

ROUTES AND SPEED OF MIGRATING TOADS (*BUFO BUFO* L.): A TELEMETRIC STUDY

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ABSTRACT

Eleven toads were tracked telemetrically during migration to and from the spawning site. Routes were established. No differences in speed could be detected between males and females or during migration to and from the spawning site. Mean speed was about 30 metres per hour. Speed is influenced (from 22.8 to 49.8 m/h) by the type of vegetation.

INTRODUCTION

Moore (1954) investigated the speed with which *Bufo bufo* migrates from its hibernation site to the spawning site. He followed migrating toads with the aid of a torch and mainly on roads. Apart from the possible disturbance caused by the nearby presence of the investigator, the fact that toads were followed only on roads might give (as is suggested by Moore himself) a biased picture of the mean speed of migration.

Van Nuland and Claus (1981) described a radiotelemetric method with which toads can be traced. Using this method, it is not necessary to follow an individual toad continuously, as it can be traced at any moment. Furthermore, it is possible to keep a relatively large distance between observer and toad and to trace the toad even when it is covered by vegetation.

Using this telemetric method, we investigated the migration of five toads before spawning and seven toads after spawning in spring 1981.

MATERIALS AND METHODS

This study was carried out in the National Nature Reserve 'Overasseltse en Hatertse vennen', situated at 5° 48' E. long. and 51° 48' N. lat. in the province of Gelderland, the Netherlands. The area consists of afforested sand dunes with a number of fens. The 'Roelofsven', one of these fens, is a breeding site of the common toad, *Bufo bufo* (Fig. 1). This fen, in origin oligotrophic, is eutrophicated by agricultural activities in its surroundings. For a detailed description of the area see Strijbosch (1976).

To track the animals we used a slightly modified CVN-3 transmitter-receiver unit, as described by Van Nuland and Claus (1981). The energy source of the transmitters consisted of two AgO batteries (Ucar professional 392). The transmitter was glued down to a harness of latex; the toads carried these harnesses on their backs (see also Van Nuland and Claus, 1981). Unfortunately, it appeared that the toads were able to throw off the harnesses, especially in the water. As each transmitter had a distinctive transmitting and

pulse frequency (between 120 and 126.5 MHz and 2 and 9 Hz respectively), each toad could be recognised in the field without disturbance.

On the batteries of each transmitter a 2 x 5mm piece of reflecting tape had been mounted. By this we aimed to recognise the toads from long distances with the aid of an infrared lamp and spy-glass. Usually, however, the vegetation inhibited this method and on these occasions cross-bearings were taken. We tried to keep the distance between observer and toad more than 5 metres. At a distance of about 10 metres the accuracy of tracing by taking cross-bearings is smaller than within one square metre.

From sunset onwards all toads were tracked about once an hour. If they did not move at all between about three subsequent observation times (or less, if weather conditions were very unfavourable for the toads), the observations were stopped that night. If at least one toad had moved, observations were made on all animals until no displacements were recorded. The shortest period between two observations was 30 minutes, the longest 90 minutes.

Continuous recordings were made of air temperature, 20cm above ground, humidity and rainfall at a fixed place in the study area. In addition, at each observation of a toad temperature was measured at the surface of the ground and 5cm below as well as 10cm above it with an electric temperature equipment (Wallace EP-400). The temperature was measured at a spot as similar as possible to the spot where the toad was found, keeping the distance between observer and toads as small as possible without disturbing the toad.

As soon as migrating toads were observed during early spring, four toads were collected at a distance of about 600 metres to the 'Roelofsven' (at the Blankenbergseweg, see Fig. 2) and one at a distance of about 100 metres. These toads were tracked on their way to the breeding site. To follow landward migration, six other toads were collected in the neighbourhood of the 'Roelofsven' shortly after the spawning season. Evaluating the data, we assumed that a toad walked in a straight line between two subsequent observations.

RESULTS

Migration to the fen was observed between 8th March and 31st March; migration from the fen from 28th March up to early June. Spawning occurred between 15th March and 30th March.

