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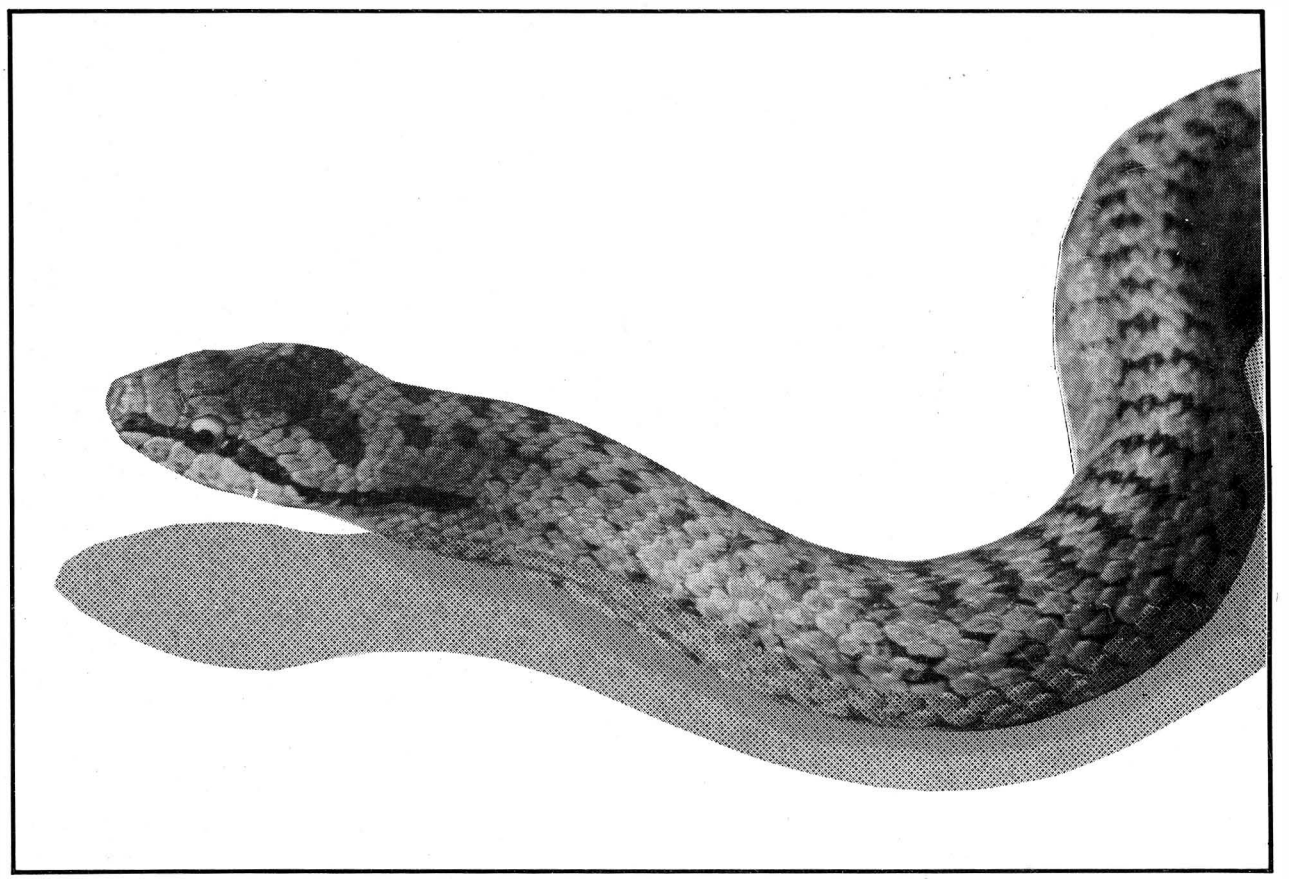

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THE DISTRIBUTION IN ENGLAND OF THE SMOOTH SNAKE (*CORONELLA AUSTRIACA* LAURENTI)

