HUSBANDRY AND CAPTIVE BREEDING OF THE SAND LIZARD (L. AGILIS) AS AN ADJUNCT TO HABITAT MANAGEMENT IN THE CONSERVATION OF THE SPECIES IN BRITAIN

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INTRODUCTION

Jon Webster's article in the previous issue of the Bulletin provided me with a timely introduction to the conservation of *L. agilis* in Britain.

In this article I wish to pass on my experiences with captive breeding of this species and the possible implications of my results for the future survival of the species in Britain.

My interest in the conservation of the rare British reptiles was sparked off when, in July 1982, my wife and I found three Smooth Snakes *(C. austriaca)* on South Canford Heath — a typical mature, dry heathland habitat. On visiting the site a couple of weeks later the first marker pegs for the planned Canford Heath relief road had appeared right in the middle of the site. It immediately occurred to us that if we didn't remove the snakes to a safer environment non-one else would.

So began our ever-increasing involvement with conservation of the British herptiles and with the BHS Conservation Committee.

Having discovered Sand Lizards on two other "doomed" sites on Canford Heath, one due for development as a school (now under construction) and the other as housing (with the associated additional threats to surrounding habitat outlined by Jon) we became heavily involved not only with collecting from these sites (under licence from N.C.C.) but also with the heathland management tasks carried out by the BHS Conservation Committee.

Having a dwindling supply of lizards as we gradually collected-out sites (lizards released at sites agreed between NCC and BHS CC) I felt that it would be useful to preserve part of the colonies by keeping a captive stock, with a view to breeding and releasing offspring on suitable sites, as has been performed by other BHS CC members.

I therefore set about constructing a reptiliary which I located in a south-facing spot against the side of my house, and an NCC licence followed in due course.

ACCOMMODATION OF ADULTS

The reptiliary design consisted of a glass barrier projecting about eight inches above the soil and about ten inches below. Rubble was buried along the lower edge of the glass to discourage lizards from burrowing underneath. Inside, the terrain was laid out as a sloping heather bank based on a pile of rubble (to give good drainage) extending eighteen inches underground, covered with a six inch layer of sand and topped with heather turf — obtained from a doomed site with the permission of Dorset County Council.

Care was taken to leave a six inch gap between the slope and the glass so that lizards could not jump over the glass. This worked very well and no lizards escaped — the only escape attempt comprising a two inch deep abortive scrape up against the glass.

The reptiliary, which measured six feet by four feet, was protected from our local domestic cats by a wooden framework covered with fine wire mesh. A hinging door in the top allowed access and the whole could be lifted off by two people, allowing photography at close quarters, and also weeding and pruning of heather to be carried out. The wooden framework stood on a layer of bricks to prevent rotting and to stop anything tunnelling into the reptiliary.

BREEDING

Lizards were caught from the end of May onwards and were therefore already gravid. It was while being held in the tank that I was presented with several clutches of eggs (see Appendix I for clutch sizes, laying and hatching dates).

These were laid under the piece of heather turf, against the bottom of the tank within six inches of each other — females obviously sensing instinctively that this was the optimal location. Prior to egg deposition females were bulging but after egg-laying were thin and wrinkled. Identification of the parent of each clutch was therefore a simple matter of spotting which female had become suddenly thinner on that particular day.

Eggs were examined carefully by digging away the sand surrounding them. When first laid eggs were a variety of shapes — one was virtually triangular — and the pinkish embryo could clearly be seen at one end. Within a couple of days, however, all eggs had filled-out to a more uniform cylindrical shape about 1.5cm long and 1.0cm across and the embryo was no longer visible (the egg wall having become more opaque). I raised all eggs about an inch away from the bottom of the tank and separated each from its neighbour to allow better gas transfer across the egg wall and prevent any anoxic spots. The sand was kept moist by occasional spraying, the frequency about once a week depending on the weather. The reptiliary was rapidly completed and the adult lizards installed in this to prevent damage to eggs by burrowing.

