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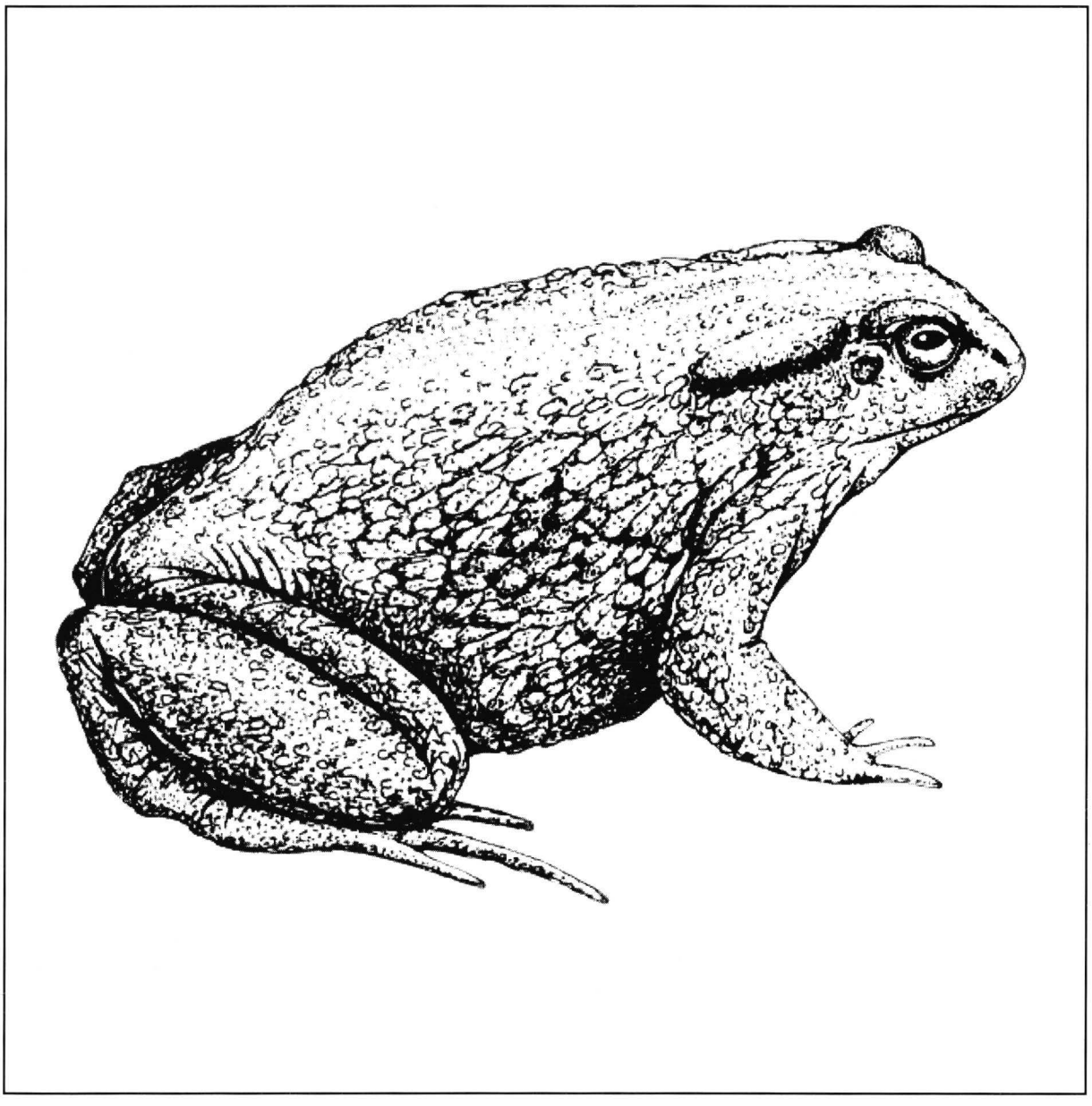

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EFFECTS OF INGESTED RADIO TRANSMITTERS ON *BUFO BUFO* AND *RANA TEMPORARIA*.

