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Research Article

Separating brown and water frogs to group & species on snout features

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ABSTRACT - Identification guidance in the herpetological literature for distinguishing between the northwest European brown frog species and brown frog and water frog groups (*Rana* and *Pelophylax* respectively) often describes the degree of snout pointedness as a diagnostic feature. This method is evaluated here and is found to have no value. On the other hand, a novel method, using the markings on the snout, has value in separating the north-west European brown frogs and in separating the two groups. Consideration is given to the possibility that earlier descriptions of species having more pointed heads than others is due to variation in the narrowness of the angles of head markings causing an illusion of greater head pointedness.

INTRODUCTION

This work has a main focus on the six indigenous northwest European frog species, comprising three brown frogs, the Common Frog *Rana temporaria*, the Moor Frog *Rana arvalis* and the Agile Frog *Rana dalmatina*, and three water frogs, comprising two species, the Pool Frog *Pelophylax lessonae* (formerly *Rana lessonae*), and the Marsh Frog *Pelophylax ridibundus* (formerly *Rana ridibunda*) and their hybrid, the Edible Frog *Pelophylax kl. esculentus* (formerly *Rana kl. esculenta*).

Water frogs are often described as having a more pointed snout than brown frogs (e.g. Wycherley, 2003; Natural England, 2008; Arkive-Images of Life on Earth, 2011). In Fig. 1 (from Arnold & Ovenden, 2002) the water frog is depicted with a more pointed snout than the brown frog and Inns (2009) describes the Common Frog as having a blunter snout than water frogs. Additionally, within the brown frogs, Common Frogs are often described as having a less pointed snout than the Moor Frog (e.g. Haltenorth, 1979; Chihar & Cepika, 1979; Hofer, 1985; Laňka & Vít, 1989; Nöllert & Nöllert, 1992) or usually having a less pointed snout (Fog et al., 1997), Arnold and Ovenden (2002). The ubiquity and longevity of this distinction is highlighted by the fact that in

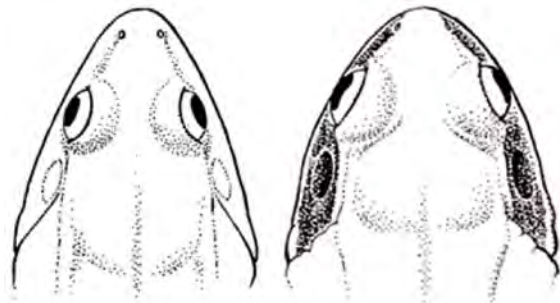


Figure 1. Depiction of the water frog snout (left) compared to brown frog (right). From Arnold & Ovenden, 2002.

Scandinavia the Moor Frog is called the Pointed Nosed Frog (spissnutefrosk (Norwegian), spidssnudet frø (Danish)) whereas the Common Frog is known as the Blunt-nosed Frog (buttsnutefrosk (Nor.), butsnudet frø (Dan)). The usefulness of using these characteristics for distinguishing between species or groups is evaluated here.

It was noticed in the course of the work on snout form, eye stripes and eye shape, that the dark facial stripes that pass across each nostril and join to the anterior edge of each eye, had quite varying angles; the utility of these are also investigated.

METHODS AND MATERIALS

Samples available for comparison

Species and sample numbers of north-west European frogs used for the investigation were as follows: water frogs, 27 (of which Pool Frogs, 15, Edible Frogs 5, Marsh Frogs 7), Common Frogs 33, Moor Frogs 19 and Agile Frogs 14.

Measuring snout pointedness

To quantify snout pointedness, electronically cut-out photographs of the heads (photographed vertically from above) of a range of water and brown frog individuals were made (Fig. 2); no conscious bias was made in the selection. These were transformed into black silhouettes (water frogs) or white silhouettes (brown frogs) and then overlain in pairs (example shown in Fig. 2B) to check for consistent variation in snout form (approximately the upper one third of the

image) between the brown and water frogs. A less time-consuming method was adopted part-way through the investigation, where a line was traced - using graphical software (MS PhotoDraw) - around the head region starting and terminating at the points where the arms met the body (Fig. 2C). These tracings overlain in permuted pairs were then individually ordered in terms of snout pointedness.

In both methods the lower two thirds of the outlines were aligned and sized (conserving proportions) to match each other as closely as possible; a method which also removed differences brought about by the size of the individual.

Facial markings and angles

The possibility of separating the groups - or even species - by differences in facial markings, proportions or angles was investigated by creating a series of computer generated tracings taken from enlarged photographs. These traced the eyes as well as the dark stripes which, starting near the snout tip, pass through the nostrils and stop at the anterior part of the eye. Fig. 3 gives an example of these and the position of tracing is shown at B, where an outline of the head is included for clarity. The eyes are the sub-semicircular shapes in the lower part of each traced line.

The angles between the two stripes - estimated by best fit (see grey dotted lines in R.a', Fig. 3) - were recorded for these and the other specimens in the samples: the turns in the facial markings anterior to the nostrils (e.g. in R.a' and R.d) and the more pronounced turns closer to the eyes (e.g. see arrows in R.a, R.a' and R.d. specimens, Fig. 3) were excluded from these "best fit" considerations.

Clearly, the greater the proportion of width compared to length, the greater the amount of eye visible from above and the more upwardly focused the frog eyes are (q.v. Snell, 2011). The right eye of Pr' shows the approximate placing of eye measurements (L = length, W = width) later used to estimate the amount of eye visible from above. The dotted lines in the R.d. and P.l. specimens were aligned to the dorsal edge of the eye and illustrate a difference between water and brown frogs in these alignments; they were not used for the angle measurements.

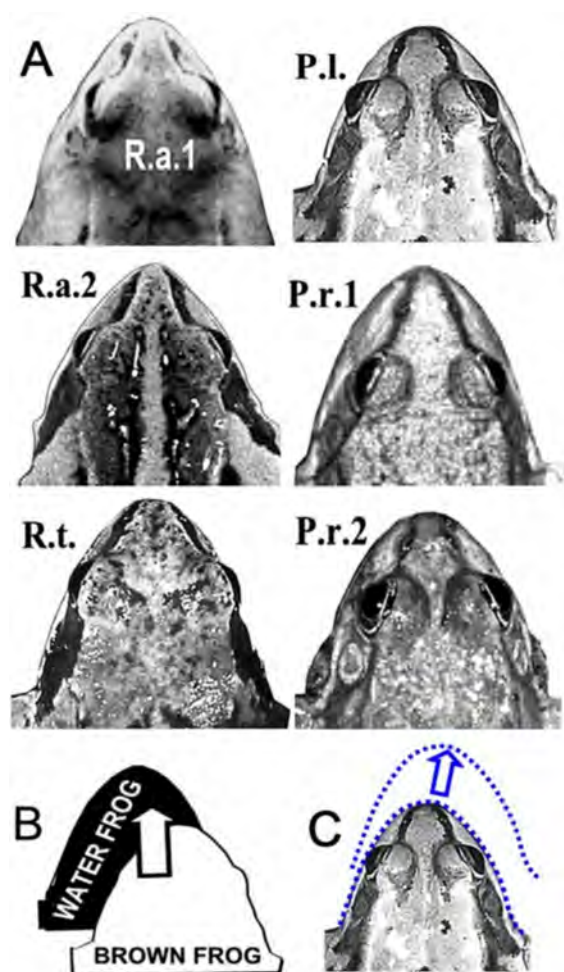


Figure 2. Electronic cut-out photographs of the heads of a range of water and brown frogs.

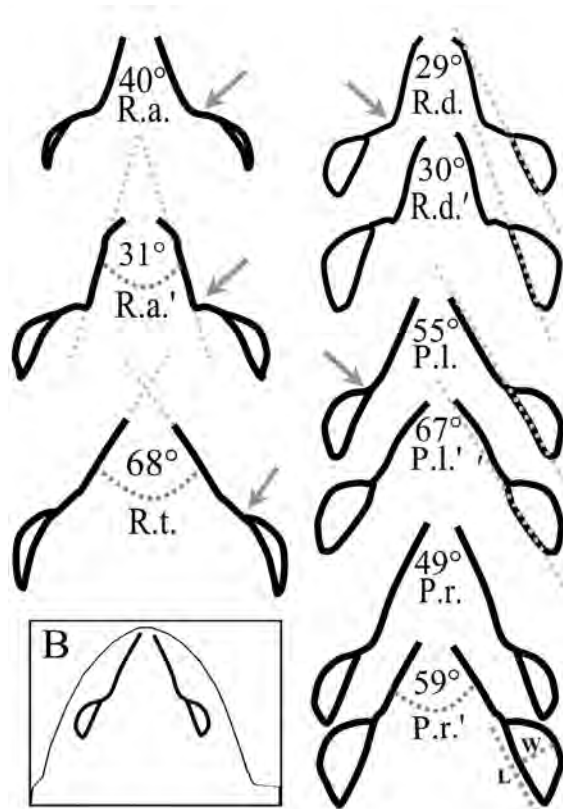


Figure 3. Computer generated tracings and estimated angles (dotted grey lines).

Statistics

Measurements of facial stripe angles and eye proportions were subject to ANOVA tests; these were followed by 2-sample t-tests to pinpoint where variation lay. The t-test results were subject to sequential Bonferroni testing (Holm, 1979); this placed more stringency on the rejection of the null hypothesis.

RESULTS

Snout pointedness - brown frogs and water frogs

Fig. 4 shows a representative sample of the possible combinations produced from the black silhouettes (water frogs) overlain with the white silhouettes (brown frogs). In total 27 water frogs and 66 brown frogs were used. The result, as with the sample in Fig. 4, showed little difference in pointedness. An observer in the field would be ill-advised to base identification on snout pointedness. The top one third (the snout area) of silhouette pair “B” (Fig. 4) shows that this Marsh Frog has a slightly more pointed snout than the Common Frog. None of the other

silhouettes or traced outlines showed substantive differences between water and brown frogs.

Snout pointedness – brown frog results

Of the brown frogs (N = 66), the three most pointed head outlines (4.5%) belonged to Moor Frogs; the five least pointed (7.58%) were Common Frogs. The remainder (87.9%) had no substantive differences.

Intraspecific differences

Intraspecific differences were also negligible when photographs which seemed to show large variation in pointedness (e.g. Pr1 and Pr2 in Fig. 2) were superimposed (Fig. 4 (I)). However, there were occasional measurable intraspecific differences in the distance between the anterior eye edge and the tip of the snout (e.g. Pr.1 was 1.4 times longer than Pr.2). A similarly large variation was found in the Common Frogs. This variation did not seem to have any substantive effect as the head region outlines were clearly more related to the underlying lateral head bone structure rather than relative eye position.