CARE OF EGGS

Eggs were left in situ, as described, until 42 days after laying when two eggs were brought inside and incubated in my cricket tank. These were buried up to their mid-line in moist sand (taking care to keep the original top surface upwards) in a plastic container with small perforations in the lid to allow entry of gases and to prevent the build-up of waste gases which might have suffocated the eggs.

This was incubated at a temperature of 25°C (±4°C) in the cricket tank, heated by a light bulb operated by a fish tank thermostat, laid flat on the bottom of the tank. The perforated lid prevented crickets gaining access to the eggs. The sand had to be carefully remoistened by spraying with warm tap water fortnightly — more often if required.

Eggs were inspected daily. Only two eggs (in situ in the outdoor tank) were affected by mould and these were treated by careful swabbing with cotton wool soaked in a weak household bleach solution (Christopher Mattison).

Once the first egg in the incubator had hatched (and I could therefore be sure that this method was successful) I brought the rest of the eggs inside and incubated them by the same method. This year I will incubate all eggs inside from the start which should, I hope, result in a shorter incubation period (the egg incubated inside hatched seven days before the rest of its clutch).

HATCHING

Several days before hatching beads of moisture appeared on the upper surface of each egg. "Sweating" is presumably a method by which the egg loses excess moisture. The moisture content of surrounding sand at birth is therefore likely to be critical for the successful hatching of the eggs — if too wet the egg will be unable to lose water properly (with unknown consequences), if too dry the egg wall may be too tough for the lizard inside to break out. The fact that three of the eggs (see Appendix I) contained fully-formed but dead lizards may be attributable to the sand being a touch on the dry side, or alternatively may have been due to the fact that no vitamin D3 or mineral supplements were given to female lizards in the three weeks between capture and laying of eggs. The latter would seem more likely (see Langerwerf) although I will ensure that the sand is on the moist side this year.

Beads of "sweat" were removed from the eggs using tissue paper as they would be lost to the surrounding sand if the egg was completely buried in its natural state. Immediately before hatching no more moisture was observed on the upper surface of the eggs, which became more spongy and started to collapse around the lizard within. Shortly afterwards a slit appeared at one end of the egg and the hatchling then emerged. The time from appearance of the slit to emergence of the lizard ranged from two to twenty four hours.

Only a small amount of yolk remained attached at the centre of the lizards belly showing that they had not hatched prematurely.

Of the thirty two eggs laid one was infertile, one was ruptured by a burrowing adult (embryo developing inside), three fully developed lizards were dead in their eggs, twenty-five eggs produced normal hatchlings and, strangely, two eggs produced twins (i.e. two hatchlings from a single egg). I have not heard of this being recorded before — both sets of twins (Mk I & Mk II) came from batch 2 and were approximately two thirds of the size of a normal hatchling from the same batch. Nothing unusual was noticed about any of the eggs in this batch, and twins emerged from apparently normal sized eggs. One of the Mk I twins later choked to death on a dried mealworm left by one of its larger siblings, but its twin was raised to adulthood and was ♀ . The Mk II twins also turned out to be ♀ and I have retained them to see if they breed twins. Although this is of obvious interest I doubt whether breeding twins in the wild would be of any benefit to the survival of the species, as, although twice as many young could be produced, because of their relatively smaller size (compared to "single" hatchlings) they would take longer to grow large enough to be safe from predators that prey on young (but not adult) sand lizards, and their chances of survival would be consequently smaller.

The Mk II twins were of similar dorsal patternation but not identical.

Some hatchlings had kinks in their tails (including both Mk 1 twins) which may also have been due to calcium deficiency during development.

The period for all eggs in the same batch to hatch ranged from two to four days.

