The HERPETOLOGICAL BULLETIN

Number 97 – Autumn 2006

PUBLISHED BY THE
BRITISH HERPETOLOGICAL SOCIETY

THE HERPETOLOGICAL BULLETIN

The **Herpetological Bulletin** is produced quarterly and publishes, in English, a range of articles concerned with herpetology. These include full-length papers of mostly a semi-technical nature, book reviews, letters from readers, society news, and other items of general herpetological interest. Emphasis is placed on natural history, conservation, captive breeding and husbandry, veterinary and behavioural aspects. Articles reporting the results of experimental research, descriptions of new taxa, or taxonomic revisions should be submitted to The Herpetological Journal (see inside back cover for Editor's address).

ISSN 1473-0928

Printed by Metloc Printers Limited, Old Station Road, Loughton, Essex.

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All submissions and correspondence arising from the Bulletin should be sent to the Editor, Peter Stafford, c/o Dept. of Botany, The Natural History Museum, Cromwell Road, London, SW7 5BD. *E-mail: herpbulletin@thebhs.org*

Front cover illustration. Intermediate form of *Vipera aspis* and *V. latastei* (adult female) from the Northern Iberian Peninsula (Covanera, Sedano Valley, NW Burgos province). Photograph © Fernando Martínez Freiría. See article on page14.

Editorial

Information for authors

Beginning with this issue, articles published in the *Herpetological Bulletin* will be grouped under a slightly different series of category headings. All shorter-length articles that include a research component and would previously have been grouped under 'Notes and Comments' or 'Short Notes', will henceforth be included within the main 'Research Articles' section; examples of material suitable for inclusion in this expanded category are faunal surveys, ecological and behavioural studies, analyses of morphological variation, and signifciant geographic range extensions. A new section has also been introduced, 'Collections Forum', for articles and news items relating to major zoological and museum collections (submissions invited!). The full list of category headings, and order in which they appear, is as follows:

Editorial; *Obituaries*; *Collections Forum; Husbandry and Propagation*; *Veterinary View*; *Research Articles*; *Natural History Notes*; *Book Reviews*.

The Herpetological Journal - on-line

The British Herpetological Society is preparing an online subscription for Institutions, Overseas and Full UK members, to be launched fully for 2007. From January 2007, the *Herpetological Journal* will be available as an online publication through our provider, Ingenta. Initially, only the *Herpetological Journal* will be available online; the *Herpetological Bulletin* will remain in hardcopy and be delivered via surface mail. It is planned to include the *Bulletin* in the online subscription by 2008/9. In brief, the advantages to members will be faster access to publications as they are released, access to all available back-copies, and cheaper subscription. Papers will of course be available as downloads, providing all the benefits that electronic access to documents brings, such as keyword searching, filing, etc. The Society will benefit from greater exposure of its content, including abstracts of all papers to non-members, and reduced printing and posting costs. In order for subscribing BHS members to test and check access to the services provided by Ingenta, all issues of the *Herpetological Journal* published during 2006 will be available online. Volume 15, No. 4 and Volume 16, No. 1 are available now. All BHS members (full inland, overseas and institutions) are invited to try this service to ensure error-free access. Please note you will need your membership number to gain access to online publications.

The normal postal subscription will remain in place for members wishing to continue to receive hardcopy publications. However, subscription rates are set to rise in 2007 to cover the ever-increasing postal and printing charges. The new pricing structure will be advertised in the coming months in preparation for 2007.

To view BHS *Herpetological Journal* content online, go to www.ingenta.com, and follow the instructions for registration. Your password is your membership number, and this field is case-sensitive. Institutional members please note a covering letter has been sent with this issue of the *Herpetological Bulletin* containing notification of your subscriber (membership) number.

Trevor Rose, BHS Secretary

British Herpetological Society 2007 AGM

The 2007 Annual General Meeting of the British Herpetological Society will be held on 31st March 2007 at the Natural History Museum, London. Following the official business of the Society, there will be a number of events including lectures and a photographic competition – full details of the programme will be published nearer the time in the *Bulletin* and *Natterjack*. Numbers will be limited, and members wishing to attend will need to register in advance. To register, please contact Peter Stafford, preferably by e-mail (herpbulletin@thebhs.org; other contact details available on inside back cover of this issue) by February 28th 2007 giving your name (including any other family member where this is applicable), BHS membership number, and a contact e-mail address. It will unfortunately not be possible to admit any person who arrives on the day without having registered beforehand. *Ed.*

Body bending: a cryptic defensive behaviour in arboreal snakes

OTAVIO A. V. MARQUES[1], MURILO G. RODRIGUES[1,2] and IVAN SAZIMA[3]

[1] *Laboratório de Herpetologia, Instituto Butantan, 05503-900 São Paulo, SP, Brazil*
E-mail: *otaviomarques@butantan.gov.br*

[2] *Pós graduação em Biologia Animal, Universidade Estadual Paulista, 15054-000 São José do Rio Preto, SP, Brazil*. E-mail: *rodrigues@butantan.gov.br*

[3] *Departamento de Zoologia and Museu de História Natural, C. P. 6109, Universidade Estadual de Campinas, 13083-970 Campinas, SP, Brazil*. E-mail: *isazima@unicamp.br*

SNAKES display a great variety of defensive tactics against predation, from immobility to biting (Greene, 1988, 1997). Some defensive tactics seem to have ecological correlates. For instance, arboreal snakes often have morphology and colour pattern similar to twigs and leaves (Lillywhite & Henderson, 1993). Additionally, vertical head display and open-mouth threats typify many arboreal species (Greene, 1997). Cryptic colouration in arboreal snakes can be accompanied by behaviours that enhance the overall camouflaging effect. Thus, some slender arboreal snakes (e.g., *Ahaetulla* spp., *Opheodrys aestivus*, *Oxybelis aeneus*) sway their body like a branch in the wind (Fleishman, 1985; Greene, 1988). Another distinctive cryptic defensive behaviour is displayed by the arboreal colubrids *Pseustes poecilonotus* and *P. sulphureus*. These snakes bend their bodies when disturbed while on the ground or among branches, which renders them similar to a piece of a liana on the forest floor or on the vegetation (Beebe, 1946; Abuys, 1986). Here we report on similar behaviours for two additional arboreal Neotropical snake species while on the ground, and treat them as instances of defensive convergence. Our records were taken incidentally while performing other field studies, and are described below.

An Amazonian green whiptail (*Philodryas viridissimus*) about 90 cm in total length (TL) was observed in a cloudy day at about 10:00 hrs, crossing a dirt road in the Amazon Forest in the neighbourhoods of the Von den Steinen River (ca. 12º05'S, 53º46'W), Mato Grosso state, north Brazil, in August 2004. The observers (M. M. Barros and F. L. Mesquita) informed that the snake bended its body upon approach (Figure 1). Upon closer approach (about 1.5 m) and photography, the snake apparently increased the bends. The snake remained in that posture during about four minutes, after which the observers left the site.

A Tiger ratsnake (*Spilotes pullatus*) about 120 cm TL was sighted on a sunny day at 12:15 hrs (27ºC), lying across a trail in a remnant of Atlantic Forest at Campinas (ca. 22º49'S, 47º06'W), São Paulo state, southeast Brazil on 10th April 1988. From a distance, the multiple and regular bends on the snake's body made it closely resemble a piece of the liana locally called 'escada de macaco' (monkey ladder), a species of the genus *Bauhinia* (Caesalpinaceae). Upon close approach, the snake slowly withdrew into the vegetation, the bends on its body still visible (Figure 2).

The defensive repertoires of *Pseustes* spp., *Philodryas viridissimus* and *Spilotes pullatus* include lateral compression of the body, S-coil posture, open mouth and striking, all of which are typical for arboreal snakes (Greene, 1979; Marques, 1999; Marques *et al*. 2004; Marques & Sazima, 2004). Bending the body is shared at least by four Neotropical snake species (Beebe, 1946; Abuys, 1986; present paper), a defensive behaviour not mentioned in previous overviews of defence in snakes (e.g. Greene, 1988; Lillywhite & Henderson, 1993). All four species dwell in forest habitats where lianas and bent sticks are frequently found on the ground. Thus, a bent body posture seems an adequate defence on the forest floor or among branches, as it increases the resemblance a snake may already have to portions of its habitat (thus, a camouflage type – see Cott, 1940; Edmunds, 1974). Additionally, the sudden transition from a stretched posture to a bent one, observed in *P. viridissimus*, quickly removes the

Figure 1. *Philodyas viridissimus* displaying the bent body posture upon close approach of the observer. Photograph © M. M. Barros.

Figure 2. *Spilotes pullatus* slowly retreating into the vegetation, with slight bends in its body still visible.

visual cues (elongate "search image") a potential snake predator may have.

The genera *Pseustes* and *Spilotes* belong to the subfamily Colubrinae and may be closely related (Ferrarezzi, 1994). However, the genus *Philodryas* is assigned to the Xenodontinae (Ferrarezzi, 1994). As the two above mentioned colubrine genera and *Philodryas viridissimus* are not closely related (Vidal *et al*., 2000) but all of them are arboreal, their very similar defensive displays possibly evolved independently in the two lineages. Thus, the defensive displays here recorded may be regarded as instances of behavioural, ecologically related convergence. However, even if the bent posture may acquire a defensive function, the possibility of a physiological response (cf. Greene, 1988) due to a sudden threat on a still non-optimally warmed snake cannot be discarded. The persistence of bends here recorded for *S. pullatus* may also be such a response or, alternatively, a slow change from a liana-like shape to a normal snake-like posture adequate for fleeing.

ACKNOWLEDGEMENTS

We thank M. M. Barros for photographs and data on *P. viridissimus*; F. L. Mesquita for field observations; A. S. Abe and D. O. Andrade for their suggestions and improvement of the manuscript; the CNPq and FAPESP for financial support.

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Notes on the distribution and natural history of the Bluntheaded vine snake, *Imantodes cenchoa*, in Ecuador

DIEGO F. CISNEROS-HEREDIA

College of Biological and Environmental Sciences, Universidad San Francisco de Quito, Casilla 17-12-841, Quito, Ecuador. E-mail: *diegofrancisco_cisneros@yahoo.com*

THE Bluntheaded vine snake, *Imantodes cenchoa,* is a widespread species distributed on the Atlantic and Pacific versants of America from southern Tamaulipas and Oaxaca, México, south to central western Ecuador (Pacific versant) and Bolivia, Paraguay and northeastern Argentina (Atlantic versant); from sea level up to 1500 m elevation (Pérez-Santos & Moreno, 1991; Savage, 2002; Köhler, 2003). *Imantodes cenchoa* has been reported in Ecuador from the provinces of Guayas, Los Ríos, Pichincha, Tungurahua, Napo, Sucumbíos, Orellana, Pastaza, and Morona-Santiago (Rendahl & Vestergren, 1941; Fugler & Walls, 1978; Duellman, 1978; Zug *et al*. 1979; Pérez-Santos & Moreno, 1991; Cisneros-Heredia, 2003; Ken Miyata, in litt.). More recently, it was recorded at the provinces of Esmeraldas and El Oro by Yánez-Muñoz *et al*. (2004) and at Manabí (Fundación Jatun Sacha [Reserva Lalo Loor] in litt.).

A specimen of *Imantodes cenchoa* (FHGO 2801) collected at Bombuscaro, province of Zamora-Chinchipe (Appendix 1), provides the first record from this province, extending the distributional range of the species in Ecuador ca. 200 km SSW from the nearest locality (Sucua) in the province of Morona-Santiago (Fugler & Walls, 1978), representing the westernmost locality in the distribution of the species on the eastern versant of the Andes, and filling the gap between localities from northeastern Peru and central eastern Ecuador. Yánez-Muñoz *et al*. (2004) reported *Imantodes cenchoa* from one locality in the province of Esmeraldas. Five specimens (FHGO 89, 120, 570, 543, 2535) of *Imantodes cenchoa* collected at various localities in the province of Esmeraldas (Appendix 1) provide additional records from this province, and fill the gap between localities from southwestern Colombia and central western Ecuador.

A sample of 23 specimens from various localities in western and eastern Ecuador includes five hatchlings (<450 mm, *sensu* Zug *et al.*, 1979; Martins & Oliveira 1998) collected in western Ecuador in May and in eastern Ecuador in August and November; eight juveniles (<800 mm SVL, *sensu* Zug *et al.*, 1979; Martins & Oliveira, 1998) collected in July and August in western Ecuador and in January, March, June, and November in eastern Ecuador; and, ten mature adults. Measurement data for these specimens are presented in Table 1. The scalation and color patterns of these specimens fall within the range of variation reported for *Imantodes cenchoa* elsewhere (Duellman, 1978; Myers, 1982; Martins & Oliveira, 1999; Savage 2002).

Two specimens (DFCH-USFQ 087, 088) were collected at night while active (foraging) in palms ca. 40–60 cm above floor at the night, in primary terra firme forest (a hatchling) and in secondary seasonal flooded forest (an adult), at the Tiputini Biodiversity Station, province of Orellana. One adult specimen (FHGO 2943) was collected between bamboos in a secondary forest at the Maquipucuna Reserve, province of Pichincha. An adult individual was observed (not collected) active (foraging) in the branches of a tree ca. 170 cm above floor at night in secondary forest at the lodge near Cascada de San Rafael, province of Napo, Ecuador.

Based on records presented herein and those from other references (Rendahl & Vestergren, 1941; Fugler & Walls, 1978; Duellman, 1978; Zug *et al.*, 1979; Pérez-Santos & Moreno, 1991; Cisneros-Heredia, 2003; Yánez-Muñoz *et al*., 2004, Ken Miyata in litt., Fundación Jatun Sacha [Reserva Lalo Loor] in litt.); *Imantodes cenchoa* is known from six provinces on the Pacific versant of Ecuador (Esmeraldas, Manabí, Guayas, Los Ríos, El Oro, and Pichincha), and all provinces on the Atlantic versant of Ecuador (Sucumbíos, Napo, Orellana, Pastaza, Tungurahua, Morona-Santiago and Zamora-Chinchipe) (Figure 1). *Imantodes cenchoa* inhabits the Northwestern Tropical and Western and Eastern Subtropical zoogeographic floors of Ecuador (*sensu* Albuja *et al*., 1980), and occurs in the following vegetation formations (*sensu* Sierra, 1999): (a) in western Ecuador: Lowland Evergreen Forest, Foothill Evergreen Forest, Lowland Semideciduous Forest, Low Montane Evergreen Forest; (b) in eastern Ecuador: Low Montane Evergreen Forest, Foothill Evergreen Forest, Lowland Non-flooded Evergreen Forest, Lowland Evergreen Forest flooded by white-waters, Lowland Evergreen Forest flooded by black-waters, Palm Flooded Evergreen Forest.