Differences in eye area and facial marking angles

Average eye width / eye length ratios results (Table 1B) show the brown frogs were more

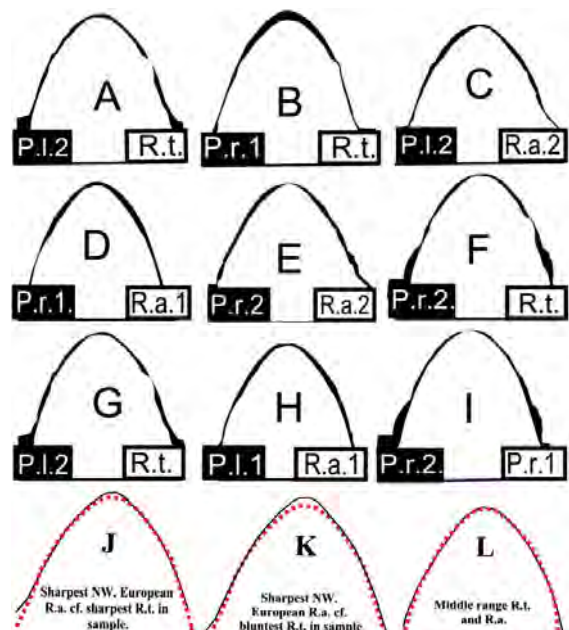


Figure 4. representative sample of the possible combinations produced from the black silhouettes (water frogs) overlain with the white silhouettes (brown frogs)

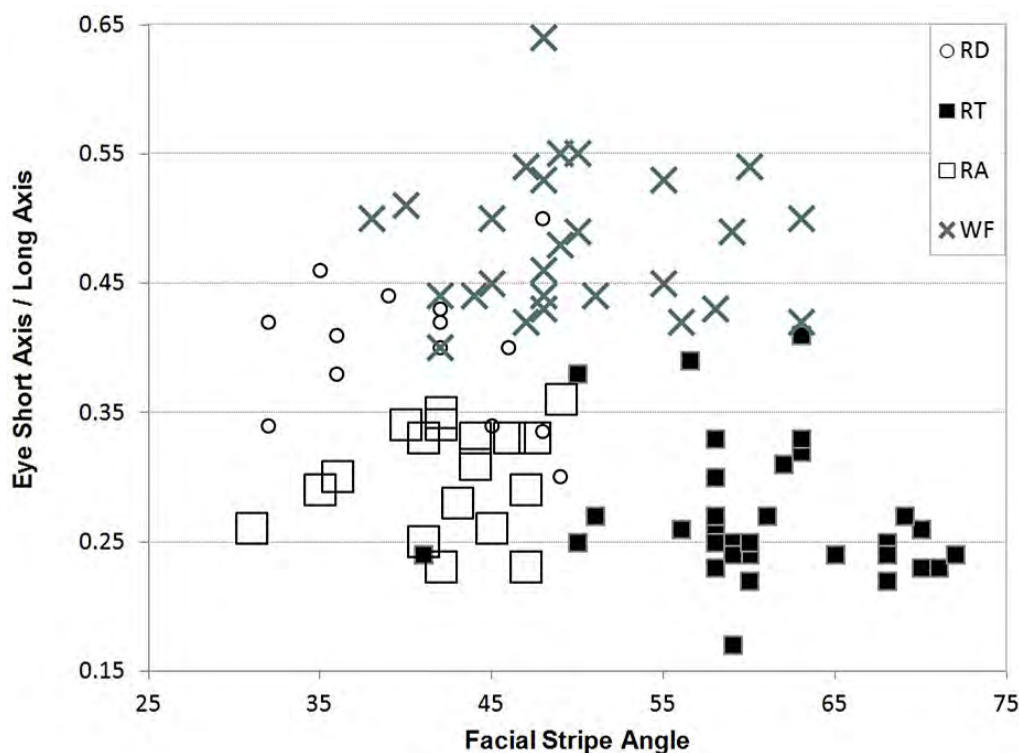


Figure 5. A scatter plot depicting eye ratios versus facial stripe angles in brown and water frogs.

laterally focused compared to the frogs; the averaged ratios were 0.33 and 0.48, respectively. Table 1B and Fig. 3 show that, viewed from above, this is particularly the case in the Moor and Common Frogs (averaging 0.3 and 0.27 respectively) which show very noticeably smaller areas of the eye than the water frogs (average 0.48). The Agile Frog average eye ratios (0.4) on the other hand were much closer to those of the water frogs, a fact emphasised in a scatter plot (eye ratios v. facial stripe angles, Fig. 5) where ca. 43% of the Agile Frog plots abut or inter-penetrate the water frog plots.

Both Moor Frogs and Agile Frogs showed an indentation in the facial lines (arrowed, Fig. 3), which was absent from water frogs and weak in the Common Frog (positions arrowed). A line drawn and aligned to the dorsal eye edge (e.g. the dotted lines in R.d. and P.l. in Fig. 3) also emphasised the indentations and straighter route taken (from the anterior of the eye to the nostril) by the snout markings in water frogs and, to a lesser degree, the Common Frog compared to the other two species.

The angles and form of the lines across the snout (Fig. 3) varied enough between the groups and species to be a potential diagnostic feature.

Statistics

Sample statistics, ANOVA and two sample t-tests results are given in Table 1.

Table 1A indicates that the Common Frog had an average angle between the markings of 60.83° ($n = 33$, SD 6.8), the Moor Frog angles averaged 42.6° ($n = 19$, SD 4.67), the Agile Frog average was 40.85° ($n = 14$, SD 5.93) and the water frogs averaged 49.3° ($n = 27$, SD 6.7).

ANOVA results (Table 1A) gave high significance values for differences between the species/groups ($p < 0.001$). ANOVA tests do not indicate where this variability lies (i.e. between which species). To remedy this, a series of two sample t-tests were carried out; the results are shown in Table 1A. This table shows that all sample comparisons yielded highly significant differences in eye stripe angle parameters between the species except in the comparison between *R. dalmatina* and *R. arvalis* ($p = 0.35$) and this remained the only case of H_0 acceptance after applying Holm's sequential Bonferroni post-hoc testing.

The ratio of eye width divided by eye length (EW/EL) obtained from the eye outline tracings described earlier (Fig. 3), used one eye for each specimen. The resulting ratios (Table 1B) were:

Separating brown and water frogs

A Facial stripe angle: Sample Statistics

Groups	RD	RT	RA	WF
N	14	33	19	27
Average	40.85°(SD, 5.93)	60.83°(SD, 6.83)	42.6°(SD, 4.67)	49.3°(SD, 6.7)
Anova	df (between groups)	df (within groups)	f	p
	3	89	50.67	< 0.001

Two-Sample t-tests: Facial stripe angles

Pair	Species	df	t	Significance
1	Water frogs v. <i>R. temp.</i>	58	-6.20	p < 0.0001
2	<i>R. arvalis</i> v. <i>R. temp.</i>	50	-10.3	p < 0.0001
3	Water frogs v. <i>R. arv.</i>	44	4.10	p < 0.001
4	<i>R. dal.</i> v. water frogs	39	-4.27	p < 0.001
5	<i>R. dal.</i> v. <i>R. temp.</i>	45	-9.51	p < 0.0001
6	<i>R. dal.</i> v. <i>R. arvalis</i>	31	-0.95	p = 0.35

B Eye Length / Eye Width: Sample Statistics

Groups	RD	RT	RA	WF
N	14	33	19	27
Average	0.4 (SD, 0.055)	0.27 (SD, 0.05)	0.3 (SD, 0.043)	0.48 (SD, 0.056)
Anova	df (between groups)	df (within groups)	f	p
	3	89	94.8	p < 0.001

2-Sample t-tests: Eye short axis length / long axis length

Pair	Species	df	t	Significance
1	Water frogs v. <i>R. temp.</i>	58	15.26	p < 0.0001
2	<i>R. Arvalis</i> v. <i>R. temp.</i>	50	2.0	p = 0.0502
3	Water frogs v. <i>R. arv.</i>	44	12.06	p < 0.0001
4	<i>R. Dal.</i> v. water frogs	39	-4.55	p < 0.0001
5	<i>R. Dal.</i> v. <i>R. temp.</i>	45	7.70	p < 0.0001
6	<i>R. Dal.</i> v. <i>R. Arvalis</i>	31	5.95	p < 0.0001

Table 1A. Facial stripe: sample statistics, ANOVA and t-test results.

Table 1B. Eye ratio (short/long axis): sample statistics, ANOVA and t-test results.

Note the highly significant p values in all tests except pair 6 in 1A and pair 2 in 1B (boxed).

all brown frogs 0.32, all water frogs 0.48, Common Frog 0.27, Moor Frog 0.3, and Agile Frog 0.4. This equates to the water frog samples here having 1.5 times as much eye area visible from above ($WF/BF = 0.48/0.32$) compared to brown frog samples. An ANOVA test (Table 1B) indicated very significant differences between the populations ($p = < 0.001$).

Corresponding t-tests (Table 1B) indicated that all groupings had highly significant differences except in the case of *R. arvalis* and *R. temporaria* where the H_0 was accepted; this remained the only case after the application of the sequential Bonferroni test. Snout angle and eye ratio results are plotted in Fig. 5.

DISCUSSION

Snout pointedness showed no value in group separation: advice that water frogs have a more pointed snout than brown frogs was inaccurate. Based on the samples available here, separation of Common and Moor Frogs using snout pointedness was also unsafe. There was a small tendency for the sharpest snouts to belong to Moor Frogs and the bluntest to Common Frogs, but these differences would be very hard to notice in the field. The majority of head outlines turned out to be indistinguishable between the species.

It has been the author's experience that younger frogs (particularly in Common and water frogs) can have relatively longer snouts (if defined as the distance from the anterior eye edge to snout tip) compared to adults, which tend with age to increasing apparent "bluntness". This phenomenon has also been reported for Common Frog (Arnold & Ovenden, 2002). Therefore, the Marsh Frog labelled P.r.2 in Fig. 2 could simply be older than the individual labelled P.r.1. If one species had a longer lifespan than another, that species may, on average, appear to have blunter head profiles. Any underlying trend for changes with age weakens the usefulness of this characteristic. The blunting effect seen in P.r.1 and P.r.2 (Fig. 2) is predominantly associated with changes in the relative distance from the nostril to the anterior edge of the eye.

Applying a method not previously described, the facial stripes had patterns and angles which did discriminate between the two groups and between some brown frog species. The "V" formed by the two snout markings was more pointed in water frogs compared to Common Frogs. While evidence of differences in snout pointedness was not found, the Moor Frog facial markings converged at significantly smaller angles than those of the Common Frog and, possibly tellingly, the Moor Frog is also described as having a more pointed snout than the Common Frog (Matz & Weber, 1983; Laňka & Vít, 1989; Fog et al., 1997; Arnold & Ovenden, 2002). References to a more pointed snout could be an illusion based on the greater pointedness of the facial markings in water or Moor Frogs compared to the Common Frog, rather than the physical structure of the snout itself.

Compared to Moor and Common Frogs, water frog eyes (viewed from above) showed relatively more area. Water and Common Frog snout stripes show greater straightness than either the Moor or Agile Frogs (Fig. 3). Hence facial detail varied widely between species and the groups.

