THE SUCCESSFUL BREEDING OF LIZARDS FROM TEMPERATE REGIONS

B. A. W. A. LANGERWERF

Beneden Kerkstraat 36a, 5165 CC Waspik
Netherlands

I have kept lizards in garden terraria for many years now and since 1976 I have bred more species each year with increasing success:–

1976 – 142 lizards of 10 species
1977 – 346 lizards of 12 species
1978 – 569+ lizards of 18 species
1979 – 900 lizards of 21 species (see Table 1)

The careful observation of many eggs has led to the adoption of improved husbandry techniques which have contributed to the increase in the number of species bred and to the numbers of young that have hatched.

My garden contains 20 terraria ranging in size from 3 metres^2 to 600 metres^2, some are fully glazed, some partially and others are completely open. Here hundreds of lizards are kept, feeding normally on insects. When eggs are found the number of the terrarium is noted and in this way I can see which terraria produce the highest percentage of eggs that hatch normally and also which species have the highest ratio of successful hatchings.

Three significant factors became apparent:–

1) Almost 100% of eggs from open terraria hatch successfully. Obviously there are some species that require warmer conditions, whereas others e.g. *Lacerta agilis* and *Lacerta viridis* are generally kept in the open air. But if these species are kept in glass-covered terraria there is a much higher embryonic mortality rate, mostly just before hatching. Of eggs found in partially-covered terraria between 20% and 60% hatched, depending on the access to free sunlight whereas eggs from the fully glazed terraria produced very poor results, generally under 20% but this is dependent on the species.

2) Species which lay large numbers of eggs have the worst hatching ratio, e.g. *Lacerta lepida pater* and *Lacerta trilineata* may lay up to 30 eggs but if these species are kept in enclosed terraria all the eggs die, again usually just before hatching.

3) Lizards which receive more sunlight in their natural habitat e.g. *Lacerta laevis* from Israel, give much worse results than lizards with less natural sunlight available such as *Lacerta muralis* and *Lacerta saxicola* from Europe and the Caucasus, although *L. laevis* and *L. muralis* have very similar clutch sizes.

A variation of incubating conditions on either side of the optimum gave no significant results. Eggs of *Lacerta lepida pater* from fully glazed terraria had a 100% mortality rate when incubated in moist sand at both 26°C and 32°C.

Consideration of these points led me to conclude that a vital factor in breeding lizards is the presence of calcium for bone formation in the embryo. If the eggs have a calcium deficiency the embryos will have rachitis before birth and as a result are unable to break out of their eggs in time as their bones are too weak. If the eggs are opened rachitis may or may not be visible in the dead embryo, but even if the egg is opened in time to allow the hatchling to escape it will only survive for a short period, although some lizards hatched by this means can be helped if calcium and vitamin D3 can be administered.

Therefore it becomes essential that gravid females are able to absorb sufficient calcium from their diet. Two factors are important; an adequate level of available

calcium in the food and the inclusion of vitamin D3 in the diet to assist the absorption of the calcium in the absence of adequate direct sunlight. Insects contain very little D3 (Martin et al., 1976) and little Ca (P.Zwart, 1977) which is important when insectivorous lizards are kept in terraria and this problem may be illustrated by the tabulation of the calcium:phosphorus ratio in some examples of reptile food, as recorded by Dr P. Zwart of Utrecht.

	Ca:P
Salad	1:1.3
Apple	1:1
Tomato	1:2
Earthworm	1:1.4
Mealworm	1:3-14
Locust	1:7.5
Cricket (*Gryllus*)	1:3
Fly larvae	1:3-10
Meat	1:20-200

From this it can be seen that of the foods most often provided for lizards, Earthworms and Crickets have the highest calcium level and meat the lowest. A mealworm is only 0.2%Ca and 0.6%P.

Insectivorous lizards maintained in indoor terraria almost always lack both direct sunlight and an adequate diet. Insects consumed in the wild will contain other materials in the gut as a result of their own feeding whereas insects maintained in captivity for a time before being fed to lizards may well have little – if any – gut contents. Assuming that the optimal Ca:P ratio of 1.2:1 for mammals may be similar for other vertebrates, it can be seen that insects contain sufficient phosphorus so that only calcium need be added to the diet. It is difficult to increase the Ca content of insects by giving them a Ca rich diet and after experimenting with several methods I now use the following system to ensure that my lizards obtain sufficient calcium:–

1) 1 teaspoonful of calcium lactate and approximately 10,000 i.u. of soluble Vitamin D3 are added to each litre of drinking water. The water must be changed every 3-4 days as the D3 oxidises rather quickly.

