

The
**HERPETOLOGICAL
BULLETIN**

Bia Vyf %\$ ĒG a a Yf &\$+\$



DI 6 @G<98 6MH<9

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

© The British Herpetological Society. All rights reserved. No part of this publication may be reproduced without the permission of the Editor.

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

Guidelines for contributing authors

1. Contributions should be submitted preferably in electronic form, either by e-mail or as text files on CD, DVD, or 100 mb zip disk, in Windows format only. The Bulletin is typeset directly from the author's electronic file, so wherever possible all manuscripts should be prepared using a word-processor. Please indicate word-processing software used. Articles should be arranged in the following general order: *Title; Name(s)* of author(s); *Address(es)* of authors (please indicate corresponding author); *Abstract* (optional - if included should not exceed 10% of total word length); *Text; Acknowledgements; References; Appendices*. Footnotes should not be included. Refer to this issue for style and format information.
2. High resolution scanned images (TIFF or JPEG files) are the preferred format for submission of illustrations, although good quality slides, colour, and monochrome prints are also acceptable. All illustrations should be entirely relevant to the text and numbered sequentially with Arabic numbers.
3. Authors will be informed promptly of receipt of their manuscript and given a time-scale within which it will be published. Acknowledgement of the receipt of work *does not* indicate acceptance for publication. Contributions are liable to assessment for suitability and ethical issues and all articles included in the main 'Research' section are subject to review. The Editor reserves the right to shorten or amend a manuscript, although substantial alterations will not be made without permission of the primary author.
4. Authors are supplied with a portable document file (pdf) of their published article and also receive a complimentary copy of the full printed issue. Slides, artwork, and other original material will be returned following publication.
5. The significance and importance of some articles may be such that the Editor will offer the author a year's free subscription to the Society for their work.
6. The Editor is keenly aware that contributors may find some of these instructions difficult to comply with and is anxious that the pages of the Bulletin should remain open to as wide a range of correspondents as possible. Therefore, if an author has concerns about the suitability of a manuscript, or would like help in preparing it, please contact the Editor to discuss.

Further information available at: <http://www.thebhs.org>

The views expressed by the contributors to the Bulletin are not necessarily those of the Editor or the British Herpetological Society.

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. *Stefania evansi* (Groete Creek carrying frog). A large female, 95.1 mm SVL, carrying the remarkable number of 30 near-term juveniles. © Philippe J. R. Kok. See article on page 38.

Book Reviews

An additional editor has recently been appointed, Neil D'Cruze, who will be assuming responsibility for managing book reviews. All books submitted for the purposes of review in *The Herpetological Bulletin* should now be sent directly to Neil (address details on inside of back cover). Please also note that *The Herpetological Journal* is to discontinue publishing book reviews.

Letters to the Editor

Dear Sir,

I think that the following information may be of interest to anyone concerned with amphibians, and perhaps you could include it in *The Herpetological Bulletin*.

Some adverse side effects of benzimidazole carbamates and related compounds on amphibians

Benzimidazole carbamates such as fenbendazole are often recommended to treat amphibian helminth infestations, however there is not much information on the adverse side effects caused by these chemicals.

I have myself noted that at a concentration of only 20 parts of fenbendazole per billion (thousand million) of water, long term exposure causes inappetance in amphibians, and at a concentration of only 200 parts per billion long term exposure results in death. I have seen similar side effects with mebendazole, albendazole and thiophanate.

Many different benzimidazoles have been developed over the years to treat human and animal diseases and also as pesticides for agriculture and horticulture. Such chemicals include the anthelmintic benzimidazole carbamates such as fenbendazole, mebendazole, albendazole, flubendazole, oxfendazole and oxibendazole, the anthelmintic probenzimidazoles such as febantel, netobimin and thiophanate, and the related anthelmintic benzimidazoles such as tiabendazole and triclabendazole. In agriculture related compounds such as benomyl are used as fungicides.

It can be expected that many if not all of these chemicals will have similar side effects on amphibians. Because of their widespread use residues in soil and in small ponds might reach the above concentration values in some places and have

adverse effects on amphibian populations; some care over their use might therefore be a good idea I think.

In contrast the antifungal imidazoles such as ketoconazole and clotrimazole do not appear to have these adverse side effects, nor do the antifungal triazoles such as itraconazole, nor the antiprotozoal nitroimidazoles such as metronidazole and dimetridazole.

Yourse faithfully,

Andrew W. Read

15th March 2007

E-mail: andwilread@hotmail.com

Dear Sir,

On 13th May 2006 in the early afternoon, BHS members Charles Montgomery, Peter Leach and myself were leaving a site in the Scottish Borders Region near Peas Bay, where for the last three years we had been monitoring a Slow worm (*Anguis fragilis*) colony. Leaving the site, a ruined cottage near mixed woodland, we had to cross a footbridge over the main Edinburgh to London railway line. This was a fairly modern structure, whose rough chip and concrete surface had eroded very slightly to allow pockets of sparse vegetation to establish themselves.

Approximately half way across, we saw a male Common lizard basking in the middle of the path. Getting out our cameras, we cautiously approached it, and, though obviously aware of our presence, it allowed us to approach unusually close. Charles slowly extended his hand, making clicking noises with his tongue, and, much to our surprise, it ran up his arm almost as far as his shoulder, then, after a quick exploration, returned down his arm to his hand, where it sat quite still. After about two minutes, Charles put the lizard down on the edge of the path, where it again remained quite still. Once more Charles put his hand on the ground, and made clicking noises. Immediately the lizard again ran up his and went back to his hand.

This was the most unusual response to sound stimuli that we have observed in lizards, though it had been noticed that Common wall lizards (*Podarcis muralis*), on the walls of Gorey Castle in Jersey, responded a little to whistling. Colin

Simms, in his book 'Lives of British Lizards', records a Sand lizard (*Lacerta agilis*) behaving strangely in relation to his shoe-cap. Are we correct in thinking that Charles's noises was the stimulus that prompted the lizard's unusual behaviour, or could it be reacting to smell or curiosity about texture, and its potential for hosting edible invertebrates? What was it doing on the bridge? Had it been dropped by a raptor, and thus become disorientated? Charles claims that he once got an urban fox to follow him into the house, so does he possess something that animals find attractive? No doubt New-Age folk would talk about 'sympathetic vibrations', etc., but herpetological science wants a sound, well researched, objective answer, adequately supported by laboratory evidence.

Behavioural and psychological studies of reptiles in general, and lizards in particular, have not matched the research done into their sensory development, such as vision. We have, for instance, only speculative comments about their intelligence. Thanks to B. F. Skinner, the behavioural psychologist, we know a great deal about inducing conditioned responses in pigeons, but nothing of a similar nature has been done with lizards. Much interesting and rewarding research could be done in this field.

REFERENCES

- Bowles, F. D. (2002). Update on the status of the Green Lizard (*Lacerta viridis*) and Wall Lizard (*Podarcis muralis*) in Jersey. *Herpetol. Bull.* **80**, 2–3.
- Simms, C. (1970). *Lives of British Lizards*. Norwich: Goose & Son.

Yours faithfully,

Frank D. Bowles

37 Albany Terrace, Dundee DD3 6HS.

BHS student grant scheme 2008

The British Herpetological Society welcomes applications to its Student Grant Scheme. Students can apply for small grants, principally aimed at supporting fieldwork and other costs associated with final-year undergraduate or masters projects. The grant scheme is intended to promote interest in herpetology through well-defined short research projects. PhD projects will not normally be

eligible. Priority will be given to BHS members. Grants will not normally exceed £300. The scientific scope of projects should be consistent with the aims of the Society.

The scheme will be administered by the BHS Research Committee Chairman, Dr Chris Gleed-Owen. Applications should be made in the form of a letter (e-mail is acceptable) of no more than four A4 pages, setting out the following:

- ~ Your name, address, telephone, e-mail
- ~ Course, stage, institution
- ~ Project title
- ~ Brief outline of the project's: aims/rationale, including locations and species involved
- ~ Proposed methodology
- ~ Timescale
- ~ Proposed expenditure and budget breakdown
- ~ Details of any funds sought and/or obtained from other sources
- ~ Previous experience of and/or interest in herpetology
- ~ A letter (or email) of support from your project supervisor

The deadline for applications is 30th April 2008, and applicants will be informed of outcomes by 31st May 2008. Applicants and/or their supervisors may be contacted before final decisions are made. Payments to successful students will be by cheque, as soon as possible after that date. The work must take place during 2008. Note that work on protected species, nature reserves or private land may require a licence and/or permission (evidence will be required where relevant). Any resulting dissertation or publication should acknowledge the financial support of the BHS. We aim to publish a summary/abstract of successful grantees' projects in *The Herpetological Bulletin*, and would also welcome a copy of the resulting dissertation.

Dr. Chris Gleed-Owen (BHS Research Committee Chairman)

The Herpetological Conservation Trust, 655A Christchurch Road, Boscombe, Bournemouth, BH1 4AP, UK.

Tel: 01202 391319

E-mail: research@thebhs.org

Successful keeping and breeding - the Collared lizard (*Crotaphytus collaris*)

RICHARD HARLING

6 Cobham Way, Merley, Wimborne, Dorset BH21 1SJ, U.K. E-mail: harling@xaltmail.com

CROTAPHYTUS *collaris* are medium-sized lizards, with a long round cylindrical tail with a broad head and fairly blunt snout. They measure approximately 25cm in average length, of which just under two thirds is tail. There is quite distinct sexual dimorphism, with the males often being spectacularly coloured, with bright blues on the dorsal and lateral body parts, and yellow on the head, depending on the subspecies. Females tend to be a more fawn colour, with white spots. Both sexes are usually white ventrally, except for their throats which may have diffuse banding and in males may be yellow. In my females a few black spots develop after egg-laying. Sometimes the males have yellow bands across the back. A pair of black 'collars' are always present just below the neck and are the characteristic after which the common name is given. In the wild there is great variation in coloration, depending on the subspecies.

The juveniles tend to adopt the general female coloration until they are sexually mature, even so far as having some orange bands and spots which may imitate gravid females. This could be helpful in reducing adult male aggression and predation (Husak *et al.*, 2004). Collared lizards will eat almost anything that is small enough to overcome, adult lizards easily taking fully grown locusts, and apparently in the wild may include smaller lizards in their diet. When hungry they will rush headlong, leaping if necessary, at anything that moves, including any fingers that are holding food. I find them not very keen on giant mealworms and the babies and juveniles I have bred are reluctant to eat normal mealworms, though they will occasionally. However, at least captive bred lizards are not aggressive in captivity; in fact they are exceptionally tame, yet pleasingly alert and lively. They sit and bask without fear and do not jump around or become startled when people move near the vivarium, except to press against the glass if they are hungry, which they are most of the time,

especially the females when gravid. They will even jump out of their vivarium to catch a locust from the pot used to put vitamin powder on them, then dutifully hop back in to the vivarium to sunbathe. After the breeding season is over, they become much less hungry and more secretive, hiding under bark much more often, as well as eating less often. At this time I have lowered the temperature a little to compensate for their lack of food intake, so they can preserve their fat reserves. Last year the male went into hibernation looking slightly thin, but he was fine. In my opinion they meet many criteria for the perfect lizard 'pet', being more active and interesting than the ubiquitous Leopard gecko and having more attractive colours than most Bearded dragons, as well as having interesting behaviour, and not losing their tails under most conditions, nor being apparently stressed by captivity. They are able to be handled without being traumatised, feed ravenously and are easy to keep healthy and seem to be easy to breed in principle, thus reducing pressure on wild stocks. The only reservation I have is that they have some reputation for not feeding and then entering a downward spiral. I must say that I have not had this except for the adults reducing their food intake after breeding (it is September as I write and they have are at this stage now). I have read on the internet, that in the wild adults will do this and it may be to reduce adult predation on the youngsters.

Captive care, housing and feeding

I keep them in a 90 cm vivarium, using cat litter or vermiculite as substrate to absorb the liquid part of the faeces. The faeces are copious and can be smelly especially if the crickets and locusts are gut loaded with dandelions and other vegetable matter. The cat litter has helped to keep down the smell and also helped keep the humidity down, but it is not infallable. Approximately 15 cm from one end there is an ordinary 100W spot lamp hanging from the top, under which is a small pile of limestone for

Clutch laid (incubation temperature)	Hatched	Number hatched
1 st April (29°C)	21 st May (7 weeks)	10 out of 11
6 th May (29 then 26°C)	9 th July (9.5 weeks)	10 out of 10
16 th June (26°C)	29 th August (11.5 weeks)	9 out of 10
	Total hatched	29 out 31

Table 1. Dates of egg-laying (+ hatching).

basking. There is also a UV light (which was used last year as well, so it is not a new bulb) inside the vivarium, so that the lizards are rarely more than 25 cm away from it. The temperature does get quite high, around 40°C at times surrounding the spot light. I have not used a thermostat to regulate the temperature, merely ensured that there is a temperature gradient, and pieces of cork bark on the floor to provide refuge at the end opposite the light. This has worked out very well and the lizards have thrived. I have a container of water in the vivarium at all times, but I have never observed the adults drinking from it, nor do they appreciate being sprayed as is suggested by some keepers; they tend to run away from the spray. They will lick water off a human finger if offered, or from a syringe, but seem to gain plenty of moisture from their food. Their faeces are moist which suggests there is no problem, and their successful breeding doubly suggests that they manage to hydrate themselves from their food.

The lights are set come on at 09:00 h and to go off at 19:00 h. I usually find they have retreated well before this time.

I feed the lizards every day and they will often eat two or three full sized locusts, or numerous crickets at one sitting. The male will tend to eat the equivalent of one locust plus a couple of full sized black (African) crickets each day. The female is usually ravenous, especially when she is gravid, which she has been for most of the time since March (as noted earlier it is now September as I write). I dust the crickets with Nutrobal for every feed. As previously mentioned, I also feed the locust and crickets on dandelion, but also any spare vegetable matter from the kitchen. I have read that over calcification or vitamin problems may occur with frequent use of powders, but the female has laid so many eggs, that I did not want

to take any chances with the opposite problem. The fact that I have achieved nearly 100% hatching success suggests that my regime is working and has done so well for two years now.

Breeding

Between November 2005 and January 2006 I placed the adult pair in our shed over a period of eight weeks. During this time I placed them into a glass aquarium, which was packed with loosely scrunched up balls of newspaper, with folded newspaper on the floor and around the walls of the aquarium. I placed a bowl of water inside in case it should be needed and inspected the pair once a week, finding them to be very torpid, but they showed no signs of weight loss. I was somewhat anxious that this desert species may be too cold, but it did not turn out to be the case and this is the second year they have been hibernated. Last year (2004 to 2005) I only hibernated them for six weeks, as the male was only in his first year. When I brought them out of hibernation, the male began to court the female a few days after switching the lights back on, but she showed no apparent interest, evading his mating attempts by twisting her body round and inflating her throat. However, she did lay one clutch of eggs, but they all failed probably due to a problem with my incubator (since corrected) – this was the only clutch she laid. After this I decided to increase hibernation to at least eight weeks, to increase availability of food and to check the eggs and incubator much more regularly, as well as making sure there was always a pot of damp vermiculite in her vivarium.

