposited from 4 to 9 cms. beneath the surface of the ground. The nest burrows were sometimes dug in the open, but more often in the cover of vegetation or under large stones. Owing to the secrecy and skill of the lizards in hiding their eggs, it was not easy to know the exact position of each clutch, but their presence somewhere in the vivarium was evident from the characteristic appearance and behaviour of the mothers immediately after laying. Preference was shown for the glass-covered part of the vivarium and five out of the six clutches actually found were placed there.

The size of the eggs when first laid was 10 to 11 mms. x 8 to 9 mms., and the number per clutch ranged from 3 to 8. They were whitish and oval, and their shells were soft and leathery. The older and larger lizards produced two or three relatively large clutches during the season, while the smaller and younger females laid one small clutch only. Two eggs from different clutches were opened a few days after laying, and were found to be fertile, the embryonic heart pulsating.

No hatch had been observed by August 31st—some three months after the first eggs had been laid—and it was decided to investigate the eggs whose positions were known, and if still vital, to warm them artificially. Two clutches were found to have decomposed at an early stage of development. They had been laid in rather damp situations. Another clutch was found to have perished, but the eggs contained embryos nearing full development, the largest being 47 mms. long overall. Three more clutches were found in good condition as follows:—

8 eggs laid July 5th

3 eggs laid July 18th

5 eggs laid August 4th.

The eggs were carefully transferred to a wooden box of sandy soil, covered with half an inch of the same soil and placed in a heated vivarium indoors, maintained at a temperature of 65° to 70°F. by day and 50° to 55°F. at night. The soil was sprayed with water once daily and the eggs were inspected once a fortnight. A steady increase in size was noted (see Table). In some cases the increase was mainly in girth, so that a spherical shape was approached. In the later stages of development, irregularities of shape arose, bulges at some points distorting the general oval form. The increasing pigmentation of the embryos showed through the shells more at some points than others, so that the darkening of the eggs appeared patchy. The following Table shows the increase in egg size, and gives the sizes of the larger eggs in each clutch. During the later stages of incubation, eggs in each clutch varied by up to 2 mm. in each dimension.

Clutch of 8 Eggs Laid	Size of Eggs in mms.	Size of Embryo in mms.	Clutch of 3 Eggs Laid	Size of Eggs in mms.	Clutch of 5 Eggs Laid	Size of Eggs in mms.
July 5th	10		July 18th	10	Aug. 4th	11
Aug. 31st	13	20	Aug. 31st	14	Aug. 31st	13
Sept. 14th	13	29	Sept. 14th	14	Sept. 14th	13.5
Sept. 28th	13		Sept. 28th	14	Sept. 28th	14.5
Oct. 12th	13.5	43	Oct. 12th	14.5	Oct. 12th	15.5
Oct. 27th	14		Oct. 27th	15	Oct. 27th	17
Nov. 10th	15		Nov. 10th	15	Nov. 10th	17.5
Nov. 24th	16		Nov. 17th	1st hatched	Nov. 24th	18
Dec. 8th	16.5	56	Nov. 21st	2nd hatched	Dec. 8th	19
Dec. 12th	1st and 2nd hatched		Nov. 24th	3rd hatched	Dec. 22nd	18.5
Dec. 15th	3rd hatched				Dec. 24th	1st and 2nd hatched
Dec. 20th	4th hatched					3rd hatched
						4th hatched
						5th hatched

## OBSERVATIONS DURING INCUBATION

On October 6th one egg had become heavily wrinkled and was opened and found to contain a living embryo 29 mms. long. Crenation of the egg was attributed to shortage of moisture, and the soil of the egg box was thereafter sprayed more frequently. It was noted that the largest eggs were all near the centre of the box where moisture would be likely to remain longest.

On October 14th, two eggs were brought to the surface of the soil by the digging activities of two young Sand Lizards. One was found to have a minute hole in the shell, through which a considerable quantity of clear fluid escaped. The eggs were covered again with soil and as they eventually hatched, it was evident that the embryos had been little affected by the disturbance.

On October 27th a further egg of the July 5th clutch was opened and found to contain an embryo 43 mms. long (snout to vent 23 mms., tail 20 mms.). A large amount of yolk was still present. The pattern of markings on the skin was well defined.

On December 8th, the shell of one of the eggs had become much discoloured and softened and the size of the egg was smaller than when inspected a fortnight before. The egg was opened by cutting round the 'equator' with fine scissors, whereupon the embryo made several convulsive movements. The egg was quickly put back into the egg box on the surface of the soil. Within a few hours, the young lizard was running about, but the yolk sac (about 3 mms. in diameter) was still attached to the creature's umbilical region. The sticky tissue had gathered a mass of soil and gravel and was restricting the lizard's movements and was therefore removed by cutting through the attachment close to the body. In a few days, the remains of this attachment had disappeared. Although somewhat "premature", the lizard seemed to be perfectly normal in appearance and behaviour, and took water and food after the usual intervals. Its size was the same as the smallest of the normally-hatched young—snout to vent 23 mms., tail 32 mms., total 56 mms. It was later observed that a few of the normally-hatched young had the remains of the yolk sac attached to their bellies.

In several instances, the eggs became reduced in size and even shrivelled and discoloured immediately before hatching, and clear fluid was seen to escape, forming "beads" on the outside of the shells.

## HATCHING

Most of the eggs hatched in the latter part of the morning, when the temperature of the vivarium had risen to 65° to 70°F., and final emergence from the soil took place early in the afternoon. Two lizards, however, hatched in the early morning and evening respectively.

Examination of the empty shells showed that the lizards escaped through a remarkably small slit near one end of the egg which quickly collapsed into a wrinkled mass after the occupant had left. Some eggs were almost dry at the time of hatching, but others contained a considerable volume of clear fluid.

