SHORT NOTES

HERPETOLOGICAL JOURNAL, Vol.5, pp. 236-238 (1995)

COMPARISON OF THE DIET OF ADULT TOADS (*BUFO BUFO* L.) WITH PITFALL TRAP CATCHES

C. A. CORNISH[1*], R. S. OLDHAM[2], D. J. BULLOCK[2**] AND J. A. BULLOCK[1]

[1]*Department of Zoology, University of Leicester, University Road, Leicester, LE1 7RH, UK*

[2]*Department of Applied Biology & Biotechnology, De Montfort University, Scraptoft Campus, Scraptoft, Leicester, LE7 9SU, UK*

[*]*Present address: Department of Applied Biology & Biotechnology, De Montfort University, Scraptoft Campus, Scraptoft, Leicester, LE7 9SU, UK*

[**]*Present address: The National Trust, 33 Sheep Street, Cirencester, Glos. GL7 1QW, UK*

As part of a wider study (Oldham & McGregor in prep.), food availability for the toad in terrestrial habitats around a breeding lake in Leicestershire was estimated. A method of sampling invertebrates at risk of toad predation was needed, enabling habitats to be ranked in terms of their importance as feeding areas.

Adult toads are generalist predators, feeding on a wide range of invertebrates, with Formicidae and Coleoptera often forming the major components of the prey (Cott, 1940; Mathias, 1971; Swan, 1986; Wheater, 1986; Gittins, 1987; Denton, 1991). Foraging strategy was assumed to be 'sit and wait', as seen in the frog *Rana temporaria* (Blackith & Speight, 1974).

Pitfall traps are commonly used for capturing cursorial invertebrates, especially Coleoptera (e.g., Mitchell, 1963; Greenslade, 1964; Luff, 1975) and Formicidae (Greenslade, 1973), and in their action they may be regarded as analogous to a 'sit and wait' predator. The use of pitfall traps to compare invertebrates in different habitats has been criticized because catch size does not correlate with abundance (Greenslade, 1964; Topping & Sunderland, 1992); catch is dependent on abundance and activity, so represents an 'activity abundance index' (Tretzel, 1965, quoted by Thiele, 1977). Activity abundance, however, could correlate well with prey encounter rate for toads. The aim of this preliminary study was to assess the suitability of pitfall trapping as an analogue of feeding toads.

The study site was a poplar (*Populus* sp.) plantation with occasional alders (*Alnus glutinosa*), immediately adjacent to a toad breeding lake (0.8 ha) at Osbaston Estate, Leicestershire (SK424046). It ranged from relatively dry areas of *Arrhenatherum elatius* dominated grassland, through to a marsh dominated by *Fillipendula ulmaria* and *Carex acutiformis*.

The pitfall trap was a plastic cup (90 mm diameter x 80 mm deep) placed in an outer glass jar (90 mm diameter x 100 mm deep) and covered by an aluminium sheet (203 mm x 203 mm) at a height of 50 mm to protect it from rainfall, accumulation of debris, and predation by vertebrates. A killing solution (50 ml) of 50% ethane diol, 30% distilled water and 20% ethanol was used in each trap (Lewis, 1988). Traps were sited in a two by five grid with five metre spacing and run for two weeks (21 June-5 July 1991). Due to constraints on time, only five of the traps were analysed (alternate trap, alternate line); but Cornish (1993) found no significant loss of information in reducing sample size from 10 to 5 in other habitats: sizes of invertebrates and numbers of different orders caught were comparable. Catches were stored in 70% ethanol.

Thirteen adult toads (nine males, two females; body length (snout-urostyle) range 47.5-69.0 mm) were caught in the proximity of the traps on 10 July 1991. Five of the toads were sitting on the basal swellings of tree trunks or associated vegetation, 20 to 30 cm above ground level. Toads' stomachs were flushed (Legler & Sullivan, 1979) and the contents transferred to 6% formaldehyde and later stored in 70% ethanol.

All invertebrates were identified to order and the Coleoptera to family. Fragmented invertebrates from the stomach samples were identified and counted using the key system of Tatner (1983), adapted by Wheater (1986). The length of each invertebrate (head to abdomen tip) was measured and assigned to one of eleven