In the middle of January 2006 I brought the pair out of hibernation and placed them back in their vivarium, without the lights on, with just a heat mat. They were soon reasonably active and I turned on the lighting. After reading articles about them on the Internet, I expected that the lizards would become interested in breeding very rapidly, but found that although the male was quickly head bobbing and trying to grab the female, she took until the end of February to allow his advances to



Figure 1. Adults (male left, female right); they often gape when under the heat lamp.

be successful. Mating was a pretty typical lizard affair of chasing and the male gripping the female's neck, while twisting his tail under hers. There was also a large amount of head bobbing by the male. If she was willing to mate, she was fairly placid (though didn't seem exactly happy). If she was not ready, she would twist her body round to make it impossible for mating to occur, when he let go she would swell up her throat and stand on extended legs while making her body vertically large, but thin (a bit like a chameleon's body) and he would lose interest for a while. I think it is helpful that the female is bigger than the male, who is at least one year younger than the female. His attentions are therefore less of a problem to her. With a more equal-sized pair, I suspect a pair of females would help them to get respite from the male's amorous advances.

Figure 3. At 28°C, the first clutch took 7 weeks to hatch (laid 1st April 2006, hatched 21st May 2006).



Figure 2. Eggs within incubation chamber.

The female began to swell up like a balloon, and I found it very difficult to feed her enough food to get her full for longer than a few hours during the day. She then developed bright orange spots on her flanks and between her black collars (Figure 1). Baird (2004) suggests that female coloration is a stimulus to mating. In the experience I have had over the past few years, the male needs little encouragement, so long as he has hibernated, and the female has not developed any sort of breeding coloration until after mating and until just before egg laying. She retained this coloration for much of the year thereafter until August, always becoming especially bright a few weeks before egg laying.

Finally two days before the end of March, she would not eat anymore. She just looked too fat to fit anything in, though she did occasionally lunge at a locust, and then lose interest.

Figure 4. It took two full days for all the hatchlings to emerge.





Figure 5. Hatchlings at 2 days old.

In the centre of the vivarium I had placed a round, plastic sweet pot that was 13 cm in diameter and 12 cm deep that was half full of damp vermiculite (6 cm depth). I laid a piece of bark up to it and occasionally put the female into the pot, so that she knew there was a source of damp substrate. She often would go to the top of the bark, occasionally jumping into the pot. On 1st April, she laid her eggs, which took a couple of hours. Once she began to cover them, I removed them from the vivarium and made sure that most were exposed so that I could monitor their progress. The female's behaviour was interesting, as she kept trying to cover the eggs, despite their removal. She pushed substrate from the bottom of the vivarium in the place where the container had been, with her forelegs and kept doing so until there was quite a pile and some disturbance to the arrangements of the vivarium.

The eggs in their container were placed into a large homemade polystyrene box incubator (Figure 2). Inside I put a heat mat on the base, and put a wire grid on it that I made out of some wire mesh from a garden centre. Onto this wire grid I placed the egg pot and covered it with loosely fitting plastic lid, with a few holes in. The heat mat was controlled by a Habistat unit, which controlled the temperature very accurately. At all times the lid of the pot had some condensation on it (not too much, but a good few drops mostly) and the vermiculite did not dry out at all so I did not need to add any more water. I checked the eggs once or twice a week and ensured that the air was fresh. One egg went off within two days, smelling of mushrooms,

so I removed it. The others had a an almost antiseptic smell, and though turning very yellow and unhealthy looking, swelled up and seemed to be developing fine (Figure 3). By the last three weeks, the eggs were quite dark inside and it seemed obvious there was life developing, though "candelling" the eggs did not show much, and not having kept collared lizards before, I was unsure whether this was normal. However by the end of incubation, before hatching, the babies could be easily seen through the shells of the eggs.

By the time the first clutch had been incubating for some weeks, the female was again swelling up like a balloon and she laid a further clutch of 10 eggs on 6th May.

Finally, on 21st May, the first clutch of eggs began to hatch (Figures 4 and 5). It took two days for the last lizard to emerge, after the first head appeared out of the first egg. I thought that there were nine eggs in total (eight not including the one that went mouldy), but in fact I got 10 babies, finding that there were two eggs buried deeper in the vermiculite that I had not noticed and thus not able to expose for checking.

The babies seemed very large compared to the parents, with large heads. They did not eat for two or three days, but once started they began literally throwing themselves onto crickets with gusto. They grew rapidly and could eat quite large crickets very early on. I have kept the babies in much the same way as the adults.

On the 16th June a third batch of eggs was laid. Nine eggs were visible, two buried in the vermiculite, another seven I gently exposed so that they could be monitored (when they hatched it transpired that there had been 10 eggs).

On 9th July the second batch of eggs hatched. The first clutch were now over 15 cm long and very sturdy, eating ravenously, often gripping each other's heads in their excitement. No permanent damage being inflicted, though occasionally some blood was spilt early on. All injuries healed very quickly.

What turned out to be the third and final clutch of the year hatched on 29th August. One egg did not hatch, and when opened there was a fully formed baby, with some yolk, indicating that it probably died a week or so before the clutch hatched. This probably indicates some calcium deficiency after three clutches, but the other babies were very healthy, with no deformities and all fed well.

Final comments

The lizards I obtained seemed to have very easy requirements. They were healthy when I bought them and always fed well, barring at the end of the season. If they are feeding they are warm enough and healthy, other than a definite slow down in the Autumn, no matter what heating and lighting regime is adopted. I would recommend that the adults are hibernated due to their relative reluctance to feed in the Autumn. The secret to keeping them successfully at this point seems to be to cool them down, to ensure they do not use up their food reserves, rather than turning up the heat and trying to stimulate them to feed – they will not feed and then will just shrivel away.

Overall they seemed to be prolific ('r Selected' having three clutches or so with multiple eggs?) as well as being very suited to and at ease with human interaction.

I have bred Ibizan wall lizards (*Podarcis pityusensis*), anoles (*A. carolinensis*) and day geckoes (*Phelsuma* spp.) before, but I must say that these are the easiest I have ever had to keep, breed and rear, as well as being much more rewarding for my children. When they sit on your hand they look at you, in much the same way as a Budgerigar or a tame mouse might, then may suddenly dart off, but they rarely try and evade capture, stopping periodically to look around. They can, if they want to, run on just their hind legs, such is the speed that they can achieve. Their back legs are reminiscent of frogs hind legs and they can leap ably. Considering that they are a desert species, they seem quite easy to provide with UV light and to ensure no problems with rickets or calcification of eggs. All the babies have grown healthily so far with no signs of crooked tails or other signs of deficiency.

Footnote – March 2007

I had an experience with the third batch of baby Collared lizards, which may be of interest as a footnote to this article.

I introduced two fairly large garden spiders as food for the babies, as a bit of variety. Soon afterwards, I noticed that one of them was dead, despite looking well fed and healthy. Later I found another that was alive, but, though breathing and with its eyes open, could not move very much. I placed the baby into an incubator and kept it alive for a week. Unfortunately it eventually died,

occasionally moving slightly but in a very uncoordinated and lethargic way. I found another baby in a similar state the next day. I did not immediately make the connection. At first I thought there must be some effect of having so many babies from one female, probably due to lack of calcium. Maybe it was an end of season slump that collared lizard babies were prone to?

I then realised that the symptoms were similar to being paralysed and removed the spiders which had not been eaten after a week.

Since this point this I have lost no other babies from the third batch (as I write this footnote it is March 2007, some months later) and had lost none at all from the previous two batches of babies. The remaining five babies which I have retained, are now, as I write this footnote, half grown, are all extremely healthy, feeding voraciously and have even undergone a hibernation for 9 weeks in the garden shed with no ill effects.

I will be very wary of feeding garden spiders to lizards again. A number of years ago I gave a full grown House spider to a male Common lizard (*Zootoca viviparous*) and it managed it with no problem and I have given small garden spiders to *Podarcis pityusensis* babies with no problem before.

Although I did not have the dead babies checked, it seems that they could well have been bitten and poisoned by the garden spiders, unless there was some other highly coincidental factor that has not affected the previous two batches of lizards, or the remaining half a dozen from the third batch of babies.

The third batch of babies also had an unfortunate tendency when lunging at food to grab other lizards' tails. This has resulted in one or two babies with half tails. Despite the fact that autotomy does not occur in this species, the tails are now showing signs of regrowing.

REFERENCES

- Husak, J. F., McCoy, J. K., Fox, S. F. & Baird, T. A. (2004). Is coloration of juvenile male collared lizards (*Crotaphytus collaris*) female mimicry? An experimental test. *J. Herpetol.* **38**, 156–160.
- Baird, T. A. (2004). Reproductive coloration in female collared lizards, *Crotaphytus collaris*, stimulates courtship by males. *Herpetologica* **60**, 337–348.

Albino Common toads (*Bufo bufo*)

S. PASH, J. SPOONER and J. P. SUMPTER.

Institute for the Environment, Brunel University, Uxbridge, Middlesex UB8 3PH, U.K.

ABSTRACT – A number of albino Common toads were found in a small pond within a suburban garden in north-west London. Albino spawn was also found in the pond. The viability of this spawn was compared in a laboratory to that of spawn from normal toads. Although albino tadpoles hatched from the albino spawn, they progressively grew darker as they aged, until indistinguishable from normal tadpoles. Presumably one parent (the male) was normal. The viability of the tadpoles hatched from albino spawn was reduced compared to normal tadpoles, although some animals survived to metamorphosis. They were then released back into the wild. Possible reasons for this occurrences of albinism are discussed.

ALBINO individuals seem to occur in all families of both plants (due to a failure to produce chlorophyll) and animals (due to a failure to produce melanin), although the condition is usually very rare. It is generally assumed that they are at a selective disadvantage and hence few are thought to survive to adulthood, and reproduce. Nevertheless, some obviously do, for albino individuals of, for example, some species of black birds (e.g. Jackdaw, Blackbird) are occasionally but regularly reported in the UK, often in the popular press. In the case of amphibians and reptiles, albino individuals of most native UK species have been reported, though all are considered very rare (Beebee & Griffiths, 2000). It was thus of some surprise and interest that one of us (JS) should find a number of albino Common toads (*Bufo bufo*) in the pond of a suburban garden. That finding enabled us to conduct some initial experiments aimed at assessing the viability of spawn produced by albino toads.

MATERIALS AND METHODS

Location

The albino toads were found in a small (approximately 1.5 by 0.75m) pond (Figure 1) in a garden of a suburban house in Ruislip, southern England. The pond contained Goldfish and populations of Smooth newts (*Triturus vulgaris*) and Common frogs (*Rana temporaria*) besides various aquatic invertebrates and plants. The toads were not originally introduced; they arrived naturally shortly after construction of the pond.

Reproductive Success

In both 2004 and 2005, toads (albino and normal) spawned naturally in the pond, leaving strands of albino and normal eggs entangled in the vegetation.

In 2004, initial observations on development of the eggs were made. The majority of the albino spawn was removed from the pond and transferred to Brunel University, which has excellent facilities for maintaining both native and tropical amphibians. This allowed closer observations on development to be made. The spawn was kept in pond water maintained at approximately 20°C.

Based on this initial experience, a more scientific comparative study on development of albino and normal spawn was conducted in 2005. On 25th March, 2005, a few strands of both albino and normal Common toad spawn were collected from the pond and transferred to Brunel University. At this time some of the eggs appeared infertile and diseased. Three days later, the healthier looking strips of spawn were cut into lengths of 50 eggs and each transferred to an individual glass beaker. Four beakers with albino spawn and four beakers with normal spawn were set up, aerated, and maintained at approximately 18°C. The eggs were maintained initially in pond water, but this was steadily replaced by filtered tap water. Seven days after transfer to Brunel University the eggs hatched. From age 7 days, the tadpoles were fed Sera-Micron, a fine powdered aquatic food used for rearing *Xenopus laevis* tadpoles. At 16 days of age, all surviving albino tadpoles were pooled together into one large tank and all the normal tadpoles into another. Numbers of surviving tadpoles were determined regularly until metamorphosis.

	Number of eggs collected	Number of eggs hatched	Survival		
			7 days	14 days	At metamorphosis
Albino	200	36 (18%)	24 (12%)	22 (11%)	22 (11%)
Normal	200	69 (34.5%)	66 (33%)	62 (31%)	62 (31%)

Table 1. Comparison of the survival of eggs and toadlets of albino and normal toads.

RESULTS

Albino common toads were first discovered in March, 2004. One albino male and one albino female, the latter in amplexus with a normal male, were found. In the following year (2005), a large female albino toad in amplexus with a normal male (Figure 2) and at least two albino male toads were present in the pond. Several other, normal, toads were also present in the pond at the same time. The albino toads had a yellowish hue to their skin and pink eyes.

The albino female toad (or possibly toads) produced albino spawn (Figure 3) that contrasted markedly with the black eggs of normal toads. In the first year of study, only albino spawn was studied; no comparison with normal spawn was made. It was nevertheless demonstrated that development to hatching occurred and that albino (i.e. light coloured) tadpoles emerged. Within just a few days, however, around 50% of these 'albino' tadpoles had assumed a darker colouration. Once the tadpoles began swimming freely, it was noticed that they had motility problems and, within a few days, all had died.

Similar observations were made in the following year, when a comparison with the development of normal spawn was also made. Again, the tadpoles hatched from albino spawn were initially albino (Figure 4) but, at 6 days old (post hatch), started to darken, becoming greyish rather than the black colour of normal tadpoles. As time progressed, the 'albino' tadpoles darkened further, until they were indistinguishable in colour from normal tadpoles.

There was very considerable variability in the proportion of eggs that hatched within replicate beakers of both albino and normal eggs. Individual

values varied between 0% and 46% for albino eggs, and 0% to 72% for normal eggs. Fungal infections probably accounted for the total (100%) losses in some beakers. This infection in some but not all beakers made comparing the development of albino and normal eggs problematic. Nevertheless, mean survival of normal tadpoles was better than that of albino tadpoles. Not only did a higher percentage of normal eggs hatch, but subsequent survival was also better (Table 1). Most losses (deaths) occurred soon after hatching. Once tadpoles were 14 days old, all survived to metamorphosis. About three times as many tadpoles from normal spawn as from albino spawn reached metamorphosis, at which time they were released into a pond at the University.

DISCUSSION

One of the more interesting questions is why there should be such a high proportion of albino toads in one small pond in a suburban setting, especially as toads rarely spawn in small urban ponds (Beebee & Griffiths, 2000). Although there have been occasional reports of albino toads (e.g. Frazer, 1983; Beebee & Griffiths, 2000; BB0WT, 2004) to have a minimum of three in one location at the same time seems unprecedented. Only a single albino toad is usually recorded. Of further interest is that both male and female albino toads have been observed in this pond, suggesting that whatever is responsible for the albinism, it is not sex linked. There seems to be two explanations for the presence of a number of albino toads at one location. One is that a mutation (presumably in a gamete) led to a single albino toad, and that the albino toads reported here are some of the offspring of that animal. Alternatively, there is something extraordinary about the pond in question (such as a chemical in the water) that induces albinism in a proportion of the toads that



Figure 1. The garden pond in which the albino toads were discovered. Photograph © S. Pash.



Figure 2. An albino female Common toad in amplexus with a normal male. Photograph taken 24th March 2005. © S. Pash.