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ABSTRACT

Fourteen adult common frogs (*Rana temporaria*) and 40 common toads (*Bufo bufo*) were forced fed with 2.5 g radio transmitters. The transmitters lodged in the stomach and were regurgitated after 2 to 13 days in the frog and 2 to 38 days in the toad. They did not significantly affect either feeding rates or mass fluctuations of the toads. Reception range was up to 100 m and battery life 33 to 47 days. Twenty three toads tracked on a daily basis during the summer showed displacement of between 0 and 108 m, animals commonly staying in one place for several days.

INTRODUCTION

Radio transmitters of 3 g or less are available commercially (see Kenward (1987) for list of suppliers) and have been used for tracking and physiological investigation of small animals by many workers (e.g. snakes: Henderson, Nickerson & Ketcham, 1976; turtles: Schubauer & Gibbons, 1978; toads: van Gelder & Krammer, 1985; Sinsch, 1988).

External attachment of transmitters is commonly used in tracking vertebrates; collars have been used for mammals (e.g. Ormiston, 1985), harnesses and tail clips for birds (e.g. Bray & Corner, 1972) and adhesive tapes for snakes (Ikeda, Iwai, Wada & Hayashi, 1979). In anurans external attachment presents problems since they have no apparent neck, a thin epidermis which is sporadically sloughed and a subcutaneous cavity which gives the animal considerable freedom of movement within its skin. A latex harness developed for *Bufo bufo* (Nuland & Claus, 1981; van Gelder, Aarts & Staal, 1986) was unsuccessful in dense vegetation or in water. If not fitted properly the harness caused irritation. Similarly Gittins (*pers. comm.*) used a flexible plastic harness with limited success.

The problems of hindrance and skin irritation can be solved by surgical implantation of the transmitter (e.g. voles: Smith, 1980; snakes: Reinert & Cundall, 1982; Weatherhead & Anderka, 1984; Tiebout & Cary, 1987; *Bufo bufo*: Olders *et al.*, 1985; *B. calamita*: Sinsch, 1988). This procedure, however, may cause trauma (Fitch & Shirer, 1971), reduced activity (Weatherhead & Anderka, *op. cit.*), infection (Olders *et al.*, 1985) and contravention of vivisection laws (Morris, 1980). Sinsch (1988), however, reported no abnormal behaviour after surgical implantation and complete healing by the conclusion of tracking experiments in *Bufo calamita*. Force-feeding provides a method of internal placement without recourse to surgery. Tagging devices have been swallowed and retained by snakes (e.g. Fitch & Shirer, 1971; Kroll, Clark & Albert, 1972; Ai, Olivier, Ambid & Saint-Girons, 1975; Henderson *et al.*, 1976; Kephart, 1980; Reinert and Kodrich, 1980; Priede, 1980) and toads (Pearson & Bradford, 1976). Pearson & Bradford (1976) do not comment upon the effects of the transmitters on the toads.

In our studies of the habitat requirements of *Bufo bufo* and *Rana temporaria* radio-tracking was used in conjunction with pitfall trapping. The detailed results of these investigations will be reported elsewhere; the purpose of the present paper is to describe the radio-tracking procedure.

Experiments with external harnesses proved unsatisfactory and an ingestion technique was investigated. Transmitter retention times, food consumption and body mass changes of internally labelled anurans, measured in the laboratory, are documented. Preliminary field trials are also described.

MATERIALS AND METHODS

EQUIPMENT

The equipment comprised transmitters ("small" 2.0 g and "large" 2.5 g; Fig.1) manufactured by Biotrack, Wareham, Dorset, UK; a portable receiver and a Yagi antenna from Mariner Radar, Lowestoft, Suffolk, UK (Fig. 2), operating within the frequency range 173.20 to 173.35 MHz. The transmitters are supplied with disconnected battery leads and were stored under refrigeration.

