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EDITORIAL REPORT FOR 1978

Papers published	1978	1977	1976
Pages published	110	91	80
Number of papers	16	18	16
Time (months) between receipt and publication. Median (range)	25.5 (7–36)	23.5 (2–26)	17.5 (7–26)

Papers received (final figures for 1977 in parentheses)

	From U.K.	From Abroad	Total
Received	5 (5)	6 (14)	11 (19)
Accepted	4 (4)	4 (7)	8 (11)
Published as letter	0 (1)	0 (0)	0 (1)
Rejected	0 (0)	2 (7)	2 (7)
Awaiting decision	1	0	1
Received specifically on British species	3 (2)	0 (0)	3 (2)
Received on captive breeding	0 (1)	0 (0)	0 (1)

Referees The Editor is most grateful to the following who refereed papers in 1978: R. A. Avery, D. R. Blatchford, A. S. Cooke, J. E. Cooper, T. R. Halliday.

Comment With a fall in the number of papers submitted and accepted during the year and with the brevity of many of the papers awaiting publication (16 compared with 21 in December 1977), a marked improvement in the time between receipt of a paper and its publication is expected.

Change of format The size of the *Journal* will be changed from the present A5 to A4 from the first part of volume 6 in December 1979.

ADVERTISEMENTS WILL BE ACCEPTED AT THE EDITOR'S DISCRETION FOR INCLUSION ON THE COVERS (contact the editor for rates)

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CONSERVATION OF THE SAND LIZARD, *LACERTA AGILIS*, BY HABITAT MANAGEMENT

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INTRODUCTION AND BACKGROUND

The sand lizard (*Lacerta agilis agilis* L.) is one of the seven large species in the "green" *Lacerta* Part 1 taxon (Arnold, 1973) and is widely distributed in Europe where it exploits a variety of habitats from open steppe to fields, hedgerows and woodland. It reaches its north-westerly range limits in Britain where it occurs only in open, sandy country (Smith, 1951), principally within the lowland dry (*Calluneta*-dominated) heaths of southern England, but also in the remnants of a less extensive habitat-type among the south-west Lancashire coastal dunes where, nevertheless, the species was once abundant. Similar habitat restriction is known elsewhere in north-west continental Europe.

This paper describes the work of one of the authors (K.F.C.) and, since 1971, of the Conservation Committee of the British Herpetological Society in the conservation of *L. agilis* by habitat management.

Habitat requirements of the sand lizard in southern England

Corbett's investigations since 1968 (summarised in Prestt, Cooke & Corbett, 1974) of this species' detailed distribution in southern England has shown that their typical habitat is based on mature Callunetum (Fig. 1), which is dominated by deep ling (*Calluna vulgaris*), with local co-dominance of bell heather (*Erica cinerea*) and dwarf gorse (*Ulex minor*). Historical data confirmed that sand lizard concentrations/colonies had been associated almost exclusively with this dwarf shrub habitat; whereas, in contrast, individual lizards are always few and colonies absent in short heath—apparently because of the relative paucity of invertebrate prey and the lack of cover against predators. Although comparable heights (50+ cm) may be attained by Calluneta of only ten years duration, stands of 15–30+ years old are those which would support that structure of cover more indicative of sand lizard habitat, and are best described as large bushy plants with deep litter, often with overlapping procumbent stems and central "pads" of mosses.

Most temperate basking reptiles tend to become concentrated on south facing (sunny) open areas; the English sand lizard also has an affinity toward local variation in topography, e.g. banks, tumuli, gullies, ridges, steep slopes and bluffs, etc., and where from stable populations have been recorded at density equivalents of 230–340 adults per ha (Fig. 2).

Fire is now one of the most immediate threats to sand lizard colony habitat, and observation at 63 colony sites burnt in 1975 and 1976, showed that whilst many lizards survived the conflagration, and some the observed increased attentions of avian predators and scavengers such as crows (*Corvus corone*) and gulls (*Larus* spp.) they rarely persisted for more than one season.

Exceptionally, survival is enhanced, and even breeding re-established, when the slow regeneration of *Calluna* is offset by the rapid growth of competitors such as gorse (*Ulex europeus* or *U. minor*) or heathland grasses such as *Molinia*. However, the resulting population never becomes so large, nor so vigorous, as that preceding it and ultimately disappears wherever bracken, *Molinia*, or *U. europeus* remains dominant.

Continuous deep heath is also incompatible with colony status, regularly successful breeding being local or peripheral and dependent on the availability of unshaded bare sand (as provided by erosion on steep slopes, spoils from fox, badger or rabbit excavations, sides of tracks etc. Indeed, *breeding populations were never found anywhere in Britain in habitat lacking this feature*. Observations in large, open air, heath vivaria confirmed this requirement; although many alternative media were available, eggs were almost always laid in bare sand, and clutches hatched successfully only when bare sand was used. The use of bare sand was first recognised by Allen (1896). Egg-laying in bare sand was also witnessed in the field by Monro (1967); many of our field-workers have reported unearthing of egg-clutches in the field, always from bare sand, as have C. Simms (personal communication, and 1971) and R. V. Skinner (pers. comm.). Finally, in the wild, concentrations of hatchlings (i.e. before dispersal of the clutch) are invariably found close to bare sand, in contrast to concentrations of newborn *L. vivipara* which are found on many substrates, including continuous deep heather on the same sand lizard sites.

Unlike *L. vivipara*, *L. agilis* is usually absent, and certainly never breeding on the localised clay outcrops on the Dorset heaths.

It should be noted that areas lacking bare sand, or with shading, overgrowth, and even replacement of the deep heather habitat (as above), can still support *L. agilis*, whether colonisers from, or remnants of, breeding populations, but do not satisfy the requirements for a colony in that egg-laying sites are absent or populations too sparse for regular breeding. For example, many of the *L. agilis* populations recorded from peripheral habitats (gardens, fields, hedgerows etc.) in Dorset, before 1970, soon became extinct after loss of adjacent heath, i.e. after loss of the colonisation source.

These findings, derived from investigations over eight seasons, at all recorded, and may previously unrecorded, *L. agilis* localities in southern England, suggest reasons for the decline and loss of colonies following habitat change. Essentially, *L. agilis* needs open habitat with dense ground vegetation as provided by mature Callunetum. Tree or scrub undergrowth, whether "natural" or through afforestation, not only suppresses the heather, but, more rapidly, causes failure of breeding. In overgrown habitats, *L. agilis* shows breeding failure leading to extinction. That this failure is caused by shading of the eggs is suggested by the longer persistence of breeding populations of non-egg-laying reptiles, and confirmed by the observations reported in this paper, when clearance of overgrowth normally resulted in immediate resumption of *L. agilis* breeding. It is significant that apart from the sparse duneland populations, *no* L. agilis *colonies were ever found in areas which were not, or had not recently been, open, dry heath.*

The decline of the English sand lizard

The past twenty years have seen a steep and accelerating decline in both numbers and distribution of *L. agilis* in Britain following widespread loss and fragmentation of habitat, principally by afforestation, urbanisation, agricultural reclamation and mineral extraction (Moore, 1962; Prestt *et al.*, 1974; Tamarind, 1975). Degradation of much of the remaining habitat has been caused by the spread of pine (*Pinus*) (Figs. 4a and 5a) spreading from plantations, and by fire-induced encroachment of birch (*Betula*; see Robinson, 1972) (Fig. 3a), bracken (*Pteridium*; see Tubbs, 1974) (Fig. 3b) and similar local spreading of *U. europeus*, *Molinia* and *Rhododendron*.

The New Forest heaths have become unsuitable for *L. agilis* from management regimes based on regular burning, this in the mistaken belief that burning of the dry heath component improves the grazing for cattle and ponies (Tubbs, 1974).

The secondary effects of widespread "fragmentation" of heathland (Moore, 1963) act via fires, collection by children, predation from urban cats, and the winter gassing of rabbit burrows (often used by reptiles as hibernacula), and so cause local declines and even extinction of *L. agilis* which can no longer be reversed by natural recolonisation from adjacent undisturbed habitat. The magnitude of these declines can be gauged by comparing 1970 estimates (Prestt *et al.*, 1974) of under 200 adults remaining in Surrey, where the species was previously abundant (Leighton, 1903; Smith, 1951), with the population densities recorded from optimum habitat of 230–340 adults/ha. Local decreases are illustrated in Table I, while none of the twenty-two breeding populations known in the mid-1950s from the large area of the New Forest now remains, and no new populations have been discovered, despite surveys.

TABLE I. Loss of known sand lizard colonies from two prominent areas of their distribution

Zone	Locality	Approx. area (km^2)	Approx. time scale (yr)	Colony loss (from–to)	% Loss	% Causes of decline Site loss	Habitat change	Other/ unknown
II	Frensham (Surrey)	110	20 to 1975	56–2	96.5	66.7	27.8	5.6
III	Bournemouth/ Poole (Dorset)	160	15 to 1975	169–24	85.8	43.5	56.5	0.0

Significantly, in the majority of cases the causes of colony decline are known (Table I), and those few tabulated under "Other" have implications for collection and rabbit gassing. The causes all appear man-made, and are collectively more than enough to account for this species' overall decline; there is no reason to postulate, nor any evidence for, climatic change or ecological factors other than habitat alteration. Even "natural succession" (overgrowth) on lowland dry heath can be seen to result almost entirely from human agency—firstly in (re)introducting pine (Figs. 4 and 5) and secondly in causing fires which allow competitors (birch, bracken, gorse) to attain dominance (Fig. 3).

The historical preoccupation of the natural history movement with "attractive" fauna and flora resulted in a general neglect of the herpetofauna, even though our twelve indigenous species represent two of the four classes of terrestrial vertebrate which, as carnivores near the top of their food chains, may act as major control factors within their respective ecosystems. It is not surprising therefore that the decline of the more restricted species continued unchecked until they became endangered. Even as general conservation activity has grown, interest in dry heath has been greatly overshadowed by concern for the botanical richness of damp and wet heath and associated bogs. Before the present programme was started in 1969 there had been no habitat management for reptiles in Britain, not even on national and local nature reserves.

Sand lizard conservation policy

In a series of internal papers to the Working Group set up by the Nature Conservancy to look into this problem, Corbett defined four geographical "zones" for the distribution of *L. agilis* in Britain. Zone I comprises the coastal dunes of south-west Lancashire, zone II, the Wealden and associated heaths of south and west Surrey, south-east Berkshire, north-east Hampshire and north-west Sussex; zone III, the New Forest and Avon Valley heaths from Ringwood to Bournemouth; zone IV, the Dorest heaths westwards from Poole. The last two had only recently become separated by growth of the Poole–Bournemouth–Christchurch conurbation.

As an interim measure to offset declines in southern England, and to maintain a reasonable semblance of its natural distribution in zones II, III, and IV, a number of "Key Sites" were proposed as a basis for conservation. However, most of these were also recognised as in need for protection and/or management—a more empirical and logical selection from those sites already representing a high status for sand lizard population and habitat condition proved too often impractical, for by 1971 much heathland was already irreversibly assigned to development or change. Initially, seventy-four "Key Sites" were agreed with the Nature Conservancy as meriting action; since when, other sites have been added to replace some of those failing at the stage of negotiation with the owner. Unfortunately, by 1976, another twenty sites had been destroyed by fires. The "Key Sites" varied from 1 to 50 ha, although they were usually less than 5 ha.

The restricted choice of sites, coupled with the backlog of neglect of dry heath in favour of wet heath, and the resultant degeneration and overgrowth dictated immediate management to rejuvenate or upgrade the habitat. Indeed, *L. agilis* had already become extinct at some of the sites it was possible to secure, prompting experimental re-introduction using stock from actual or incipient development sites; these experiments have all proved successful (Corbett, in preparation).

The Key Site strategy was adopted by the British Herpetological Society's Conservation Committee as a major part of its policy (1973). Protection was to be achieved by negotiations with landlords and lessees, normally in collaboration with the relevant Nature Conservancy Region and County Naturalists' Trust; habitat management was based empirically on the above knowledge of *L. agilis* ecology from which it was predicted that clearance of invading pine, birch etc., together with provision of bare sand either by direct excavation or by removing shade from existing tracks etc., would increase *L. agilis* populations and their breeding potential on parts or all of the sites. Experiments in Surrey (see Tamarind, 1975) had already shown restoration of breeding by just such management.

Preliminary studies by Corbett (Prestt *et al.*, 1974), including investigation of its historical distribution, had shown that the smooth snake (*Coronella austriaca*) was also rare and primarily an inhabitant of mature dry heath in Britain, and that it too had declined severely; thus it was anticipated that the same management might well benefit this species.

METHODS

Habitat management

Work was carried out between October and March to minimise disturbance to the fauna, since reptiles and amphibians are mainly hibernating, and birds are not nesting, in this period. Because of the limitations of funds and labour, management of individual sites was rarely completed within a single season, but several were part-managed each year, usually to re-establish or maintain a breeding nucleus from which animals could colonise the managed areas as it was subsequently extended. Priority was given to heavily overgrown habitat before the heather became irrecoverable.

(i) *Scrub clearance*

Clearance was rarely total; from ornithological and aesthetic considerations, some gorse was left, as well as selected trees, always with their lower branches removed ("brashed") to minimise shading and leaf fall on to the heather below (Fig. 5). Clearance was principally in mature heath areas, with some removal of peripheral trees where these shaded the heather, and particularly where this shade was encouraging bracken invasion. Although the pines cleared were usually self-seeded, some planted pine were removed (with the kind co-operation of the Forestry Commission and of Tillhill Forestry Ltd.) in areas where this was dictated by overall loss of habitat (Fig. 4). Birch, gorse and rhododendron stumps were "painted" with growth inhibitors to reduce coppicing.

(ii) *Sand exposure*

The aim was primarily to provide egg-laying areas which would remain viable for several seasons, and which might also act as territorial foci, and sometimes also to aid access and protect against fire (provision of exposed sand was not intended to provide basking areas, and observations showed they were very rarely used as such). It was recognized as impractical and uneconomical to attempt to recreate the large amount of exposed sand (up to 15% of the site area) or the variation in local topography (banks, gullies, tumuli etc.), both typically associated with the densest natural colonies. Overall, therefore, a compromise was adopted based on conditions known from colonies with ca. 125 adults/ha.—with locally 5%, overall 1 to 20%, of the site area so exposed (Fig. 7). Inevitably, no two sites were treated alike because of local topographical differences, fire-breaking considerations and, often, the landowner's preferences.