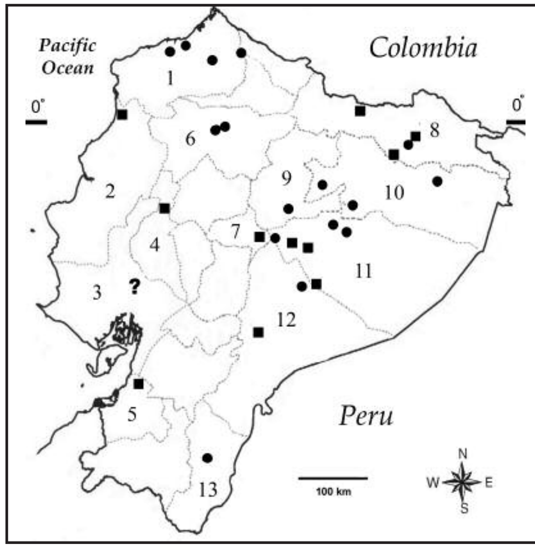

Figure 1. Distribution of *Imantodes cenchoa* in Ecuador. Circle = examined material; square = data from literature. A symbol can represent more than one locality. Pérez-Santos & Moreno (1991) did not report a precise locality for Guayas (question mark). Numbers correspond to the mainland Ecuadorian provinces: Esmeraldas (1), Manabí (2), Guayas (3), Los Ríos (4), El Oro (5), Pichincha (6), Tungurahua (7), Sucumbíos (8), Napo (9), Orellana (10), Pastaza (11), Morona-Santiago (12), Zamora-Chinchipe (13). Continuous thick line: international border; thin dotted line: provincial borders.

Table 1. Measurements of 23 specimens of *Imantodes cenchoa* from various localities in Ecuador. Mean ± 95% confidence interval in boldface followed by range.

	n	TTL	TaL	SVL	TaL as % of TTL
Hatchlings	5	363.0 ± 65.6	110.0 ± 19.1	253.0 ± 47.42	8.8 – 31.7 %
		(315 – 450)	(95 – 135)	(215 – 315)	
Juveniles	8	666.8 ± 74.7	190.6 ± 24.6	476.3 ± 51.1	27.2 – 30.8 %
		(545 – 805)	(150 – 230)	(395 – 575)	
Adults	10	1020.8 ± 62.7	286.5 ± 37.5	734.3 ± 51.3	19.9 – 31.6 %
		(895 – 1180)	(195 – 355)	(620 – 825)	

ACKNOWLEDGEMENTS

I am grateful to Jean-Marc Touzet and Ana María Velasco for granting access to specimens deposited at the FHGO, to the Tiputuni Biodiversity Station staff (especially Consuelo Barriga de Romo and David Romo) for their support on my work at the station; to Angel Chiriboga for his field companionship, to Andrés León, Tomi Sugahara, Daniel Proaño, and María Olga Borja for laboratory assistance, and to Roy W. McDiarmid and Mario Yánez-Muñoz for access to the unpublished thesis of Ken Miyata. My gratitude to Maria Elena Heredia and Laura Heredia for financial and moral support. Tiputini Biodiversity Station provided partial funding, and Universidad San Francisco de Quito provided institutional support.

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APPENDIX 1 – Examined material of *Imantodes cenchoa* from Ecuador. Institutional abbreviations: FHGO, Fundación Herpetológica G. Orcés, Quito, Ecuador; DFCH-USFQ, D. F. Cisneros-Heredia collection, housed at the Universidad San Francisco de Quito, Quito, Ecuador.

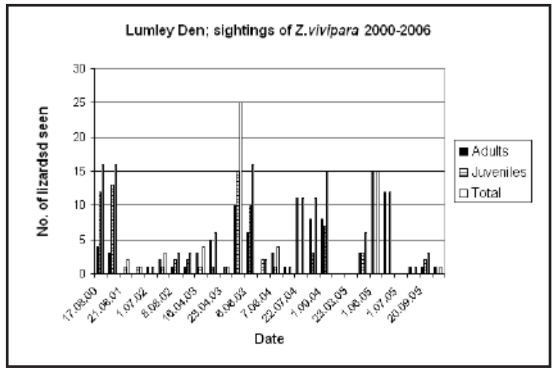
ESMERALDAS: FHGO 089, Km 17 vía Lita-Alto Tambo (00º51'N, 78º31', 830 m), 17 February 1991; FHGO 120, Km 18 vía Lita-Alto Tambo (00º51'N, 78º31'W, 830 m), 11 August 1990; FHGO 543, Zapallo Grande - Río Cayapas (00º54'N, 78º57'W, 90 m), 13 July 1992; FHGO 570, Tabiazo - Finca Esperanza (00º49'N, 79º42'W, 20 m), November 1992; FHGO 2535, Canton Río Verde, Parroquia Juan Montalvo, La Mayronga (150 m), 01 November 1998. PICHINCHA: FHGO 1317-19, Mindo (00º02'54"S, 78º46'21"W, 1200 m), 13 May 1996; FHGO 2943, Reserva Maquipucuna (1400 m). NAPO: FHGO 456, Runa Huasi - Rio Arajuno - confluencia río Napo (01º03'S, 77º32'W, 340 m). SUCUMBÍOS: FHGO 826, San Pablo de Kantesiaya (00º15'00"S, 76º25'30", 240 m), 21 November 1993. ORELLANA: DFCH-USFQ 087, 088, 452, Tiputini Biodiversity Station (00°37'05"S, 76°10'19"W; 215 m.s.n.m.), 10 August 1999; FHGO 216, Cononaco (01º01'05"S, 76º53'31", 230 m), July 1989; FHGO 1069, Km 77 vía Hollín - Loreto - Río Huataraco (00º43'S, 77º22'W, 480 m), 15 January 1995; FHGO 1140-1, Km 77 vía Hollín - Loreto - Río Huataraco (00º43'S, 77º22'W, 480 m), 27 March 1995. PASTAZA: FHGO 119, Pozo Garza - Oryx (00º26'S, 77º03'W, 300 m), 06 July 1989; FHGO 520, Shell (01º29'S, 78º02'W, 600 m), 05 August 1992; FHGO 1656-7, Comuna Curaray (01º22'22"S, 76º56'52"W), 02 November 1997; FHGO 3593, Shell-Te Zulay (1000 m), 04 March 1999. MORONA-SANTIAGO: FHGO 1096, Makuma (02º08'75"S, 77º42'98"W, 600 m), 14 September 1994; FHGO 1192, Makuma (02º08'75"S, 77º42'98"W, 600 m), 19 June 1995. ZAMORA-CHINCHIPE: FHGO 2801, Bombuscaro (07º09'06"S, 78º58'10"W, 1270 m), 16 December 1999.

Numbers of *Zootoca vivipara* observed at Lumley Den, a road cutting through the Sidlaw Hills, from 8th August 2000 to 29th March 2006

FRANK D. BOWLES

37 Albany Terrace, Dundee DD3 6HS, Scotland, UK. E-mail: *frankdbowles@ hotmail.com*

LUMLEY Den is a cutting through the Sidlaw Hills, approximately 6 miles north of Dundee City Centre, which allows the A 926 to cross them in a north-westerly direction. The south-west facing escarpment, roughly 75 meters long, has heather moor rising to 400m behind it and vegetation and rubble at its foot. Noting that there were lizard sightings recorded there in 1970, I visited the site on 8th August 2000, and saw 4 adults and 12 juveniles, basking on stones and flattened fence posts. I have since visited the sight for the next six years, making 28 visits all told, the last being 29th March 2006. As demonstrated in the bar-chart (right), there have been considerable fluctuations in the population. 2001, with its polar spring, was a particularly bad year, with only one juvenile noted, on only two occasions, the first being midsummer's day! The largest number of animals noted was 25, 10 adults and 15 juveniles, seen on 30th May 2003. However the greatest number of adults, 15 were seen on 1st June, 2005. While most of the lizards seen demonstrate normal colouring and pattern (below), we saw a truly green male on 18th April 2003.



Howard Inns, of the Herpetological Conservation Trust, writing in the April edition of *British Wildlife*, states that there was growing evidence that Common toads, Adders and Common lizards were declining. This certainly would seem to be the case with lizards in southern England. Over the past few years we have visited sites in Buckinghamshire, Somerset, and the Isle of Wight which were excellent Common lizard sites in the 1940s, but now showed nothing despite there being no visual evidence that environmental degradation had taken place. It is therefore gratifying to find a good lizard site in the Scottish lowlands so near the heart of a large industrial city like Dundee.

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Population structure and translocation of the Slow-worm, *Anguis fragilis* L.

D. S. HUBBLE[1] and D. T. HURST[2]

[1] *7 Ainsley Gardens, Eastleigh, Hampshire SO50 4NX, UK*
E-mail: *dshubble@yahoo.com* [Corresponding author]

[2] *3 Bye Road, Swanwick, Hamphsire SO31 7GX, UK*

ABSTRACT — Proposed redevelopment work in Petersfield, Hampshire required capture and translocation of Slow-worms to fulfil the legal obligations of 1981 Wildlife and Countryside Act (as amended). Numbers of adult males, adult females and juveniles were recorded. Only 3 of 577 Slow-worms captured were found moving or basking on the surface. On days with high capture rates, females and juveniles were more active. The disturbance pattern due to sampling, as well as human activity not related to translocation, affected capture rates. The settling-in period for refugia was not as important as believed. When translocating Slow-worms, it is important to ensure significant capture effort is made throughout the season rather than attempting to choose 'suitable' conditions. It is also important to ensure that the density of refugia placement is as high as possible.

ALTHOUGH frequently occurring close to human habitation, the Slow-worm is poorly understood due to its secretive behaviour, the difficulty of studying individuals over long periods and the subsequent lack of detailed study (Beebee & Griffiths, 2000). The species is widespread in the South and South East of England but there are indications of a decline during the second half of the 20th century (Baker *et al.,* 2004). Urban development has been identified as a particular threat with Slow-worms often found on brownfield sites targeted for redevelopment following recent changes in planning policy (Defra, 2003). As reptiles are protected from 'intentional' death and injury under the 1981 Wildlife and Countryside Act (as amended), it is necessary in some cases to translocate Slow-worms prior to development work. With consultation still taking place regarding the South East Plan (HCC, 2005), a regional UK Governmental plan for increases in housing levels, there is still uncertainty about the location and amount of redevelopment that will take place, and hence about the subsequent threat to Slow-worm habitat. It is clear that greater understanding of Slow-worm populations and the processes of capture and translocation is required.

Although attempts have been made to standardise reptile survey methods (Reading, 1996, Reading, 1997), there is no single accepted standard methodology for surveying reptile populations (RSPB *et al.,* 1994). UK Government body English Nature advise that the method used for translocation should be based on guidelines produced by the Herpetofauna Groups of Britain and Ireland (HGBI, 1998). More recent advice (JNCC, 2003) is also taken into account to meet the legal requirement of 'reasonable effort' to avoid death and injury to Slow-worms on site. Following an initial survey (CPM, 2005), it was determined from HGBI (1998) guidelines that a "good" breeding population of Slow-worms was present in the rear gardens of properties in Grange Road and Borough Grove, Petersfield, Hampshire. As the entire site is due for redevelopment, translocation was necessary. This was recognised as an opportunity to record Slow-worm numbers and relate these data to translocation methodology.

Translocation methodology

A suitable receptor site of approximately 10 hectares was identified at Goswell Brook in the Beaulieu Estate, New Forest, Hampshire, southern England (OS grid reference SU395044). The suitability of the site was determined to be high for the following reasons:

a. Being within Hampshire, it is relatively local to the Petersfield donor site, reducing the period of captivity and transit.

b. The site has undergone clearance of invasive *Rhododendron ponticum* and subsequent regeneration as heathland and acid grassland which are known to provide suitable reptile habitat (Wynne *et al.,* 1995; Haskins, 2000) and are within the natural range of the species.

c. Following discussion with the Goswell Brook conservation advisor regarding previous survey work, the receptor site was believed to support very few reptiles. This is because the site is still surrounded by *Rhododendron*, and so a significant level of Slow-worm colonisation has not previously occurred as individuals would need to migrate through considerable stretches of unfavourable habitat. As Slow-worms have a small home range averaging approximately 200m^2 with few moving more than 4m in a single day (Smith, 1990), colonisation from existing populations external to the site has not occurred.

d. It is not subject to planning or other threats in the foreseeable future.

e. There is little or no disturbance by humans.

f. Planned site management for nature conservation purposes will continue to maintain, enhance and expand the habitat suitable for Slow-worms, and future voluntary monitoring will determine the success of the translocation.

Translocation started on 14th July 2005. Broadly following the initial survey (CPM, 2005), 117 numbered artificial refugia (0.5m x 1m rectangles of roofing felt) were placed in areas of suitable habitat in the rear gardens of 36 properties. Slow-worms are well known to hide under debris which is fully or partially exposed to sunlight and artificial refugia provide a controllable method of using this behaviour to aid capture (JNCC, 2003). Refugia were placed in all 34 properties identified in the CPM survey plus 2 added after being observed to include suitable habitat. After a settling-in period of several days, a series of visits during July to September was undertaken, avoiding days considered too hot or wet. This gave a total of 48 worker-days of capture effort plus extra visits made to those gardens where the greatest proportion of the population appeared to be concentrated. Hand catching by lifting refugia was the main method used and, although the site covered approximately 2.5 ha, capture focused on smaller areas such as compost heaps where high numbers of individuals were expected, or 'hotspots' (defined as areas where Slow-worms were captured regularly, even when total capture for the day was low). This allowed sampling density to match that suggested by a key study of Slow-worms in southern Britain (Gent, 1994) which recommends 50 refugia per 0.1 ha with a minimum of 15–20 visits in order to capture a 'reasonable' proportion of the population. This targeting was amended throughout the work period as some areas became depleted and others began to produce greater numbers of individuals. Due to the gradual refocusing of capture effort, this study effectively reduced the area being sampled from 2.5 ha to approximately 0.1– 0.2 ha. Therefore, the 117 refugia represent a sampling density of up to 1170/ha.

Particular efforts were made to make as many visits as possible before the September birth period as this would repopulate depleted habitats with hatchlings which would then need to be captured. During the final visits, destructive searches were made where necessary. This allowed the primary aim of the the translocation (the capture and translocation of as large a proportion of the population as possible) to be met while also producing data suitable for analysis. The following data were recorded separately each day:

1. Total number of adult males, adult females and juveniles. As it is difficult to determine the sex of a Slow-worm before its third season (JNCC, 2003), all individuals too young to be sexed were recorded as juveniles. Plates 1 & 2 show the contrasting male and female patterns. The percentage contribution of each to the total number of individuals could then be calculated.
2. Number of days since the previous visit.
3. Number of gardens where individuals were captured.
4. Maximum temperature during daily capture effort.

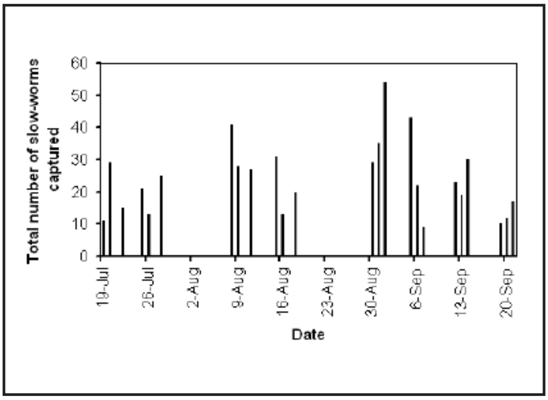

Figure 1. Number of Slow-worms captured during daily visits during 2005.

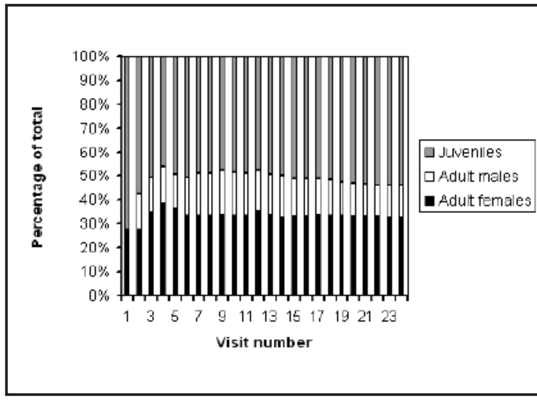

Figure 2. Proportion of Slow-worm captures by sex and age group.

