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Research Article

Abundance and diversity of anurans in a regenerating former oil palm plantation in Selangor, Peninsular Malaysia

JAMES B. BARNETT[1, 3], ROSMUND L. BENBOW[1], AHMAD ISMAIL[2] and MARK D. E. FELLOWES[1]

[1]*School of Biological Sciences, University of Reading, Whiteknights Park, Reading, Berkshire, RG6 6BX, U.K.*

[2]*Department of Biology, Universiti Putra Malaysia 43400 UPM Serdang, Selangor Malaysia.*

[3]Corresponding author: *4D27, School of Experimental Psychology, University of Bristol, 12a Priory Road, Bristol, BS8 1TU, U.K.* (j.barnett@bristol.ac.uk)

ABSTRACT - The spread of oil palm plantations across Southeast Asia has resulted in significant species loss and community change due to the simplification of what were once complex ecosystems. In this study we examined how the return of a former area of oil palm plantation in Selangor, Malaysia, to other uses may have affected the anuran assemblages present. In our study site, a tract of oil palm plantation had been retained, while other areas of former oil palm plantation had been converted to coconut plantation, grassland, or allowed to naturally regenerate to secondary woodland. We found no evidence of recolonisation by habitat specialists in regenerating areas, instead finding species commonly associated with disturbed habitats. While the number of anuran species found was similar between habitats, the assemblage composition varied. Furthermore, there was a considerable difference in anuran counts, with the greatest numbers in secondary woodland, followed in rank order by grassland, oil palm plantation and coconut plantation, and a near 10-fold difference in anuran counts between secondary woodland and coconut plantation. Oil palm plantation was below optimum even for disturbed habitat specialist species which increased in diversity and abundance once oil palm had been removed.

INTRODUCTION

Peninsular Malaysia has experienced rapid change and development of its economy and landscape in recent years (Birdsall et al., 2001). These changes have led to conflicts between the native fauna, including amphibians, and the needs of the local people (Pautasso, 2007). As a result of development, a large proportion of native forest has been removed and replaced with agricultural and urban landscapes. Southeast Asia contained 11% of the world's tropical rainforest in 2007 (Koh & Wilcove, 2007) but the region has the highest rate of deforestation in the world (Soh et al., 2006), double the world average (Liow et al., 2001). The greatly increased production of palm oil from oil palm (*Elaesis* spp.) is one of the biggest factors in Malaysia's rainforest degradation (Wilcove & Koh, 2010).

Together Indonesia and Malaysia produce >80% of the world's palm oil (Koh & Wilcove, 2007), which in 2007 equated to 3.6 million hectares of plantation in Malaysia alone with a 55-59% rise in production rate between 1990 and 2005 (Koh & Wilcove, 2008). The conversion of primary forest to oil palm has the highest biodiversity loss of any land use change in Malaysia, and has been considered the most important threat to Southeast Asian biodiversity (Wilcove & Koh, 2010).

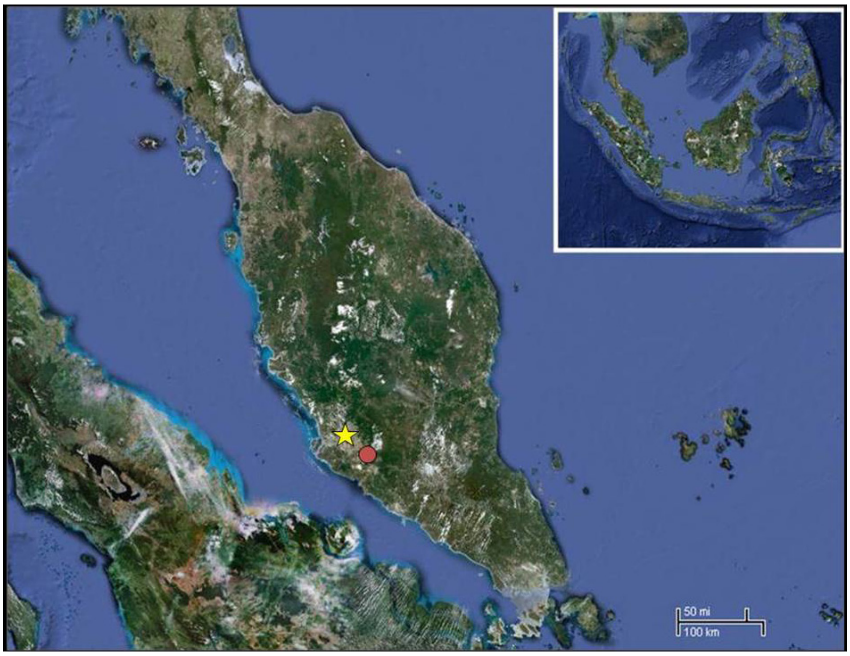

Figure 1. Location of the study sites, near the Universiti Putra Malaysia campus in Selangor, Malaysia; Kuala Lumpur (star) UPM campus and field sites (circle).

A reversal of the conversion to oil palm is needed to protect biodiversity and ecosystem services (Kettle, 2010). This is particularly important where fragmentation threatens the sustainability of the remaining natural ecosystems (Haddad et al., 2003). Agricultural landscapes may provide connectivity for common species but many specialised species require continuous natural habitat in order to connect breeding populations and preserve gene flow (Gamage et al., 2011). In order to preserve biodiversity in remaining habitat and to increase species' range, regeneration of natural areas and corridor habitat will likely be required (Yaap et al., 2010).

Currently, 107 species of amphibian have been recorded in Peninsular Malaysia (Onn et al., 2010), the majority of which are adapted to primary forest. A range of species do take advantage of human-influenced ecosystems, appearing to tolerate or even thrive in disturbed habitats (Inger et al., 1974). The amphibian richness of Peninsular Malaysia may have been underestimated, as many new species have been described in recent years from areas currently being deforested (Grimser, 2007). A key approach to maintaining anuran biodiversity will rely on the conversion of oil palm plantations to other habitats, including secondary woodland (Dunn, 2004). It is not clear if this alone will allow natural anuran assemblages to re-establish, or if these assemblages will be dominated by habitat generalists in place of the former, more specialised anurans. To address this key concern, we studied the abundance and diversity of anurans inhabiting a current oil palm plantation, and three habitats which previously had been part of that plantation, but since 1931 had been converted to coconut plantation, open grassland or allowed to regenerate to secondary woodland (Samad, 2011).

MATERIALS AND METHODS

Study site

Four different disturbed habitats around the Universiti Putra Malaysia (UPM) campus in Selangor, Peninsular Malaysia, were studied in June and July 2010 (Fig. 1). Historically the sites would have been covered in lowland dipterocarp forest (Heaney, 1991). However, they had been cleared for oil palm production, until the university took over the land in 1931, and now have reverted to other uses (Samad, 2011). One area of remaining working oil palm plantation (2˚59'06.23"N, 101˚43'11.44"E) was studied along with three different habitats which have arisen since 1931. These were a coconut plantation (2˚59'04.35"N, 101˚43'19.88"E), semi-natural grassland

(2˚59'13.29"N, 101˚43'23.57"E) and secondary forest (3˚00'29.81"N, 101˚42'29.13"E) which have all developed on the sites of former oil palm plantations. It is not clear when the transformation from oil palm plantation to coconut, open grassland and areas allowed to regenerate to secondary woodland occurred. However, this is likely to have occurred at least 30 years ago, and more likely >50 years ago.

Habitat description

For each habitat, twenty 1 m^2 quadrats were set up at random intervals within the surveyed habitat. This work was undertaken diurnally to maximize visibility and to reduce any impacts on the amphibian surveys. Percentage ground cover was estimated in 10 quadrats by the same observer to within 10% discrete categories following Babbitt et al. (2010). Plant diversity was estimated in 10 separate quadrats by counting the number of different plant families found in each 1 m^2. All species, independent of abundance or size, were counted equally. All habitats were situated close together (< 3 km apart) and were likely to be within the dispersal potential of the species studied. It seems likely that migration and colonisation would have occurred between sites if species were able to exploit the habitat.

Anuran surveys

Fifteen nocturnal 50 m transects were used to survey for amphibians within each site: regenerating forest, grassland, coconut plantations and oil palm plantations. Transects were unconnected but due to safety concerns and restricted access transects had to follow small precut paths. Each habitat was surveyed once a week, on separate days, for three weeks with five transects being completed each night, with each habitat therefore receiving a total of fifteen transects. Anurans were searched for, between 1 and 3 hours after sunset, with the use of handheld and head torches along 50 m long transects within each habitat. Transects were walked slowly by the same three observers, with each surveying 2 m (Marsh & Haywood, 2010) either side of the transect line thoroughly and quickly scanning for additional specimens outside of the area. Transects were walked slowly at a steady pace to ensure replication between sites. The search was also suspended while a specimen was being examined, to prevent certain areas being searched more comprehensively than others. The species, lifestage and sex of frogs were recorded; using morphological features following Inger & Stuebing (2005) and Inger (1966), as well as a web resource (amphibia.my, 2009).

Statistical analysis

Simpsons Diversity Index; (D = diversity score, N = total abundance, n = species abundance), was used to estimate species diversity. Each replicate transect provided the raw data for the analyses (count data for total anurans and individual species counts). For species richness and relative abundance, data was analysed using a non-parametric approach, with overall comparisons between habitats made using Kruskal-Wallis tests in SPSS version 18 (SPSS Inc, Chicago, IL, USA). To correct for unintended Type I errors following repeated post-hoc pairwise comparisons, Holm's sequential Bonferroni approach was applied (Holm, 1979).

RESULTS

Habitat

Habitats visually differed in their botanical structure and substrate (Table 1) (Fig. 2, results below). Secondary forest contained the greatest diversity of plants as well as a thicker leaf litter. Diversity was present in height and age of plants with synergy between different forest components from canopy to leaf litter. Conversely, grassland was dominated by short grass with scattered groups of trees and scrub. Small open water sources (small ponds) were present in the grassland. The two plantations were dominated by crop trees, which formed a canopy far above all understorey vegetation. Scrub plants were common but a bare sandy soil was visible (Fig. 2).

Species richness

Overall, 229 individual anurans were recorded, belonging to 10 species. There was great overlap in species between habitats with most species being found in multiple habitat types: except for *Microhyla heymonsi* that was only found in regenerating secondary forest, *Hylarana erythraea* only in grassland, *Ingerophrynus parvus* only in coconut and *Leptobrachium*

Figure 2. Examples of ground vegetation variation between sites: A – Grassland, B – Secondary Forest, C – Oil Palm Plantation, D – Coconut Plantation. (Photographs by J.B. Barnett).

nigrops only in the oil palm plantation (Table 2).