Sand "patches" and paths were orientated roughly east–west to present the largest area of sand to the south and thus to the sun. On flat land and gentle slopes, a width of 1 m (much greater than that needed for egg-laying alone) was used to minimise shading and delay overgrowth by the peripheral heather. On steeper slopes narrower patches were practicable and were shelved into the hillside to prevent erosion. Patches were of maximum size 2 × 1 m thus barely exceeding the natural spoils at the entrances to fox or badger excavations (Fig. 6).

Most patches and even some paths were excavated by hand, by first cutting the heather with the back of the spade and then "turfing" down to about 10 cm to expose the sand. The inverted turves were piled on the north side of the excavation (Fig. 6d), following Corbett's early observation that adult *L. agilis* tended to colonise these artifical "banks". The Forestry Commission kindly used a tractor and plough to create wider tracts of sand (serving also as fire-breaks) on two of the larger sites.

Provision of additional sand exposure for existing breeding populations (whether native or produced by habitat management) was carried out between mid-April and mid-May to minimise the risk of digging up either hibernating lizards or eggs—alternatives made possible by the vagaries of the English climate.

Monitoring of L. agilis *populations*

To minimise disturbance and for other reasons (see Discussion) complete reliance was placed on visual survey. In the smaller sites (<2 ha.), all the habitat could be searched, but "sampling" was often necessary on the larger sites. Purely objective sampling by "transects" had been well tested by Corbett in his original work and later (Corbett, 1974), but proved totally impractical for these small, territorial animals in such densely vegetated terrains (Fig. 2); unlike more subjective searching of the same areas, it frequently failed to reveal lizards. Further, rigid adherence to straight-line transects damages the heather.

Use was made of the fact that reptiles show definite preference in their choice of basking spots, during which activity they are most readily found, and potential basking places were searched throughout the sites. As well as those observed basking, many lizards were initially located by the characteristic sounds of their rustling through the vegetation or by slight movement at the periphery of the observer's vision; therefore several return visits were often needed to record size, sex and species (Fig. 1). The collective field experience of the participants confirmed that choice of weather, time of day and season were important in timing site visits.

L. agilis were assigned to one of three age-maturity groups according to size and appearance, and with regard to time of year, as:

"juvenile"—hatchlings between birth and first hibernation;

"immature"—lizards between their first and second hibernations; 7 to 14 months old;

"mature"—adult, sexually mature lizards after their second hibernation; from 18 months of age.

Wide individual variation in subsequent growth rates (Corbett, unpublished) forbade systematic assignment of adults to specific ages, however, "young" adults (18 to 24 months old) were normally distinguished in field records from very large, i.e. very old, ones—a category predominant on degraded, non-breeding habitat before management.

The locations of *L. agilis* sightings were recorded on site maps bearing a reference grid in order to follow detailed changes in distribution.

For *quantitative assessment* a sightings frequency technique was adopted as the only practicable method for routine monitoring, since Lincoln Index type sampling techniques are inapplicable (see Discussion). Sightings of lizards of each age-maturity group were expressed as "numbers per man-hour" (i.e. "sightings frequency"). Mean sightings frequency values from individual sites were taken as indices of population density to permit (a) assessment of age-maturity group composition and (b) detection of the direction and approximate magnitude of changes in adult population density from year to year.

RESULTS

QUALITATIVE

Intersite variations in the status of the population before management and in the extent and time-course of management make comparison difficult between individual sites, although the following generalisations can be made:

(a) Sites with a low *L. agilis* population, little or no evidence of recent breeding and with no nearby colony (typical of zone II in 1970): from being scattered, lizards gathered in the cleared areas in the first season after the start of management and definite concentrations became apparent, associated with the ridges and turves of freshly exposed sand and/or in the vicinity of natural bare sand from which shade had been removed. These concentrations were localised to a small proportion of the sand areas and the lizards were predominantly very large; their sizes corresponded to those of *L. agilis* known from mark-recapture studies as at least 5 years old. Subsequently, the number of sightings fell, but rose again by the third season, when young (18 to 24 months old) adults predominated. In contrast to the localised distribution shown by the old adults of the first season, these young lizards were distributed throughout the sites, according with Corbett's findings on naturally viable sites in which immature lizards dispersed widely from their birthplaces. The new distribution was maintained in subsequent years.

Use of freshly-exposed sand for breeding was recorded during the first full season after its provision, but on average only about 10% of the potential egg-laying areas were used. Utilisation, as revealed by the number and distribution of associated broods, increased markedly in the third and later seasons. However, at one zone II site the patches rapidly became overgrown by bracken and although the initial concentration of old adults was recorded, sightings subsequently declined to below premanagement levels, followed by presumed local extinction.

(b) Sites with a low *L. agilis* population, but with local (often peripheral) breeding, and/or breeding populations in adjacent heath (a typical 1970 zone III/IV situation). This group showed similar concentrations of adults close to freshly-exposed sand; however, these were more widely distributed and although large adults tended to predominate (particularly where the breeding nuclei were small or distant) they were not the only age-class represented. These sites did not show a comparable fall in sightings between the first and third seasons, and the transition from old to young adult predominance, although observed, was less marked.

The number of clutches of young lizards, and the extent and dispersion of exposed sand usage, was initially much greater than in the first group of sites, with up to 70% being exploited in the first season.

The evidence was consistent with continuous recruitment of lizards from the existing breeding areas, but until management these colonists did not breed. Similar patterns were seen whether the existing breeding population was "natural" or produced by earlier management.

In summary, successful use of exposed sand for breeding was recorded in the first full season after its provision, the degree and rate of utilisation being directly related to the original population density; the rate of increase and dispersion of sightings were similarly dependent on the premanagement population level, with formerly non-breeding and low-density sites usually exhibiting a trough in sightings during the second season after management.

A further conclusion was that tree and scrub clearance alone did not promote breeding, unless of itself it removed shade from existing bare sand. This was seen strikingly at those sites where clearance preceded sand exposure by up to two seasons. In contrast, provision of unshaded bare sand in continuous deep heath, even when short or sparse overgrowth had not been cleared, resulted in immediate lizard concentration and breeding. Of the twenty-six sites studied in detail, this occurred at all fourteen where clearance was accompanied by sand exposure and at all five where sand was exposed in continuous deep heather (despite the continued presence of light tree growth at two of them). However, colonisation and breeding were not recorded at any of the seven cleared sites without bare sand, until after sand had been exposed a season or more after the initial clearance.

The experiment of providing exposed sand in shaded locations was not tried as this was already a natural feature of many unmanaged areas at which *L. agilis* was failing to breed.

QUANTITATIVE

Age-maturity group composition of L. agilis *populations*

For this and succeeding analyses, sites were classified as:

Unmanaged—at which examination of the habitat showed that immediate management was needed to reverse degradation (Fig. 4a and 5a).

Viable unmanaged—where the habitat was consistent with a stable breeding population (large or small), and potential management was only to extend the breeding area.

Managed—(sites cleared of overgrowth, but lacking bare sand were classed as unmanaged).

Natural recovery—sites with good habitat at which the population was recovering from the effects of known collection, or of partial habitat destruction by fire.

Results from all types of site cover the period 1969 to 1976, with the widest coverage from 1972 to 1975. Sightings frequencies of adult and immature lizards were averaged for all surveys throughout the active season. As hatching can occur at any time between the beginning of August and mid-September (sometimes even in October), depending on the weather during the incubation period, juvenile sightings frequencies were averaged for all surveys after the first was seen on the site in question. If no juveniles were seen, but surveys did not extend to mid-September, it was taken that the site had received no post-hatch surveys; if surveys continued beyond mid-September still failed to reveal juveniles, a zero "birthrate" was assumed for statistical purposes. Juvenile : mature ("observed birthrate") and immature : mature ratios were calculated (for individual sites) from these data.

It should be noted that owing to differences in behaviour and mortality patterns in the three groups, these ratios provide only a reflection of the age-maturity composition and not an absolute value which would include more juveniles and immatures than are locatable by comparative observation.

The results are summarised in Tables II and III.

Mean birthrates were higher in all groups of managed sites than in unmanaged sites, significantly so ($P < 0.001$) for all combined and for all separate groups ($P < 0.01$), save the first season value which was based on observations from very few sites.

None of the managed site values differed significantly from one another.

The mean immature : mature ratio from the first season of management was almost identical with that from unmanaged sites, confirming similar poor breeding success before management, but in each subsequent season was elevated significantly ($P <$ 0.01 or better), reflecting improved breeding and confirming a "real" birthrate increase in the first season.

Ratios at viable unmanaged sites were intermediate between those from managed and unmanaged sites. This might suggest that managed habitat was even better than the naturally good habitat on which it was modelled, but there is another interpretation. Predation of young *L. agilis* by their elders occurs in the wild (see Discussion) and would naturally be more intense where adult density was high, as at stable, naturally viable sites, than where it was relatively low as in the first few years after the start of management work. Cannibalism would thus tend to depress the *observed* ratios more at viable unmanaged than at managed sites. In these circumstances, extension of the habitat available to an already thriving colony should

TABLE II. Age/maturity-group composition of *L. agilis* populations

Site group	Number of sites	Sightings frequency ratios Immature : mature	(Mean ± Standard error) Juvenile : mature
Unmanaged	16	0.0723 ± 0.0259 (22)*	0.423 ± 0.214 (9)†
Managed—			
1st season	9	0.0753 ± 0.0371 (9)	1.758 ± 0.985 (5)
2nd season	15	0.3515 ± 0.0877 (15)	1.939 ± 0.479 (9)
3rd season	15	0.2523 ± 0.0488 (15)	2.436 ± 0.627 (11)
4th and later seasons	17	0.324 ± 0.0791 (17)	1.945 ± 0.368 (10)
All managed	24	0.3095 ± 0.0425 (47)‡	2.079 ± 0.273 (36)
Viable unmanaged	11	0.1606 ± 0.0589 (19)	1.181 ± 0.312 (11)
1st season "extension" management	5	0.396 ± 0.085 (5)	2.240
Unmanaged + viable unmanaged	27	0.1132 ± 0.0031 (41)	0.8398 ± 0.2105 (20)
Natural recovery	6	0.3000 ± 0.142 (8)	3.030 ± 0.230 (2)

* Number of observations. Differs from number of sites as sites can fall into the same group (other than a specific season after the start of management) for more than one year.

† Number of observations. Less than (*) since not all sites were surveyed after hatching time.

‡ Excludes the immature : mature ratio for the 1st season as this reflects breeding in the season before management.

Mean number of surveys per site per year = 7.8.

TABLE III. Statistical comparison of age/maturity-group compositions

Site group	Compared with	Immature : mature ratio		Juvenile : mature ratio	
		"t"	*P*	"t"	*P*
Unmanaged	1st season managed	Inapplicable		n.s.†	
	2nd season managed	2.94	<0.01	2.90	<0.01
	3rd season managed	3.26	<0.005	3.04	<0.01
	4th and later season managed	3.19	<0.005	3.65	<0.005
	All managed*	4.65	<0.001	5.88	<0.001
	Viable unmanaged	1.37	n.s.†	2.16	<0.05
Viable unmanaged	1st season extension management	2.27	<0.05	Inapplicable	
	All managed*	2.045	<0.05	2.15	<0.05
Unmanaged + viable unmanaged	All managed*	3.73	<0.001	3.60	<0.001

* Excludes 1st season immature : mature ratios.

† n.s. = not significant ($P > 0.05$).

enable an increased proportion of young lizards to escape adult predation, thus increasing the immature: mature ratio in the first post-management season; there is evidence for this in Tables II and III.

Ratios in "natural recovery" sites were similar to those in managed sites, presumably because in both classes a small population was growing to fill a large area of suitable habitat, and confirming the similarity between managed and naturally good habitats.

"Absolute" incidence of breeding

Evidence for successful breeding in any given year can arise from records of juveniles in that year, of immatures the next year, or of young (newly mature) adults the spring following. Using these as criteria, it is clear from Table IV that successful breeding was both more frequent and more regular on managed than on unmanaged sites, with viable unmanaged sites again occupying an intermediate position.

TABLE IV. Absolute incidence of breeding in *L. agilis* populations

	Unmanaged	Viable unmanaged	Managed
Sites with any breeding	5/10 = 50%	16/17 = 94%	25/25 = 100%
Site-years with breeding	8/27 = 30%*	38/44 = 86%†	70/71 = 98%
Breeding every year for which there is evidence	0/10 = 0%	11/17 = 65%	24/25 = 96%
Breeding in 2 consecutive years	1/9 = 11%	10/13 = 62%	19/19 = 100%

* By X^2 test: significantly different from viable unmanaged ($P < 0.001$) and from managed ($P < 0.001$).

† Significant different from managed sites ($P < 0.005$).

Annual changes in adult population density

Increases in adult density resulting from management cannot be expected before the third season, when the first season progeny reach maturity; earlier changes can only be the result of movements or of natural wastage of the original stock. However, where management is aimed to extend the habitat of an already viable colony, increased numbers of immatures escaping adult predation should yield an increase in adult population in the second post-management season (before this, outward diffusion of adults from the original nucleus may well reduce population density).

For Table V, annual mean adult sightings frequencies are calculated as proportions of the previous years' values for individual sites monitored in consecutive years (paired results); the managed site group includes observations only where one of the years was the third, or later, after the start of management, save for one—an initially viable colony whose habitat had been extended by management—where the second season value is compared with the first.

Unmanaged sites showed a mean, significant ($P < 0.001$) fall of over 50% *per annum* in sightings frequency; viable unmanaged sites showed no significant annual change, but managed sites showed a significant ($P < 0.001$) annual doubling.

Statistically, these sightings frequency observations show clear trends, and it is of value to compare the mean annual changes from managed and unmanaged sites. The ratio is $2.173/0.436 \simeq 4.98$, indicating that managed sites were nearly five times as "productive" of adult lizards as were unmanaged sites. The ratio between the mean "birthrates" of the two groups is $2.079/0.423 \simeq 4.91$, a remarkably close agreement. Similarly, the managed sites appeared about twice as productive of adults as viable unmanaged sites, and had about twice the mean birthrate.