2) In summer, when the female lizards are gravid, 2 spoonfuls of calcium lactate and about 20 drops of Vitamin D3 (20,000 i.u. per ml) are spread over approximately 1 dm^3 of crickets before they are fed to the lizards.

In addition the gravid females of the larger species, e.g. *Lacerta lepida pater*, receive new-born rats; this produces better results than a diet only of insects.

Using this method of diet-enrichment over 95% of eggs laid have hatched satisfactorily. Moreover there have been no indications of damage due to the ingestion of too much Calcium or D3, rather there are indications that the amount should be increased because there are still some embryos dying just before they should emerge from the egg.

THE CONDITIONS REQUIRED TO STIMULATE REPRODUCTION

In the natural habitat these conditions are generated by the climate, either directly (sunlight and temperature) or indirectly (food availability). The lizards in my terraria are all from areas in which they undergo a period of natural hibernation, including the Caucasus, Central Asia, Israel, Morocco, Spain, Turkey and the USA. For all the species I endeavour to create the optimum microclimates, based on my native Dutch climate with as little modification as possible. This is done by using different methods of construction for the terraria, three of which are listed below:–

TABLE 1. BREEDING RESULTS : 1979

	Hatched	Generation
Lacerta schreiberi	11	F 2
strigata	131	F 1 & F 2
t. trilineata	18	F 1
lepida pater	215	F 1 – F 3 (F4)
a. agilis	171	F 1 – F 5
viridis	79	F 1 – F 4 (F5)
erhardti	4	F 1
monticola cyreni	36	F 1
caucasia	2	F 1
armeniaca	2	F 1 (F2)
saxicola *rudis* *raddei* *armeniaca*	130	F 1 – F 4
danfordi anatolica	51	F 1 & F 2
praticola pontica	5	F 2
laevis	6	F 2 & F 3
Agama stellio	14	F 2
caucasia	21	F 1
Algyroides nigropunctatus	1	F 1
Gerrhonotus multicarinatus	3	F 1

1) A large open terrarium, 30 x 20 m, surrounded by a simple wall and containing hilly ground. In these conditions *Lacerta viridis* flourishes.
2) Glasshouses of $30m^2$ and $50m^2$ which are built on a North-South axis and are unheated in winter. These contain, among others, *Lacerta lepida pater* and *Gerrhonotus multicarinatus* which hibernate for approximately 4 months.
3) The hottest and driest microclimate is created by building an East-West wall with a sandhill behind and glass (double in places) in front, angled at about 45^{o} and facing due South so that in summer it can be removed to allow direct sunlight into the terrarium. It is possible to improve this unit still further by the installation of water-filled solar panels above so that extra heat is provided during periods of spring and autumn sunshine.

The lizards kept under these conditions always commence copulation in the spring. It appears probable that hibernation alone is not the main stimulus for mating, rather that the decrease/increase in photoperiod during autumn and spring is the main factor. Lizards born in August and kept warm throughout the winter will reproduce in the next spring or summer.

INCUBATION OF THE EGGS

Before incubation the eggs must be located, often a very difficult task in large terraria. Observation revealed that most eggs were laid in sandy places where sunlight warmed up the sand and where it stayed slightly moist during the summer. The next

step was the creation of a small area to reproduce these conditions, with approximately $1m^2$ of sand in a sunny place, covered by flat stones, in terraria ranging in size from $10 - 50m^2$. At the same time the rest of the terrarium was made unsuitable for oviposition: very dry sand, very hard clay with stones, dense vegetation, etc. depending on the type of terrarium and its inhabitants.

The eggs are removed from the garden terraria for incubation which takes place in small all-glass terraria 50 x 30 x 20 cm. The base is covered by a layer of slightly moistened sand about 8 cm deep and up to 100 eggs may be incubated in each container at one time. In the centre of the sand small porous earthenware pots are placed and the eggs are covered with approximately 3 cm of moist sand: this sand must not be pressed down otherwise it may prevent air reaching the eggs.