Results of the British Herpetological Society Survey, 1984-7

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ABSTRACT

The British Herpetological Society (BHS) contracted with the Nature Conservancy Council during the years 1984-7 inclusive to determine the distribution and population characteristics of the smooth snake *Coronella austriaca* Laurenti in England. 14-19 BHS members, assisted by other persons, surveyed likely areas by direct observation and by searching under metal sheets (tins) and debris. Snakes were identified by descriptions, measurements, drawings or photographs and their occurrence marked on maps; they were usually sexed by relative tail length. Weather conditions at the time of sighting were recorded. BHS members surveyed altogether 196 sites and found not less than 261 snakes on 86 sites. The survey measured 118 males, 64 females and 58 immature (less than 42cm total length) snakes: the remaining 21 were not measured. Evidence of breeding (gravid and/or immature snakes) was found on 40 sites. Implications for conservation are considered. A map shows the approximate limits of *Coronella* occurrence and 10km squares in which snakes were found. The text includes observations on mating, times of birth, length of snakes and persistence in small areas.

INTRODUCTION

The smooth snake *Coronella austriaca* Laurenti is the rarest British reptile. Smith (1951) indicated its distribution by dots on a map showing populations in two separated regions; A Dorset/Hants/Wilts and B Hants/Surrey (with two observations in Sussex). Frazer (1983) reproduced a Biological Records Centre map based on a 10km square grid. Particularly since about 1970, there have been massive losses of the dry heathland habitat type preferred by the smooth snake (Nature Conservancy Council, 1983) with, presumably, decrease also in its population. To obtain more systematic and up-to-date information, the Nature Conservancy Council (NCC) offered the British Herpetological Society (BHS) a contract to make a survey of suitable habitats in and peripheral to areas A and B to establish the distribution and status of *Coronella* populations. The survey ran from 1984-7.

METHODS

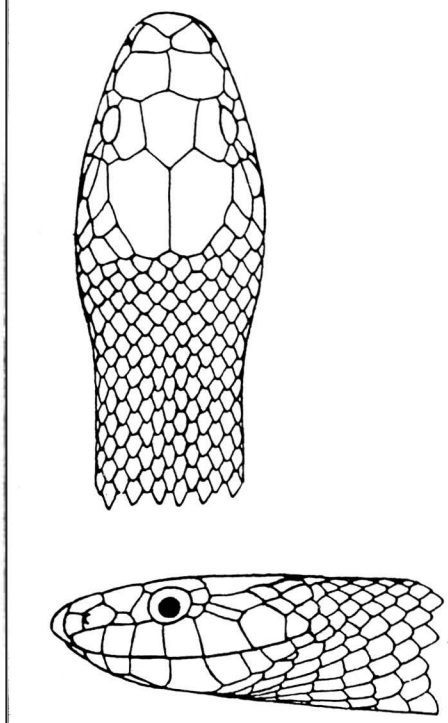
Personnel. For each survey year, the BHS formed a *Coronella austriaca* team (CAT) for fieldwork. Numbers for each year were: 1984, 15; 1985, 17; 1986, 19; 1987, 14.

Organisation and methods of survey. By discussion, the CAT and NCC selected sites to be surveyed during each season: an agreed list was given to each member. Members communicated findings as these were made. Surveys of sites were curtailed as soon as evidence of breeding (gravid snakes or juveniles) was obtained. The CAT found smooth snakes by searching under flat or corrugated iron sheets ('tins') and other debris and also by direct observation. On most sites, members laid tins unobtrusively: these were not laid where there was much public access or where owners refused permission. Members prepared maps of almost all sites, showing the positions of numbered tins, if laid.

Recordings. CAT members recorded findings of smooth snakes and their circumstances in a booklet containing pages as Fig. 1; weight was usually omitted. A code for scale clipping was devised but most observers did not use this method, preferring instead to identify snakes by measurements and by drawings or photographs of the head and proximal dorsal patterns (Fig. 2), a method employed by Goddard (1981) for small *Coronella* specimens. Some observers also recorded scale abnormalities and damage.