CARE OF HATCHLINGS

Hatchlings were housed in 12" x 10" x 10" aquaria with an inch of aquarium gravel on the floor. Heat was provided by a 25W tungsten light bulb suspended some four inches above the gravel surface. A sprig of dead gorse below this not only enabled the hatchlings to get nearer the heat source if required but also assisted in sloughing. Shade was provided at the end of the tank furthest from the heat source by several pieces of cork bark under which hatchlings could seek shelter. This is a safer means of providing shelter than pieces of slate or stone under which hatchlings could accidently be crushed.

Later when hatchlings had grown considerably they were transferred to a 36" x 12" x 12" tank with a 60W tungsten bulb giving a gravel surface temperature of 20°C. immediately below the bulb, and, on top of the gorse of 32°C. (which was also used as an occasional basking spot). In a 36" tank the far end of the tank provided a safe area for cooling off.

Hatchlings began to feed 2-4 days after emergence from the egg and were started on greenfly which were particularly plentiful on Nicotiniana plants with which I have planted our garden this year. Once feeding, my wife and I collected spiders from the gorse bushes on the heath which became a real chore as the hatchlings grew. I have boosted my breeding stock of crickets and mealworms so that I will be self sufficient in small insects to feed hatchlings on this year — important, as the site we collected spiders from has now been bulldozed in preparation for a new school!

Having read Bert Langerwerf's paper stressing the importance of calcium and vitamin D3 to the metabolism of lacertids I set about finding a vitamin/mineral supplement. Plenty of liquid preparations contained D3 but I could not find a soluble calcium source to complement this. Eventually I settled on a powder supplement manufactured for pigeons. It seemed not unreasonable that reptile and avian metabolism of calcium/D3 would be similar. So all prey items were dusted with Harker's Pigeon Minerals (see Appendix III for constituents) and all my hatchlings were raised on pink spiders and crickets! One kilogram of this powder cost £1.23 and I used about 200g to raise 27 sand lizards hatchlings to adulthood, making it considerably cheaper than many of the preparations intended primarily for reptiles. No signs of calcium/D3 deficiency (or overdose) were observed despite the fact that hatchlings received no direct sunlight or artificial UV, and I put this down to prophylactic use of Harker's from their first feed onwards (no deficiency ever being allowed to build up). Vitamin supplementation was completed by addition of Abidec drops to drinking water (one drop to 80ml. of tap water) which was available at all times in a shallow jar lid (to avoid any chance of hatchlings drowning). Water was changed every second or third day as it dried up or was contaminated by lizards trampling through it. Having had success with this combination with hatchlings, I now use the same supplementation for my adults which I hope will result in greater propertions of eggs hatching successfully.

Newly sloughed mealworms (of suitable size) were fed to hatchlings in addition to spiders and crickets. Being soft these do not present the problems with digestion that "hard" mealworms do, although they did make the faeces rather fluid.

As the lizards grew the larger individuals were grouped together in separate tanks to enable their smaller siblings to get enough food and to stop them being worried or losing their tails (which happened to one of the Mk II twins).

First signs of sexual differentiation were noted in batch 1 lizards when several lizards started to develop a deep lemon colouration on the throat, flanks and belly at 40-43 days old. This lemon colour gradually turned to the green colouration of the adult ♂ at 50-58 days old in two individuals, where snout — vent measurements at that time were 5.00cm and 5.2cm respectively. Batch 3 and 4 males coloured up when 149-151 days old (snout — vent 5.4cm and 5.5cm); and 112-113 days old (snout — vent 5.5cm) respectively, which corresponds more closely with Malcolm Smith's statement that "The youngest breeding male that I have seen measured 55mm. in length from snout to vent."

I had expected colouration to develop at approximately this size and indeed it did. The difference in the time taken for lizards to reach this size will, I hope, be explained by my next comments.

While the reptiliary was under construction lizards were housed temporarily in a metal framed fish tank in the garden, containing a four inch layer of sand and a piece of heather turf. This had a secure wire-mesh lid and was protected from water, during storms, by a piece of slate raised above the top on two bricks. This prevented water getting into the tank while allowing sufficient air circulation to prevent lizards from cooking during hot, sunny spells.