These samples suggested that Agile Frogs also have more upwardly looking eyes than the other two brown frog species. The author has experienced, both in the wild and in outdoor enclosures, that water frogs are more likely to leap up and intercept flying insects than the Common or Moor Frogs. Having more upwardly focused eyes would benefit this mode of feeding. This suggests future research. Where the Agile Frog shares habitat with other brown frog species, it might similarly benefit from its long legs and more upwardly focussed eyes to feed in a similar way; i.e. is there a degree of habitat and trophic partitioning where the ranges overlap?

The results have suggested that differential eye ratios and facial stripe angles offer value in the identification of north-west European frog groups and species. The methods given here might also aid identification from images; it is the author's experience that agencies supplying images for publication frequently misname species. Published guidance on discrimination between these species suggest using metatarsal tubercle (MT) form (not usually visible in photographs) (e.g. Arnold & Ovenden, 2002), or temporal mask form to separate Moor and Common Frogs (Fog et al., 1997) and leg length to separate Agile from other (shorter legged) brown frog species and to help separate water frog forms (e.g. Nöllert & Nöllert, 1992; Fog et al., 1997; Arnold & Ovenden, 2002). These parameters, as with some parameters given here, overlap to some degree and some methods described in the literature (e.g. the absence of a temporal mask in water frogs) are inaccurate (Snell, 2011). Where ambiguity exists, it is desirable to have recourse to extra distinguishing methods which might provide more unequivocal separations. Detail on frogs' heads, while not easily useable in the field (but likewise leg length and MT), are potentially more useful than flawed guidance suggesting the use of snout pointedness or the presence of a temporal mask.

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Research Article

First authenticated record of green turtle *Chelonia mydas* (L.) from Irish waters, with a review of Irish and UK records

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INTRODUCTION

During November 2007, a live, albeit weak, juvenile female green turtle *Chelonia mydas* (L.) was found stranded at Castlegregory (52.2555° N, 10.0210° W), Dingle Peninsula, Co. Kerry, SW Ireland (Figs 1 & 2). Unfortunately, attempts to revive the specimen at Dingle Oceanworld proved unsuccessful, and the animal died within two days of receipt. The specimen was subsequently weighed, measured and donated to the National Museum of Ireland (NMINH: 2012.67.1).

The current specimen represents the first authenticated record of *C. mydas* from Irish waters. Although Frazer (1983) stated that “a single specimen of the green turtle has been recorded from the west coast of Ireland”, and Langton et al. (1996) later quoted this record, it was originally noted by Taylor (1963), based on an erroneous press report which was subsequently confirmed as a leatherback turtle *Dermochelys coriacea* (L.) by Stephen (1961) and Brongersma (1972). King and Berrow (2009) also referred to two unconfirmed records of *C. mydas* observed off Cape Clare, Co Cork. One of these specimens, measuring c.1.0 m in length, was observed 500 m off the island on 1st May 1995. No details were provided on the second record, and despite recent enquiries by the author, no further details were discovered. Details of all known records of *C. mydas* reported from Irish and UK waters are summarised in Table 1. Although initially reported as *C. mydas*, the identification and provenance of record numbers 1-4 & 6 remain equivocal. Since 1980, a total of 8 specimens

have been confirmed from the following geographical locations: Orkney (2), W Scotland (1), E Scotland (1), Lancashire (1), Essex (1), Guernsey (1), and Kerry (1) either as dead strandings (5), live strandings (2), or observed at sea (1).

Apart from record number 11 (40 kg, 86.5



Figure 1. Specimen of the green turtle *Chelonia mydas* found stranded at Castlegregory, Co Kerry during November 2007 (dorsal view).



Figure 2. Specimen of the green turtle *Chelonia mydas* found stranded at Castlegregory, Co Kerry during November 2007 (ventral view).

First record of *Chelonia mydas* from Irish waters

Record No.	Date	Location	Method	CCL (cm)	SCL (cm)	CCW (cm)	SCW (cm)	Weight (kg)	References	Notes
1?	05.10.1874	c3.2 km S Mousehole Island Mount's Bay Cornwall	Taken alive in pilchard drift-net					32-36.00	Cornish (1874); Brongersma (1972); Penhallurick (1990)	Measurements taken from carapace of green turtle at St Michael's Mount (Penhallurick, 1990)
2?	December 1875	Off Hastings, Sussex English Channel	Found floating & dead		105.4		91.4		Bowerbank (1876); Brongersma (1972)	A female with more than a quart (1.136 litres) of eggs in it
3?	1887 or 1888	West Bay near Chesil Beach Dorset	Found floating & dead						Richardson (1889); Cambridge (1894); Brongersma (1972)	Brongersma (1972) speculated that the specimen may have been thrown overboard dead from a ship conveying it into British waters
4?	04.01.1956	Meal Beach Barra Isle Shetland	Dead strand-ing		c.91.4			c.76.20	Editors (1956); Parker (1956); Stephen, Rae and Lamont (1963); Brongersma (1972); Branson (1997)	Unidentified turtle but probably <i>Chelonia mydas</i> (Parker, 1956; Brongersma, 1972); identified from fragments (Parker, 1956) Thought to be a green turtle, but a probable, rather than a definite identification
5	27.01.1980	Loch of Stenness Orkney	Dead strand-ing		33.0		28.0	5.45	Anon (1980); Gray (1981); Branson (1997); Booth and Booth (1994); Pierpoint and Penrose (2002)	Badly decomposed (Branson, 1997)
6?	01.05.1995	Cape Clare Island Co Cork	Observed at sea		c.100.0				King and Berrow (2009)	Unconfirmed identification
7	13.01.1997	S River Reach Crouch Corner Foulness, Essex	Dead strand-ing		37.0		30.0	4.00	Branson (1997)	
8	08.07.1999	Off Firth of Forth Scotland	observed at sea						Pierpoint and Penrose (2002)	Sighted by Kees Camphuysen in the North Sea during a seabird survey
9	30.12.2001	Knot End near Blackpool Lancashire	Dead strand-ing	38.0	36.0	33.0	29.0	5.00	Penrose (2003)	Post mortem found large amounts of plastic material in oesophagus and stomach

10	25.02.2002	Achmelvich N of Loch Inver Scotland	Dead strand- ing						Penrose (2003)	
11	13.01.2003	Grand Rocques Saline Bay Guernsey	Live strand- ing	76.0	*86.5	67.5	55.5	*40.00	Penrose (2004)	*Measurements on leaving Guernsey on 05.02.2003 for subsequent release at Canaries on 04.04.2003
12	November 2007	Castlegregory, Co Kerry Ireland	Live stranding (but died 2 days later)	25.0	24.5	22.0	20.0	1.74	Present study	(NMINH: 2012.67.1)
13	13.12.2011	On beach at Newark South Ronaldsay Orkney Islands ND468907	Freshly dead strand- ing	29.5		27.0		3.05	Booth (2012)	Immature male, good body condi- tion, no internal or external injuries - cause of death thought to be hypothermia

Table 1. Records of green turtle *Chelonia mydas* (L.) reported from Irish and UK waters.

cm SCL), most likely a sub-adult, all of the specimens were juveniles, weighing 1.7-5.5 kg (mean weight, 3.8 kg, N=5) and measuring 24.5-37.0 cm SCL (mean SCL 36.6 cm, N=4). Although one specimen was observed in the Firth of Forth (E. Scotland) during July 1999, all of the others were found stranded during the winter: November (1), December (2), January (3), and February (1).

Arnold and Ovenden (2004) noted that although *C. mydas* had been recorded from waters surrounding the British Isles, Netherlands, Belgium, France, Spain and Portugal, the species is rare in European Atlantic waters. In a recent review of French Atlantic records, Duguy (1997) remarked that *C. mydas* was rarely found in the Bay of Biscay, with a total of 6 juveniles recorded during the winter and spring. Brongersma (1972) carried out a detailed investigation of all known reports of *C. mydas* from European Atlantic waters, and in many cases noted difficulties in verifying and provenancing records.

Brongersma (1972) also noted that large numbers of green turtles were imported into European countries prior to the Second World War as a gourmet food and that many of these died during transport and were thrown overboard from ships. He concluded that very few green turtles arrived in European waters of their own accord. The paucity of incontrovertible records

since the Second World War would support this hypothesis.

The green turtle is distributed circumglobally in tropical and subtropical oceans (Carr, 1967). Although several nesting sites occur on both sides of the North and South Atlantic, as well as in the eastern Mediterranean (Arnold and Ovenden, 2004; Rees et al., 2005), the origin of naturally-occurring specimens in northern European waters is unknown.

Small juvenile green turtles are known to disperse extensively during their pelagic oceanic feeding phase, whereas larger individuals appear to feed in neritic areas closer to their natal breeding grounds (Monzon-Arguello et al., 2010). This differential ontogenetic behaviour may explain the occasional occurrence of juvenile green turtles in northern European waters, and the apparent absence of subadults and adults. Also, Witt et al. (2007) speculated that green turtles may have a greater physiological intolerance to cooling than more frequently-recorded species (e.g. leatherback turtle *Dermochelys coriacea* (L.), loggerhead turtle *Caretta caretta* (L.), and Kemp's Ridley turtle *Lepidochelys kempii* (Garman)), thus reducing their chance of survival in cooler waters.

Hybridisation has also been postulated as a factor driving green turtles to northern waters. While individual populations have been shown

to be genetically discrete (Encalada et al., 1996), green turtles can hybridise with both loggerhead turtles and hawksbill turtles *Eretmochelys imbricata* L. (James et al., 2004; Wood et al., 1983). Although green x loggerhead hybrids have not been recorded from European waters, James et al. (2004) suggested that the loggerhead component of its genotype may have been responsible for directing the hybrid to higher (and colder) latitudes in Canadian waters.

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Research Article

Apparent influences of mechano-reception on great crested newt *Triturus cristatus* behaviour and capture in bottle-traps

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ABSTRACT - Increased knowledge of great crested newt behaviour may benefit the effectiveness of survey techniques. Factors associated with trap entry, distribution of each sex related to availability of display areas and quality of egg-laying sites were investigated in a small garden pond in Surrey England. Video-records of 50 newt entries into a trap funnel and eleven captures suggested water disturbance was a factor related to capture. From night-counts males appeared to seek out display areas unused by other males, and female presence correlated ($P < 0.05$) with the number of leaves large enough for crested newt egg deposition. Discrepancies in the totals of night-counts with over-night catch totals provided evidence supporting the view that mechano-reception is important for this species. In open water newts in front of and within 30 cm of the trap entrance were susceptible to capture.

INTRODUCTION

Surveying for this European protected species is most effective whilst newts are in their breeding ponds, and for qualitative data the methods used are night time bottle-trapping and torchlight counts (Griffiths et al., 1996; English Nature, 2001). Further analysis of earlier work (Hughes, 2012) found that more newts entered regions where traps faced into open water than where traps were absent. This was explored further in 2002. In 2007 effects on newt distribution related to availability of breeding resources and the expanse of vegetation free water in front of traps were investigated and whether swimming newts enter traps.