Figure 3. Spawn of both albino and normal common toads collected on 25th March, 2005, from a pond in Ruislip, southern England. © S. Pash.

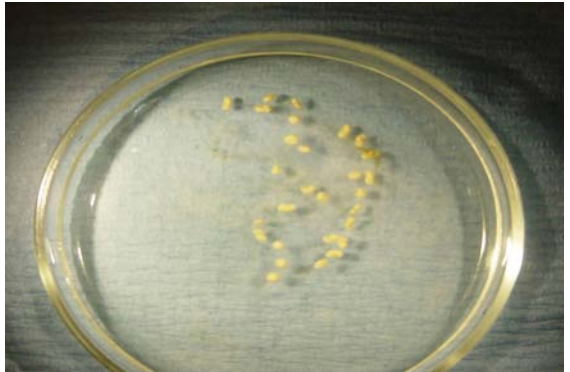


Figure 4. Albino tadpoles of the Common toad as they emerge from their eggs. © S. Pash.



develop from eggs spawned in the pond. Although this latter possibility might seem extremely unlikely, the appearance of an albino newt in the same pond in 2006 (Figure 5; see also page 11) might add some credence to it.

Albino toads (and other amphibians and reptiles) are said to be very rare (Beebee & Griffiths, 2000). Of course it is possible that albino toads other than those reported in the readily accessible literature have been found (e.g. BBOWT, 2004). Their rarity can be gauged from the fact that, in the last 8 years (1999 to 2006 inclusive), over 27,000 adult Common toads migrating to breeding ponds have been carried across a road linking Henley-on-Thames and Marlow in Buckinghamshire, England, and not one albino has been seen (our unpublished information). Even if some toads have been counted twice (because they migrated on two or more consecutive years), and

Figure 5. The albino Smooth newt (*Triturus vulgaris*) found in April, 2006. Note the pink eye and complete lack of body pigment (see also article on page 11). © J. Spooner.

hence the number of individual toads is somewhat less than 27,000, this example demonstrates the extreme rarity of albino adult toads.

Our data on the degree of successful development of albino and normal toads, although not unequivocal, do suggest that eggs and tadpoles of an albino parent (presumably the very pale 'albino' eggs came from an albino female) are not as viable as those of normal toads. The motility problems experienced by many of the albino tadpoles (such as swimming upside down, or round and round in tight circles) provided visual evidence of the developmental problems experienced by albino tadpoles. Some 'albino' tadpoles (they were by now quite dark) did survive, however, and metamorphosed into toadlets. Presumably some of these can survive in the wild (in a suburban setting) for a number of years, and reach sexual maturity. It has been reported that male Common toads first reach sexual maturity when 2 years old, and females are probably 3 years old when they first spawn, at least in a population in mid-Wales (Gittins *et al.*, 1985). It is generally considered that albinos (of any animal) are at a significant disadvantage as far as survival is concerned; they are presumably very visible, for example, to predators. Being largely nocturnal may reduce the risk. Perhaps albino toads survive better in a suburban setting than they would in more rural locations (where there may be more, and/or different, predators).

The tadpoles that hatched from albino spawn were initially very pale (i.e. albino in appearance), but soon become darker, and were a normal colour (black) when those that survived metamorphosed. This probably indicates that they were offspring of an albino female (hence the pale eggs) and a normal male. The latter would provide the genes required for melanin synthesis (such as the hormone melanocyte stimulating hormone from the pituitary gland). If albinism is due to a single gene defect (the most simple explanation) and that gene was recessive (as seems likely), then the albino female would have been homozygous for the gene defect and the normal male homozygous for the wild type (normal) gene. All offspring would therefore have been heterozygous, but presumably darkened through development due to the dominance of the wild type gene. These heterozygous toads, if they reach maturity and spawn, can potentially perpetuate the albino 'line'. The presence of both male and female albino toads in the pond for a number of years makes the continued existence of a 'line' of albino toads a distinct possibility.

REFERENCES

- B. B. O. W. T. (2004). Wildlife News. May 2004, p. 15.
 Beebee, T. J. C. & Griffiths, R. A. (2000). *Amphibians and Reptiles*, London: Harper Collins.
 Frazer, J. F. D. (1983). *Reptiles and Amphibians in Britain*. London: Collins.
 Gittins, S. P., Kennedy, R. I. & Williams, R. (1985). Aspects of the population age-structure of the common toad (*Bufo bufo*) at a Llandrindod Wells lake, mid-Wales. *Br. J. Herpetol.* **6**, 447–449.



Occurrence of an albino newt and albino Common toads (*Bufo bufo*) in the same garden pond.

J. SPOONER, S. PASH and J. P. SUMPTER

Institute for the Environment, Brunel University, Uxbridge, Middlesex, UB8 3PH, U.K.

AS reported in the preceding paper (Pash *et al.*, 2007), one or more albino toads were present in a small garden pond in southern England in 2004 and 2005. In 2006, after that paper had been written and submitted, a probable albino newt, together with two albino common toads, were found in the same garden.

The newt had the same salmon-pink body colour as the albino toads (Figure 1; see also Figure 5 on page 10). Its eyes, however, were pink, like those of the toads. There were no black spots on the body, nor any yellow, orange, or blue stripes or other marks on the animal. The lack of any black spots in particular suggest that the newt was



Figure 1. An albino Common toad (*Bufo bufo*) and an albino Smooth newt (*Triturus vulgaris*) found in the same small garden pond in west London in April, 2006. Photograph © J. Spooner.

unable to synthesise the black pigment melanin, and strongly supports the assignment of albinism. As far as we are aware, there are no reports in the open literature of albino newts, and so it is not possible to compare the colouration of the one reported here with previous records.

We consider it most likely that the newt was a male Smooth (or Common) newt (*Triturus vulgaris*). The obvious, though not especially pronounced, crest along the upper body and tail (Figure 1 above and Figure 5 on page 10) suggest the newt was a sexually-maturing male. The lack of a fine filament on the end of the tail, and lack of palmated (webbed) rear feet, make it unlikely that the newt was a Palmate newt (*Triturus helveticus*). The newt was also possibly too large to be a Palmate newt. Further support for this identification comes from the fact that previously

only Smooth newts have been recorded in the pond (although palmate newts do occur in at least one pond locally).

The occurrence of albino newts seems to be extremely rare. Most albino newts and salamanders that have been reported have also been neotenous (Beebee & Griffiths, 2000). However, the newt reported here was

obviously not neotenous; there was absolutely no sign of external gills, for example.

The most interesting, and remarkable, fact is the co-occurrence of albino toads (now for 3 consecutive years) and an albino Smooth newt in the same pond (and a very small, urban one at that). This probably represents a unique situation, making it very tempting to conclude that a common environmental factor must have been responsible for inducing albinism in both species. However, if that reasoning is correct, the nature of the factor (perhaps chemical) is unknown currently.

REFERENCES

- Beebee, T J. C. & Griffiths, R. A. (2000). *Amphibians and Reptiles*. London: Harper Collins.
- Pash, S., Spooner, J. & Sumpter, J. P. (2007). Albino common toads (*Bufo bufo*). *Herpetol. Bull.* **100**, 8–11.

Recent distribution records of Estuarine crocodiles (*Crocodylus porosus*) in northern Sulawesi, Indonesia

STEVEN G. PLATT¹, JOHNY S. TASIRIN², IWAN HUNOWU²,
STEPHAN SIWU² and THOMAS R. RAINWATER³

¹ Department of Biology, P.O. Box C-64, Sul Ross State University, Alpine, Texas, 79832, USA.
Email: splatt@sulross.edu [author for correspondence]

² Wildlife Conservation Society Indonesia Program – Sulawesi, Jl. Sam Ratulagi No. 41,
P.O. Box 1580, Manado, 95000, Sulawesi, Indonesia.

³ The Institute of Environmental and Human Health, Department of Environmental Toxicology,
P.O. Box 764, Jefferson, Texas, 75657, USA.

SULAWESI (formerly known as Celebes) is a large equatorial island in the Indonesian Archipelago situated between Borneo and the Maluku islands (Whitten *et al.*, 1987; Gillespie *et al.*, 2005). Its fauna is among the most distinctive in Indonesia with high levels of endemism across all vertebrate groups (Whitten *et al.*, 1987). Despite the biogeographical significance of Sulawesi, little is known about the distribution and biology of most reptiles inhabiting the island (Gillespie *et al.*, 2005), and this is particularly true with regards to crocodiles (Ross, 1986; Platt & Lee, 2000).

Although various authors (e.g., Schmidt, 1935; Groombridge, 1982; Ross, 1986; Sebastian, 1994) have suggested that as many as four species of crocodylians (*Crocodylus porosus*, *C. siamensis*, *Crocodylus* n. sp., *Tomistoma schlegelii*) might be found in Sulawesi, the Estuarine crocodile (*C. porosus*) is the only species definitely known to occur on the island (see review in Platt & Lee, 2000). Historic accounts suggest that *C. porosus* was formerly widespread and abundant on Sulawesi (Guillemard, 1889; Hickson, 1889; Whitten *et al.*, 1987). Indeed, *C. porosus* was once so common that many riverside villages were forced to construct waterfront stockades of tightly woven bamboo fences to protect villagers from crocodile attacks (Whitten *et al.*, 1987). However, decades of unrestricted skin hunting, collecting to stock crocodile farms, and habitat degradation have reduced *C. porosus* populations to scattered remnants (Groombridge, 1982; Whitten *et al.*,

1987; Cox, 1992; Platt & Lee, 2000). Although now regarded as rare and declining (Groombridge, 1982), field surveys have yet to be undertaken (Thorbjarnarson, 1992; Ross, 1998), and there is a notable paucity of information regarding the current distribution of *C. porosus* in Sulawesi (Platt & Lee, 2000).

In the most recent review, Platt & Lee (2000) noted that populations of *C. porosus* persist in the Sangihe Talud Islands where villagers refrain from killing crocodiles for religious reasons. Similarly, Cox (1992) suggested that substantial numbers of *C. porosus* may occur in the Ancona, Cerekan, and Parakayu rivers where crocodiles are locally protected as a totem animal. According to Whitten *et al.* (1987), Estuarine crocodiles inhabit an extensive (ca. 31,400 ha) peat swamp comprising the northern portion of the Rawa Aopa-Watumohae National Park (Whitten *et al.*, 1987). Platt & Lee (2000) examined a number of crocodiles captured near Gorontalo and Kotamobagu, but could not determine their specific provenance, and Gillespie *et al.* (2005) found *C. porosus* in mangrove swamps on Buton Island in southeastern Sulawesi. Herein we report additional distribution records for *C. porosus* from Sulawesi, and comment on the conservation status of these populations. Our distribution records were opportunistically collected during a recent survey of endemic chelonians in northern Sulawesi (Platt, 2006).

We documented the occurrence of *C. porosus* at three localities in northern Sulawesi (Figure 1);

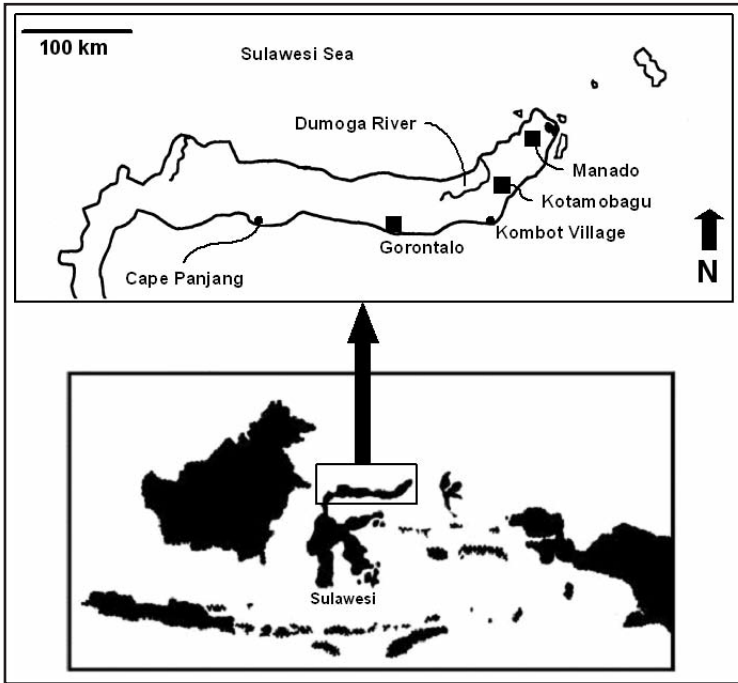


Figure 1. Map of northern Sulawesi, Indonesia showing localities where estuarine crocodiles (*Crocodylus porosus*) were found during July 2006. Dark squares indicate major population centres.

these include two coastal sites (Cape Panjang and Kombat Village), and an inland river (Dumoga River). Notably, all of the crocodiles that we examined lacked post-occipital scutellation (Figure 2), a character consistent with the description of *C. porosus* (Brazaitis, 1973; Ross, 1990). This is significant because others have observed crocodiles in Sulawesi that exhibited prominent post-occipital scutellation (Cox, 1992; Platt & Lee, 2000); these have been variously identified as *C. siamensis*, *C. novaeguineae*, *C. raninus*, or a hitherto undescribed taxa (Ross, 1990; Cox, 1992; Platt & Lee, 2000), but their taxonomic status currently remains unresolved. Regardless, these observations strongly suggest that at least one additional species of crocodilian besides *C. porosus* occurs in Sulawesi.

While interviewing residents of a roadside hamlet near Wonggarasi Village (00°31.16'N; 121°45.67'E) on 15th July 2006, we were shown an adult *C. porosus* measuring approximately 230 cm in total length (TL) being held in a make-shift pen. The crocodile was reportedly captured in a

coastal mangrove swamp on Cape Panjang, a short distance from the village. According to area residents, crocodiles remain common in these swamps where they are regarded as a nuisance by local fishermen. However, we noted that an extensive area of coastal habitat on Cape Panjang has already been converted to prawn culture and additional land-clearing is underway, casting doubt on the long-term viability of this population.

On 27th July 2006, we examined two hatchling *C. porosus* (TL = 34.0 cm) that were captured by farmers on the outskirts of Kombat Village (00°23.81'N; 124°09.36'E). We later accompanied villagers to the capture site (00°24.31'N; 124°08.30'E), a

flooded rice field adjacent to an extensive freshwater coastal swamp characterized by dense, monotypic stands of high grass (*Saccharum* sp.). Farmers stated that hatchlings and small juvenile crocodiles are encountered every year in rice fields near the swamps, indicating that local population recruitment is occurring; large adults are occasionally encountered as well. Similar herbaceous swamps are important nesting habitat for *C. porosus* in northern Australia (Webb *et al.*, 1983). The extensive and largely inaccessible grass swamps near Kombat probably function as an important local refuge for crocodiles. Moreover, human population density in this coastal area is low and the relatively high wages people receive from local timber extraction and processing enterprises provide little incentive for commercial exploitation of wildlife (Platt, 2006). Thus, crocodile populations in this area appear to be under minimal threat and relatively secure at the moment.