There was a significant difference in amphibian species richness between habitats (H = 26.891, df = 3, P < 0.001). Pairwise tests showed no difference in the number of species recorded between grassland and forest, or between oil palm and coconut plantation. However, forest held significantly higher species richness than oil palm (H = 14.423, df = 1, P < 0.001) and coconut (H = 15.370, df = 1, P < 0.001), as did grassland when compared to oil palm (H = 9.792, df = 1, P = 0.002) and coconut (H = 10.827, df = 1, P = 0.001). All were significant at P < 0.05, following Holm's sequential Bonferroni correction.

Species diversity

Simpson's diversity index showed all habitats to have very similar scores (S = number of species, n = total abundance, D = diversity indices): coconut (S = 5, n = 13, D = 0.722), forest (S = 6, n = 126, D = 0.667), grassland (S = 7, n = 73, D = 0.665) and oil palm (S = 5, n = 17, D = 0.644).

Species counts

Although anuran diversity was similar in each habitat, there were differences in the number of individuals recorded in each. A Kruskal-Wallis test comparing total anuran counts across all four habitats found significant differences in abundance (H = 39.351, df = 3, P < 0.001). Pairwise post-hoc tests showed no significant difference in anuran counts between forest and grassland, or oil palm and coconut habitats. There were significant differences in total anuran counts between secondary forest and oil palm (H = 18.747, df = 1, P < 0.001), secondary forest and coconut (H = 19.939, df = 1, P < 0.001), grassland and oil palm (H = 18.132, df = 1, P < 0.001) and grassland and coconut (H = 19.638, df = 1, P < 0.001). All were significant at P < 0.05 following Holm's sequential Bonferroni correction.

Species also showed significant difference in counts between habitat types (*Duttaphrynus melanostictus:* H = 26.420, df = 3, P < 0.001; *Kaloula pulchra:* H = 29.197, df = 3, P < 0.001; *Polypedates leucomystax:* H = 12.991, df = 3, P = 0.005; *M. fissipes:* H = 43.567, df = 3, P < 0.001; *H. erythraea:* H = 9.310, df = 3, P = 0.025; *M. heymonsi:* H = 9.382, df = 3, P = 0.025; *L. nigrops:* H = 23.304, df = 3, P < 0.001). *Fejervarya limnocharis* and *F. cancrivora* showed no significant difference between sites, and as only a single *I. parvus* was recorded, statistical analysis for this species was not possible.

Grassland had significantly higher counts of *D. melanostictus* than secondary forest (H = 13.770, df = 1, P < 0.001), coconut (H = 10.185,

Habitat	Mean % ground cover	Mean no. of plant species per 1 m²	Major plant familes
Grassland	90≥100	1	Poaceae
Oil Palm	80≥90	2.3	Arecoideae (*Elaesis guineensis*), Poaceae
Coconut	80≥90	3.1	Arecoideae (*Cocos nucifera*), Poaceae
Forest	50≥60	3.2	Poaceae, Eudicotyledonae, Pteriodphyta

Table 1. Vegetation structure per habitat, mean % ground cover and mean number of plant.

Anuran species	Grassland	Oil palm	Coconut	Forest
Duttaphrynus melanostictus (Schneider)	38	1	2	0
Fejervarya limnocharis (Boie)	12	2	4	4
Fejervarya cancrivora (Gravenhorst)	15	4	5	20
Polypedates leucomystax (Gravenhorst)	1	0	1	11
Kaloula pulchra (Gray)	1	1	0	19
Microhyla fissipes (Boulenger)	1	0	0	66
Microhyla heymonsi (Vogt)	0	0	0	6
Hylarana erythraea (Schlegel)	5	0	0	0
Ingerophrynus parvus (Boulenger)	0	0	1	0
Leptobrachium nigrops (Berry and Hendrickson)	0	9	0	0
Total recorded per habitat	73	17	13	126

Table 2 Number of individuals of each species captured during the study per habitat type.

df = 1, P = 0.001) and oil palm (H = 11.816, df = 1, P = 0.001). Although *H. erythraea* was only recorded in grassland it was data deficient in terms of pairwise comparisons. All were significant at P < 0.05 following Holm's sequential Bonferroni correction.

Pairwise tests showed that secondary forest had higher counts of *K. pulchra* than grassland, coconut and oil palm plantation (all H = 13.555, df = 1, P < 0.001), and *M. fissipes* was more abundant in secondary forest than grassland, coconut and oil palm plantation (all H = 17.841, df = 1, P < 0.001). *P. leucomystax* showed a significantly higher count in secondary forest than in oil palm (H = 7.151, df = 1, P = 0.007), but pairwise tests were unable to conclusively show difference between the other habitats. *M. heymonsi* was only recorded in secondary forest habitat, but the count was too low to statistically conclude on habitat preference.

L. nigrops was only found in oil palm, and so was significantly more abundant there than in forest, grassland or coconut habitats (all H = 8.7, df = 1, P = 0.003). The single *I. parvus* was recorded in the coconut plantation, and there was no significant pairwise difference in the counts of *F. limnocharis* or *F. cancrivora*.

DISCUSSION

In this study we found that areas of former oil palm plantation (presently coconut plantation, open grassland, regenerating secondary woodland) had similar numbers of anuran species to current oil palm plantations. However, the anuran faunas of these habitats were surprisingly different, with different species dominating each habitat area. Furthermore, significantly more individuals were found in grassland and regenerating secondary woodland than in areas of coconut and oil palm plantation. In all cases, the anuran fauna remained highly depauperate, and we found that plantations and regenerating habitats do not support pre-plantation fauna, only those species commonly associated with disturbed habitats (Inger, 1966).

Diversity in each habitat was low. In forest and grassland, one species dominated (*M. fissipes* and *D. melanostictus* respectively), whereas in plantations all species counts were very low. The distribution of species between these habitats showed that they may be split into 'specialists', with the majority of their

Anuran species	Generalist/specialists	Major habitat
Duttaphrynus melanostictus	S	Grassland
Hylarana erythraea	S	Grassland
Polypedates leucomystax	S	Forest
Kaloula pulchra	S	Forest
Microhyla fissipes	S	Forest
Microhyla heymonsi	S	Forest
Ingerophrynus parvus	S	Coconut
Leptobrachium nigrops	S	Oil palm
Fejervarya limnocharis	G	Grassland/coconut
Fejervarya cancrivora	G	Grassland/forest

Table 3. Habitat preference of amphibian species. Specialist species are found predominantly in a single habitat type, whereas generalists are found in multiple.

population in one habitat type, and 'generalists' which are found in equal counts in multiple habitats (Table 3). Grassland and forest have equal species richness and total counts, which is significantly higher than either plantation. However, secondary forest has a greater number of specialist species (*K. pulchra*, *P. leucomystax*, *M. fissipes*, and *M. heymonsi*) which may be more valuable for conservation (Pardini et al., 2009).

Published work on the native anuran biodiversity of this region may provide an insight into the expected amphibian fauna of the study site. The original habitat for this region would have been lowland dipterocarp forest, some of which remains in parts of Peninsular Malaysia. A recent study in the Gunung Inas Forest Reserve in Kedah an area of intact primary forest in northern Peninsular Malaysia, recorded 28 species of anuran (Ibrahim et al., 2012). Also, the Ayer Hitam Forest Reserve is situated close to the field site of this study and its ecology has been extensively studied. This area represents a highly disturbed, logged and fragmented patch of remaining dipterocarp forest but one which has never been clear felled for oil palm (Awang Noor et al., 2007). There have been 18 species of anuran recorded in this patch (Haji et al., 1999; Nuruddin et al., 2007). Therefore, it is likely that at least 18 species of anurans could potentially be found in the regenerating forest surveyed.

Of the species recorded in Ayer Hitam only four were detected in this study; *D. melanostictus*, *F. limnocharis*, *P. leucomystax* and *H. erythraea*. Of these, all but *H. erythraea* were found in working plantations as well as regenerating patches (although in low numbers), indicating possible persistence through the land use transition. The other species recorded within plantations and regenerating habitats do not represent the fauna seen in the original forest habitat, and all species are commonly associated with disturbed and human environments in the IUCN red list assessments (IUCN, 2011).

We believe that once the primary forest is removed, the amphibian assemblage is reduced to a minimal indigenous fauna, lacking the vast majority of forest species, as well as the adaptable species commonly found in disturbed habitat. Once the plantation is removed, disturbed habitat species colonise and increase in abundance. However, there is no evidence of recolonisation by the majority of the original amphibian fauna. A similar situation is seen with rainforest ants in Sabah, Malaysia, and is seen in all parts of the forest structure (Fayle et al., 2010). Oil palm plantations only support 5% of the ant species found in the original forest, and the assemblage is dominated by non-forest and introduced species (Bruehl & Eltz, 2010). This pattern is also seen in birds (Aratrakorn et al., 2006; Koh & Wilcove, 2008; Azhar et al., 2011), and in small mammals (Stuebing & Gasis, 1989). A recent meta-analysis has shown that across all taxa, 85% of forest species are lost in conversion to oil palm; and of the vertebrates, only 22% are found in both habitats, with plantations supporting 38% of the number of vertebrates found in forest (Danielsen et al., 2009).

The simplification of the landscape due to plantation monocultures has also been implicated in the loss of amphibian diversity. Heinen (1992) found a positive correlation in herpetofauna diversity and species richness with leaf litter depth and moisture content in forest regenerating from plantations in Costa-Rica, indicating that the lack of leaf litter seen in plantation habitats reduces their suitability for anurans. Amphibian diversity is linked to habitat heterogeneity through microhabitat and keystone features, both biotic and abiotic (Tews et al., 2004), and is especially linked to aquatic breeding sites (da Silva et al., 2011). These features are significantly diminished in oil palm plantations when compared to primary forest (Luskin & Potts, 2011).

Oil palm plantations are a poor substitute for degraded forest (Fitzherbert et al., 2008). Plantations are below optimum for all species, even those able to successfully exploit other semi-natural habitats. This has conservation implications because simply allowing land to regenerate is not sufficient in itself to restore amphibian biodiversity due to the effects of fragmentation (Lehtinen & Galatowitsch, 2001; Cushman, 2006). Natural recolonisation by amphibians seems limited and so management may be needed to restore the natural amphibian assemblage.