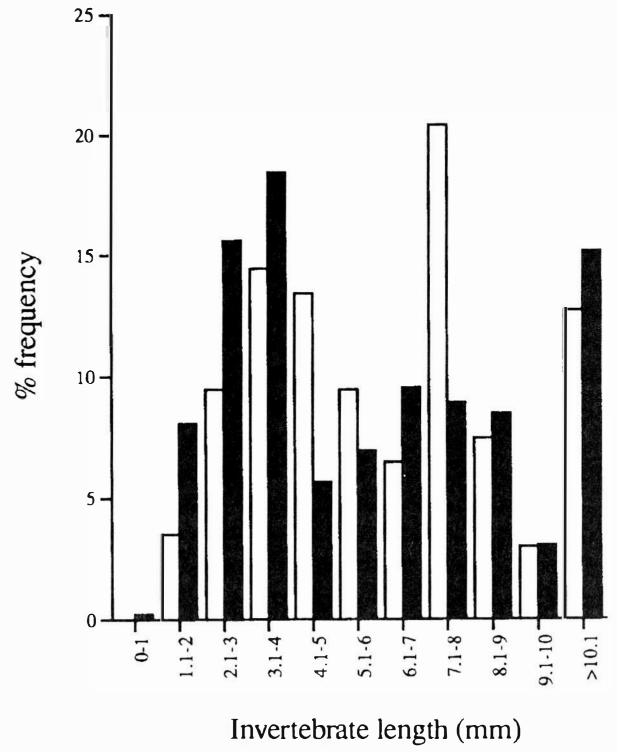

FIG 1. Length of invertebrates in toads' diet (unshaded bars) and pitfall traps (shaded bars).

TABLE 1. Percentage frequency occurrence and abundance of invertebrate taxa in pitfall traps (total catch = 461) and toads' diet (total catch = 383). Modified data excluded groups unlikely to be fed on by toads or caught in pitfall traps.

	% occurrence		% abundance			
Invertebrate taxa	pitfall trap	toads' diet	pitfall trap	modified	toads' diet	modified
Oligochaeta	100	0	2.39	5.05	0.00	0.00
Araneae	80	70	3.48	0.46	4.44	7.06
Opiliones	60	54	0.65	0.46	1.83	1.76
Acari	80	8	3.04	-	0.26	-
Isopoda	80	16	3.26	6.88	7.31	16.47
Diplopoda	80	47	2.83	5.96	4.18	9.41
Chilopoda	20	23	0.43	0.92	0.78	1.76
Collembola	100	16	14.35	-	0.78	-
Dermaptera	0	85	0.00	-	16.45	-
Heteroptera	0	8	0.00	0.00	0.26	0.59
Homoptera	40	77	0.65	1.38	4.18	7.65
Lepidoptera (larva)	0	39	0.00	0.00	1.31	2.94
Diptera (adult)	100	100	11.09	-	19.06	-
Diptera (larva)	0	8	0.00	0.00	1.04	2.35
Hymenoptera	60	77	1.30	1.83	4.18	8.82
Carabidae	100	70	3.70	7.80	4.18	9.41
Staphylinidae	100	70	20.65	42.66	3.66	7.65
Curculionidae	20	85	0.22	-	12.79	-
Other Coleoptera	100	100	6.74	6.42	9.66	18.24
Coleoptera (larva)	100	54	9.57	20.18	2.61	5.88
Pulmonata	100	31	15.65	-	1.04	-
			n=218			*n*=170

size classes (i.e. 0-1 mm, 1.1-2.0 mm .... 9.1-10.0 mm, >10.1 mm).

No significant correlation was found between the invertebrates in the pitfall trap catches and those in the toads' stomachs, either in terms of frequency occurrence (r_s=0.13; P>0.05) or abundance (r_s=0.11; P>0.05) (Table 1). The major differences were: (1) the widespread capture of Oligochaeta, Acari, Collembola and Pulmonata in the pitfall traps compared with the toads' diet, and vice versa for Dermaptera and Curculionidae; and (2) the most numerous taxa in the pitfall traps were Collembola, Staphylinidae and Pulmonata, whereas in the toads' diet Dermaptera, adult Diptera (mainly Tipulidae) and Curculionidae were the most abundant.

Toads fed on significantly larger invertebrates than those caught in pitfalls (Kolmogorov-Smirnov two-tailed test for large samples, $D_{m,n}$=0.149; P<0.01). The modal length class in the toads' diet was 7.1-8.0 mm (due mainly to the Dermaptera) and in the pitfalls it was 3.1-4.0 mm (Fig. 1).

Differences between the two sets of catches may be ascribed to four causes:

(1) The pitfall trap is an inappropriate device for sampling some invertebrates. Some species of Araneae, Isopoda and Coleoptera are not caught because the trap is detected and avoided (Adis, 1975; Lewis, 1988). Certain spiders can escape from traps (Topping, 1993) as can carabids with adhesive tarsi (Benest, 1988; Halsall & Wratten, 1988). Many dermapterans and curculionids have adhesive tarsi so may avoid capture in pitfall traps.

(2) Adult toads avoid small invertebrates such as the Acari, Collembola and some Staphylinidae because they are below the size threshold taken (Kuzmin, 1990), and pulmonates are taken infrequently because of their heavy mucous secretions (Cott, 1940; Mathias, 1971; Swan, 1986; Wheater, 1986).

(3) The pitfall traps captured invertebrates throughout the day and night, whilst the toads' main feeding activity was crepuscular and nocturnal.

(4) Toads are not restricted to cursorial feeding, but climb on to vegetation as noted in the present work and also by Denton (1991). Dermapterans and curculionids, well represented in the toads' stomachs (Table 1), are herbivores found on vegetation, and adult tipulids, the main dipteran component of the toads' diet, are low flying insects which commonly clamber on vegetation.