The top is left open to permit the free circulation of air. When necessary a little water can be placed in the pots to keep the sand over the eggs porous. Lizard eggs grow considerably during incubation and when they are placed in the incubation chamber they should be separated by a space about their own length. When watching females laying their eggs I have noticed that they allow some space for growth.

The incubation units are kept in my cricket-breeding rooms which have a constant air temperature of 28-30°. For smaller quantities of eggs (less than 100) a broken refrigerator may be adapted as an incubator by using a small electric heater and thermostat, an aquarium air-pump will circulate the air.

However, the main problem in the successful breeding of lizards is not in the incubation but in climatic regulation and proper nutrition of the adults to ensure that viable eggs are produced. Those laid by females lacking in Calcium and Vitamin D3 have a very high mortality rate whereas those laid by healthy females can be incubated in sand at temperatures between 25-30°C and sometimes as low as 20°. Moreover the moisture level can vary somewhat and the eggs can be turned in any direction, yet will still produce healthy hatchlings.

Clean natural sand is used for incubation, taken from some decimeters below the surface where it is sufficiently moist. The sand is not sterilized before use but is used once only to avoid any risk of contamination.

REARING THE YOUNG

The importance of Calcium and D3 to the babies must be stressed – if they lack these two essentials or if they do not receive direct sunlight they will die of rachitis within 2-3 months or even less, depending on the condition of the female prior to egg-laying. Before death bone deformations can be seen or symptoms of cramp may be observed: I have seen numbers of young Varanids and Crocodilians killed by rachitis as a result of continual feeding with a diet – often raw meat – hopelessly deficient in Calcium and D3. These deaths are unnecessary and could easily be prevented with better food.

As the majority of my lizards hatch out in August, September and October they are not hibernated during their first winter but are grown on in a variety of terraria sited in a heated glasshouse, 8m x 3m. The North-facing side and roof are covered with a 5 cm layer of insulation, the other sides consist of double-glazed windows which are easily removable. Heating is by a small oil stove but this must be turned off to prevent overheating whenever the house is warmed by the late autumn or winter sun. The young lizards love to bask in the sunlight, even though it is filtered through glass.

The young are reared in very densely populated terraria, there may be as many as 70 living on a surface area 70 x 40 cm. I have had most success with larger terraria, 0.5m

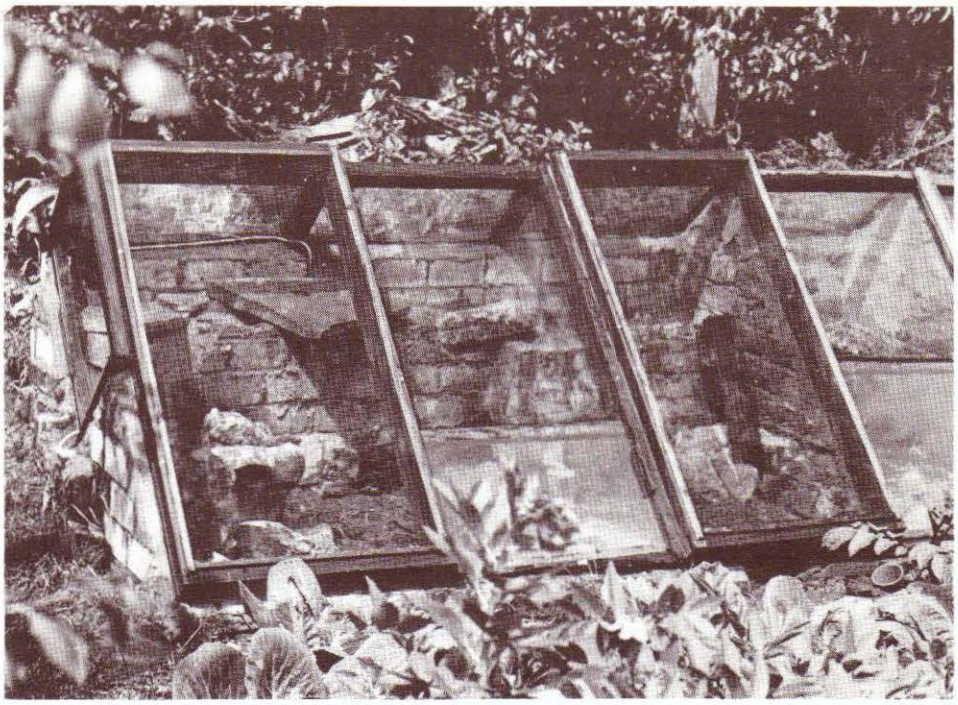

Plate 1. A small garden terrarium with glass directed to the south.