Management maybe required, especially in the short term, to increase habitat heterogeneity, and to aid recolonisation (Kettle, 2010; Hector et al., 2011). When comparing rehabilitated forest to naturally regenerated forest, the act of planting native plant species, such as Dipterocarpaceae, in the regenerated plots has been shown to increase avian diversity within 15 years (Kobayashi, 2007; Edwards et al., 2009). Amphibians are less able to colonise habitat due to a lack of mobility and often strict microhabitat requirements (Williams et al., 2009) and cannot recolonise at all unless direct connectivity with a source population in undisturbed habitat exists. Therefore, a management strategy of regeneration coupled with corridor and buffer habitat linking to primary forest may be required (Laurance & Laurance, 1999; Gamage et al., 2011).

Given how widespread oil palm plantations have become in Southeast Asia, there is little doubt that further investigation of their influence on abundance and diversity, as well as how these effects can be reduced is needed. Global demand for the products of oil palm will continue to grow, and there is an urgent need to devise strategies to mitigate this great threat to tropical biodiversity. We recommend further study of oil palm plantations and the impacts on amphibians, especially as they seem to offer even less than other disturbed habitats. Specifically, more work is needed to understand which species make use of plantations on a wider scale. Continued monitoring of the success of amphibian recolonisation and establishment in regenerated habitats is desirable. Assessment of the viability of natural recolonisation is also crucial, as it will determine whether human assistance is needed to repair connectivity. Additionally, identification of key habitat features may allow for improved management of oil palm to allow greater amphibian success within plantations.

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Research Article

New data on larval development in *Pelobates varaldii*

DANIEL ESCORIZA

Institute of Aquatic Ecology, Department of Environmental Science
University of Girona, Campus Montilivi, Faculty of Sciences
17071 Girona, Spain. E-mail: daniel_escoriza@hotmail.com

ABSTRACT - *Pelobates varaldii* is an endemic anuran from north-western Morocco. It is a poorly studied species and is threatened by the destruction of breeding habitats. In this paper larval development of *P. varaldii*, specifically the relationship between length and stage of development and the possible existence of allometric growth is described. The results indicated a significant relationship between length and Gosner's stage, but with high individual variability, and an isometric growth of the body, tail length and tail height, suggesting a morphofunctional stasis during larval development.

INTRODUCTION

Pelobates varaldii Pasteur & Bons 1959 is the only species of the family Pelobatidae occurring in North Africa (Bons & Geniez, 1996). It is an endemic species of the Atlantic plains of Morocco (Salvador, 1996), where is distributed in coastal regions, favouring areas with abundance of temporary ponds and sandy soils (Pasteur & Bons, 1959; El Hamoumi et al., 2007). This species could be severely threatened due to habitat destruction and the introduction of exotic fish species (Fekhaoui, 1997; El Hamoumi & Himmi, 2010). Pasteur and Bons (1959), Salvador (1996), Schleich et al. (1996), and Beukema et al. (2013), discussed aspects of phenology and reproduction of this species. These authors provided accurate descriptions of the size and coloration of larvae of *P. varaldii*, but not about the morphological variability during larval development stages. The present article provides new data on the morphological development of larvae of *P. varaldii*.

METHODS

Several temporary ponds in the localities of Larache and Kenitra (north-western Morocco) (Fig. 1) were sampled to examine larval habitat and the morphology of *P. varaldii* larvae. The observations were made during three times throughout the breeding season: in January, March and May of 2011. Chemical and physical water parameters were measured in situ using a Crison 524 conductivity meter (for conductivity), an EcoScan ph6 (for pH) and a Hach HQ10 Portable LDO meter (for dissolved oxygen and temperature). Ponds were sampled between 12 h and 15 h (local time) in order to maintain maximum homogeneity of measured parameters. The values of pond morphology (surface area and depth), physical and chemical parameters of the water as well as the number of specimens captured and the range of their developmental stages (Gosner, 1960) are shown in Table 1. A total of 118 tadpoles of *P. varaldii* were measured using a digital calliper to the nearest 0.1 mm. The morphological variables measured were as follows: total length, body length, tail length and tail height (Fig. 2). After handling, tadpoles were released in the same place of capture. This morphological data were used for two purposes: 1) to assess the relationship between the development stages and larval length; 2) to determine the existence of allometric growth during larval development. This relationship between larval development (measured as Gosner's stages) and total length was established by linear regression. The possible allometries during the larval development were assessed by calculating the allometric coefficient (Kowalewski et al., 1997). These analyses were performed using the packages Statistica vs. 7 and R (R

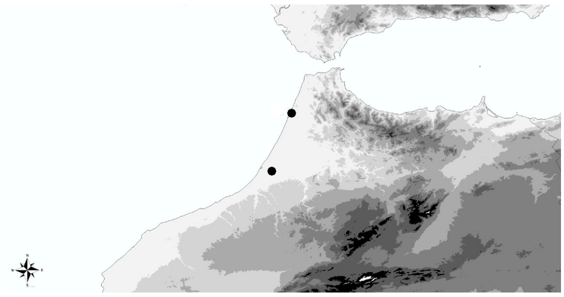

Figure 1. Study region, in the northwest of Morocco. Black circles: sampling areas.

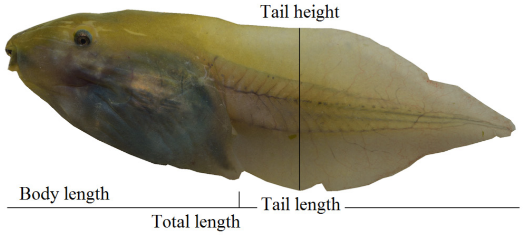

Figure 2. Morphological variables measured.

development core team, 2011).

RESULTS

The survey revealed the presence of *P. varaldii* in relatively large and deep ponds, typically with low conductivity values (Table 1), similar to those values obtained by Hamoumi et al. (2007). The results indicated the existence of a significant correlation (r^2 = 0.6, P <0.001) between Gosner stages and larval length, although there is a significant individual variability (Fig. 3). The maximum larval length in our sample was observed at Gosner stage 35 and was 124.2 mm (Fig. 3). In January and March there was higher length variability (standard deviation of total length), than in the month of May. All examined variables produced an allometric coefficient close to 1, indicating an isometric growth during the larval development (Table 2).

DISCUSSION

The data revealed that *P. varaldii* showed broad variability in the length at the same development stages, in the same way as described for the sister species, *Pelobates cultripes* (Álvarez et al., 1990). This larval growth was also isometric. This could be due to the conservation of a similar morphofunctional/trophic niche along larval development. It is possible that the larvae forage in the same microhabitats (i.e. water column) at the beginning and at the end of their development, as described for *P. cultripes* (Díaz-Paniagua et al., 2005), although there is no specific information on *P. varaldii.* This data also indicated a decline in length variability in the month of May, which is possibly caused by the end of larval development and the absence of new larval recruitment (caused by the end of reproductive activity of the adults).

P. varaldii is one of the most endangered anurans occurring in Morocco (Stuart et al., 2008). Amphibians of North Africa are experiencing a sharp decline and several species could be close to extinction (Escoriza & Comas, 2007; Ben Hassine & Nouira, 2012a,b; Samraoui et al., 2012). My data also showed that *P. varaldii* breeds in relatively large ponds, which may be affected by intensive agricultural practices, particularly for the extraction of

	n	Surface Area (m²)	Average depth (cm)	T (ºC)	O_2 (mg/L)	pH	Cond (µS/cm-1)	*P. varaldii*	
January	15	5007	41	17.3	9.1	7.1	68	N; Length SD; Gosner stage	71; 19.7 26-35
March	11	4551	33	16.7	5.3	7.5	254	N; Length SD; Gosner stages	42; 18.2 27-38
May	3	15244	49	23.4	7.9	7.2	82	N; Length SD; Gosner stages	5; 4.3 31-39

Table 1. Descriptive statistics (mean values) of the parameters measured in temporary ponds. n: number of surveyed ponds; T: water temperature; O_2: dissolved oxygen in water; Cond: water conductivity; N: number of specimens; Length SD: standard deviation of total length.

	Body length	Tail length	Tail height
Allometric coefficient	1.07	1.08	0.96
95% confidence intervals	1.03-1.10	1.04-1.12	0.91-1.01

Table 2. Allometric coefficient obtained for morphological variables. Values>1 indicates positive allometry whereas that values <1 indicates negative allometry. Mean and 95% confidence intervals for the allometric coefficients obtained after 2000 bootstraps replicates.

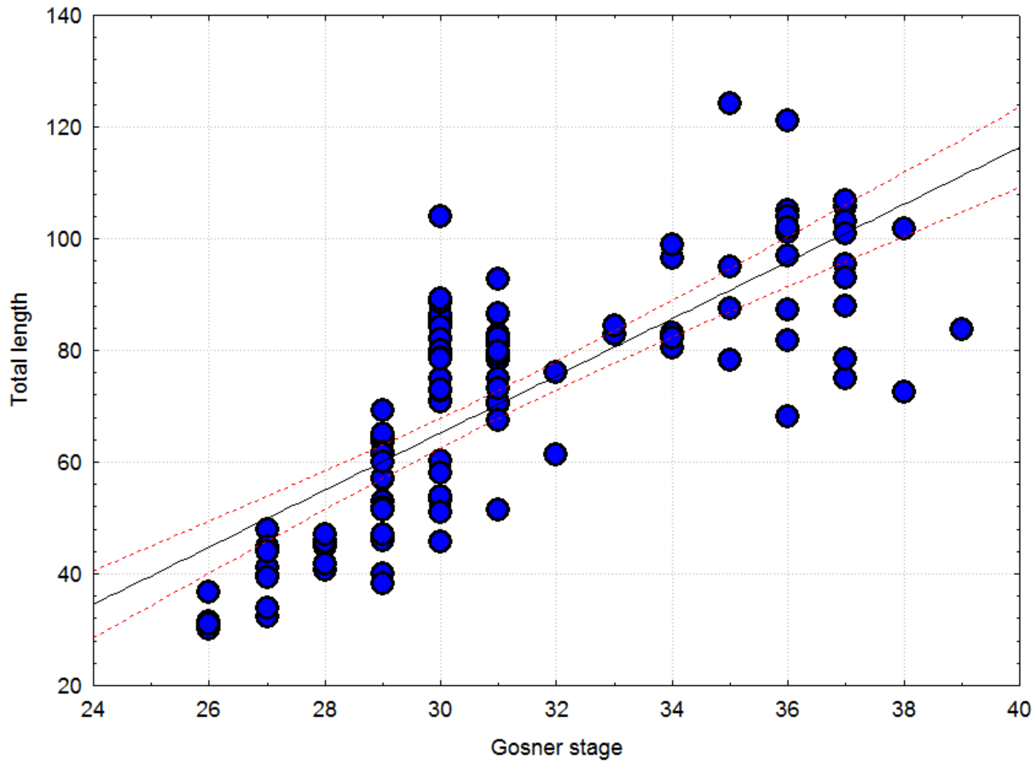

Figure 3. Linear regression obtained by relating the total length (in mm) against Gosner's stages (continuous line). Dashed line indicates the 95% confidence intervals.

water for irrigation (Hamoumi & Himmi, 2010), so it would be advisable to carry out an intensive monitoring of these remaining populations.

