Influences of microhabitat and light level on great crested newt *Triturus cristatus* capture in bottle-traps

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ABSTRACT - Bottle-trapping is an important surveying method for the European protected species *Triturus cristatus*, yet little is known of factors affecting capture. Influences of light level and trap proximity to plants were investigated in a garden pond in Surrey England, using video-records and comparing night counts with trap success. In shallow water (15 cm) males were highly sensitive to light levels; compared with females, 70% avoided capture. In small, 0.05 m^2, shaded spaces for both sexes catches were proportional to the number present. Proximity of egg substrate material appeared conducive for female capture.

Surveying and monitoring are key elements of nature conservation; data is required for determination of the conservation status of target species, to support research, inform policy makers and implement conservation measures (Beebee & Griffiths, 2000; Sutherland, 2000; Gleed-Owen et al., 2005). For newts this is undertaken when they are concentrated in ponds for the breeding season, a two month period during March to May (English Nature, 2001). Of the four methods used (egg-searching, netting, night-time counts and bottle-trapping (Griffiths, 1985)), only counts and trapping are considered suitable for assessment of population status (Griffiths et al., 1996). Visual detection is impaired by rain, wind (English Nature 2001) water turbidity and vegetation (Griffiths & Inns, 1998), but for both of these methods detection is enhanced with increasing water temperature above 5°C (Sewell et al., 2010). Further factors influencing capture appear to be unknown (Jehle et al., 2011) beyond negative effects of moonlight (Deeming, 2008) and increasing amounts of aquatic vegetation (Oldham et al., 2000). However, illumination within bucket traps might be beneficial for catching breeding crested newts (Beckham & Göcking, 2012). Identification of further factors affecting the probability of newt detection could benefit conservation effort (Foster & Beebee, 2004; Schmidt, 2004).

This study aims to identify microhabitat features that influence the likelihood of newt capture. Specific objectives are to determine any effects of a light intensity gradient and the extent of vegetation-free water either side of a trap. Behaviour close to bottle-traps was studied in a garden pond using video-recording. Without the artificial lighting necessary for this, visual observations were used to assess newt presence to compare with catches from overnight bottle-trapping and determine behaviour characteristics throughout the pond. A possible effect of trap orientation was also investigated.

MATERIALS AND METHODS

The study site

The eight square metre garden pond (Figure 1), supports natural populations of all three native urodeles, the great crested newt *Triturus cristatus*, the smooth newt *Lissotriton vulgaris* and the palmate newt *L. helveticus* besides the common frog *Rana temporaria*. It has a flat floor 50 cm deep, steep sides and a marginal shelf at 20 cm depth and width 25 cm (Figure 2). Plants on the shelf, in black plastic baskets with vertical 20 cm sides, are some emergent *Iris* and *Carex* species beside egg-deposition plants, *Myosotis scorpioides*, *Ranunculus flammula* and *Veronica beccabunga*, that trail over the basket edges into the water. Further egg-deposition plants fill regions at the east and west ends of the pond. The floor is covered in *Ceratophyllum demersum*, and baskets

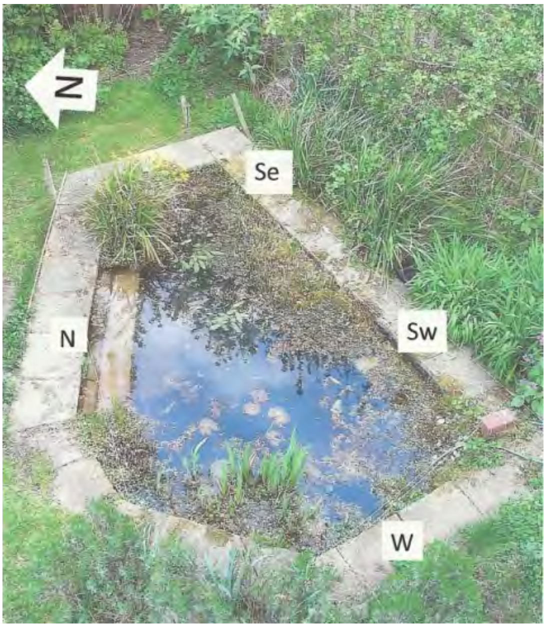

Figure 1. The garden pond (3.9 x 2.6 m), depth 0.5 m. The four spaces on the marginal shelf, N, W, Sw and Se were in length 155 or 80 cm and three 22 cm long respectively. Trailing plants partially mask the smaller spaces.

contain *Aponogeton distachyos* and a Nuphar lily.