Smooth snakes can be conveniently sexed because the tail in females is shorter than in males, the percentage ratio vent-tail length/total body length being about 20-22 in males and 16-17 in females. The CAT used this method or subcaudal scale counts throughout the survey. The accuracy of these methods for sexing has been assessed by van Gelder *et al.* (1988).

Sites were visited as often as time and opportunity allowed, and at the end of each season information recorded was, for each site: number of tins, number of visits, smooth snakes found, individual observers. The CAT paid particular attention to readily accessible sites for which it had no previous *Coronella* records. In general the team surveyed dry heathland areas, but many of these included wet heath, grassy places and conifer tree plantations.



TIN No.	GRID REF.
CLIP No.	SITE
O.A.LENGTH (mm)	DATE
V.T.LENGTH (mm)	TIME
WEIGHT (g)	SUN: STRONG/OCC'/NONE
MALE/FEMALE/JUVENILE	SHADE TEMP (DEG.C)
FIRST CAPTURE/RECAPTURE	CLOUD /8
PRE SLOUGH/POST SLOUGH	WIND: STILL/LIGHT/STRONG
	WIND DIRECTION
	RAIN Y/N
	PREVIOUS RAIN Y/N
NOTES	

Fig. 1 Field record sheet used by BHS smooth snake survey 1984-7.

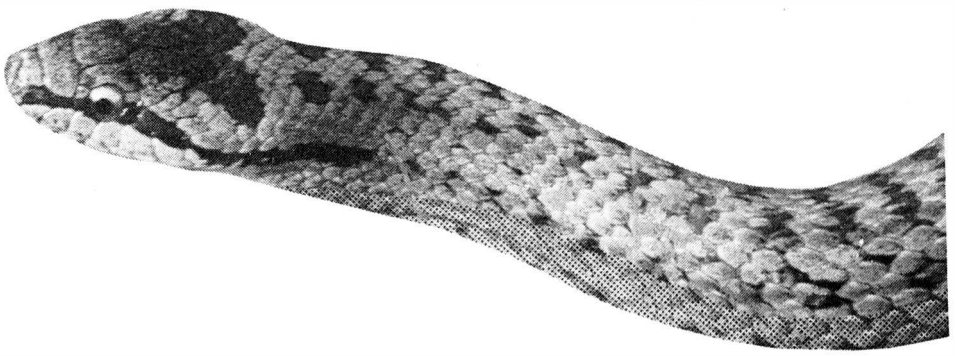


Fig. 2 Forepart of *Coronella austriaca* from area A (see text). Head and proximal dorsal patterns together with measurements of total length and vent-tail length were sufficient to identify smooth snakes found on the BHS survey 1984-7.

RESULTS

Ordnance survey boundaries within which the CAT found smooth snakes are shown as areas A and B in Fig. 3. The vertical line at OS 440 represents the limits of sightings (in 1986) as supplied by A. H. Gent (see DISCUSSION). The team found no smooth snakes in Sussex or Wilts.

A 'site' was defined arbitrarily as a heathland area through which a smooth snake might be expected to travel until checked by difficulties such as roads, urbanisation, mining, cultivation etc. The CAT surveyed 196 sites; 140 in area A (Fig.3), 22 in area B (Fig. 3), 10 peripheral to A and 24 peripheral to B (including 4 in Sussex). Evidence of breeding (gravid or immature snakes) was found on at least 36 sites in region A and 4 in region B. The number of visits was determined by accessibility (e.g. military sites could be visited only with permission and when activity was minimal), opportunity and desirability (see METHODS). Tables 1 and 2 show the extent to which sites were furnished with tins and surveyed.

The number of new sites surveyed in each season, minimal numbers of smooth snakes seen for the first time and the proportions found under tins are shown in Table 3. Sloughs, snakes not caught, doubtful sightings and recaptures are not included.

