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A TECHNIQUE FOR MONITORING THE FINAL PHASE OF METAMORPHOSIS IN NEWTS

A S COOKE (1) and S D COOKE (2)

(1) English Nature, Northminster House, Peterborough PE1 1UA
(2) The Nottingham Trent University, Clifton Lane, Nottingham NG11 8NS

INTRODUCTION

Studying metamorphosis and emergence in newt populations can provide both basic ecological data and information of relevance to conservation eg on reproductive success. One field technique for monitoring emergence involves erecting plastic fences around breeding sites and catching metamorphs in pitfalls or other types of trap (eg. see van Gelder, 1973: Hagstrom, 1974; Harrison *et al*, 1983; Duff, 1989). However this technique needs a large time investment and may still fail to catch or hold all metamorphs (Duff, 1989). An alternative technique involves trapping or netting a sample of tadpoles in the pond itself and selecting and studying those that are close to emergence. One difficulty with newt tadpoles in this respect is that they acquire four legs relatively early during their aquatic phase and for much of their later development morphological changes are much more subtle than the obvious ones displayed by anuran larvae. We report here on a straightforward field technique that readily allows separation of larvae into early and late development stages.

THE WALKING STAGE

When netted, younger tadpoles, even at the four-legs stage, behave like fish; they generally lay on their sides and flap. However, their legs are evidently growing in strength and there comes a point in their development at which, when netted, tadpoles turn on their bellies and walk; such tadpoles we define as "walkers". A few seconds observation is usually all that is needed to decide whether or not a netted tadpole is a walker. In some samples, these may be in the majority (see below). Overwintering animals taken from November onwards are inclined to be sluggish and may not walk when netted, although they do right themselves onto their bellies.

For most of the walking stage, animals retain the typical larval skin colour and texture, and gill and fin size. But immediately before and after emergence these change (contrast drawings in Figure 1).

APPLICATIONS

Measurement of length. During summer and autumn, walkers may be caught in good numbers and their measurement can provide a constant sampling stage for comparison between populations in different ponds or between the same pond in diferent years. Thus in one particular netting area of the newt reserve at Stanground, Peterborough, mean number of Crested newt tadpoles *(Triturus cristatus)* caught per five minute sampling period during July and August was in 8 in 1992 (n = 4, standard error = 2), but 37 in 1991 (n = 4, SE = 2). The unusually high "density" in 1991 was reflected in a reduced mean length of walkers of 42 mm (n = 6, SE = 2), compared with 57 mm in 1992 (n = 7, SE = 2). The different in mean lengths between the two years was highly significant (t_{11} = 6.16, P 0.001).

Time of metamorphic climax. Sampling for walkers provides a method for determining when emergence occurs and allows comparison between species and between sites. Netting details from two sites are given in Table 1. At Woodwalton Fen in 20 small ponds (refer to Cooke *et al.* 1980 for details of the ponds), walkers occurred earlier for the Smooth Newt *(Triturus vulgaris)* than for the Crested Newt. However, the greatest number of walkers was recorded during the same netting session (25/26 August) for both species. Although netting did not

continue at Woodwalton until catches were zero, low numbers of non-walkers of both species were caught at the end of September.

At Stanground, Crested Newts appear to have had a short, concentrated period of emergence, with walkers only being caught on two occasions. For Crested Newts, walkers peaked earlier at Stanground than at Woodwalton Fen. At Stanground, peak numbers of breeding Crested Newts are typically recorded in March, which is unusually early for this area. Smooth newts may have overwintered as tadpoles, with walkers still being found when netting stopped in November.