When inspecting the eggs on November 24th, one was found to be hatching. The head only protruded from the shell and the lizard writhed its whole body in order to free itself. The eyes were fully open. There were short resting periods between the efforts, but as soon as the fore-limbs were clear, progress became more rapid. In an hour, the lizard was running about.

On December 15th, more complete observations were made on the hatching of one of the eggs. When first seen, the shell had not been pierced, but violent struggles inside were bulging and distorting the envelope in all directions. The tip of the snout eventually broke through at one end of the egg and the head was forced out, splitting the shell further. Again there were resting periods, and the kicking of the fore-limbs and later the hind limbs did much to effect the final escape.

#### DESCRIPTION OF YOUNG

The skins of the newly-hatched lizards were damp and a quantity of sand and soil was usually adhering to them. But their first activities in the warmth of the vivarium quickly rendered them dry and clean. The size of the young lizard was roughly proportional to the size of the egg and varied from 56 mms. (Snout to vent 24, tail 32) to 65 mms. (snout to vent 26, tail 39), the majority being about midway between these two measurements.

The members of a brood were all very much alike in their dorsal markings, and this pattern bore a remarkable resemblance to that of the mother of the brood. The only two adult males kept in the outdoor vivarium, whose colouration and markings were very distinctive, must almost certainly have been the fathers of all the young under consideration.\* It was surprising to note that much less of the characteristic markings of either male was apparent in any of the young.

The green colouration of the adults was absent in the young, but otherwise the colours present were similar—black, various shades of brown, yellow and cream, disposed in the characteristic longitudinal stripes and rows of spots. The under sides were almost white or faintly bluish (reminiscent of mother-of-pearl) and in one brood some darker spots were present. A small area marking the point of attachment to the yolk-sac, in the centre of the belly, remained visible for about three weeks after hatching.

The egg-tooth was so small as to be just visible to the naked eye and only if the newly-hatched lizard could be viewed from a favourable angle. Under ten diameter magnification, the tooth could be seen, attached to

\* *Footnote.* Delayed fertilisation by sperm stored from a long previous mating is only known among lizards in chamaeleons, though it occurs in other reptiles.

the premaxilla, the sharp tip projecting a little beyond the snout. The tooth was certainly lost early and was not observed after the day of hatching.

#### EARLY BEHAVIOUR

The young were at once capable of full activity, but usually took a prolonged rest after the strenuous efforts of hatching. Fighting among the lizards became common when only a few days old and was similar to that seen among the adult Wall Lizards. The quarrels arose chiefly over food, but sometimes seemed to concern favourite basking positions nearest to the source of heat. At other times there seemed to be no specific reason for the conflicts. The larger would usually attack and defeat the smaller but no noticeable injury was ever inflicted.

As in the case of adults, the speed and agility of the young Wall lizards was vastly superior to that of the Common and Sand Lizards. They could walk up vertical wooden surfaces with ease and leap horizontally for four or five inches soon after hatching.

Activity was at its height at a temperature of 70°F. Below this temperature, all movement was slower, but feeding was observed at below 60°F. on some occasions. Towards 80°F. the lizards showed a tendency to take cover. As soon as the electric lighting and heating were switched off at night, all would retire into a shelter of bark filled with dry moss, and cautiously emerge the next morning, when the temperature had again risen to about 65°F. A spray of water would send them quickly into cover.

#### FEEDING

The young sought water as soon as they were hatched. All quickly found the drinking vessel in one corner of the vivarium and some remained in it for a considerable period. Usually the first food was taken about twenty-four hours after hatching, but one exception fed half-an-hour after leaving its shell and two others did not eat for their first three days.

They were fed twice a day, at mid-day and in the early evening and their favourite food was small spiders of several species. These were accepted more eagerly than anything else, and often after all other food had been refused. Almost as popular were young mealworms and small moths and their caterpillars and pupæ. Fruit-flies and their larvæ, mosquitos, small millipedes, earthworms and aphids were also taken by certain individuals. Young woodlice and various small beetles were sometimes chewed, but appeared to be distasteful, and were nearly always rejected.

Although living prey was obviously preferred, freshly killed food was taken at times, and when particularly hungry pieces of "gentles" and large mealworms (especially the soft internal parts) and even shreds of meat both cooked and raw, were accepted. Blow-flies, earwigs and large spiders were also consumed if cut into suitable pieces. They would lick sweet things for a long time, but were never seen to eat any bulk of such food. Smith (1954) mentions similar habits in sand and viviparous lizards.

The young wall lizards pursued their prey with all the speed and agility of the adults, poisoning themselves with arched necks over the object of interest and finally seizing it with a sudden snap. Struggling prey was usually shaken very thoroughly. The prey was then shifted into a favourable position in the mouth by vigorous jaw movements and finally swallowed. Any excess left clinging to the jaws was rubbed off against the ground.

Considerable intelligence was displayed in hunting and capturing food and once interest had been aroused, a search was kept up for some time. On seeing a movement in the gravel of their vivarium (due to a buried mealworm) they would investigate with the fore-feet and seldom failed to find the mealworm. Rollinat (1934) also comments on the intelligence of this species in finding prey.

On one occasion, a spider was seen in a crack too narrow for the lizard to enter. It extended its fore-limb into the crack, scratching at the spider until it moved into an accessible position, whereupon it was caught and eaten.

Another method of obtaining food was frequently practised. The lizards would lie motionless under dry moss or other suitable cover and as soon as any movement was seen, would dart out to investigate. Their perception of movement was extremely keen, but the range did not seem to extend much over a foot.

When the young lizards saw movement in the room where their vivarium was kept (or possibly heard sounds), they would come to the glass to investigate. If the top of the vivarium was taken off they would climb up the walls as if to see what food was being offered. They took food from tweezers freely, and appeared to associate the instrument with food, as they would often snap at it when empty. The adult Wall Lizards in the outdoor vivarium also came out from their hiding places when I went to feed them, looking up and waiting for a considerable time until the food was dropped. In the most favourable weather some of them would take food from the tweezers, but were always more nervous of doing so than their young. Rollinat (1934) obtained similar results.