RESULTS

A total of 577 individuals (186 adult females, 81 adult males and 310 juveniles) were captured. Of these only 3 were found moving or basking on the surface and 3 blue-spotted males were found. Figure 1 shows the pattern of capture with a peak around late August to early September. After this, a decline was seen, especially given that the last two visits included destructive searches which increased numbers slightly above those found by the standard methods of hand searching and checking refugia. Figure 2 shows a steady contribution to total captures by sex and age group with adult females forming 33.13% of total captures, adult males 15.12% and juveniles 51.75%.

Population ecology

Correlating the number of gardens where Slow-worms were captured with the total number captured gives a significance of $p < 0.001$. Correlating the number of gardens where Slow-worms were captured with the number captured by sex or age class gives $p < 0.001$ for adult males, adult females and juveniles. For each of these classes, correlating the overall total number of captures with total captures by group also gives $p < 0.001$. Hence increases are due equally to all classes rather than any section of the population. Total captures by sex and age class were correlated with mean number of captures per garden overall:

Adult females	$0.01 > p > 0.001$
Adult males	not significant
Juveniles	$p < 0.001$

Correlating the mean number captured per garden where individuals were found with the total number captured gives $p < 0.001$. There is no significant correlation between the mean number captured per garden where individuals were found and the total number captured. Correlating the total number of captures with the maximum temperature during each day of capture effort, shows a significant relationship ($0.01 > p > 0.001$). Correlating maximum daily temperature with age and sex classes shows a significant increase across the whole population:

Adult females	$0.05 > p > 0.01$
Adult males	$0.01 > p > 0.001$
Juveniles	$0.05 > p > 0.01$

Methodological effects

Correlating the mean of number of days since the last visit with the total number captured is not statistically significant. However, correlating the mean of the previous three periods against the total number captured is significant at $0.01 > p > 0.001$.

DISCUSSION

With 577 individuals captured, the size of population far exceeded that estimated in the initial survey (CPM, 2005). With a full range of age ranges from new hatchlings to large adults, a well-established breeding population was clearly present consisting of approximately equal number of adults and juveniles, with twice as many adult females found as adult males. This is likely to be a site-specific sex ratio as this is known to vary from previous studies (Stumpel, 1985; Smith, 1990). An excess of females has previously been explained in terms of gravid females basking in the open more frequently and being easier to catch (Stumpel, 1985), but in this case only 3 individuals were captured on the surface, so this explanation does not hold here. Recent work (Meek, 2005) indicates that above-ground activity has a thermoregulatory function, suggesting that the low numbers of basking animals is due to suitable temperatures being attained in sub-surface locations. Although the longevity of the species means that numbers of adults are usually much higher than numbers of juveniles (Beebee & Griffiths, 2000), some populations are not dominated by adults with one other key study finding a population in which around half the individuals were juveniles (Riddell, 1996). Suggestion has been made that gardens may provide consistently good conditions and thus lead to greater reproductive success and greater numbers of juveniles than more 'natural' habitats (Beebee & Griffiths, 2000). Alternatively, given the apparently high level of feline predation on site, the longevity of Slow-worms may be reduced here. This could at least partially account for the age structure if feline predation primarily affects adults and is sufficient to outweigh the usual predation of juveniles by insectivorous birds, frogs, toads and shrews, all of which are known to prey on small Slow-worms (Beebee & Griffiths, 2000).

The habitat is split into several isolated sections and as Slow-worms generally move short distances (Smith, 1990), these are likely to have partially separate sub-populations with some overlap due to movement of individuals. Along with the well-established nature of the population, this suggests a high level of genetic diversity which is important for successful translocation. As the primary aim of translocation is to capture as many Slow-worms as possible, it is important to consider the time of year when most Slow-worms will be encountered. Reading (1996) found the peak to be in mid to late September, Beebee & Griffiths (2000) indicate that this will be in May and June, while Figure 1 shows peak capture during late August and early September. Local and climatic conditions are likely to be of primary importance, but as it is impossible to determine what these will be in advance, it is essential to plan capture effort throughout the season.

In this study, higher temperatures led to greater numbers of captures although it is believed that hot dry weather leads to a reduction in Slow-worms' use of surface refugia and that Slow-worms will not tolerate termeratures above 35°C (Beebee & Griffiths, 2000). This is explained by the hottest periods being avoided during translocation so that capture effort occurred only during suitable conditions. When refugia were checked during hotter periods, very few Slow-worms were found. Reading (1996) also found that the capture rate increased with density of refugia placement with no noticeable tail-off at higher densities. This can be explained by the sedentary nature of Slow-worms as an individual may stay in a very small area (possibly a single compost heap or ant nest of 1–2 m^2) for a considerable period of time if food supply and cover remain adequate. Thus a very high density of refugia would be required before the number of captures began to tail off. Reading

Plate 1. Adult male during release at receptor site.

Plate 2. Adult female during release at receptor site.

(1996) suggests this would occur above approximately 3200 refugia/ha, and used a maximum density of 379 refugia/ha which the author notes was not enough for the number of captures to level off. Here a sampling density of up to 1170/ha was used. Thus key considerations when translocating Slow-worms are:

1. To make significant capture effort throughout the season rather than attempting to choose suitable conditions.
2. To place refugia as densely as realistically possible. Given that the species moves only short distances daily (Smith, 1990), refugia need to be placed in close proximity to the Slow-worms rather than assuming that Slow-worms will disperse to the refugia.

Undertaking sufficient capture effort is all the more important given that in many cases it is impossible to determine Slow-worm population size from initial surveys due to both the difficulty of individual recognition (Baker *et al.,* 2004) and the species' fossorial lifestyle (Platenberg, 1999). Increases in total capture rate are due to individuals being found across a greater proportion of the site, rather than increased density of capture per garden. On days with fewer captures, those found were mostly in the key 'hotspots'. Increases are therefore due to Slow-worms being found over a larger area, rather than higher densities being found in key areas.

The period between single pairs of visits does not have an effect on capture success (e.g. in terms of disturbance or having depleted numbers locally by the previous visit's captures), but increased disturbance does have an effect over longer periods. With an average of three visits per week, individual disturbance events (i.e. shorter periods between pairs of visits) do not reduce capture success, but a series of closely-spaced visits within one week does reduce capture success. As refugia density was reduced in areas where captures had fallen to zero, and refugia moved to areas of high capture rate, it can not be clearly determined whether disturbance or depletion of numbers is the reason for this result. However, if the number of visits is limited, the result suggests that it is better to spread them evenly. There is no evidence that leaving longer gaps and thus introducing periods of low/zero disturbance increases the number found. Conversely, when refugia were moved or suffered unplanned disturbance, Slow-worms were very often found beneath them the next day, whereas if an entire garden was disturbed (e.g. by grass-cutting), Slow-worms were not found there for some weeks if at all, even once vegetation had regrown. This suggests that the usual 'settling in' period for refugia (often considered to be around 10 days) may not be essential, but that if Slow-worms suffer enough disturbance to move away from one location, their sedentary behaviour means that the recolonisation period may be considerable.

Increases in capture density were due to increased capture of juveniles and adult females, but not adult males. This implies that adult females and juveniles can become more active with adult males level of activity remaining the same. Given the correlation with maximum daily temperature, this indicates that factors other than temperature were important in determining activity levels. A number of reasons for the difference between male and female-juvenile activity are suggested:

1. Adult males populate the best areas of habitat and have no need to move. It is already known that males emerge from hibernation before females.
2. Adult females may use these periods to move to locations relating to reproductive activity such as courtship, mating and birth.
3. Juveniles may use these periods to seek new home ranges, although these may overlap considerably as Slow-worms are not territorial.

Following the end of translocation work in 2005, areas of suitable habitat were managed in order to concentrate any remaining Slow-worms in small areas such as grass piles, compost heaps and dense piles of other debris. Along with the removal of any loose household debris, this requires the cutting of grass around these areas, with cuttings being collected and either disposed of or used as habitat piles as appropriate following consulatation with an experienced ecologist. This concentrates the remaining population in a smaller overall area, renders densely vegetated areas accessible for searching, and facilitates future capture. Phase 2 of translocation work began in March 2006 and is planned to continue until September 2006 to ensure that the requirements of a full season and sufficient number of visits has been met according to HGBI guidelines (1998). This will also prevent recolonisation between the end of the survey and the start of the second phase of development in late 2006. A survey is planned which will assess the success of translocation.

Evaluation

The data gathered during this study helps to explain the effects of sampling strategy on capture success and provides some information about the aspects of population dynamics relevant to Slow-worm capture and translocation. It is important to note that data gathering was a secondary aspect of a translocation programme undertaken as consultancy work. Therefore, although this work was undertaken with data gathering in mind, its primary aim was to capture as many Slow-worms as possible during the alloted visits. Gardens without Slow-worms were removed from the programme while areas with abundant populations were sampled more intensively. Along with differences in accessibility between gardens, this means that capture effort was not evenly distributed across the site in terms of either density of refugia placement or number of visits. However, care was taken to collect data in as consistent and thorough a manner as possible given these constraints.

ACKNOWLEDGEMENTS

Our thanks go to Dave Butler of Croudace Ltd. and Debbie Harvey of Drum Housing Association for their help during the translocation. Also, we are most grateful to the residents of Grange Road and Borough Grove for allowing us access to their gardens.

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Intermediate forms and syntopy among vipers (*Vipera aspis* and *V. latastei*) in Northern Iberian Peninsula

FERNANDO MARTÍNEZ[1]*, JOSÉ C. BRITO[2,3] and MIGUEL LIZANA AVIA[1]

[1] *Dpto. Biología Animal, Parasitología, Ecología, Edafología y Química Agrícola, Facultad de Biología, Universidad de Salamanca, Campus Miguel de Unamuno, 37007 Salamanca, Spain*

[2] *CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Instituto de Ciências Agrárias de Vairão, R. Padre Armando Quintas, 4485-661 Vairão, Portugal*

[3] *Dpto. Zoologia e Antropologia, Faculdade de Ciências da Universidade do Porto, 4099-002 Porto, Portugal*

*Address for correspondence: *Pazos de Reis, Circos 26. 36715 Tui, Pontevedra, Spain*
E-mail: *flyssi@lycos.es*

THE general distribution pattern of the European vipers is mostly parapatric (Saint-Girons, 1980). However, several biogeographical studies conducted in contact zones between the distributions of different species confirm an allopatric distribution at a local scale (Saint-Girons, 1975; Saint-Girons, 1980; Saint-Girons & Duguy, 1976; Duguy & Saint-Girons, 1978; Monney, 1996; Bea, 1985; Naulleau, 1986; Brito & Crespo, 2002). Only a few cases of syntopy between European vipers have been reported, mostly between *Vipera aspis* and *V. berus*, such as in a narrow band of 1–2 km in the Atlantic-Loire region, west of France (Saint-Girons, 1975), and in a 70 ha area in the Pre-Alps, west of Switzerland (Monney, 1996).

In the Iberian Peninsula there are three viper species, one Euro-Siberian, *V. seoanei*, and two sibling Mediterranean species, *V. aspis* and *V. latastei* (Garrigues *et al*., 2005), which have several contact zones in their distribution areas. Biogeographical analysis of contact zones between no-sibling species, such as between *V. seoanei* and *V. latastei* in Peneda-Gerês National Park, northwest Portugal, or between *V. seoanei* and *V. aspis* in the Spanish Bask country, revealed differential habitat selection patterns, even opposite, suggesting an allopatric distribution at the local scale (Bea, 1985; Brito & Crespo, 2002). The two sibling species, *V. aspis* and *V. latastei*, exhibit a wide contact zone with populations in apparent sympatry south of the Pyrenees, northeast Spain (Pleguezuelos *et al*., 2002). However, *V. aspis* selects fresh and humid areas in north-faced slopes whereas *V. latastei* selects rocky and dry areas in south-faced slopes, thus no syntopy was detected (Duguy *et al*., 1979; Pleguezuelos & Santos 2002). In this area, some specimens are difficult to classify as belonging to *V. aspis* or *V. latastei* due to intermediate morphological traits between these vipers in the snout, shape and colour pattern (Duguy *et al*., 1979; Gosá, 1997).

Sympatry between the three Iberian vipers was reported for an area located in the high course of Ebro River (Fig. 1A), between south-eastern of Santander and north-western of Burgos provinces, northern Spain (Duguy *et al*., 1979; Barbadillo 1987; Pleguezuelos *et al*., 2002). In this area, sympatry was reported at a regional scale (10x10 km UTM squares), but nothing was known at the local scale. In this note it is reported syntopy and intermediate morphological traits between the two sibling Iberian vipers for northern Spain.

The study area covers 1.200 km^2 and it is located in the transition between Euro-Siberian and Mediterranean regions (latitude 42º37.7'N to 42º58.7'N and longitude 3º58.5'W to 3º37.3'W). It consists mostly in limy plateaus excavated by the Ebro River and its tributaries, Rudrón and Panero rivers, forming canyons and sloppy valleys (Fig. 1B). Altitude ranges from 590 to 1256

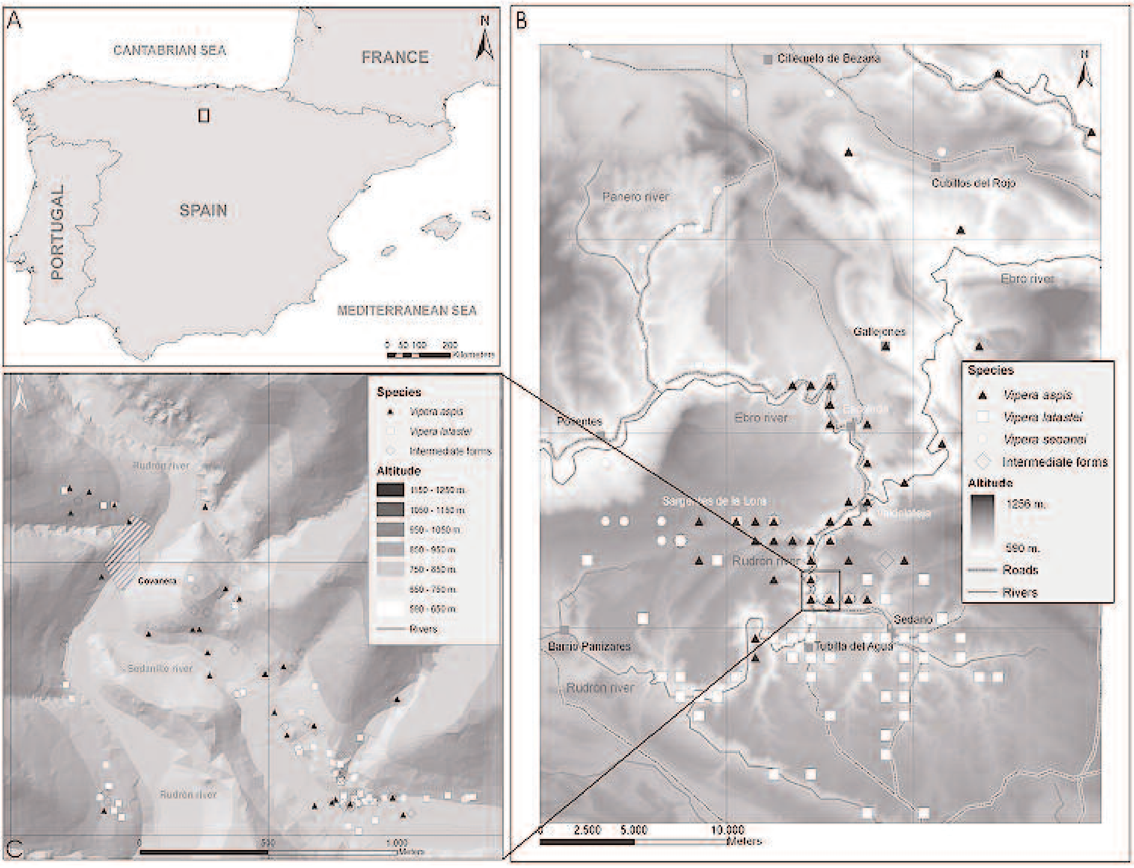

Figure 1. A) Geographic location of the study area in the Iberian Peninsula. B) Distribution of the three vipers and the intermediate forms between *Vipera aspis* and *V. latastei* based on UTM 1x1 squares. C) Distribution of *V. aspis*, *V. latastei* and intermediate forms in the sympatry area.

m.a.s.l. Climate is sub-humid Mediterranean with Central European tendency (Andrade, 1990). Although the most representative bioclimatic stage is the Supra-Mediterranean there are elements of the Mountain stage of the Euro-Siberian region, mostly in the northern and north-western areas (Rivas-Martínez 1987). Correspondingly, the climate is characterised by low levels of precipitation, average annual rainfall of 740 mm/year (range: 614-959 mm/year), low average annual minimum temperature (-0.8ºC, ranging from -2.0 to 0.0ºC) and high average annual maximum temperature (25.9ºC, ranging from 22.8 to 28.0ºC) (SIGA 2005).