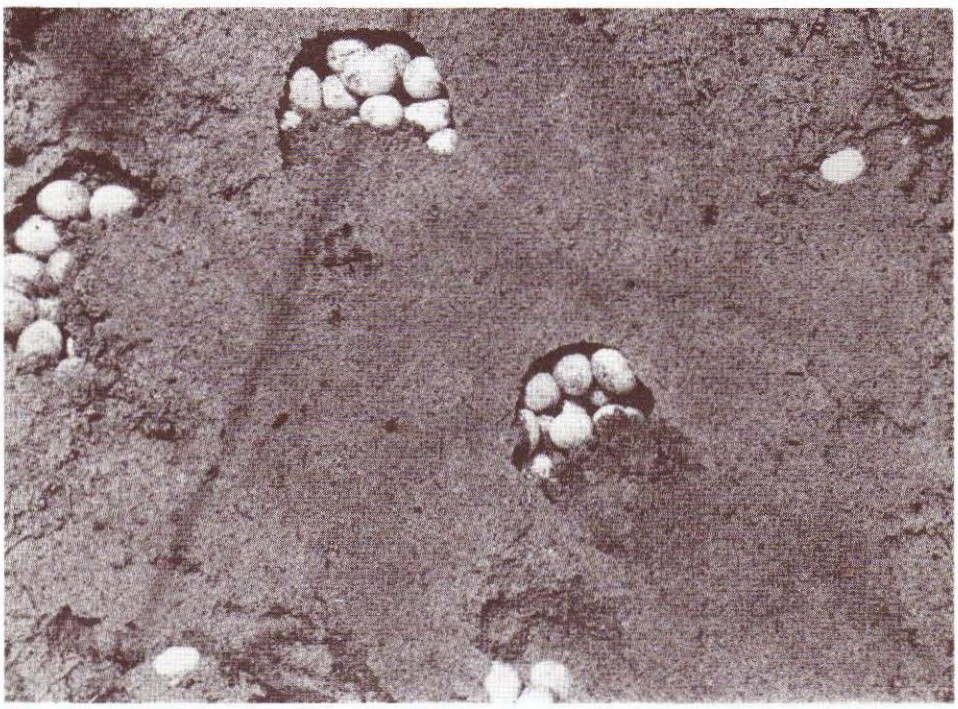

Plate 2. Eggs of *Lacerta agilis*, with up to 19 eggs per clutch found in a favourable place in the terrarium.