Feeding was regular and extremely vigorous during the first four or five weeks of life, and as much as eight spiders or young mealworms could be consumed by one lizard at one feed. They frequently snatched food from each other's mouths and there was obvious rivalry among them for possession of prey. After the first four or five weeks of life, their appetites became more moderate and interest was first lost in "dead" food. Spiders of suitable size remained of interest longest. In most cases, the rate of feeding continued to decline until the lizards were taking food about once a week, despite every effort to tempt them with a wide variety of fare. It seems likely that spiders form a large part of the Wall Lizards' food in nature, as is the case with the Viviparous Lizard (Smith, 1954).

On January 5th, the lizards were divided into two groups, the youngest brood in one vivarium and the two older broods in another, both these small vivaria being within the main heated one. This was primarily to

relieve overcrowding, but also for another reason. At first there was no indication as to which of the two males in the vivarium was the father of the newly hatched young. One of these males, like both the females, had greenish markings, while the other male was of the mottled brown and cream variety. As the young increased in size and shed their skins it could be seen that the two older broods resembled the greenish male and the females in colour, while the later brood resembled the brownish male. It is possible, therefore, that these differences in colour, like certain differences in behaviour, were due to differences in the male parentage.

#### THE TWO OLDER BROODS

These lizards shed their skins for the first time at four to five weeks of age, the process taking a week to complete. Immediately after the first slough they stopped feeding, in some cases for over a week. They became less active during this period and remained in cover most of the day. Burrows were dug in the soil and the lizards used these when in retirement. Curious nodules appeared on the ends of the digits of the fore-limbs, apparently in association with digging. They were later lost, and had, I think, merely consisted of consolidated soil.

When feeding was resumed it was less copious, some individuals taking food only once in several days. Appetites continued to decline and the lizards were in uninterrupted retirement during the first half of February. In the middle of this month (coincident with a spell of spring-like weather) the lizards reappeared looking rather thin, and fed eagerly, soon regaining their former plumpness. They frequently chased and fought each other.

#### THE YOUNGEST BROOD

The first shedding of skin occurred earlier than in the other two broods (some at barely three weeks of age) and the loose skin was shed more quickly. Growth was more rapid and some sloughed a second time at five weeks. They did not lose interest in food after the first slough and grew steadily, so that they were soon larger than any amongst the other two broods.

These lizards did little digging and simply used the bark shelters provided when in retirement. They remained extremely active, and caution was always needed when approaching them. There was sometimes a sinuous quivering of the tail when excited, but these lizards seldom chased or fought each other.

On April 27th the young lizards were transferred to an outdoor vivarium 2-ft. x 3½-ft. where they fed well and were extremely active when the weather conditions were good. Their first week in the open was very warm and sunny and the lizards were more active and hungry than at any time in their lives. They took the fullest variety of food from tweezers and even from the fingers and could catch the swiftest moving prey with ease. The green caterpillars of cabbage butterflies and ants' pupæ were added to their diet.

## FURTHER OBSERVATIONS

The incubation periods, ranging from four to five and a half months, seemed very long, especially as, for a large part of that time, their temperature was artificially maintained. With lower temperatures, the incubation periods would have been, presumably, even longer, and it appeared possible that some eggs could have over-wintered and hatched in the following Spring.

Eggs containing almost fully-developed embryos were found on August 31st, 1957, three months after being laid. The following Spring three clutches of eggs were dug up in the outdoor vivarium, and were found to contain well calcified skeletons, indicating that the embryos had reached an advanced stage of development. It appeared that a number of eggs came near to hatching, and that in a season of more favourable weather conditions, they might actually have done so.

It was interesting to note that, during their stay in the indoor vivarium, the young lizards reacted markedly to the outside weather conditions, especially when the spring set in. Marked individual variations in growth rate, appetite and behaviour were observed.

One young lizard had a deformation of one of the fore-limbs and another an asymmetry of the mandible; these abnormalities were present at hatching, and tended to become rather less apparent with increasing age. The abnormalities did not seem to interfere with growth or behaviour. No other abnormality or disease was observed in the young and no casualty had occurred among them by the time they retired into hibernation in October, 1958.

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THE DICE SNAKE (*NATRIX TESSELLATA*) IN CAPTIVITY

by

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The Dice Snake or Tessellated Water Snake, is one of the most easily obtained foreign snakes in this country. It is therefore rather strange that comparatively little mention of it has been made in herpetological literature, apart from the short account in G. A. Boulenger's *Snakes of Europe* (1913). It does not very often appear on dealers' lists, obviously because those offered here for sale mostly come from Italy, where they are usually lumped together with *Natrix natrix* and sent here as "Grass Snakes". During the last few years, possibly a quarter of the so-called Grass Snakes imported into this country have in fact been Dice Snakes. This is in many ways a pity, as the habits of the Dice Snake vary considerably from those of the Grass Snake and it requires somewhat different treatment in captivity. Given proper care, the Dice Snake is quite hardy in captivity and certainly a most interesting snake to study, and the object of this article is to give more information than is normally available to those who wish to keep this particular species.