MATERIALS AND METHODS

The study site

Hughes (2012) described the 8 m² pond, trap design and procedures for bottle-trapping, night-counts and video-recording. Spaces, between 20 cm high plant baskets with vertical sides, were created for placing traps at 15 cm depth on the marginal shelf (Fig. 1). Plants trailing from the baskets into these spaces were removed. Normally traps faced the pond centre (Fig. 2) and were tilted at 30° to the horizontal (Hughes, 2012).

Experimental design

Entry into traps

Newt behaviour, both associated and un-associated with trap entry, was examined on an area (80 x 45 cm) of bare substrate (Fig. 3a). Traps placed facing the pond side allowed all activity in front of them to be video-recorded. Any shading (a preferred microhabitat feature (Hughes, 2012)) was minimised by using clear colourless, rather than green, bottle-traps placed horizontally on the 80 x 45 cm recorded area. As air reservoirs could not be enclosed escape holes were provided. Ten three-hour records commencing at sunset were obtained between 26 March and 17 May 2002. The trapezoidal funnel-sectors (Fig. 3a) had perimeters of 112 + 10 cm and 82 + 10 cm, the 10 cm being the trap diameter was taken as the trap threshold (Fig. 3b). To test for any tendency to cross this threshold into the trap funnel (Fig. 3b), for each newt entry into a funnel-sector the exit boundary was noted.

Factors potentially influencing capture were investigated by examining newt locations and activities associated with three events: capture, funnel-entry followed by retreat from the funnel and no funnel-entry by newts which settled

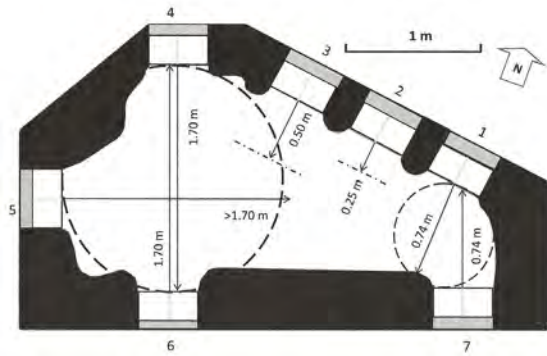


Figure 1. Plan view of the garden pond in 2007. Black regions denote plant baskets either side of spaces 1–7 and other vegetated regions on the shelf. When trapping, two curtains (Figure 2) were alternately positioned in front of spaces 2 and 3.

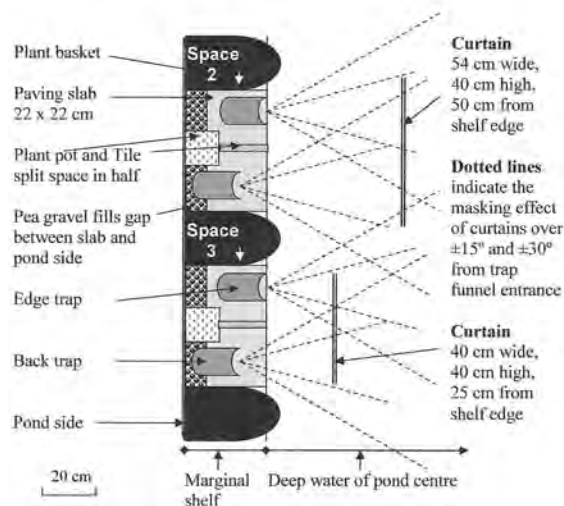


Figure 2. Plan view of spaces 2 and 3 when trapping. Spaces 1, 4, 5, 6 and 7 (Figure 1) were identical in structure except without curtains in front of the marginal shelf.

within five centimetres of a trap threshold. Prior to these events the newt was either beyond the trap funnel-sectors or in a funnel-sector plus the bordering coping stones (Fig. 3a). 'Interacting' implies newts were within five centimetres of each other and usually a male was hand-standing. 'Scouting' refers to the predominate male activity observed: they would settle and were stationary on the substrate, but frequently re-orientated themselves or in stages moved across the substrate over < 10–25 cm often with a wave of the tail and outstretched fore legs then settled again. The arrival of another newt triggered an approach in the same manner, as a sequence of stages over short distances and settling as it progressed towards the new arrival. Of 32 arrivals 21 first landed > 20 cm away.

'Loner' is used to describe single newts in the recorded area including males not apparently scouting.

Male distribution

The spaces on the shelf were used by males as display areas (Hughes, 2012). Using count data male distribution was examined with seven and 14 display areas. The surface of the seven 45 cm long spaces (Fig. 1) was composed of two paving slabs 22 x 22 cm placed one centimetre apart. By placing a vertical tile in the gap and pushing it against a small plant pot at the pond edge (Fig. 2) 14 separate display areas were created. Between 10 March and 27 April 2007, about two hours after sunset the number and sex of newts within each half space were counted on 24 nights, for 12 of these spaces were divided and traps set.

Female distribution

Female capture appears to be influenced by the amount of egg-laying material close to the trap (Hughes, 2012). The plant pots (Fig. 2) contained a mix of species used for egg deposition, *Myosotis scorpioides*, *Ranunculus flammula* and *Veronica beccacunga*. To rank the quality of each space for egg-laying, on 8 April 2007 the number of leaves judged to be large enough for crested newt oviposition was counted (17–42) and used to test for correlation with the total catches in each space and counts in undivided spaces.

Capture of swimming newts

Newt capture can occur when newts are in front of and on the same substrate as the trap (Hughes, 2012). Their susceptibility to capture when swimming in front of traps was investigated by comparing trap success between traps with substrate or deeper water at the threshold using pairs of traps, a back and edge trap (Fig. 2).

Extent of vegetation-free water in front of traps

If newts are randomly distributed in a pond and attracted to traps perhaps trap success would be related to the area of vegetation-free water in front of the trap. With floor vegetation, *Ceratophyllum demersum*, less than 20 cm high this could be explored in the 50 cm deep study pond, although later in the season in front of

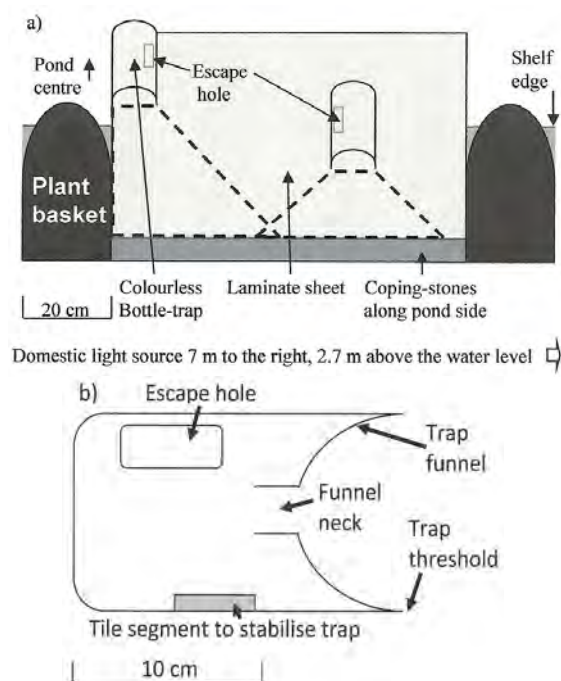


Figure 3. a) Plan view of an 80 x 45 cm laminate sheet; the video-recorded area of 2002. Facing the pond side traps were placed horizontally 30 and 15 cm from coping-stones. The dotted lines outline the trapezoidal funnel-sectors of each trap. b) Cross-section of a horizontal trap.

space 4 *Nuphar* leaves might be growing above this height. Three categories of 'extent' were defined. Spaces 4, 5 and 6 faced into a 2 m² circular vegetation-free region and spaces 1 and 7 into a 0.43 m² region (Fig. 1). Thirdly, when trapping, mesh curtains (mesh size 2.5 x 3.5 mm) limited the extent of unobstructed water in front of spaces 2 and 3 to alternately 25 or 50 cm (Fig. 2). Analysis of data after 12 sessions revealed an inconsistency between newts counted and caught in spaces 2 and 3. To investigate this, 12 further counts followed; six with spaces undivided and six with the dividing tiles and curtains in place, no traps were set.

RESULTS

Entry into traps

Using the four video-records where newt activity was highest there were 286 and 240 newt entries into the left and right funnel-sectors (Fig. 3a) respectively. For application of a G-Test this gave expected numbers of funnel-entries of 23.4 and 26.1. Observed values being similar, 26 and 24, indicated no tendency to approach a trap.

Eleven of these 50 funnel-entrants entered

the trap. All incidents of newts settling at the trap threshold, but not entering the funnel (26) were examined on one video-record where newt activity was relatively high, but not too complex for analysis. Of the 50 funnel-entrants 94% were previously in the funnel-sector (Table 1) compared with 54% of those not entering a funnel and predominately scouting across all the recorded area. Prior to capture five newts entered a funnel-sector from the adjoining coping-stones, two of these first settled in the right hand funnel 17 cm away. The other three approached the more distant left hand funnel at 32 cm, in two to four stages. This 'scouting' like behaviour as they approached the funnel was similarly followed by the other six incipient captives. They all settled in the funnel before passing through the neck into the trap. Shortly after capture, about five to ten minutes later, they escaped through the hole provided. Capture could follow arrival in the funnel with or without other newts being in the funnel-sector. Three 'interacting' in the funnel were static females; the presence of a male at their side appeared to prompt them to enter the trap. Only on four occasions a captive was visible clawing at the trap envelope and simultaneously another newt was within the funnel-sector. These free newts appeared to be attracted to the trap resulting in four funnel-entries and one capture. Newts entering the funnel behaved as if they had detected a newt in the funnel or trap, in

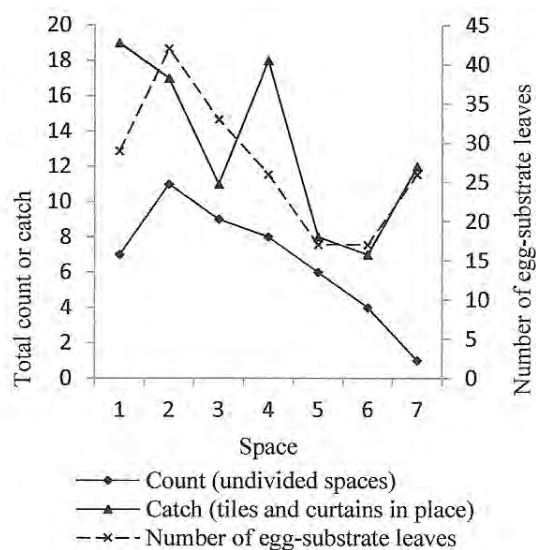


Figure 4. Total female count (18 sessions) and catches (12 sessions) related to the quantity of egg-substrate leaves in each space.