FEEDING

Lizards were fed on mealworms, crickets, spiders and blow-flies. No vitamin or mineral supplements were given, although since the successful rearing of hatchlings I now dust all food with vitamin supplements. Drinking water was available at all times in an inch deep coffe-jar lid.

As autumn turned into winter the temperature in the "reptile room" fell to about 13°C. at night and after several weeks I noticed that many of the lizards had lost their appetites and had become noticeably skinny. Bert Langerwerf states that "..... *Lacerta agilis* and *Lacerta strigata* cease feeding and prepare for hibernation if the minimum temperature reaches 5-10°C .....". So I was quite surprised that mine had ceased feeding at this higher temperature. I overcame this problem by increasing the tank temperatures to a minimum of 15-18°C. at night. All lizards were soon feeding well again and filled out over several days.

Photoperiod at this time was 10-12 hours.

This cessation of feeding may explain the difference in time taken for males in different batches to develop adult colouration — batches 3 and 4 being at an earlier stage of development at this time, and therefore, perhaps, being slowed down at their most rapid time of development.

Batches 1 and 3 both included one individual which grew at a faster rate than other hatchlings in their brood. Both of these individuals were females (see Appendix II). One individual (also a ♀) in batch 4 turned out to be a runt, but all other lizards were more or less the same in their rate of growth.

HIBERNATION

Having returned the lizards to their former sleekness I decided to prepare them for a simulated hibernating — hopefully to induce reproduction in the spring. Those individuals (♂ and ♀) which seemed fullest in the body were selected and transferred to an 18" x 12" x 12" tank, the heat source in which was dropped from 40W to a 25W tungsten bulb to produce a lower temperature. A small box containing hay and a slit entrance was provided as a retreat. In this hibernation preparation tank lizards were starved for 7-13 days to allow the gut contents to be voided, thereby removing the risk of death during hibernation due to fermentation of recently ingested food. Water was provided to ensure that lizards were fully hydrated at the start of their hibernation.

At the end of the starvation period most lizards had retired to the box of hay, not emerging during the day. They were then transferred to a large polystyrene box packed with polystyrene chips which was placed in a cool outside cupboard. Unfortunately the cupboard became too cold during the winter (—7°C.) so the box was transferred during cold periods to our hallway, resulting in a higher hibernation temperature than I had desired (0-14°C., average daily temperature 8.6°C.). Clearly this is not satisfactory and this year the hibernation box will be placed in a refrigerator at a constant 4°C. By keeping lizards at a low, constant temperature energy consumption should be minimal and they should emerge from hibernation in better condition as a result. Clearly the hibernation temperature must not drop below freezing point.

Hibernation period varied from 31-79 days (smaller lizards being brought on for longer before being hibernated, resulting in a shorter hibernation period). On being brought out of hibernation lizards were placed into the "hibernation preparation tank" to re-adjust. Water was provided and all lizards drank heavily. Several females were noticeably dehydrated particularly at the base of the tail which was virtually skin and bone. Mike Preston (pers. comm.) has also experienced this and has also lost lizards during hibernation of a longer period.

This year, therefore, I will add a layer of damp foam rubber at the bottom of the hibernation box to minimise dehydration.

Within a couple of days of emergence from hibernation all lizards had made good their water loss.

Only one lizard did not survive hibernation — a female which laid six eggs in the hibernation box and died as a consequence.

SEXUAL ACTIVITY

Lizards exhibited sexual activity some three weeks after coming out of hibernation, which was induced purely by chance. I was photographing and measuring individuals, and placed lizards in a single large tank for holding before release into the wild. About 45 minutes later I observed several males courting females; one pair copulated successfully.

Mating activity, and some violent aggression between males (described fully by Malcolm Smith) was also induced by turning on the "reptile room" light about two hours after dark — perhaps simulating daybreak.