Finally, we examined two captive adult female *C. porosus* (TL ca. 180 and 210 cm) at a fish farm in Tambun Village (00°35.31'N; 124°07.13'E) on 25th July 2006. These crocodiles were captured in late December 2004 while nesting along the Dumoga River, approximately 30–40 km upstream



Figure 2. Female Estuarine crocodile (*Crocodylus porosus*) photographed in Tambun Village, northern Sulawesi, Indonesia. This crocodile was captured by villagers at a nest along the Dumoga River in late December 2004. Note the absence of post-occipital scutellation. Photograph © Iwan Hunowu.

from the river mouth. The two nests contained 40 and 52 eggs, although it was unclear which female was associated with the larger clutch. Although the nesting ecology of *C. porosus* has not been well-studied outside of northern Australia, these values for clutch size are within the range reported by others (Deraniyagala, 1939; Neill, 1971; Webb *et al.*, 1977; Hollands, 1987; Thorbjarnarson *et al.*, 2006). Hunters captured the crocodiles by placing snares along well-worn trails leading from the nests to the river.

On 29th July 2006, we accompanied villagers to the nest site where the larger clutch was found. The nest was constructed in a bamboo thicket on a low ridge approximately 30 m from the river, which at this point flows swiftly through a rocky channel. Other than a narrow strip of riparian vegetation where the nest was constructed, the surrounding habitat is largely fallow agricultural fields and coconut plantations. Additionally, villagers reported capturing two adult crocodiles

(ca. 250 to 300 cm) while electro-fishing in the Dumoga River; these animals were held briefly in hopes of establishing a crocodile farm, but escaped during a flood in early July 2006. While MacKinnon (1981) suggested that *C. porosus* occurred in the Dumoga River based on 'unsubstantiated reports from villagers', our observations constitute the first verified records from this region. Collectively these data suggest that the Dumoga River harbors a significant number of crocodiles; however, given the density of human settlement and conversion of wetlands to agriculture in the river valley (Goodland, 1988), we regard the viability of this population as questionable.

In conclusion, our records and those of others (reviewed by Platt & Lee, 2000) indicate *C. porosus* continues to occur at scattered localities in northern Sulawesi, although the long-term viability of many of these populations must be regarded as tenuous. While commercial skin hunting and trade in live crocodiles now appears minimal (Lee *et al.*, 2005; J. Tasirin, unpubl. data), populations are undoubtedly threatened by the continued loss of coastal wetland habitats. Furthermore, our records highlight the need for an island-wide crocodile survey in Sulawesi. Particular attention should be devoted to rivers, swamps, and wetlands in the mountainous and relatively undisturbed interior of the island, and the large freshwater lakes where an as yet undescribed species of *Crocodylus* is thought to occur (Schmidt, 1935). Such a survey is essential for conservation planning and management, and will also hopefully resolve the taxonomic confusion that currently surrounds the crocodilians of Sulawesi.

ACKNOWLEDGEMENTS

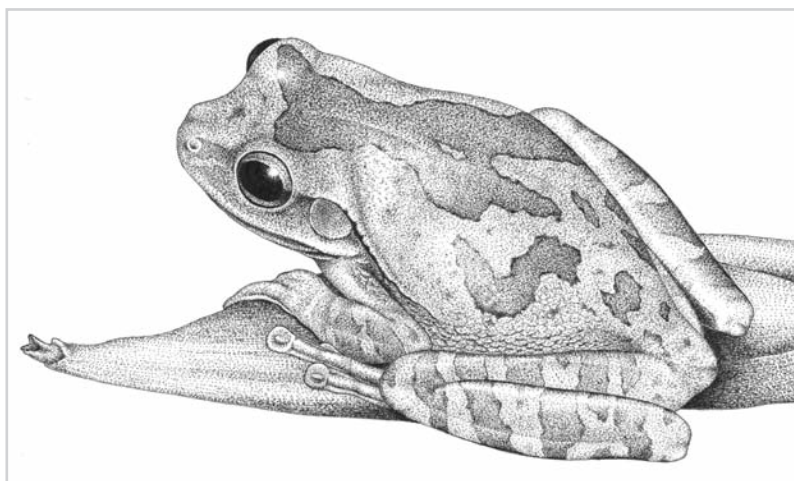
Our fieldwork in Sulawesi was supported by grants from Bradley Trevor Greive and Wildlife Conservation Society. Additional support was provided to SGP by Sul Ross State University. The logistic assistance of Colin Poole and Nick Brickle was instrumental in insuring the success of our venture. We are also indebted to Franky Wongkar, Toar Unsulangi, Verra Linelejan, Livemy Pajan, David Kosegeran, and Usman for field assistance and making our expedition an enjoyable one. Finally, we are grateful for the assistance, accommodation, and information provided by the many rural villagers we met during our field work. Several obscure references were located by Mike Robinson and the interlibrary loan staff at Sul Ross State University, and an early draft of this manuscript benefited from the comments of Lewis Medlock.

REFERENCES

Brazaitis, P. (1973). The identification of living crocodilians. *Zoologica* **58**, 59–101.
Cox, J. (1992). *Development of the crocodile industry on a sustainable basis – terminal report*. FAO-PHPA Project GCP/INS/060/JPN.

Report to Food and Agriculture Organization of the United Nations, Rome.
Deraniyagala, P. E. P. (1939). *The tetrapod reptiles of Ceylon. Vol. 1. Testudines and crocodilians*. Colombo: Colombo Museum.
Gillespie, G., Howard, S., Lockie, D., Scroggie, M. & Boeadi. (2005). Herpetofaunal richness and community structure of offshore islands of Sulawesi, Indonesia. *Biotropica* **37**, 279–290.
Goodland, R. (1988). Protecting wildlife and watersheds at Dumoga Bone, Indonesia. In: *Saving the tropical forests*, pp. 94–96. Gradwohl, J. & Greenberg, R. (Eds.). London: Earthscan Publ., Ltd.
Groombridge, B. (1982). *The IUCN Amphibia-Reptilia Red Data Book. Pt. 1. Testudines, Crocodylia, Rhynchocephalia*. Gland: IUCN Publications.
Guillemard, F. H. H. (1889). *The cruise of the Marchesa to Kamschatka and New Guinea with notices of Formosa, Liu-Liu, and various islands of the Malay Archipelago*. London: Murray.
Hickson, S. J. (1889). *A naturalist in north Celebes*. London: Murray.
Hollands, M. (1987). The management of crocodiles in Papua New Guinea. In: *Wildlife Management: Crocodiles and Alligators*, pp. 73–89. Webb, G. J. W., Manolis, S. C., & Whitehead, P. J. (Eds.). Sydney: Surrey Beatty and Sons, Pty. Ltd.
Lee, R. J., Gorog, A. J., Dwiyahreni, A., Siwu, S., Riley, J., Alexander, H., Paoli, G. D., & Ramono, W. (2005). Wildlife trade and implications for law enforcement in Indonesia: a case study from North Sulawesi. *Biol. Conserv.* **123**, 477–488.
MacKinnon, J. (1981). *Proposed Dumoga-Bone National Park, North Sulawesi, Indonesia: Management Plan 1982–1983*. Report from World Wildlife Fund to Directorate of Nature Conservation, Bogor.
Neill, W. T. (1971). *The last of the ruling reptiles: alligators, crocodiles, and their kin*. New York: Columbia Univ. Press.
Platt, S. G. (2006). *A survey to determine the conservation status of endemic chelonians in*

- northern Sulawesi, Indonesia. Report to Wildlife Conservation Society, Bronx, New York.
- Platt, S. G. & Lee, R. J. (2000). Notes on the distribution and current status of crocodiles in Sulawesi, Indonesia. In: *Crocodyles*. Proceedings 15th Working Meeting of the Crocodile Specialist Group, pp. 531–538. Gland: IUCN/SSC Crocodile Specialist Group.
- Ross, C. A. (1986). Comments on Indopacific crocodile distributions. In: *Crocodyles*. Proceedings 7th Working Meeting of the Crocodile Specialist Group, pp. 349–353. Gland: IUCN/SSC Crocodile Specialist Group.
- Ross, C. A. (1990). *Crocodylus raninus* S. Muller and Schlegel, a valid species of crocodile (Reptilia: Crocodylidae) from Borneo. *Proc. Biol. Soc. Washington* **103**, 955–961.
- Ross, J. P. (1998). *Crocodyles: status survey and conservation action plan*. Gland: IUCN SSC Crocodile Specialist Group.
- Schmidt, K. P. (1935). A new crocodile from the Philippine Islands. *Field Mus. Nat. Hist., Zool. Series* **20**, 67–70.
- Sebastian, A. K. (1994). The Tomistoma, *Tomistoma schlegelii* in Southeast Asia, a status review and priorities for its conservation. In: *Crocodyles*. Proceedings 7th Working Meeting of the Crocodile Specialist Group, pp. 98–112. Gland: IUCN/SSC Crocodile Specialist Group.
- Thorbjarnarson, J. (1992). *Crocodyles: an action plan for their conservation*. Gland: IUCN/SSC Crocodile Specialist Group.
- Thorbjarnarson, J., Platt, S. G., Win Ko Ko, Khin Myo Myo, Lay Lay Khaing, Kalyar, & Holmstrom, B. (2006). Crocodiles in Myanmar: species diversity, historic accounts, and current population status and conservation. *Herpetol. Nat. Hist.* **10**, 77–89.
- Webb, G. J. W., Messel, H. & Magnusson, W. (1977). The nesting of *Crocodylus porosus* in Arnhem Land, Northern Australia. *Copeia* **1977**, 238–249.
- Webb, G. J. W., Sack, G. C., Buckworth, R. & Manolis, S.C. (1983). An examination of *Crocodylus porosus* nests in two northern Australian freshwater swamps, with an analysis of embryo mortality. *Austr. Wildl. Res.* **10**, 571–605.
- Whitten, A. J., Mustafa, M., & Henderson, G. S. (1987). *The ecology of Sulawesi*. Yogyakarta: Gadjah University Press.



Smilisca baudini (Mexican treefrog) on bract of *Heliconia* sp., Cayo District, Belize. Pen and ink illustration by P. Stafford.

Distribution and habitat use of *Sordellina punctata* (Serpentes, Colubridae), with a new record from State of São Paulo, Brazil

DONIZETE NEVES PEREIRA ¹, FERNANDA STENDER-OLIVEIRA ^{1,2}, MURILO GUIMARÃES RODRIGUES ^{1,3} and RENATO SILVEIRA BÉRNILS ⁴

¹ *Laboratório de Herpetologia, Instituto Butantan, São Paulo - SP, Brazil.*

E-mail: doni_pereira@butantan.gov.br [corresponding author]

² *Pós Graduação em Ecologia, Instituto de Biociências, Universidade de São Paulo, São Paulo - SP, Brazil.* E-mail: fernandastender@butantan.gov.br

³ *Pós Graduação em Biologia Animal, Instituto de Biociências, Letras e Ciências Exatas, Universidade Estadual Paulista, São José do Rio Preto - SP, Brazil.*
E-mail: rodrigues@butantan.gov.br

⁴ *Departamento de Vertebrados, Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro - RJ, Brazil.* E-mail: renatobernils@terra.com.br

ABSTRACT – *Sordellina punctata* occurs throughout south and southeastern Brazil in the Atlantic Forest domain (states of São Paulo, Paraná and Santa Catarina). Records from the states of Rio de Janeiro and Mato Grosso do Sul are questionable. A new record from southwestern São Paulo extends its distribution west and northward, probably indicating a wider range in the past. Habitat use in *S. punctata* implies that it may be more associated with wetlands and other saturated areas than truly aquatic ones.

THE genus *Sordellina* Procter, 1923 is monospecific, including only *Sordellina punctata* (Peters, 1880; Figure 1), an uncommon snake in scientific collections. There is little available data in the literature about this species. Its taxonomic history was presented by Hoge (1958), Peters & Orejas-Miranda (1970) and Hoge & Romano (1978); the systematic position of the genus as a Xenodontinae *incertae sedis* was discussed in Ferrarezzi (1994) and Zaher (1999); some data on natural history and habitat was presented by Procter (1923), Amaral (1977), Cadle & Greene (1993), Marques (1996; 2001), Marques *et al.* (2001) and Marques & Sazima (2004); illustrations of the species are available in Hoge (1958), Hoge & Romano (1978) and Amaral (1926; 1977), Marques *et al.* (2001) and Marques & Sazima (2004). Apart from a study by Hoge & Romano (1978), information relating to its distribution is still lacking. This is the first study providing information about habitat use in *Sordellina punctata*.

To assess the distribution of *S. punctata* we examined the literature and checked the collections of the following institutions: Museu Nacional, Rio de Janeiro (MNRJ), Instituto Butantan, São Paulo (IBSP), Museu de Zoologia da Universidade de São Paulo, São Paulo (MZUSP), Museu de História Natural da Universidade Estadual de Campinas, São Paulo (ZUEC), Museu de História Natural Capão da Imbuia, Paraná (MHNCI), University of Michigan Museum of Zoology, Michigan (UMMZ) and National Museum of Natural History, Smithsonian Institution, Washington (USNM).

Distribution and occurrence

Sordellina punctata is known from the Atlantic Forest domain in south and southeast Brazil (Amaral 1977; Hoge & Romano 1978; Marques *et al.* 2001; Marques & Sazima 2004) with confirmed specimens from the states of São Paulo, Paraná and Santa Catarina. A single record from western Mato Grosso do Sul and all literature citations for Rio de Janeiro are questionable.

It is possible that records from State of Rio de Janeiro (see Peters & Orejas-Miranda 1970) were equivocated, as previously stated by Hoge & Romano (1978), although as recently indicated by Marques *et al.* (2001) and Rocha *et al.* (2004), the occurrence of *S. punctata* in Rio de Janeiro is not without basis. In spite of this, there is no voucher specimen which confirms its presence in the state.

The extremely western record from Porto Esperança, State of Mato Grosso do Sul, should also be interpreted with caution. It's based on a single old specimen (from 1943) of the Instituto Butantan herpetological collection, which arrived by a railway line (Linha Férrea Bauru) and could be kept by mistake into a box sent from other locality. Porto Esperança lies into a very distinctive environmental and geographical region, and it is about 900 km far from all confirmed records of *S. punctata* – more than the extremes of the remain known range of the species.

Literature revisited

Some localities showed in the literature associated with *S. punctata* need repair. The type locality of *Sordellina brandon-jonesii* Procter, 1923 – a junior-synonym – is “The campas [sic] near Castro, on the R. de Tibeira, Paraná, S.E. Brazil” (Procter 1923), but Peters & Orejas-Miranda (1970) mentions as “Near Castro, Rio de Tiberia, Paraná, Brazil”. The unintentional use of “Tiberia” instead of “Tibeira” difficult its recognition as the Rio da Ribeira (or rio Ribeira), an important river in the border area between Paraná and São Paulo states – which in fact has its source near the city of Castro, Paraná.

The specimen MZUSP 3481 (currently USNM 200693) was cited by Hoge & Romano (1978) as sent from “Camboriú SC” (Camboriu municipality, in the state of Santa Catarina), but in the MZUSP archives this record clearly refers to the railway station of Camboriu, Itanhaém municipality, State of São Paulo.

Hoge (1958) wrongly cites “São Bento, Staat São Paulo, Brasilien” as the type locality of *Sordellina pauloensis* Amaral, 1923 – a junior-synonym of *Sordellina punctata* (Peters, 1880). São Bento (now São Bento do Sul) is a city in the state of Santa Catarina, given by Afrânio do Amaral as the type-locality of *Atractus trihedrurus*, a species described as new in the same paper (Amaral, 1926) where a description (in



Figure 1. Adult example of *Sordellina punctata* (female from São Paulo-SP). Photograph © O. A. V. Marques.