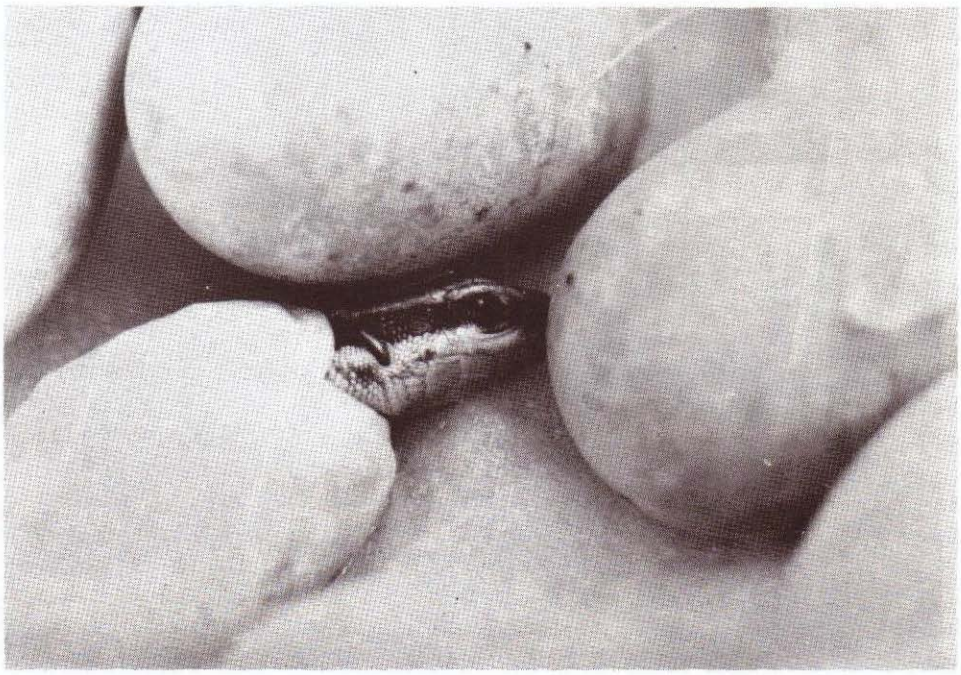

Plate 3. *Lacerta laevis*, hatching

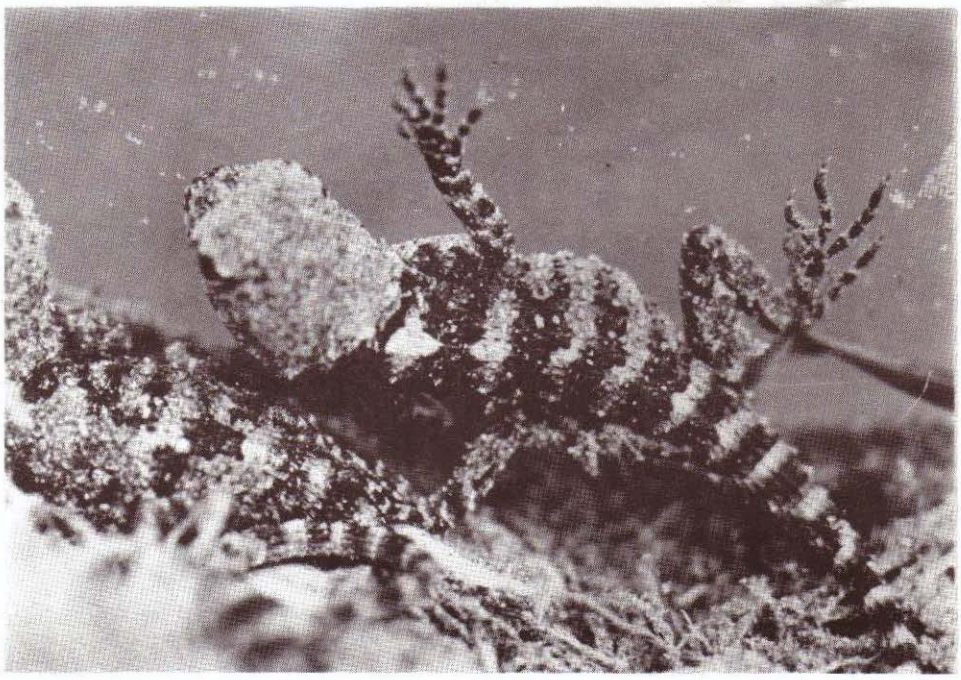

Plate 4. *Agamo stellio*, just hatched.