Environmental conditions and experimental design

Experiments were conducted under favourable weather conditions during the newt breeding season in 2001 and 2002. Spaces for bottle-traps, 155 or 80 cm and 22 cm long, were created on the pond shelf between plant baskets (Figure 1). Traps, constructed from green transparent two litre drinks bottles (Figure 2), on paving slabs at a depth of 15 cm, 10 cm from the deeper water faced the pond centre. Video-recording equipment (Figure 3) was set up over the 155 or 80 cm length with a laminate sheet on the paving slabs defining the recorded area (Figures 3 & 4). Traps were set just before sunset and removed shortly after sunrise the following morning. Video-recording commenced at sunset as newt nocturnal breeding activity commences at dusk (Dolmen, 1983; Zuiderwijk & Sparreboom, 1986). Records of three hours duration captured representative samples of behaviour (Zuiderwijk

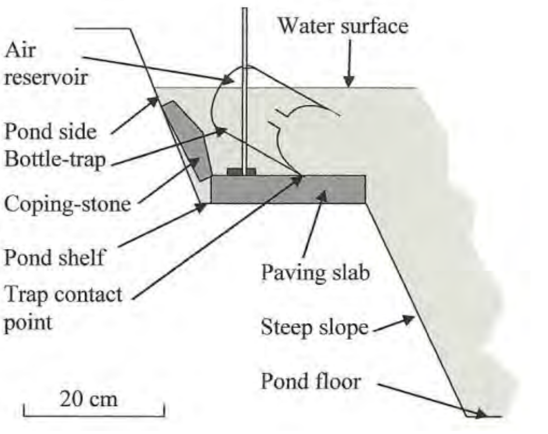

Figure 2. Bottle-trap design, pond profile and trap location. Traps tilted at 30º to the horizontal were held in place by a cane passing through the trap and inserted in a section of tile on the substrate. To give a uniform horizontal substrate, depth 15 cm, paving slabs were placed on the shelf. Coping-stones resting on the slabs formed a straight edge at the pond side (Figures 3 & 4).

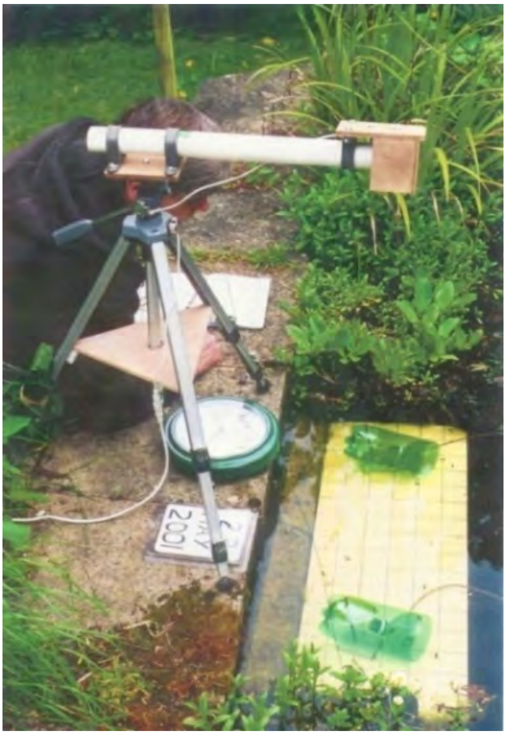

Figure 3. The video-recording set-up with a 30 x 80 cm laminate sheet defining the recorded area and the camera mounted over the area centre.