Portuguese) of *Sordellina punctata* was presented. The correct type locality of *Sordellina pauloensis* Amaral, 1923 was presented in the original description and in Peters & Orejas-Miranda (1970) and Hoge & Romano (1978) as Poá, State of São Paulo, Brazil.

Finally, Amaral (1926) and Hoge & Romano (1978) made one more mistake. They both cited the specimens MZUSP 1578 and 1579 as paratypes of *Sordellina pauloensis*. However, an examination of the MZUSP collection shows that the true paratypes, respectively from “Rio Grande” and “Conceição de Itanhaém” (both in State of São Paulo), are MZUSP 1577 and 1578. MZUSP 1579 is not a *Sordellina*, but an *Atractus pantostictus* from São Paulo (C. Castro-Mello, *in litt.*). Today, “Conceição de Itanhaém” is only called Itanhaém; in the same way, Rio Grande da Serra is the current name of the locality given by Amaral (1923) as “Rio Grande, near Serra de Cubatão”.

The new record

We present here a new record: Piraju municipality (23°11'S, 49°23'W, 646 m), southwestern region of the state of São Paulo. Eight specimens were collected during fieldwork at the Usina Hidrelétrica de Piraju (a hydroelectric power station), between March 2002 and September 2003. Of these, four were marked with microchips and released (method in Nogueira *et al.*, 2003), and the remaining four were sent to Instituto Butantan (IBSP 67661, IBSP 67695, IBSP 67696 and IBSP 67818). A search of herpetological collections indicated this record was new, increasing its distribution further to the west as well as to the north of its confirmed range (Figure 2).

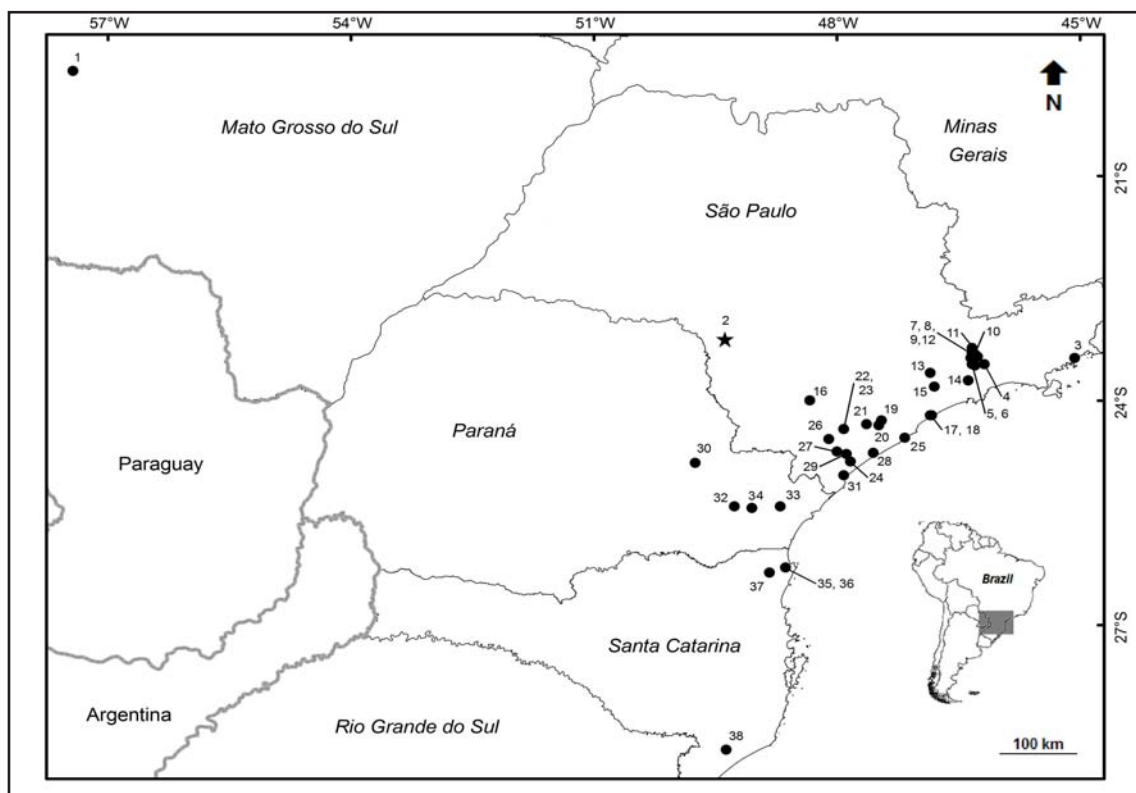


Figure 2. Localities with records of *Sordellina punctata* (Peters, 1880). Star: New occurrence for the species in the municipality of Piraju, São Paulo, Brazil. Localities: 1-Porto Esperança (Fazenda Cáceres); 2-Piraju; 3-Ubatuba (Ilha do Rosário); 4-Mogi das Cruzes; 5-Poá; 6-Suzano; 7-São Paulo; 8-São Paulo (Butantã); 9-São Paulo (Jardim Aeroporto); 10-São Paulo (Ipiranga); 11-São Paulo (Santo Amaro); 12-São Paulo (Parelheiros); 13-Embú; 14-Rio Grande da Serra; 15-Embú Guaçu; 16-Capão Bonito; 17-Itanhaém; 18-Itanhaém (Camboriu); 19-Miracatu; 20-Miracatu (Biguá); 21-Juquiá; 22-Sete Barras; 23-Sete Barras (P. E. Carlos Botelho); 24- Registro; 25- Iguape (E. E. Juréia-Itatins); 26- Eldorado Paulista; 27- Jacupiranga; 28-Iguape; 29-Pariquera-Açu; 30- Castro (Rio da Ribeira); 31-Cananéia; 32-Curitiba; 33- Antonina; 34-Piraquara (Chácara Medianeira); 35-São Francisco do Sul; 36-São Francisco do Sul (Praia de Ubatuba); 37-Joinville; 38-Criciúma.

The area of the reservoir is covered by open formations (agricultural and cattle raising areas, with remnants of scrubland) and forest fragments (riparian vegetation and semi-deciduous broadleaf forest) with multiple serial stages of succession. The individuals of *S. punctata* were found in the nearby of Paranapanema river, a vast water course with 929 km long and maximum width 800 m.

Near the western bank, five snakes were found and from these, two were encountered at a site named Brejo do Jacaré (meaning “caiman wetland” or “caiman bog”), a humid and muddy area, with movable and slimy soil covered with hydrophilic Cattail plants (*Typha dominguensis*: Typhaceae). Another specimen was captured in riparian vegetation, with the same soil conditions as a cattle path. The other two were found in distinct formations of riparian vegetation, but with the same physical characteristics as low humid, forest, and with a high level of human disturbance.

On the eastern bank, three individuals were found, one of them in riparian vegetation with movable and ‘slimy’ soil on a cattle path, and another by a pitfall trap line 300 m from the river’s edge, and 50 m from a small disturbed fragment of semi-deciduous forest. The last snake was found 30 m from the river in a small, disturbed and in regenerating forest with herbaceous plants.

At other localities in the state of São Paulo, like Estação Ecológica Juréia-Itatins (Iguape municipality) and Parque Estadual Carlos Botelho (Sete Barras municipality), individuals of

Sordellina punctata were found in the same humid soil near water bodies (O. A. V. Marques and R. A. Moraes, pers. comm.).

Habitat use

Since Procter's (1923) description of *Sordellina punctata*, this species has been associated with aquatic environments in various forms. Discussing the habitat where his unique specimen was caught (by another person), Procter mentions "probably in moist places"; however, he didn't justify his suspicions. Amaral (1977: p. 90) gives "várzea do Rio Pinheiros" (floodplains of Pinheiros river) as the origin of the IBSP 6791 specimen, but he did not make any other comment about environments inhabited by the species.

Habitat use of *S. punctata* were published first in Marques (1996), following Marques (2001), Marques *et al.* (2001) and Marques & Sazima (2004). Based mainly in field observations of the authors, these affirmations, on the other hand, do not specify how and which "aquatic" environments the species in fact inhabits. Our data, conjugated with other field observations indicates that *Sordellina punctata* is not a truly aquatic species. It seems more associated with wetlands and other soak soils, surrounding lakes or rivers, than water bodies itself.

Procter (1923) corroborates our statement of muddy and soaked soils in floodplains as habitat for *S. punctata*. This author found the burrowing limbless amphibian *Chthonerpeton indistinctum* (Gymnophiona, Typhlonectidae) in the stomach of his unique specimen of *S. punctata*. Typhlonectidae is a family of caecilians known for its secondarily aquatic habits (Taylor 1968), but this species, in particular, is much more common in riverside muddy environments, floodplains or wetlands, than water bodies – where it was seen only occasionally (Ihering 1911; Serié 1915; Liebermann 1939; Lema *et al.* 1983; Gudynas *et al.* 1988).

ACKNOWLEDGEMENTS

We thank Francisco L. Franco for the critical reading, pertinent literature and comments that improved the manuscript; Valdir J. Germano, Hebert Ferrarezzi, Rodrigo R. Scartozzoni, Jorge D. Williams and José A. Langone for helpful suggestions and literature; Fabia Parkinson for English review; Michel Miretzki for drawing the map; Otávio A. V. Marques and Renato A. Moraes

for field information. For permission to access the collections or help in the inventory of specimens: Daniel Fernandes and Ronaldo Fernandes (MNRJ), Francisco L. Franco (IBSP), Gregory E. Schneider (UMMZ), Hussam E. Zaher (MZUSP), Julio C. de Moura-Leite (MHNCI), Rainer Günther (Museum für Naturkunde, Berlin), Roy McDiarmid (USNM) and Vagner Ariedi Jr. (ZUEC). The authors thank Gaia Consultoria Ambiental and Companhia Brasileira de Alumínio for allowing and facilitating our fieldwork. FSO acknowledges the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES. MGR acknowledges the Fundação de Amparo à Pesquisa do Estado de São Paulo – FAPESP, and RSB acknowledges the Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq (Process # 142373/2005-2).

REFERENCES

- Amaral, A. (1923). New genera and species of Snakes. *Proc. New England. Zool. Club* **8**, 85–105.
- Amaral, A. (1926). Novos gêneros e espécies de Ophidios brasileiros – Contribuição III para o conhecimento dos Ophidios do Brasil – *Arch. Mus. Nac. Rio de Janeiro* **26**, 95–121.
- Amaral, A. (1977). *Serpentes do Brasil. Iconografia colorida*. São Paulo: Editora Melhoramentos and Editora Universidade de São Paulo. 247 pp.
- Cadle, J. E. & Greene, H. W. (1993). Phylogenetic Patterns, Biogeography, and the Ecological Structure of Neotropical Snake Assemblages. In: Ricklefs, R.E. & Schluter, D. (Eds.). *Species diversity in ecological communities: historical and geographical perspectives*, pp. 281–293. Chicago: University of Chicago Press.
- Ferrarezzi, H. (1994). Uma sinopse dos gêneros e classificação das serpentes (Squamata): II. Família Colubridae. In: Nascimento, L.B., Bernardes, A.T. & Cotta, G.A. (Eds.). *Herpetologia no Brasil, I*, pp. 81–91. Belo Horizonte: PUCMinas, Fundação Biodiversitas and Fundação Ezequiel Dias.
- Gudynas, E., Williams, J. D. & Azpelicueta, M. M. (1988). Morphology, ecology and biogeography of the South American Caecilian *Chthonerpeton indistinctum* (Amphibia: Gymnophiona: Typhlonectidae). *Zool. Mededel.* **62**, 5–28.
- Hoge, A. R. (1958). Die systematische stellung von *Xenodon punctatus* Peters 1880 und *Philodryas taeniatus* Hensel 1868. *Mitt. Zool. Mus.* **34**, 49–56.
- Hoge, A. R. & Romano, S. A. R. W. D. L. (1978). Redescription and range of *Sordellina punctata*

- (Peters) (Serpentes: Colubridae). *Mem. Inst. Butantan*, São Paulo **40/41**, 63–70.
- Ihering, R. (1911). Cobras e amphibios das ilhotas de “Aguapé”. *Rev. Mus. Paulista* **8**, 454–461.
- Lema, T., Araújo, M. L. & Azevedo, A. C. P. (1983). Contribuição ao conhecimento da alimentação e do modo alimentar de serpentes do Brasil. *Comum. Mus. Ci. PUCRS (Zool.)* **26**, 41–121.
- Liebermann, J. (1939). Distribución geográfica de los caecílicos argentinos y observación acerca de la biología. *Physis* **16**, 83–88.
- Marques, O. A. V. (1996). *Sordellina punctata*. Diet. *Herpetol. Rev.* **27**, 147–147.
- Marques, O. A. V. (2001). *Sordellina punctata*. Reproduction. *Herpetol. Rev.* **32**, 51–52.
- Marques, O.A.V., Eterovic, A. & Sazima, I. (2001). *Serpentes da Mata Atlântica: Guia Ilustrado para a Serra do Mar*. Ribeirão Preto: Holos. 184 pp.
- Marques, O. A. V. & Sazima, I. (2004). História natural dos répteis da Estação Ecológica Juréia-Itatins. In: Marques, O.A.V. & Duleba, W. (Eds.). *Estação Ecológica Juréia-Itatins: ambiente físico, flora e fauna*, pp. 254–274. Ribeirão Preto: Holos.
- Nogueira, C., Sawaya, R. J. & Martins, M. (2003). Ecology of *Bothrops moojeni* (Serpentes: Viperidae: Crotalinae) in the Brazilian Cerrado. *J. Herpetol.* **37**, 653–659.
- Peters, J. A. & Orejas-Miranda, B. (1970) Catalogue of the Neotropical Squamata: Part I. Snakes. *U. S. Nat. Mus. Bull.* **297**, viii + 347 pp.
- Peters, W. (1880). Neue oder weniger bekannte Amphibien des Berliner Zoologischen Museums. *Monatsb. Preus. Akad. Wiss.* **1880**, 217–224.
- Procter, J. B. (1923). On a new genus and species of Colubrinae snake from SE Brazil. *Ann. Mag. Nat. Hist.* **9**, 227–230.
- Rocha, C. F. D., Bergallo, H. G., Pombal Jr., J. P., Geise, L., Van Sluys, M., Fernandes, R. & Caramaschi, U. (2004). Fauna de anfíbios, répteis e mamíferos do Estado do Rio de Janeiro, Sudeste do Brasil. *Publ. Avulsas Mus. Nac.* **104**, 1–24.
- Serié, P. (1915). Notas sobre un batracio ápodo de la Argentina: *Chthonerpeton indistinctum* (R. L.). *Physis* **2**, 41–43.
- Taylor, E. H. (1968). *The Caecilians of the World*. A Taxonomic Review. Lawrence: University of Kansas Press. 848 p.
- Werner, F. (1909). Über neue oder seltene Reptilien des Naturhistorischem Museums in Hamburg. I. Schlangen. *Mitt. Naturhist. Mus. Hamburg* **26**, 205–247.
- Zaher, H. E. (1999). Hemipenial morphology of the South American xenodontine snakes, with a proposal for a monophyletic Xenodontinae and a reappraisal of colubroid hemipenes. *Bull. Amer. Mus. Nat. Hist.* **240**, 1–168.