TABLE V. Proportional annual changes in sightings frequencies of adult *L. agilis*. Mean ± S.E.

	Number of		
Site group	Sites	Paired observations	Mean proportional sightings frequency change
Unmanaged	5	9	0.436 ± 0.123*
Viable unmanaged	3	7	1.200 ± 0.250†
Managed	13	23	2.173 ± 0.375‡

* Significantly less than unity ($P < 0.001$); less than viable unmanaged ($P < 0.01$); less than managed ($P < 0.001$).

† Not significantly different from unity (i.e. no change).

‡ Significantly greater than unity ($P < 0.001$); greater than viable unmanaged ($P < 0.05$).

Correlation of the immature: mature ratio of one year with the birthrate of the previous year and the proportional change in adult sightings frequency by the next year

The preceding analyses consider groups of, rather than individual, sites. Although the intrinsic sampling errors of the field observations preclude a rigorous analysis, the values should, however, show some degree of correlation at individual sites.

From the observations at viable unmanaged sites, a juvenile: mature ratio of ca. 1.2, and an immature: mature ratio of ca. 0.16, are associated with stable populations. Juvenile: mature ratios were therefore categorised: 0 to 0.499 as 0; 0.5 to 0.999 as 1... > 3.0 as 6. Immature: mature ratios were categorised: 0 to 0.059 as 0; 0.06 to 0.119 as 1 . . . > 0.36 as 6. Proportional changes in mean adult sightings frequency were categorised: 0 to 0.399 as 0; 0.4 to 0.799 as 1 . . . > 2.4 as 6. Significant correlations were found between the juvenile: mature ratio of one year and the immature: mature ratio of the next ($r = 0.516$; $N =$ number of observations $= 38$; $n =$ number of sites $= 22$; $P < 0.01$), between the immature: mature ratio of one year and the proportional change in adult sightings frequency by the next ($r = 0.531$; $N = 50$; $n = 26$; $P < 0.001$) and even between the juvenile: mature ratio of one year and the proportional change in adult sightings frequency over the next two years ($r = 0.551$; $N = 18$; $n = 11$; $P < 0.02$) for individual sites surveyed in consecutive years irrespective of the stage of management, if any.

These findings accord with the more general conclusions drawn from the preceding analyses and further confirm that a habitat in which *L. agilis* shows a high level of breeding success is one consistent with a high survival rate so that the species will maintain or increase its adult population density.

Other rarities

Most important amongst our reptiles, because of its extreme rarity in Britain, is the smooth snake (*Coronella austriaca*). This too is a specialised dry heathland species and, although the complete habitat requirements are as yet unknown, its historical distribution closely parallels that of *L. agilis* in zones II, III and IV (Corbett in Prestt *et al.*, 1974). By 1970, it was virtually extinct in zone II, with reliable, but rare, records from only three sites, two of which have since been destroyed by fire. However, a number of different specimens (all significantly large adults) were initially recorded from a very isolated site without previous *C. austriaca* records, and which was being managed to receive an experimental re-introduction of *L. agilis*. Immature snakes were then found there during the 1978 season.

C. austriaca is now found on most of our zone III and IV sites; a number of sites managed to promote colonisation from adjacent *L. agilis* populations have also been colonised by breeding *C. austriaca*. It is particularly interesting that the sole management for two of these, and the main management for another, was provision of sand patches in continuous mature heather.

TABLE VI. Proportional annual changes in sightings frequencies of adult *C. austriaca*. Mean ± S.E.

Site group	Sites	Number of Paired observations	Mean proportional sightings frequency change
Unmanaged	3	7	0.477 ± 0.179*
Viable unmanaged	2	5	1.144 ± 0.210†
Managed	6	11	2.324 ± 0.653‡

* Significantly less than unity ($P < 0.01$); less than viable unmanaged ($P < 0.025$); less than managed ($P < 0.05$).

† Not significantly different from unit.

‡ Significantly greater than unity ($P < 0.05$).

Few sites receive the intensive study needed to yield useful quantitative results on this species and a detailed statistical analysis as for *L. agilis* is not yet feasible. However, comparison of mean adult sightings frequencies year by year (Table VI cf. Table V), indicates that population changes in *C. austriaca* parallel those of *L. agilis* in the different groups of sites.

In addition to reptiles, most sites have developed breeding populations of one or more of the rare or restricted heathland bird species: Dartford warbler (*Sylvia undata*), nightjar (*Caprimulgus europeus*) and stonechat (*Saxicola torquata*). Increases in numbers and species of sand wasps (Hymenoptera) have also been recorded from many sites, apparently in direct response to sand excavations.

DISCUSSION

It is of interest that the preferred habitat-type resembles that described by Peters (1970) for the closely related *L. viridis* at its own northern European range limits in E. Germany. Recent study of *L. agilis* in the Lancashire dunes (Corbett, 1974) showed that an essentially similar habitat was exploited there, but based on mature, tangled marram (*Ammophila arenaria*) in place of mature *Calluna*.

Methods

As all British reptiles favour densely vegetated habitat, and populations are usually disperse, population estimation demands intensive, prolonged mark-recapture study; Corbett found that one season's full-time work sufficed to mark only 70% of the adults on his two intensive study sites, which is clearly impractical for routine use on our more numerous and generally larger Key Sites.

Trapping is similarly restrictive, inefficient, and appears irresponsible on both academic and conservational grounds. The restraint must distort the trapped animals' behaviour, notably interfering with basking patterns and hence physiology, so threatening modifications of the populations structure. Traps in sunny places present risk of heat-deaths; pitfall-type traps can fill with rainwater and cause drowning. They give the lizards no opportunity to escape predators, and may reduce food availability. As they can catch only those individuals with whose ranges they coincide, many traps are needed to capture a useful sample of the population, with a consequent increase of the hazards. Frequent inspection every day could reduce these, but the attendant disturbance would also distort the observations. Further, and particularly in dry weather, mature *Calluna* is very vulnerable to destruction by trampling (Burden & Randerson, 1972; Bibby & Tubbs, 1975), an inevitable consequence of frequent inspection.

A sampling method was clearly essential, but Lincoln Index-type techniques are inapplicable, notably because of the difficulty of catching adequate population samples in single surveys (cf. Avery, 1975); the limited mobility of many reptiles (e.g. *L. agilis*; Simms, 1971; Corbett, unpublished observations), such that marked animals do not mix randomly with the general population; wide individual variation in habits and longevity, such that survival of a batch of marked animals is unknown at any given time without accurate knowledge of mortality patterns throughout life and possibly for each individual site (for the small proportion of *L. agilis* reaching maturity, Corbett estimated an average total life expectancy of 4–5 years, but some marked individuals attained 8 years in the wild; 10 years has been recorded in captivity—Walters, 1971). Thus the sightings frequency technique was the only practicable method for routine use. It has the enormous advantage of causing minimal disturbance, hence minimal distortion of the results. The results show great internal consistency providing strong evidence that the technique yields valid results when analysed statistically. The observations have a built-in control against observer bias in that sites of all types were surveyed throughout the period of investigation by a diversity of fieldworkers.

All the results depend upon visual observation and it is worth considering whether a secondary effect of management was to render the animals more easily visible. However, this view is contradicted by:

(*a*) In overgrown habitat, reptiles are observed mainly during basking. By increasing the number of basking places, management actually *reduced* the probability of seeing reptiles in a given time, tending to reduce sightings frequency for a constant population.

(b) Increased visibility would cause only a once-and-for-all increase in sightings, not the progressive increases obtained.

(c) Increased visibility to the human observer implies increased visibility to predators, so were this a factor, the increased sightings should be short-lived.

(d) Short heath, where visibility is high, yields fewer observations than deep heath, where visibility is low.

(e) The differing patterns of sand-patch utilisation also confirm that the observed responses were not an artifact of increased visibility.

In practice, the available data showed no overall mean change in adult sightings frequency between the immediate premanagement and the second post-management seasons. Most individual sites showed decreases, but a few showed increases, considered attributable to incursions from surrounding unmanaged habitat.

Implications of the observations: population control and colonisation

The qualitative and quantitative observations, effectively four independent modes of assessment, agree in confirming that the method of management provides a habitat in which *L. agilis* can thrive, and even rebuild from relict populations. That the increased density is not an artificial concentration of lizards is suggested by the high stable populations found naturally in similar habitat, supported by the sequence of events observed and by the absence of increase before the third season after the start of management—when the first post-management hatchlings reach maturity but many of the original adult stock have died.

Similarly, the increased populations are not temporary, artificial peaks. A single female may lay up to 13 eggs, with a 100% hatch in a good summer, therefore potentially, without controlling factors, any breeding population of *L. agilis* should quickly peak, and presumably crash. On the contrary, stable populations are the rule once the optimum colony level is reached, and no evidence has been obtained to suggest any fluctuation.

One of the most important and logical factors for the natural control of colony population size is cannibalism, by the adults on their young, and particularly on the juveniles and young immatures. Corbett (in preparation) has found field evidence from the results of faecal pellet analyses, and has also observed avid cannibalism in large outdoor heath vivaria—even from well-fed adult populations. Field observations of adults eating their young have recently been made from various Dorset sites (Nature Conservancy Staff personal communication; British Herpetological Society, 1975). Such habits have also been noted from the wild in Germany (Peters, 1970) and in Holland (Van de Bund, 1957, 1964). Clearly, pressure of adults on young would tend to increase natural colonisation rates into habitat with lower density, or entirely lacking, adult populations. Corroborative evidence may be seen above, when extension of the habitat available to viable unmanaged colonies produced an immediate increase in the immature:mature ratio.

The evidence indicates that further declines in *C. austriaca* can also be prevented, and probably be reversed, by the same management, giving time to determine the exact optimum habitat, home range and thereby minimal viable areas. The managed sites have also proved viable for Britain's four other reptile species. The essential aim was to restore areas of a rapidly disappearing form of habitat, lowland mature dry heath, by removal of invading vegetation, on the assumption that restoration of an open, heather-dominated habitat would lead to natural regeneration of the whole ecosystem. The response of the reptiles, and the recolonisation by specific heathland birds, for example, suggests that the approach was sound.

Significance of exposed sand

It is important to note that the policy was simple and empirical, being based on descriptive investigation of the habitat in which *L. agilis* was found to thrive best. A crucial factor was identification of the particular habitat features required for breeding, as opposed to those needed by the animals for all other aspects of their lives. The distinction between the "living" and "breeding" facets of occupied habitat does not appear to be generally recognised, despite the obvious (and significant) example of Britain's only other oviparous reptile, *Natrix n. helvetica*. This species probably owes its wide distribution in Britain to use of the warmth of rotting vegetation to incubate its eggs (Howes, 1972), although rarely having such features as part of its normal home range. The evidence from artificially introduced reptiles in Britain (Fitter, 1957; Frazer, 1964), and from *L. agilis* itself, suggest that the northerly range of oviparous reptiles is limited by the availability of suitable conditions for egg incubation; the free-living animals can survive for an apparently normal life-span of many years under conditions that do not permit breeding. Strictly, the limitation is that "breeding" habitat must occur within the species normal range of movement; where this is small, as in *Lacerta* spp., "living" and "breeding" habitat must occur side by side, for more mobile animals such as *Natrix n. helvetica* (Prestt *et al.*, 1974; Prestt, pers. comm.) the two may be widely separated, providing the intervening terrain is one which the animals can cross.

The importance to *L. agilis* of sand, which is sterile (heath) or wind-disturbed (dunes), is thought to be linked with its poor colonisation by plants. In a preliminary experiment, Corbett transplanted mixed clutches of eggs into bare sand, loam and chalk soils; hatching occurred of all the eggs in sand (which showed little plant colonisation during the incubation period), but of only a few of those in loam and chalk, which were rapidly vegetated. All the unhatched eggs were found to be enmeshed in developing root systems, which presumably altered the temperature and humidity of their immediate environment. All eggs placed in clay failed to hatch, irrespective of vegetation, presumably because of mechanical damage from the physical changes of clay with wetting and desiccation.

The dependence on bare sand probably arose with the fall of about 2°C in average summer temperatures accompanying the close of the sub-Boreal period about 2000 years ago. During the sub-Boreal period, it is probable that a wide range of habitats were exploited, as in central Europe today, where eggs hatch successfully under logs, stones, leaf litter etc. Significantly, only in the cooler climates of Britain, Netherlands and Sweden is *L. agilis* known as the "sand lizard".

One interpretation of the observed increase in *C. austriaca* populations following sand exposure is that they are secondary to the concentration, and population increases, in *L. agilis*. *C. austriaca* feeds predominantly on lizards (see Bruno, 1970, and apparently preferentially on *L. agilis* (Andren and Nilsen, 1976).

Other species

Most temperature climate reptiles are "shuttling heliotherms" which depend on basking, and would therefore be expected to benefit from reduction of shade by tree and scrub clearance. Certainly, thriving populations of adders (*Vipera berus*) and viviparous lizards (*Lacerta vivipara*) now occur on all of our managed Key Sites. *L. vivipara* often became restricted to areas not favoured by *L. agilis*, probably because of dampness or distance from exposed sand, and at least partly because of their predation by the latter, which has been observed in the field and confirmed by the occurrence of lizard remains in *L. agilis* faecal pellets (Corbett, in preparation). Slow-worms (*Anguis fragilis*) occur widely on our managed sites; their secretive habits tend to obscure population densities, but where assessment was possible, they were usually found to be abundant.

The grass snake (*Natrix n. helvetica*), primarily a predator of amphibians and fish, has not previously been recorded as being regularly associated with a dry heath habitat (Appleby, 1971; Smith, 1951; Spellerberg, 1975), yet the species is common on our managed sites. Overall, sightings have doubled since 1972, and recapture records from marked snakes confirm that they are residents on the sites, not transients. Regurgitated stomach contents show that the main food in dry heathland is the toad, *Bufo b. bufo* (more surprisingly, our heathland adders have also regurgitated toads!). In this context it is interesting to note how often *B. bufo* is found in dry heath; it is not unusual to find sites over 1 km from the nearest breeding pools reliably having newly-metamorphosed toads by late summer.