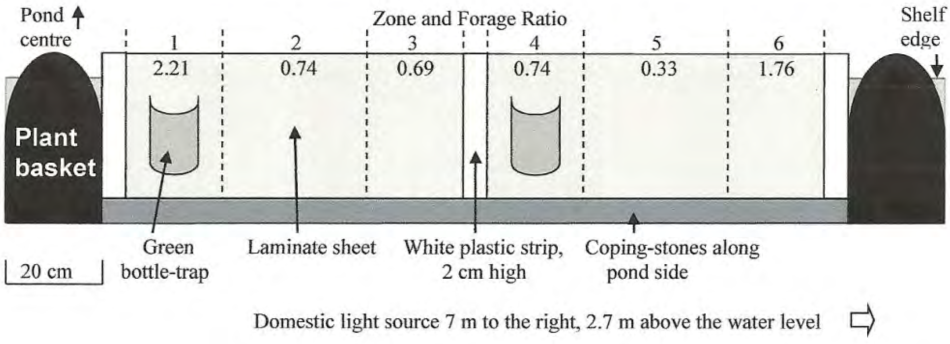

Figure 4. Plan view of the first video-recorded area, the 155 x 30 cm laminate sheet. Three white plastic strips define the side boundaries of two identical trap microhabitats 70 x 30 cm. Traps were 10 and 60 cm from the nearest basket. Zone 1 of six was most distant from the light source to the right. Forage Ratio is defined in the text, values greater than one indicate a greater than expected newt presence.

& Sparreboom, 1986; Lehner, 1996). Visual observations and a night count took place about two hours after sunset on nights when no traps were in place.

Light intensity gradient

The illumination required when recording was from domestic lighting shining along the length of the area from the right (Figure 4), so with a slight reduction in light strength from Zone 6 to Zone 1. Light intensity, measured 25 cm above the centre of Zone 2 and Zone 5, was five lux in each case using a light meter with a resolution of one lux. Forage ratios (Krebs, 1989), the observed/expected time spent in each zone were compared. The observed time was obtained from eight video-records and the expected time derived from the proportion of the recorded area taken up by the zone.

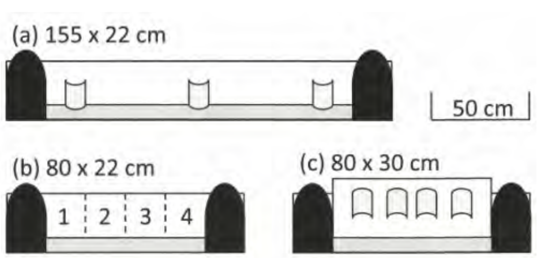

Figure 5. Areas of spaces between baskets and trap locations: (a) used for comparison with results obtained on video-recording nights; (b) the 80 cm long space treated as four 20 cm sections, 1 – 4; (c) four traps, 5 cm apart, facing and 10 cm from the coping-stones; to ensure trap stability they were placed on a laminate sheet.

Extent of vegetation-free water either side of the trap

In 2001, traps were placed 10 or 60 cm from the nearest plant basket on video-recording nights (Figure 4 eight sessions and Figure 3 four sessions). The shorter length (Figure 3) increased the chance of newts in the recorded area encountering traps. After three hours of recording the domestic lighting was switched off and traps remained in place until the following morning. Numbers of newts recorded entering a trap funnel, then either retreating or passing through the funnel neck into the trap were compared with trap proximity to plants. In the absence of any artificial lighting three traps were set on five further nights using the same 155 cm long space; two 10 cm from the nearest basket, the third 72.5 cm (Figure 5a). The results were compared with the overnight catches obtained when there had been video-recording.

Results from 2001 showed a difference in susceptibility to capture between the sexes and also the proximity of plant baskets influenced trap success. The effects on capture for traps in smaller spaces were explored in 2002; the 80 cm space being used with three 22 cm spaces, at respectively N, W, Sw and Se (Figure 1). Presence in each space of each sex was assessed from night

Period of collection	Space length (cm)	Video record	Number of sessions	Funnel entries						Captures					
				L		C		R		L		C		R	
				♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
12.4 -20.5	155	Yes	8	20	2	5	1	*	*	1	2	0	0	*	*
3.5 -13.5	80	Yes	4	14	3	*	*	5	4	0	0	*	*	0	2
12.4 -20.5	155	No	8							2	3	0	2	*	*
3.5 -13.5	80	No	4							2	3	*	*	0	6
10.4 –8.5	155	No	5							8	4	1	1	4	2

Table 1. Numbers of video-recorded funnel-entries and captures and overnight catches compared for traps 10 cm from plant baskets (L & R) with those ≥60 cm (C) distant (Figures 4, 3 & 5a). *No trap present.