The equipment was tested on open playing fields where an audible signal was received from 200 m using a hand-held transmitter, of either size, 1m above ground level. To overcome the problem of exact transmitter location in dense vegetation a loop aerial permitting use within about 0.1 m^2 of the signal source was used (Fig. 2).

The transmitters had a working life of approximately 47 days (large transmitters) and 33 days (small transmitters) at the ranges cited above. Beyond this time the signal was weaker and detection harder.

INTERNAL PLACEMENT

Dummy transmitters were eased down the throats of frogs and toads, whose mouths had been prised open using the corner of an index card. The swallowing reflex, indicated by the sinking of the eyeballs, drew the package down the oesophagus. Both species were restrained by wrapping tissue around their bodies to secure the front legs. The process was not difficult with either species, but easier with frogs. Occasionally the transmitter was rejected immediately; in this case it was reinserted.

After ingesting the transmitters, 40 toads and 14 frogs were placed singly in vivaria (0.07 to 0.10 m^2 floor area) and kept at a range of temperatures between 7 and 20 °C between August and

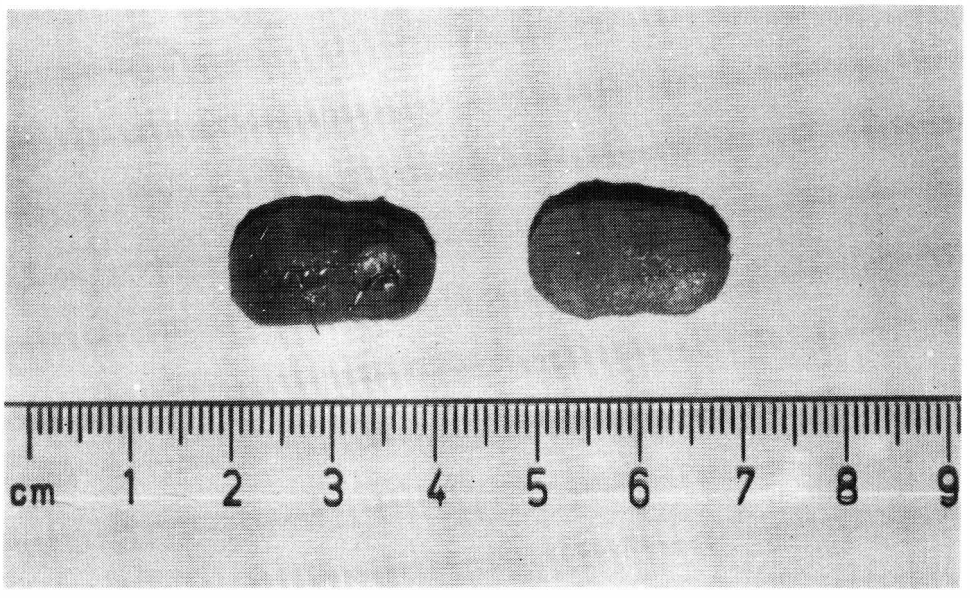

Fig. 1. Transmitter potted in silicone aquarium sealant, with battery terminals unconnected (left); dummy transmitter (right).