Appendix: Examined specimens

Sordellina punctata – **BRAZIL**: ZMB 9647 – holotype of *Xenodon punctatus*, from “Brasilien”; **Mato Grosso do Sul**: Porto Esperança (Fazenda Cáceres; 19°36’S, 57°26’W, 86 m): IBSP 10464; **São Paulo**: Cananéia (25°00’S, 47°55’W, 8 m): IBSP 55332; Capão Bonito (24°00’S, 48°20’W, 705 m): IBSP 46054; Eldorado Paulista (24°31’S, 48°06’W, 62 m): IBSP 56081; Embu (23°38’S, 46°51’W, 775 m): IBSP 42518, 62203, 71106; Embu-Guaçu (23°49’S, 46°48’W, 742 m): IBSP 54552; Iguape (24°42’S, 47°33’W, 5 m): IBSP 40166, 40851, 41186, 49404, 56068, ZUEC 857, UMMZ 204200; Iguape (Estação Ecológica Juréia-Itatins; 24°30’S, 47°10’W, 3 m): IBSP 56066; Itanhaém (24°10’S, 46°47’W, 6 m): IBSP 66199, MZUSP 1578 – paratype of *Sordellina pauloensis*; Itanhaém (Camboriu; 24°12’S, 46°51’W, 3 m): USNM 200693 (former MZUSP 3481); Jacupiranga (24°41’S, 48°00’W, 33 m): IBSP 24313; Juquiá (24°19’S, 47°38’W, 17 m): IBSP 22313; Miracatu (24°16’S, 47°27’W, 27 m): IBSP 32762, 46023, 46611; Miracatu (Biguá; 24°20’S, 47°29’W, 27 m): ZUEC 1364; Mogi das Cruzes (23°31’S, 46°11’W, 742 m): IBSP 9077; Pariqueira-Açu (24°42’S, 47°52’W, 39 m): IBSP 32749, 40285, 48744; Piraju (23°11’S, 49°23’W, 646 m): IBSP 67661, 67695, 67696, 67818; Poá (23°31’S, 46°20’W, 760 m): IBSP 3007 – holotype of *Sordellina pauloensis*, IBSP 25130, 41375, 41377, 41408, 44176; Registro (24°29’S, 47°50’W, 25 m): IBSP 41071, 52934, ZUEC 796; Rio Grande da Serra (23°44’S, 46°23’W, 739 m): IBSP 46958, 46959, MZUSP 1577 – paratype of *Sordellina pauloensis*, IBSP 55692, 55693; São Paulo (Butantã; 23°25’S, 46°16’W, 760 m): IBSP 6791; São Paulo (Jardim Aeroporto; 23°22’S, 46°20’W, 760 m): IBSP 49190; São Paulo (Ipiranga; 23°35’S, 46°36’W, 760 m): type-locality of *Liophis rehi* Werner, 1909; São Paulo (Parelheiros; 23°32’S, 46°38’W, 760 m): IBSP 34286, 34290, 42914; São Paulo (Santo Amaro; 23°18’S, 46°20’W, 760 m): IBSP 22936, 22937, 33201; São Paulo (23°26’S, 46°21’W, 760 m): IBSP 57742; Sete Barras (24°23’S, 47°55’W, 30 m): IBSP 29487; Sete Barras (Parque Estadual Carlos Botelho; 24°23’S, 47°55’W, 30 m): IBSP 74951; Suzano (23°32’S, 46°18’W, 738 m): IBSP 55084, MZSP 2003; Ubatuba (Ilha do Rosário; 23°26’S, 45°04’W, 3 m): IBSP 69511; **Paraná**: Antonina (25°25’S, 48°42’W, 20 m): MHNCI 3072; Castro (Rio da Ribeira; 24°50’S, 49°45’W, 900 m): type-locality of *Sordellina brandon-jonesii*, in The Natural History Museum at London (collection number not given at the original description); Curitiba (25°25’S, 49°16’W, 934 m): IBSP 40760, MHNCI 7953; Piraquara (Chácara Medianeira; 25°26’S, 49°03’W, 905 m): MHNCI 1110; **Santa Catarina**: Criciúma (28°40’S, 49°22’W, 46 m): IBSP 25159; Joinville (26°18’S, 48°50’W, 3 m): IBSP 69512, MNRJ 774; São Francisco do Sul (26°14’S, 48°38’W, 9 m): UMMZ 115650; São Francisco do Sul (Praia de Ubatuba; 26°14’S, 48°38’W, 9 m): MNRJ 1817.

Non-lethal injury in Hermann's tortoise, *Testudo hermanni*, in Croatia and Montenegro

ROGER MEEK

7 Rue Georges Clemenceau, Chasnais, France. E-mail: Rogermeek85@aol.com

ABSTRACT – Field injuries in Hermann's tortoise (*Testudo hermanni*) from Croatia and Montenegro are described. In Montenegro, male damage scores were significantly lower than those of females, but in Croatia the difference was not significant. Regression analysis indicated that damage score in Croatia was associated with growth ring number (i.e. age) but in Montenegro with body mass, although only in females. Based on mark-release/recapture data, damaged tortoises were recaptured more frequently than undamaged tortoises. No significant differences were found between body mass levels or body temperatures of damaged or undamaged tortoises.

THE ability of animals to survive injury in field populations is a key factor in population ecology. Survival from injury may enhance reproductive effort (Harris, 1989) and contribute to the evolution of anti-predator strategies (Vermeij, 1982). Reptiles show several physiological characteristics that pre-adapt their survival from injury. For example, blood loss from a wound is much less than in an endotherm and reptilian nerve tissue is resilient and may remain viable for long periods without oxygen (Close *et al.*, 1996; 1997). However, other than direct physiological impacts from injury, including secondary infection, there may be ecological costs. These include a reduction in locomotory capacity, the ability to secure food items, reduced growth, delayed maturation and also injured animals could fare poorly in intra-sexual conflicts (Gregory & Isaac, 2005). Therefore the ability to tolerate sub-lethal injury, either through contact with predators or accidental contact with objects in the environment, has broad evolutionary and ecological consequences.

A well known form of non-lethal injury in reptiles is autotomy. Found mostly in lizards and to a lesser extent in snakes and salamanders (e.g. McConnell & Whiting, 2003; Bernando & Agosta, 2005; Gregory & Isaac, 2005) autotomy has evolved as a defence mechanism, but its employment may necessitate behaviour changes or have ecological costs (e.g. Brown *et al.*, 1995; Downes & Shine, 2001). Non pre-adapted wounds, which could be more debilitating, may

also have behavioural and/or physiological consequences, but most studies of reptilian field injuries have focused on the squamates, species that usually have relatively short life spans and fast generation times (e.g. Schoener & Schoener, 1980; Gregory & Isaac, 2005). The chelonians on the other hand are typically long-lived and although known to sustain damage from a variety of sources, have been less studied in this respect. For instance, Hailey, (1990) has indicated that successful repeated annual reproduction in Hermann's tortoise *Testudo hermanni* is a critical component of lifetime reproductive success, since although it is mature for an estimated 42 – 56% of its lifespan with egg production approximately 1–6 eggs per clutch, hatching success may be low (Swingland & Stubbs, 1985) with mean annual survivorship in the region of 3–5% (Meek, 1985, 1989; Stubbs & Swingland, 1985). Under such reproductive constraints, it might be expected that by necessity, there would be a trend towards the evolution of high tolerance of field injuries, at least in the adult state.. This paper examines this possibility using information on injuries or damages gathered during field studies of *T. hermanni* in Montenegro and Croatia where both population ecology (Meek, 1985; 1989) and thermoregulation (Meek, 1984; 1988a; 1988b) was studied.

METHODS

The data used in this paper is based on tortoises measured during fieldwork undertaken in

Montenegro during 1983 and 1986 and Croatia in 1986. There were three study sites in total, all typical Mediterranean mixed scrub, situated on the Adriatic coast. However, because of the small sample sizes of damaged individuals and the fact that the Montenegrin populations were living in more rocky environments alongside agricultural activities, the data from these populations were pooled. Typical habitat types are shown in photographs in Meek (1989) and Meek & Inskeep (1981). Field methodology was described in the original papers (Meek, 1985; 1989) so only brief descriptions are given here. The results are derived from 127 (18 damaged) tortoises from Croatia (20 kilometres south of Dubrovnik) and in total 168 animals in Montenegro (18 damaged; 8 from Sutomore - Meek, 1989) and 10 from Budva (Meek, 1985).

Carapace length was taken as a straight-line measurement between the leading edges of the nuchal and supracaudal scutes and body mass by suspending the animals in a cloth bag using a spring balance. Hermann's tortoise produces one growth ring annually at least until maturity of 13-14 years (Castanet, 1985) and age estimates were made using these counts (e.g. Meek, 1985; 1989, Stubbs & Swingland, 1985). Body temperatures recorded were cloacal and recorded with mercury bulb thermometers. They were spot measurements of animals when they were located and not continuous on any one animal (Meek, 1984; 1988a).

Information of physical injury was collected in both written and photographic form and examples are shown in Fig 1. A score system was employed reflecting the degree of the injury sustained. This was based on estimates of 1) the estimated impact of the injury at the time it occurred and 2) on the

estimated effect throughout its life. Other factors taken into account was the likely physiological effort the animal would have needed to recover from the wound, based partly on known veterinary treatments for wounds in captive tortoises. A high score (5) was applied to animals with jawbone breaks, limb loss or major shell damage (Figure 1) on the assumption that the injury would probably have been a major threat to life and indeed continued to act as a handicap to normal activity. Middle scores (2-4) were applied to animals exhibiting large or small dents in the shells with these scores generally reflecting the extent of injury; Figure 1D for example would be scored as 2 and Figure 1E scored as 3). So generally lesser damages were given progressively lower scores with a score of 1 applied to animals showing minor shell damage, for example around the shell margins.

Means of body masses, growth ring numbers, damage scores and body temperatures have been given with standard deviations. Standard errors have been attached to the regression coefficients in equations (1) and (2) and the allometric exponents.

RESULTS

Size comparison of damaged and undamaged tortoises. Figure 2 shows the ranges of damaged tortoises in relation to the ranges of the undamaged sections of the population. Undamaged animals in the graphs include juveniles and/or immatures but these were not included in the statistical analysis unless stated, as they could not be sexed. There was no significant difference (ANOVA, $p > 0.05$) between the mean size (determined here as a function of body mass but excluding unsexed juveniles) of undamaged or damaged males in the samples (Croatia damaged $mean = 605.7 \pm 72.3$, not damaged $mean = 608.1 \pm 128.3$; Montenegro damaged $mean = 824.9 \pm 123.4$, not damaged $mean = 835.9 \pm 147.6$) or between females (Croatia damaged $mean = 864.2 \pm 180.1$, not damaged $mean = 968.4 \pm 211.9$; Montenegro damaged $mean = 1114.2 \pm 279.0$, not damaged $mean = 1097.0 \pm 251.7$). Excluding unsexed juveniles or those showing less

Table 1. Mean growth ring counts with standard deviations of damaged and undamaged tortoises. Values of p from ANOVA tests for comparisons of damaged and undamaged data sets are also given.

	Damaged	Undamaged	p
Croatia males	22.4 5.3	21.1 5.2	0.36
Croatia females	18.0 2.3	20.2 3.6	0.18
Montenegro males	23.2 3.0	22.6 4.9	0.79
Montenegro females	20.9 3.1	20.2 2.8	0.59

than 14 growth rings, Levine's tests were applied for homogeneity of variance between damaged and undamaged samples. The results indicated no significant differences between body mass variances (Levine's test statistics from 0.07 – 2.97 and p values from 0.78 – 0.09). These results suggest that although the ranges of injured/damaged tortoise were smaller than non-damaged individuals, tortoises are just as likely to sustain some sort of injury once they reach maturity – no juvenile was found with any damage.

Comparison of growth ring numbers.

There was no significant difference between growth ring counts of either males or females that had sustained injury against males and females that had no injuries in either population (ANOVA, all tests at $p = 0.05$). There was also no inter-population differences between damaged male or damaged female growth ring counts (ANOVA). Table 1 shows the basic data sets on which the statistical testing was applied.

Comparison of damage scores. Croatian males with injuries ($\text{mean damage score} = 1.7 \pm 1.3$, $\text{range} = 1 - 5$, $n = 13$) had slightly lower means than females ($\text{mean damage score} = 1.8 \pm 1.1$, $\text{range} = 1 - 3$, $n = 5$) with the difference not significant (Mann Whitney U -test, $w = 137.5$, $p = 0.85$). In Montenegro, injured males ($\text{mean damage score} = 1.6 \pm 1.1$, $\text{range} = 1 - 4$, $n = 8$) also scored lower than females ($\text{mean damage score} = 3.2 \pm 1.3$, $\text{range} = 1 - 5$, $n = 10$) with the difference significant ($w = 38.5$, $p = 0.024$). Male damage scores were not significantly different between populations ($w =$

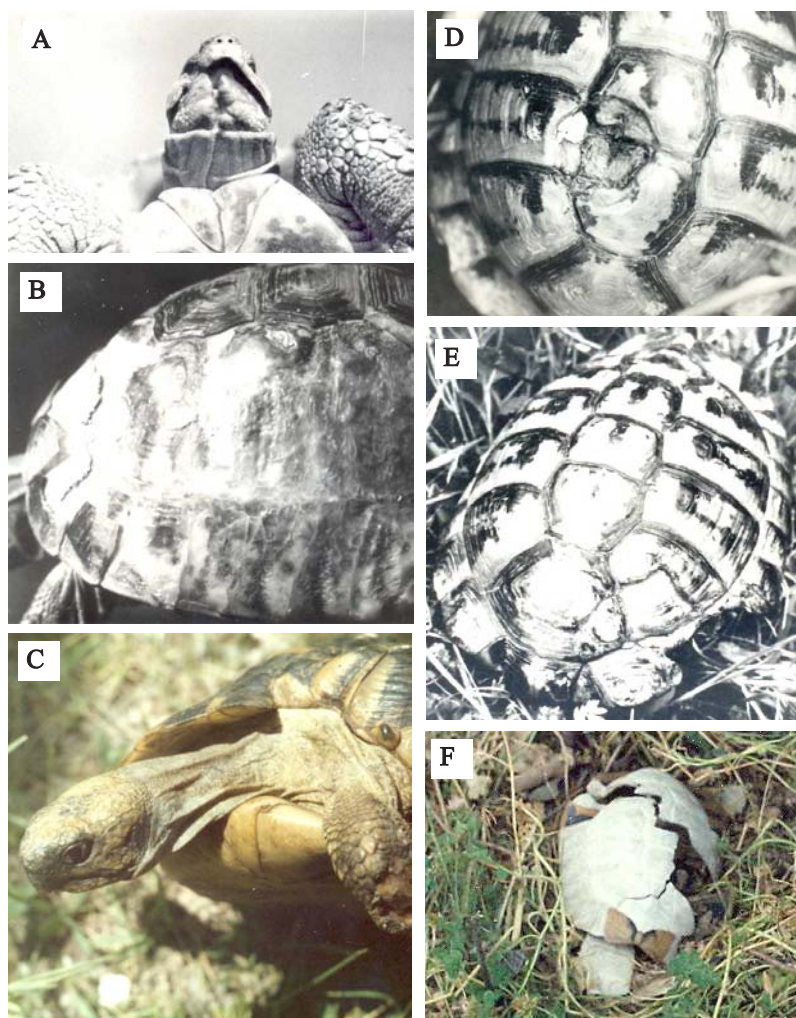


Figure 1. Examples of injuries and mortality in *T. hermanni*. **A:** male with broken lower jaw at the anterior region of the dentary bones (Croatia). **B:** female with heavy scute damage probably from fire (Croatia). **C:** female with front limb and shell damage possibly from farm machinery (Montenegro). Photographs **D** and **E** show tortoises (Montenegro) with dents and shell breakages. These were the common injuries and most probably caused by falls. Photograph **F** shows the remains of a dead tortoise (Montenegro).