Length (cm)	Space Section	Location	Total count ♂	♀	*	Total catch ♂	♀
80		N	57	6	4	17	10
	1		22	3	3	2	2
	2		13	1	0	6	0
	3		5	0	0	4	3
	4		17	2	1	5	5
22		W	23	11	10	19	15
22		Sw	15	7	4	19	7
22		Se	19	1	1	17	1
	Elsewhere in the pond		51	54	37		

Table 2. Count and catch totals in four spaces (Figure 1), also for each 20 cm section (Figure 5b) of the 80 cm space. Counts were extended to include all newts visible in the pond. *Number of sightings of egg laying females.

counts (32 sessions) and compared with catches (15 sessions). During counts a possible bias due to plant proximity in the 80 cm space was investigated by treating it as four 20 cm long sections (Figure 5b). In this longer space traps faced the pond side (Figure 5c) where video-records showed relatively high newt presence, to explore the influence of trap orientation.

Behaviour characteristics

With excellent water clarity the expectation was that a high proportion of newts above the floor vegetation would be visible, so the count survey was extended to cover the whole pond. To determine behaviour characteristics of the active population, sex, habitat and activity were recorded for each sighting.

RESULTS

Light intensity gradient

Any influence due to trap or plant proximity was expected to be identical in Zones 2 and 5 (Figure 4). The forage ratios of 0.74 and 0.33 respectively suggest negative phototaxis, further suggested by the highest forage ratio, 2.21, being in Zone 1 most distant from the light source. Shading from the trap, and plant basket in Zones 4 and 6 respectively were seen to be attractive to newts on the video records resulting in the relatively higher forage ratios in these zones. Since 84% of newt sightings were male, this preference for places with lower light levels may be sex related.

Extent of vegetation-free water 155 or 80 cm

Video-records of 54 newt entries into a trap funnel were obtained (Table 1). Only five resulted in capture; these all occurred in a trap 10 cm from a basket. As too did 22 (79%) funnel-entries, compared with 7 (21%) at the trap 60 cm from a basket. Funnel-entrants were predominantly male (81%), but four of the five captives were female.

In the complete absence of any video-recording illumination there was still a tendency for higher trap success near plant baskets with 12 of 13 males (Table 1) in the two end traps of the 155 cm long space (G_{adj} = 4.697, df = 1, $P < 0.05$). The female total in these traps, six of seven captures, suggests a similar bias. Possible influence of three hours of artificial lighting on the overnight catch of each sex was examined by comparing the mean catch/trap of traps 10 cm from a basket. For males with and without lighting these were 0.25 and 1.2 respectively and 0.7 and 0.6 for females.

Newt capture and activity at traps was greater near vegetation baskets and males compared with females were avoiding capture. This avoidance was far greater when there was or had been period of elevated light level (intensity 5 lux). This lighting had no effect on female capture.

Extent of vegetation-free water 80 or 22 cm

Along the 80 cm length there were 22, 13, 5 and 17 male sightings in sections 1 to 4 respectively (Table 2), indicating a bias towards sections 1 and 4, those closer to plants (G_{adj} = 7.853, df = 1, $P < 0.01$). Also five of six female sightings were in these sections. For each of the four spaces count/catch ratios were similar in all spaces for females, 0.6 - 1.0 (Table 2). For males this was also the case in the three short spaces, 0.8 - 1.2. However in the larger space, the total number of male sightings was 57, and much lower for catches: 17, 30% of the count.

A preference was shown for being less than 20 cm, rather than 20 to 40 cm, from plant baskets. Where traps were within 10 cm of plant baskets on both sides and partially shaded by floating vegetation, the catch of both sexes was representative of the number present, but in the larger space much depressed for males.

Trap orientation

With traps facing the pond centre (Figure 5a) the mean catch per night was four newts (Table 1) and when facing the much smaller region (Figure 5c) at the pond side 1.8 (Table 2). The proportion of sightings that were male was 84% and 90% and of captures 65% and 63% respectively. Newts on the substrate at the pond side were susceptible to capture and with a similar proportion of each sex caught, capture appeared unaffected by trap orientation.

Behaviour characteristics

From the night counts throughout the pond, 69% of the male sightings (n = 165) were within the four spaces created for placing traps and typically on the substrate (Table 2); these were used as display areas. In total 85% were in a display area and or interacting with other newt(s). For female sightings (n = 79) only 32% were within the spaces and 89% were among plants many egg-laying. In the four spaces egg substrates were more abundant where catches and counts of females were highest, space W, and little was available in space Se where there was a single capture and sighting. This suggests female presence and capture is related to the availability of egg substrate material close by.