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Research Article

Trauma healing and post-trauma rehydration in a *Boa constrictor*: case report

ROBERTA DA ROCHA BRAGA[1] and JOÃO FABRÍCIO MOTA RODRIGUES[1,2]

[1]*Núcleo Regional de Ofiologia da Universidade Federal do Ceará (NUROF-UFC), Av. Mister Hull, S/N, Campus do Pici, Bloco 905, Fortaleza, Ceará, Brazil, 60.455-760*

[2]*Programa de Pós-Graduação em Ecologia e Recursos Naturais (PPGERN-UFC), Av. Mister Hull, S/N, Campus do Pici, Bloco 906, Fortaleza, Ceará, Brazil, 60.455-760*

E-mail address: robertarocha@ufc.br

ABSTRACT - Dehydration is a common clinical situation, especially in sick or traumatised reptiles. The objective of this paper was to report procedures of trauma handling and post-trauma rehydration in *Boa constrictor*. On visual inspection, a laceration was observed on the right ventro-lateral region. The wound handling demanded local antisepsis and healing antibiotic balm. The snake had perfect healing of the lacerated area; however, there were episodes of inappetence, severe dehydration and emaciation. It was prescribed oral rehydration, multivitamin supplement, assisted feeding and water soaking baths. After six weeks from admission, the snake had regained around 83% of its lost weight, performed ecdysis and started spontaneous feeding.

INTRODUCTION

Dehydration and weight loss are common clinical conditions in sick or traumatised reptiles. These conditions might be the result of anorexia or pathological processes of several aetiologies, and they could be noticed on physical examination (Paranzini et al., 2008). Rehabilitation in captive reptiles is rarely recorded. This paper describes rehydration and body mass rehabilitation of a traumatised *Boa constrictor,* received by the Núcleo Regional de Ofiologia da Universidade Federal do Ceará.

CASE HISTORY

A young, female, wild common boa (*Boa constrictor)*, measuring SVL = 58.8 cm / TL = 6.7 cm and weighing 105 g, was collected on Taíba Beach, municipality of São Gonçalo do Amarante, Ceará. It was brought to Núcleo Regional de Ofiologia da Universidade Federal do Ceará (NUROF-UFC), a scientific snake collection and herpetological research laboratory, after sustaining an injury from a collision with a tractor.

On visual inspection, the snake seemed alert, with normal movements, body condition and hydration status. A laceration was noticed at the right ventro-lateral region, measuring 3.0 x 1.4 x 0.4 cm, 7.0 cm from the snout. An oesophagic probe was passed through the oral cavity, and no discontinuity of the oesophagus was noticed. A 10 g young mouse was offered to the snake, which showed normal senses and reflexes, including normal strike and constriction. However, during deglutition, eventration of the oesophagus could be observed (Fig. 1), due to the lesion of muscle tissue of the body wall. The prey remained in the injured portion of the oesophagus for an abnormal length of time, and so, regurgitation was stimulated.

Treatment of the laceration comprised local antisepsis with saline solution and application of penicillin/urea balm once a day, achieving good results (Fig. 2). Within 25 days of treatment, the laceration had healed perfectly; nevertheless, there were some inappetence episodes, which were most likely associated to general stress linked to trauma in the oesophagus

Figure 1. Oesophagus eventration. Note the sacculation by the time of deglutition of a 10 g mouse (arrow).

Figure 2. Trauma healing. Note the scar, 20 days after the start of the treatment (arrows).

wall. During the next four months, some procedures were used to improve the snake's body condition and hydration status. In the first three weeks after admission, the snake lost 30% of its initial body mass, reaching 69 g. It became lethargic and anorexic, with dry, folded skin.

Oral fluid therapy was applied for twenty days, using a steel feeding tube with mineral water and multivitamin supplement (Vitamins A, B complex, D and E). In addition, assisted feedings with newborn mice were performed weekly (2-5 g). Fluid therapy dosage varied between 10 to 30 ml/kg daily, as per Donaghue (2006), being progressively adjusted in line with the increment in body mass. 10 ml/kg were used in the first five days of treatment; 20 ml/kg in the next ten days and 30 ml/kg in the final five days of the period of rehydration. The stress was assumed to have aggravated the general condition of the snake, which had dysecdysis secondary to anorexia and dehydration. Its skin became very fragile and started to disrupt, because of the frequent handling. The shed skin started to be retained, especially around the skin disruptions.

Soaking baths in tap water at 30ºC were performed as per Fitzgerald and Vera (2006) to help the shedding (twenty minutes daily / ten days) and babosa leaf resin (*Aloe vera*) was applied to the skin and its disruptions (five days). Sunbathing (30 minutes daily) was also performed. After six weeks from the beginning of treatment, the snake reached a body mass of 96 g, recovering 83% of its lost weight. Complete ecdysis had developed imperfectly and more slowly than normal, occurring within fifteen days, but the new skin appeared fresh and without folds. One month after the end of the therapeutic procedures, four months after its arrival in NUROF-UFC, the snake started to feed on young mice (10-15 g) without assistance. It exhibited weak constriction at first, but regained strength in the following weeks.

DISCUSSION

Reptile's nutritional needs are greatly affected by its metabolism which in turn is greatly affected by its diet. Variations in temperature also play a key role in the metabolism of reptiles (Craft, 1997). Captivity does not always provide the best conditions for keeping reptiles in good health; thus, many clinical situations occur due to husbandry failures.

Secondary anorexia was diagnosed in this snake, because it was not related to the appetite centre of the nervous system. Traumatic oesophagitis was most likely the direct cause, because the inflammatory response usually affects the neuroendocrine regulation of feeding (Kuininger, 1990; Dunn, 2001). Another possible determinant was the change in deglutition biomechanics in the subject snake. The oesophagus in snakes has no important muscle layers acting in peristalsis, unlike in mammals, so deglutition is performed by the movements of axial musculature and skeleton (Funk, 2006).

Anorexia in wild reptiles is influenced by specific physiological states, such as reproductive season and ecdysis, and environmental factors like seasonality (Lourdais et al., 2002; O'Donnell et al., 2004; Funk, 2006).

As reported by Donaghue (2006), energy requirements increase in proportion to the complexity of each metabolic process, for instance feeding, locomotion, growth and healing wounds. Therefore, trauma was another factor, requiring adjustment to the food and water consumption of this snake.

According to Fitzgerald & Vera (2006), dysecdysis is not a primary disease, but a symptom of a subjacent pathology. They advise soaking baths daily until the skin can be totally removed, which usually resolves the dysecdysis within two days, and also contributes to the snake's water consumption. These last authors warn that pieces of shed skin can be retained around scars of wounds, and should be gently removed. The use of babosa *(Aloe vera*), natural or in topical formulation, is indicated for treatment of several dermatopathies. Babosa resin was efficient, strengthening the healing wounds and acting as an emollient in sites of retained pieces of shed skin (Chithra et al., 1998; Fitzgerald & Vera, 2006; Hernandez-Divers, 2006).

The correction of hydration status and body mass in captive snakes does not demand complex procedures, but the understanding of connections between thermoregulation, nutrition and ecdysis was very important to the composition of the treatment.

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Editor’s note: The photograph of two iguanas on the cover of *Herpetological Bulletin* issue 124 was taken by R.R. Braga.

Short Note

Altitudinal and life zone extension of the Harlequin frog *Atelopus laetissimus*, in the Sierra Nevada de Santa Marta, Colombia

JUAN MANUEL CARVAJALINO-FERNÁNDEZ ,[1,2] LUIS ALBERTO RUEDA- SOLANO[3] and MITZY F. PORRAS [4]

[1] *Universidade de São Paulo, Instituto de Biociências, Departamento de Fisiologia, Laboratório de Ecofisiología e Fisiología evolutiva. Rua do Matão, Travessa 14 No. 321, Cidade Universitária, CEP 05508-900, São Paulo, SP, Brasil*

[2] *Grupo de Ecología Neotropical, Facultad de Ciencias Básicas, Universidad del Magdalena, Santa Marta, Columbia*

[3]*Universidad de los Andes, Grupo de Eco-fisiología*

[4] *Department of Entomology, The Pennsylvania State University, 501 ASI Building, University Park, PA 16802, USA*

[1]*Corresponding author:* juanmacarvajalino3@gmail.com

INTRODUCTION

The endemic species, *Atelopus laetissimus* Ruiz-Carranza, Ardila-Robayo & Hernández-Camacho (1994), from Sierra Nevada de Santa Marta (department of Magdalena, Cuchilla de San Lorenzo, Colombia), inhabits streams and rivers in humid low montane (sub-Andean) forest (bmh–MB; Espinal and Montenegro, 1963; Tamarís-Turizo & López-Salgado, 2006) between 1900 and 2880 m. This species belongs to the world's most endangered vertebrate genus (Young et al., 2004), listed under the Critically Endangered category by Ramírez-Pinilla (2004). Since its description in 1994 it was not seen again until 2006 (Carvajalino-Fernández, et al. 2008). After rediscovery, the species has been subject of only limited research (Granda-Rodriguez et al., 2008). Here we report new localities for *A. laetissimus*, which extend its lower altitudinal limit and report another life zone for the specie; with temperature data from different microhabitats used.

The study area is known as "La Cascada" (11°10'02.0" N, 74°10'41.5" W, 1,560 m; Fig. 1). It is characterized by steep slopes and has an average annual rainfall of 2446 mm. The area is surrounded by forest composed mainly of Anarcadiaceae, Areaceae, Cecropiaceae, Moraceae, Piperaceae and Sapotaceae. Microhabits are characterized by rocky areas with sand and leaf litter on the banks at the river (Fig 2a). The soil in the forest is mostly covered by leaf litter and wood in decomposition process; and ferns in open fields (Fig. 2b).