The routes covered during spawning migration are shown in Fig. 2. Females 2 and 20 reached the 'Roelofsven' in the third night of tracking, migrating in an almost straight line. In the fen both toads very soon lost their harnesses. Males 8 and 14 lost their harnesses under dense vegetation before reaching the fen. Toad 8 obviously did not migrate to the spawning sites in the 'Roelofsven'. Just before male 12 reached the fen it was replaced at the spot where it was caught. That night it walked another 25 metres in the direction of the 'Roelofsven'. The next night it changed its direction and started landward migration (see also Fig. 3). Another 6 toads were tracked during their landward migration (Fig. 3). Migration was considered to have ended if a toad left its hiding place and returned to that place during at least three favourable nights. The end of the landward migration route, being the summer quarter, could be established for 4 toads, viz. males 5, 9 and 12, and female 8a.

We made observations during 27 toad nights (if e.g. 3 toads migrated during one night this is regarded as three toad nights). Only twice was the distance covered during one toad night less than 15 metres (viz. 4 and 14 metres). The maximum distance covered during one toad night was larger during migration to the spawning site than during landward migration. The four largest values were 440, 399, 361, 319 metres and 290, 118, 113, 89 metres respectively. We got the impression that if during the night weather conditions (humidity or temperature) became worse, toads searched for a forest or (in any case) a bush to hide.

Data on the speeds of movements are summarised in Table 1. No significant differences were apparent between sexes or between migration to and from the fen.

It was possible to pick out those observation periods during which a toad migrated through only one 'vegetation type'. We distinguished between forest, grassland and open field. 'Forest' here includes places

with trees and a little bit or much ground cover as well as coppice strips and dense bushes; 'open field' includes forest paths, (asphalt) roads and arable land (without vegetation during early spring). In Table 2 all data (male-female, to and from the fen) are lumped together.

Testing statistical differences in mean speed between vegetation types, it is necessary to compare at least the data of six different animals observed in more than one vegetation type (rank sign test, using the mean of the data). With our data we could test in this way only the difference between forest and grassland. The speed in grassland appeared to be significantly higher ($p < 0.05$). The highest speed was observed in a female which moved 61 metres during 30 minutes in open field.

DISCUSSION

The method of fixing the transmitter to the toads seems not to interfere with their activity, as was established by direct observations of toads in their summer habitat as well as in a great vivarium (Aarts, 1982). In our opinion the method is also applicable to migrating toads. It appeared, however, that toads were able to throw off the harnesses in the water and in brambles. This made it impossible to get information about the duration of the stay in the water, the activity pattern during that period and the fidelity to a certain route of migration.

Little information is available in the literature about the migration routes of individual toads. In this study toads migrated in a straight line to their spawning site, neither avoiding nor preferring a special type of vegetation. At daybreak, however, toads preferred a forest (or at least a bush) to hide in at daytime. There they might be better capable of withstanding a sudden period of frost than in the open field (as supposed by Heusser, 1968). Toad nr. 8 did not migrate in a straight line to the 'Roelofsven'. Perhaps it was migrating to another spawning site situated about 300 metres north of the 'Roelofsven'.

Heusser (1968) states that landward migration proceeds at a faster rate than migration to the spawning site. Toads reached their summer quarters soon after the spawning period, having there an

| | nr. | Migrating to the fen | | | Migrating from the fen | | | | |
|---------|-----|----------------------|-----------|------|------------------------|----|-----------|------|--|
| | | n. | \bar{x} | s.d. | nr. | n. | \bar{x} | s.d. | |
| Males | 8 | 31 | 34.9 | 15.2 | 9 | 6 | 26.7 | 13.4 | |
| | 14 | 10 | 39.9 | 18.9 | 5 | 4 | 37.9 | 12.1 | |
| | 12 | 3 | 24.7 | 14.9 | 12 | 9 | 30.7 | 11.1 | |
| | | | | | 7a | 11 | 19.2 | 19.7 | |
| Females | 2 | 15 | 42.0 | 33.6 | 8a | 10 | 50.0 | 36.0 | |
| | 20 | 8 | 27.6 | 11.5 | 15 | 2 | 16.0 | 5.7 | |
| | | | | | 6 | 9 | 23.7 | 16.7 | |

TABLE 1: Mean speed of male and female toads during migration to and from the spawning site. nr. = toad identifier; n. = number of periods in which the toad concerned was observed; \bar{x} = mean speed of the toad (in m/h); s.d. = standard deviation.