Significant discrepancies were found between the toads' diet and pitfall trap catches, suggesting that the traps do not provide a satisfactory model of toad foraging strategy in the situation tested. However, the absence of correlation may be the result of the inclusion in the analysis of inappropriate invertebrate groups. If the small (<3 mm) organisms, pulmonates, and the groups unlikely to be found in pitfall traps, Dermaptera, Diptera and Curculionidae, are excluded, the level of correlation between percentage abundance of invertebrate taxa in pitfall trap catches and toads' diet improves (r_s=0.587; P<0.05) (Table 1). There is a need to repeat the study using a larger number of toads over a longer period, and in a wider array of habitats, with pitfall traps closed during the day. Invertebrate sampling may be augmented using a series of techniques in tandem with pitfall traps: suction-trapping, sweep netting and sticky traps, which will sample invertebrates on vegetation and in flight as well as those on the ground.

Acknowledgements. The authors thank the European Social Fund for providing a student bursary and the financial support provided by NERC through its Joint Agriculture and Environment Programme; Dr. J. W. Arntzen and D. M. Latham for assisting with fieldwork; Dr. K. Stewart and two referees for their comments on drafts of the note.

REFERENCES

Adis, J. (1979). Problems of interpreting arthropod sampling with pitfall traps. *Zoologischer Anzeiger* **202**, 177-84.

Benest, G. (1988). The sampling of a carabid community I. The behaviour of a carabid when facing the trap. *Revue D' Ecologie et de Biologie du Sol* **26**, 205-11.

Blackith, R. M. & Speight, M. C. D. (1974). Food and feeding habits of the frog *Rana temporaria* in bogland habitats in the west of Ireland. *Journal of Zoology* (Lond.) **172**, 67-79.

Cornish, C. A. (1993). *Estimating Food Supply for the Toad Bufo bufo (L.) in Terrestrial Habitats.* M.Phil thesis, University of Leicester.

Cott, H. B. (1940). *Adaptive Coloration of Animals.* Methuen, London.

Denton, J. S. (1991). *The terrestrial ecology of the natterjack (Bufo calamita) and the common toad (Bufo bufo).* Ph.D thesis, University of Sussex.

Gittins, S. P. (1987). The diet of the common toad (*Bufo bufo*) around a pond in mid-Wales. *Amphibia-Reptilia* **8**, 13-17.

Greenslade, P. J. M. (1964). Pitfall trapping as method of studying populations of Carabidae. *Journal of Animal Ecology* **33**, 301-10.

Greenslade, P. J. M. (1974). Sampling ants with pitfall traps: digging-in effects. *Insectes Sociaux* **20**, 343-53.

Hallsall, N. B. & Wratten, S. D. (1988). The efficiency of pitfall trapping for polyphagous predatory Carabidae. *Ecological Entomology* **13**, 293-99.

Kuzmin, S. L. (1990). Trophic niche overlap in syntopic postmetamorphic amphibians of the Carpathian mountains (Ukraine: Soviet Union). *Herpetozoa* **3**, 13-24.

Legler, J. M. & Sullivan, L. J. (1979). The application of stomach-flushing to lizards and anurans. *Herpetologica* **35**, 107-10.

Lewis, D. W. (1988). *Estimation of Population Densities of Carabid beetles in cereal crops.* Ph.D thesis, University of Leicester.

Luff, M. L. (1975). Some features influencing the efficiency of pitfall traps. *Oecologia* (Berl.) **19**, 345-57.

Mathias, J. H. (1971). *The Comparative Ecologies of two species of Amphibia (Bufo bufo and B. calamita) on the Ainsdale Sand Dunes NNR.* Ph.D thesis, University of Manchester.

Mitchell, B. (1963). Ecology of two carabid beetles *Bembidion lampros* (Herbst) and *Trechus quadristiatus* (Schrank) II. Studies on populations of adults in the field with special reference to the technique of pitfall trapping. *Journal of Animal Ecology* **32**, 377-92.

Swan, M. (1986). *The Conservation Ecology of Rana temporaria and Bufo bufo in Leicestershire.* Ph.D thesis, Leicester Polytechnic.

Tatner, P. (1983). The diet of urban Magpies *Pica pica. Ibis* **125**, 90-107.

Thiele, H. U. (1977). *Carabid beetles in their environments. (Zoophysiology and Ecology V.10.)* Springer-Verlag.

Topping, C. J. (1993). Behavioural responses of three linyphiid spiders to pitfall traps. *Entomologia Experimentalis et Applicata* **68**, 287-93.

Topping, C. J. & Sunderland, K. D. (1992). Limitations to the use of pitfall traps in ecological studies exemplified by a study of spiders in a field of winter wheat. *Journal of Applied Ecology* **29**, 485-91.

Wheater, C. P. (1986). Prey-size and parasitic relationship in the common toad (*Bufo bufo*). *Herpetological Journal* **1**, 62-66.

Accepted: 5.9.94