Specimens are both cheap and easy to obtain. In many shops which sell Grass Snakes, it may be possible to find a few Dice Snakes among them, and although prices for Grass Snakes vary somewhat, it should not normally be necessary to pay more than about six shillings for a specimen. It is quite easy to tell the two snakes apart. The Dice Snake is generally olive brown or greyish with a more or less distinct pattern of dark and light squares, which stand out more clearly in water. The lower flank normally has a pinkish or vermilion tinge. A V-shaped dark mark is nearly always present on the neck, as is a yellowish streak along the upper lip. The under-surface varies considerably in colour but is usually yellowish or orange marbled with dark brown or black, sometimes nearly white. The head of the Dice Snake is quite different from that of the Grass Snake, more closely resembling that of some of the American species of the genus. It is comparatively small with an angular snout, almost square in section, somewhat swollen behind the temples and particularly so in large females. The eyes are quite small, rather prominent, set well forward and high on the head, with a small black pupil and quite distinct light iris. The males do not often exceed two feet in length but the females frequently reach three feet. Scallation is: 19 scale rows, 160 to 187 ventrals, 48 to 89 paired sub-caudals.

The distribution of the Dice Snake suggests that it was originally a South-West Asian snake which entered Europe from the south-east after the last ice age. It ranges from West Asia and north-east Egypt into south

Russia, through the Balkans and Austria into Poland, Czechoslovakia and Italy (where it reaches as far south as Naples but is absent from the islands) and in places into Germany, notably in Saxony and in West Germany as far as the Middle Rhine and Moselle. The German name "Würfelschlange" also means 'Dice Snake'.

It seems probable that the westward range of the Dice Snake is limited by climatic conditions and that in this country, for example, it would not be possible to introduce it on a permanent basis. While individual specimens often do quite well outdoors here, and have no difficulty in hibernating over winter, there are two factors which have to be watched very carefully by anyone trying to keep them permanently outdoors. One is that the females require more warmth for the development of their eggs than is sometimes provided by an English summer. Given a long period of really warm weather at the right time, they will lay their eggs at any time between late July and early September, but a period of cool weather at this time is likely to delay oviposition and allow the eggs to increase in size inside the female until they are too large to be laid. A snake which has become egg-bound in this manner is not a happy sight, as the eggs enlarge so that the skin is tightly distended over each one of them. Not only does the snake become extremely sluggish and unable to feed or even move about properly, but it becomes infested by flies, which lay their eggs in great numbers between and under the scales. Once the snake has reached this stage, even if it is taken indoors, cleaned up and given considerable warmth, it is rarely able to lay its oversize eggs, and dies. The other difficulty in keeping Dice Snakes outdoors in this country again relates to the climate, as Dice Snakes normally take their food in water and will not enter the water to search for food at a temperature below about 50 degrees Fahrenheit. Given a warm autumn, the snakes will feed right up to the time of hibernation about the middle of October, but a cold late summer may well mean that they enter hibernation underfed. In addition to this, the Dice Snake tends for some reason to awake early from hibernation and as the water in an outdoor pond is rarely warm enough for them to begin feeding before the beginning of May at the earliest, they often become somewhat emaciated by this time and may not survive.

If kept indoors at slightly higher temperatures, these difficulties do not arise, and it is, of course, quite possible to keep the snakes outdoors during the summer for as long as the weather is warm enough for them to feed, except that gravid females do need a fair amount of warmth and should not be kept outdoors from about July onwards unless the weather is really quite warm.

The Dice Snake is mainly a fish-eater, although it is fond of tadpoles and newts when available and occasionally takes small frogs. Small prey is usually swallowed under water but large fish are nearly always dragged out of the water and swallowed on land. Larger fish are usually seized across the body and it is then quite normal for the snake to drag the fish on to land, drop it and pick it up again by the head before swallowing it.

At times there is quite a delay between dropping the fish and picking it up again, and the snake may even leave the fish on the ground for a while and crawl quite some distance away before coming back to swallow it. As regards size of prey, Dice Snakes are quite reckless in attacking fish far too big for them to swallow, and show amazing strength in dragging large struggling fish out of the water, even up a steep bank, and sometimes as far as 10 or 12 feet away from the water. A two-foot Dice Snake can easily deal with a half-pound fish in this manner, and is even likely to attack much larger fish. In fact, there is no question of keeping Dice Snakes and fish together; it is hardly an exaggeration to say that either the fish is large enough to kill the snake, or is small enough to be killed by it. On the other hand, even a large snake will take quite small fish and tadpoles. The Dice Snake will attack any species of fish, but has difficulty in swallowing sticklebacks on account of their spines, and often rejects them after a lengthy effort to swallow them. It seems, however, to have little difficulty with small perch.

The method of catching fish is extremely interesting. When a Dice Snake enters the water, it submerges at once and does not swim on the surface as the Grass Snake often does. It prefers weedy areas through which it can crawl, and often lies in a clump of weed with its head sticking out, watching for fish. If no weed is available, it crawls slowly along the bottom with its body rather flattened, and literally stalks its prey in a cat-like manner. The technique is always the same—when a fish is sighted, the snake commences a stealthy crawl towards it. As it gets near, the snake shows obvious signs of excitement, frequently protrudes and slowly vibrates its tongue, and repeatedly jerks its head and neck sideways in a very odd manner. From observation, it would seem that these movements may act as a lure, as small fish often approach the snake's head as though for a closer examination. The snake does not attack the fish unless it comes very close, an inch or two from its head, and then strikes very quickly, sometimes by straightening the neck to effect a direct stroke, but more often by what can best be described as a "sideways swipe". When hunting, the Dice Snake usually remains submerged for 4 or 5 minutes, then pushes its head above water and remains motionless to breathe for one or two minutes, and again submerges by withdrawing the head below the surface. It can, of course, stay under water for much longer if necessary, and has been timed to remain submerged for as long as 20 minutes.

The Dice Snake can hardly be called an active snake. It spends hours curled up motionless, choosing for its resting place either a branch or twigs overhanging the water, or on the top of a rock or pile of stones. This choice of a high position for resting seems to be a fixed habit, and a Dice Snake rarely for choice curls up in a hollow or at the foot of a rock or bush as the Grass Snake so often does. The Dice Snake rarely moves in a hurry. If disturbed when resting it will drop off its perch, either into the water where it submerges at once, or on to low ground where it is easily caught

if it has not a convenient hole to fall into. There is, by contrast, a period of intense activity in early spring, when the snakes are mating. At this time the males move around constantly at quite a rapid rate for long periods at a stretch, looking for females, and when they find them indulge in frenzied outbursts of courtship.