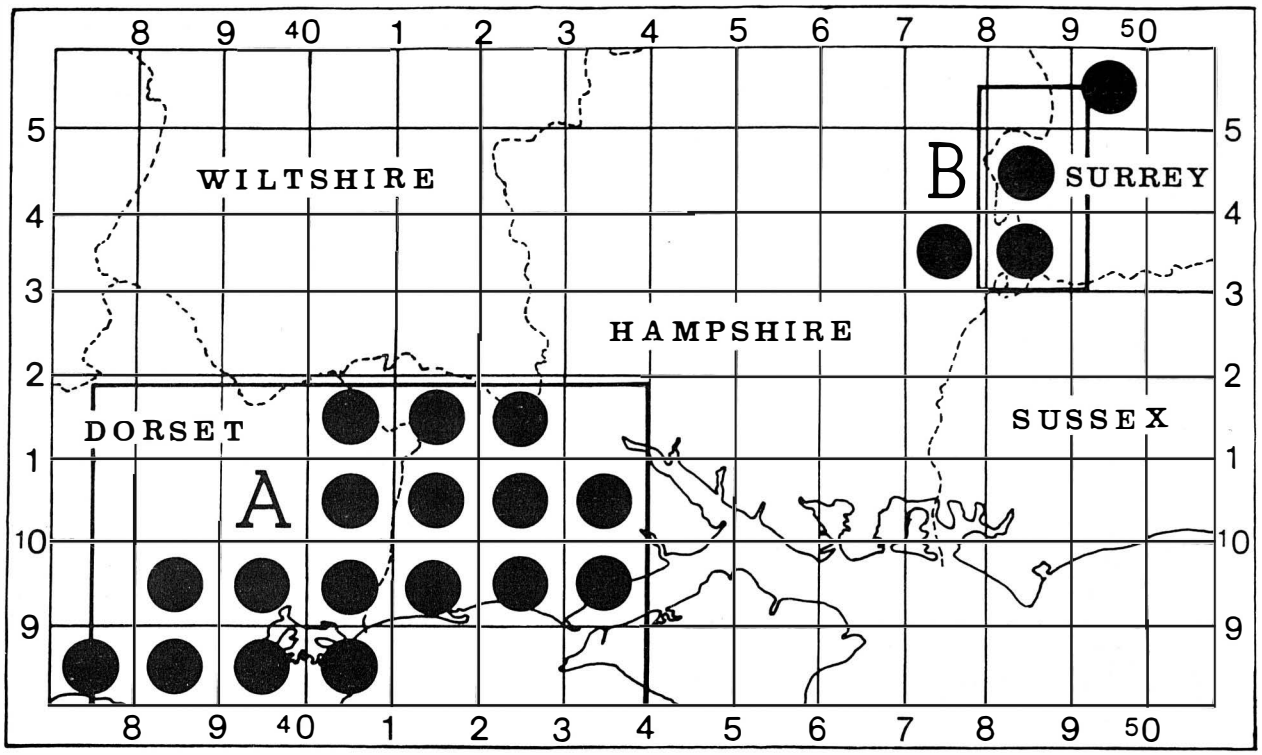


Fig. 3 Approximate limits of the range of occurrence of *Coronella austriaca* as found by the British Herpetological Society smooth snake survey 1984-7. The map shows Ordnance Survey gridlines at 10km intervals. The line at 440 represents the limit as found by A. H. Gent (see text). A solid circle (●) in a 10km square indicates that at least one smooth snake was found in that square. Records in 2 10km squares were supplied by the New Forest Study Group. Broken lines are county boundaries.

Number of visits	*Number of sites*
1	21
2	7
3	12
4	10
5	17
6	10
7	20
8	13
9	9
10	7
11-20	52
21-30	13
31-40	2
41-50	1
?	2

TABLE 1: Number of visits paid to sites on BHS smooth snake survey 1984-7.

Number of tins	*Number of sites*	*Numbers of snakes*
0	30	6
1	4	0
2	15	2
3	24	13
4	19	22
5	23	22
6	18	39
7	9	24
8	5	2
9	10	13
10	8	6
11-20	22	77
21-30	3	25
Debris only	4	4
?	2	6
Total	196	261

TABLE 2: Number of sites having from 0-30 tins and smooth snakes found on sites on BHS smooth snake survey 1984-7.