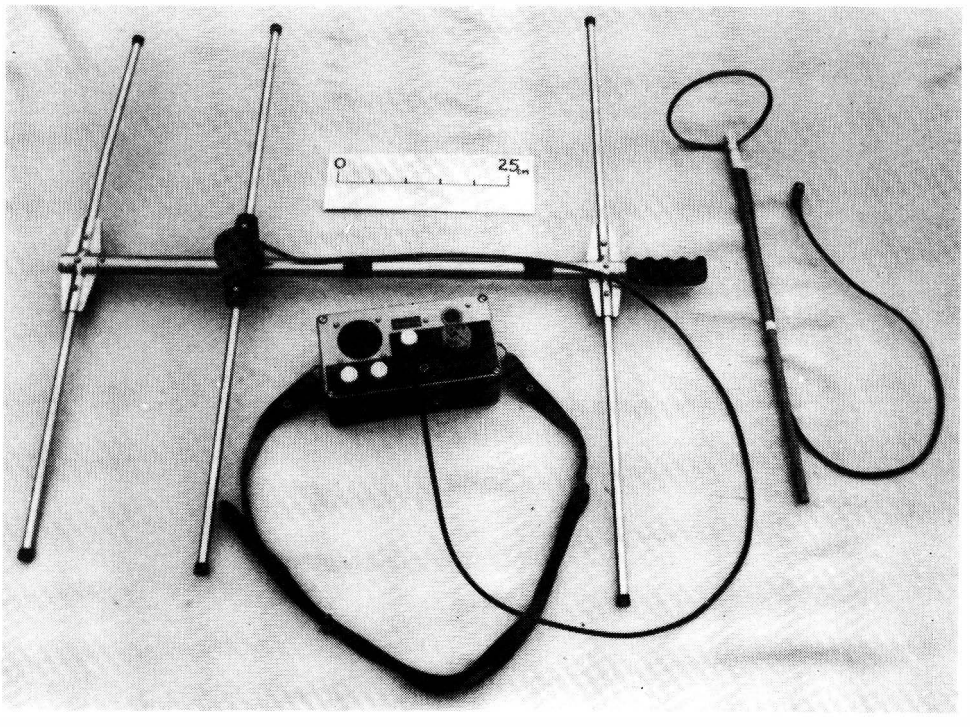

Fig.2. Portable receiving equipment. Yagi antenna and receiver and loop aerial.

December. The animals were examined daily and if the transmitters were rejected they were reinserted. If reinsertions are included the toads were used in a total of 92 retention trials and the frogs in 21 trials. A further 25 toads and 15 frogs were used as controls. All were weighed at intervals throughout the experiments.

A known number of house cricket nymphs (*Acheta domestica*) was provided daily as food in each vivarium and any left were counted at the next feeding time. It was thus possible to estimate the number consumed each day.

RESULTS

Effects of Transmitters

After periods ranging between 2 and 38 days all the dummy transmitters were deposited on the vivarium floor. To assess whether they were regurgitated or defaecated an additional nine toads and two frogs (masses between 25 g and 55 g) were dissected 3 to 16 days after ingestion of transmitters. All 11 had retained them within their stomachs, the pylorus being too narrow to permit passage.

Toads had median retention times of 13 days (range 2 to 38 days) and frogs six days (range 2 to 13 days, Table 1). Thirty-seven (69%) of the animals regurgitated the transmitters within two weeks; the remainder retained them for over three weeks. Reinsertion of transmitters into toads (an additional 52 trials) produced a similar array of retention times. Neither frogs nor toads showed significant differences in retention times between animals kept at 13, 16 and 19 °C ($P>0.05$). However, an additional four frogs and two toads kept at 7 °C became torpid, neither eating crickets nor regurgitating transmitters.

With transmitters in their stomachs neither frogs nor toads ate significantly fewer cricket nymphs than the control animals ($P>0.05$, Table 2). The slight apparent difference between the two groups of toads in Table 2 was caused by reduced feeding in some animals during the few days following initial implantation of the transmitter. On the other hand, on several occasions toads were observed to feed within minutes of implantation.

Mass changes during the experiments ranged from 11% decrease to 41% increase in the toads (Table 3) and from 0% to 12% increase in the frogs. There was no consistent relationship between animal size and percentage mass change ($P>0.05$) and toad mass loss did not correlate with length of dummy retention time ($P>0.05$).

FIELD TRIALS

Between 1982 and 1987 field trials were conducted with 23 toads in Leicestershire. All took place during the toads' active season, in spring and summer, but not in the migratory phase. All the animals were released within 25 m of their site of capture and were followed, usually at daily intervals, for up to 22 days. They were detected from a range of up to 150 m. Distances between recorded positions ranged between 0 m and 108 m. During tracking, animals were commonly detected in scrub, on one occasion beneath 10 cm of water, once buried at a depth of 5 cm in soil and once in a retreat amongst rocks. In nine of the 23 instances both the toads and the transmitters were lost. In a further five cases transmitters were regurgitated by the toads and retrieved separately. The remainder were recaptured complete with transmitters, which they subsequently regurgitated.