157.5, $p = 0.82$) but female damage scores in Montenegro were significantly higher than damaged females in Croatia ($w = 15.0$, $p = 0.03$).

Regression analysis has been used to test for the probability of tortoises sustaining greater damage score with increases in either growth ring count, body mass or carapace length. Damage score has

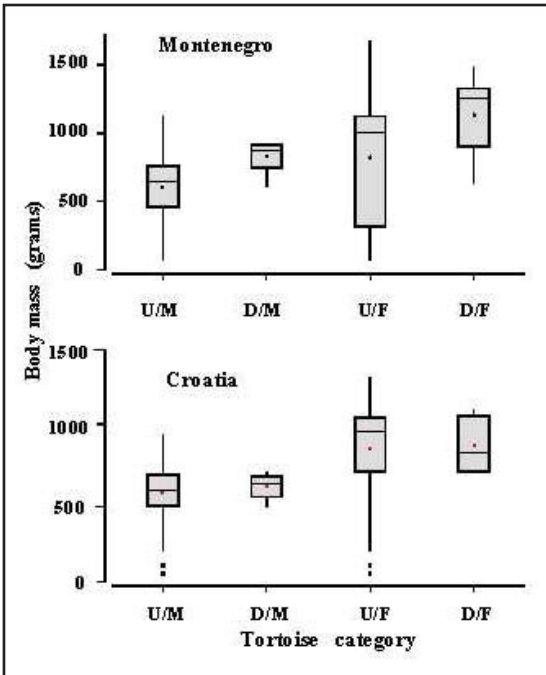


Figure 2. Box plots of body mass distributions of damaged and undamaged *T. hermanni*. The keys are U/M = undamaged males, D/M = damaged males, U/F = undamaged females and D/F = damaged females. The boxes represent the interquartile ranges with the means indicated as solid circles and medians as horizontal bars. The vertical lines either side of the interquartile ranges represent the general ranges of the data. Solid squares represent outliers – data that are between 1.5 to 3 times from the interquartile ranges.

been treated as the dependent variable y and the other variables as independent (x). The equations have the form:

$$\text{damage score}(y) = mx + b$$

where m is the regression coefficient and b the y -intercept. In theory, damage score will be seen to increase as a function of any independent variable when $m > 0$ and no relationship when $m = 0$. To test for significant departures from 0 or between regression coefficients, t -tests at $n-2$ degrees of freedom have been applied.

The results showed that in Croatian tortoises the probability of sustaining injury was more closely associated with growth ring number (i.e. age). The regression coefficients for males ($m = 0.35$) and females ($m = 0.40$) were not

significantly different ($t = 0.28$, $p > 0.05$) and the data sets were pooled. This gave,

$$\text{Damage score} = 0.39 \pm 0.1 \text{ growth ring number} - 5.49, r^2 = 50.0\% \quad (1)$$

with the departure from 0 significant, $t = 3.87$, $d.f. = 16$, $p = 0.001$. In Montenegro, the only association was found with increasing body mass in females and gave,

$$\text{Damage score} = 0.003 \pm 0.001 \text{ body mass} + 0.94, r^2 = 39.0\% \quad (2)$$

with the regression significantly different from 0, $t = 2.66$, $d.f. = 10$ $p = 0.02$.

Comparisons of body mass. To test for the possibility that injury may have a long-term impact on body mass condition, Model 1 allometric equations were calculated after transforming the data into logarithmic form. Body mass has been treated as the dependent variable y and straight line carapace length the independent variable x . Model 1 equations have the form,

$$y = ax^b$$

where b is the exponent and a the y -intercept. Juveniles were included into each of the sub-sets to give a true indication of the y -intercepts. Tortoises with lower body masses will therefore have lower exponents and were compared using a t -test at $n-2$ degrees of freedom.

The results for the y -intercepts were in good agreement between all groups ranging from 0.0002 to 0.0003 in Montenegro and from 0.0002 to 0.007 in Croatia. The exponents for damaged and undamaged tortoises were virtually identical in all data sets and gave, with undamaged values first; Montenegro males $b = 3.05 \pm 0.09$ and 3.1 ± 0.13 , females both $b = 2.99$ with standard errors of 0.08 for undamaged and 0.11 for damaged; Croatia females $b = 3.1 \pm 0.07$ and 3.2 ± 0.12 , males $b = 2.73 \pm 0.11$ and 2.82 ± 0.10 . The latter exponents for damaged and undamaged males in Croatia showed the greatest departures but the difference was not significant, $t = 0.08$, $p > 0.05$. Hence no differences in body mass status between damaged and non-damaged animals could be found in any population.

Body temperatures. Hermann's tortoise is a heliotherm regulating body temperature by shuttling between sunlit and shaded areas (Meek, 1984; 1988a). To test the assumption that damages, perhaps due to impaired locomotory capacities, may have influenced thermoregulation, the data were examined for differences in means (here shown with their standard deviations) and variances in body temperature. These data include autumn body temperatures, which were lower than in summer, but within season body temperatures of males and females were not significantly different, so were pooled. No differences were detected in body temperature means in any of the samples; Croatia in summer, non-damaged $mean = 30.8 \pm 1.9^\circ\text{C}$ versus damaged $mean = 31.0 \pm 1.4^\circ\text{C}$; Croatia in autumn, non-damaged $mean = 24.4 \pm 4.8^\circ\text{C}$ versus damaged $mean = 24.3 \pm 5.0^\circ\text{C}$; Montenegro in summer, non-damaged $mean = 29.7 \pm 3.0^\circ\text{C}$ versus damaged $mean = 30.4 \pm 3.0^\circ\text{C}$ (ANOVA, p values from 0.43 to 0.94). To test for influences of damages on an ability to precisely thermoregulate, it was assumed that body temperature variances around the means were indicators of thermoregulatory precision. The results, using variance ratio tests, showed no differences between damaged and non-damaged tortoises in any of the data sets; F -values from 0.91 to 1.8, p from 0.52 to 0.91. These results generally indicate that damages had no thermoregulatory effect.

Recapture rates. Field sampling was carried out by making routine patrols of regular routes with each tortoise encountered marked and released. If injury or damage does not influence mobility or behaviour, then it is reasonable to assume that all marked tortoises had equal chance of being recaptured. To test this, the percentage differences of recapture frequencies between injured and non-injured tortoises were compared using h -tests which compares percentage differences after calculating their corresponding x -values. The results (males and females pooled) showed that in both populations tortoises that had sustained some sort of injury were recaptured more frequently than those that had not, with the differences significant; Croatia, damaged = 16.7%, non-damaged = 7.3%, $h = 0.49$, 38.4 d.f., $p < 0.05$;

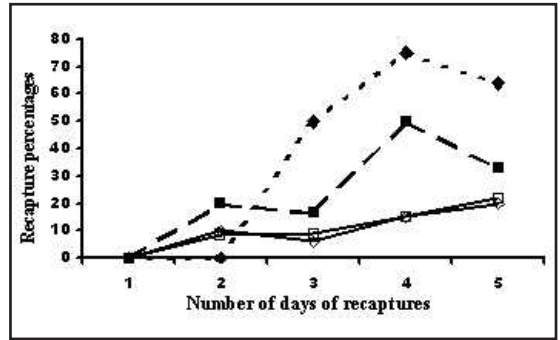


Figure 3. Graph showing percentage recapture frequencies of damaged and undamaged tortoises. Closed diamonds represent damaged Montenegrin tortoises, closed squares damaged Croatian tortoises, open squares undamaged Croatian tortoises and open diamonds undamaged Montenegrin tortoises.

Montenegro, damaged = 53.3%, non - damaged = 17.6%, $h = 0.78$, 23.2 d.f., $p < 0.01$. Figure 3 shows the daily percentage recapture rates for both damaged and undamaged tortoises in both areas.

DISCUSSION

The results of this study support the view that *T. hermanni* is able to survive injuries in the field with only apparent negligible ecological effects. These include, broken jaw, major shell damage, limb loss and fire damage. The ability to survive such injuries must be adaptive given the low annual recruitment and necessity for reproduction over a relatively long time period in *T. hermanni* (Hailey, 1990). Effects of injury, where they were indicated, appeared to be largely confined to recapture rates, which is interesting and potentially important, but it should also be noted that sample sizes for damaged individuals within the populations were relatively small and any conclusions regarded as tentative. For example, application of the Sequential Bonferroni Procedure suggested that the significant results could have arisen by chance and $p < 0.0016$ the appropriate test statistic for significance. Using this criterion the differences in recapture frequencies between damaged versus undamaged animals would not be significant. However, behavioural shifts in reptiles as a result of injury are known, for instance tail loss influences the behaviour of lizards (e.g. Downes & Shine, 2001)

and hence there is the possibility that damaged tortoises had indeed altered / restricted activity levels and / or departures in behaviour rendering them liable to higher encounter frequency.

Absent limbs must handicap locomotory performance, but apparently not enough to influence thermoregulation or body mass condition - even tortoises with broken jaws had normal body mass. Presumably, the effects of limb loss on armoured reptilian herbivores are less critical than in non-armoured reptiles, as mobility is key in the latter. Similarly, shuttling heliothermy may be less affected if the distances between shaded and sunlit areas are small and less locomotory effort required. The damage score results are problematical, as the criteria in which they were applied were subjective and may not truly represent a real or significant ecological impact and hence some standard criteria for score counts should be determined for future studies. However, damage score differences, if approximate to reality, could be explained by size and an associated loss of agility in the larger females from Montenegro (Meek, 1985; 1989, Meek & Inskeep, 1981). For instance, the body masses of Montenegrin damaged females ($mean = 1114.2 \pm 279g$) were greater than Croatian damaged females ($mean = 864.2 \pm 180.1g$). This difference, although not significant (ANOVA, $p = 0.09$) may nevertheless represent a potential for injury during activity in the rockier Montenegrin environment - tortoises are frequent climbers and females may migrate to nesting areas (Stubbs and Swingland, 1985). The increase in damage with age seen in Croatian tortoises may simply be a consequence of living longer and hence higher probability of accident, as suggested for the Grass snake *Natrix natrix* (Gregory & Isaac, 2005). General dents in the carapace and jawbone breakages were likely the result of falls whilst climbing in all three populations.

Hailey (1990) has proposed that damage and survivorship for females in field populations could involve male courtship attempts, although based on the observations of the extensive damages survived by tortoises in the present study, these would surely need to be major injuries. Remains of dead *T. hermanni* were found in somewhat limited numbers and formed only 2.3–3.05% of

the total field samples (Meek, 1989). All appeared to have been older individuals with 20–25 annuli (see example in Figure 1F) with largely intact shells and did not appear to have suffered violent deaths. Certain tortoises showed what appeared to be injury from fire damage (see Figure 1B) although this was found only in large tortoises and, as suggested in previous studies (e.g. Lambert, 1982), may indicate that old/large *T. hermanni* survive fire better than juveniles.

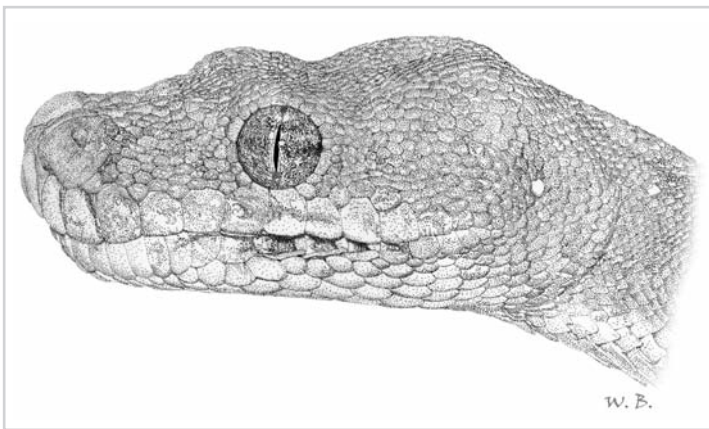
ACKNOWLEDGEMENTS

The field work was funded by a research grant from the British Ecological Society. I thank Drs Roger Avery and Adrian Hailey and also Edie Jolley for comments on an earlier draft of the manuscript.

REFERENCES

- Bernardo, J. & Agosta, S. L. (2005). Evolutionary implications of hierarchical impacts of non-lethal injury on reproduction, including maternal effects. *Biol. J. Linn. Soc.* **86**, 309–331.
- Brown, R. M., Taylor, D. H., & Gist, D. H. (1995). Effect of caudal autotomy on the locomotor performance of wall lizards. *J. Herpetol.* **29**, 98–105.
- Castanet, J. (1985). La squelettechronologie chez les reptiles. 1. Resultats experimentaux sur la signification des marques de croissance squelettiques chez les lizards et les tortues (1). *Annls Sci. nat. Zoologie* **13**, 23–40.
- Close, B., Bannister, K., Baumans, V., Bermoth, E. M., Bromage, N., Bunyan, J., Erhart, W., Flecknell, P. Gregory, N., Hackback H., Morton, D. & Warwick, C. (1996). Recommendations for the euthanasia of experimental animals. Part 1. *Lab. Animals* **30**, 293–316.
- Close, B., Bannister, K., Baumans, V., Bermoth, E.M., Bromage, N., Bunyan, J., Erhart, W., Flecknell, P. Gregory, N., Hackback H., Morton, D. & Warwick, C. (1997). Recommendations for the euthanasia of experimental animals. Part 2. *Lab. Animals* **31**, 1–32.
- Downes, S. J. & Shine, R. (2001). Why does tail loss increase a lizard's vulnerability to predators? *Ecology* **82**, 1293–1303.