When kept indoors, it is not essential that the Dice Snake should have a large water container. Like most of the American *Natrix* snakes, it does quite well if kept in a dry cage with a small water bowl for drinking, and usually learns to take fish from such a bowl. Freshly-caught specimens will not always take dead fish at first, but usually learn to do so after a while. If slow to learn this, forced feeding may be necessary for a while, and although this practice is in general not to be encouraged, it is often found that a Dice Snake will readily swallow a fish if the head is introduced into its mouth, and a snake which has consistently refused to feed and is once treated in this way will often resume feeding by itself as a result. However, in order to really study the interesting habits of this snake, there is no doubt that it is best to have a water container large enough so that the snake can move around in it and catch its prey in the normal manner. The water need not be more than 4 to 6 inches deep and it is best to have plenty of weed in it, as this definitely encourages the snake to enter the water to feed. If some small branches or twigs are arranged to overhang the water, the snake will use these as a resting place and when sufficiently tame will learn to glide down into the water when food is introduced. It is, of course, necessary to ensure that the water container does not leak or slop over into the rest of the cage, as like all snakes the Dice Snake will quickly develop skin sores if kept in permanently damp surroundings.

The eggs, which in a wild state are laid in July and August, may be any number between 5 and 25, according to the size of the female, and hatch in about twelve weeks. Any eggs laid in captivity should be treated as those of other snakes, by being kept at suitable temperature and humidity, packed in sphagnum moss, wood shavings or the like. The young take to the water almost as soon as hatched and feed largely on fish fry, or small amphibian larvæ. If this food can be obtained, they are not particularly difficult to rear.

Altogether, this is an interesting snake, well deserving more attention than it seems to have received in the past.

SOME ECOLOGICAL NOTES ON THE BRITISH REPTILES,  
WITH PARTICULAR REFERENCE TO THEIR  
FEEDING HABITS

by

D. G. BROADLEY,

Honorary Keeper of Herpetology,  
National Museum of Southern Rhodesia

These observations are based on a study of a collection of reptiles maintained at Southampton during the seasons 1953-54. Most of the specimens were collected in Hampshire and Dorset, but a few *Lacerta vivipara* came from Stamford, Lincolnshire.

*ANGUIS FRAGILIS* Linné

**HABITAT.** The Slow-worm is very common in Hampshire and Dorset, but rarely seen because of its secretive habits. I trapped scores of specimens on the slopes of an old quarry at Crabwood, Southampton, simply by laying pieces of wood or cardboard flat on the grass. The reptiles were attracted by the warmth and humidity under the cover and often several Slow-worms would be found in one trap. Several male Blue-spotted Slow-worms (var. *colchica*) were taken. The spots were usually pale blue-grey or Cambridge blue immediately after sloughing, but often turned brownish later.

**DIET.** Small slugs taken by captive specimens.

*LACERTA AGILIS AGILIS* Linné

**HABITAT.** Thirteen Sand-Lizards were captured in Dorset, but none in the New Forest, although thoroughly searched for. Specimens were taken along an overgrown ditch at Wareham and on Stoborough and Studland Heaths near Corfe Castle.

**DIET.** A breakdown of the food taken by captive specimens is given in comparison with the data for *Lacerta vivipara*, under which species the table appears.

**HABITS.** A less active reptile than the next species. The Sand-Lizard is usually found in colonies on small hillocks or banks which are often covered with thick heather. These lizards quickly became tame in captivity and fed from hand.

*LACERTA VIVIPARA* Jacquin

**HABITAT.** The Viviparous Lizard is very common in Hampshire and Dorset on dry heaths and along ditches. I have never found this species in the areas inhabited by the Sand-Lizard. At Stamford, Lincolnshire, a colony of *Lacerta vivipara* lives in a limestone wall within a few yards of the Great North Road (A1) and appear to thrive because the heavy traffic frightens away their enemies. One male from this colony measured 165 (60 + 105) mm. and found his long heavy tail quite a handicap. There were two melanica individuals out of a collection of 200 lizards. One was a pitch black female, fully grown and with an original tail, taken on Southampton Common. The other was a young male from Bournemouth in which the lighter markings were just discernible.

**DIET.** During the seasons 1953 and 1954 a collection of lizards was kept in an open air vivarium. They were taken out in the evening and placed in an empty box, into which a mixed selection of invertebrates was emptied. A card was made out for each lizard and everything eaten was recorded on it, each item being assessed at a value in points according to bulk (e.g., 1 for a small spider or house-fly; 4 for a centipede; 6 for a large spider, beetle, etc.). The following table shows the various groups of creatures preyed upon, expressed as a percentage of the total amount of food consumed.

Key to columns: 1. The variation in the 20 best feeders in 1953. 2. All *L. vivipara* for the period 4/4/53 to 17/10/53. 3. All *L. vivipara* for the period 20/3/54 to 21/8/54. 4. *L.a. agilis* (9 specimens) for the period 10/7/54 to 21/8/54.

