

and *Cornufer*) which includes arboreal, large disked species. In default of knowledge about the calls of other arboreal *Platymantis* it is impossible to speculate further about the evolution of this group of species.

Whether the male call is a female attractant or a territorial signal is immaterial as, in either case, it must give information as to species and location. Frequency differences are often determined by body size rather than species (Menzies & Tyler, 1977) so specific information may be given by modification of temporal call parameters (*i.e.* the shape of the "envelope" in an oscillogram). Orientation may be given by recognizing changes in phase, amplitude or time-of-arrival at left and right ears (Marler, 1967) but in the acoustically confused conditions of the forest floor it is possible that the first two methods are unsatisfactory. Time-of-arrival orientation requires short concise notes, rapidly repeated, somewhat contradicting the need for a lengthy species-identifying signal. Some frog species appear to have overcome this problem by uttering a two-part call, the first signal serving to alert conspecifics, the second to orientate them. *Platymantis* species may have achieved the same object by uttering single notes at fairly long intervals, for recognition, followed by rapidly repeated notes in lengthy series, for orientation. Clearly the calls of *papuensis* and *schmidti* would be superior in this respect to the less well defined notes of *magnus* and *solomonis*.

The call of *neckeri* does not appear to follow the same pattern as notes are uttered in consistent 6-note

series rather than short series followed by long series. As its short concise notes offer satisfactory orientation, it is possible that recognition is less important in an arboreal habitat where few spp occur.

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## RELOCATION OF THE LIZARD *LACERTA AGILIS*: AN EXERCISE IN CONSERVATION

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#### SUMMARY

During August 1976, 30 sand lizards (*Lacerta agilis*) were removed from a heathland National Nature Reserve. A few days before this most of the Reserve had been destroyed by a fire and about 800 lizards were killed. A specially designed vivarium was later constructed on an unburnt part of the Reserve and lizards were released in the vivarium during 1978. The objective was to return the lizards to the Reserve, using a controlled method, and assist the natural recolonization process. Three years later (in 1981) the vivarium had a small breeding population of sand lizards.

#### INTRODUCTION

In Britain, the sand lizard, *Lacerta agilis* L. is restricted to southern counties and an isolated population in the north-west of England. Although locally abundant in the south, it is limited, by ecological requirements, to relatively undisturbed areas of heathland and marginal land. A species which is on the edge of its geographical range in U.K., and threatened by many factors (Spellerberg, 1975), it is included in the list of endangered species in the 1981 Wildlife and Countryside Act.

The National Nature Reserves in southern England

provide some of the few remaining habitats for the sand lizard. During August of 1976 an intense heathland fire destroyed more than 70% of a 258 ha National Nature Reserve in Dorset. This Reserve was known to contain suitable habitats for the sand lizard but sadly the fire completely destroyed all known sand lizard habitats—apart from a few small potential habitats near the perimeter of the Reserve. It had been established that prior to this fire, about 800 sand lizards were on the Reserve (Moore, 1976). A thorough search of the vast area of burnt heathland was undertaken during the two weeks following the fire and 30 live sand lizards were found and removed from the Reserve (Spellerberg, 1977). It seemed unwise to liberate these lizards in the small fragmented areas of heathland which had been untouched by the fire because it was not known at that time if these small areas were suitable for sand lizards. With most of the heathland vegetation destroyed, shelter was reduced, the difficulty in finding sufficient food increased and the lizards were at a greater risk from predators. During the following spring, an examination of the same area revealed a further five emaciated sand lizards that had died near burrows, suggesting that conditions for survival after the fire were not suitable for the lizards.

With the agreement of the Nature Conservancy Council, the lizards were kept in a temporary vivarium pending discussions on how to proceed. It was later decided that in order to preserve the inherent genetical characteristics of the population, the animals should all be returned to the Reserve when plant communities had become re-established and provided suitable habitats. Following a previous but less severe fire on the same Nature Reserve in 1959, the sand lizard had regained good populations by 1973. It was expected, therefore, that suitable vegetation would not be available for several years after the 1976 fire. If the lizards were to be kept in captivity for this length of time, any genetical advantages gained in keeping them and their progeny together, would be lost.