Note The numbers of tins shown in the first column are approximate for many sites contained debris, including tins as defined, which was searched but not numbered on maps.

Four sites yielded sloughs but no snakes. 86 sites (43.9% of the total surveyed) yielded at least 1 snake. Taking sloughs as proof of reptiles, 90 sites (45.9% of the total) had smooth snakes. Sexually mature smooth snakes have been defined as those not less than 42cm long (NCC, 1983). CAT members measured 118 males and 64 females in this category. They found 58 snakes classed as immature by the above definition; 21 snakes were not measured. Evidence of breeding (gravid and/or immature snakes) was found on 40 sites.

Tables 4 and 5 show recorded numbers of smooth snakes found in calendar months and times of day during the four years of the survey. These figures

Season	*No. of sites newly visited*	*No. of snakes newly seen*	*No. of snakes in area A (Fig. 3)*	*No. of snakes in area B (Fig. 3)*	*No. under tins*	*% under tins*
1984	47	38	36	2	23	60.5
1985	49	73	68	5	57	78.1
1986	56	67	61	6	58	86.6
1987	44	83	76	7	77	92.8
Total	196	261	241	20	215	82.4

TABLE 3: New sites and smooth snakes found for the first time and their occurrence under tins on BHS survey 1984-7.

Month	*Year* 1984	1985	1986	1987	*Total for 4 years*
March	0	1	0	0	1
April	4	0	1	1	6
May	5	12	14	8	39
June	7	13	4	11	35
July	4	8	10	13	35
August	9	13	21	6	49
September	8	23	27	15	73
October	2	4	2	1	9
November	0	3	0	0	3

TABLE 4: Numbers of smooth snakes found in calendar months of the years 1984-7 during BHS survey.

Hours	*Year* 1984	1985	1986	1987	*Total for 4 years*
9-10	1	8	1	0	10
10-11	2	12	8	3	25
11-12	5	8	8	6	27
12-13	4	9	9	5	27
13-14	5	5	11	6	27
14-15	5	5	10	10	30
15-16	2	10	8	5	25
16-17	6	10	11	11	38
17-18	4	5	3	3	15
18-19	3	2	4	1	10
19-20	0	2	1	0	3

TABLE 5: Hours (British Summer Time = GMT + 1) between which smooth snakes were found on BHS survey 1984-7.

include recaptured reptiles and, of course, reflect the presence of observers as well as that of snakes. The figures in Tables 4 and 5 are thus not comparable with results of systematic searches on defined sites such as reported by Goddard (1981).

We do not wish, for security reasons, to specify which sites yielded the largest numbers of snakes, but the CAT concluded that two areas of greatest populations were in the neighbourhoods of Hurn in the Avon Valley and of Wareham, Dorset. The survey in the New Forest was limited by an agreement not to intrude in areas of field research by Southampton University and by reluctance of the Forestry Commission to permit the laying of tins. However, the CAT was able to have the numerous observations of A. H. Gent of Southampton University in this region: these are not included in Tables 1 and 2. The CAT survey was also inadequate on the Studland Peninsula: tins were removed by unknown persons from one site. The CAT also knew that *Coronella* records were continually made in this region by the Warden. A fire in February 1986 destroyed the surface vegetation of

much of a large Studland heath: later in the same year an observer found a fresh *Coronella* slough on the blackened land.

As well as defining the smooth snake's range and mapping its occurrence on sites the CAT made incidental observations as detailed below.

(1) Mating of *Coronella* in Britain in the wild has been recorded only once, in May (NCC, 1983). At 1735 hours BST on 9th August, 1987, on a site in area A, under a tin, a CAT member found a male smooth snake (length about 50cm) holding the head of a female (length 47cm) crosswise. The snakes were briefly bagged: on removal for measurement the male again held the female, who opened her cloaca and exuded a little fluid. The snakes were released together and at 1825 hours they moved under the tin, making a sound interpreted as a renewed grasp of the female by the male. The head ends of the snakes were out of view under the tin: the male was loosely twined round the female and rubbed the visible part of her body; the vents were positioned together. At 1830 hours, the snakes were picked up to check that the hemipenis was inserted: as the snakes were firmly attached, this was assumed. The snakes were left mating. The weather was warm and sunny.