	Variation	<i>L. vivipara</i>		<i>L.a. agilis</i>
		1953	1954	1954
Orthoptera (Grasshoppers)	0 to 17	5.4	5.3	32.4
Dermaptera (Earwigs)	0 to 14	2.7	0.6	0.5
Odonata (Damsel-flies)	0 to 54	11.5	2.1	5.0
Lepidoptera (Moths, Butterflies)	0 to 12	1.7	0.8	8.5
Diptera (Two-winged flies)	0 to 34	16.3	5.2	1.4
Colcoptera (Beetles)	0 to 6	0.3	0.5	0.6
Hymenoptera (Ants)	0 to 6	1.5	3.4	0.2
Insect larvæ and pupæ	0 to 11	2.0	2.7	6.4
Crustacea (Woodlice)	0 to 5	1.5	—	0.5
Arachnida (Spiders)	8 to 47	26.1	30.0	24.6
Chilopoda (Centipedes)	5 to 79	31.0	48.0	19.7
Oligochaeta (Earthworms)	Nil	—	1.2	0.2
		<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>

The first column clearly shows the great variation in individual tastes. Of the 20 lizards for which data was collated three came from Stamford, and these specimens accounted for the most spiders (47%, 45% and 40% respectively). So there may be variation in food preferences between specimens from different districts.

The other columns show the food preferences for the average lizard. In the wild state lizards certainly consume less Damsel-flies and Centipedes, but the percentage of spiders would probably be higher. Very few specimens would show any interest in beetles, woodlice or worms. The figures for *L.a. agilis* differ little from those for *L. vivipara*; being a larger reptile it can more readily tackle the larger insects and this is indicated by the higher figures for Grasshoppers, Butterflies and Moths and larvæ.

One of the most interesting points is the great liking shown by both species for centipedes. Most lizards showed some intelligence by always seizing the Chilopod by the head and crushing it before they could be bitten. A few individuals were less sensible and regularly got bitten after taking a centipede in the middle of its body.

I was rather surprised to find that lizards would take moth pupæ, crushing them and then lapping out the contents with their tongues, which always reminded me of a child with an ice-cream cornet!

All the lizards were very fond of sweetened tea, lapping it up from a saucer. Often when the ring of lizards had drunk their fill some of them would climb into the saucer and flatten their bodies in the warm tea.

**HABITS.** The Stamford specimens were taken as they basked on the wall on which they lived. In Hampshire most specimens were taken on heaths, where they often basked in gorse bushes a few feet from the ground. Each lizard had a series of basking places according to the position of the sun and the lizard always returned to its basking place, even if it had narrowly avoided capture several times in succession. In captivity they demonstrated the curious habit of flattening their bodies to receive the maximum amount of warmth and then twisting their limbs so that the soles of the feet pointed upwards. I have observed the same behaviour in African lacertids (*Ichnotrophis squamulosa*; *Ichnotrophis capensis*; *Nucras intertexta holubi* and *Eremias lugubris*) in Southern Rhodesia. During spells of dull weather they basked quite happily in the heat of an electric fire, in the usual position with feet in the air and eyes closed. While writing in the evening I often had a few tame lizards climbing around my body or absorbing the heat it offered. On one occasion a lizard snuggled down in my breast-pocket and climbed out 24 hours later, much to my surprise.

*NATRIX NATRIX HELVETICA* (Lacépède)

**HABITAT.** The Ringed Snake is very common in the New Forest, being particularly abundant near Brockenhurst, where many specimens were taken along the Ober Water. From my field notes: 3/5/53—4 snakes captured out of 6 seen; 24/5/53—4 captured out of 10; 19/7/53—2 captured out of 5; 27/4/54—5 captured out of 8.

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DIET. I witnessed an adult snake swallowing a large toad (*Bufo b. bufo*) at Crabwood, Southampton. Captive specimens fed readily on newts (*Triturus v. vulgaris* and *T. helveticus*), frogs (*Rana t. temporaria*), very small toads (*Bufo b. bufo*) and tadpoles. One large female swallowed a dozen small lampreys. On one occasion an adult snake took 12 newts in succession and was still looking for more.

HABITS. A three-foot female from the New Forest hissed fiercely and struck with closed mouth when captured; later she shammed death, lying on her back with limp body and open mouth. Most specimens discharged a foul-smelling fluid from the vent when captured. The only African snake in which I have noted this habit is *Mehelya c. capensis*, and to a lesser degree in *Thelotornis k. capensis*. My attention was drawn to one snake by a bird fluttering around it as it climbed up a bank via some tree roots.

#### CORONELLA AUSTRIACA Laurenti

HABITAT. An adult female was found coiled by the roadside on Set Thorns Heath in the New Forest on 5.7.53. She was about to slough and her vision was poor. The local vegetation was thick heather and gorse. A pair of specimens were taken near Corfe Castle in Dorset on 11.7.54. The male from Studland Heath measured 562 (437 + 125) mm. and the female from Stoborough Heath was 651 (540 + 111) mm.

DIET. In four months the New Forest snake consumed 14 *Lacerta vivipara* and 5 *Anguis fragilis*. Live lizards were held against the snake's coils but never constricted. The Dorset specimens took the same species and also *Lacerta a. agilis* when offered.

BREEDING. The New Forest female, 500 mm. in length, produced five young on 31/9/53, each encased in a semi-transparent membrane. This brood appeared too late in the year and the hatchlings did not survive the winter.

HABITS. All three Smooth Snakes were very docile, liked to be handled and fed very well on live or dead prey. The pair from Dorset were presented to the Zoological Society of London when I sailed for Rhodesia in September, 1954.

#### VIPERA BERUS BERUS (Linné)

HABITAT. Many Adders were collected in the New Forest, particularly along the Ober Water. On the 27th April, 1954, a warm spring day, I encountered 17 snakes along a stretch of a mile and a half, of these nine were adders. I took many snakes along the edge of New Park Enclosure, where they assembled to bask in the late afternoon sun. Several specimens were taken on the heaths round Corfe Castle.

DIET. One Adder had swallowed a lizard (*Lacerta vivipara*). No specimens could be induced to feed in captivity.

HABITS. Captive specimens could be handled freely, but they were apathetic, not tame.