Most of the tagged animals inhabited woodland, scrub or gardens. In five instances, however, toads were located in habitats on the verge of woodland/scrub and arable fields. These were observed to forage in the fields during the night and hide in the scrub, up to 20 m distant, during daylight. The nocturnal phase of this behaviour was confirmed, for large numbers of toads, by independent torchlight searches.

	Sex	*n*	Mass range (g)	Days retained Range	Median
B. bufo	M	23	18 - 53	2 - 38	15
	F	17	17 - 88	2 - 38	13
R. temporaria	M&F	14	11 - 47	2 -13	6

TABLE 1. Retention times of dummy transmitters in laboratory toads and frogs.

	Mean no. crickets eaten per day						
	Experimental group			Control group			Mann-Whitney U test
	n	Mean	S.D.	*n*	Mean	S.D.	*P*
B. bufo	40	1.4	0.41	25	1.6	0.57	>0.05
R. temporaria	14	2.5	0.71	15	2.4	0.67	>0.05

TABLE 2. Effect of transmitters on toad and frog food consumption during experiments lasting between 21 and 44 days.

		n	% Mass change range	median	
B. bufo	with transmitter	40	-11 to+41	+4	$P>0.05$
	control	25	-2 to+18	+9	
R. temporaria	with transmitter	14	0 to +12	+5	$P>0.05$
	control	15	+2 to +4	+3	

TABLE 3. Effects of transmitters on mass changes in toads and frogs in experiments lasting between 7 and 45 days.

DISCUSSION

The mean transmitter retention times in the laboratory, of 16 and 6 days for toads and frogs respectively, seemed to allow sufficient time for tracking both species. This was confirmed for toads by field trials in which the animals were detected in a range of habitats.

Laboratory evidence indicated that the transmitters had no effect upon the feeding and associated mass changes of toads. There are no reports in the literature of similar trials for amphibia, but Reinhert & Kodrich (1982) believed that the appetite of the grass snake *Sisturus* was unaffected by an ingested transmitter. However, the possibility of reduced field activity consequent upon the presence of the transmitter, as reported for *Agkistrodon* and *Coluber* by Fitch & Shirer (1971) cannot be excluded.

A serious disadvantage of the method was the high frequency of loss of expensive transmitters, despite thorough searches. This was particularly frustrating since it was impossible to know whether the loss was animal specific (predation, deep burial, extensive wandering etc.) or equipment specific (e.g. failed battery). This problem can be overcome by continuous monitoring but, aside from the practical difficulties of nocturnal work, this incurs the problems of animal disturbance and habitat damage.

The field trials suggest that toads are relatively sedentary during their summer terrestrial phase. The trials also show that toads will forage at night in arable fields and retreat to scrub refugia during the daylight. Van Gelder *et al.* (1986) describe a similar activity pattern during the migration of toads in the Netherlands. The fact that they do not avoid bare ploughed land is of significance in terms of conservation since such cultivation may not be inimical to toads. If they retreat from the field during the day they are unlikely to suffer physical damage by machinery. At the same time it seems important that areas of rough grass and scrub be retained as refugia in intensively cultivated land.

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REFERENCES

Ai B., Olivier, H., Ambid, L. & Saint-Girons H. (1975). Enregistrement continu par biotelemetrie de la temperature interne de Reptiles et de Mammiferes hibernants de petite taille. *C. R. Acad. Sc. Paris.* **280**, 1015-1018.

Bray O. E. & Corner G. W. (1972). A tail clip for attaching transmitters to birds. *J. Wild. Manag.* **36**, 640-642.

Fitch H. S. & Shirer H. W. (1971). A radiotelemetric study of spatial relationships in some common snakes. *Copeia* **1971**, 118-128.