Sampling was by visual encounter surveys (VES; Lips et al., 2001; Crump & Scott, 1994) in an approximate area of 1000 m x 30 m along the watershed, including 10 m at each side of the riverside. Field work was conducted on November 11 and 12, 2008; January 30 and 31, 2009; March 18 and 19, 2009, during the following periods: 09:00 to 11:00 h, 12:00-14:00 h, 15:00-17:00 h, 18:00-20:00 h and 21:00-23:00 h by a single person. Sampling was repeated from October 18 to 28, during the following periods: 09:00–12:00 h, 15:00–17:00 h, 19:00–21:00 h and 22:00-00:00 h by two observers. This gave a total sampling effort of 234 hours/person.

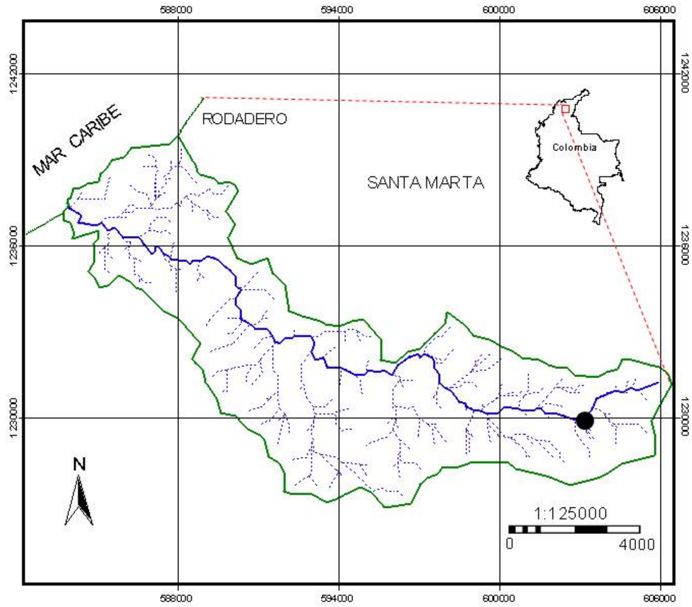

Figure 1. Map of Gaira river in the Sierra Nevada de Santa Marta (Colombia) showing the new locality for *A. laetissimus* (black point).

Microhabitat	T°max	T°min	T° mean	Differences between T°max and T°min
Air	17.66	14.90	16.23	2.76
Rock	16.71	15.86	16.36	0.85
Green Leaf	17.76	14.80	16.25	2.96
Dead wood	17.28	15.28	16.37	2
Soil	16.38	14.85	15.84	1.53
Leaf litter	17.14	14.85	16.18	2.29

Table 1. Available microhabitat possibly used by *A. laetissimus* in a very humid subtropical forest in the Sierra Nevada de Santa Marta. Maximum temperature (T°max). Minimun temperature (T°min). Mean temperature (T°mean). All data of temperature are in degrees Celsius (°C).

Body and substrate temperature were recorded with an infrared thermometer (Oakton InfraPro D:S=12:1). In total eight temperature sensors recorded temperatures in the different microhabits available for *A. laetissimus*. Microhabit use was previously evaluated in another locality (Granda-Rodriguez et al., 2008). The micro-environmental temperature graph was developed using the software HOBOware Pro (Oneset Computer Corporation, 2006).

Two juveniles were found. The first was on March 19 at 14:10 h, the second on October 19 at 11:05 h. The first frog was found on rocks on the banks of the watershed with a body temperature of 19.4ºC and a substrate temperature of 18.6ºC. The second frog was found on green leaf litter at the right riverside with a body temperature of 15.7ºC and a substrate temperature of 15.7ºC (Fig. 3). Both individuals were recorded at an altitude of 1560 m, which corresponds to the life zone of very humid subtropical forest (Espinal & Montenegro, 1963). Morphometric measurements of the second frog were: snout vent length (20.4 mm), arm length (5.5 mm), femur length (8.8 mm), head width (7.2 mm), forearm length (6.6 mm). Additionally we show the temperature of some microhabitats probably used by *A. laettisimus* (Granda-Rodriguez et al., 2008). Temperatures ranged from 0.85 ºC to 2.96 °C, and the average of 2 ºC did not vary more than 1 °C (Table 1).

The conservation of any species depends on biological knowledge. This is a limiting premise

Figure 2. Sites where *A. laetissimus* frogs were found. The right riverside (A); Rock banks of the watershed (B).

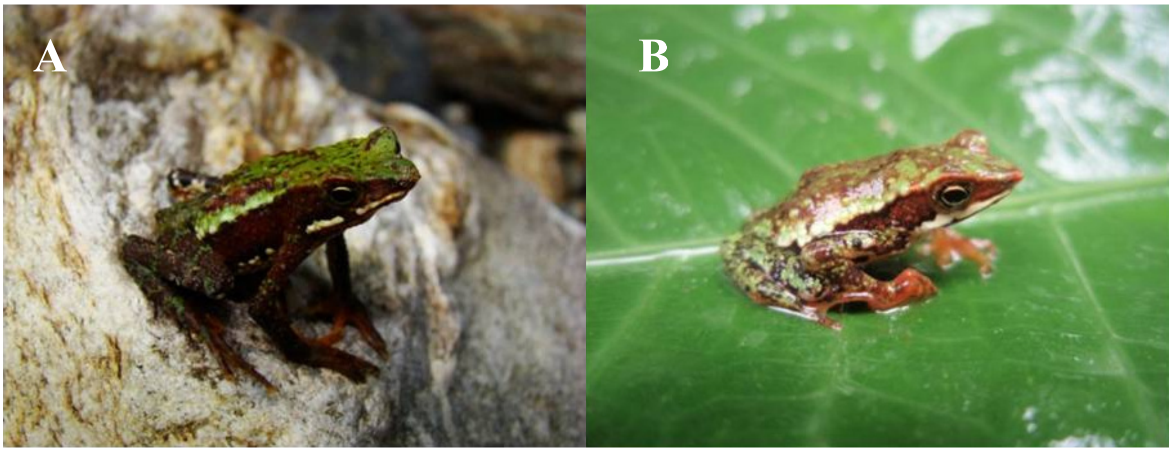

Figure 3. Photographic records of specimens of *A. laetissimus* in a very humid subtropical forest in the Sierra Nevada de Santa Marta. Individual found on rock on March 19 of 2009 (A). Individual found on green leaves on October 19 of 2009 (B).

in the case of endangered and poorly known species such as *A. laettisimus*. The first step for the conservation initiative of this species is the localization of populations, and basic knowledge regarding to habitat use and life history. This work had a significant sampling effort but found few individuals, which is in concordance with its current classification status as an endangered species. These results report a new locality at a lower altitude than previously reported in the same watershed (Carvajalino-Fernández et al., 2008; Granda-Rodriguez et al. 2008).

In addition to extend the altitudinal range, we report the species in a life zone with plant physiognomy different to that previously known. The very humid subtropical forest is a good scenario for *A. laettisimus* conservation, mainly because of the absence of pine tree plantations, a factor that has been considered detrimental for amphibian communities (Paris & Lindenmayer, 2004) and that possibly poses a conservation problem for the species in the type locality (Carvajalino-Fernández et al., 2008).

The differences between extreme temperatures among localities varied more than 2°C (Table 1). Therefore, the species is potentially tolerant to diverse thermal regimes in altitude settings. This will be important for *A. laettisimus*, because other species within the Andean region have been reported to display body temperatures matching soil temperature. Thus, the temperature data reported here will serve as a reference for future thermal ecology studies.

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Short Note

Post hibernation movements in an aspic viper, *Vipera aspis*

ROGER MEEK

7 rue Georges Clemenceau, Chasnais, France.

Rogermeek85@aol.com

INTRODUCTION

Animals typically use distinctive areas for daily activities, defined as the home range. Knowledge of home or activity ranges provides insight into behaviour, bioenergetics and is key information in conservation efforts. The movements of snakes are often difficult to study, primarily because of their highly secretive behaviour and frequent use of habitat that is difficult to access. Hedgerows are habitat for snakes and other reptiles particularly in fragmented landscapes where they form important movement corridors (Saint Girons, 1996). Hedgerows are also structurally simple, facilitating observations of snake behaviour especially when they move to the edges for basking. Defined as a sentinel predator the aspic viper (*Vipera aspis*) frequently occupies hedgerows both as a home territory and to access woodland patches. It has limited daily movement compared to wide ranging foragers and crosses roads less frequently (Meek, 2009) and hence details of movement whilst living alongside road corridors is of interest. This note gives details of post hibernation movements in a female aspic viper (*Vipera aspis*) in a hedgerow system adjacent to a low traffic volume road.

METHOD

Movement was monitored during a 2-month period using VES (visual encounter survey; McDiarmid et al., 2011). The snake was one of several reptiles found in the close vicinity of a hibernaculum in early spring, that included four additional *V. aspis*, the last of which were seen on April 24. The aspic viper varies to some degree in both colour and pattern and photographs were used to enable identification. The viper described here had an approximate snout to vent length of 405 mm (later determined from its carcass) and estimated age of 3-5 years (Bonnet et al., 1998). The location was on the edge of the village of Chasnais, Western France (46^{o}27\`N;1$^{o}$\`53\`\`W).