Between March 2004 and October 2005, visual encounter surveys based in UTM 1x1 km squares and road sampling were performed throughout the study area. Specimens were captured by hand and their geographic location (UTM coordinates in the European-1950 datum) was recorded with a G.P.S. Specimens were sexed, measured, counted for pholidosis, photographed, and classified as *V. seoanei*, *V. aspis*, *V. latastei* or intermediate forms. Criteria for the classification of specimens included a combination of morphological traits: 1) snout elevation and number of apical scales: very small snout with two apical scales in *V. seoanei*, snout slightly upwards with two to three apical scales in *V. aspis* and snout upwards, forming an appendix with three to nine apical scales in *V. latastei* (Bea, 1998; Bea & Braña, 1998; Braña, 1998a; Brito *et al*., 2006); 2) shape of the dorsal stripe: alternated cross bands with a thin vertebral line (type 0) or narrow angular zigzag (type 1) in *V. aspis* (Bea, 1998), wide zigzag (type 2) or rounded-rhomboidal marks running together to

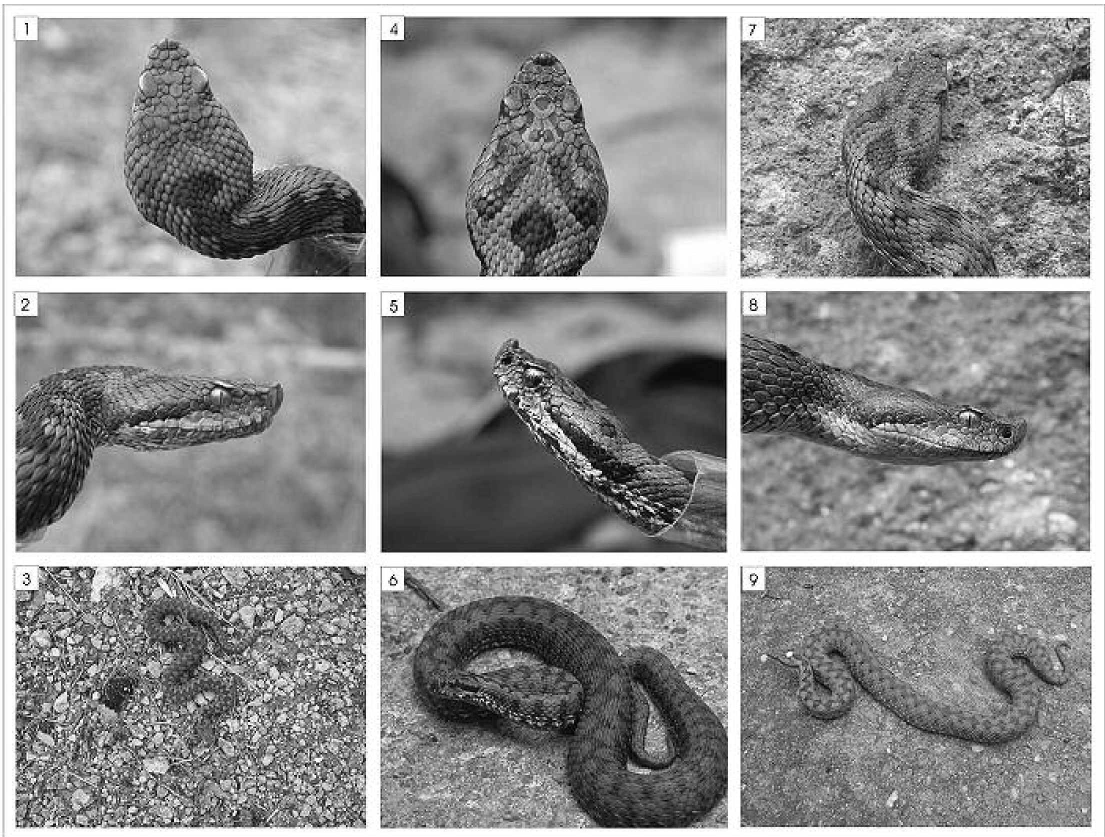

Figure 2. Three specimens collected in the sympatry area classified as intermediate forms between *V. aspis* and *V. latastei*: sub-adult male with two apical scales, dorsal pattern type 2 and 51 dorsal marks (1, 2 and 3); adult male with three apical scales, dorsal pattern mixture of types 1/2, and 48 dorsal marks (4, 5 and 6); adult female with five apical scales, dorsal pattern mixture of types 1/2, and 46 dorsal marks (7, 8 and 9).

form a wavy or zigzag stripe (type 3) in *V. latastei* (Bea & Braña, 1998), and short alternated or opposite bands with a wide vertebral line (type 4) in *V. seoanei* (Braña, 1998b); 3) number of dorsal marks: 60 to 80 in *V. seoanei*, 45 to 78 in *V. aspis* and 33 to 57 in *V. latastei* (authors, unpublished data). Specimens were classified as intermediate forms when exhibiting contradictory or intermediate morphological traits.

A total of 327 specimens were collected, 12 belonging to *V. seoanei*, 138 to *V. aspis* and 124 to *V. latastei*. *Vipera seoanei* was restricted to the north and north-western zone of Euro-Siberian influence, and occupied pastures and meadows (Fig. 1B). At a local scale, no syntopy was found between *V. seoanei* with the other two vipers. This allopatric distribution seems to be similar to the pattern identified for north-western Portugal (Brito & Crespo, 2002), where differential habitat selection precludes sympatry. *V. aspis* was distributed throughout the central and north-eastern zone while *V. latastei* occurred in the southern zone (Fig. 1B). Both species selected similar habitats, but *V. aspis* tended to select more humid habitats and with denser vegetation cover than *V. latastei*.

Vipera aspis and *V. latastei* were located in sympatry in the central zone of the study area, in the middle-lower course of the Rudrón river, lower course of its tributary Sedanillo River and in La Lora Plateau (Fig. 1B). These were characterized by the abundance of abandoned fields with disaggregated stone walls, herbaceous vegetation and thorny bushes. The sympatry area was a 15 km east-west oriented band and a total of eight UTM 1x1 km squares were detected with the two sibling species present (Fig. 1B and 1C). Fifty three specimens with intermediate morphological characteristics between *V. aspis* and *V. latastei* were collected in 13 UTM 1x1 square mostly inside the sympatry area (Fig. 1C). These specimens presented two to five apical scales, the shape of the dorsal stripe including type 1, mixture of types 1/2 and types 2/3, and with 37 to 59 dorsal marks (Fig. 2). Intermediate forms were not observed in nearby populations of *V. aspis* to the north and *V. latastei* to the south (authors, personal observation). No intermediate specimens were detected between *V. seoanei* with *V. aspis* or with *V. latastei*.

During spring mating season in the sympatry area some specimens of *V. aspis* and *V. latastei* were found together in syntopy, forming part of mixed populations with typical specimens of each species and intermediate forms. The occurrence of intermediate forms and syntopy between specimens of both species during the reproductive period suggests that hybridization between *V. aspis* and *V. latastei* may occur. In order to enlighten this question and establish the correspondent evolutionary scenario according to the allopatric speciation theory (Brown & Lomolino, 1998; Garrigues *et al*., 2005), further studies about gene flow and comparative biology of these two sibling species are currently being developed.

ACKNOWLEDGEMENTS

This study was partially supported by the project POCTI/BIA-BDE/55596/2004 from Fundação para a Ciência e Tecnologia (FCT, Portugal). F. Martínez-Freiría was supported by PhD grant (AP2003-2633) from Ministerio de Educación, Cultura y Deporte (Spain) and J.C. Brito was supported by a Post-doctoral grant (SFRH/BPD/11542/2002) from FCT. Authors acknowledge "Asociación Sociocultural Hoces del Alto Ebro y Rudrón".

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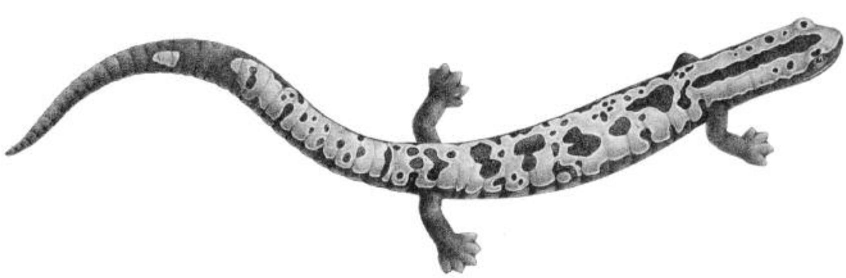

Spelerpes variegatus = *Bolitoglossa mexicana*. Reproduced from an original lithographic plate in *Biologia Centrali-Americana; Reptila and Batrachia* (Albert C. L. G. Gunther, 1902).

Herpetological observations on the Greek islands of Kefallinia and Zakynthos

MATT J. WILSON

48 Harehill RD, Littleborough, Lancashire OL15 9HE, UK
E-mail: *mjwilsonherp1@yahoo.co.uk*

ACQUIRING information on the herpetofauna of Kefallinia and neighbouring islands is somewhat difficult, and when this information is located, it is not in plentiful supply. Very little has been published on reptiles and amphibians in the Ionian Islands, except Corfu, probably due to the variety of species present there. Relatively recent contributions on the islands of Kefallinia and Zakynthos include that of Clark (1970), *"Observations of the lizard and snake fauna of the islands Kephallinia and Zakynthos, Ionian Sea, Greece",* and also of significance is that by Keymar (1986), *"Amphibians of the Ionian region: their origin, distribution and future".* Mention must also be made of D. Kock, whose work elsewhere in the Ionian group is also considerable. One of his papers *"Zwei Schlangen neu fur Kephallinia, Ionische Inseln, Grieschenland* describes the first records of two species on Kefallinia. These islands have developed a stronger summer tourism schedule and they are becoming more popular with holidaymakers. Zakynthos in particular has suffered greatly form the effects of tourism and many species on this island are in apparent decline (pers. obs.). Kefallinia is yet to develop large tourist centres but it is perhaps only a matter of time before this island too suffers in the same way others have from development and construction destroying animal's habitats. The aim of htis article is to give a better view and understanding of species composition on the two islands, and provide further information on abundance and distribution. Results are based on a number of field visits undertaken by the author in June 2003 (8th–22nd), May 2004 (1st–15th, and May 2005 (5th–12th)respectively, most time being spent on Kefallinia.

GEOGRAPHY

Kefallinia is the largest of the Ionian Islands and is almost twice the size of neighbouring Lefkada, with a distance of 90 kilometres from the Skala region in the far southeast to Fiskardo at its most northerly point. The island has very cold winters, contrasted by very hot, dry summers during which – as elsewhere in Greece – the majority of water sources dry-out. Kefallinia is a mountainous island, and is generally drier than others in the Ionian group. The most evident and impressive peak is Mount Ainos, which reaches a height of almost 1630 metres. This mountain is a National Park and was declared so in 1962, not due to its herpetofauna but the Cephalonian fir *(Abies cephalonica*), which covers the majority of the National Park. The altitudinal range over which the mountain extends includes habitats from rocky hillsides, humid forests comprised of the endemic fir and not surprisingly the majority of the island's reptiles are recorded within the National Park. Other prominent habitats on Kefallinia include vast expanses of agricultural land, mainly consisting of olive-groves, and less frequently, vineyards. The southern part of the island contains the most continuous areas of agricultural land, and is abruptly contrasted to the north by the slopes of Mount Ainos. Water sources are particularly difficult to come by on Kefallonia, although the large lagoon area situated in the island's capital Argostoli provides habitat for the Loggerhead sea turtle *(Caretta caretta*). During the spring there are freshwater streams that provide habitat for vast numbers of amphibians during the mating season, but once the summer approaches the majority of these dry-out, making amphibians more difficult to track down. Notwithstanding this, the majority of toads (*Bufo* spp.) can be found commonly on

Figure 1. The resorts of Kalamaki and Laganas, despite continuing development, still provide habitat for most recorded species on Zakynthos. All photographs © M. Wilson.

Figure 2. The most common amphibian of the Ionian islands, *Rana ridibunda* (Marsh frog) is found in most freshwater habitats on both Zakynthos and Kefallinia.

Figure 3. *Podarcis taurica ionica*, a widespread, common lizard on both islands.

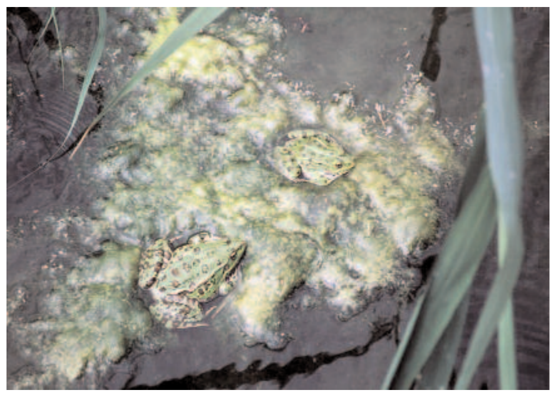

Figure 4. The Moorish gecko (*Tarentola mauritanica*), despite being an introduced species on Kefallinia and Zakynthos, is one of the most common reptiles.

Figure 5. *Algyroides nigropunctatus kephallithacius*, occupies a small range of just three islands, Kefallinia, Ithaca and Lefkas.

agricultural land, near human habitation. The island does have some permanent fresh-water sources; these are large ponds situated mostly on the eastern side at Koulourata and Agios Nikolaos.