Conclusions

The qualitative and breeding incidence observations showed that management, to reproduce the natural habitat conditions in which stable *L. agilis* populations occurred, led to restoration and/or enhancement of breeding and to colonisation of recreated habitat by breeding lizards. This produced population increases manifested by sightings at increasing numbers of locations within sites. The quantitative observations confirmed this, with significantly higher proportions of juvenile and immature lizards on managed compared with unmanaged sites. This led to increases in overall adult sightings frequency, whilst monitored unmanaged sites, by contrast, showed progressive falls in sightings frequency.

Management achieved its original aim of offsetting the continuing decline of both species and habitat and in establishing practical techniques for their conservation. However, the Key Site strategy must be seen as a short-term measure filling an urgent need; in the long term, conservation of dry heath *per se* is essential. Apart from persistent pressures for various forms of development, the habitat is exceptionally vulnerable to fires, which are increasing in frequency with increasing public pressure. Thousands of hectares, including many vital Key Sites, have burnt even as this paper was being prepared (Bibby, 1976; DNT/RSPB, 1976; SNT/RSPB, 1977). These fires have again had a noted and disproportionate effect on the all important mature dry heath—such that only an estimated 5% of Dorset heaths are thought to have survived unburnt for 20 or more years (DNT/RSPB, 1976).

Dry heath reserves are urgently needed, ideally large in order to allow effective fire-breaking and the containment of local, accidental fires; this in turn necessitates an acceptance of "compartmentation" from primary and secondary ploughed breaks, both of which can twist and follow contours aesthetically. Intermittent management seems likely to be needed in perpetuity, although this is not in the experience of our field-workers considered to be an over-demanding commitment, once the initial back-log of clearance is complete. It should only involve periodic clearance of young pine scrub and maintenance of exposed sand, every 5 to 10 years. Local control of bracken by summer spraying of new fronds with Asulam (Cadbury, 1976) is also strongly recommended to prevent further encroachment, and to recover Calluneta so degraded.

The National Nature Reserves should provide the required security, but in practice occupy only a small fraction of even the little dry heath which remains. The hazards of relying on such reserves alone are illustrated by the recent total loss, by fire, of one of the three relevant reserves. Another dry year could mean loss of all. However, as yet, there is no national policy for the conservation of lowland dry heath either from the Nature Conservancy Council or the Society for the Promotion of Nature Reserves, although the loss of comparable areas in continental Europe led Bibby (1975) to report on the international importance of conserving our own dry heath.

Recent action

Recognition of the overall problem has led the Nature Conservancy Council to set up in January 1977 a representative Advisory Group on Herpetofauna, and whose main responsibility is to undertake the drafting of a detailed National Policy for the Conservation of Endangered Herpetofauna and their Habitat. At the same time, the publication of the Nature Conservation Review (1977) may be seen as justification for the acquisition of more lowland heath reserves, hopefully with the accent on dry heath.

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LODGING OF DATA

Extended versions of Tables II, IV, V and VI are held in the library of the British Herpetological Society.

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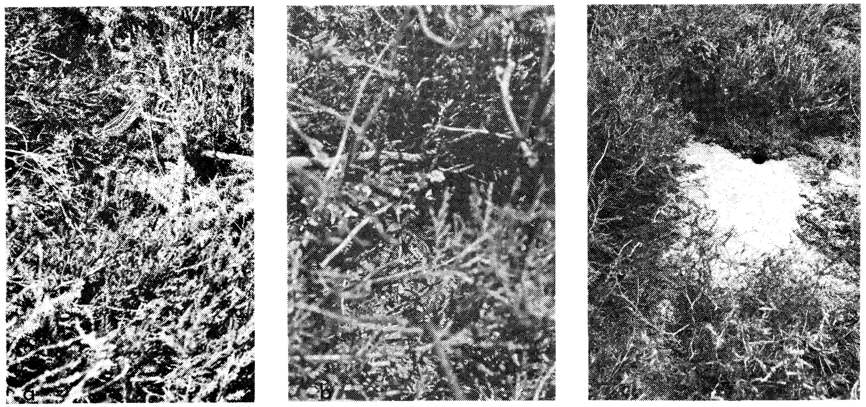

FIG. 1. Sand lizards in relation to deep heather habitat: (a) basking in tops of mature callunetum (male); (b) "mosaic basking" within filtered canopy of bush (gravid female); (c) self-excavated burrow on edge of bush, others often within litter—note ex-hibernation spoils.

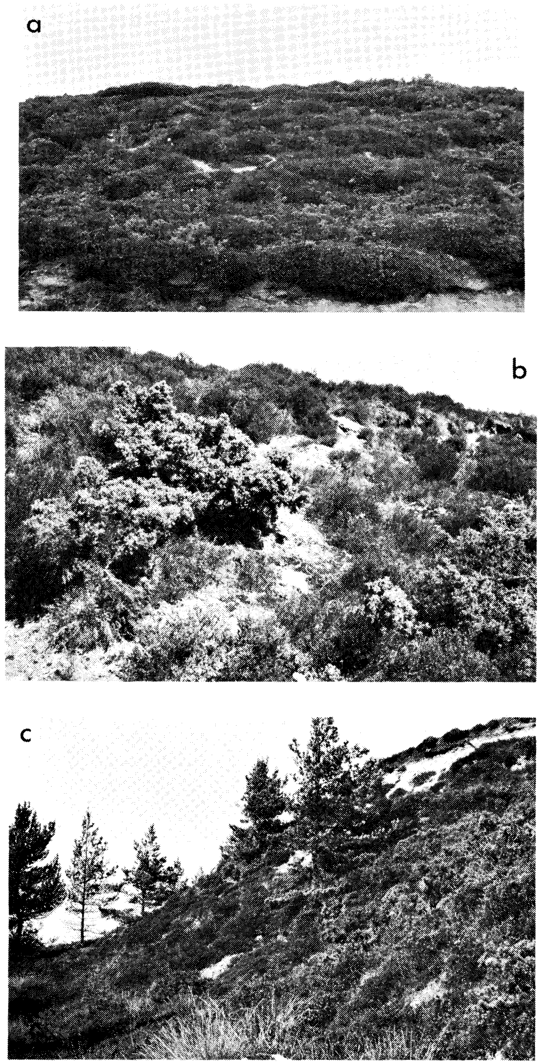

FIG. 2. Typical sand lizard colony habitat; southern slopes, bushy heather, sand exposure: (a) Hampshire; (b) Surrey; (c) Dorset—pine invading from nearby plantation.

FIG. 3. Secondary effect of fire on dry heath: (a) suppression of heather slopes by even-aged birch, following a fire 22 yr previously. Mid-ground shows bracken invasion induced by tree shade and leaf fall; (b) immediate replacement of heather by vigorous bracken on colony site following a local fire on far side of gully.

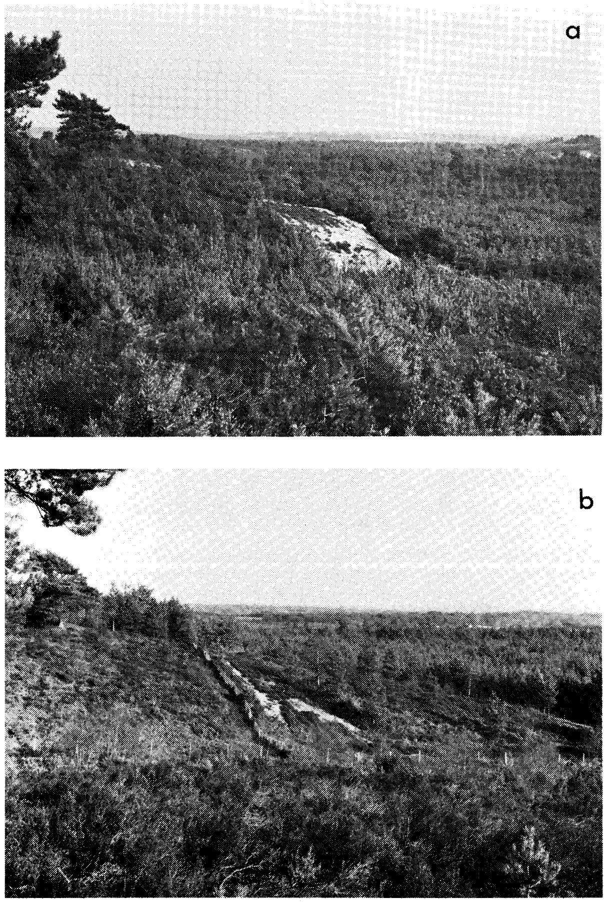

FIG. 4. Pine invasion on dry heath. A site (a) before and (b) after management: (a) self-sown pine in mid-ground and to left of fire-break, planted pine to right of fire-break; (b) note bracken invasion in response to previous tree shade on steep slope on left.

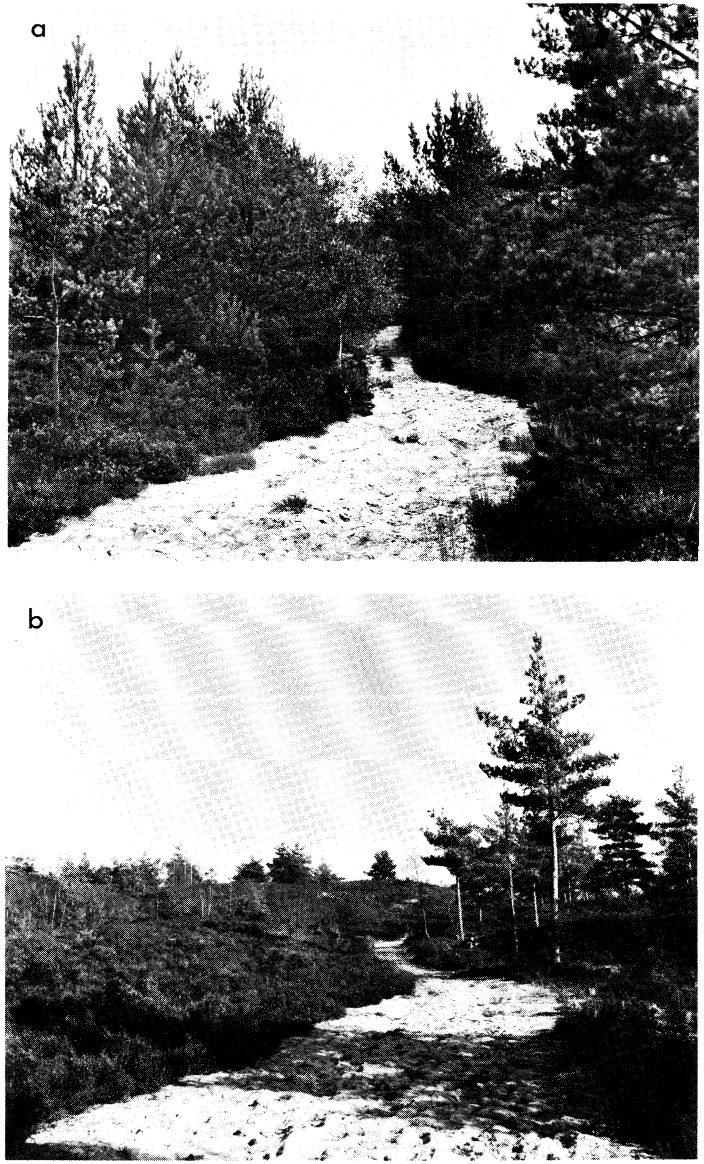

FIG. 5. Clearance of overgrown heath and reduction of shade on sand lizard egg-laying site: (a) site before management; (b) scrub clearance nearing completion—note "brashed" pines and the tongue of even-aged birch saplings corresponding to a previous localized fire line.

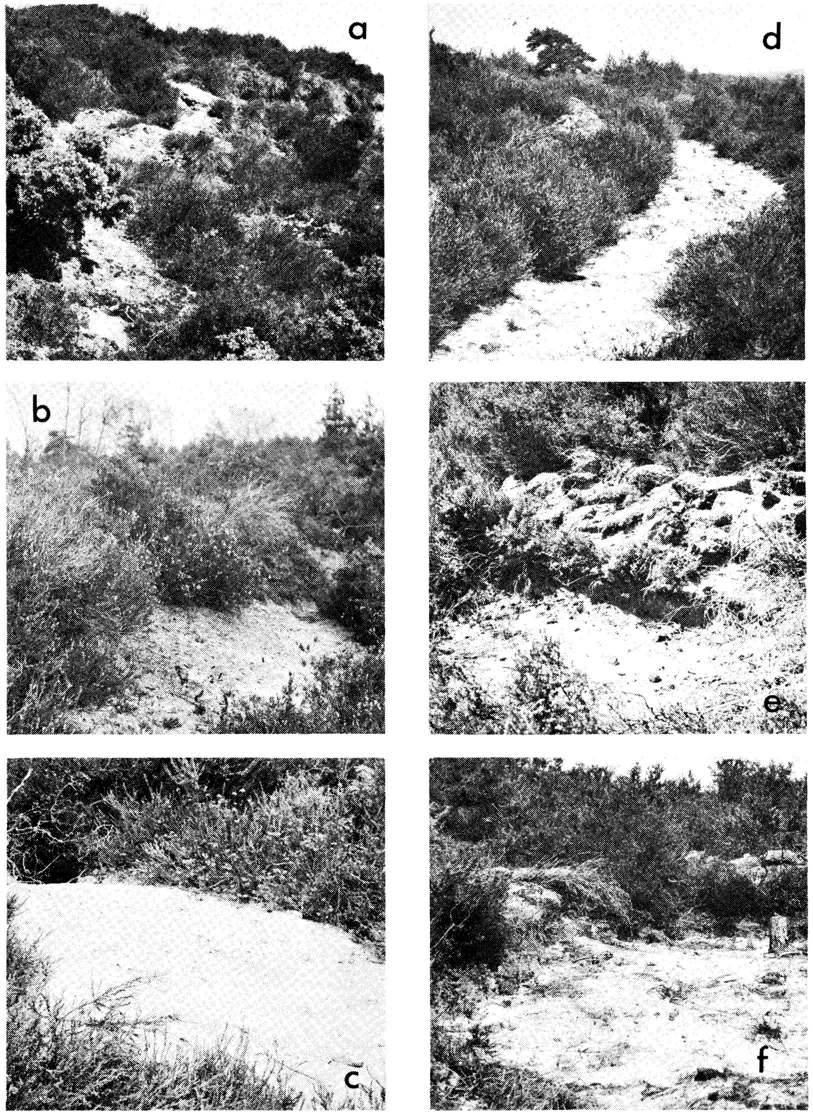

FIG. 6. Comparison of "natural" (a–c) with "managed" (d–f) sand exposure, used for egg-laying and incubation; (a) heather bluff; (b) natural erosion on steep slope; (c) spoils at entrance to fox earth; (d) narrow path cut across slope; (e) small "sand-patch" on sloping ground; (f) larger "patch" on flat ground. Note inverted heather turfs and piled to north edge of excavations, maturing in (d), newly cut in (e) and (f).