Acting within the accepted principle that each animal should be replaced as near as possible to the original site, it was originally suggested that the lizards be marked and released on the Reserve and subsequent movements noted. It would, however, have been difficult to make an adequate investigation of this sort and useful information about these animals may have been lost. Lizards placed in any of the isolated fragments of unburnt heathland would have no doubt dispersed and found difficulty in surviving without protective cover of the vegetation.

Instead, it was agreed with the Nature Conservancy Council that the lizards should be enclosed within one area of the Reserve and released at a later date when the surrounding habitat became more favourable. The enclosure, or vivarium, would act as an intermediate stage where lizards would be safeguarded and fed if necessary. This step-by-step procedure was an attempt to aid the re-colonization process and was the main objective.

A second objective was to investigate the ecological needs of the lizards, bearing in mind that an enclosed area might not enable the population to be entirely self-sufficient. The conditions provided in the vivarium

were based on those outlined by Spellerberg (1975). The sand lizard's use of the vivarium was observed and this information contributed to a long-term analysis of sand lizard habitat (House & Spellerberg, 1980). The project was an exercise in experimental design for man-made habitats which could be employed in the practical conservation of the sand lizard and other wildlife species.

## METHODS AND MATERIALS

An investigation of possible sites for the vivarium took place in March 1978. Criteria used for the selection of the site included the following: an area of unburnt heath; diverse plant species composition and structure; suitable topography to maximize insolation; environs suitable for recolonization of the lizards if and when they were released. Four potential sites within the Reserve boundary were carefully examined and one of these was selected for the vivarium. The chosen site was in an area of over 3 ha of unburnt heathland and surveys had shown that there were a few sand lizards in the area.

The vivarium (18 × 30 m) was sited on a south-facing and free-draining slope of about 15°. Details of materials used and costs involved have been included in a detailed report to the Nature Conservancy Council. The area was enclosed with corrugated plastic sheets bolted firmly together so that the corrugations ran vertically. The plastic was placed 30 cm into the ground with about 100 cm above ground. Individual sheets of plastic (0.6 m wide), were bolted together. At every alternate join, the two sheets were nailed to a wooden stake driven firmly into the ground. The vivarium corners were re-inforced with larger posts.

Nine larger posts were placed inside the vivarium to support netting which covered the whole structure and protected lizards from predatory birds. The large posts (2–3 m high) supporting the netting enabled easy access to the central area of the vivarium. Aluminium strips were placed near the top of each supporting stake in order to prevent the lizards from climbing out.

In order to provide suitable conditions for the lizards during their period of winter dormancy, it was necessary to construct three "overwintering sites" (Fig. 1). Each "overwintering site" consisted of a shallow depression (2 m × 1.5 m × 30–40 cm deep) filled with peat, sand and gravel. A drainage channel was provided in each site. Peat, logs, straw and sand was then placed on each site, resulting in a mound of material about 40 cm high. A glass covering was then placed on each mound (to prevent too much water entry) and the whole structure was covered with turfs incorporating live plants, mainly *Calluna vulgaris*.

It had been noted during extensive field research that lizards readily bask on logs and stone surfaces. In addition, most basking sites appeared to be on the interface between vegetation types of low and high profiles (House & Spellerberg, 1982). To accommodate these apparent preferences, several large logs and concrete slabs were placed in the vivarium. These generally coincided with an interface between heather