Condition	Funnel-entry then capture n = 11		Funnel-entry only n = 39		No funnel-entry n = 26	
	%	f	%	f	%	f
Previous location						
In funnel-sector	100	11	92	36	54	14
Outside funnel-sector	0	0	8	3	46	12
Previous activity						
Interacting	18	2	31	12	27	7
Scouting	18	2	46	18	62	16
Loner	64	7	23	9	12	3
Previous and during event						
A captive seen moving around within the trap		1		3		0
During event within a funnel-sector						
Interacting	27	3	28	11	15	4
Not interacting - only 1 newt present	36	4	49	19	65	17
Not interacting - >1 newt present	36	4	23	9	19	5

Table 1. Frequency (f) of conditions prior to and during the events; capture, funnel-entry only, no funnel-entry but newt settled at a trap threshold. Conditions are defined in the main text.

each case the water had or could have been recently disturbed by a newt(s).

Male distribution

With 14 separate half-spaces no instance of more than one male in a display area was observed. In the seven undivided spaces (12 + 6 sessions) there were a total of 106 male sightings (Table 2) and five instances with two males present in the same area. In three of these cases eight males were within the seven display areas. Males appeared to seek out display areas unoccupied by other males. Also with total counts within a space of 11-18, each space was similarly located.

Female distribution

The number of female sightings in each undivided space correlated with the number of leaves ($r_s = 0.786$, $P < 0.05$) and there was a similar trend for captures (Fig. 4).

Trapping from dusk till dawn (12 sessions) there were 92 female captures (Table 2) however from 18 night-counts the number of female sightings was 46. This indicates many females went uncounted as they were egg-laying in vegetation beyond the surveyed spaces, but overnight moved around the pond passing in front of traps.

Capture of swimming newts

In back traps and edge traps (Fig. 2) the total catches were 29 and 24 respectively for males, and 47 and 45 for females. For both sexes capture was similarly likely whether newts approached directly from water deeper than the trap (swimming) or could settle on the substrate at the trap threshold. These data show 37% of captives were male. The unique belly patterns of all 2007 captives had been photographed. Only nine (38%) of the 24 individuals caught were male. Both sexes were similarly susceptible to capture with traps facing into open water, but shielded within 10 cm from it on three sides, a result consistent with previous work (Hughes, 2012).

Extent of vegetation-free water in front of traps

Female data have been excluded from this aspect of the analysis as their distribution was influenced by the availability of egg-substrates. In spaces one to seven, six to ten males were caught (Table 2) with no indication of catch differences between the three 'extent' categories ($G = 0.605$, $df\ 2$, $P > 0.05$).

Comparing the male count data when traps were set, only one or two were seen in the spaces facing the curtains, elsewhere the counts,

Influences of mechano-reception on great crested newt capture

Period of collection	Total	Number of sessions	Tiles and curtains	Space														All spaces	
				1		2		3		4		5		6		7		♂	♀
				L	R	L	R	L	R	L	R	L	R	L	R	L	R		
14.3 - 26.4	Catch ♂	12	Yes	7	3	4	5	5	3	2	4	5	1	5	3	3	3	53	
	Catch ♀			6	13	11	6	8	3	14	4	4	4	3	4	8	4		92
14.3 - 26.4	Count ♂	12	Yes	6	5	2	0	0	1	0	9	2	5	3	4	4	4	45	
	Count ♀			1	2	3	0	1	1	0	1	0	2	0	2	1	2		16
10.3 - 27.4	Count ♂	12	No	5	9	7	5	3	4	3	7	6	5	9	2	6	5	76	
	Count ♀			2	0	4	6	4	1	2	2	3	1	2	1	1	0		29
2.5 - 10.5	Count ♂	6	Yes	1	3	5	0	0	3	0	5	1	2	3	1	4	5	33	
	Count ♀			2	1	0	0	0	1	0	2	1	2	0	0	0	1		10
1.5 - 12.5	Count ♂	6	No	0	4	4	0	1	3	0	5	3	4	0	2	1	3	30	
	Count ♀			1	4	0	1	2	2	2	2	0	0	1	0	0			17

Table 2. Totals of catches and counts in the left (L) and right (R) half of the seven spaces (Figure 1). Counts were made both with and without spaces divided by tiles and curtains in place.

seven to eleven, were significantly higher ($G_{adj} = 8.238$, $df = 1$, $P < 0.01$). The total newt count for each half-space (18 sessions) with and without dividing tiles and curtains in place (Table 2) were compared. When undivided these totals were between six and seventeen, with curtains and tiles in place four to seventeen except in three half-spaces where it was zero or one. These half-spaces were the right half of space 2 and the left half of space 3, the half spaces nearest to the gap between the two curtains. Thirdly the left half of space 4; on examination the side of the left hand basket instead of being vertical sloped from the base into the space. These geometrical situations appeared to influence newt behaviour.

DISCUSSION

The lateral-line system is used by newts for detection of other newts (Stebbins & Cohen, 1995). Males frequently re-orientate themselves in their display areas (Green, 1989) possibly to advertise their presence (Krebs & Davies, 1993). Whilst stationary they would be receptive to waves (Roberts, 1986) created by other animals. A male's approach to a female commenced after she moved within about 20 cm of him (Green, 1989). With a light level of 5 lux (Hughes, 2012) males already on the substrate were immediately approached by

other newts when these arrived, usually at distances > 20 cm. The visual acuity of the great crested newt, maximum visual range 20 cm, declines below 10 lux (Roth, 1987). Courtship can take place in total darkness (Green, 1989) and turbid conditions (Frazer, 1983). Pheromones as the attractant from > 20 cm seems unlikely as these take time to disperse (Petranka et al., 1987) and compared with visual or water disturbance stimuli they would not give a precise directional cue (Himstedt, 1994). Mechano-reception may important for the detection by males of the arrival of other newts in their display area. Also, from this study, it appears water disturbances reflected off trap funnels are interpreted by newts as indicating the presence of another newt to which they are attracted. Non-reflected disturbances caused by captives may result in more energetic waves emanating from the funnel and is consistent with occasional large catches (Oldham & Nicholson, 1986).

Newts move within their breeding pond (Hedlund & Robertson, 1989) to find the resources they require (Hayward et al., 2000). They use mechano-reception for spatial orientation (Wilczynski, 1992). Propelling themselves in open water then, whilst gliding/drifted, as some fish species (Bone & Marshall, 1982). Presumably they could detect waves

reflected from their surroundings that provide navigational cues. This, and the design of my pond with display areas, and egg-substrates confined to the marginal shelf, suggest that newts stayed near this shelf. By following the shelf within 25 cm of the edge, each trap location would be passed with similar frequency.

There were two situations where newt presence was established by their capture, yet none were seen on the 22 x 22 cm area of substrate on which single traps were set. In close proximity there were two planes from which waves generated by a newt would be reflected back simultaneously. Interference between these two wave fronts may have caused confusing signals detected through the lateral-line system that the newts did not tolerate. If this assumption is correct newt-generated waves reflected off a vertical plane surface (area 40 x 54 cm) \geq 50 cm distant were being detected.

In more heavily vegetated ponds Oldham et al. (2000) found bottle-trapping was less successful. From this study in open water newts apparently detected traps by mechano-reception and then approached them as they do other newts. This suggests capture is more likely in traps adjoining open water than those laid in highly vegetated areas.

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Research Article

Captive management and reproduction of the Savu Island python *Liasis mackloti savuensis* (Brongersma, 1956)

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INTRODUCTION

The Savu Island python, *Liasis mackloti savuensis*, is a poorly-studied taxon both in captivity and in the wild. The lack of scientific literature is evidence for this. Although *L. m. savuensis* was described many decades ago (Brongersma, 1956), specimens were collected for the first time in 1993 for the private sector and zoological institutions (Barker & Barker, 1994). Juvenile colouration is light orange but adults are dark brown or black. The iris changes from orange/gold to bright white, and the latter gives the subspecies a unique appearance (Klingenberg, 1999; Young, 2011). The subspecies is endemic to Savu, located in the Lesser Sunda Islands, and has the smallest geographical distribution of any pythonid (Barker & Barker, 1994). According to the IUCN Red List (09/06/12) the conservation status of *L. m. savuensis* is unknown. Habitat loss is affecting their population size (Ibarrondo, 2006) and ecological studies are needed to assess the population to determine if this taxon is in fact endangered (De Lang, 2011). There is limited information on this species either under natural or captive conditions, particularly with regards to reproduction. This paper gives details of the successful captive breeding of *L. m. savuensis* at Birmingham Nature Centre (BNC) in 2010.

MATERIALS & METHODS

Three males and one female were used in the captive breeding programme. All were wild caught and so could not be accurately aged. The males weighed between 600 and 800 g, the female weighed 1,300 g. The snakes were housed individually and only introduced together for breeding purposes. They were

housed in plastic and fibreglass vivaria, measuring 60 x 60 x 60 cm for the males and 90 x 60 x 60 cm for the female. Branches were provided to facilitate climbing and a large pile of dried leaves in each cage was used as a retreat. A large basking area was also provided.

Ambient daytime temperature was 26-30°C with a basking area surface temperature of 35°C. Ambient night temperature was 22-25°C. Temperatures were recorded using an Exo Terra digital min/max thermometer and an Extech 42509 I-R thermometer. Relative humidity was maintained at 40-50% with sporadic spraying of each enclosure with warm water. Orchid bark substrate and sphagnum moss helped to maintain the humidity. Males were fed up to three weaner rats per month, but the larger female was fed a small or medium-sized adult rat each month.

RESULTS

All four snakes were introduced together into a larger enclosure measuring 120 x 80 x 100 cm in early September. This was furnished in the same way as the smaller enclosures. A photoperiod of 10 hours light/ 14 hours dark was implemented using two 10% UVB true lights and a large 250 W infra-red bulb was used to provide a basking spot. Once introduced, all three males displayed rapid tongue flicking and explored the enclosure. After two hours of observation, all males were resting under leaf litter and the female was basking.

On the first night the ambient temperature was lowered to 18-20°C and this night time temperature was maintained for one month. The ambient and basking temperatures were not altered. No mating behaviour or copulation was observed in September. At the beginning of October, the night temperature was further



Figure 1. Female Savu python coiled around egg clutch.

reduced to 14-16°C. This was immediately followed by the female sloughing overnight. During the following morning, one male was observed using his spurs down the body of the female. Copulation was observed within the next hour. Further copulation was sporadic and observed on only two occasions in October and one in November, all involving the same male. All snakes were offered food: the males refused, the female continued to eat until the beginning of December.

All three males were observed attempting to copulate during December; no antagonistic or aggressive behaviour was recorded. Copulation usually occurred in the morning from 08:00 h and it occasionally continued until 16:00 h. Overall, copulation was recorded 18 times during December, most frequently by the same male. Pre-mating behaviour, including movement of the spurs and rapid tongue flicking, was occasionally observed following a rise in humidity after spraying, and copulation usually followed.

During mid-January the female was basking continually and raising her body temperature to 29-36°C, measured using the infra-red thermometer. When handled, six large eggs were easily palpated. She was removed and isolated in an enclosure measuring 60 x 60 x 60 cm. A nest box containing dry sphagnum moss was provided. Relative humidity was maintained between 70-90% using wet sphagnum moss around the nest box and spraying twice daily with warm water. The female had a pre-oviposition slough on February 12th. She was usually in the nest box between 08:00 h and

09:00 h but then spent time basking until 17:00 h although she sometimes re-entered the nest box for about an hour. During the final week of gestation, the female was observed rotating her body ventrally, exposing her body to the heat above.