FIG. 7. Maximum extent of sand "patch" (before turf piling) in deep heath on flat ground.

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OVIDUCAL ANATOMY OF SOME HIGH ALTITUDE LIZARDS FROM KASHMIR

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SUMMARY

Aspects of the oviducal structure in *Agama tuberculata* and *Lygosoma himalayanum* have been studied. In both lizards, the typically lacertilian oviduct includes an anterior tubal, middle uterine and posterior vaginal region. The oviduct of *L. himalayanum* has a low folding in the vaginal region with less pronounced mucosal layers and a conical epithelium with broad bases against the muscular layers. In both genera oviducts are flat inconspicuous cords situated along the dorsal body wall during the quiescent period of the reproductive season. The changes correspond to those in the ovaries. Seminal receptacles appear to be secretory; spermatozoa in appreciable numbers could not be detected in them.

INTRODUCTION

The morphology and histology of oviducts of oviparous reptiles, mostly tropical forms, have been described (Saint Girons, 1962; Fox, 1963; Cuellar, 1966; Bons, 1972; Botte, 1973, 1974; Ortiz & Morales, 1974). The present study concerns two common temperate lizards in Kashmir, *Agama tuberculata* (Agamidae) and *Lygosoma himalayanum* (Scincidae), which reside at two different altitudinal belts, 1950–1960 m and 2285–3045 m respectively.

Hypertrophy and histological changes of the oviduct, which occur during the breeding season, are considered together with changes which occur in the ovary. Comparisons are made with similar features in other reptiles.

MATERIALS AND METHODS

Adult female lizards (*A. tuberculata* > 75 mm and *L. himalayanum* > 40 mm) used in the present study were collected from different regions of Kashmir during 1971–1973 (hibernation period excluded). The laboratory processing of the material has been described by Koul & Duda (1977).

OBSERVATIONS

In *A. tuberculata* (an oviparous form), paired oviducts which extend far in front of the ovaries are suspended in the body cavity by a mesotubarium. Anteriorly each oviduct possesses a wide-mouthed, thin-walled funnel, which opens into the body cavity by an elongated slit-like opening, the ostium. Posteriorly the funnel leads into a thick-walled, flattened oviduct, which gradually narrows towards the urodaeal chamber of the cloaca into which it opens. Each oviduct externally shows three recognizable regions; an anterior infundibular, middle uterine and posterior vaginal region. The infundibular region is flattened anteriorly and much folded posteriorly with folds oriented dorsoventrally; the uterine and the vaginal regions are broadly tubular. The folding is, however, more pronounced dorsally. The oviduct is about 52 mm long and the uterine and vaginal regions together account for nearly 58% of the length.

The oviducts in *L. himalayanum* (an ovo-viviparous form) are generally similarly situated and differentiated. The infundibulum, however, is less expansive and the oviducts not as strongly folded as in *A. tuberculata*. Each oviduct is about 35 mm long and suspended by a periotoneal fold, which in the region of oviducal funnel is a broad mesotubarium. The three regions are clearly recognizable. The uterus and vagina account for about 60% of the total length of the oviduct.

The wall of the oviduct of *A. tuberculata* includes an outer longitudinal and an inner circular muscular layer between the inner mucosa and outer serosa. The outer longitudinal muscle layer, which forms a relatively thick sheet over practically the entire vagina, comprises smooth fibres with very prominent nuclei. In the more anterior region of the vagina this layer is thrown into longitudinal folds which are highest at the region where it meets the uterus (Fig. 1a). The longitudinal layer is relatively thinner posteriorly. The circular muscle fibres are uniformly thick along the length of the vagina but thicker at the hinder region.

Along the entire length of the vagina, the innermost mucosa is thrown into longitudinal folds, which rest upon a lamina propria of richly vascularised connective tissue. The mucosal fold, approximately 31 μm high, is variable in thickness along most of the vagina. In contrast the lumen of the vagina reaches a maximum around its centre. The mucosal epithelium is columnar and ciliated. Each cell, on average 9.2 μm high, has a basal deeply-staining nucleus. The mucosal folds are less easily recognizable at the transitional zone between the vagina and the uterus and here cilia are restricted to merely a few cells arranged in ciliary rows. Such rows, however, extend along the length of the uterus. The cuboidal ciliated cells vary in height from 5.5 to 8.2 μm and cilia project into the lumen.

The uterine outer longitudinal muscle layer is reduced in thickness along its length and the mucosa is a thin sheet of columnar cells some of which are aggregated into glandular structures which open into the lumen of the uterus (Fig. 1b).

Each seminal receptacle comprises simple and branched tubules formed from a single layer of lobed, cuboidal epithelial cells. The lumen of a receptacle is generally very small. They occur in the anterior part of the vagina and the hinder region of the uterus and are located within the wall of the oviduct (Fig. 1b), between the mucosa and circular muscle layer (Fig. 1c), or between the two mucosal layers (Fig. 1d). Spermatozoa do not occur in appreciable numbers, in these structures.

In *L. himalayanum* the histological structure of the oviduct is similar to that described for *A*. tuberculata. The longitudinal muscle layer, however, is more uniform and prominent nuclei (2.4 μm diameter) stain dark blue with hematoxylin. The circular muscle layer is as thick (9.4 μm) as the outer longitudinal layer.

The mucosal epithelium is not thrown into very prominent folds. In the infundibular region, the serosa and combined outer and inner muscle layers are relatively the thinnest, both 6.8 μm thick. The fan-like epithelial cells of the mucosa are narrowest on the basement membrane (Fig. 1e). During the breeding season (May–July) these cells

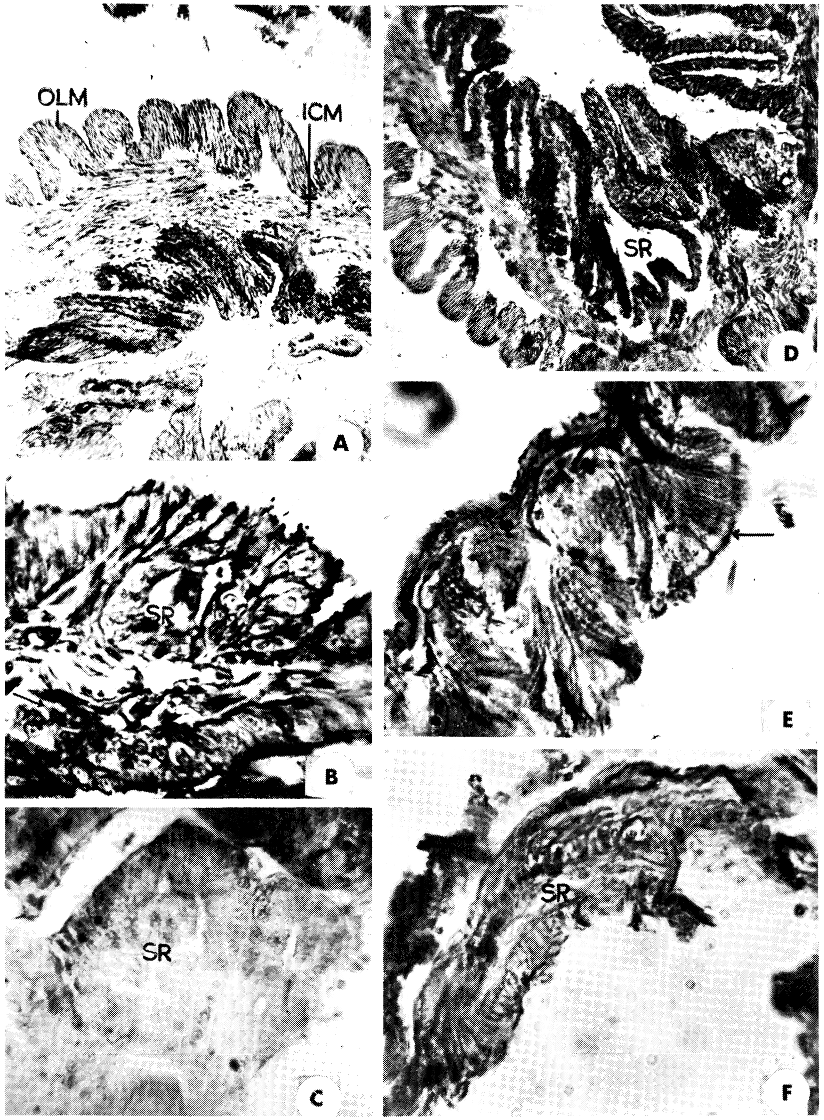

FIG. 1. (a) The anterior vaginal region of the oviduct of *A. tuberculata*. Outer longitudinal muscle layer (OLM); inner circular muscle layer (ICM). (b) Uterine wall of *A. tuverculata*; shell glands (arrow) and seminal receptacles (SR). (c) Seminal receptacle (SR) between mucosa and circular muscle layer of the oviduct in *A. tuberculata*. (d) Seminal receptacle (SR) between two mucosal layer in *A. tuberculata*. (e) *L. himalayanum*. Inner folded mucosal layer. Note fan shape of the cells (arrow). (f) *L. himalayanum*. Seminal receptacle (SR).

reach a maximum height of 17.6 μm. Each cell has a distal, oval nucleus, 2.6 μm in diameter.

The uterus has only few uterine glands, which are deeply located. The mucosa is folded up into cell aggregates, which assume the appearance of pyramids whose apices insert on the general mucosa. The columnar cells of the mucosa are 17.5 μm high in the pyramids and 14 μm high in between them. Oval nuclei are 2.4 μm in diameter. Deep within the uterine walls, blind tubular cavities of the obliquely disposed seminal receptacles have characteristic cuboidal epithelia (Fig. 1f). They are also scattered throughout the anterior part of the vaginal region, which is deeply furrowed with thick mucosa. The epithelial cells of the vagina and uterus are generally ciliated.

Seasonal changes

During October to April there are only few changes in the oviducal histology of *A. tuberculata*. However, when the lizards are reproductively active (May–July), mucosal height is minimal and the glandular masses the most secretory in appearance. At the height of the reproductive cycle the oviducts increase in width and change position, dorsally to laterally. The two oviducts are later situated side by side ventrally in the middle of the body. During August and September the oviducts are inconspicuous against the body wall.

Throughout the breeding season from May to the end of July, the only changes in *L. himalayanum* were the highly corrugated nature of the oviduct and the intense secretory activity of the cell pyramids. The uterus was extremely distended with eggs. In specimens captured in August–October, the entire oviduct was regressed and there was neither a prominent funnel nor infundibulum.

DISCUSSION

Although the oviducts of *A. tuberculata* and *L. himalayanum* resemble each other to a great extent in their histomorphology there are differences.

In *L. himalayanum* there is a low folding pattern in the vagina, the mucosal folds being tallest nearer the posterior third. The mucosal layers are also less pronounced than in *A. tuberculata*. The tall uniform columnar cells of the mucosae of *A. tuberculata* differ from the conical epithelial cells with broad bases against the muscular layers in the vagina of *L. himalayanum*. The mucosal nuclei of the epithelial cells are basally situated in *A. tuberculata* but more peripherally in *L. himalayanum*. The glands in the uterine region of the *L. himalayanum* are also fewer than *A. tuberculata*.

The paucity of uterine glands and the highest mucosal folds restricted nearer the posterior third of the vaginal length in *L. himalayanum* may be related to ovoviviparity. The low uterine glands can be related to the lesser amount of secretion needed for the development of a comparatively less resistant shell compared with oviparous forms. The occurrence of high vaginal folds would be an anatomical specialisation to allow for distension that this region should suffer during intra-uterine development.

Histological similarities are apparent in the four layers of the vaginal region, reduction of thickness of the outer longitudinal muscle layer in the posterior part of the vagina and the tallest longitudinal folds at the utero-vaginal transition zone in the anterior part of the vagina. The rise and fall in height of vaginal folds and the presence and location of seminal receptacles within the middle and anterior vaginal region in *A. tuberculata* and *L. himalayanum* are similar to the arrangement in iguanids (Cuellar, 1966).

The presence of seminal receptacle in lizards has been described in chamaeleons (Saint Girons, 1962), iguanids (Fox, 1963; Cuellar, 1966), geckos and eublepharids (Cuellar, 1966). There are no histological differences between the tubules in *A. tuberculata* and *L. himalayanum* and other lizards. The cells lining the seminal receptacles appear to be secretory and no spermatozoa were observed within them.

When oviducts of *Agama* and *Lygosoma* are inconspicuous cords during August to October (the quiescent phase of the reproductive period), the ovaries are completely regressed. The oviducts increase in size and thickness in late October. In the reproductively active period (April–July), the changes begun in the pre-hibernation period become extensive. During the breeding season (May–July), when the ovaries frequently possess corpora lutea, the oviducts are highly corrugated with intense secretory activity and are extremely distended. The distension is greater in *L. himalayanum* in regions containing eggs at different stages of development. These changes are similar to those described in other lizards (Cuellar, 1970; Ortiz & Morales, 1974). These changes in the oviduct suggest a relationship related to ovarian maturation. FSH and LH may well stimulate ovarian development and ovarian oestrogens the development of the oviduct. Oestrogens are considered to be responsible for regulation of oviducal size and function (Dodd, 1960; Licht, 1972; Bons, 1972; Botte, 1973, 1974; Ortiz & Morales, 1974).