### BREEDING BEHAVIOUR OF THE CHAMAELEON (*CHAMAELEO GRACILIS*) IN SIERRA LEONE

by

J. I. MENZIES,

Biology Section, Bo School, Sierra Leone

#### INTRODUCTION

Previous records of chamaeleons breeding (Milner, 1947, and Rose, 1950) refer to south and south-east African species which appear to differ in some respects, notably in length of incubation, from the West African *Chamaeleo gracilis*. These notes are based on observations on two females, one wild and one in captivity, in September, 1956, but anatomical studies of other specimens seem to confirm that breeding takes place only about that time of year. The possible implications of this are discussed later.

#### OVIPOSITION

Rose (1950) and Milner (1947) report that *Ch. dilepis* digs a tunnel in which to lay its eggs. *Ch. gracilis* also does this and detailed observations are given below. ♀ No. 1 had been in captivity for several days.

17th September, 14.30 hours. This chamaeleon appeared to be trying to dig through the floor of the cage. A heap of soil was introduced and she at once commenced to dig into this.

18th September, 14.30 hours. Still digging.

19th September, 10.00 hours. Still digging, but rather haphazardly, soil was obviously not deep enough.

12.30. Egg laying nearly finished.

18.30. Eggs buried and soil being stamped down.

The stamping down continued until 14.30 next day.

♀ No. 2 (wild). Some days later.

18.40 hours. Observed digging a hole beside a path. Hole was then 85 mm. deep.

21.00 hours. Squatting across the hole, egg-laying almost finished.

08.30 hours. Hole filled, stamping down.

11.30. Site now covered with stones.

Animal 1 took 44 hours to dig the nest hole. The time taken by No. 2 is not known as the hole was practically completed when first observed. Milner reports that *Ch. dilepis* takes 24 to 30 hours to dig a hole 10" to 24" in depth and Rose over two hours for the same species to dig a hole as deep as the length of the female's body. In all cases the digging procedure appears to be the same. Soil is removed with the forefeet and passed

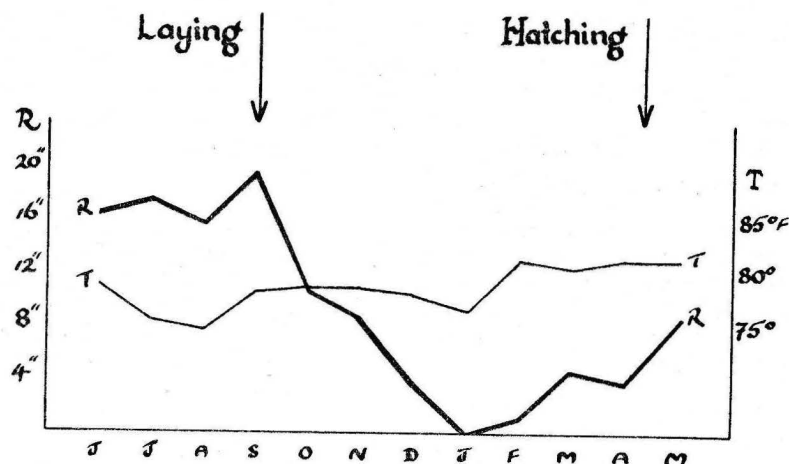


Fig. 1. Monthly rainfall (R) and mean temperatures (T) at Bo 1956-57

back to the hind feet, the head is also used to push aside loose soil. Throughout the procedure it was strikingly obvious how ill-adapted are chamaeleons' feet for digging. Each "handful" of soil had to be picked up by a forefoot and transferred to a hind foot, a most laborious procedure. The normal scraping procedure adopted by digging reptiles appeared to be quite impossible.

Animal 1 laid 45 soft-shelled eggs, each 10 x 14 mm.

#### INCUBATION

These eggs were removed and placed on a bed of sand under 80 mm. of moist soil. They hatched on the 24th of April, 1957, after an incubation period of 219 days. This compares with 9-11 months recorded for *Ch. dilepis* (Milner), 10 months for the same species (Rose), 3½ months for *Ch. isabellinus* (Rose) and "well over a year" for the gestation of the viviparous *Microsaura pumila* (Rose).

#### PHENOLOGY

The climate of Bo is tropical with fairly well marked wet and dry seasons and a temperature varying between 75° and 82°F. with maxima

from February-April and October-November. At the time of egg-laying the rains are coming to an end and hatching occurs before the heavy rains begin (see Fig. 1). During the dry season the ground becomes so hard that it is impossible to dig, even with a garden fork. It would be difficult for chamaeleons to construct nest holes at that time. During the heavy rains (July and August) the ground is often waterlogged. Were the eggs or hatching young to remain below ground at that time they might well be drowned.

The association of climate with reptilian breeding cycles is well known in temperate regions, where the seasons are quite distinct and temperature would appear to be one of the chief controlling factors. In the tropics it seems that one must look for other controlling factors. Baker (1947) in his work on the breeding cycles of various vertebrates in the New Hebrides, where there are scarcely any seasonal changes, remarks that "the breeding seasons of the vertebrates of the northern New Hebrides are controlled by environmental factors of a totally unsuspected kind, not affecting the sense organs or meteorological instruments of man". Perhaps further studies on the cycles of reptiles in those parts of the tropics which do have fairly distinct seasons will shed some light on this problem. It would be interesting, for example, to know whether chamaeleons in other parts of Africa show the same association with climate as they appear to do in Sierra Leone.

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#### NOTES

#### A RECORD SPECIMEN OF THE EUROPEAN WORM SNAKE

#### *TYPHLOPS VERMICULARIS* MERREM

Through the kindness of Dr. M. Dor, Director of the Teachers' Seminary at Cofit, Israel, I have been permitted to examine a very large specimen of *Typhlops vermicularis*, preserved in formalin, collected by Mr. M. Cornmel, July 16th, 1957, at Qibuc Talmey-Yafe near Ascalon, Central Israel. A careful examination of its pholidosis and comparison with other material has obviated the possibility that there should be a mistake in specific identification.