On March 22nd, 39 days after the slough the female laid 9 eggs in total and was found coiled around a clutch of 6 eggs outside the nest box (Fig. 1). A further three eggs were discarded to the side by the female and after analysing were determined infertile. The female was removed from the eggs to allow a quick collection of data before incubating. The six fertile eggs had a combined mass of 236 g and their mean dimensions were 64 x 38 mm. One of the eggs looked malformed but because it adhered to the others it was allowed to remain.

The eggs were incubated in a clear sealed plastic box that fitted within a large neonatal incubator. Vermiculite mixed with water (ratio 2:1) was used as substrate. The clutch was placed on top of the vermiculite. Damp sphagnum moss was added to the corners of the box to help to raise the humidity. The eggs were incubated at 30°C and 90-100% relative humidity. The container lid was lifted off for a few seconds every 2-3 days to allow gaseous interchange. The eggs began to dimple and look desiccated on day 63 of incubation. Two hatchlings began to emerge on day 71 (Fig. 2a) and all had emerged by day 73. One egg did not hatch. On examination, this egg was seen to contain a premature embryo that appeared to have died during development. The head and spine both appeared deformed.

The hatchlings were housed and reared individually in contico boxes on a rack system measuring 37 x 25 x 13 cm. Orchid bark chippings and dead leaves were used as substrate and created opportunity to hide. Sticks were provided to allow climbing but were never observed to be used. The hatchlings were often coiled up under dead leaves. They were very defensive and would strike out at any movement.

The hatchlings sloughed from days 6-12 after emerging from the eggs and the humidity was then raised from 40-50% to over 70% to ensure that no skin was left attached. As is usual for this subspecies, the hatchlings were dull brown in colour at birth but after the first slough they turned bright orange (see the cover



Figure 2a. Hatchlings emerging from the eggs, which took place after 71 to 73 days of incubation. **2b.** Eight month old specimen showing mottled black/brown colouration.

illustration for this issue). After about 8 months the colour changed again, to mottled black/brown (Fig. 2b). The hatchlings readily accepted pinkie mice shortly after the first slough and they quickly progressed to larger mice of appropriate size.

DISCUSSION

There has been little scientific research on the subspecies *L. m. savuensis*: most information comes from magazine articles or the internet. To the best of my knowledge, the subspecies has only been bred twice in UK Zoological Institutions, first at Bristol Zoological Gardens (BZG) in 2003 and at BNC in 2010. A few professional institutions and private keepers outside of the UK have had success, see Barker & Barker (1994), Klingenberg (1999) and Young (2011). Previous attempts at BNC did not involve temperature cycling and no obvious follicular development was observed. Incorrect temperature cycling in many snakes is widely

acknowledged to adversely affect spermatogenesis, which can result in infertile ova (Ross & Marzec, 1990). Mating behaviour and copulation in this subspecies have been observed most frequently using multiple males, see for example Klingenberg (1999). Male-male combat has been observed in *L. m. mackloti* (Ross & Marzec, 1990) and *L. m. dunni* (Carmichael et al, 2007), but not in Savu Island pythons.

Incubation temperature clearly affects embryonic development. Eggs incubated at 31.5°C at BZG hatched after 61 days (Skelton, personal communication) compared with 71-73 days at 30°C in this study. *L. m. mackloti* appears to be able to produce fertile eggs throughout the year – the clutch at BZG was produced in September (Skelton, personal communication) and the clutch recorded here in March - and so it is difficult to specify an optimum time for fertility, ovulation and egg production. Overall, it is possible that the main factors in successful reproduction are a sudden drop in night-time temperatures and the introduction of multiple males to a single female.

During the writing of this paper, a different female in the collection at BNC laid a clutch of 8 fertile eggs using the methods described above, except that UVB full spectrum lighting was not used. UVB is therefore unlikely to be a reproductive stimulus. The eggs were incubated at 31°C and four of them hatched after 64-66 days.

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Short Note

Clutch size, incubation time and hatchling morphometry of the largest known *Tropidurus* of the *semitaeniatus* group (Squamata, Tropiduridae), in a semi-arid area from northeastern Brazil

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The recently described lizard *Tropidurus jaguaribanus* (Passos, Lima & Borges-Nojosa, 2011) constitutes one of the four formally described species that compose the *semitaeniatus* group, which is characterized by marked dorsoventral flattening of the body and longitudinal dorsal light stripe colour pattern (Passos et al., 2011). These species are saxicolous, endemics of Caatinga from northeast of Brazil and have their ecology virtually unexplored, except *T. semitaeniatus* for which there are some studies, especially on its reproductive biology (Vitt & Goldberg, 1983), trophic ecology (Kolodiuk et al., 2010) and thermoregulatory behaviour (Ribeiro & Freire, 2010). *Tropidurus jaguaribanus* has its distribution restricted to the Rio Jaguaribe Valley, east region of Ceará state, northeastern Brazil, and up until the present little is known about its ecology, with only basic knowledge of daily activity and habitat usage (Passos et al., 2011). Herein we present, for the first time, data on clutch size, incubation time and hatchling morphometry for *T. jaguaribanus*.

On January 2011 in a semi-arid Caatinga area from São João do Jaguaribe municipality (5°19'21" S, 38°11'58" W, GPS datum: WGS 84), the type locality of *T. jaguaribanus*, we captured two gravid females of the species. We



Figure 1. Newly hatched *Tropidurus jaguaribanus*.

took the lizards to the Laboratory of Herpetology at the Núcleo Regional de Ofiologia da Universidade Federal do Ceará (NUROF – UFC), where they were housed individually in terrariums measuring 50 cm x 30 cm x 25 cm with environmental enrichment (sand, gravel and a clay tile) and were monitored until oviposition.

The eggs were incubated in a container measuring 35 cm x 25 cm x 10 cm on a mixture of damp sand and gravel. A small depression was made in the substrate to put the eggs in a manner that each egg was only half buried. Incubation occurred under laboratory conditions (ca. 25 °C, 65% RH and 12 h photoperiod).

Hatchling voucher specimens were placed in the scientific collection Coleção Herpetológica da Universidade Federal do Ceará (CHUFC).

The length and diameter of eggs were measured before hatching. The following body measurements of newborns were taken immediately upon hatching: snout-vent length, head length, head width, head height, axilla-groin length, body height, body width, humerus length, foreleg length, fourth finger length, femur length, hindleg length, fourth toe length, tail length, tail base width and mass. The measurements were made with a digital caliper with 0.1 mm precision and an electronic balance with 0.1 g precision.

On 25 January 2011, three days after collection, a female (CHUFC – L 4511; SVL = 78.7 mm; M = 17 g) laid two eggs (22.7 and 22.4 mm in length; 9.9 and 9.6 mm in diameter; 1.2 g in mass each one), and three days after that, the other female (CHUFC – L 4512; SVL = 80.5 mm; M = 18 g) also laid two eggs (23.6 and 21.4 mm in length; 10.3 and 9.6 mm in diameter; 1.24 and 1.1 g in mass). In both events, the eggs were found aggregated and juxtaposed to one another, oviposited under the clay tile within the enclosure. This trend of fixed clutch size with two eggs seems to be an ancestral trait of *Tropidurus* of the *semitaeniatus* group, possibly related to the saxicolous habits and mainly with the use of narrow rock fissures (Vitt, 1981). All the eggs were white, slightly elongated and had flexible soft shells in a similar way as found for other tropidurid species.

On 11 April 2011, 76 days after the first oviposition, a hatchling emerged (CHUFC – L 4509). The other egg within the clutch, after 90 days of incubation, began to discolour and was opened up revealing absence of embryos. On 24

April 2011, after 89 days in incubation, a neonate of the second clutch hatched (CHUFC – L 4510). In a similar way as occurred in the first clutch, the other egg became discoloured and desiccated. It was also opened up and its interior was dehydrated without evidence of embryonic development. The measurements of the two hatchlings are presented in Table 1.

Both the hatchlings presented the typical colouration of its species (Fig. 1) with a single mid-dorsal longitudinal light stripe that extended from the snout to the scapular region (Passos et al., 2011). This finding demonstrates that this colour pattern is present in the early stages of ontogeny, allowing accurate identification of this species, and reinforces the use of this character as diagnosis for *Tropidurus* of the *semitaeniatus* group. In view of the scarcity of ecological data on *T. jaguaribanus* and the difficulty of gathering data of this kind, these findings expand the understanding of the reproductive biology of this species, beyond contributing to knowledge on ecology of this poorly known *Tropidurus* of the *semitaeniatus* group.

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VOUCHER	SVL	HL	HW	HH	AG	BH	BW	HUL	FLL	FFL	FL	HLL	FTL	TL	TBW	M
CHUFC L 4509	25.1	8.0	6.1	3.5	8.1	4.2	6.3	6.0	5.5	5.3	7.3	8.4	6.6	56.4	4.3	0.8
CHUFC L 4510	25.9	7.3	5.5	3.3	9.4	3.4	5.4	4.9	7.1	4.9	6.4	7.2	6.9	47.0	3.4	0.6

Table 1. Data on two *Tropidurus jaguaribanus* hatched in the Núcleo Regional de Ofiologia da Universidade Federal do Ceará. Snout-vent length (SVL), head length (HL), head width (HW), head height (HH), axilla-groin length (AG), body height (BH), body width (BW), humerus length (HUL), foreleg length (FLL), fourth finger length (FFL), femur length (FL), hindleg length (HLL), fourth toe length (FTL), tail length (TL), tail base width (TBW) and mass (M). Measurements are in millimeters, and mass is in grams.

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Natural History Notes

HYDROMEDUSA TECTIFERA

(snake-necked turtle): EPIZOIC AND ECTOPARASITIC FAUNA. *Hydromedusa tectifera* Cope, 1869 is a widely distributed chelid, occurring in Argentina, Uruguay, Brazil, Paraguay and Bolivia (Lema & Ferreira, 1990; Quintela & Loebmann, 2009). In Rio Grande do Sul State, southern Brazil, it is a common species, generally occurring in association with swampy habitats (Lema, 2002; Quintela & Loebmann, 2009). Herein we report the epizoic fauna associated with an individual of *H. tectifera* in southernmost Brazil.

On November 11, 2009 an adult male *Hydromedusa tectifera* (rectilinear carapace length 257 mm, rectilinear carapace width 170 mm, rectilinear plastron length 224 mm, rectilinear plastron width 164 mm, height 88 mm; body mass 2,275 g) was found around 21:18 h moving on a road between marsh areas in a locality known as "Capilha" (32°23'59"S, 52°33'27"W, 10 m a.s.l.), Rio Grande municipality, Rio Grande do Sul State, southern Brazil. The individual was collected and placed in a plastic box containing water treated by the local sanitation company, with a chlorine concentration of 0.2 mg/l. The individual remained submersed about three-quarters of its height for approximately 12 hours. Subsequently, the turtle was taken to the lab, where a careful examination of epizoic fauna was carried out. All the material attached to the body as well as living fauna found in the water where the individual stayed submersed, were collected and preserved in 70% ethanol solution.