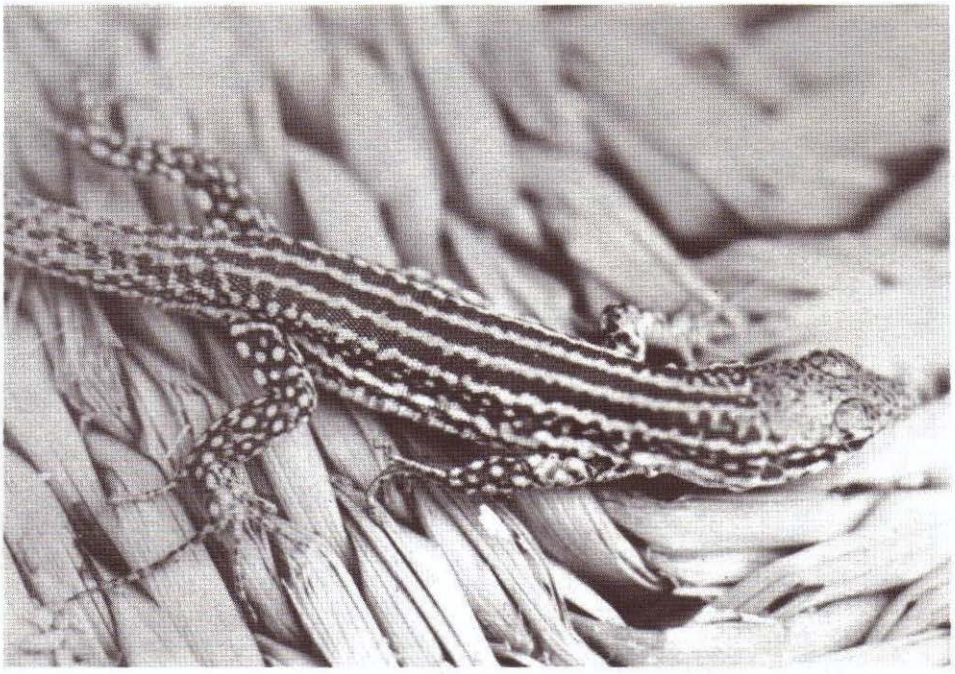

Plate 5. *Lacerta pityusensis formenterae*, just hatched.

Plate 6. *Lacerta saxicola brauneri*, just hatched.

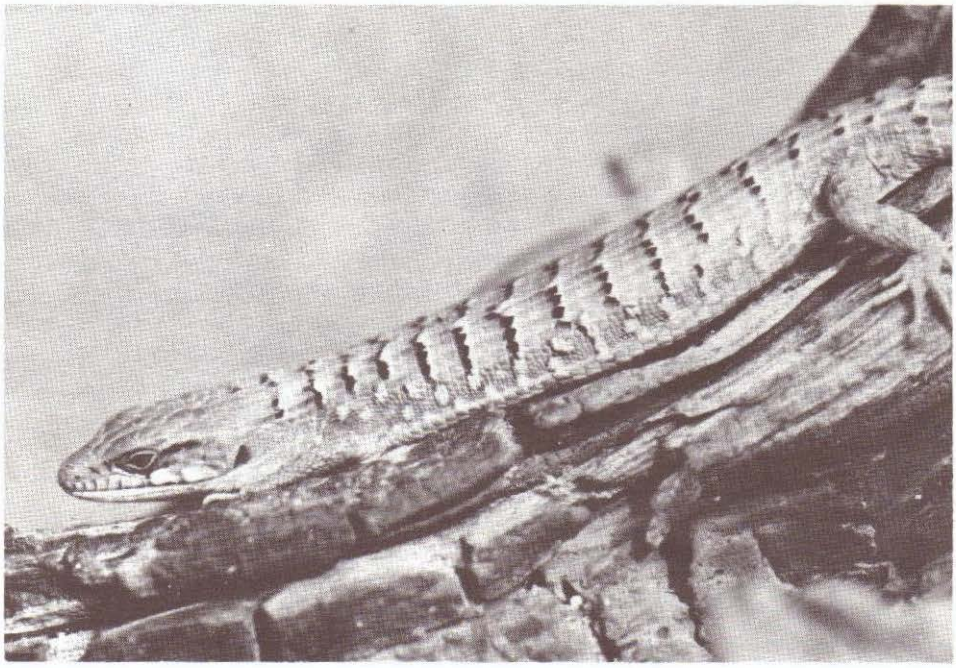

Plate 7. *Gerrhonotus multicarinatus,* six months old.