DISCUSSION

In this study as in others (Zuiderwijk & Sparreboom, 1986; Hedlund & Robertson, 1989) the proportion of newts that were male in open water and usually on the pond floor was high; this being the microhabitat they use for displaying to other newts. Preferred regions of open water appear to be where they could be less conspicuous (Cooke, 1986; Oldham & Nicholson, 1986; Zuiderwijk & Sparreboom, 1986; Grusser-Cornehis & Himstedt, 1976; Gustafson et al., 2006), at edges such as plant boundaries or a steep pond side or shaded by vegetation. Displaying males could attract predators and their nocturnal breeding habit and these preferences suggest anti-predator behaviour (Endler, 1986, 1987). They appear to behave as unthreatened in water at a depth of 50 cm (Hedlund & Robertson, 1989). In my study, in a water depth of 15 cm, a high proportion of males avoided capture, a trait not observed for females even with a raised light level. Females in fulfilling their egg-laying role could be attracted to lighter regions of a pond beneficial for plant growth (Cooke et al., 1994) and where egg-laying occurs (Sztatecsny et al., 2004).

With males concentrated in display regions bottle-trap success might benefit by placing traps on the pond floor facing into open water and beside edge features or in shaded open water. With female capture apparently associated with egg-laying setting traps amongst egg deposition plants is also recommended. Placing these traps near the water surface may be beneficial (Miaud, 1995; Langton et al., 1994). Further work including video-recording might allow a fuller understanding of factors influencing the capture of crested newts.

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REFERENCES

Beckmann, C. & Göcking, C. (2012). Wie die Motte zum Licht? Ein Vergleich der Fängigkeit von beleuchteten und unbeleuchteten Wasserefallen bei Kamm-, Berg- und Teichmolch. *Zeitschrift für Feldherpetologie* 19: 67-78.

Beebee, T.J.C. & Griffiths, R.A. (2000). *Amphibians and Reptiles: A Natural History of the British Herpetofauna*. London: HarperCollins Publishers.

Cooke, A.S. (1986). Studies of the great crested newt at Shillow Hill, 1984-1986. *Herpetofauna News* 6: 4-5.

Cooke, S.D., Cooke, A.S. & Sparks, T.H. (1994). Effects of scrub cover of ponds on great crested newts' breeding performance. In *Conservation and Management of Great Crested Newts: Proceedings of a Symposium Held at Kew Gardens*, pp.7-17. Gent, A. & Bray, R. (Eds.). English Nature report No. 20. Peterborough: English Nature.

Deeming, D.C. (2008). Capture of smooth newts (*Lissotriton vulgaris*) and great crested newts (*Triturus cristatus*) correlates with the lunar cycle. *Herpetological Journal.* 18: 171-174.

Dolmen, D. (1983). Diel rhythms and microhabitat preference of the newts *Triturus vulgaris* and *T. cristatus* at the northern border of their distribution area. *Journal of Herpetology* 17: 23-31.

English Nature (2001). *Great Crested Newt Mitigation Guidelines*. Peterborough, English Nature.

Endler, J.A. (1986). Defense against predators. In *Predator-prey Relationships, Perspectives and Approaches from the Study of Lower Vertebrates*, pp.109-134. Fedor, M.E. & Lauder, G.V. (Eds). Chicago, University of Chicago Press.

Endler, J.A. (1987). Predation, light intensity and courtship behaviour in *Poecilia reticulata* (Pisces: Poeciliidae). *Animal Behaviour* 35: 1376-1385.

Foster, J.P. & Beebee, T.J.C. (2004). Research as a tool to inform amphibian conservation policy in the UK. In *Global Amphibian Declines: Is Current Research Meeting Conservation Needs?* Proceedings of the Society for Conservation Biology Symposium, University of Kent, Canterbury 15 July 2002. Griffiths, R.A. & Halliday, T.R. (Eds). *Herpetologcal Journal.* 14: 209-214.