Rhynchobdellida leeches ($n > 200$) were found on all dorsal and ventral surfaces of the carapace and plastron, epidermis of the neck, proximal parts of all limbs, anal region and base of the tail. *Temnocephala* sp. (Platyhelminthes, Temnocephalida) encapsulated eggs ($n > 200$) were found on the anterior dorsal surface of the plastron, anterior ventral surface of the carapace and bridges while adult worms ($n > 200$) were located clustered on the epidermis adjacent to the anterior ventral surface of the carapace and epidermis of the bases of neck and limbs (Fig. 1). Living fauna recovered from the water comprised Chironomidae larvae ($n = 3$),



Figure 1. Location of *Temnocephala* sp. encapsulated eggs (arrows A) and clustered worms (arrows B) in a *Hydromedusa tectifera* individual from southern Brazil.

Planorbidae ($n = 1$), Hydrobiidae molluscs ($n = 7$) and Hyalellidae amphipod crustaceans ($n = 2$).

Among the organisms found occupying the body surface, leeches represent ectoparasites, since they were found attached to the skin obtaining nourishment directly from the blood of the turtle. With regard to Temnocephalids, authors point to the relationship between parasitism and commensalism (Ernst & Lovich, 1996) and symbiosis (Brusa & Damborenea, 2000). It is worth noting that the epidermal areas where adult Temnocephalids were attached peeled easily when the worms were removed, which implies that its presence may cause injuries to the turtle skin. Considering the large number of leeches and *Temnocephala* sp. worms and eggs, it is likely that the *H. tectifera* could have been diseased. Temnocephalids previously recorded on chelids are: *Acanthochelys radiolata* (Montcelli, 1899), *Acanthochelys spixii*, (Ferreira Yuki et al., 1993) and *Hydromedusa maximiliani* (Ernst & Lovich, 1996). On *H. tectifera*, Soares et al. (2007) cited the occurrence of *Temnocephala* sp. in central Rio Grande do Sul, while *Temnocephala brevicornis* is recorded in southeastern Brazil (Novelli et al., 2009) and eastern Argentina (Brusa & Damborenea, 2000). Recently, two species of Temnocephalids (*Temnocephala pereirai* and *T. cuocoloi*) were also described from a *H. tectifera* specimen from southern Uruguay (Volonterio, 2010). It is not clear what kind of interaction (if any) operates between

Chironomidae larvae, molluscs, amphipods and the *H. tectifera* individual. As these invertebrates were not found in the corporal visual search, they were probably occupying the shell cavities between the surfaces of the ventral carapace and dorsal plastron. Failing any indications of parasitic behaviour involving these invertebrates, it is probable that the relationships may be restricted to the utilization of the spatial resource provided by the *H. tectifera* body.

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LIOPHIS POECILOGYRUS (Yellow-bellied Liophis). COPULATION. *Liophis poecilogyrus* (Fig. 1) is a common Colubridae species in Rio Grande do Sul state, southern Brazil, occurring mainly in open areas (Lema, 2002; Quintela & Loebmann, 2009). The reproductive pattern and diet of this species has previously been described in southeast Brazil (Pinto & Fernandes, 2004), but without observations on its copulatory behaviour. Despite its abundance in the southern Rio Grande do Sul, there is no detailed information available for their reproductive behaviour. Data is presented here on the copulation of *L. poecilogyrus* that was observed in nature and captivity.

On September 9, 2004, at about 13:30 h, in Campus Carreiros of Federal University of Rio Grande, municipality of Rio Grande, state of Rio Grande do Sul, southern Brazil (32°04'28" S; 52°09'78" W; 3 m a.s.l.), four individuals of *L. poecilogyrus* were found in copulatory activity. The four specimens were interlaced, partially submersed in a pluvial channel near a natural shallow lake (depth 5 cm), under a wooden plate. A few moments after being discovered, two individuals (later identified as males) left the cluster. These males presented the following measurements: male A snout-vent length (SVL) 361 mm, vent-tail length (VTL) 81 mm; male B SVL 364 mm, VTL 82 mm. The other two individuals, a male and a female connected by their sexual organs, were carefully placed in a terrarium. The couple was observed at 30 minute intervals until the end of the copulatory activity.

The duration of the copulatory activity from the first (September 9, approximately 13:30 h) to the last observation (retraction of the hemipenis - September 10, about 19:00 h) was recorded at around 29 hours and 30 minutes. Considering the period that preceded the discovery of the cluster, the duration of the copulatory activity was probably longer than the period determined by the observations.



Figure 1. *Erythrolamprys poecilogyrus* male (SVL = 297 mm, VTL = 66 mm) from coastal southern Brazil.

Upon completion of copulation, the male and female were measured and had the following values: male SVL 365 mm, VTL 85 mm; female SVL 52 mm, VTL 99 mm. This is the first observation of both a mating cluster and duration of copulation for *L. poecilogyrus*, which contributes to the understanding of reproductive biology of such a Neotropical colubrid.

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GEKKO HOKOUENSIS, HEMIDACTYLUS STEJNEGERI. PREDATION. The Kwangsi Gecko (*Gekko hokouensis* Pope, 1928) has a natural distribution that extends through eastern China, Taiwan (including adjacent Lanyu and Guishan islets), and Japan (southern Kyushu Island and Ryukyu Archipelago) (Zhao & Adler, 1993; Lue et al., 2002). In Taiwan, this species can be found all over the island at altitudes below 1,000 m (Shang & Lin, 2001). According to Lin & Cheng (1990), the diet of *G. hokouensis* consists of insects, other arthropods and possibly fruits from inside human houses. The Stejneger's Leaf-toed Gecko (*Hemidactylus stejnegeri* Ota & Hikida, 1989) naturally occurs in China, Taiwan, Philippine (Luzon Islands), Thailand, and Vietnam (Zhao & Adler, 1993; Lue et al., 2002). In Taiwan, this species is not common, but can be found in the central to southern and eastern parts of the island, at altitudes below 1,200 m (Shang & Lin, 2001). Lin & Cheng (1990) stated that the diet of *H. stejnegeri* primarily consists of insects.

The Black Belly Wolf Spider (*Lycosa coelestis*) has a natural distribution that extends over China, Japan, Korea, and Taiwan, where they occur in a variety of low altitude habitats (Chen, 2001). Like all other members of the family Lycosidae, *L. coelestis* is a ground runner (Uetz et al., 1999), and their activities are mostly restricted to the ground, seldom being found on vegetation and other objects above the ground. We found no dietary descriptions for *L. coelestis* in the literature, although wolf spiders (Lycosidae) are generalist predators feeding mostly on Diptera, Hemiptera, Collembola, and Araneae (Nyffeler & Benz, 1988).



Figure 1. Example of *H. stejnegeri* predation on *L. coelestis*.

At 19:50 h, on the 20th March, 2008, a male *G. hokouensis*, with a snout-vent length (SVL), tail length (Tail-L) and the body mass (BM) of 62 mm, 42 mm and 4.7 g respectively, and which had suffered tail autonomy, was noticed as it moved ca. 1.7 m above the ground on a red brick wall, of an abandoned house in a private citrus orchard in the Dahu area, Yuanshan District, Yilan County, northeastern Taiwan (24°44'31.01"N, 121°40'41.95"E; elevation 65 m; WGS84). The gecko, which had a black spider in its mouth, was captured and placed in a small plastic cage. Soon afterwards the gecko ejected the spider, which was identified as a male *L. coelestis*, with a body length (BL) and BM of 14.5 mm and 0.2 g respectively. The *G. hokouensis* was released a week later back into the wild in the locality where it had been collected.

At 00:00 h, on the 20th of May 2009, an *H. stejnegeri*, with a black spider in its mouth, was seen moving along the gutter of a nursery greenhouse, located in the Da-jiou-shi Experimental Forest of National Ilan University, Yilan County, northeastern Taiwan (24°47'11"N, 121°40'39"E; elevation 250 m; WGS84). The gecko was photographed (Fig. 1), but when attempts were made to capture the gecko, it dropped the spider and fled. The prey item was collected and identified as a female *L. coelestis*, with a BL and BM of 12.8 mm and 0.1 g respectively.

According to Lue et al. (1987) *H. stejnegeri* is a nocturnal feeder and our observation supports this statement. The microhabitat utilization of *G. hokouensis* and *H. stejnegeri* is distinct to a certain degree. *G. hokouensis* may be found near human habitations but tends to prefer more natural settings like secondary forests and rocky cliffs (Goris & Maeda, 2004), where as *H. stejnegeri* is more human commensal and often occurs on the exterior walls of buildings in anthropogenic settlements. Predation on spiders by geckoes has the potential benefit of reducing competition (Holt & Polis, 1997) although intraguild predation events may be far more complex. For example, geckoes may risk mortality during predation on some spiders (e.g. Ramires & Fraguas, 2004).

During observations of lizard and spider predation events, we would encourage identification of the species involved to the

lowest taxonomical category possible. Such information would enhance interdisciplinary cooperation among specialists, and can possibly contribute to the understanding of intraguild predation by these organisms. Based on our available reference review, this appears to be the first reported instances of *H. stejnegeri* and *G. hokouensis* preying on *L. coelestis*.

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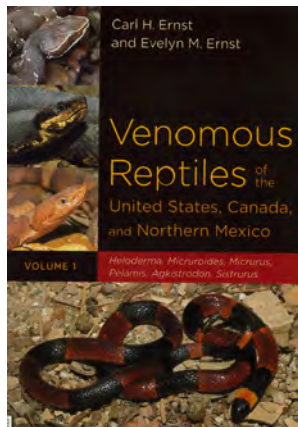
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Book Reviews

Venomous Reptiles of the United States, Canada, and Northern Mexico Volume 1: Heloderma, Micruroides, Micrurus, Pelamis, Agkistrodon, Sistrurus

Carl H. Ernst and Evelyn M. Ernst

John Hopkins University Press, 392 pp



The stated aims of this book are threefold: to present as much current knowledge as possible about the biology and life history of these animals while indicating areas that require further research; to discuss reptilian venom in detail and finally to enhance understanding of venomous reptiles (and thereby their conservation) by providing a ‘balanced picture’ of their lives. This, the first of two volumes, covers both species of helodermatid lizard, all of the elapid species (including the single species of seasnake) in this geographic region and the vipers belonging to the genera *Agkistrodon* and *Sistrurus*. The genus *Crotalus* will be featured in the second volume, completing a comprehensive guide to all the strictly (dangerous to humans) species to be found in these regions. Note that other (Colubrid) species, such as the hog-nosed or ring-necked snakes that have been implicated in envenomations are not covered here. The book is split into three sections; the first dealing in great detail with venom, envenomation and treatment followed by the conservation section and then, for the bulk of the book, the species accounts.