inactive 'latency period' of 2-3 weeks before initiating summer activity. We observed that landward migration was less directional than migration to the spawning site. On 25 out of the 27 toad nights it was raining or raining was stopped just before. As a result long periods of inactivity were observed between short periods of migration. The total period of landward migration, beginning after spawning (late March) up to reaching the summer quarters (early June), was much longer than the period of migration to the spawning site (8th-30th March). Perhaps the discrepancy between our results and those of Heusser can be explained by differences in climate with a longer change-over from winter to summer in the Netherlands as compared to Switzerland. It must be emphasised, however, that during several nights after spawning the toads did not migrate whereas weather conditions were much better than during migration to the fen.

| | N. | n. | \bar{x} | s.d. |
|------------|----|----|-----------|------|
| Forest | 9 | 34 | 22.8 | 7.1 |
| Grassland | 6 | 23 | 36.7 | 9.8 |
| Open field | 8 | 20 | 49.8 | 14.5 |

TABLE 2: Mean speed in m/h (\bar{x}) and standard deviation (s.d.) of toads migrating in different vegetation types (see text). N. = number of different toads observed; n. = number of observation periods.

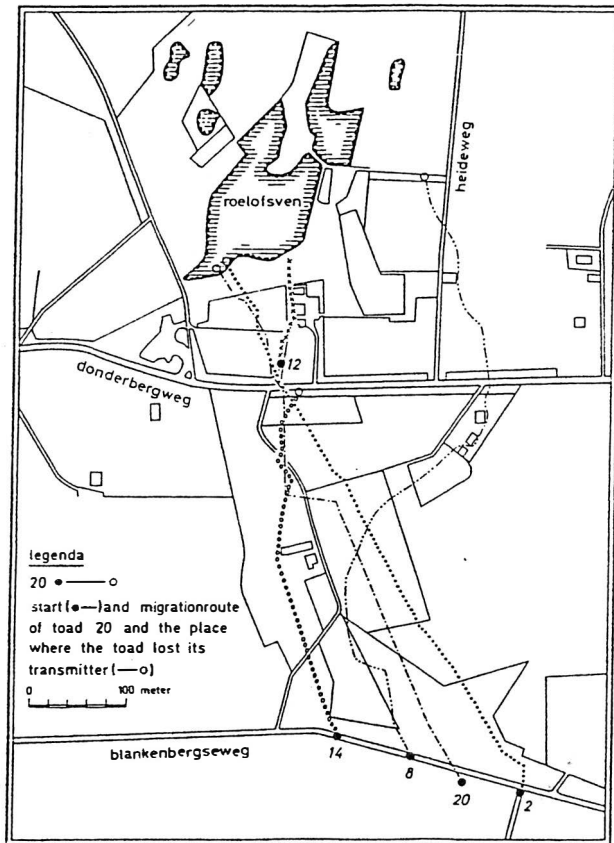


Fig. 2 Routes of five toads during migration to the fen.

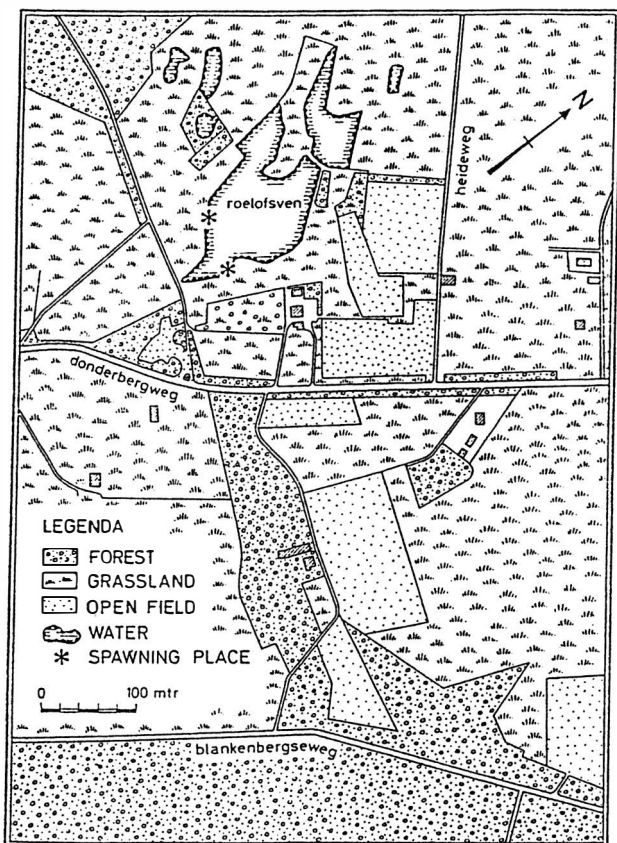


Fig. 1 Survey map of the area. Forest includes dense bushes and coppice strips; open field includes forest paths, (asphalt) roads and arable land (without vegetation at the time of the year).