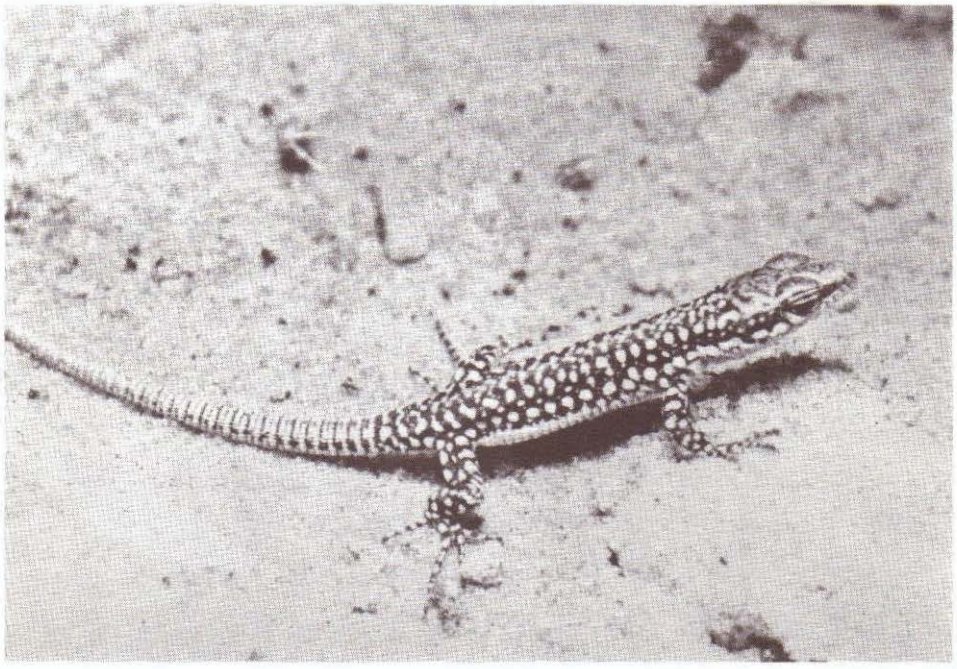

Plate 8. *Lacerta danfordi anatolica,* just hatched.

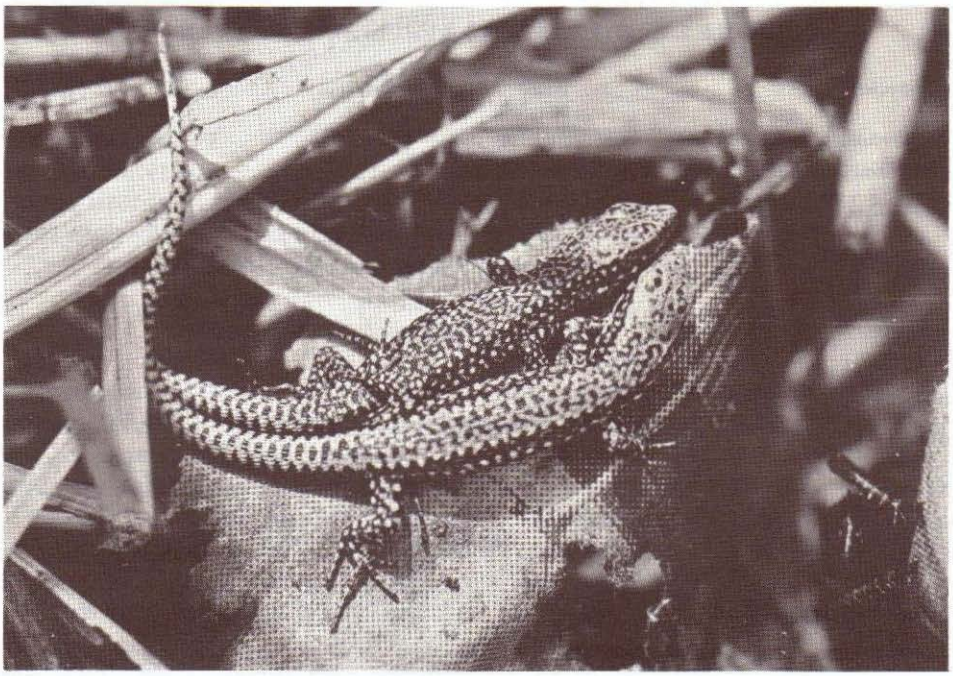

Plate 9. Two newly hatched *Lacerta monticola.*

wide and 2-3m long. These can contain a variety of habitats: moist sand with grasses and weeds from the garden (replaced every 14 days); a pile of leaves; layers of paper, cardboard and other insulating material in which the lizards find hiding places; a sandy plain; a heap of rotting fruit to furnish food for the ever-present flies and crickets and layers of board separated by slivers of wood to provide additional refuges. Water is provided by spraying the whole terrarium once or twice a day, this way the young lizards receive a continual fresh supply of the Calcium and D3 dissolved in the water.