RESULTS AND DISCUSSION

The focal animal was first observed basking on 28 March 2013 alongside a dense hedgerow invaded by bramble in an area enclosed mostly by agricultural land (Fig 1). In total 27 visits were made to the site during appropriate weather conditions at varying times of day when the hedgerow and hedgerows to the west (opposite side of the road) and north were searched for snake presence. The viper was sighted on 20 occasions, all within the one hedgerow (Fig.1). The earliest sighting was made at 09:20 and latest at 18:40h (CET). Most observations were of basking but movement within the hedgerow was occasionally seen during afternoon visits. Morning basking was at the east facing side of the hedge but shifted to the west side in the afternoon. However, as spring vegetation increased in height, basking locations tended towards the southern end of the hedgerow where vegetation was less dense. Shaded air temperatures during morning at basking locations (30 cm above the basking location using an electronic thermometer) ranged from 16.2 – 20^{o}C, *mean* = 18.2^{o}C and substrate temperatures from 16.2 – 26.3^{o}C, *mean* = 22.3^{o}C. The final live observation was of

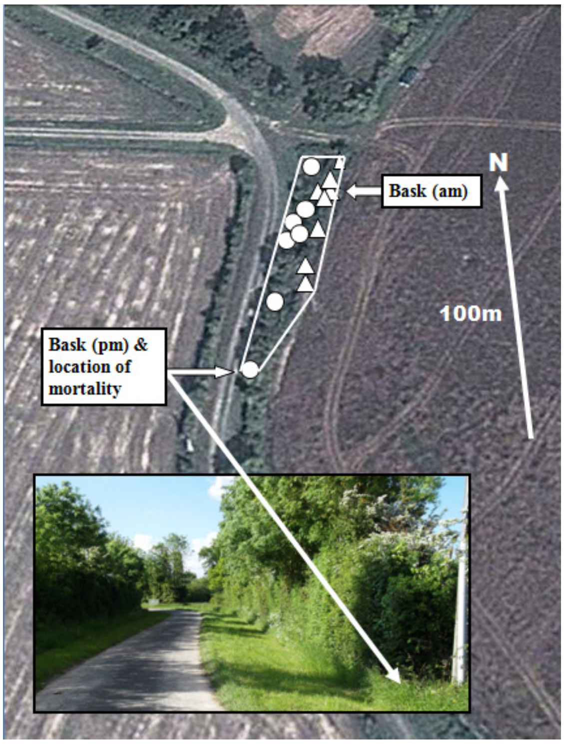

Figure 1. Map of study locality showing locations of female *V. aspis* during am (triangles) and pm (circles) visits. Arrows indicates main clusters of frequent am (n = 6) and pm (n = 6) basking locations and site of mortality (May). The minor road shown has a maximum of 25 or so vehicles per day.

basking at the north end on the morning of 28 May, but later on the same day (15:20 h) the snake was found deceased at a frequently used afternoon basking spot on the west side (Fig.1). To calculate the area that enclosed all the sightings the data were plotted on a *Google Earth* map then converted into the smallest convex polygon that enclosed all the locations. The results gave an estimated area of 0.094 ha with maximum distances between daily locations 70 – 80 m and minimum of 12 m.

The distances enclosed by the polygon are within home ranges recorded for gestating female *V. aspis* of 0.3 to 0.03 ha (Bonnet & Naulleau, 1996) and daily movements (5 - 30 m) in good agreement with a radio tracked *Vipera ursini* previous to entering a hibernaculum (Ujvari & Korsos, 1998). The cause of the mortality is not known but two other *V. aspis* (sex unknown) were found dead at frequently used basking spots at a woodland edge only a few weeks previously. The study locality is close to the northern limit of the range of *V. aspis* and the spring of 2013 was unusually cool and wet with frequent north to northwest winds.

Figure 2. Female *V. aspis* basking in a relatively exposed locality approximately 0.5 m from the cover of thorny bramble.

Vipers were repeatedly seen basking in relatively open areas at distances from dense cover (Fig. 2). Bonnet and Naulleau (1996) recorded increased basking and risk of mortality in gravid *V. aspis*, especially from avian predators (Naulleau et al., 1997). The carcass was partly consumed when found and hence it is not known if the viper was in a reproductive condition, but if so cooler weather and increased basking intensity probably increased risk of predation.

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Natural History Notes

AGALYCHNIS CALLYDRIAS (red eyed tree frog) RANGE EXTENSION. Hylidae is a large family of tree frogs, has 926 recognized species and is characterized by having long legs and well developed digital disks in the hands and feet. In the subfamily Phyllomedusinae specifically, individuals have vertical pupils, a highly retractable tongue and eggs are normally laid on the water (Faivovich et al., 2005). *Agalychnis callidryas* (Cope, 1862) is known as the Red-Eyed Tree frog and is distinguished in life by a combination of a red iris and flanks on the body with a series of vertical stripes on a clear blue to brown background; this species is very common and its natural history has been well documented (Whittaker, 2013). *A. callidryas* is distributed from southeastern Veracruz and northern Oaxaca in Mexico to Panama (Savage, 2002; Solis, 2004). The species inhabits lowland humid rainforest and montane rainforest margins, including disturbed areas and mangrove forests. This paper reports the ocurrence of this species by the North Pacific in a Costa Rican Tropical Dry Forest.

On 19 July 2012 three males were heard calling by K. V. G. to the side of a road in the Buena Vista district (9°54’48’’N, 85°31’46’’W, 30 m a.s.l), near Samara Beach, Canton of Nicoya in Guanacaste province. This location is 52 km northwest of the nearest record in the Pacific: 7 km northeast of Mal Pais (Cornell University 2013. Code: CU: CUMV-Amphibian: 14213). During this visit, a mass of eggs was found (Fig. 1), but no adult specimens were observed. During a second visit on 15 September 2012, an adult male with an SVL of 57 mm (Fig. 2) was collected about 6 feet off the ground, on *Guazuma ulmifolia* (Sterculiaceae). Correct identification of the specimen was confirmed by Adrian Garcia (University of Costa Rica) and was deposited in the Museum of Zoology at the University of Costa Rica (catalogue number MZUCR- 21927)

The colour pattern of this specimen is typical of individuals found in the Central Pacific, where the colouration of the flanks, anterior and posterior thighs is orange, with blue and white colours being absent. This is similar to a pattern described by Robertson and Robertson (2008), but lacks the upper horizontal line connecting the other stripes. *A. callydrias* exhibits a marked difference in flank patterns at the regional level,

Figure 1. Egg mass of *A. callidryas* in the new location.

Figure 1. Adult male of *A. callidryas* from Samara.

because of existing biogeographic barriers that limit gene flow, thereby increasing phenotypic diversity (Robertson et al., 2009)

The location where this sample was collected is 130 m from the Rio Buena Vista. There are pastures and livestock areas present in a marshy area beside a busy road, and the area displays typical early successional vegetation, evidenced by the presence of *Guazuma ulmifolia* (De Araujo et al, 1999). This area is subject to human disturbance. The observation described here further demonstrates that the species can survive in disturbed environments (Savage, 2002) and also that it has a great climatic tolerance. This report extends the range of *A. callidryas* in Guanacaste, Costa Rica, to an uncharacteristic xerophytic area for this species, which is not typical of Tropical Dry Forest.

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Submitted by: KATHERINE V. GONZÁLEZ *Escuela de Ciencias Biológicas, Universidad Nacional de Costa Rica.* kattygv.09@gmail.com and JUAN G. ABARCA, *Sistema de Estudios de Postgrado. Maestría Académica en Microbiología. Universidad de Costa Rica.* antinosedal@yahoo.es.

LITORIA DENTATA (Bleating Treefrog): UNUSUAL CALL. *Litoria dentata* (Keferstein, 1868) (Anura: Hyloidea: Pelodryadidae) is a small arboreal frog common and widespread on the coast and mountain ranges of central eastern Australia (Cogger, 2000) including in anthropogenic urban habitats. Calls by adults typically consist of a series of extended bleating notes. This note reports a case of apparent alarm calling by a subadult *L. dentata* in an urban habitat.

On 6 January 2013, 17:19 h (Australian Eastern Standard Time), in Werrington (a western suburb of metropolitan Sydney), New South Wales, Australia, at 33°45’35.2”S, 150°45’25.4”E (WGS84 grid), 29 m elevation, ambient temperature 29.0°C, 0/8 cloud cover, occasional medium gusts of easterly breeze, after the sun had descended behind the neighbouring house to the west in the late afternoon of a hot sunny day, whilst inspecting with the aid of a torch the axils of an exotic potted bromeliad positioned ~0.6 m above ground on an old eucalypt stump behind the covered area next to the author’s residence as part of ongoing study and monitoring of herpetofauna at this locality, a subadult (SVL ~35 mm) *L. dentata* was observed on the inner side of one axil (internal diameter ~2 cm), ~4 cm above the surface of water trapped within it, which immediately dropped down into the water, whereupon repeated short yapping calls were heard from the axil; closer inspection revealed two subadult *L. dentata* of similar size jostling for position at the water surface, both aligned head up with the venter of one subject pressed against the dorsum of the other, one of which (the one underneath) was emitting the repeated calls which were continuous for ~2 minutes until 17:21 h when even closer inspection by the author prompted both subjects to duck below the water surface and calling stopped; shortly after retreat of the observer alarm calling was resumed intermittently with frequency decreasing until 17:25 h when alarm calling finally ceased; subsequent close inspection at 17:35 h revealed the protagonists had separated, one subject on one side of the axil with about two-thirds of the body submerged, the other on the opposite side of the axil with the urostyle just above the water surface. These calls were markedly different from both territorial and reproductive advertisement calls of *L. dentata*; much shorter, more frequently emitted notes, with calling extended well beyond the durations of typical diurnal calls. *L. dentata* is commonly observed on the property, and axils of this bromeliad were regularly utilised as diurnal refugia over the warmer months of the 2012-2013 season by up to 7 subadult *L. dentata* and occasionally by 1 small adult *L. peronii* (author, unpublished data). It is possible temperature of the water may have been a factor in the apparent dispute over position within the axil, and for the alarm calling; water temperature within the axil was 29.7°C (recorded using a digital probe thermometer); another slightly larger (SVL ~40 mm) small adult male *L. dentata* was detected at 17:36 h on the inner side of a large plastic barrel located ~1 m north of the bromeliad positioned to catch rainwater runoff from the roof, ~15 cm above the water surface, and immediately dropped into the water, ambient temperature 28.1°C, water temperature within 10 mm of the surface 31.9°C. A further possibility is suggested by the relative positions of the protagonists within the axil, similar to that adopted by amplectant pairs, which is that the subject embraced by the other was emitting a ‘release call’ as reported for several overseas Anura in cases of misdirected amplexus by conspecific males, however such release calling has not yet been reported in any *Litoria*. It was of interest that a subadult *L. dentata* of this size was capable of any vocalisation; sex of the two subjects in the axil was undetermined, however subadult male *L. dentata* of this size observed at this locality typically do not engage in either territorial or advertisement calling although may occasionally attend the periphery of reproductive choruses (author, unpublished data). This appears to be the first report of alarm calling and heterophony in *L. dentata*.

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Submitted by DEAN C. METCALFE. *PO Box 4056, Werrington, New South Wales, Australia 2747.* dean_metcalfe@yahoo.com.au

TRACHEMYS DORBIGNI (Brazilian slider turtle): PREY. The distribution of *Trachemys dorbigni* (Duméril & Bibron, 1835) is restricted to South America, occurring in Brazil, Uruguay, and Argentina (Fritz & Havas, 2007) where it occupies reservoirs, rivers, ponds, and wetlands (Quintela & Loebmann, 2009). This species is the most abundant freshwater turtle to the state of Rio Grande do Sul, Brazil. Its distribution has been extended to other Brazilian states, probably due to the illegal trafficking of wild animals (Bujes & Verrastro, 2007; Quintela & Loebmann, 2009). The species has been described as an opportunistic omnivore by Hahn (2005).