It may therefore be possible to induce reproduction by keeping ♂ and ♀ lizards separately and placing single pairs in a new tank together, perhaps an hour before dark. If they receive direct sunlight the next morning one could reasonably expect courting to take place then, as is the standard procedure for spawning egg-laying fish. While this is an interesting theory, I did not follow it up as my aim was to raise lizards to sexual maturity for release into the wild, while disturbing their natural cycle as little as possible. From what I have seen of those that I have retained in my reptiliary as future breeding stock, they have integrated well and their behaviour is identical to that of the adult lizards which overwintered naturally. Speeding up their development rate does not, therefore, appear to have adversely affected them.

Although it may be possible to induce reproduction in captive-bred lizards, which are said to be less dependent on seasonal cycles, without hibernation, four males (two hibernated for 31 days, and two for 42 days) showed no signs of sexual activity which would suggest that a longer, more severe hibernation than these four received is necessary.

LIZARD INTRODUCTIONS/REINTRODUCTIONS

Corbett and Tamarind have commented on the success of sand lizard introductions on suitable sites. It seems likely that a single introduction of a sufficient number of lizards would result in the establishment of a colony provided that the site is chosen to meet, as closely as possible, the criteria set out by the above authors.

By introducing lizards which have been raised to sexual maturity and which can be expected to breed in the same year as introduction, successful colonisation of that site is even more likely, particularly given that survival of wild hatchlings beyond the second hibernation period (i.e. to sexual maturity) is only 5% (N.C.C.).

Twenty-two lizards (10 ♂, 10 ♀ and two wild-caught juveniles) were released on a site at Arne, Dorset (agreed between BHS CC and NCC) in mid-April. Future monitoring will assess the success of the introduction.

CONCLUSIONS

English sand lizards, bred from wild-caught adults from doomed sites, can be raised to sexual maturity in under seven months (including the period of simulated hibernation) provided the precautions I have outlined are taken. I hope to generate further data this year and particularly to standardize environmental conditions to make growth data comparable.

The purpose of my article is to stimulate interest in the conservation of *L. agilis* in Britain, particularly on the heathland sites that I know so well.

As my title implies, I see the role of captive breeding as secondary to the vital task of habitat conservation and management, in order to preserve, improve or reclaim sites for sand lizard habitation. This is the area where work is most urgently needed and must be given top priority if the rare reptiles are to maintain their slender foothold in Britain.

ACKNOWLEDGEMENTS

I am deeply indebted to my long-suffering wife Anne for her invaluable help in collecting food for the hatchlings, and to those members of the BHS Conservation Committee (particularly Dave Dolton and Mike Preston) for their advice and guidance. I would also like to thank Geoff Haslewood for sorting out the licensing details and the technicialities of the release.

Many thanks also to Brenda Burton for typing the manuscript.

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APPENDIX I: BATCH DETAILS

BATCH NUMBER	MEASUREMENT OF PARENT (cm)		DATE OF LAYING	NUMBER OF EGGS	INCUBATION PERIOD (DAYS)			NUMBER OF HATCHLINGS	NUMBER OF HATCHLINGS REACHING SEXUAL MATURITY	
	S–V*	TAIL			IN SITU	IN INCUBATOR	TOTAL		MALE	FEMALE
1	8.5	7.1**	16/6/84	12	42**	14	56	10	8	2
					56	7–10	63–66			
2	7.9	9.0	22/6/84	8	50	12–13	62–63	8	–	7
3	7.7	11.4	1/7/84	6	41	18–20	59–61	6	2	3
4	Not known	Not known	Not known	6	Not known	Not Known	Not known	5	2	3

* Snout-Vent Length
** Short tail due to loss and regrowth before capture
*** Two eggs given initial trial incubation.