Gelder J. J. van, Aarts H. M. J. & Staal H. W. M. (1986). Routes and speed of migrating toads (*Bufo bufo* L.): a telemetric study. *Herpet. J.* **1**, 111-114.

Gray H. R. & Haynes J. M. (1979). Spawning migration of adult chinook salmon (*Oncorhynchus shawyshu*) carrying external and internal radio transmitters). *J. Fish. Res. Board Can.* **36**, 1060-1064.

Henderson R. W; Nickerson M. A. & Ketcham S. (1976). Short term movements of the snakes *Chironius carinatus*, *Helicops angulatus* and *Bothrops atrox* in Amazonian Peru. *Herpetologica* **32**, 304-310.

Ikeda K; Iwai N; Wada Y; & Hayashi Y. (1979). Technological development of the radio tracking system for studies of Habu movement. *Snake* **11**, 122-123.

Kenward R. E. (1987). *Wildlife radio tagging.* London: Academic Press.

Kephart D. G. (1980). Inexpensive telemetry techniques for reptiles. *J. Herpet.* **14**, 285-290.

Kroll C. K; Clarke D. R. & Albert J. W. (1972). Radiotelemetry for studying thermoregulation in free-ranging snakes. *Ecology* **54**, 454-456.

Morris P. (1980). An elementary guide to practical aspects of radio tracking mammals. In *A handbook on biotelemetry and radio tracking*, 161-168. Amlaner, C. J. & MacDonald, D. W. (Eds.). Oxford: Pergamon Press.

Nuland G. J. van & Claus P. F. H. (1981). The development of a radio tracking system for anuran species. *Amphibia-Reptilia* **2**, 107-116.

Olders J. H. J; van Gelder J. J. & Krammer J. (1985). A thermo-sensitive transmitter for radio tracking small animals. *Neth. J. Zool.* **35**, 479-485.

Ormiston B. G. (1985). Effects of a subminiature radio collar on activity of free-living white footed mice. *Can. J. Zool.* **63**, 733-735.

Pearson O. P. & Bradford D. F. (1976). Thermoregulation of lizards and toads at high altitudes in Peru. *Copeia* **1976**, 155-170.

Power J. H. & McCleave J. D. (1980). Riverine movements in hatchery reared Atlantic salmon (*Salar salar*) upon return as adults. *Env. Biol. Fish* **5**, 3-13.

Priede I. G. (1980) An analysis of objects in telemetry studies of fish in the natural environment. In *A handbook on biotelemetry and radio tracking*, 105-118. Amlaner, C. J. & MacDonald, D. W. (Eds.). Oxford: Pergamon Press.

Reinert H. K. & Cundall D. (1982). An improved surgical implantation method for radio-tracking snakes. *Copeia*, **1982**, 702-705.

Reinert H. K. & Kodrich W. R. (1982). Movements and habitat utilization by the Massasauga, *Sisturus catenatus catenatus. J. Herpet.* **16**, 162-171.

Schubauer J. P. & Gibbons J. W. (1978). Home range and movement patterns of *Chrysemys scripta* (Reptilia: Emydidae) in a thermally altered lake in South Carolina. *Assoc. Southeast Biol. Bull. (USA)* **25**, 73.

Sinsch U. (1988). Temporal spacing of breeding activity in the Natterjack toad, *Bufo calamita. Oecologia* **76**, 399-407.

Smith H. R. (1980). Growth, reproduction and survival in *Peromyscus leucopus* carrying intraperitoneally implanted transmitters. In *A handbook on biotelemetry and radio tracking*, 367-374. Amlaner, C. J. & MacDonald, D. W. (Eds.). Oxford: Pergamon Press.

Tiebout H. M. & Cary J. R. (1987). Dynamic spatial ecology of the water snake, *Nerodia sipedon. Copiea* **1987**, 1-18.

Weatherhead P. J. & Anderka F. W. (1984). An improved radio transmitter and implantation technique for snakes. *J. Herpet.* **18**, 264-269.