During the necropsy of an adult female of *T. dorbigni,* whilst searching for helminths, a specimen of *Erythrolamprus poecilogyrus* (Wied-Neuwied, 1825) (Serpentes: Dipsadidae) (Fig. 1) was found in the small intestine. The chelonian was collected in February 2011, in a channel in the urban area in the municipality of Pelotas (31°46'16.9" and 52°18'45.9"), state of Rio Grande do Sul, Brazil, under license (N°23196-1) of Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). The snake was fixed at 5% formalin and preserved in 70ºGL alcohol.

Most information about the diet of *T. dorbigni* come from studies and reports conducted *dorbigni*. *E. poecilogyrus* is found in Brazil, in the state of Rio Grande do Sul, Brazil. For example, Pereira (1998) found insects, weeds, seeds, algae, leaves, bone fragments, and scales in sample of feces from free-living *T. dorbigni*. Hahn (2005) based on the stomach contents of 75 turtles in southern Rio Grande do Sul State

Figure 1. *Erythrolamprus poecilogyrus* collected in the small intestine of *Trachemys dorbigni* in the state of Rio Grande do Sul, Brazil.

reported that 85.27% of the diet was plant matter (macrophytes, filamentous algae, and plant waste) with animal matter (molluscs, crustaceans, arthropods, leeches, and vertebrates) forming 13.23% of total volume. The vertebrates in the diet of Hahn`s (2005) sample consisted of anurans from two turtles and Characiformes in a single individual. Bujes et al. (2007) recorded *T. dorbigni* preying on the golden mussel, *Limnoperna fortunei* (Dunker, 1857), a bivalve mollusc originating from Southeast Asia that was introduced in the state of Rio Grande do Sul in the 1970s (Mansur et al., 2003). Bujes et al. (2007) also analyzed the fecal content of eight specimens and recorded the presence of gastropods, crustaceans, plant matter, sand, and synthetic materials.

Snakes have only been previously recorded as food in captive turtles (Lema & Ferreira, 1990) although these authors did not indicate which species. This note is the first reported predation on *E. poecilogyrus* by *Trachemys.* The snake *E. poecilogyrus* is found in Brazil, Uruguay, and Argentina where it inhabits fields, dunes, woods, marshes, margins of ponds, channels, and some other aquatic environments (Quintela & Loebmann, 2009).

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Submitted by: CAROLINA SILVEIRA MASCARENHAS, *Laboratório de Parasitologia de Animais Silvestres, Instituto de Biologia, Universidade Federal de Pelotas, Campus Universitário, caixa postal: 354, CEP 96010-900, Pelotas, Rio Grande do Sul, Brazil - phrybio@hotmail.com.* MARCO ANTONIO AFONSO COIMBRA, *Núcleo de Reabilitação da Fauna Silvestre e Centro de Triagem de Animais Silvestres, Universidade Federal de Pelotas Campus Universitário, caixa postal: 354, CEP 96010-900, Pelotas, Rio Grande do Sul, Brazil* - tobaco@bol.com.br

VIPERA BERUS (common viper): FEIGNING DEATH. On a sunny afternoon (17°C) in June 2013 a fox (*Vulpes vulpes*) was surprised worrying something on the ground on the North Downs, in south east England. The fox retreated at speed and within one or two seconds of arriving at the location a female common viper (*Vipera berus*) was found. The snake's body was supine, loosely coiled, motionless and with the posterior third of the tail coiled in the opposite direction to the rest of the body (Fig. 1). The head was positioned below and extended slightly beyond the coils, and was turned 90° so that one eye could observe what was happening (Fig. 2).

Gradually, over a period of about two minutes, the snake returned to the prone position, remained still for a few seconds, and then moved fast into cover. It appeared that it had been feigning death. When the animal was stationary both ventral and dorsal surfaces were inspected for any signs of injury. The only damage that could be seen was a tear running across two ventral scales (Fig. 2) but this looked like an old wound. The viper`s vigorous retreat suggests that she was unharmed and that her strategy had paid off.

This particular viper is well known to the 'Adders in Decline' monitoring programme of the Kent Reptile and Amphibian Group; she was born in late summer of 2008 and had been seen 15 times. To date it is uncertain whether she has bred, although she is now certainly old enough and big enough (about 45 cm) to do so; her relatively light build and rapid movements suggest that she was not gravid. At the time of the encounter a moulting cycle was imminent since 5 days later she was observed with eyes opaque.

Common vipers have a repertoire of active defensive behaviours that include fleeing, coiling tightly, rapid inhalation and exhalation of air accompanied by hissing, and if cornered, striking with mouth open or closed. To this might be added the adoption of a 'corkscrew' posture but this has only been described once and may instead be related to the poor health of the animal (Arbuckle, 2012). Feigning death is a well known, although not necessarily a frequently observed, phenomenon in several snake species but appears not to have been described previously in *V. berus,* or at least

Figure 1. Female adder apparently feigning death.

Figure 2. Detail of the head of the adder positioned below the coils of the body.

certainly not in standard texts on the British herpetofauna. On the internet, the ARKIVE website (www.arkive.org) mentions a picture of "a female adder feigning death on a rock", however the link to the picture has been lost and it is not clear whether it actually refers to *V. berus*. On asking other herpetologists only one experience of this behaviour was reported and this happened when handling *V. berus* (Brett Lewis, pers. comm.).

The British grass snake (*Natrix natrix*) feigns death with a display that may include a completely limp supine body and head, mouth gaping and tongue protruding. Gregory et al. (2007) observed that 66% of captured grass snakes exhibited some or all of these features.

The sham put on by the viper appears to have been less elaborate with no mouth gaping or protruding tongue. Other differences from the grass snake may be the position of the head beneath the coils, head turned to look upwards (although some pictures of supine grass snakes do show the head rotated so that one eye could be watching), and perhaps also the opposing curve of the last third of the tail. This last feature was quite eye catching and pictures on the internet show it to be part of the death-feigning display of the Hognose snake (*Heterdon platyrhinos*). It may be intended to look like contortion or *rigor mortis* so making the sham more realistic but alternatively it may be intended to be eye catching, perhaps drawing attention away from the head so offering a safer target if a predator proceeds to attack.

The conditions leading to the release of this display in *V. berus* might be thought to occur frequently when people walk their dogs off-lead in suitable habitats but the apparent absence of any accounts from dog walkers suggests this is not the case. So it would seem that either this behaviour is restricted to the repertoire of a few individuals (due to genetic predisposition or life stage) and/or the conditions that trigger its release are uncommon and, as in other species, it may be a behaviour of last resort.

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Submitted by: RICK HODGES, *Kent Reptile and Amphibian Group,* info@kentarg.org

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PANTHEROPHIS OBSOLETUS OBSOLETUS (black rat snake): FEEDING OBSERVATION. The North American rat snake (*P. obsoletus*) is a climber that forages in trees for bird's nests and squirrels (Ernst & Ernst, 2003). Although predation on bird's eggs is common (Ernst & Ernst, 2003), reports of simultaneous predation on a bird's nest by two foraging *P. obsoletus* have not been reported. During a visit to Pennsylvania, United States in June 2013, a pair of *P. obsoletus* with estimated lengths of over 1 m were observed predating on nestlings of the American Robin, *Turdus migratorius* (Harrison, 1975; Baicich, & Harrison, 1997). The predation event is shown in Fig. 1 and the location of the nest which was situated on the sill above the front door of a property on Kensington Drive, Port Matilda, State College, Pennsylvania (approximate co-ordinates: 40° 47′ 29″ N77° 51′ 31″ W) is shown in Fig 2. The house was situated in an area with extensive open areas, dense deciduous woodland, network of small ponds and scrub areas and is typical rat snake habitat (Ernst & Ernst, 2003). The snakes were later removed to the surrounding woodland. Further observations of foraging *P. obsoletus* were observed within the grounds of the property on two additional occasions (12 and 17 June) but it is not known if these were the same individuals. Blouin-Demers and Weatherhead (2001) have suggested that forest clearing has increased the available edge habitat that is preferred by *P. obsoletus* for thermoregulation, and that this inadvertently increases contact between the snakes and nesting birds.

Figure 1. A pair of *P. obsoletus* predating on chicks of the American Robin *T. migratorius* in Port Matilda, Pennsylvania, USA.

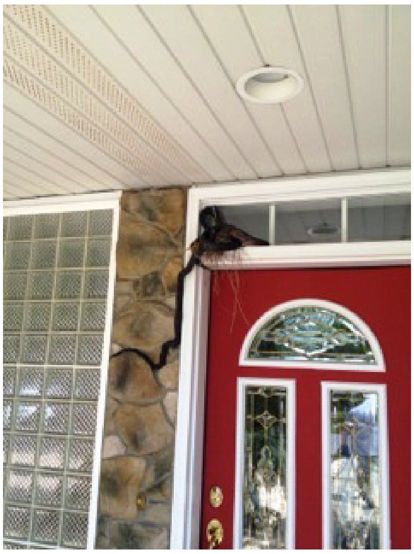

Figure 2. Photograph illustrating both the predation event and climbing abilities of *P. obsoletus.*

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Submitted by: CHARLES BECKHAM*, 31 Hewitson Road, Darlington, County Durham, DL14NU.* E-mail: charles.beckham@gmail.com

NATRIX NATRIX (Grass snake): HABITAT. During site-based research undertaken at Ynyslas Nature Reserve on 25 May 2013, a single adult *N. natrix* was observed basking briefly. Approximately 1 m total length with a sizable girth, the body was a dark olive colour with a cream collar behind the head; bordered to the rear by black marks and numerous black bars on the flanks. Although it could not be confirmed, the size and girth would suggest that it was a gravid adult female (Beebee & Griffiths, 2000).

The location was a small south-east facing section of sand dune within the County of Ceredigion, Wales (SN60506 94095 +/- 3m); Fig. 1 shows a map of the location on the dune system with an image insert of the dune habitat. The aft or secondary dune ridge is located some 45 m from MHW, 1600 m from the nearest permanent fresh water body and a minimum of 840 m from the nearest identified potential egg-laying site; which is a manure heap.

Whilst it has already been demonstrated that *N. natrix* will utilise a range of habitats, they do not often seem to be seen on dune systems in the UK; although records are not un-common in continental Europe (Mark Barber, pers. comm.). With a small number of records for *N. natrix* supplied by rangers and members of the public at the site, this is the first outside of the grassland habitat within the interior of the site.