APPENDIX II
GROWTH DATA

BATCH 1 DAYS FROM HATCHING	MEASUREMENTS (cm.) 6 – 9 (+7)*		101 – 104 (+7)		235 – 238 (+7)**		COMMENTS
	S–V	Tail	S–V	Tail	S–V	Tail	
	3.1	4.3	5.6	9.1	6.4	10.1	
	3.0	3.8	5.9	9.1	6.4	9.5	
	3.1	4.3	6.4	9.4	6.5	9.9	
	3.0	4.2	6.7	9.8	6.6	10.2	
	3.0	4.1	6.0	10.5	6.3	10.3	
	3.1	4.6	6.2	9.8	5.9	9.6	
	3.1	4.8	6.1	10.3	5.6	8.6	
	3.3	4.4	5.2	7.9	6.35	11.1	
	3.2	4.5	6.2	9.7	7.0	9.6	
	3.2	4.1	7.1	10.1	7 2	10.2	

BATCH 2 DAYS FROM HATCHING	MEASUREMENTS (cm.) 0–1		95 – 96		232 – 233		COMMENTS
	S–V	Tail	S–V	Tail	S–V	Tail	
	3.0	4.0	6.2	8.6	6.7	9.0	
	3.0	3.8	4.8	7.0	7.0	10.2	
	2.2	2.8	6.0	8.6	6.6	8.5)	Mk 1
	2.4	2.8	–	–	–	–)	Twins
	2.8	4.0	5.4	8.6	6.6	10.3	
	2.8	3.7	5.7	9.1	6.5	9.6	
	2.4	2.8	4.6	6.5	7.2	9.3)	Mk II
	2.3	2.3	5.3	4.7	7.1	5.9)***	Twins

* (+7) days refers to the single lizard that hatched 7 days before the rest

** Third measurement includes two non-growth periods – starvation period of 7–13 days and hibernation period of 31–79 days.

*** Shorter tail due to loss, at an early stage, and regrowth.

APPENDIX II (cont.)
GROWTH DATA

BATCH 3	MEASUREMENTS (cm.)						COMMENTS
DAYS FROM HATCHING	5 – 7		88 – 90		225 – 227		
	S–V	Tail	S–V	Tail	S–V	Tail	
	2.7	4.1	4.4	7.7	6.6	10.3	
	2.9	4.1	5.0	6.5	–	–	Kinked tail
	3.0	4.2	4.8	8.7	6.2	10 4	
	3.0	4.0	6.9	10.5	7.0	10.5	Toe missing
	2.9	3.9	4.4	7.3	6.1	10.1	
	2.9	3.8	–	–	6.4	9.6	

BATCH 4	MEASUREMENTS (cm.)						COMMENTS
DAYS FROM HATCHING	1		65		203		
	S–V	Tail	S–V	Tail	S–V	Tail	
	2.8	3.4	4.2	6.7	7.1	10.0	
	2.7	3.8	4.7	8.4	6.9	9.9	
	2.8	3.5	4.0	6.1	6.6	10.7	
	2.8	3.4	4.6	7.0	6.3	10.5	
	2.8	3.5	4.0	5.8	5.5	8.7	

APPENDIX III

CONSTITUENTS OF HARKER'S PIGEON MINERALS

Contents per kilogram:

Vitamin D3	40,000 i.u.
Calcium	328g.
Phosphorous	6,600mg.

Also vitamins A, B2, Iron, Cobalt, Manganese, Copper, Zinc, Iodine, Magnesium and Sodium Chloride.

N.B.
Abidec drops, used to complete vitamin supplementation, contain vitamin D2 (not D3) and are therefore not sufficient vitamin supplementation on their own (nor do they contain calcium).

APPENDIX IV
SUMMARY OF LOSSES OF EGGS AND HATCHLINGS

	Initial Number	REASONS FOR FAILURE TO SURVIVE: Infertile	Fatally Damaged by Adult	Dead in Shell	Choked to Death	Died in Hibernation	Number Surviving
Eggs	32	1	1	3	–	–	27
Hatchlings	29*	–	–	–	1	1	27

*Includes two sets of twins