(2) On 29th July, 1985, an observer found a gravid smooth snake and this was recaptured on 2nd November, apparently soon after it had given birth. On 9th November 3 newly-born *Coronella* were found close to where the above female had been seen: the snakes were coiled together just behind a tin and one of them was under this tin about 2.5 hours later. On 10th November the same 3 snakes with 2 other new-born were found basking and, later, all under this tin. On 16th January, 1986, BHS members found three partially decomposed new-born smooth snakes under the same tin. This incident may be relevant to current views on *Coronella* breeding and is considered under DISCUSSION.

(3) On 5th September, 1986, a gravid smooth snake was found under a tin on a Dorset site: its total length was 79.2cm and vent-tail length 8.5cm. The tail was truncated. The measurements give an unacceptable percentage tail/total length ratio of 10.7. On the assumption that the intact snake had a minimal female percentage tail/total length ratio of 16.0, simple algebra shows that the undamaged reptile would have been more than 84cm long. This considerably exceeds the length of the longest British smooth snake known to us, i.e. one found basking on another Dorset site in the presence of 7 BHS and NCC personnel on 14th July, 1984; this, also gravid, measured 72.5cm.

(4) CAT members found snakes under tins in all except hot weather conditions at times between 22nd April (1987) and 10th November (1985). Some individual reptiles repeatedly returned to the same tins, even in successive seasons: they were clearly not deterred by the handling they received. For example, the same snake was under the same tin on a Hants site in 1985, 6 and 7. A tin on a Dorset site harboured the same reptile twice in 1985 and twice in 1986. Another snake in Dorset was caught 5 times in an area of about 0.1ha; a second, 3 times.

DISCUSSION

Method of survey. The survey was as thorough as time and opportunity allowed. BHS members' previous knowledge of suitable sites was essential in selecting those to be examined each season. Some of the CAT were experienced snake spotters; others quickly became proficient. Table 3 clearly shows that laying tins increased the chances of finding snakes, with the considerable advantage in this type of survey that these could yield snakes in most weather conditions. The lower percentage (60.5) of snakes found under tins in 1984 (Table 3) is partially explained by frequent searches made in limited Surrey/Hants areas in that season, resulting in the detection of more snakes lying out in the open than was usually the case during the survey. Measurements as set out in Fig. 1, together with drawings of the head and proximal dorsal markings proved sufficient to identify all snakes found, even in successive seasons; the CAT encountered no cases of ambiguity.

Birth of young. In normal years smooth snakes are born between August and October inclusive. It has been suggested that some females may retain young over winter and give birth in the following spring: this behaviour has not been confirmed in the wild (NCC, 1983). During the present survey, gravid reptiles were found well into October, still basking. As described under RESULTS an apparently recently born clutch was found alive on 10th November (1985). The daytime temperature may have been too low for these animals to feed or seek hibernacula and unusually severe night frosts of about −5°C occurred at that period. It is not surprising that 3 of these snakes were later found dead at the place of their original discovery. It seems that some females may produce young well into the normal hibernation period.

Sex ratio. Goddard (1981) was unable to find any difference in the proportions of the sexes at different ages of *Coronella* in populations he studied. He also found a 1:1 sex ratio in hatchlings. Street (1979) commented that male snakes are encountered more frequently than female. The CAT survey results agree with this. This imbalance is perhaps an artefact of the sampling technique. Goddard (1981) could find no significant difference between the home ranges of male and female *Coronella* on two sites. This aspect of the CAT survey needs further study. Van Gelder *et al.* (1988) pointed out that tail/length ratios and subcaudal scale counts do not in all cases clearly establish sex.