With *N. natrix* being an adaptable, highly mobile species (Corbett, 1989; Beebee & Griffiths, 2000), as an opportunistic hunter it is known to prey on reptiles, mammals, hatchling birds and invertebrates (Brown, 1991), all of which are found in varying abundance across frontal dune systems, possibly explaining its presence within the area.

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Source: "Ynyslas", Ceredigion, Wales lat 52.526802 and lon -4.055386. Google Earth. May 05, 2009. July 09, 2013.

Submitted by: STUART ANDREW GRAHAM, Bangor University, College Road, Bangor, Gwynedd, LL57 2DG. E-mail: *stuartgrahamuk@hotmail.co.uk*

Figure 1. Location map and image of the habitat in which *N. natrix* was observed basking (Google Earth, 2013).

VIPERA BERUS (adder): **GRAVID OVERWINTERING.** Atkins (2011) reported a gravid smooth snake *Coronella austriaca* from Dorset, southern England, in April 2011. The timing of this observation indicated that the snake had remained gravid over the winter months rather than giving birth at the more normal time of three to five months following mating. Overwintering gravid, and giving birth the following spring, has also been observed in the adder *Vipera berus* in captivity and reported by Street (1979) to occur in the extreme north of this species' range and following unusually cold summers. Nevertheless, it seems sufficiently unusual to merit note of a specific instance of gravid overwintering in the wild.

The current observations were made during ongoing monitoring of adders in the Malvern Hills, Worcestershire, central England. In 2013 the first snake observed on emergence from hibernation (14 February) was a female. This was unusual in several ways. Normally males are first to appear. Further, the female appeared to be gravid and was seen repeatedly, basking in the same spot throughout the month and into March, even on surprisingly cool days when no other snakes were observed. Adders normally mate in April and May and give birth at the end of August/September of the same year. In this case the female presumably mated in the spring of the previous year (2012) during which the poor weather conditions in summer and autumn delayed clutch development.

At the end of March 2013 the weather changed with heavy snow on the hills and temperatures dropping to -3°C (22 March). On a subsequent visit to the site (7 April), the snow remained and the snake was found dead under a layer of bracken litter. Post mortem examination confirmed that she was gravid, containing ten fully developed young (Fig. 1). One side of the snake was green, indicating decomposition in the area of the young suggesting that one or all of them died within the female causing septicaemia.

This confirms that adders can carry developing embryos over winter in the wild in England and is consistent with Street's observation in that it followed a cool summer. The deaths of the female and offspring in this case may well have been caused by the unusually protracted winter conditions during the following spring (2013).

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Submitted by: *NIGEL HAND, Central Ecology, 45 Albert Road, Ledbury, Herefordshire HR8 2DN, UK,* nigel@centralecology.co.uk

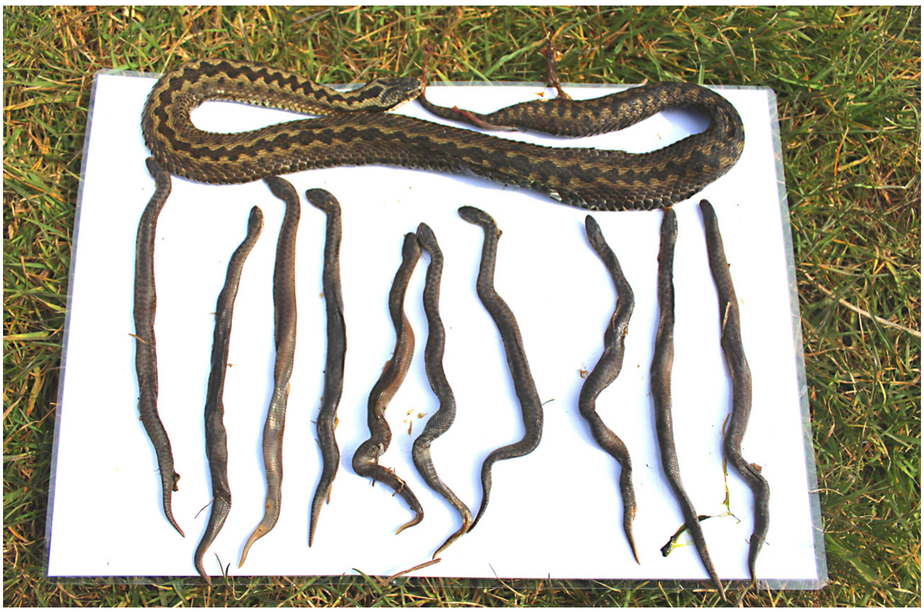


Figure 1. Female adder, post mortem, and overwintered clutch.

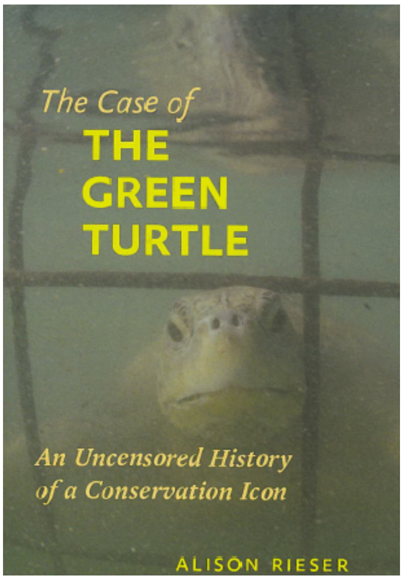
Herpetological Bulletin (2013) 125: 35-36

Book Review

The Case of The Green Turtle: An Uncensored History of a Conservation Icon

Alison Reiser

2012 The John Hopkins University Press, 338 pages



A further subtitle to this book could be 'conservation versus commercialisation' as that is essentially the focus of the story as it unfolds over time, beginning way back in the 1600s. As with all discussions of conservation issues such as this it is not as simple as the good guys struggling to save a species while the bad guys kill defenceless animals. In many places that turtles nest they were a long-standing, traditional and very important source of nutrition, taken in a sustainable fashion. When money entered the situation, demand for animals increased and pressures on populations eventually began to be noted. Turtles have been commercialised for a surprisingly long time, with canned meat and soup once popular items, often considered 'gourmet', as well as various parts of turtles being used in cosmetics and as jewellery and ornaments. The numbers of animals killed reached staggering levels and the various cruelties visited upon sea turtles during the process of turning them into 'products' also makes for unpleasant reading. Thankfully unthinkable today (although officially legal until the 60s) at one point turtle 'derbies' were a popular sport. Turtles would be 'turned' to prevent escape, often for many hours, and then ridden down the beach.

Central to this book are two important issues. Firstly the difficulties in assigning a meaningful level of threat and risk of extinction to an incredibly wide-ranging, late maturing, long-lived animal such as *Chelonia mydas* about which so little was known when concern was first raised. At this point in time little was known about breeding population sizes, migration, frequency of egg-laying, age at maturity and other issues vital to assessing the status and long-term prospects of a species. Depending on the criteria used (and the motive behind the designation) a number of answers can be reached regarding scarcity and need for protection and the argument raged long and hard over just how threatened green turtles were. Added to this is the debate over the efficacy, sustainability and morality of turtle farming. The concept behind 'mariculture' is simple: initially wild-caught adults and eggs were reared in enclosed areas and the farmed meat and egg product, as well as the calipee (a substance attached to the interior of the plastron and used in the making of turtle soup) and other 'luxury' items (shell etc.) could be sold on, thereby reducing the pressure and impact on wild populations. The title of Chapter 14 'Conservation through Commerce' sums it up. The pro-mariculture argument is that surplus animals can be returned to the wild resulting in a nett gain in turtle numbers. The argument against farming is built on a number of factors: that the increased availability of turtle products would actually increase the overall demand and that illegal catches and harvesting would continue. Also would a species with an ecology such as that of a sea turtle thrive in artificial human mediated environments? Could the species be manipulated (e.g. would captive raised turtles return to natal beaches to breed)? Those against the concept refuted any claims of conservation benefit and pushed for the total ban on turtle products. The philosophy employed here is that animals should be conserved purely for their own intrinsic value, without any commercial aspect being involved in the judgements over their classification or value.

The book covers many years, is witness to some pivotal events in conservation (the beginnings of wildlife legislation and organisations such as IUCN and CITES, the early stages of sea turtle conservation and population studies) and features some well - known names such as Archie Carr and Peter Scott amongst many others. Anyone who has read more than the odd paragraph about sea turtle conservation won't be surprised to find that Carr (initially treating the idea of turtle farming as at least potentially promising but later becoming a firm opponent) is a prominent character and participant in many of these discussions and arguments regarding the designation and protection of marine reptiles. It also touches upon aspects of history such as colonialism, war and as ever, human greed and an apparent lack of respect for the natural world. Global in scope, as you would imagine with a species such as this, we see exotic locations, glorious beaches and different cultures.

This is a serious read underpinned by politics, the realities of conservation that are often hidden from the wider public and the often frustrating lack of cooperation between, and pursuit of personal agendas by scientists, conservationists and policy makers.

There are a number of good sea turtle books available at the moment and this would not be the book to turn to if you want an overview of the various species and their biology with colour pictures, distribution information or an accessible account of their ecology. This is a valuable book however if taken as a history: of an imperilled species and of our attitudes towards it and the attempts to protect or consume it. In places it is quite dense, dealing as it does with extended court cases and referencing many letters concerning policy issues and scientific debates. There are extensive notes and a ten page bibliography should the reader seek even more detail and information. It contains some very good and informative black and white photographs which serve to illustrate some of the practices that turtles suffered from in the past as well as many of the characters central to the story. The topics covered and the philosophical, social and political issues raised could equally apply to other groups of animals that are exploited by humans, and the debate on classifying and designating animal species (and the seemingly unavoidable personal agenda imposed by those involved) is relevant to conservation in general. Although the events of this book took place decades ago the story is far from over and *Chelonia mydas* remains 'Endangered' on the IUCN Red List of Threatened Species, with a 'demonstrable risk of extinction' (www.iucnredlist.org/details/4615/0). The causes concerning the original group of turtle conservationists are still considered the major causes today, but since then we have added new ingenious ways of depleting the oceans of wildlife and both marine and terrestrial habitats have become more degraded. Just as well then that we still have conservationists passionate about protecting sea turtles: it appears they are still much needed.

GARY POWELL

c/o Amphibian and Reptile Conservation, 655a Christchurch Road, Bournemouth, BH1 4AP
gary.powell@arc-trust.org