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BRITISH JOURNAL OF HERPETOLOGY, Vol. 5, pp. 831–833

AMPHIBIANS WITH SCALES: THE STRUCTURE OF THE SCALE IN THE CAECILIAN *HYPOGEOPHIS ROSTRATUS*

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SUMMARY

Scanning electron microscopy reveals that the dermal scales in the caecilian, *Hypogeophis rostratus*, have an upper layer of ossified elements located in depressions in a mineralised basal plate.

INTRODUCTION

Of the three extant amphibian orders, the anurans (frogs and toads) and the urodeles (newts and salamanders), are well known. However, the "worm-like" caecilians of the order Gymnophiona (Apoda) are poorly described and hence it is not widely known that some apodans possess scales. Such scales are unknown in other extant amphibian groups.

The structure of the scales is not well documented. We therefore present a preliminary description of the scales in the caecilian *Hypogeophis rostratus* Cuvier, including the first scanning electron micrographs.

DISTRIBUTION OF SCALES

Histological examination of the skin reveals that the scales occur in rows which encircle the body below the epidermis (Fig. 1a). The scales are located in pockets in the middle dermal layer and typically two to six rows are present in each pocket. It has been reported (Wake, 1975), that in other caecilian species there may be as many as eight overlapping rows in each pocket, however, the maximum number we have observed in *H. rostratus* is six. The fibres of the lower dermal layer form the ventral boundaries of the scale pockets and these fibres connect to the ventral portion of the bony scales; in all cases these fibres separate the scales of adjacent rows (Lawson, 1963).

Each scale in any particular row is overlapped dorsally by the ventral portion of a scale from the row preceding it. However, the members of any particular scale row do not overlap. The number of scale rows in any particular scale pocket varies with the location of the pocket on the body and the number tends to increase towards the posterior end. Except for the extreme posterior end of the animal, the scale rows are incomplete dorsally and ventrally.

STRUCTURE OF SCALES

Individual scales are cycloid and subcircular in shape, with their shorter axes running antero-posteriorly when the scales are *in situ*. Each scale is composed of two distinct layers: a mineralised basal layer (basal plate) and an upper layer consisting of ossified elements (bony plates), which are arranged concentrically about an anterocentric focus (Figs. 1 and 2). The upper surface of the bony plates is relatively smooth and the edge which faces the periphery of the scale is curved. The edge facing the focus is serrated (Fig. 1b).

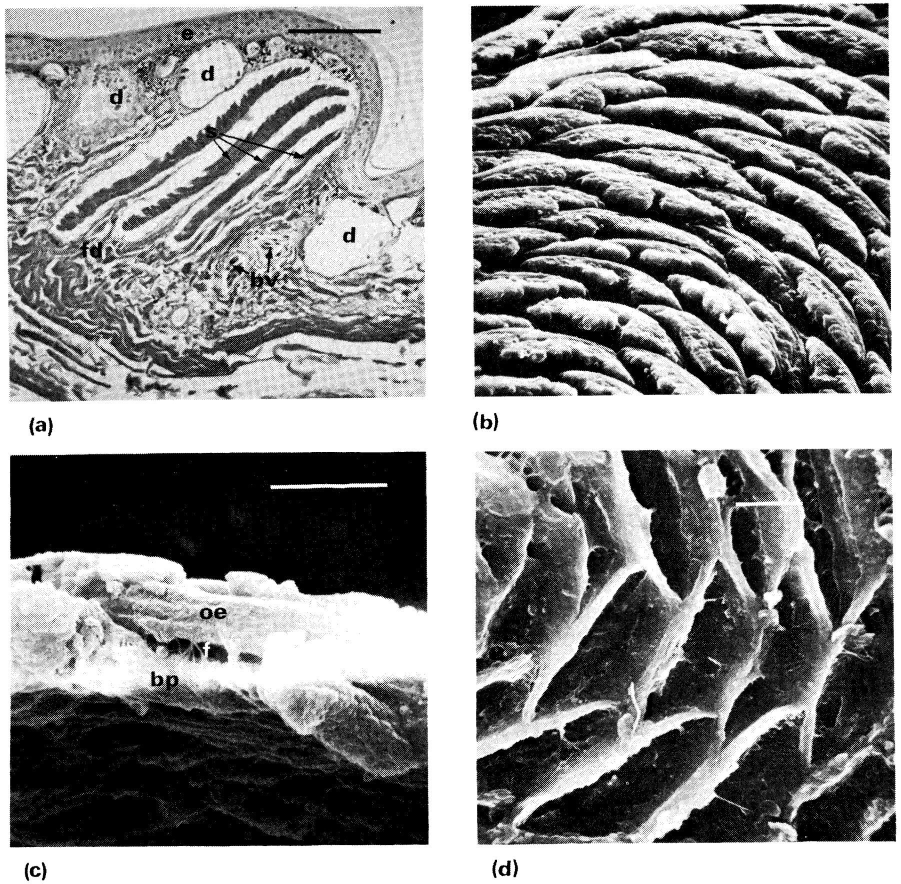

FIG. 1. (a) Longitudinal section through the skin of *Hypogeophis rostratus*. Anterior is to the left. The scales lie directly beneath the epidermis in the scale pockets and are connected to the dermis by fine fibres. Decalcified; Wiegerts haematoxylin & Van Gieson. bv = blood vessels, e = epidermis, d = dermal glands, fd = fibres of lower dermal layer, s = scales. Marker bar = 150 μm. (b) Scanning electron micrograph of the upper surface of a mineralized scale showing the arrangement of the bony plates. Marker bar = 30 μm. (c) Scanning electron micrograph of the edge of a mineralized scale showing basal plate and ossified elements or bony plates. The fibres anchoring the ossified elements to the basal plate are visible. bp = basal plate, oe = ossified element, f = fibres. Marker bar = 10 μm. (d) Scanning electron micrograph of the upper surface of a demineralized scale showing depressions in the upper surface of the basal plate which house the ossified elements of the upper layer. Marker bar = 15 μm.

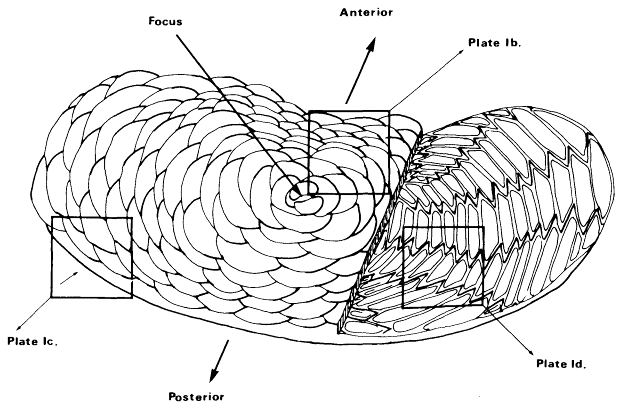

FIG. 2. Stereodiagram of a generalized scale. The left portion represents the mineralized scale while the right portion shows the scale with the ossified elements removed. The insets refer approximately to the areas shown in the respective scanning electron micrographs (Fig. 1b–d).

It has been previously indicated that the basal plate consists of two layers of collagenous fibres orientated perpendicular to the long axis of the scale and that in some forms there is, in addition, a middle lamella and a basal lamella with fibres orientated parallel to the long axis (Wake, 1975). However, we have not been able to demonstrate this in *H. rostratus*, in which the basal plate is composed of groups of fibres which are aggregated into large bundles (Fig. 1c). Such bundles are bound together by interconnecting fibres and this gives the ventral surface a uniform though gently undulating appearance. However, the arrangement of the fibre bundles is such that the upper surface of the basal plate consists of series of depressions around the focus. These depressions are typically four-sided and house the ossified elements which constitute the upper layer (Fig. 1d). The ossified elements are anchored in the depressions by fibres extending from the basal plate (Fig. 1c).

This preliminary description of caecilian scales demonstrates an essentially bilayered structure and thus their intrinsic similarity to scales in other groups of vertebrates both living and fossil. Although the ancestry of the caecilians is a matter of considerable debate, it is true that many early tetrapods were scaled and it seems that the caecilian scales are remnants of a more extensive ancestral squamation.

ACKNOWLEDGEMENTS

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BRITISH JOURNAL OF HERPETOLOGY, Vol. 5, pp. 835–837

A CASE CLOSELY RESEMBLING A NEUROEPITHELIOMA IN *TRITURUS ALPESTRIS*

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The majority of malignant growths occur in mammals and birds. Tumours of invertebrates, which are exceedingly rare, have been studied by Matz (1975). Reviews of the tumours of amphibians and reptiles, which are also rare, have been published by Schlumberger & Lucké (1948), Elkan (1960, 1963), Balls (1962), Reichenbach-Klinke & Elkan (1965) and Brunst & Roque (1967). Only about ten of these cases arose in urodeles and half of these arose in the skin which therefore remains the seat of predilection of malignant growths in this group.

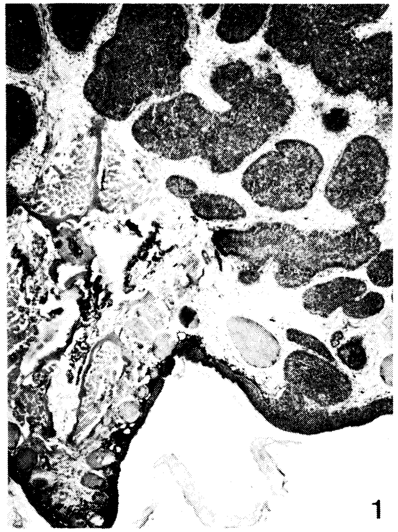
The tumour described arose in a specimen of *Triturus alpestris* (Laurenti) kept for six months by an amateur herpetologist in France. When the specimen reached the laboratory the tumour, on the tail, had reached a diameter of 9 mm. It was fixed in Bouin's picro-formol, sectioned at 7 μ and stained mainly with haematoxylin-eosin. Secondary deposits were not discovered. Part of the material has been deposited in the Registry of Tumours in Lower Animals at the Smithsonian Institution in Washington.

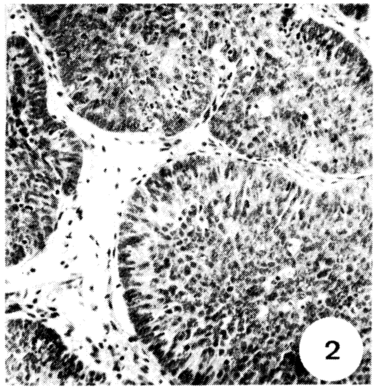
The tumour arose from the tail in several lobes, separated by sheets of connective tissue. Some of the lobes were round, others elongated, the centre always consisting of compact strands of tumour cells of epithelial type (Fig. 3) or of an empty space loosely filled with degenerating cells. The surface of the lobes always consisted of simple or stratified epithelial cells, mostly of fusiform shape and resembling bipolar cells. The tissue making up these lobes showed many mitotic figures which are rarely seen in normal tissues or in the cells covering the tumour. Skin glands which normally make up a large part of the skin were totally absent from the area of the tumour. In some areas the epithelium seemed to be budding into new lobes which detach themselves from the main tumour (Figs. 4 and 5).

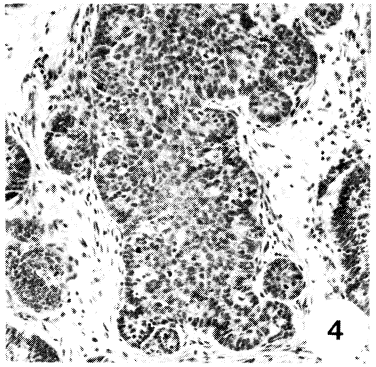
The appearance in this tumour of fusiform, bipolar and fibrillar cells with large ovoid nuclei would assign it to the neuro-epitheliomata, a group of tumours which usually arises in connexion with some part of the nervous system. The nomenclature and the classification of these tumours is still under discussion and I prefer the general term of neuroepitheliomata. A similar case has been described from *Siredon mexicanum* by Brunst & Roque (1967).

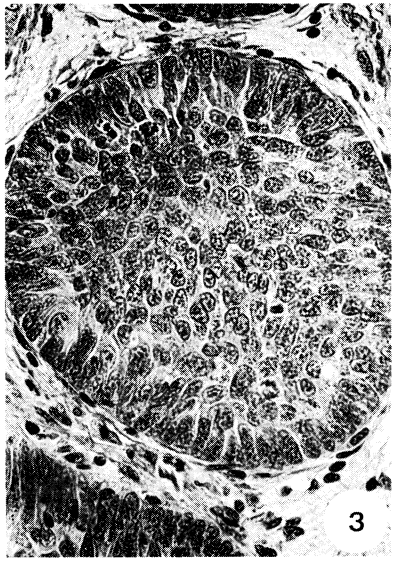
Malignant growths are more frequently seen in anurans which are also more sensitive to carcinogenic substances than urodeles. According to Darquenne (1971) such substances show their efficacy in urodeles only when they are applied to an area with a strong potential for regeneration or implanted into a regenerating area.

It is generally considered that tumours of the nervous system are congenital, arising from any undifferentiated part of the nervous ectodermal germ layer not used in the course of organogenesis. The fact that this tumour grew to an appreciable size without









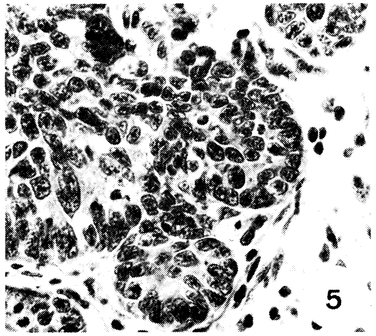


FIG. 1. Part of section through tail and tumour.
FIG. 2. Part of a lobe of the tumour covered by epithelium.
FIG. 3. Epithelium at higher magnification.
FIG. 4. Cells invading adjacent smaller lobes.
FIG. 5. As Fig. 4 at higher magnification.

producing any secondary deposits underlines the suggestion that it may be similar to those observed in the kidney of *Xenopus* by Elkan (1963). In urodeles such tumours must be regarded as exceedingly rare, and it is to be hoped that any such cases arising will immediately be made available for examination.