Temperature ranges from 25-30°C during the day down to 15-25°C at night. On dull days 100W flood lamps are automatically switched on, controlled by a thermostat and a time-switch. Small aluminium plates can be placed in the terraria beneath the lights to absorb and spread the warmth. It is important that the night temperature does not drop too low because some species, e.g. *Lacerta agilis* and *Lacerta strigata*, cease feeding and prepare for hibernation if the minimum temperature reaches 5-10°C, even though the succeeding day temperature may exceed 25°C.

For the first 2-3 weeks after hatching the lizards spend most of their time in concealment and grow very little. From 1-4 months, under optimal conditions, they grow extremely quickly and consume large quantities of insects. Their main source of food is the cricket (*Gryllus bimaculatus*) and some examples of growth rate are shown in Table 2.

Of the lizards that hatch out in my terraria each Autumn over 95% are alive in the Spring and the majority of these are adults and will commence breeding. At this stage some are transferred to the large terraria where they will spend the rest of their lives since it is impossible for me to retain them all.

TABLE 2. GROWTH RATES OF NEWLY–HATCHED LIZARDS

Species	Date Hatched	Length (cm)	Date	Length (cm)
Gerrhonotus multicarinatus	21.8.77	9.5	5.12.77	22
Lacerta lepida pater	Oct. 1975 (Females laid eggs in August 1976)	12	June 1976	32
	Aug. 1978	12	3.11.78	25
Lacerta agilis) *Lacerta praticola*)	Aug. 1977 – became adult in December 1977.			
Lacerta laevis	July 1977 (Female laid 5 eggs on 3rd December 1977)	7	Nov. 1977	18

TABLE 3. INCUBATION PERIODS

Species	Temperature (°C)	Period (days)
Agama sanguinolenta	27-28° (last 14 days 30-31°)	50-52
Agama stellio	29°	50-52
	30°	47
Gerrhonotus multicarinatus	29°	40-43
Lacerta agilis	31°	35-36
Lacerta danfordi anatolica	30°	43
Lacerta lepida pater	29°	88-89
Lacerta saxicola brauneri	c. 7 days at 20° + 31 days at 30°	
Lacerta schreiberi	28-29°	42-47
Lacerta strigata	29-30°	44

PRODUCTS MENTIONED IN THE TEXT

Ursovit D3: wassrig 20 or wassrig 1000, VEB Jenapharm, Serumwerk, Bernburg, DDR.

ACKNOWLEDGEMENT

I would like to thank Dr P. Zwart (University of Utrecht) for his contribution to my work and therefore to this article.

REFERENCES

Classen, H. (1976). De mechanismen bij de ontwikkeling en het uitkomen van Reptiele – eieren en de praktishe toepassing ervan. *Lacerta* 35, 2, 23-28.

Grenot, C. & R. Vernet (1973). Les lezards heliophiles du Sahara: Facteurs ecologiques et conditions d'elevage. *Bulletin Soc. Nat. de l'Afrique du Nord* 64, 53-78.

Langerwerf, B. (1976). Het kweken van hagedissen I. *Lacerta* 34, 5, 59-61.

Langerwerf, B. (1977). Contribution a la reproduction des *Lacerta* species et autres lezards des zones temperees septentrionales et des subtropiques. *Cobra*, pp 77-80.

Langerwerf, B. (1977) De Marokkaanse Parelhagedis *Lacerta lepida pater* in het terrarium. *Lacerta* 35, 2, 63-65.

Langerwerf, B. (1978) Het kweken van hagedissen II. *Lacerta* 36, 6, 101-103.

Laszlo, J. (1975) *The effect of Light and Temperature on Reptilian Mating and Reproduction: Recent Developments.* Published by the Knoxville Zoo.

Zwart, P. (1977) Ca-P Versorgung bei Reptilien und durch Defizienzen verursachte Krankheiten. Lecture given in Vienna, 1977.

Zwart, P. (1980) Nutrition and Nutritional disturbances in Reptiles. Paper presented at the International Herpetological Symposium, Oxford, 1980.