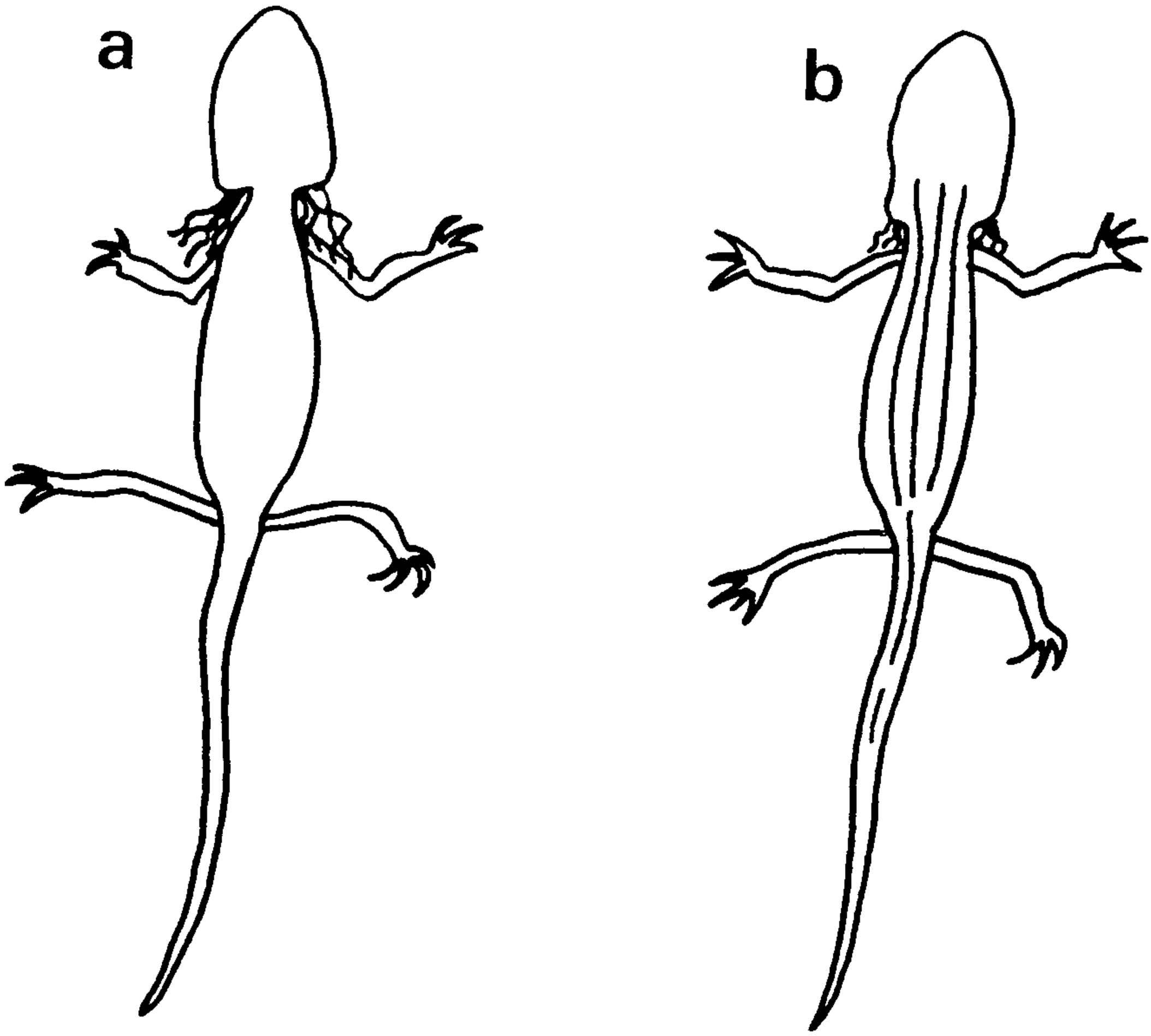

Fig. 1. Dorsal views of Smooth Newts *(Triturus vulgaris):* Fig 1a shows the typical walking tadpole;
Fig 1b represents an animal at emergence.

To test whether walkers emerge in (late) autumn, ten Smooth Newts at the walking stage were kept in a cage measuring 30 x 30 x 30 cm in a garden pond, their natal site. The experiment was run from 29 September till 14 November 1992 (pond temperature ranged 3-16°C). During that time five metamorphs emerged, the last being on 2 November. Thus the other five walkers remained in that state for 46 days without emerging. The duration of the walking phase at the height of the season remains to be determined.

Number of walkers. During specific periods, the number of walkers caught in a standardised manner may reflect the number of metamorphs that emerge. Thus at Woodwalton Fen, netting sessions took place at intervals of roughly two weeks; 216 Smooth Newt walkers were caught from mid July till the end of September and this total may be regarded as an index of emergence. A repeat of this catching regime in future years could reveal how those years compare for emerence with 1992. As the 20 ponds at Woodwalton are all the same size and shape it may be possible to compare catches of walkers between them, but it would be most unwise to compare two ponds where ability to catch tadpoles is likely to be different. Moreover, information from catches later than September should be treated with great caution as walkers may take longer to emerge and may indeed overwinter.

TABLE 1. Catches of walking and non-walking newt tadpoles at two breeding sites

Date	No. of ponds/ areas*	Total netting time (minutes)	Crested Newts			Smooth Newts		
			Total	Walkers	Non-wealkers	Total	Walkers	Non-walkers
Woodwalton Fen								
14.7.92	20	100	75	0	75	206	4	202
27/28.7.92	19	95	101	1	100	152	26	126
9/10/11.8.92	19	95	111	13	98	126	57	69
25/26.8.92	19	95	89	19	70	99	70	29
8/10.9.92	18	90	51	14	37	47	34	13
26/27.9.92	20	100	15	6	9	27	25	2
Stanground								
16.7.92	4	20	32	0	32	65	14	51
27.7.92	4	20	23	11	12	53	27	26
13.8.92	4	20	13	10	3	35	16	19
28.9.92	4	20	0	0	0	53	27	26
21.10.92	4	20	0	0	0	34	22	12
12.11.92	4	20	0	0	0	6	6	0

•Two ponds at Woodwalton dried out, then re-filled.

CONCLUSION

This paper should be regarded as preliminary recognition of the walking stage and its application to ecological study. At this point in time it seems to hold considerable promise for the study of the final phase of metamorphosis in newts.

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