Zakynthos is the third largest of the Ionian group and is a fertile island with an abundance of lush green vegetation. The island is 406 sq km in area and triangular in shape with its apex pointing northwest. Geographically, the ground surface can be divided into three parts. The first part north to south is Cape Skinari, a sparsely populated area dominated by Mt Vrachionas, which reaches a height of 756 m. The middle part starts from the north, from the bay of Alikes and ends at the bay of Laganas, taking in the plain of the town of Zakynthos. Here it is flat, and contains expanses of agricultural land, where most of the island's 400,000 inhabitants can be found. The third part comprises the eastern and south-eastern side of the island, up to the southern cape Yeraki, including Mt Skopos (492 m) and its foothills. Rivers flow along the southern bay of Laganas, and lakes at Alikes and Keri provide freshwater habitats for some species.

Species Accounts

Hyla arborea arborea (L.)

This species, a well-known member of Greece's amphibian fauna, is surprisingly known from perhaps only one or two record on Kefallinia. Keymar (1986) questioned its presence on the island, but confirmed its occurence on Zakynthos. Specimens were found and heard by mysefl on both

Figure 6 (top). *Elaphe quatuorlineata* is not uncommon in southern Zakynthos. **Figure 7** (lower left). *Malpolon monspessulanus*, a very common species on Kefallinia. **Figure 8** (lower right). Due to shortage of fresh water sources the future of *Emys orbicularis* (pictured) on Zakynthos, and *Mauremys rivulata* on Kefallinia is uncertain.

islands. On Zakynthos, examples were found near Laganas bay on the south coast, as well as further inland at the villages of Moyzakioy and Ampelokipi. DOR (dead on road) specimens were also observed near to a small church in the same area. Loud calls were heard every night at my Kalamaki and Gerekas accommodations, as well as the stream passing through Laganas leading to the main beach area. In particular, near to the main Kalamaki road, the chorus was especially loud and persistent, denying me much sleep as the frogs seemed to be located in a nearby garden. On Kefallinia this species was scarcer, the only examples found being at the southern lush area of Livathos, where there are many small villages. Strangely the only water sources seen in the area were roadside ditches that had already begun to dry out.

Bufo bufo spinosus (L.)
Even more so than the previous species, records of this toad from the southern Ionian are scarce. However, examples were found on both islands, especially Kefallinia. On this island the species was recorded mostly from specimens found dead in dry remote areas, these being near to dry streambeds near to lake Ag. Nikolaos, where six very large dead specimens were found. These appeared to have died due to hot, dry conditions of which this species is usually quite tolerant, as all were heavily emaciated. A 15 cm adult was found hiding within a dry stone wall close to Lake Avithos one evening. A single DOR adult toad was found near to the village of Vassilikos on Zakynthos Island where the species appeared less abundant.

Bufo viridis viridis (Laurenti)
As elsewhere in the northern Ionian, being a common species on Corfu, this toad was abundant in agricultural areas of both islands, preferring flat regions on the south coast. It was evident however over much of both islands. On Kefallinia several specimens were observed within the Livathos region and surrounding villages, as well as many toadlets in small sand dunes at Katelios and within a dried out river bed passing through the town of Lixouri in the western peninsula. Tadpoles were also seen at most minor water sources in the eastern area of the island. Similar habitats were observed on Zakynthos, particularly the flat regions near to the resorts of Laganas and Kalamaki, where several toads were found, as well as many other animals killed by vehicles.

Rana ridibunda (Pallas). Figure 2.
A common frog on both islands, found wherever temporary or minor fresh water sources were available. Its abundance did vary, however. This species was observed in relative abundance at marshes near to the village of Zola on Kefallinia, as well as in roadside ditches near Svoronata and the airport boundary fence. Examples were also found at the few remaining areas of water in the Lixouri river. Streams in the eastern areas of the island also contained a relative abundance of frogs, but not however compared to populations in such areas on Corfu or the adjacent mainland. On Zakynthos this frog was often encountered within concrete cisterns, many of which appeared to be in imminent threat of destruction due to building work. Roadside ditches at the southern inland villages were also utilised by this species, being most abundant within the Laganas river. Specimens were also seen at Gerekas, in garden ponds.

Triturus vulgaris graecus (L.)
The only tailed amphibian known from the southern Ionian was recorded only on Kefallinia; its presence on Zakynthos remains unknown. Examples were mostly still in larval stages at Lake Avithos and within roadside ditches at Svoronata, where an adult was also found.

Podarcis taurica ionica (Pallas). Figure 3.
This was a very common species on both islands, being found in almost all locations, including the capital cities of Argostoli and Zakynthos town. On Kefallinia it was most abundant close to sea level and in coastal areas; it became scarcer once a certain altitude was attained on Mount Ainos, where only occasional individuals were seen. Animals were observed mating within the valley of Zervata, as well as near to my apartment balcony in Svoronata. Many specimens were also found killed on the roads and path edges. This species was found to be most common within the flat coastal areas of southern Zakynthos, especially along road edges passing through inland villages near Laganas. It was found at every location visited, including Keri Lake, Gerekas, Zakynthos town and Argassi, all being well inhabited tourist areas. However, when

cloudy weather was apparent very few Wall lizards were encountered, most often heard rustling in bushes near to the path edges on which they often bask, waiting for the sunlight to return.

Algyroides nigropunctatus kephallithacius (Duméril and Bibron). Figure 5.
Unlike the previous species, this lizard is found only on Kefallinia, where the subspecies *kephallithacius* occurs (also found on Ithaca and Lefkas). Obserservations of specimens have previously been reported from Zakynthos, but it seems likely that these were in error (*A. nigropuctatus* is absent from the adjacent mainland). Both males and females have differing characteristics to those found on Corfu and areas of northern Greece. The distribution of this species was quite patchy, and appeared to be far less abundant. In contrast to my observations on Corfu, it was not found near human habitation, being most common within shady valleys near streams, and was often found coniferous forest basking in patches of sunlight penetrating through the trees. Most specimens were seen basking on tree trunks and low stone walls. Some were found in olive-groves in the valley of Zervata, these again being well shaded and away from human habitation. The species also seemed to prefer higher altitudes well above seas level, being found at a height of 1,200m on Mt. Ainos in well shaded *Abies* forest, and was relatively common where sufficient sunlight was able to penetrate through the trees.

Algyroides moreoticus (Bibron & Bory de Saint-Vincent)
A common lizard on both islands, being a representative of the Peloponnesian herpetofauna, this species would appear to be widespread and abundant given the right conditions. It has previously been reported from both islands by Clark (1970), who found specimens at Zervata and Valsamata on Kefallinia and at the village of Volimai on Zakynthos.

On both islands it was found to be most abundant during cloudy weather and in late evening, especially around dusk. Principal habitats were path edges in agricultural areas near the coast. On Kefallinia these habits were noted with the area of Livathos, were several males and females were seen together. Males lacked the white markings typical of specimens in reproductive condition, these markings instead often being green or yellow. Females were observed at higher altitudes (1,200m) on Mt Ainos. As *A.nigropunctatus* also occurs on Kefallinia, this species was more often found in habited areas, even behind well-used beaches and on heath-land, where *A.nigropunctatus* was absent.

It was generally less abundant on Zakynthos, possibly due to warm weather during the trip. Most animals were seen one one overcast day.

Lacerta trilineata trilineata (Bedriaga)
Despite being a well-known and common member of Greece's herpetofauna, this species was surprisingly uncommon on both Kefallinia and Zakynthos. Clark (1970) did not report finding this species on Zakynthos, whereas a few animals were seen on Kefallinia. My own observations were similar, although examples were found on Zakynthos. Kefallinian specimens were often seen sporadically during my two trips to the island, at Lassi, Svoronata, Valsamata, Mt Ainos, Fiskardo and Farsa. It was observed in some abundance on areas of heath-land near to beaches in Lassi. Dead specimens were seen on the main road on Mt Ainos, and several other either basking or crossing roads at the base of the mountain near the village of Valsamata. Similar observations were made in the north of the island at the fishing village of Fiskardo.

This species was an even rarer sight on Zakynthos, being identified at only two localities, with no specimens seen on the south coast at Laganas and Kalamaki or in any of the inland villages. It seemed to be abundant only on the hillsides behind Gerekas beach, where animals with the typical blue throat more reminiscent of *Lacerta viridis* (Cyren, 1933) were encountered. The few adults seen preferred to bask at the base of vegetation along dirt tracks.

Ablepharus kitaibelli kitaibelli (Bibron & Bory de Saint-Vincent)
This secretive skink has been previously reported from both islands, and I was able to observe a few specimens on each myself. The shy nature of this species resulted in the finding of only two animals on Kefallinia. The first was seen basking on a

boulder at the entrance to the national park of Mt Ainos. The second animal was seen moving in a serpentine motion through pine-tree leaf litter behind a beach in Lassi. This animal was able to effectively hide within fallen leaves.

Only one animal was seen on Zakynthos. It was moving through leaf litter on a hillside near to Kalamaki beach.

Tarentola mauritanica mauritanica (L.). Figure 4.
This gecko is believed to have been introduced to the southern Ionian Islands from N. Africa, and would appear to be common on both Kefallinia and Zakynthos, in a wide and varied range of habitats. The only time this species was not encountered was late morning and early afternoon; at other times it could be seen basking, fully exposed to the sun. It was more often seen early morning and in the evening around dusk basking on olive-tree trunks and on dry hillsides next to patches of vegetation. After nightfall several animals would congregate around outside lights catching insects. Some very large specimens measuring 10cm were captured on my apartment balconies on both Kefallinia and Zakynthos. Animals seen during the day were a brown colour, whereas specimens seen at night were a grey colour in comparison.

Hemidactylus turcicus turcicus (L.)
Unlike the previous species, this gecko does not seen to occur on Zakynthos, I myself finding it only on Kefallinia. No animals were found during daylight hours, all specimens being observed only around night-lights in the evening and throughout the night. Various sizes were observed from very small juveniles to large adults at the resorts of Lassi and Svoronata.

The presence of this species on Zakynthos is unknown, although it can be expected, as it is present on the Peloponnesian mainland.

Cyrtopodion kotschyi (Steindachner)
Previous knowledge of this Peloponnesian species from the Ionian are scarce, although recently Buttle (1999) found four specimens on Zakynthos. However during my trip no animals were seen on this island, and only one specimen was observed on Kefallinia. This animal was hunting mosquitoes close to an outside light at about 21:00 hrs in the resort of Lassi behind the main beach area. Many other geckos were seen in the vicinity that may have been representatives of this species, but disappeared before they could be positively identified.

Anguis cephallonicus (Werner)
Now considered disitinct from *Anguis fragilis,* this species is characterised by a longer head in adults and longer tail, as well as a general larger appearance. As well as being present on the Peloponnese mainland it is found elsewhere only on Kefallinia and Zakynthos. Although I was able to observe animals on both islands, unfortunately these were all found dead on roads. Generally the species seemed relatively secretive and very difficult to track down in warm conditions. On Kefallinia two freshly killed adults measuring 40cm and 35cm were found at the village of Svoronata. A juvenile was also discovered next to an olive-grove, all three animals being found after a very rainy night within the early hours before the afternoon. No further examples were found on Kefallinia.

Similar observations were made on Zakynthos where two dead adults were found. The first was found after a rainy night by the side of the main Kalamaki road in a rather flattened state and measured 25cm. The second animal was found freshly killed on the pavement of the main bar/night club strip in Laganas! This animal was larger; despite having most of the tail missing it measured 40cm.

Pseudopus apodus thracius (Pallas)
This large anguid lizard was found to be uncommon on both Kefallinia and Zakynthos. Only one specimen was observed, this being on Kefallinia. It should however be stated that weather conditions during the trip were not ideal for this species. At the village of Petrikata a large adult measuring 75cm was found dead next to the main village road. The wounds were quite fresh and the animal had been discovered after a rainy night.

No examples were found on Zakynthos, although recently Buttle (1999) found an adult on a hillside behind Sekania beach in the eastern part of the island.

Dolichophis (Coluber) caspius (Gmelin)
As this species is absent from the Peloponnesian mainland its occurrence on Zakynthos is doubtful.

On Kefallinia, however, it was found in be relatively abundant. During my first visit in June 2003 three specimens were found. The first was an adult measuring 125cm that appeared to have been beaten to death. No wounds from a vehicle etc were evident and it was discovered at the side of a path next to a group of newly constructed holiday villas in the village of Svoronata. The markings were unlike the striped specimens found on Corfu and were more typical of *caspius* elsewhere in Greece. Further to this a finding of a dead juvenile measuring 30cm on the main road leading from Lassi to Argostoli. A sloughed skin was also found near here.

The only live example seen was a juvenile seen crossing the main road at the western resort of Lixouri. A relatively recent record of this species is that reported by Clark (1970) stating the capture of a specimen at Valsamata.

Hierophis (Coluber) gemonensis (Laurenti)
Despite having been recorded on both islands, from the author's experience this species can be regarded as very rare on Kefallinia. No evidence of its occurence here was found at all during several excursions. Currently, only one record exists from Kefallinia based on an observation reported by Koch (1979), who found a specimen at Aghia Efimia on the north-eastern coast of the island.

Its rarity on Kefallinia is contrasted, however, by its abundance on Zakynthos, where a considerable number of examples were found during the week spent there. The first specimen was found dead, and was a juvenile measuring approximately 20cm found directly behind Kalamaki beach. The first live example was seen on a sunny morning basking at ground level on a hillside near to Kalamaki beach not far from the path leading onto Mt Skopos. Another adult, approx 100cm was found basking next to a path edge along a coastal route at the bay of Gerekas. A few days later another adult, was seen hunting along the same track and remained still for several minutes at 10:00am on a cloudy morning. A number of dead adults and sub-adults were found on roads at Laganas, Kalamaki, Vassilikos, and the village of Moyzakioy.

Elaphe quatuorlineata quatuorlineata (Lacepede). Figure 5.
Previously this species has been reported from both islands. Clark (1970) found two sloughs of the species at Zervata on Kefallinia, and recently Buttle (1999) observed several specimens in southeastern Zakynthos. On the former Island, no evidence of the species was found at all, despite prolonged attempts in suitably ideal looking habitat. However on Zakynthos, the author found this species to be very abundant in suitable habitat. A total of seventeen examples were found during a week spent on Zakynthos in early spring. Most of which were found killed on roads, and more interestingly, most were juveniles with an average measurement of 30-40cm. Around Laganas and Kalamaki this snake was common. A large adult was found on an area of sand dunes behind the main Kalamaki beach and measured 170cm. Many dead juveniles were found near to my accommodation slightly inland at Kalamaki, as well as near to inland streams and rivers near to Laganas. A live juvenile was captured at the side of a road passing through the village of Moyzakioy on a sunny morning, it measured approx 45cm. Further to this a sub-adult, measuring 85cm was found moving slowly along a track just off the Gerekas trail on a warm afternoon. Although initially it made several attempts to bite, it calmed down very quickly. A juvenile was also found near to Gerekas, next to a field edge. More juveniles were found on the main road from Vassilikos to Gerekas. This was in an area of pine forest where bird hunters often congregate in great numbers at this time of year.

Zamenis (Elaphe) situla (L.)
This beautiful snake has been recorded on both Kefallinia and Zakynthos, where it would appear to be quite secretive and uncommon. Having said this a few examples were found. One adult, measuring 80cm was near to the fishing village of Fiskardo at the smaller inland area of Mangonas, at the most northern tip of Kefallinia. Unfortunately however the author was too late in preventing several locals from attacking the snake, which was moving along the edge of a garden wall, and it subsequently died shortly afterwards from the injuries inflicted by stones and rocks. Two specimens were found during the week on Zakynthos, both measured approx 30cm in total length. The first was found freshly killed next to an olive-grove just off the main road leading down to the Gerekas bay. The other animal was found killed by the side of a busy main road leading directly towards Zakynthos town from Kalamaki.