Population. It is important not to exaggerate the quantitative significance of this survey as the CAT conducted it. The sites as arbitrarily defined varied greatly in size from, for example, the banks of a disused light railway about 10m apart and extending for about 300m to wide heathland areas of up to 200ha. All heathland sites, with the exceptions mentioned in RESULTS, known to BHS members in and close to areas A and B were covered by the survey although some large sites were no more than sampled. It is highly improbable that any likely *Coronella* habitat in the above category entirely escaped search. Sites usually did not consist of uniform heathland; many

had been partly damaged by fire and were fragmented by wet areas, tracks and mown fire-breaks. Tins were not uniformly laid but put on what seemed to layers to be promising places, for example sunny slopes, ridges and banks and were hidden from casual observation. At many New Forest sites where aspect or topography looked favourable, vegetation and soil type did not. Results indicated that the New Forest *Coronella* populations were in areas isolated by sub-optimal habitat. In most cases tins were placed only on a small proportion of a site. Tins varied in size and, presumably, in attractiveness to reptiles. For these reasons, and others, we can by no means claim that the CAT found a fair sample of the smooth snake population. Goddard (1984) suggested that the total UK population of smooth snakes might be '26,656-53,312'. He obtained this figure by assuming that the total heathland area of central southern England (in 1976) had the same population density as he found on two sites in the New Forest. We find it difficult to take this estimate seriously, especially since Goddard's sites were in areas known to have good *Coronella* populations. As stated above, the BHS survey was organised and quite thorough; over 4 years it produced a minimal total of 261 different snakes, to which we may add 126 specimens from the New Forest recorded in 1984-6 during a survey by A. H. Gent. Figures of 1000-3000 adults (in 1974) and BHS estimates in 1983 of 2000 adults have been suggested (NCC, 1983). Results of the present survey seem to indicate that the total *Coronella* population is numbered in thousands rather than tens of thousands. The point is important for if Goddard's (1984) estimate was of the right order, there need be much less concern for the snake's survival.

Implications for conservation. Knowledge of actual numbers remaining on the declining heathland habitats is of much less importance than knowing whether the populations are viable and breeding. The CAT team found breeding evidence for only 40 sites (20.4% of the total surveyed; 46.5% of those with snakes). On several sites only a single mature snake was found: these might be no more than survivors of relict populations. Although habitat associations were not the prime aim of the survey the importance for conservation of an understanding of such associations can scarcely be overstated. We hope that further analysis of the survey records will provide material for more research on this topic and what follows are preliminary remarks. On many sites the preferred habitat of the densest populations of *Coronella* appeared to be deep stands of mature dry heather (*Calluna vulgaris*). These stands were usually more than 20 years old, in three instances between 30 and 40 years old and, characteristically, with basal pads of bryophytes and lichens within the heather bushes. Five of the six densest populations in SE Dorset, the three densest from the Hants/Surrey Weald and the only apparent surviving population from N Surrey all fitted this category. A correlation between mature heather and good smooth snake populations has also been noted in the New Forest. One exception was a younger stand of dry heath seemingly enhanced by many old piles of rubble, slates and general debris which the snakes used as refuges: on another site snakes were found under metal plates some distance from heathland. The conclusion of an affinity with maturer dry heath is in accord with that previously deduced (NCC, 1983). Because tins were generally not laid in shaded and hence treed parts of heaths, we cannot comment on the snakes' possible use of open woodland or woodland edge habitats.

Of course the type of habitat described above is widespread on lowland UK heaths, so well described by Webb (1986). What, then, is the explanation for the remarkably limited areas in which the smooth snake occurs, areas which have remained more or less constant for well over a century (Smith, 1951)? Some CAT observers stated that they could recognise differences between Dorset and Surrey *Coronella* examples: however these differences were not precisely noted. An investigation by biochemical methods into the genetic patterns of smooth snakes from different areas might help to define *Coronella* races. The snake's distribution suggests that climate is an important factor in its survival and that the reactions between it and its environment must, in the UK, be delicately balanced. The still largely mysterious biology of *Coronella austriaca* in Britain presents problems of the greatest interest and this alone makes a strong case for the conservation of this snake wherever it may still be found.

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