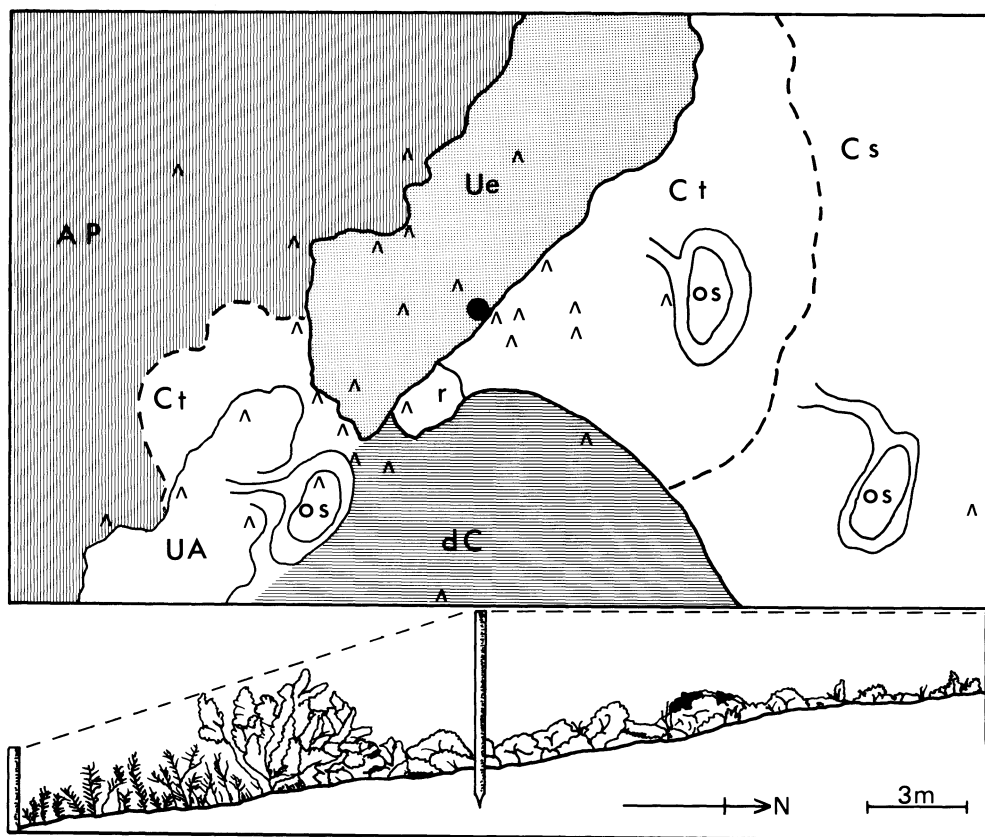


FIG. 1. Plan and cross section diagram of the vivarium. ● centre post. ▲ position of a sand lizard when first seen (see text). OS overwintering site. Cs *Calluna* less than 30 cm tall. Ct *Calluna* more than 30 cm tall. Ue *Ulex europaeus*. AP *Agrostis* and *Pteridium*. UA *Ulex* and *Agrostis*. dC degenerate *Calluna*. r Rockery. The posts and vegetation in the cross section are not drawn to scale.

and gorse or heather and grass so that each basking site was associated with adequate cover.

The area enclosed by the vivarium contained a good variety of plant species, typical of the sand lizard habitat (House & Spellerberg, 1982). Five distinct vegetation zones were recognized (Fig. 1). *Calluna*-dominated vegetation; *Calluna* in a degenerate phase; gorse (*Ulex europaeus*); grass (*Agrostis* and *Festuca*); bracken (*Pteridium*).

## RESULTS AND DISCUSSION

The 30 lizards taken from the burnt areas of the reserve were initially kept in a small temporary enclosure. By 1978 there were 9 males and 7 females surviving. Some lizards had died, probably as result of burns received during the heathland fire. The male lizards were released in the vivarium during June of 1978, the females 4 weeks later. Each lizard could be individually recognized from skin colour patterns on its throat and dorsal region.

The vivarium was visited at least once every two weeks until September, then again during April and May of 1979. Eight males and five female lizards survived the 1978–79 winter and were first seen in the vicinity of the overwintering sites. Mating was observed during April 1979 and newly hatched lizards were seen in the vivarium during October of that year.