Natrix natrix persa (L.)
With both Kefallinia and Zakynthos lacking in ponds and other sources of fresh water, it initially appeared that finding this species maybe somewhat difficult. However, quite a number of specimens were observed, especially on Zakynthos. On Kefallinia, only one example was found, this being caught in a small stream passing beneath the main road through the valley of Zervata. After having first disturbed the snake, it returned several minutes later and was captured whilst moving over the author's foot. It measured 70cm and lacked the typical stripes of *persa*. However, the usual stripes were found on the snakes seen on Zakynthos. The first of these was floating on its back in the main Laganas river. It was not evident how the snake had died; when its recovery from the water for examination its length measured an impressive 120cm. Minutes later a live specimen was seen trying to negotiate the bridge wall and subsequently failed, several times falling back into the water before eventually moving off down stream. A dead hatchling was also found on the bridge road in this area. Two other hatchlings were found near to the sand dune system directly behind the main Kalamaki beach.

Malpolon monspessulanus fuscus (Hermann). Figure 7.
This is a common species, with a wide European distribution, and is a well-known member of Greece's Herpetofauna. Previous records of its occurrence are available for both islands. This species was relatively abundant on Zakynthos, but found to be particularly common on Kefallinia. In total, during four weeks spent on Kefallinia, upwards of sixty snakes were found killed on roads throughout the island. With such a large number of snakes present many live examples were also observed. During the first excursion to Kefallinia five live examples were seen. The first was seen moving quickly near to an area of marshland near to the village of Zola. Another was found crossing the road near to the town of Lixouri and was struck by a vehicle and had to be euthanised. Many dead snakes were also found on this road. At the village of Svoronata a large adult was seen moving along a drystone wall on a warm afternoon and disappearing very quickly. About a dozen dead juveniles were also found on the road from Lassi to Svoronata. A large dead male measuring 160cm was also found freshly killed beside a small road in the Livathos region. On the final day of the first trip to Kefallinia the author was summoned to rescue a snake swimming in the sea off one of the island's most crowded beaches at Lassi. After swimming out about eight metres a sub-adult was found swimming on the surface and was flushed onto the beach were it was captured and released elsewhere. It reacted very aggressively and had to be forcibly restrained for photography. The second trip to Kefallinia resulted in the finding of many more live examples of this species. Several large adults were seen basking in areas of bramble near to my accommodation in Svoronata. Most mornings at least two examples could be found sunning themselves in the same area. A number of dead snakes were found on roads throughout the busier areas of the island near to the capital Argostoli. A sub-adult crossed the main town road in front of my vehicle in a small area of pine forest. At the valley of Zervata another animal was captured crossing the road at midday, another snake had to be euthanised on this same road a few days previously. Towards the end of the excursion a large male measuring 175cm was found killed on the main Lassi to Svoronata road in the late evening. Finally, an adult which had retained juvenile colouring was caught on the edge of a field near to the airport boundary fence, where a number of dead specimens were also observed. Upwards of a dozen sloughs were also found in various habitats from olive-groves, stonewalls, gardens and beaches.

On Zakynthos only seven examples were found, only two of which were live specimens. Near to the main road on Mt Skopos a dead adult was found, and a live snake was found basking in the same area at about 17:00 hrs. The second live example was found basking beneath a bush near to a path at the bay of Gerekas. An adult was found dead on the main road leading to Keri lake, the final animal was observed at Kalamaki.

Telescopus fallax fallax (Fleischmann)
This interesting nocturnal species is particularly well known amongst Kefallinians as a snake of the Virgin Mary. On 15th August this snake is used in religious ceremonies at the villages of Arginia and Markopoulo on the southeastern slopes of Mt

Ainos. Although it is also known from Zakynthos, the only evidence of its occurrence on Kefallinia was from Mt Ainos. Two dead snakes were found on the main road leading to the peak of the mountain. The first was found at high elevation at the base of the National Park, it was in a rather flattened state and measured approx 30cm. The second snake was found freshly killed early one morning further down the main road near to the monastery near Gioupari. As the weather during the trip was quite hot the snakes must have been killed in the very early morning as nobody ventures onto the mountain at night when the species is most often active in hot weather conditions.

Vipera ammodytes meridionalis (L.)
Despite a number of herpetological excursions from various individuals, no record of this dangerously venomous snake can be found for Zakynthos. Although having discussed this with locals and shown photographs, most insist the snake does occur on the island; hopefully future surveys will reveal more. The author's attempt to discover any records of snakebite from the island also failed. Therefore this taxon was only found on Kefallinia, where a few examples were discovered. The first example was found killed just after the main area of tarmac road on Mt Ainos, along the dirt track that replaces it. It was a male, and measured approx 40cm. A few days later on a cloudy afternoon a juvenile female was found moving along a rocky hillside leading up to the main road on Mt Ainos, near to a small monastery of St Eleutherios, not far from the smaller Roudi Mountain. A young male, even smaller was found moving among small boulders in the same area a few days later. During the second trip to Kefallinia a large female, measuring 75cm was found next to the main road at the base of Mt Ainos, not far from the village of Valsamata in an area of Mediterranean maquis, with areas of farmland.

Emys orbicularis hellenica (L.). Figure 8.
After having read the herpetological paper *"Zum Vorkommen von Emys orbicularis hellenica auf Zakynthos"* by Richard Podloucky and Uwe Fritz, which describes the threat of extinction for this species on Zakynthos, it seemed a useful idea to follow up on their study. It is apparently only known to occur in the marshes and rivers near to Limni Keri in the southwestern area of the island. It was here that six specimens were observed during my week on the island. Two juveniles and four adults were found in a river that leads directly to the main beach area, and it was not found in any other wetland areas in the vicinity. Despite several searches at the Laganas river and other smaller freshwater habitats along the south coast no more examples could be found. Several areas around Limni Keri had been drained, and the main river in the area would appear to be the only remained stronghold for this species on Zakynthos. Records of the Terrapin are also known for Kefallinia, where the situation would appear even worse as no specimens were seen at all.

Mauremys rivulata (Valenciennes)
This taxon can be found on both Kefallinia and Zakynthos, and is generally a common fresh water species throughout its range. Unfortunately however on Kefallinia its presence may soon become a thing of the past. On this Island it was only found to be relatively common at one locality, a reasonably large area of marshland near to the isolated coastal area south of Zola near to the main road leading to Lixouri. At this locality about a dozen adults and juveniles were observed. However like other such habitats throughout Greece they have a tendency of being turned into local rubbish dumps. During the first trip to this area there was little evidence of this, however the second trip revealed an abundance of wastage and general pollution throughout. A large fence had even been constructed along the small path leading down the side of the area down from the hillside to prevent public access. After navigating this fence the area where the terrapins were present was in state of devastation, with fridges, cookers and various other items subsequently left along the edge as well as in the marshes themselves. Although this species is usually very tolerant of such conditions the author suspects that this locality, the island's only terrapin stronghold is destined to become a much larger dumping area as the presence of draining pipes was also sadly evident. Elsewhere, a single adult was found in small beach side pond at the resort of Skala. On Zakynthos it was found to be abundant in the rivers of Limni Keri, and a specimen was also seen in the Laganas river.

Testudo hermanni hermanni (Gmelin)
This species is previously known from both islands. Recently, Buttle (1999) found a previous year's hatchling near to Gerekas beach on Zakynthos, which appears to be a new Island record. The author did not find this species on Zakynthos, despite a prolonged search in the Gerekas area, which has suffered serious fires in recent years associated with the conservation of *Caretta caretta* in the area. As a result, such fires were probably responsible for considerable losses of tortoises around the Gerekas hillsides. On Kefallinia, three specimens were found. The first two animals, both sub-adults were found in a garden near to St Georges castle in the south. The other animal, a juvenile was almost trodden upon at the previously mentioned marshland area south of Zola, feeding along the edge of the marshes.

DISCUSSION

To conclude, it would appear that both Kefallinia and Zakynthos have significantly fewer species of herpetofauna in comparison to the more northerly island of the Ionian group, Corfu. The habitats on Zakynthos in particular did not appear to be as diverse as those found on Corfu, and throughout both islands there was a considerable lack of fresh water sources, especially on Kefallinia. This in itself leads me to believe that the future of *Emys orbicularis* on Zakynthos, and *Mauremys rivulata* on Kefallinia is uncertain, due to destruction of the few remaining habitats left for these animals on both islands.

Some taxa such as *Podarcis taurica ionica* and *Tarentola mauritanica* are especially common on both islands and seem to be found in almost every habitat. This can also be said for several of the snakes, such as *Malpolon monspessulanus*, *Coluber gemonensis* (only on Zakynthos), and *Elaphe quatuorlineata* on Zakynthos to a lesser extent. However the very large numbers of road-killed snakes on these Islands was certainly disturbing; around 80 dead snakes were found during four weeks on Kefallinia and 27 during a week on Zakynthos. Naturally, there is little than can be done about these unfortunate statistics, as development and tourism will only continue to expand and increase the pressure on the island's reptiles and amphibians.

There is still much to be learned regarding recording of new species, and the author is certain that there are taxa yet to be found on both islands. On Kefallinia a large sand dune system was noted but not explored near to the town of Lixouri, which may provide a habitat for *Eryx jaculus, and* similar dune systems were seen near to Laganas on Zakynthos, although the latter seemed less promising.

Rare species from both islands appear to be *Ablepharus kitaibelli*, *Cyrtopodion kotschyi*, *Zamenis situla, Telescopus fallax* and on Kefallinia, with only one recording ever, the elusive *Coluber gemonensis*. All four amphibian species are relatively abundant, even away from water in agricultural areas, apart from *Bufo bufo* on Zakynthos where only one dead example was found. It would appear that *Natrix tesselata*, and *Typhlops vermicularis* are not found on either island.

ACKNOWLEDGEMENTS

From Zakynthos I would like to thank Maddy and Yannis for their kind assistance with accommodation and transport during my stay at Gerekas. Secondly, I am deeply indebted to those who have conducted previous studies on the islands covered, and David Buttle for kindly sharing his contemporary observations with me from Zakynthos. Finally, I would like to thank David Bird for sending me countless amounts of literature for these islands as well as others over a number of years, and for his help during my first stay on Kefalonia when we made many recordings together.

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Microhabitat use by the Eastern worm snake, *Carphophis amoenus*

JOHN M. ORR

J.E.B. Stuart High School, 3301 Peace Valley Lane, Falls Church, Virginia 22044, USA

ABSTRACT — Soil moisture, soil pH, and temperature of microhabitats used by the Eastern worm snake, *Carphophis amoenus*, were measured at Mason Neck National Wildlife Refuge, Fairfax County, Virginia. Microhabitat soil moisture ranged from 10-83% depending on the season and year. Soil pH had a mean of 6.1. The range (5.0-6.9) was similar to the preferred range of the Eastern worm snake's main prey, the earthworm. Cloacal temperature was moderately correlated to air and substrate temperatures and varied significantly depending on time of day, season, or year. There were no significant differences between males and females or adults and juveniles for any of the parameters. Eastern worm snakes were found at a wide range of soil moistures, soil pHs, and temperatures. Eastern worm snakes, particularly males, showed site fidelity but were also capable of quickly exploiting new habitats.

THE Eastern worm snake, *Carphophis amoenus,* is probably the most common snake in northern Virginia (Ernst *et al.*, 1997). It is seldom noticed or studied, however, because of its small size, cryptic lifestyle, and lack of glamour, relative to other larger or venomous snakes. Little specific habitat data and no growth data exist for this species (Ernst *et al*., 2003). It is most often found under rocks and logs and occurs in a wide variety of habitats (Barbour, 1960). Barbour *et al*. (1969) found that its average home range is relatively small (253 m^2) and that its daily activity peaks between 15:00 and 18:00 hours. Hartsell (1993) studied the thermal ecology of *Carphophis amoenus* at the Mason Neck National Wildlife Refuge and found that air temperature, substrate temperature, activity, and daily high and low environmental temperatures may all help to predict the snake's cloacal temperature. The purpose of this study is to describe microhabitat use by the Eastern worm snake, *Carphophis amoenus*, and compare it to the Western worm snake, *Carphophis vermis*.

METHODS AND MATERIALS

The research was conducted from April 2001 through June 2003 at the Mason Neck National Wildlife Refuge, Fairfax County, Virginia (38°38'14"N,77°11'41"W). Mason Neck is one of several sites in the Washington, D.C. area known to have a large population of *Carphophis amoenus* (C. Ernst, pers. comm.). Creque (2001) estimated the snake's population size at the site to be 100 individuals, with a population density of 9.7/ha. The study site at Mason Neck is closed to the public and so receives minimal disturbance.

Sampling effort was concentrated in the spring months when *Carphophis* was most likely to be encountered (Creque, 2001), ended each fall in November prior to an annual deer hunt on the refuge, and resumed the following spring in late March or April. Coverboards, concrete blocks, large wood ties, sheets of roofing tin, and natural cover were checked periodically for *Carphophis*. Unfortunately, extensive tree roots from secondary growth trees limited digging, so pitfall traps could not be used. Because of their small size, the worm snakes could not be tracked with radio transmitters or tagged with PIT tags, and so captured snakes were marked with a numerical identification code by clipping their ventral scales. Soil moisture and pH of capture sites were determined at the time of capture with a KELWAY® Soil Acidity and Moisture Meter. In some cases, the soil was too thin or rocky and the moisture and pH could not be read and these measurements were not attempted when the snake was found inside a log. During the summer and fall of 2001, soil moisture readings were taken at a fixed location at a depth of 20 cm using a Delmhorst digital soil moisture meter and gypsum blocks. Days that worm snakes were encountered were compared to days that they were not encountered.

Cloacal temperatures, substrate temperatures, and air temperatures were recorded as soon as a snake was found. Cloacal temperatures were taken with a Miller and Webber Schultheis quick-reading cloacal thermometer accurate to 0.2°C. Gloves were worn to minimalize human heat transfer to the snake and the snakes were handled as little as possible while inserting the bulb of the thermometer into the cloaca. It was not possible to take the cloacal temperature of small juveniles, and if the snake required much handling to record its cloacal temperature that datum was discarded. Air and substrate temperatures were also taken at time of capture (including at the site where an individual snake had escaped) using a Hanna Instruments 9053 thermocouple thermometer. Air temperature was recorded at a height of 10 cm above the initial position of the snake. Substrate temperature was measured by inserting the probe under the cover item to the approximate position of the snake.

Snout-vent length and total length were measured by holding the snake along a measuring tape, and the snake's body mass was recorded with a 30 g Pesola spring scale. Cloacal temperature, air temperature, substrate temperature, snake behavior, sex, health, date, time, and location of capture were also recorded.

Data were analyzed using the SAS 8.2 program. Two sample t-tests were used to compare the means. A Mann-Whitney test was conducted to compare medians of fixed location soil moisture (Chase & Bown, 1997). Significance level for all tests was set a priori at < 0.05.

RESULTS

The mean percent of 62 soil moisture measurements was 53% (10–83%, *n*=62). No significant differences were found between the average soil moistures for males and females or adults and juveniles. Males had a greater range (10%–83%) than both females (35%–80%) and juveniles (29%–75%). Also notable is the difference in soil moisture at capture sites from month to month (Fig. 1) and from year to year. Mean soil moisture at the capture site for 2003 was 63.5% (35–83%), significantly higher (*p*=0.05) than the mean soil moisture for the corresponding months of 2002, 47.4% (28–60%). There was no statistical difference in the soil moistures at the sites where the *Carphophis* were found undergoing ecdysis. It is interesting to note, however, that all shedding events observed took place during the wet months of May and June, except for one observation in September. The median soil moisture at a fixed location was significantly higher for days that worm snakes were encountered, 91.3% (41.1–96.4%), than for days that they were not encountered, 21.4% (1.3–96.2%).