An attempt to measure the overall length of the specimen, which was preserved in a loose coil, showed that it had some tendency to stretch. Without any undue exertion of force it can, however, be taped out at 392 mm. This result, it is admitted, is somewhat arbitrary as regards its last digit. It may be assumed that the specimen, measured immediately after death and before fixation, would probably have attained 2 or 3 mm. more. Maximum diameter around midbody, measured (with callipers) as 7 mm. and slightly more, say 7.25 mm. around the base of the tail.

The next-longest specimen, available for comparison, No. 3019 in the Hebrew University Collection, Jerusalem, from Rehovot, Israel, measures 306 mm.

It is not surprising, in view of the elasticity of the material, that all measurements hitherto published of the lengths which this species may attain, seem to be conveniently rounded off to the nearest (or upper) integer. The only measurement in which an actual specimen is mentioned appears on the supplementary page 413 of the Brit. Mus. Cat. Snakes I, 1893, and refers to an individual from "Serahs, Transcaspia" of 310 mm. total length. Other published approximations are: 300 mm. (Schreiber, *Herp. eur.* 1912; Barash and Hoofien, *Rept. Isr.* 1956); 330 mm. (Werner-Brehm V, 1912; Nikolskii; Hellmich, 1956); 14 inches (= 356 mm. Corkill, Iraq, 1932) and finally 360 mm. (Terentiev-Cernov, 1940).

The specimen in the Cofit collection, therefore, seems to be the largest ever recorded and to carry the maximum size which the species may attain into the 390-400 mm. range.

J. H. HOOFIEN, P.O. Box 2, Tel-Aviv, Israel.

#### THE CAVE SALAMANDER (*HYDROMANTES GISTEL*)

Since the publication of my paper on this genus in Vol. 2, No. 6, Dr. J. Gorman drew my attention to the fact that I omitted to mention some of the more recently discovered Californian species. The following is a list of the species of *Hydromantes* known up to date:—

- H. brunus*, Gorman, 1954 (Mariposa County, California).
- H. genei*, Schlegel, 1838 (Sardinia).
- H. italicus italicus*, Dunn, 1923, syn. *Geotriton*, syn. *Spelerpes fuscus* (Italy).
- H. ambroni*, Lanza, 1954 (Italy).
- H. gormani*, Lanza, 1952 (Italy).
- H. platycephalus*, Camp, 1916, Mount Lyell Salamander (Central California).
- H. shastae*, Gorman and Camp, 1953 (Shasta County, N. California).

As to the mode of reproduction in *Hydromantes*, Gorman (1956) has observed the production of spermatophores in *H. brunus* and the development of deposited eggs in *H. shastae*. The mode of reproduction of the remaining, in particular of the European, species, remains to be studied.

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E. ELKAN, 62 Woodhall Gate, Pinner, Middlesex.

#### DISTRIBUTION OF ADDER

The statement made in my note on the distribution of the Adder in the county of Northamptonshire (*Brit. J. Herpetol.*, 1957, Vol. 2, No. 5, p. 95, referring to the maps appearing in R. H. R. Taylor's paper on the distribution of British reptiles in Vol. 1, No. 1, of this Journal (1948) was incorrect. The complete blacking of the county in the map shown for this species does not indicate that it is distributed throughout the whole area. I wish to express my apologies to Colonel Taylor.

KENNETH BLACKWELL, 19 Queen Street, Upper Weedon, Northants.

#### RELEASE OF LIZARDS

Mr. D. R. Hewitt (47 Birmingham Road, Great Barr, Birmingham, 22A) reports that on the 19th August, 1958, he liberated 16 Common Lizards (*Lacerta vivipara*) on Lundy Island, off North Devon, near the Old Lighthouse. The numbers of each sex were about equal, and the lizards were originally collected in various places in North Devon. Information on the possible survival and breeding of these lizards would be welcomed.

(EDITOR)

## REVIEW

REPTILE LIFE, by Z. VOGEL, translated by Margot Schierl. Spring Books, London.

This attractively illustrated book is superficially rather like *Living Reptiles of the World* by Schmidt and Inger, but the mode of presentation is very different. It deals mainly with lizards and snakes; crocodylians are briefly described and Tuatara figured, but there is hardly anything about tortoises and turtles. The treatment of the different species is not systematic, the various sections having such headings as "Life on wall and ceiling" [Geckos], and "The most rapacious lizards" [monitors]. There is a section on snake-bite, especially as experienced by the author. Many of the observations are of great interest, especially those on central European forms which tend to be neglected in the numerous books on reptiles written by Americans. The author speaks with special authority on keeping reptiles.

Though written primarily from the standpoint of the field naturalist and reptile curator, this book contains some information on the structure and evolution of snakes and lizards. Most of this is accurate, but here and there one finds statements with which few zoologists would agree. As a herpetological anatomist I must comment on the remark in the preface that living animals provide far more complete biological material than those preserved in alcohol. In a sense this is true, of course, but one's approach depends on the kind of information one wants to obtain. The photograph of the extraordinary skull of the agamid *Phrynocephalus* shown in Plate 43 shows that dead lizards as well as live ones may be fascinating material for study.

I think it is a pity that this book contains no list of contents or index (though there is a list of species described) and is not dated. Nevertheless, with its carefully selected and mostly excellent photographs, and informative, if somewhat patchy text, it can be recommended to all who are interested in reptiles.

A. D'A. BELLAIRS.

Dr. MALCOLM SMITH

We much regret to announce the death of Dr. Malcolm Smith, the first President of the British Herpetological Society, on the 22nd July, 1958. The following number of the British Journal of Herpetology will be dedicated to him and will contain an obituary and an appreciation of his work.