The venom section starts with a clear and simple broad description of the types of venom to be discussed. After being gently ushered into the subject we then get thrown in at the deep end as the non-technical aspect (as we are warned in the preface!) of the book is replaced by the necessarily more technical discussion of the different categories of toxic venom and their components. While much useful information is gathered here it is quite difficult to find amongst the reams of chemical names and symbols. The section closes with an interesting review of the medical uses, both actual and potential, of reptile venoms.

The following section, on envenomation’s, sets out a few statistics regarding fatalities caused by reptile venoms in the US and shows surprisingly few from an area with a large amount of people and quite a few venomous species. The Mexican picture is less clear as not all the venomous species from the country are included here. What these Fig.s really show is the absolute necessity of medical treatment and the need to make it rapidly accessible to keep these Fig.s low – compare with the amount of snakebite fatalities in countries such as India - on average less than 10 per year in N. America compared with an estimation of almost 11,000 in India (Kasturiratne et al., 2008). Even given the difference in population size of these countries there is a staggering increase in percentage of bites that are reported as fatal. Again, though I thought that the book could be more user friendly with perhaps tables or graphs comparing snakebite statistics from different parts of the world.

The ‘Treatment of envenomation’ section is very interesting and highlights not only the do’s and don’ts of reptile bite first aid, but also the global shortage and the different types of anti-

venom, along with the problems of developing new products. The section closes with a brief look at the use of plants to treat snakebite in historical and current practice and how there is still the prospect of gaining some knowledge from these traditional uses of plants.

The conservation chapter is relatively brief and covers the expected subjects – the threats and declines faced by these species and some possible broad conservation strategies to counter them. Levels of protection for the species covered by this book are given in table form and I can't help thinking that the paragraph (page 48) highlighting the varying levels of vulnerability of the species would have benefitted from similar treatment. As with comments on previous sections I do not mean to imply that the information is lacking in any way, just difficult to digest in the form in which it is presented.

Following this are the species accounts which are incredibly detailed and cover everything you are likely to need to know about the species concerned. Subjects covered include the obvious such as recognition, distribution, habitat, behaviour and ecology, as well as comprehensive information on karyotype (when known), venom and bites, parasites and pathogens, reproduction, and much more. There is an incredible level of detail here. The discussion of solenoglyphous dentition, and the ligament and muscle function associated with this unique mode of predation is incredibly detailed, as are many other sections: reproduction in cottonmouths, male combat in gila monsters etc. There are keys to the genera of each family covered, distribution maps, some very good black and white photos, as well as some slightly disappointing colour plates. The bibliography is huge, taking up 90 pages, and very much up-to-date.

However, I feel that this very impressive piece of work is marred somewhat by the way in which the information is presented. The amount of detail and quality of information is certainly more than sufficient but it is not always that easy to find. At times the text becomes an impenetrable list, which, when mixed with the citations makes for heavy going. This is a shame as there is some great writing here, with a welcome dash of humour in places. I was very taken with the description of *Sistrurus*

miliarius as 'a nasty little snake with a fiery temper!' and the closing remarks of the gila monster species account, dealing with some of the myths surrounding the species, are hilarious!

This is not a book for a casual reader and certainly requires some prior knowledge of subjects such as sexual cycles (spermiogenesis, recrudescence etc.), snake bone structure and indeed chemistry if one is to fully grasp the sections on venom and the chemical processes involved in venom delivery. Even though rattlesnakes and helodermatid lizards are covered elsewhere in very good publications it is refreshing to see the *Agkistrodon* species given such thorough coverage and it becomes apparent that some of the coral snake species are comparatively little known.

Putting small criticisms aside I fully support the concept behind this well researched book, that the conservation of these species is dependent on gaining as much information as possible and that globally, education is one of the key elements in helping us conserve reptiles and in particular venomous species. This book will certainly help greatly on both counts.

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The Crested Newt. A Dwindling Pond-Dweller

Robert Jehle, Burkhard Thiesmeier and Jim Foster

Laurenti-Verlag and the BHS, 152 pp



This A5-size book, published jointly by Laurenti-Verlag and the BHS, draws on the large body of research into the crested newt. It provides an English translation and update of two editions of the German publication *Der Kammolch – ein 'Wasserdrache' in Gefahr* (Thiesmeier & Kupfer, 2000; Thiesmeier et al., 2009). This is helpful to herpetologists who cannot read German, opening up a wealth of previously inaccessible literature. This latest edition includes input from a British author, notably a chapter on conservation and management in the UK. It is, nevertheless, still a few pages shorter than its predecessor. Certainly some illustrations have been dropped.

After a one-page introduction, Chapter 2 gives descriptions of the crested newt species, including information on distribution and habitat. Although formerly regarded as a single species (*Triturus cristatus*) *The Crested Newt* describes six separate species, adding *T. arntzeni* to the five recognised in the previous edition and acknowledging that genetic differentiation within *T. karelini* is sufficiently great that further splitting may still be on the cards. Due to the large international range of *Triturus cristatus* (which includes the UK) and a longer history of interest in this particular species it gets the lion's share of attention in this chapter and throughout the publication. This section

includes an examination of detailed distribution, entering the turbulent waters of estimating national population size in the UK.

Chapter 2 also includes information on habitats, recognising the much greater understanding of aquatic rather than terrestrial phases of life. Among plentiful natural history information I noticed reference to Precht (1951) (p. 46) that *T. cristatus* needs the presence of submerged plants as a prerequisite to produce eggs. Is this really true? Are there really no other more recent observations of great crested newts egg-laying and breeding in water bodies devoid of submerged aquatic vegetation? Precht's work popped up for me again (p. 87) reporting observations of great crested newts apparently showing submissive postures (lying flat) after threats from larger males. Really? I enjoy going back to older literature and I would love to read Precht's work. But as I don't read German this little book is the next best thing.

Chapter 3 provides an account of the annual activity of crested newts. The chapter title 'A complex life cycle' is used to describe variations on a generalised pattern. But the authors take the terminology from Wilbur (1980) who clearly states that 'complex' refers to life cycles in which there are distinct stages with different morphology, physiology and behaviour. This is certainly true of amphibians, but the terminology is misused in the current publication. In spite of this the chapter provides useful information on the timing and direction of migrations between land and water, the length of time spent in the water, breeding site fidelity, feeding and egg-laying behaviour and larval ecology. I was interested to read of the electroreceptive ability of great crested newts as this is something new to me. The authors, however, give no specific reference to back this up.

The crested newt is unusual in that juveniles can sometimes be aquatic rather than wholly terrestrial as is the case in other European newts. The section dealing with this cites Bell (1979) reporting 0-71% of aquatic captures in a

pond being immature, whereas he in fact reported on variation between several ponds (actually a better demonstration of the point being made). This minor inaccuracy could easily have been an error of translation, but the authors further mistakenly cite Bell making reference to palmate newts when in fact he confined his work and comments to smooth and great crested newts.

Chapter 3 also includes a section on life on land, noting that crested newts spend about two-thirds of their lives there. This is an important point because our knowledge is biased towards the briefer aquatic life stages. In fact I would argue that the subtitle of this publication is unhelpful in that it reinforces this discrepancy by describing the crested newt as a pond-dweller. I would also have included Halliday & Verrell (1985) in the section on autumn migration as, although dealing with only a small number of newts at a single pond, they were probably the first to document this phenomenon in *T. cristatus* in the UK.

Chapter 4 deals with mating and reproduction and Chapter 5 covers population dynamics, including reference to metapopulations. Chapter 6 'Field methods' provides an overview of marking, pattern mapping, radio tracking, genetic methods and the habitat suitability index. Possibly due to limitations of space, these accounts are not sufficiently detailed to provide practical guidance on usage, but this can be found in the publications cited and will be well known to herp workers in the UK.

The final chapter includes new material and covers conservation and management of the great crested newt in the United Kingdom. It provides a succinct summary of our understanding of population trends, threats to the species, conservation measures and mechanisms, the organisations involved in great crested newt conservation and the policy framework that drives it all. For readers who may be surprised to see the UK held up as an example of how to conserve great crested newts there is also recognition of shortcomings. For example the designation of a series of protected sites (Special Areas of Conservation are required under the Habitats Directive) is of limited use as a measure to conserve a widespread (but declining) species. Furthermore, the broad range of landowners required to make a

difference to great crested newt conservation status may be discouraged from doing so due to the strict legal protection of the species, which is widely regarded as restrictive to other interests. Widespread, proactive measures, potentially delivered through agri-environment schemes may be more effective. Similarly, there are accounts of some effective development mitigation projects, but also acknowledgement that mitigation is beset by a range of problems and there is recognition that a fundamental shift in approach may be needed to improve outcomes more generally.

The book is well illustrated, with many colour and black and white photographs and a great deal of graphed data reproduced from the original research publications. High quality colour plates illustrate five of the species, different life stages and habitat. Perhaps due to the practicalities of production these are confined to a single block in Chapter 2. There are a few typographical errors and even fewer internal inconsistencies. For example Table 2.2, summarising the distinguishing features of the crested newt species, describes the ventral blotches of *T. cristatus* as small and roundish whereas Fig. 2.2 and plates 2, 6 and 7 illustrate that they are a range of sizes and irregular shapes.

The glitches are minor, though, in this otherwise thorough and useful publication, drawing together a large amount of research and making German literature more widely accessible. The authors' stated intention is to assist in conservation. In reality many conservation practitioners in the UK may be more readily served by practically orientated handbooks (e.g. English Nature, 2001; Langton et al., 2001). But for those wishing to learn more about the natural history of the crested newt then this is an excellent publication and it is pleasing to hear that some ecological consultants are using it as a reference.

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Herpetological Bulletin Report 2012

A total of 63 manuscripts were received during 2012 of which 46 were accepted (acceptance rate 73%). The categories are:

Full papers 28; 20 accepted (71% acceptance).

Short Notes 16; 12 accepted (75% acceptance).

Natural History Notes 19; 14 accepted (73.7% acceptance).

Three review papers have been solicited, the first of which by Professor R. McNeill Alexander on Reptile Locomotion appeared in issue 121, the second by Professor Trevor Beebee et al., on Herpetology at ARC appeared in issue 122. We hope to continue and expand this idea, especially regards information on herpetological activities at various institutions perhaps also including work on captive breeding and conservation at Zoological Gardens or elsewhere. To continue publishing work on these themes we would invite authors to submit reports of their work in their respective areas of interest to the Bulletin for consideration.

Commencing with issue 1 of the 2013 Bulletin, the format has changed from the current A5 to A4. This also includes page layout changes. Competition for the higher quality manuscripts is increasing all the time and we hope the new layout will improve the presentation of papers. Submissions continue to be buoyant with at least enough papers for the next two issues of 2013.

The following people reviewed manuscripts for Herpetological Bulletin during 2012: Roger Avery; Francis Baines; John Baker; Chris Barratt; Trevor Beebee; Daniel Bennett; Arnold Cooke; Kevin Eatwell; Chris Gleed-Owen; Stuart Graham; Richard Griffiths; Laurence Jarvis; Simon Maddock; Roger Meek; Gary Powell; David Sewell; Christine Tilley.

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