At Mason Neck, the mean soil pH of 62 capture sites was 6.1 (5.0–6.9). Mean soil pH did not differ significantly among adult males, adult females, or juveniles.

Mean cloacal temperature for the total sample of 110 adults was 22.4 °C (11.0–33.0 °C), that of 62 adult males was 22.1 °C (11.0–33.0 °C), and of 33 adult females was 22.5 °C (12.0–30.8 °C). The difference between sexes was not significant. It was not possible to compare body temperatures of juveniles and adults because of the difficulty in taking juvenile cloacal temperatures due to their small and narrow bodies.

Cloacal temperature was significantly correlated to both air temperature (r = 0.792) and substrate temperature (r = 0.768). Adults were found at a mean air temperature of 20.6°C (10.5–38.7°C) and a mean substrate temperature of 20.2°C (11.0–33.5°C). Juveniles were found at a mean air temperature of 20.8°C (13.5–29.6°C) and a mean substrate temperature of 20.5°C (12.7–32.3°C). Although juveniles made up 14.8% of the total captures for 2001 and 2002, none were found during July and August – the two hottest, driest months at Mason Neck. Most *Carphophis* eggs laid at Mason Neck hatch in late August or September (C. Ernst, pers. comm.)

Mean cloacal temperature for all snakes in 2003 (18.4ºC) was significantly lower than for the corresponding months of 2002 (23.3ºC) and 2001 (24.3ºC). The mean cloacal temperature for 2001 and 2002 combined was 24.0ºC, which was not significantly different from the means calculated in other studies at Mason Neck (Hartsell, 1993; Creque, 2001).

In this study, cloacal temperature rose during the day (Table 1). The differences between those recorded in the early and late morning and the differences between those taken in early morning and the afternoon are significant. The mean for afternoon captures is higher than that of those

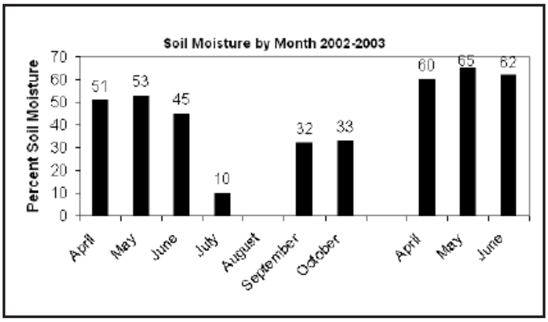

Figure 1. Average soil moisture at capture sites by month at the Mason Neck National Wildlife Refuge (only one *Carphophis amoenus* was captured in August).

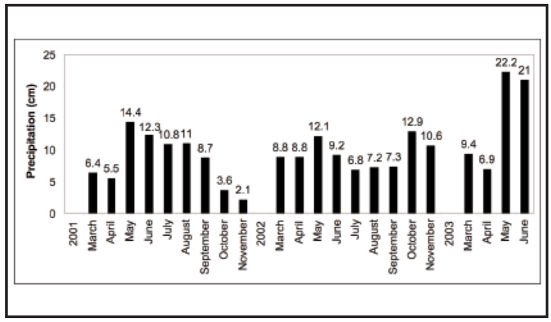

Figure 2. Monthly precipitation in Washington D.C. during months of study (National Climatic Data Center).

from late morning, but this difference was not significant.

All recaptures were under the same cover object or nearby. Of 68 captures of adult males, 30 (44%) were recaptures. Of 36 captures of adult females, only 4 (11%) were recaptures. Most recaptures occurred within a few days of the original capture, and it was not clear if the individual snake had moved during the intervening time period. At other times, the snake was not present when the specific cover item was checked, but later returned to the same location.

DISCUSSION

Soil Water Content — Mean soil moisture of microhabitats was significantly higher ($p<0.01$) than like means reported for Kansas *Carphophis vermis* (Table 2). Clark (1970) found Kansas *Carphophis vermis* at soil moistures from 17.6–73.5%, but they were found most often at soil moisture levels of 21-30%. Soil moisture of *C. vermis* averaged 33.8% for males and 31.5% for females, but this difference was not significant. Small *C. vermis* (less than 200 mm) had a higher average (37.8%) than large individuals (30.9%), but again the difference was not significant. Elick and Sealander (1972) found 20 Kansas *C. vermis* within a soil moisture range of 15.9-42.1% (mean 20.4%). In the laboratory, *Carphophis vermis* were given a choice of 14-30% soil moistures and averaged 25% (Clark, 1967), significantly lower than the mean for this study.

The last year of the Mason Neck study, 2003, was an unusually wet and overcast year, while 2001 and 2002 were dry years (Figs. 2 and 3); however, such short term field studies are unlikely to detect the year-to-year variations that organisms must be able to tolerate.

Many snakes in the laboratory select different habitats with the onset of ecdysis, but this has not been well documented in free-ranging snakes (Reinert, 1993). Under natural conditions, the cost of this behavior may outweigh the benefits. Moving to a more optimal environment results in a cost of energy and greater exposure to predators at a time when the snake's vision may be occluded.

Limitations exist in taking soil moisture at a fixed location. Soil moisture at a single location does not adequately represent the complete range and variation of soil moistures available in different microhabitats. Despite these limitations, the similarity in maximum values at Mason Neck indicates that soil moisture alone does not signify the presence of worm snakes, but may play a role in their microhabitat selection. The difference in medians and minimums, however, suggests that at low soil moisture levels worm snakes move to more moist sites inside logs, deeper into the soil,

Table 1. Time of day and mean cloacal temperature of *Carphophis amoenus* at the Mason Neck National Wildlife Refuge.

Time of Day	Time	Mean	*n*
Early morning	Before 09:30	19.8	37
Late morning	09:30 to 12:00	23.2	32
Afternoon	After 12:00	25.2	20

Study	Species	Mean %	Range %
This Study	*C. amoenus*	53	10–83
Elick & Sealander (1972)	*C. vermis*	20.4	15.9–42.1
Clark (1970)	*C. vermis*	–	17.6–73.5
Clark (1967)	*C. vermis*	25	–

Table 2. Summary of soil moisture preferences of species of *Carphophis* from different studies.

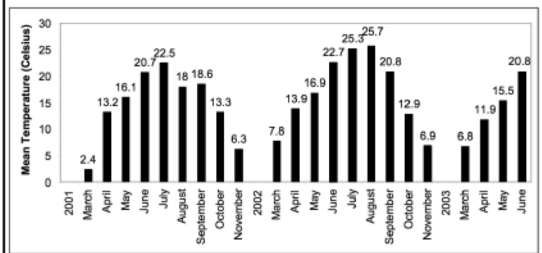

Figure 3. Monthly mean temperature in Washington D.C. during months of study (National Climatic Data Center).

or to other microhabitats where they are less easily sampled. Johnson *et al*. (2004) reported that activity level of *C. vermis* was unaffected by rainfall within 24 h of sampling.

Soil pH — The distribution of *Carphophis amoenus* is probably influenced by soil pH. Sugalski and Claussen (1997) found that soil pH was the most influential factor influencing distribution of the salamander, *Plethodon cinereus*, and Wyman (1988) reported that the distribution of five species of amphibians was significantly influenced by soil pH. Of 16 species of amphibians studied, 11 may have been selecting areas of high soil pH or avoiding areas of low soil pH. *Carphophis amoenus* may not be found in acidic soils for the same reasons that amphibians avoid them. Low pH on the soil surface may indicate different conditions at deeper levels, such as in hibernacula, and may cause the build up of heavy metals or the decrease of essential ions (Wyman, 1988). Low pH has been shown to depress sodium uptake and increase sodium loss in amphibians (Frisbie & Wyman, 1992), and may possibly affect small snakes in the same way. Soil pH is also important in determining the composition of the plant community which determines which other organisms are present. Animals may simply avoid low pH if they are able to sense it, as low soil pH may reduce the availability of prey (Wyman, 1988). Earthworms, the main prey of *Carphophis amoenus* (Ernst & Ernst, 2003), may vary in soil pH preference by species but are most numerous in soils with pH 4.5–7 and are absent from soils where pH < 3.5 (Lee, 1985). The range of soil pH observed for Eastern worm snakes at Mason Neck matches the preferred range of earthworms. Unfortunately, this tells us nothing of the limits of pH tolerance of the snake.

Temperature — Although juveniles might be expected to occur at lower temperatures because they are more susceptible to dessication, the difference between mean substrate temperature and air temperature for adults and juveniles was not significant. Two earlier studies found higher mean cloacal temperatures for *Carphophis amoenus* at Mason Neck than occurred during the present study (Table 3). Creque (2001) reported a significantly higher mean cloacal temperature of 23.9°C for 161 *C. amoenus* during the years 1997–2000, and Hartsell (1993) found that 60 *Carphophis amoenus* at Mason Neck had a significantly higher mean of 24.58°C (16–32°C) during 1991–1993. In her study, 23 males averaged 24.89ºC (19.0–30.0ºC), 27 females averaged 24.47ºC (16.0–30.5ºC). The difference in means between these studies could be attributed to differences in collecting season, differences in collecting times, or annual climatic variation.

The time of day that field work was performed probably has an effect on mean temperature. By late morning and early afternoon the snake had probably reached its optimal temperature. This is consistent with Barbour *et al*. (1969) who found that most movement by *C. amoenus* occurred in the afternoon. However, Johnson *et al*. (2004) reported that *C. vermis* activity level was not affected by temperature.

In a laboratory study, Clark (1967) found that 31 Kansas *C. vermis* preferred a body temperature of

Study	Species	Mean (°C)	Range (°C)	*n*
This study*	*C. amoenus*	22.1	11.0–33.0	110
Creque (2001)*	*C. amoenus*	23.9	10.0–32.2	161
Hartsell (1993)*	*C. amoenus*	24.58	16–32 60	
Fitch (1999)	*C. vermis*	25.7	19–31.7	21
Clark (1970)	*C. vermis*	18.3	9.9–23.8	42
Clark (1967)	*C. vermis*	23.01	14.4–30.8	31

Table 3. Cloacal Temperatures of species of *Carphophis* from Different Studies. * = Mason Neck National Wildlife Refuge.

23.01 °C on a thermal gradient, however, the relationship of laboratory studies to field results is unclear. Snakes in the field may not have their optimal temperature available to them. They may face a trade-off between staying at a less-than-optimal body temperature and expending energy or exposing themselves to predators while trying to find a better microhabitat. Clark (1967) found that the temperatures chosen by Western worm snakes along the thermal gradient ranged from 14.4–30.8°C, indicating that *C. vermis* can tolerate a wide range of temperatures. This is important because small snakes, such as the species of *Carphophis*, are generally less able to control their body temperatures physiologically than are large snakes (Peterson *et al*., 1993). Another reason that individuals of *Carphophis* would be expected to have a wide body temperature range is that a narrow range is incompatible with a snake that spends most of its time underground or under cover, and whose temperature depends largely on the surrounding soil (Clark, 1970). Elick *et al*. (1980) and Clark (1967) thought that lower body temperatures in small snakes are correlated with a greater burrowing tendency. *C. vermis* seems more fossorially adapted than *C. amoenus* because it is larger, more brightly colored, and has a narrower head, shorter tail, and smaller eyes (Fitch, 1999); therefore *C. vermis* should prefer a lower mean cloacal temperature than *C. amoenus*, but it does not seem to do so (Table 1). Fitch (1999) reported that the average body temperature of 21 Kansas *C. vermis* averaged 25.7°C (19–31.7°C), and Clark (1970) found that 42 had a mean body temperature of 18.3°C (9.9–23.8°C) with males having a slightly lower average temperature than females, but the difference was not significant. However, Clark (1970) conducted his study earlier in the day than Fitch (1999), which may explain why Fitch's mean body temperature was higher.

No single body temperature is optimal for all individuals or at all times. The optimal body temperature may depend on other factors such as the degree of hydration of the snake, the time since its last meal, general health, the presence of parasites, and its reproductive condition. Other environmental factors such as soil moisture may also play a role. Seasonal changes in temperature appear to be more important to worm snakes than short-term fluctuations (Clark, 1970). The differences between mean cloacal temperatures for consecutive months at Mason Neck were significant from April to May and from May to June (Table 4).

When *C. amoenus* were found at Mason Neck, they typically were coiled under a cover object. In some cases, when the cover object was removed the worm snake also moved, but more typically, it remained motionless for a few seconds as if it was either startled or possibly unaware that it had been exposed. The coiled body posture is used by cold animals to minimize the body surface that is exposed to colder elements. It also minimalizes regional heterothermy, variation in temperature among different parts of the body. Most of the individuals found during the course of this study were probably thermoregulating to raise their body temperatures. Unfortunately, because the snake is secretive, individuals engaged in other activities were not available for sampling. Hartsell (1993) reported the cloacal temperatures of two exposed individuals were 27°C and 30°C, respectively; few exposed individuals were found during this study. One active individual captured while mating had a cloacal temperature of 24.6°C. These temperatures are higher than the average cloacal temperatures for their respective studies, indicating that active worm snakes may achieve higher body temperatures. There is no evidence as to what is the most common body temperature, particularly when the small snakes are underground.

It is possible that worm snakes aggregate to help control their body temperature. Barbour (1950) found a 'ball' of seven Kentucky *C. amoenus* about 20 cm underground in August, and such aggregations may be related to rare but important habitat (Reinert, 1993). On four occasions during the course of this study two worm snakes were found using the same cover item. On 6th June 2001 a male and female were found under the same rock. They were coiled next to each other, their bodies touching slightly. On 17th May 2002 a male and female were discovered under the same coverboard but several centimeters apart. On 14th June 2003 two females were found using the same coverboard. One was gravid, and both were about to shed. This indicates that there may be at least some degree of overlap in microhabitat use for gravid and nongravid females. Finally, on 28th June 2003 a male and female were found mating under a rock.

Month	**Mean (°C)**	**Range (°C)**	***n***
March	23.3	–	1
April	23.3	11.0 – 31.8 27	
May	18.4	12.0 – 26.0 36	
June	26.1	22.4 – 32.4 31	
July	26.4	22.6 – 33.0 7	
August	27.8	–	1
September	25.1	21.6 – 28.6 3	
October	21.1	14.8 – 29.6 5	

Table 4. Monthly Averages of cloacal temperature of *Carphophis amoenus* at the Mason Neck National Wildlife Refuge.

Use of Cover — An abandoned farm at Mason Neck may have been a better habitat for *Carphophis* than the surrounding natural habitat because of the many cover items available there. Artificial shelters, such as a woodpile, were often present in higher densities than natural shelters, which may have made them more attractive to the snakes. The artificial shelters were also usually located in the forest edge ecotonal habitat. It is possible, however, that the *C. amoenus* were simply more accessible to sampling when artificial shelters were used. They are difficult to find when inside logs, deep in the ground, or under the surface leaf litter.

Movements — Several individuals at Mason Neck exhibited site fidelity. This was more common among males than among females. Barbour *et al*. (1969) noted that *C. amoenus* traveled over a limited area and returned periodically to certain cover items or favorable microhabitats.