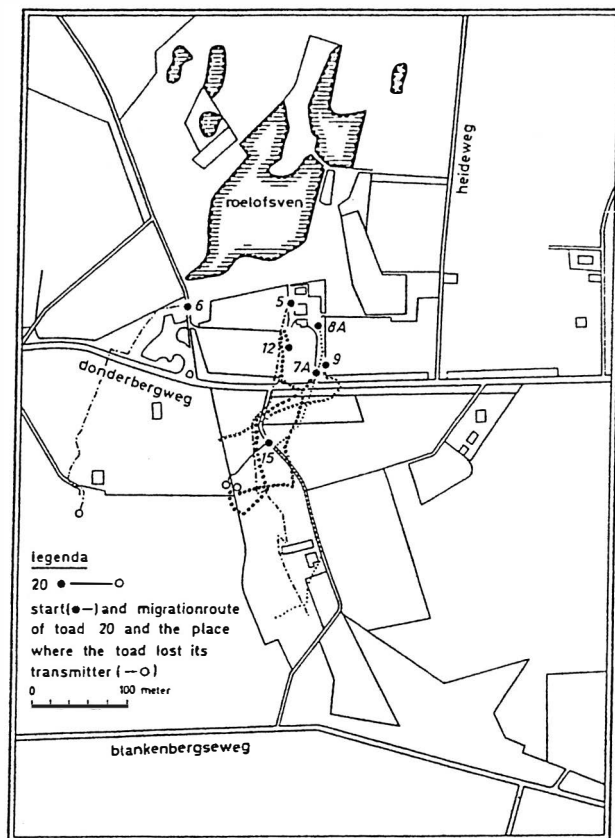


Fig. 3 Routes of seven toads during landward migration. Toad no. 12 in the Figs. 2 and 3 is the same individual (see text).

There are few data in the literature concerning the speed of migrating toads. Based on 14 specimens, Moore (1954) found speeds of 88-176, 59-122 and 44-88 m/h for males, females and pairs in amplex respectively. He suggested that his results could have been influenced by his method. Every few minutes he traced a toad migrating in open areas (roads, gravelpaths and grassfields) with the aid of a torch. Our data confirm his suggestion that the vegetation influences the speed of a migrating toad. Nevertheless, the speed reported by him is very high, even if compared with our 'open field' data. In our opinion the nearby presence of the investigator might have forced the toads to increase their speed.

Gittins *et al.* (1980) marked toads on their way to the breeding site and recaptured them after a certain period. They state that during one 'activity night' toads migrate between 100 and 250 metres. Oldham (1966) reports that *Bufo americanus* covers a distance of about 225 metres during one night. These data are comparable with ours. This implies that the maximum distance between hibernaculum and breeding site of a toad depends on the number of nights with favourable weather conditions between overwintering and spawning period. For the area studied this number is usually less than six.

Many authors (Kleinstauber, 1964; Heusser, 1968; Wisniewski *et al.*, 1981) mention threshold temperatures for migration. We could not confirm this as after a very long period with low temperatures, the mean temperature suddenly rose to about 10°C, a value far above the threshold temperatures mentioned. Toads reacted very quickly to these favourable conditions and started the spawning migration; a phenomenon described already by many authors (Jungfer, 1943; Moore, 1954; Kleinstauber, 1964; Heusser, 1968; Gittins *et al.*, 1980; Wisniewski *et al.*, 1981).

Heusser (1968) and Sander *et al.* (1977) found a correlation between temperature and speed of migration. We did not find such a correlation in the temperature range of 7-14°C. At threshold temperature the speed is possibly lowered, as is suggested by one observation at 4°C of a toad walking only 5 m/h.

Measuring relevant toad temperatures is very difficult. Surface and air temperatures are not precise measures for the temperature of the toad. Therefore we are developing a thermotelemetric system measuring the temperature of the toad itself. We have planned to place thermosensitive transmitters in the abdominal cavity of the toads, enabling us to follow the same toad during its migration to the fen, its stay in the water as well as its landward migration.

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