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CHAMAELEO CHAMAELEON IN THE PROVINCE OF MALAGA, SPAIN

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One species of chamaeleon, *Chamaeleo chamaeleon* L., extends from North Africa, where it originated (Bons, 1972), to the Iberian peninsula. In addition to the provinces of Cadiz and Malaga, it has been introduced into southern Portugal and into other localities in Andalusia (Mertens & Wermuth, 1960; Hellmich, 1962; Bons, 1973).

Bosca (1877) observed chamaeleons in Velez-Malaga and Gadow (1901) considered the species had been introduced into Malaga during recent times. Alvarez-Lopez (1934) and Salvador (1974) mentioned the existence of the chamaeleon in Malaga but did not indicate the places of collection, although Palaus & Schmidler (1969) collected specimens in Periana, a montane locality. Crespo (1972) considered that the chamaeleon occupies a continuous coastal zone in Andalusia from Huelva to Malaga, although this information appears to be based only on the potential and not on the actual population.

Over the past few years, I have made a study of the habitat of this species in Malaga. This involved periodic visits to collecting areas. Population was estimated from the number captured in a season; in addition mark-recapture studies were attemped. From these studies the map shown in Fig. 1 has been constructed.

It was found that the species occupies a very restricted zone in the east of the province. To the north, the population is limited by the mountains of Tejeda and Almijara; to the south the sea is the natural barrier. However, the zone is not homogeneous in terms of population density and five areas are evident (Fig. 1). The area with the largest population is that of Velez-Malaga where more than 100 individuals have been captured during a year; it is the only zone where marked specimens have been recaptured. The vegetation is rich in olive trees, almond trees and vineyards. In general, the altitude does not exceed 400 m except on the eastern side of the area. Around this area is another which in the north has an altitude of 750–800 m and in the south is limited by the coast. Fifty to one hundred specimens have been collected in this part except in the east where the population decreases markedly and the species becomes scarce.

In the west of the zone, the populations decrease slowly (25–50 individuals) until the city of Malaga, where the colony has its westerly limit, is reached. In the city 10–25 individuals have been captured. To the north-west, up to 800 m in altitude, and on the eastern side of the province, the species becomes scarce and individuals have only been captured from time to time (<10 per year). While in Malaga, the chamaeleon does not occur at altitudes higher than about 800 m, in North Africa it occurs up to 1700 m (Pasteur & Bons, 1960).

Still without confirmation are reports that these animals live on the other side of

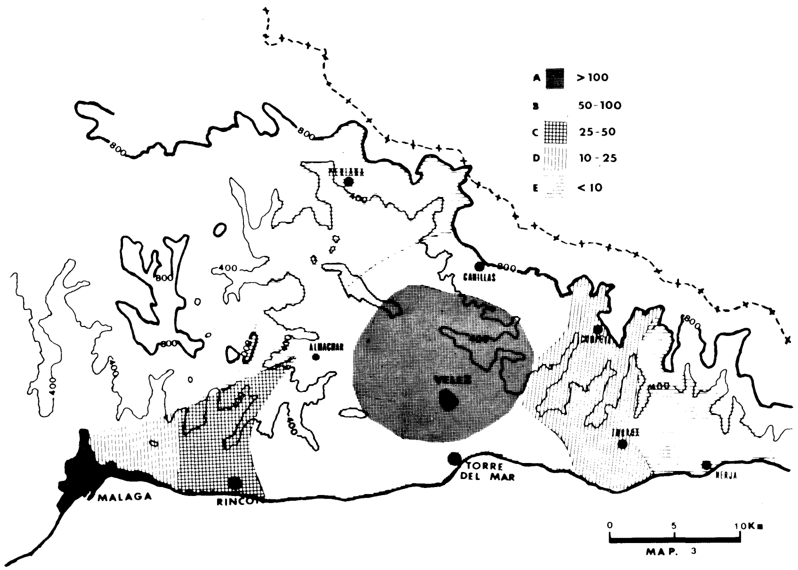

FIG. 1. Map showing the distribution and populations of *C. chamaeleon* in the province of Malaga. Localities studied in each area were: (a) Velez-Malaga, Viñuela, Arenas, Benamocarra; (b) Benejarafe, Bermuza, Almachar, Benamargosa, Canillas Aceituno, Algarobo, Torre del Mar; (c) Cala del Moral, Rincon de Victoria, Benagalbón; (d) Malaga (city), Cerro San Anton, Torrox, Competa; (e) Periana, Nerja, Frigiliana, Maro, Cutar. A–E = number captured/year.

Malaga City (Torremolinos); the possibility of artificial introduction, as has happened at other times, must be considered.

In 1976, the number of males (775) captured was greater than that of females (413). It is also of interest to note that only 28 young were captured.

After studying field data, I believe that the population of the chamaeleon is under pressure from human habitation. In the south, the enormous increase in urbanization and building connected with tourism, means that the chamaeleon's main centres of population are being forced into the interior without the possibility of establishing new colonies because of geographical limitations. This may make it necessary to re-introduce these reptiles into the coastal areas and to establish colonies beyond the natural barriers in suitable habitats.

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BRITISH JOURNAL OF HERPETOLOGY, Vol. 5, pp. 843–844

SURGERY ON A CAPTIVE SALAMANDER

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INTRODUCTION

On 4 January 1977 it was observed that a salamander (*Salamandra* sp.) that had recently been purchased from a commercial dealer, had a large ulcerous lesion on the right mandible just behind the mental angle. The surrounding tissues were grossly swollen and the mandible itself was broken, with the free ends protruding from the tissues. Subsequent investigation indicated that the lesion was caused by a species of fungus, not yet identified, that had infected most of the original stock. By 7 January it was apparent that the injury would not heal and that the animal could not feed. It was therefore decided to attempt to repair the jaw surgically, although the chances of recovery were considered minimal.

Sick or injured amphibians should, whenever possible, be referred to a veterinary surgeon experienced in their treatment if unnecessary pain to the patient and possible risk of prosecution are to be avoided. In this country, however, there are no veterinarians with such experience, and I was obliged to carry out the procedure in my own surgery.

ANAESTHESIA

Because no literature on methods of anaesthetising salamanders was available to me at the time, the procedure followed was entirely empirical. Sagatal (pentobarbitone sodium, 60 mg/ml—May & Baker (S.A.) (Pty) Ltd.) was chosen because of its satisfactory results with major procedures on reptiles (Lambiris, 1976), and used in the same way. Surgical anaesthesia was induced in approximately 70 min without any complications.

I have since been informed that the fish anaesthetic MS 222 gives very good results with amphibia, and that the *UFAW Handbook on the Care and Management of Laboratory Animals* is a useful source of information on anaesthetic agents.

SURGICAL EQUIPMENT

The surgical equipment consisted of the following instruments: 1 small Graefe knife; 1 Bowman's ophthalmic needle; 1 curved pointed iris scissors; 3 pairs of curved Weiss iris forceps (two toothed, one smooth-tipped); 1 pair of bone-holding forceps; 5/0 braided steel suture; 1 G-6 atraumatic half-circle, reverse cutting edge suture needle with 6-0 Vicryl (Polyglactin 910, synthetic absorbable suture—Ethicon, Inc.) suture; 1 pair of suture-cutting scissors; 1 fine bone awl.

PROCEDURE

After anaesthesia had been satisfactorily induced, the animal was positioned with the right side of the body uppermost, between two gauze pads. The body was covered with moist gauze and the head and neck left fully exposed.

The original intention had been to drill through the mandible near each side of the break, appose the ends and hold them together with a steel suture passed through the bone. However, the mandible proved to be broken near the articular condyle as well, making a simple repair quite impossible.

The mandible on the right side was therefore displayed and completely removed. The broken ends remaining behind were debrided, but it was difficult to do so entirely satisfactorily because of the rather limited working area. Pieces of periosteum, which still appeared to be healthy, were stripped from the excised portion of bone and replaced; they were held in position with fine Vicryl sutures. It was hoped that sufficient osteoblasts within the deeper layers of periosteum would survive to induce even partial regeneration of the bone. The tissues were sutured together as far as possible, but the original lesion could not be repaired completely. It was not possible to devise some system of traction for the period of recovery.

After the operation the salamander was given 0.02 ml of Oxycline (Oxytetracycline hydrochloride—Panvet (Pty) Ltd.) and 0.01 ml of picrotoxin intramuscularly, and replaced in a recovery cage containing a little water with a trace of mercurochrome (2%) added.

POST-OPERATIVE HISTORY

Contrary to expectations, the salamander recovered consciousness some 20 hr later. It seemed rather sluggish at first, but soon revived fully. It was kept in the recovery cage for two days, then returned to the aquarium with its mate. The only post-operative treatment given was the topical application of mercurochrome (2%) every second day for about two weeks.

Five days after surgery the salamander ate an earthworm about 4.5 cm long without any apparent difficulty, and another one two days later. Gentle palpation of the area indicated apparent regeneration of the excised bone, and the wound itself was almost completely healed. Ten days after surgery another two worms were taken in rapid succession and it was clear that the bone was regenerating rapidly, with unimpaired function and minimal distortion. At the time of reporting the case, eleven months later, the salamander has thrived without any evidence of neuromuscular or circulatory damage.

ACKNOWLEDGEMENTS

I wish to thank Mr N. Girvan of Glaxo-Allenbury, Salisbury, for his many years of invaluable advice and assistance with the selection of instruments for herpetological surgery; Mr G. Parrish, Salisbury, who made available the delicate ophthalmic sutures essential to such surgery; and to Dr C. Sparrow, Salisbury Central Hospital, who very generously donated a set of ophthalmic knives without which such an operation would have been impossible.

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NOTES ON THE REPRODUCTION OF THE LIZARD *COPHOTIS CEYLONICA*

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INTRODUCTION

Little is known about the habits and reproduction of the prehensile-tailed lizard, *Cophotis ceylonica* from Sri Lanka. This small, slow moving, arboreal species found on tree trunks in the mountainous regions of its range (Deraniyagala, 1931), is one of the two known viviparous agamid lizards (Smith, 1935; Fitch, 1970). The present paper details the birth of one brood and describes the young of two broods.

MATERIALS AND METHODS

On 20th January 1976, the Fort Worth Zoological Park received one adult male and two adult female *C. ceylonica*, which were exhibited in a 60 cm fibreglass cage (Hulsey, 1973) decorated with branches, rocks, and several live plants with a substrate of small pea gravel (3 mm) and dried leaves. A three foot Vita-lite fluorescent tube provided lighting between 08.00 and 17.30 hr and there was additional natural light and a natural photoperiod through clear skylights. Although a small water dish was provided, the cage was misted daily. The adults fed bi-weekly on small live crickets, mealworms and occasionally small earthworms, especially the latter two, probably because they were easier to catch. Temperature ranged between 20 and 26°C.

OBSERVATIONS

Although no courtship or copulation was noted, both females gained weight and expanded laterally. The lizards stayed mainly on the branches and plants until 15th February 1976 when one female (58 mm snout-vent length, 126 mm total length, 4.3 g, *post partum*) descended for longer and longer periods each day. On 20th February, four young were discovered on the branches. The adults were not in immediate proximity. The juveniles had snout-vent lengths of 19 mm, total lengths of 38 mm, and weights of 0.3 g. Adult coloration varied from olive-green to a greenish-brown; all juveniles had a ground colour of light charcoal mottled with black and possessed conspicuous black tail bands on a light charcoal body ground colour. Colour shades changed depending on temperature, humidity and substrate, which is possibly a protective device not readily apparent in adults. The adults were generally broad and compressed with an elongated snout; the juveniles were considerably more elongated with a short, anteriorally flattened snout.

Juveniles were housed in a 19-litre aquarium and readily climbed numerous small branches but usually remained within 5 cm of the floor, resting horizontally among the twigs. Soil containing mites was used as a substrate and the lizards fed on these immediately after birth. Later *Drosophila* were consumed. Probably any slow moving insect or arachnid of suitable size is eaten in the natural habitat. By 20th March 1976, 3 of the 4 died of unknown causes and the last one died on 22nd March (snout-vent length 23 mm; total length 46 mm).

From 5th March 1976, the second female (53 mm snout-vent length, 116 mm total length, 3.3 g, *post-partum*) remained longer on the substrate. On 10th March at 09.00 hr, near the front of the cage in a shaded area, she raised the anterior region of her body and remained stationary for 5 min. Five newborn young were found at 09.30 hr, positioned in an oval, each about 2.5 cm apart. It seemed that she had taken one or two steps after each birth with a time interval of about 5 mins. After 10 mins when the young were removed, the female refused to move from the rock. All juveniles were in a coiled position and enclosed in a transparent but fairly thick membrane. Three of the juveniles possessed large dorso-lateral yolk sacs (6 × 4 mm, 9 × 4 mm, 7 × 5 mm) immediately behind the head under the birth membrane. An umbilicus extended laterally from the venter into the yolk sac. Only one juvenile actively attempted to escape from its encasement, though its movements were weak. By 15.00 hr, all appeared dead. The following measurements were made: snout-vent length 17–18 mm (mean 17.6 mm), total length 32–35 mm (mean 34 mm), weight 0.2–0.3 g (mean 0.22 g). For both broods, means of the snout-vent length were 18.3 mm, total length 36 mm, and weight 0.26 g. Coloration and morphology closely paralleled the descriptions given above.

DISCUSSION

Within the Agamidae, viviparity occurs in *Cophotis* and *Phrynocephalus* (Smith, 1935; Fitch, 1970). Among 6 groups of lizards, Fitch (1970) found that the majority of species with the smallest (1–3) or largest broods (more than 15) are tropical; those with intermediate sized broods (4–15) are mostly temperate. *Cophotis* with broods of 4–5 is thus characteristic of a temperature zone species yet it is a subtropical mountain dweller. *Phrynocephalus*, which occurs in an extremely xeric habitat, generally produces two embryos (Smith, 1935), and thus is characteristic of tropical forms. The transition to viviparity in these cases may be due to adverse climatological conditions. Embryos of *Phrynocephalus* always have a large complement of yolk but it is not known how far development proceeds before young are born (Smith, 1935). In the second brood of *Cophotis*, three young had large yolk sacs, and all five had thick birth membranes. Since all of them were at full term or nearly so, it is possible that *Cophotis* (and *Phrynocephalus* also) are born with structures usually present only in less advanced embryos of other viviparous lizards. Since oviparity is the normal mode of reproduction for the Agamidae, it is possible that *Cophotis* and *Phrynocephalus* have only recently become viviparous and they still possess evidence of former oviparity. *C. ceylonica* still lacks well developed placental structures and embryos appear more self-supporting during gestation than in other viviparous species. Fitch (1970) concluded that although the transition from oviparity to viviparity is not readily reversible, recently evolved forms conceivably might be able to revert under certain conditions. Perhaps this is the case for these two genera.