The most recaptured *C. amoenus* in the present study, #126 (male), serves as an example. It was originally captured 12th June 2001 under a board in a woodpile. It was not seen again until 18th April 2002 when it was recaptured under a coverboard less than 2 m away from the first capture site. It was recaptured under the same coverboard on 20th May, 21st May, 23rd May, 1st June, and 18th June, but on 20th June, it was found under a coverboard adjacent to its usual location. On 29th June and again on 5th Oct 2002, it was under the usual coverboard. On 12th April 2003 it was captured for the last time, at its original location in the woodpile, 669 days after the original capture. This seems to indicate a small home range, but there were many occasions during this period that #126 was not located and it could have gone underground, into logs, under the leaf litter, or moved to a more distant location. The lack of distant recapture sites hampers a conclusive estimation of home range size. Barbour *et al.* (1969) reported that the home range of *C. amoenus* in Kentucky averaged 253 m^2.

Although worm snakes were frequently recaptured under the same cover items, they were also capable of exploiting new habitat. On one occasion, a coverboard which had produced no captures was relocated to a more promising position. The following week a worm snake was found beneath it. On another occasion, an old wooden structure that had housed weather monitoring equipment fell apart. The boards were spread around as cover sites, and were soon utilized by *Carphophis* and other small snake species (*Diadophis punctatus, Thamnophis sirtalis, Storeria dekayi, Virginia valeriae*). These boards became some of the most productive cover sites in the study. The ability to find and make use of new shelters is important to a woodland species that relies on fallen trees for natural cover. The frequent strong storms in northern Virginia bring down many trees, thus drastically altering the landscape from the worm snake's perspective by providing additional cover sites.

ACKNOWLEDGEMENTS

Thanks to Carl Ernst and Terry Creque for the opportunity to conduct this research and for critical reviews of the manuscript. Thanks also to Joe Witt for providing permission to access the Mason Neck National Wildlife Refuge.

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NATURAL HISTORY NOTES

Natural History Notes features articles of shorter length documenting original observations of amphibians and reptiles mostly in the field. Articles should be concise and may consist of as little as two or three paragraphs, although ideally will be between 500 and 700 words. Preferred contributions should represent an observation made of a free-living animal with little human intrusion, and describe a specific aspect of natural history. Information based on a captive observation should be declared as such in the text and the precise geographical origin of the specimen stated. With few exceptions, an individual 'Note' should concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their observation (e.g. Diet, Reproduction). The use of photographs is encouraged, but should replace words rather than embellish them. Contributions are accepted on the premise that they represent a previously unreported observation, and may be edited prior to acceptance. Standard format for this section is as follows:

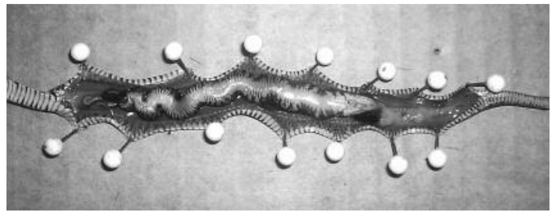
SCIENTIFIC NAME (Common Name): KEYWORD. Text (there are no constraints on how information is presented but the date, time, and locality – with full map co-ordinates if possible – must be included, as should precise details on the nature of the observation with some discussion of its significance, and references to pertinent literature). If the information relates to a preserved specimen, its catalogue number and place of deposition should also be given. REFERENCES. Then leave a line space and close with name and address details in full.

***LIOPHIS MILIARIS* (Common water snake): CANNIBALISM**. *Liophis miliaris* is a medium size, semiaquatic and diurnal-nocturnal colubrid snake (Marques *et al*., 2001) usually associated with moist environments (Dixon, 1980). It is a species widely distributed in South America, from the Guianas to northeastern Argentina, being common in southeastern Brazil (Gans, 1964; Dixon, 1983). Its diet is based on anurans, fishes and eventually lizards (Amaral, 1933; Lema *et al*., 1983; Vitt, 1983; Michaud & Dixon, 1989; Machado *et al*., 1998; Marques & Souza, 1993). This note reports an incident of cannibalism in *L. miliaris* involving two individuals of a litter kept in captivity.

On 12th November 2005, an adult female *L. miliaris* with a snout-vent length (SVL) of 930 mm, tail length (TL) of 192 mm, and mass of 330 g, was collected in Itapecerica da Serra (23°43'S, 46°50'W), São Paulo State. On 17th November 2005 it laid 31 eggs that were incubated in a container with moistened soil as substrate and a mean room temperature of 25°C. From 6th–8th February 2006, eighteen of the eggs hatched. All newborns were housed in the same plastic box (20 x 32 x 35 cm) with water ad libitum and cardboard as substrate. On 31st March 2006, while cleaning the cage, we noted the lack of one individual and that one female (IB 74409, SVL = 171 mm, TL = 41 mm and 2.54 g) showed several undulations in its body, typical of snakes that have previously been observed to exhibit ophiophagy (Jackson *et al*., 2004). This female was euthanised and dissection revealed that it had ingested another conspecific female (IB 74410, SVL = 135 mm, TL = 41mm and 1.28 g) (Figure 1). The prey was swallowed headfirst, length ratio (LR = prey total length/predator SVL) was 1.03 and weight ratio (WR = prey mass/predator mass) was 0.50. It was fitted in the predator stomach, compressed in several waves such that its total length had decreased ca. 2.28 times (= 77 mm), and with no digestive activity apparent, had evidently been swallowed recently. It was not possible to determine whether or not the prey was alive or dead at the moment of ingestion.

The predator/prey size ratio of 1.03 is high for *L. miliaris* considering its natural prey (anurans and fishes). We used total length for prey and SVL for predator because the SVL of the predator is the useful space into which the entire length of the prey has to fit (cf. Jackson *et al*., 2004). There are few data published to compare with ours, but the length

Figure 1. Hatchling female *L. miliaris* (IB 74409, SVL = 171 mm, TL = 41 mm and 2.54 g) with conspecific as prey (IB 74410, SVL = 135 mm, TL = 41mm and 1.28 g); prey mass/predator mass = 0.50.



ratio obtained here is lower than the LR found by Jackson *et al*. (2004) in observations of ophiophagy in *Lampropeltis getula californiae*. Young snakes usually feed on large prey, a fact explained by the lower availability of adequately sized prey in nature, and there are reported occurrence of young snakes having died from trying to eat prey above their ingestion capacity due to evaluation error (see Sazima, 1990). *Liophis miliaris* appears to be habitat specialist and food generalist (Dixon, 1983). Although it is known that this species feeds on anurans and fishes, it occasionally preys on lizards, increasing its prey spectrum and thus demonstrating its opportunistic habits (Michaud & Dixon, 1989; Machado *et al*., 1998). In a review of published data on the diet of *L. miliaris*, we could find no mention of snakes as a recorded food item for this species (Amaral, 1933; Lema *et al*., 1983; Vitt, 1983; Michaud & Dixon, 1989; Marques & Souza, 1993). The incident described here therefore leads us to speculate that *L. miliaris* probably feeds on snakes also in nature. However, cannibalism among newborn snakes kept in captivity seems to be a relatively frequent behaviour even in species that do not include snakes in the diet (e.g. Hoge & Federsoni, 1981; Lema *et al*., 1983; Cardoso Júnior *et al*., 1990). Furthermore, the litter had never been fed and the individual concerned may therefore have been hungry. Nevertheless, this was the only incident of cannibalism that occurred in the litter. Further research about the diet of *L. miliaris* should elucidate the possibility of ophiophagy in nature.

ACKNOWLEDGEMENTS

The authors are grateful to FUNDAP by the financial support.

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HENRIQUE BARTOLOMEU PEREIRA BRAZ[1]*, PRISCILA HESS LOPES[1, 2], MARISA MARIA TEIXEIRA DA ROCHA[1] and MARIA DE FÁTIMA DOMINGUES FURTADO[1]

[1] *Laboratório de Herpetologia, Instituto Butantan, Av. Dr. Vital Brazil, 1500, CEP 05503-900, São Paulo, SP, Brazil.*

[2] *Departamento de Fisiologia Geral, Instituto de Biociências, Universidade de São Paulo, CEP 05422-970, São Paulo, SP, Brazil.*

* Corresponding author: *h_braz@butantan.gov.br*

***CROTALUS DURISSUS TERRIFICUS* (Rattlesnake): A CASE OF XANTHISM**. Colouration and pattern are very important to snakes, providing such advantages as camouflage, mimetism or warning. It is alleged that most species of snakes that present albinism or other anomalies are nocturnal (Sazima & Di-Bernardo, 1991). This supposition may be explained by selection against albinism in diurnal snakes, because the loss of protective colouration can make the animal more exposed and vulnerable to predation.

Chromatic anomalies in snakes are rare, and in Brazil, cases of albinism, melanism, erithrism, among others, have been reported in only a few species of the Boidae, Colubridae and Viperidae families (Amaral, 1927a,b; Amaral, 1932; Amaral, 1934; Hoge, 1952; Hoge & Belluomini, 1957/58; Andrade & Abe, 1998; Duarte *et al.*, 2005). However, some cases of xanthism are known: one concerning a specimen of *Epicrates cenchria* (Hoge & Belluomini, 1957/58) and another in *Sibynomorphus turgidus* (Amaral, 1933/34). Xanthism is defined as a pigmentary anomaly of genetic origin, in which there is lack of melanin and predominance of yellow pigments <www.ophidia.org.ve>.

Snakes of the genus *Crotalus* are terrestrial ambush predators; their most salient characteristic is the presence of a rattle in the tip of the tail. In Brazil there is only a single species, *Crotalus durissus*, which has a large distribution within savannah (*cerrado*), arid regions (*caatinga)* and open areas (Melgarejo, 2003). There are a few reported cases of albinism in this species (Amaral, 1927a; Amaral, 1932; Amaral, 1934; Duarte *et al.*, 2005) and also melanism (Silva *et al.*, 1999). This note reports a case of xanthism in a specimen of *Crotalus durissus terrificus*. The snake, a young female (500 mm in snout vent length, 35 mm in tail length, and 100g), was collected in Lindóia – SP (22°31'S; 46°39'W) in July 2005, with two other individuals of a similar size, but with normal colour patterns. This individual is yellow throughout the entire body, including the head, with lighter stains in the post-ocular region. The characteristic dorsal markings are dark yellow, bordered with scales of lighter yellow. The nape marking is also dark yellow, bordered by light yellow scales, and the gular region is light

Figure 1. *Crotalus durissus terrificus* with xanthism. Female (500 mm in snout vent length, 35 mm in tail length, 100 g).

yellow. The venter is yellowish and its eyes are a silvery colour (Fig. 1). The snake is currently maintained as a captive in the Herpetology Laboratory at Instituto Butantan, São Paulo, Brazil.

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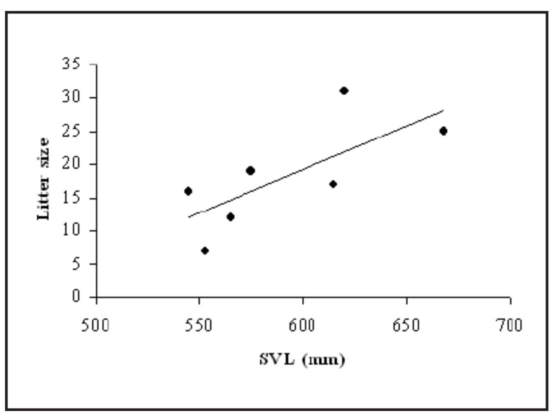
SILVIA REGINA TRAVAGLIA CARDOSO (E-mail: *silviacardoso@butantan.gov.br*) and ANA CAROLINA PARPINELLI (E-mail: *acp_venom@butantan.gov.br*).

Laboratório de Herpetologia, Instituto Butantan, Av. Vital Brazil, 1500, CEP 05503-900, São Paulo, SP, Brazil.

HELICOPS LEOPARDINUS **(Water snake): REPRODUCTION**. *Helicops leopardinus* is an aquatic and viviparous snake (Lira-da-Silva *et al*. 1994), distributed from the Guianas to Argentina (Peters & Orejas-Miranda, 1986). It is widespread in Brazil, and one of the most common species in the Pantanal region (Strüssmann & Sazima, 1993). Data on reproduction of this species are scarce. Lira-da-Silva *et al*. (1994) and Freitas (1999) recorded litters (n = 4) of seven to 15 newborns for *H. leopardinus* from Bahia, northeast Brazil. Here we present a new record of a litter, as well as provided additional information on the fecundity of the species.

One female *H. leopardinus* collected in the city of Lageado (09°45'S, 48°12'W), Tocantins, northern Brazil, was brought to Instituto Butantan on 21st January 2001. The female (IB 66413; 620 mm in snout-vent length (SVL), 145 mm in tail length (TL), and a mass of 145 g after parturition) gave birth to 31 newborns (21 alive and 10 dead but fully developed) on 8th February 2001. The live newborns averaged 118 mm in SVL (range = 100–135 mm), 39 mm in TL (range = 35– 45 mm), and 1.8 g (range = 1.4–2.4 g). The relative clutch mass (RCM; total clutch mass/body mass of mother after parturition; see Shine, 1980) was 0.39. The RCM calculated following Seigel & Fitch (1984) (total clutch mass/body mass of mother + clutch mass) was 0.28.

Figure 1. Relationship between the litter size (including oviductal embryos) and the female's body size in *Helicops leopardinus*. $r_{Spearman} = 0.82$, $n = 7$, $p = 0.02$.



IB	Region	Co-ordinates	Female SVL (mm)	Litter size
22667	–	–	553	07
20024	Fortaleza, Ceará	03º43'S, 38º32'W	668	25
2646*	Bahia	–	575	19
24534*	Batovi, Mato Grosso	15º51'S, 53º30'W	615	17
44051*	Campo Grande, Mato Grosso do Sul	20º26'S, 54º38'W	545	16
45883*	Campo Grande, Mato Grosso do Sul	20º26'S, 54º38'W	565	12
66413	Lageado, Tocantins	09º45'S, 48º12'W	620	31

Table 1. Summary of data on litter and female's body size for *Helicops leopardinus*. * = oviductal embryos. All preserved individuals were from the Herpetological Collection of the Instituto Butantan (IB).

Additional litters of six preserved specimens presented seven to 25 newborns or oviductal embryos (Table 1). The average litter size in *H. leopardinus* including oviductal embryos is 18 (range = 7–31), and is positively correlated with the female body size ($r_{\text{Spearman}} = 0.82$, $n = 7$, $p = 0.02$; Figure 1). This correlation is a common trend encountered in various snake species (Shine, 1994). Moreover, *H. leopardinus* produce litters of similar size to other congeneric species, particularly *H. infrataeniatus* (Aguiar & Di-Bernardo, 2005) and *H. modestus* (RRS, unpubl. data). The RCM value reported for *Helicops leopardinus* is high but similar to the maximal values reported for other unrelated viviparous and aquatic snakes (e.g. some natricines of the genus *Nerodia* and *Regina*; see Seigel & Fitch, 1984).

ACKNOWLEDGEMENTS

We thank Valdir J. Germano for technical support and Ricardo J. Sawaya for the manuscript review. Finances were supported by FAPESP.

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RODRIGO ROVERI SCARTOZZONI (E-mail: *rodrigobuta@yahoo.com.br*) and SELMA MARIA DE ALMEIDA-SANTOS (E-mail: *almeidasantos@butantan.gov.br*).

Laboratório de Herpetologia, Instituto Butantan, Av. Vital Brazil, 1500, CEP 05503-900, São Paulo, SP, Brazil.

BRITISH HERPETOLOGICAL SOCIETY COUNCIL 2005/2006

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