On each of five days during April and May of 1980, the location of each lizard, when first sighted, was recorded. The combined results indicated that the lizards were more often found (during April and May) in the central parts of the vivarium. Subsequent day-long observations showed that the lizards utilized all four vegetation zones in the vivarium. On each occasion when the vivarium was visited, there appeared to be an abundance of prey items. Lizards were frequently seen taking spiders, particularly *Pardosa* sp. (Lycosidae). During September of the same year, two further visits resulted in the sighting of nine newly-hatched lizards.

Five newly hatched lizards were seen during a visit to the vivarium in October 1981. On the same occasion five adult males and three adult females were recorded. It was evident by this time that the habitat in the vivarium supported a small breeding population of sand lizards. Consequently, a decision had to be taken, whether or not some lizards should be moved from the vivarium to suitable areas on the Reserve. Ideally it was important to first establish precisely how many lizards (adults and sub-adults) were in the vivarium, and also to evaluate the condition of the regenerating heathland on the Reserve. During October and November of 1981, efforts were made to determine the number of lizards in the vivarium. It proved impossible to survey the lizards without entering the vivarium and the exercise was eventually abandoned when trampling

threatened to damage the vivarium vegetation. It was unfortunate that a precise count of the lizards could not be achieved but nevertheless a decision was taken to release immediately four sub-adult lizards, and a similar number in subsequent years.

By October 1981, five years after the fire, a general survey of the Reserve showed that recolonization and regeneration process by ericoid species was proceeding slowly. Recolonization is probably mainly from seed. An on-going survey (Roger Daniels personal communication) of the rate and extent of recovery after the fire has confirmed that recolonization by *Calluna* and other ericoid species has not been rapid. In the area where the original 30 sand lizards were found, the survey by Daniels has shown that by September 1980, percentage cover by *Calluna* ranged from zero to 71% (mean of 33% for 23 sampling sites, each of 1 m radius). To date (February 1982) there has been no noticeable change in the heather recolonization. A further setback in the recolonization process has been attributed to damage caused by the heather beetle (*Lochmaea saturalis*).

There are as yet few suitable areas on the Reserve which could confidently be used for the relocation of the sand lizard. By contrast, the 3 ha of unburnt heathland surrounding the vivarium, together with at least two further and adjacent hectares of rapidly regenerating heathland, seemed suitable for relocation. The vegetation on this area of the Reserve will continue to enlarge so therefore it seemed logical to adopt the policy of releasing each year a few sub-adult lizards in the vicinity of the vivarium. Within one or two years it may be considered safe to release all lizards in the vivarium. This being the case, then part of the vivarium wall would be removed so as to allow the lizards to disperse naturally.

It might well seem that unnecessary time and effort has been directed towards the conservation of so few lizards. Taken in isolation, this exercise in practical conservation may indeed seem trivial but when considered in relation to the number of lizards that perished in the fire, and also in relation to the apparent dwindling number of sand lizard colonies, then the value of this exercise becomes evident. Previous attempts to relocate the sand lizard or introduce it to areas outside its existing distribution, have met with little success. Since at least 1949, sand lizards have been taken from areas of southern England and relocated to what seemed suitable sites further north (Bunting, 1950; Allen, 1973; Arnold, 1973; Prestt *et al.*, 1974; Spellerberg, 1976). Vivaria were not used in these cases at the relocation site, and dispersal of the

lizards would have occurred very quickly. There seems no doubt that relocation of these reptiles (and perhaps other species) should be attempted only if the dispersal of the relocated animals can be prevented. With the restricted movement of the animals, however, it is necessary that sufficient food, shelter, and other resources be provided.

The vivarium, together with an additional similar vivarium built by the Nature Conservancy Council, will be maintained for future occasions if and when relocation of sand lizards becomes necessary.

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