One individual of brood 1 and the five of brood 2 are in the museum collection of the University of Texas at Arlington.

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A SECOND SPECIMEN OF THE MATANNA WATER SNAKE, *ENHYDRIS MATANNENSIS* (BLGR.), FROM RAHA, MUNA ISLAND, INDONESIA

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The matanna water snake, *Enhydris matannensis* (Boulenger) is known only from a single specimen, an immature male, obtained from Matanna Lake (altitude approximately 415 m), Central Celebes. This specimen was collected by P. & F. Sarasin around 1893–1896 (Boulenger, 1897) and the holotype is deposited in the National Museum, Basel (NMB, 1735). Until now it is the only known example of the species.

In early January 1977, a female specimen (485 mm, tail 78 mm) was collected by Mr Gregori G. Hambali from a fish pond in Raha, Muna Island, southeast Celebes. This specimen matches well with the descriptions given by Boulenger, de Rooij (1917) and Ko Ko Gyi (1970) except for some minor features. It has a single internasal, one right and two left postoculars. Only the fourth upper labial enters the orbit and the fifth left upper labial forms a suture with the eye. The single loreal is nearly as long as high, in contact with the second and third upper labial, forming a suture with the first left upper labial. There are nine right and ten left lower labials; the fifth right and sixth left lower labials are the largest; the first four right and five left lower labials are in contact with the first pair of chinshields. It has 134 ventral and 47 subcaudal scales; the seventh ventral is incomplete. The scale reduction in this specimen according to Dowling's formula is:

$$21 \frac{3 + 4\ (114)}{2 + 3\ (113)} 19\ (134)$$

It has 4–5 gular scales and two incomplete ventrals.

The colour matches very well with the illustration in Boulenger (1897) except that the ventral scales of this specimen have less conspicuous greyish brown spots.

The freshwater fish pond where the snake was found lies about 100 m from the coast, which is separated from the pond by the main road which leads to the harbour. The nearest river lies about 2000 m from the place where this specimen was obtained. The snake was caught at 20.00 hr while it was resting.

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THE STATUS OF MARINE TURTLES IN THE WATERS OF THE YEMEN ARAB REPUBLIC

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INTRODUCTION

Information on the marine turtles (Arabic, *Sulkhafa*) of the Yemen Arab Republic (YAR) is very scanty. The only published work from adjacent Red Sea countries found by the author is a taxonomic paper on the Green Turtle of the Dahlak Archipelago (Hoofien & Yaron, 1967). The characteristics of the specimens of *Chelonia mydas* obtained enabled them to be placed in the subspecies pertaining to the Atlantic and Mediterranean. There have been no marine turtle surveys along the coast of the YAR to date. I have been in the YAR since March 1974, and some preliminary information is presented.

Four species of marine turtle have been observed living in the waters of the YAR. They are the Green Turtle (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Olive Ridley (*Lepidochelys olivacea*), and the Leatherback Turtle (*Dermochelys coriacea*). The species most commonly observed and accidentally caught in our bottom trawl has been the Green Turtle. As many as four large Green turtles (100–120 cm. carapace length) have been caught while trawling over shallow (7–9 m) silt-sand bottom. Coastal areas which often have good stands of aquatic macrophytes along the bottom are thought to afford good pasturage for marine turtles. The most abundant skulls and shells found washed up on the beaches are of Green turtles followed by Hawksbills. Only one Ridley Turtle has been seen. This was caught while trawling in 26 m water 16 km northwest of Ras Katib.

Large Leatherback turtles have been seen on the surface 6.5 km off the shore of Mandar village, swimming over rough coral at a depth of 24 m. A dead Leatherback specimen was washed up on the shore of Hodeidah on April 1976.

DISTRIBUTION

The coastline of the YAR is some 450 km long with a shelf area of 17 700 km^2. Marine turtles have been seen in all the areas studied to date, although the area south of Ras Mujamila has not received much attention. Most of our turtle sightings have been in the shallow protected waters around Ras Kati. This of course may, in part be, due to the fact that almost 50% of our fishing effort has been directed in this area. Marine turtles have also been seen on the reefs around Dicno Gulf in Kamaran Bay, Rhisa, and Kadaman Zaghir Island. A large group of turtles were reported swimming off a beach in Isa Bay during February. Although this report was not confirmed it may indicate possible mating aggregations.

FEEDING AREAS

Pastures of marine angiosperms offering good feeding are abundant in the Ras Katib/Khor Katib area, in Isa Bay, probably also in Kamaran Bay and the Khor Gulaifiga (Ras Mujamila Bay). Pastures of aquatic macrophytes are also present in the lagoons along many of the islands off the YAR coast. Coral reef environments are abundant in YAR waters especially around the island groups. Hawksbill turtles have been seen in these areas.

NESTING GROUNDS

The best nesting areas seem to be the uninhabited, low-lying coral islands located 3–30 km off the coast. There may also be important nesting areas on Zugar Island and on the Hanish Archipelage. These islands, located on the south coast of the YAR, are all uninhabited and are only visited occasionally by fishermen. They are volcanic in origin and may offer very good isolated nesting grounds for several species. Zubair Island, unlike the southern Archipelago, located Northwest of Hodeidah does not offer any suitable nesting beaches along its entire shoreline.

The coastal region may also offer some nesting habitat although disturbance by man, feral dogs, foxes, and jackals may present a serious limiting factor. Beachcombers have even been seen walking along the isolated Ras Isa–Ras Bayad peninsula. Fishermen using small *Houri* type fishing craft (dugouts) frequent the entire coastline as well, and probably search out turtle eggs whenever fresh tracks are seen.

PREDATION

Marine turtles are not protected by legislation in YAR waters. At present, there is some predation by man on turtle flesh, although Yemenis are selective in that they will not eat females, nor will they eat any dead turtles caught in their nets. The flesh does not seem to be highly desired. Turtle eggs on the other hand are eaten with great relish and much evidence of nest disturbance has been seen in the nesting areas on some of the offshore desert islands. Turtle eggs are locally reputed to be aphrodisiac.

Natural predators include an assortment of sea birds on the hatchlings. Ghost crabs (*Ocypode* sp.), dogs, jackals, and monitor lizards may also be significant if any nesting still occurs on the mainland, although none has been seen to date. Sharks and other marine predators also take their toll on the turtle population. One large Tiger shark was dissected in the Hodeidah market and found to have in its stomach a 27 cm long Hawksbill femur, several costal plates, and skeletal parts. On piecing together the remains it was estimated that the turtle eaten had a carapace length of approximately 60 cm.

PRESENT STATUS

It is doubtful if the population trends of the various species of marine turtle found in YAR waters have fluctuated much over the past few years, as there is still no organized exploitation of the adults, and the eggs seem only to be obtained when the opportunity presents itself. An increase in human population could cause a higher fishing pressure on the Yemen coast. However, the increased standard of living, greater percentage of imported meats and foods, and the diversion of labour from subsistence fishing to more profitable trades may be contributing factors limiting the exploitation of turtles.

The present status of the marine turtle resources, from the fragmentary information available, is rated as good. Continued uncontrolled predation on nests will reduce the populations of marine turtles to a level below their optimal carrying capacities as has been mentioned in many reports, for example Hirth & Hollingworth (1973), Frazier (1973) and Bacon (1975).

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A MODIFICATION TO THE METHOD FOR PREPARING DRIED SKINS OF ANURANS

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The method developed by Kincaid (1948) for preserving the dried skins of anurans suffers from the disadvantage that details of the digits and phalanges, characters important in taxonomy and field identification, are often not visible as a result of the skinning process. We have therefore modified the method by retaining all or some of the metacarpals and metatarsals together with the phalanges as part of the dry skin preparation.

In large specimens the metacarpals and metatarsals are cut proximally whereas in small or delicate specimens these bones are retained. This inclusion of the bones in the preparation enables the web and other structures to be displayed effectively. In other respects, the procedure follows that outlined by Knudsen (1966).

Fig. 1. Dry skin preparation of a specimen of *Bufo melanostictus*.

An illustration of the type of preparation that is obtained using the modified technique is shown in Fig. 1. The method is clearly useful for preserving external characters, including colour patterns, as an aid to taxonomy and identification, although wet-preserved specimens are of course required for full taxonomic studies.

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BOOK REVIEWS

SNAKES AND SNAKESBITE. By J. Visser and D. S. Chapman (1978). 152 pp. Cape Town: Purnell (in U.K. from Bailey Bros & Swinfen Ltd, Warner House, Folkestone, Kent). £10.

This is an extraordinarily comprehensive account, the combined effort of a herpetologist and of a surgeon, of venomous snakes and the problems of snakebite in southern Africa. After a general introduction, a chapter on the epidemiology of snakebite gives fascinating statistics of general incidence; seasonal incidence; site of the bite; susceptibility of people of different sex, age and occupation; morbidity and mortality. There is then a general description of the venom-injecting system, variables affecting the seriousness of the bite and the composition of venoms. The species involved are described, aided by colour plates and distribution maps, together with their type of venom.

The pathological effects are illustrated by horrific photographs of cases. Treatment and first-aid are then covered, followed by a number of illustrative case-notes.

Although I am not competent to judge the detailed medical aspects, the book seems to me to be excellent in all respects. All herpetological libraries, as well as those working in southern Africa, should have a copy.

M. PEAKER

WHY THE DINOSAURS BECAME EXTINCT. By J. L. Cloudsley-Thompson (1978). 186 pp. Shildon, Co. Durham: Meadowfield Press. £2.80.

To those of us with an outsider's interest in palaeophysiology and the extinction of the dinosaurs, Cloudsley-Thompson's essay is very welcome. By presenting the gist of arguments for and against the numerous hypotheses that have been advanced over the years, and culminating in the "hot-blooded dinosaur" controversy, he has produced a very readable book which should be of value to students as an introductory text and to those comparative physiologists who wish to be informed of developments in this field. Although he deals with the many hypotheses he also makes it clear which horse his money is on, and like a good detective novel, his suspect is revealed at the end.

My one criticism is that in 76 pages (there are four pages of references) it is difficult to give the necessary background to a number of the arguments. Therefore it is, and rightly so, a scientific essay couched in a way suitable for students with some knowledge of zoology and comparative physiology. It is not for the popular market, which in many ways is a pity because it is far less partisan than a fairly recent book at least half aimed in that direction. I enjoyed it and profited from reading it.

M. PEAKER

ECHSEN IM TERRARIUM. By W. Kästle (1978). 96 pp. DM 7.80.
SCHLANGEN IM TERRARIUM. By W. Franck (1978). 64 pp. DM 8.80. Stuttgart: Franck'hsche Verlagshandlung.

Every large country has at least one publisher who caters for the amateur wanting to keep small animals. In Germany it is "Kosmos" from the Stuttgart firm of Franckh. These two slender volumes are in their "Vivarium" series, one on lizards, the other on snakes, which, if only they are translated, would make ideal reading for many members of the British Herpetological Society. Unfortunately, however, they are not, and those unfamiliar with the German language would have to limit themselves to looking at the pictures which, whether in black-and-white or colour, are of a high quality. The text, written by authors with a vast experience of the subjects, contains everything the beginner can possibly want to know; what he should—and particularly what he should not—do. The prices of these booklets are moderate. The publishers should be encouraged to put them on the Anglo-American market.

E. ELKAN

INTRODUCTION TO HERPETOLOGY. By C. J. Goin, O. B. Goin, and George R. Zug (1978). Third Edition, 378 pp. San Francisco; W. H. Freeman and Co.

The third edition, as have the previous editions of around 350 pages, met the challenge of providing an introduction to herpetology by providing an excellent balance between brevity and depth. The authors claim that their aim is not to be encyclopaedic but to provide a comprehensive text on amphibian and reptilian biology for students who have had some background to biology. There is no doubt that this aim has been achieved and that the excellent style first seen in Chapter One (introduction to history, systematics and nomenclature of herpetology) is continued throughout the remaining pages. In a logical sequence, the next two chapters give an account of amphibian and reptile form and function: it is a brief account but most of the relevant aspects seem to have been noted. This is followed by two chapters on the origin and evolution of amphibians and reptiles, a topic which so often can be very confusing. If the reader is prepared to accept that some experts think of the Lissamphibia as a subclass while others think of them as a super-order, then there should be no need for concern.

Chapters Six and Seven provide every stimulation to find out much more about the reproduction and life history of amphibians and reptiles: its an absorbing but all too brief an account. I felt that the term "courtship" was just as adequate as "Liebespiel" (love play) when it came to describing the fascinating and elaborate dances of salamanders.

The next two chapters deal with ecological aspects and I found this account to be well up to date and in some instances even putting an end to many old misconceptions about the homeostasis of these animals. The chapter on behaviour is particularly useful and follows the section on ecology with the same excellent but brief account of important terms and concepts.

There then follows a theme of genetics and speciation with a very valuable account of zoogeographical aspects of amphibians and reptiles. Finally, the last six chapters give an adequate and brief account of each group, commencing with the caecilians and ending with the rhynchocephalians and crocodilians. Like each of the previous chapters, the last six are written in an excellent style: in particular I found that the list of references placed at the end of each chapter was preferable to the usual scientific journal style of including references in the text.

But the book does not end at Chapter Seventeen, for there then follows a brief guide to the classification of living amphibians and reptiles, a list of references for identification of amphibians and reptiles in each of the zoogeographical regions, a scientific name index and a subject index.

There is no doubt that this 3rd edition continues to have the same high quality as do the previous editions and I am in no doubt that this very useful text will prove to be very popular.

I. F. SPELLERBERG