Gleed-Owen, C., Buckley, J., Coneybeer, J., Gent, T., McCracken, M., Moulton, N. & Wright, D. (2005). *Costed Plans and Options for Herpetofauna Surveillance and Monitoring*. English Nature Research Reports Number 663. Bournemouth, Herpetological Conservation Trust.

Griffiths, R.A. (1985). A simple funnel trap for studying newt populations and an evaluation of trap behaviour in smooth and palmate newts, *Triturus vulgaris* and *T. helveticus*. *Herpetological Journal* 1: 5-10.

Griffiths, R.A. & Inns, H. (1998). Surveying. In

Herpetofauna workers' manual, pp. 1-8. Gent, A.H. & Gibson, S.D. (Eds). Peterborough: Joint Nature Conservation Committee.

Griffiths, R.A., Raper, S.J. & Brady, L.D. (1996). *Evaluation of a Standard Method for Surveying Common Frogs (*Rana temporaria*) and Newts (*Triturus cristatus, T. helveticus *and* T. vulgaris*)*. JNCC Report No. 259. Peterborough: Joint Nature Conservation Committee.

Grüsser-Cornehls, U. & Himstedt, W. (1976). The urodele visual system. In *The Amphibian Visual System – a Multidisciplinary Approach*, pp. 203-266. Fite, K.V. (Ed). New York, Academic Press.

Gustafson, D.H., Pettersson, C.J. & Malmgren, J.C. (2006). Great crested newts (*Triturus cristatus*) as indicators of aquatic plant diversity. *Herpetological Journal*. 16: 347-352.

Hedlund, L. & Robertson, J.G.M. (1989). Lekking behaviour in crested newts, *Triturus cristatus. Ethology* 80: 111-119.

Jehle, R., Thiesmeier, B. & Foster, J. (2011). *The Crested Newt: A Dwindling Pond-dweller*. Bielefeld, Laurenti-Verlag.

Krebs, C.J. (1989). *Ecological Methodology*. New York: HarperCollinsPublishers.

Langton, T.E.S., Beckett, C.L., Morgan, K. & Dryden, R.C. (1994). Translocation of a crested newt *Triturus cristatus* population from a site in Crewe, Cheshire, to a nearby receptor site. In *Conservation and Management of Great Crested Newts: Proceedings of a Symposium Held at Kew Gardens*, pp. 92-103. Gent, A. & Bray, R. (Eds). English Nature report No. 20. Peterborough, English Nature.

Lehner, P.N. (1996). *Handbook of Ethological Methods.* Cambridge, Cambridge University Press.

Miaud, C. (1995). Oviposition site selection in three species of European newts. *Amphibia-Reptilia* 16: 265-272.

Oldham, R.S. & Nicholson, M. (1986). *Status and Ecology of the Warty Newt* Triturus cristatus. Peterborough, Nature Conservancy Council.

Oldham, R.S., Keeble, J., Swan, M.J.S. & Jeffcote, M. (2000). Evaluating the suitability of habitat for the great crested newt (*Triturus cristatus*). *Herpetological Journal* 10: 143-155.

Schmidt, B. (2004). Declining amphibian populations: the pitfalls of count data in the study of diversity, distribution, dynamics and demography. In *Global Amphibian Declines: Is Current Research Meeting Conservation Needs? Proceedings of the Society for Conservation Biology Symposium, University of Kent, Canterbury 15 July 2002*. Griffiths, R.A. & Halliday, T.R. (Eds). *Herpetological Journal* 14: 167-174.

Sewell, D., Beebee, T.J.C. & Griffiths, R.A. (2010). Optimising biodiversity assessments by volunteers: The application of occupancy modelling to large-scale amphibian surveys. *Biological Conservation* 143 (2010): 2102-2110.

Sutherland, W.J. (2000). *The Conservation Handbook: Research, Management and Policy*. Oxford, Blackwell Sciences Ltd.

Sztatecsny, M., Jehle, R., Schmidt, B.R. & Arntzen, J.W. (2004). The abundance of premetamorphic newts (*Triturus cristatus, T. marmoratus*) as a function of habitat determinants: an a priori model selection approach. *Herpetological Journal* 14: 89-97.

Zuiderwijk, A. & Sparreboom, M. (1986). Territorial behaviour in crested newt *Triturus cristatus* and marbled newt *T. marmoratus* (Amphibia, Urodela). *Bijdragen tot de Dierkunde* 56: 205-213.