- Gregory, P. T. & Isaac, L. A. (2005). Close encounters of the worst kind: patterns of injury in a population of grass snakes (*Natrix natrix*). *Herpetol. J.* **15**, 213–219.
- Hailey, A. (1990). Adult survival and recruitment and the explanation of an uneven sex ratio in a tortoise population. *Can. J. Zool.* **68**, 547–555.
- Harris, R. N. (1989). Nonlethal injury to organisms as a mechanism of population regulation. *Am. Nat.* **134**, 835–847.
- Lambert, M. R. K. (1982). Studies on the growth, structure and abundance of the Mediterranean spur-thighed tortoise, *Testudo graeca*, in field populations. *J. Zool., London* **196**, 165–189.
- McConnachie, S & Whiting, M. J. (2003). Costs associated with tail autotomy in an ambush foraging lizard, *Cordylus melanotus melanotus*. *African Zoology* **38**, 57–65.
- Meek, R. (1984). Thermoregulatory behaviour in a population of Hermann's tortoise, *Testudo hermanni*, in southern Yugoslavia. *Brit. J. Herpetol.* **6**, 387–391.
- Meek, R. (1985). Aspects of the ecology of Hermann's tortoise, *Testudo hermanni*, in southern Yugoslavia. *Brit. J. Herpetol.* **6**, 437–445.
- Meek, R. (1988a). The thermal ecology of Hermann's tortoise, *Testudo hermanni*, in Yugoslavia in summer and autumn. *J. Zool., London* **215**, 99–111.
- Meek, R. (1988b). Thermal loads experienced by a nesting female *Testudo hermanni*. *Amphibia-Reptilia* **9**, 311–312.
- Meek, R. (1989). The comparative population ecology of Hermann's tortoise, *Testudo hermanni*, in Croatia and Montenegro, Yugoslavia. *Herpetol. J.* **1**, 404–414.
- Meek, R. & Inskeep, R. (1981). Aspects of the field biology of a population of Hermann's tortoise (*Testudo hermanni*) in Southern Yugoslavia. *Brit. J. Herpetol.* **6**, 159–164.
- Schoener, T. W. & Schoener, A. (1980). Ecological and demographic correlates of injury rates in some Bahamian *Anolis* lizards. *Copeia* **1980**, 839–850.
- Stubbs, D. & Swingland, I. R. (1985). The ecology of a Mediterranean tortoise (*Testudo hermanni*); a declining population. *Can. J. Zool.* **61**, 169–180.
- Swingland, I. R. & Stubbs, D (1985). The ecology of a Mediterranean tortoise (*Testudo hermanni*): Reproduction. *J. Zool., London* **205**, 595–610.
- Vermeij, G. J. (1982). Unsuccessful predation and evolution. *Am. Nat.* **120**, 701–720.



Morelia viridis (Green tree python). Pen and ink illustration by Will Brown. www.blueridgebiological.com

New opportunities and hazards brought by humans to the island habitat of the skink *Euprepis atlanticus*

JOÃO LUIZ GASPARINI¹, PEDRO LUIZ PELOSO^{1,3} and IVAN SAZIMA²

¹ Departamento de Ciências Biológicas, Universidade Federal do Espírito Santo, Av. Marechal Campos 1468, Maruípe, 29040-090 Vitória, ES, Brasil

² Departamento de Zoologia and Museu de História Natural, C.P. 6109, Universidade Estadual de Campinas, 13083-970 Campinas, SP, Brasil

³ Corresponding author: pedropeloso@terra.com.br

THE Noronha skink, *Euprepis atlanticus* (see Mausfeld & Vrcibradic, 2002; Mausfeld *et al.*, 2002; Whiting *et al.*, 2005 for taxonomic accounts), is endemic to Fernando de Noronha Archipelago, off northeast Brazil, where it is the most abundant terrestrial vertebrate (Carleton & Olson, 1999). The generalist diet of *E. atlanticus* along with the lack of natural predators on the island may have contributed to the large population density of this lizard on the island. The skink feeds on various prey items including arthropods, conspecific eggs and juveniles, dead vertebrates, plant material, and human leftovers (Silva-Jr. *et al.*, 2005). During the dry season the skink seeks water and sugar from the flower nectar of a leguminous tree (Sazima *et al.*, 2005).

We report here on new and unusual food sources for *E. atlanticus*, brought to Fernando de Noronha Island by human influence and comment on the presumptive importance of these sources (new opportunities), as well as of introduced predators (new hazards), to the presently large population of this skink on the island.

In January 2006 (end of the dry season) we recorded *E. atlanticus* feeding on dry seeds of the leguminous shrub *Acacia* sp. ($n = 5$) and on the faeces of the Rock cavy *Kerodon rupestris* ($n = 2$) (Figure 1). In June 2006 (wet season) we recorded the skink deftly catching calliphorid carrion flies that swarmed on dead nestlings of the Noronha dove *Zenaida auriculata noronha* ($n = 5$) on the ground. We also recorded the Noronha skink chasing and preying on juveniles of the House gecko *Hemidactylus mabouia* ($n = 3$) during this period. Although nocturnal, in the relatively cold wet season this gecko sunned on low branches,

wooden stakes, and on occasions crawled on the ground. The geckos were chased while they were on the ground or on sunning perches (see Sazima *et al.*, 2005 for the climbing abilities of the skink). Another unusual food source for skinks was provided by tourists, who attracted these lizards with cookie crumbs at some of the most visited sites (Figure 2).

Notwithstanding the fact that the Noronha skink is regarded as an ultimate food generalist (Sazima *et al.*, 2005; Silva-Jr *et al.*, 2005), the food items here presented add considerably to the resources presently available to this lizard. The Rock cavy, House gecko, carrion flies, and the *Acacia*, all are introduced organisms on Fernando de Noronha (Carleton & Olson, 1999; pers. obs.) and presently occur at high densities on several sites of the island. Tourism is steadily increasing on the island as well, with the arrival of large ship cruises and jet planes about four years ago (pers. obs.).

Lizards that dwell in insular or desert habitats often have broad feeding habits (Pianka & Vitt 2003, Vitt & Pianka, 2005). For instance, when arthropod availability is low, raising the amount of plant material intake is one solution (Robinson & Cunningham, 1978; Pianka & Vitt, 2003). In some cases low prey availability may have been caused by high lizard densities, which would increase intraspecific competition unless new resources are sought (Schoener 1968; Pianka & Vitt 2003). The dry season in Fernando de Noronha archipelago likely lowers arthropods' availability, although this assumption remains to be tested. The lacertid *Meroles anchietae*, which lives in sand dune habitats in the Namib Desert switches to plant seeds when insect abundance is low (Robinson &



Figure 1. The Noronha skink *Euprepis atlanticus* mouthing a dry seed of the leguminous shrub *Acacia* sp. (A), and sitting on a pile of faeces of the Rock cavy *Kerodon rupestris* (B).

Cunningham 1978) and a similar situation may be occurring with *E. atlanticus* while feeding on acacia seeds. The Rock cavy feeds on plants and thus the Noronha skink may take its faeces for plant material.

Euprepis atlanticus is regarded as ‘incredibly abundant’ at Fernando de Noronha (Carleton & Olson 1999; see one figure in Silva-Jr *et al.*, 2005). A major factor that may have contributed to such large population could be the historical absence of lizard predators on the island. Following human colonisation several predators were brought to the island: rats (*Rattus norvegicus* and *R. rattus*), mice (*Mus musculus*), domestic cats (*Felis catus*), and lately the large Tegu lizard (*Tupinambis merianae*), all of which prey on the Noronha skink (Silva-Jr *et al.*, 2005). The introduction of exotic species on Fernando de Noronha Archipelago, along with human occupation likely changed the population dynamics and density of *E. atlanticus* on the island.

One of two different historical processes may have occurred on Fernando de Noronha Archipelago: (1) lizard densities were lower there than in present days and went through an increase following human colonisation due to introduction of new food resources, or (2) lizard densities were high even before human colonisation. Considering the evolutionary trend of organisms living in isolated habitats free of predators, it seems to us that the second assumption is more realistic (see Pianka, 1973; Bennett & Gorman 1979; Schoener & Toft 1983; Vitt & Pianka 2005). Several lizard

Figure 2. *Euprepis atlanticus* foraging on cookie crumbs provided by tourists at one of the island’s most visited sites.



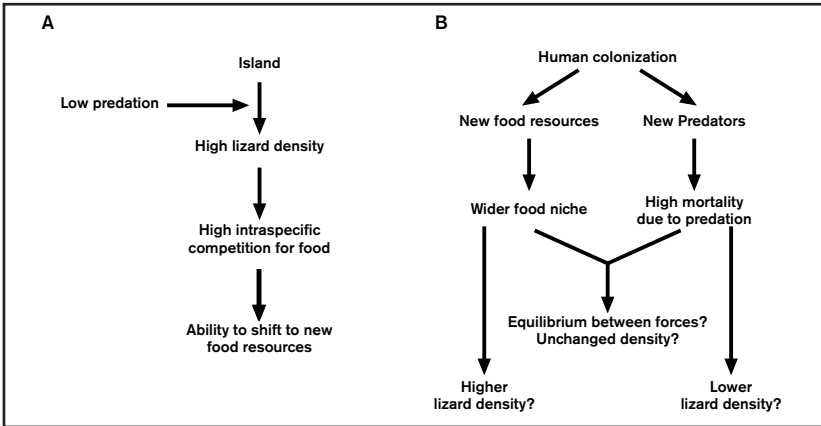


Figure 3. Historical processes that may have influenced the population of *Euprepis atlanticus* in Fernando de Noronha Archipelago; before human colonisation (A) and after human colonisation (B) and introduction of several exotic food sources and predators.

populations on islands without predators increase their densities (see Figure 3A), which likely increases intraspecific competition, especially for food, usually resulting in a broader dietary niche (Pianka & Vitt, 2003; Olesen & Valido, 2003). The introduction of predators on the island, however, likely reduces local lizard abundance (Figure 3B). This latter assumption seems to hold true especially at sites where domestic cats and Cattle egrets (*Bubulcus ibis*) are abundant (Silva-Jr *et al.*, 2005). A deft predator and a recent migrant and coloniser, the Cattle egret benefits from regular weeding, horse breeding, and man-made open spaces, and thus its numbers are steadily increasing on the island (pers. obs.). Cavies, acacias, geckos, and carrion flies are presently abundant at several sites on Fernando de Noronha and thus may act as important additional and/or alternative food sources for the Noronha skink, enabling it to thrive there even with increase of predators and low arthropod prey availability (Fig. 3B). We suggest here that the skink population may depend on food sources provided by human activities past and present to persist at the current density in the long run.

ACKNOWLEDGEMENTS

We thank Laurie J. Vitt for insightful ideas and comments on an earlier version of the manuscript; Albert D. Ditchfield added some comments; the Centro Golfinho Rotador (José Martins Silva Jr.)

for help and logistical support; the CNPq, FAPESP and SECIRM (Brazilian Navy) for financial support.

REFERENCES

- Bennett, A. F. & Gorman, G. C. (1979). Population density, thermal relations, and energetics of a tropical insular lizard community. *Oecologia* **42**, 339–358.
- Carleton, M. D. & Olson, S. L. (1999). Amerigo Vespucci and the rat of Fernando de Noronha: a new genus and species of Rodentia (Muridae: Sigmodontinae) from a volcanic island off Brazil's continental shelf. *Am. Mus. Novit.* **3256**, 1–59.
- Mausfeld, P. Schmitz, A. Bohme, W. Misof, B. Vrcibradic, D. & Rocha, C. F. D. (2002). Phylogenetic affinities of *Mabuya atlantica* Schmidt, 1945, endemic to the Atlantic Ocean archipelago of Fernando de Noronha (Brazil): necessity of partitioning the genus *Mabuya* Fitzinger, 1826 (Scincidae: Lygosominae). *Zool. Anz.* **241**, 281–293.
- Mausfeld, P. & Vrcibradic, D. (2002). On the nomenclature of the skink (*Mabuya*) endemic to the western Atlantic archipelago of Fernando de Noronha, Brazil. *J. Herpetol.* **36**, 292–295.
- Olesen, J. M. & Valido, A. (2003). Lizards as pollinators and seed dispersers: an island phenomenon. *Trends Ecol. Evol.* **18**, 177–181.
- Pianka, E. R. (1973). The structure of lizard communities. *Ann. Rev. Ecol. Syst.* **4**, 53–74.
- Pianka, E. R. & Vitt, L. J. (2003). *Lizards: windows to the evolution of diversity*. Berkeley: University of California Press. + 347 pp.
- Robinson, P. L. & Cuninghame, A. B. (1978). Comparative diet of two Namib Desert sand lizards (Lacertidae). *Madoqua* **11**, 411–453.
- Sazima, I. Sazima, C. & Sazima, M. (2005). Little dragons prefer flowers to maidens: a lizard that laps nectar and pollinates trees. *Biota Neotrop.* **5**, 1–8.

- Schoener, T. W. (1968) The *Anolis* lizards of Bimini: resource partitioning in a complex fauna. *Ecology* **49**, 704–726.
- Schoener, T. W. & Toft, C. A. (1983). Spider populations: Extraordinarily high densities on islands without top predators. *Science* **219**, 1353–1355.
- Silva-Jr, J. M. Péres-Jr., A. K. & Sazima, I. (2005). *Euprepis atlanticus* (Noronha skink). Predation. *Herpetol. Rev.* **36**, 62–63.
- Vitt, L. J. & Pianka, E. R. (2005). Deep history impacts present day ecology and biodiversity. *Proc. Natl. Acad. Sci.* **102**, 7877–7881.
- Whiting, A. S. Sites-Jr, J. W. Pellegrino, K. C. M. & Rodrigues, M. T. (2005). Comparing alignment methods for inferring the history of the new world lizard genus *Mabuya* (Squamata: Scincidae). *Molec. Phylogen. Evol.* **38**, 719–730.



NATURAL HISTORY NOTES

TRITURUS ALPESTRIS (Alpine newt):

HYPOMELANISM. Various colour aberrations have been described in many species of caudate amphibians including *Triturus* newts (Dyrkacz, 1981; Bechtel, 1995; Grossenbacher & Thiesmeier, 2003; Thiesmeier & Grossenbacher, 2004). Although the terminology is sometimes confusing, the most frequently reported colour aberrations are albinism – absence of melanin including eyes, hypomelanism or partial albinism – partial absence of melanin, and leucism – lacking of all integumentary pigments except of eyes (Bechtel, 1995). Here, we describe a recent incidence of hypomelanism in the larva of *T. alpestris*.

The aberrant and three typically pigmented larvae were captured by dip-net in a temporary water puddle (approx. 8 km SW Jihlava, Czech Republic; 620 m a.s.l.) on 9th September 2006. Whereas the unusually coloured individual was at climax larval stage (stage 18, after Watson & Russell, 2000; total length 48.2 mm), the typically pigmented larvae were already metamorphosing. In comparison with ‘normally’ coloured counterparts, the aberrant larva had greatly reduced dark (melanin) pigmentation (Figures 1 and 2). The basic colour was white-yellow with a few dark spots on the tail and greatly reduced dark marbling pattern on the dorsal and ventral tail fins. Although the eye pupil was black, the iris completely lacked black pigmentation.

To record coloration after metamorphosis, all larvae were transported to the laboratory and then placed in an aquarium at 17°C. The aquarium was filled with soft water (conductivity 100 µS/cm) up to 5 cm, and equipped with a clump of Java moss and a piece of Styrofoam. Larvae were fed with live *Tubifex* worms every second day. Under these conditions all typically pigmented larvae metamorphosed within one week. However, the aberrant individual remained at the climax stage without any sign of metamorphosis (i.e., tail fin and gill reduction) for two months after capture, which suggests that the larva was not only hypomelanistic, but also paedomorphic. This seems a little surprising given that both melanin synthesis and metamorphosis are under the same endocrine control in amphibians (Herman, 1992; Rose, 1999).

During two consecutive seasons (2005 and 2006) we checked pigmentation in 520 larvae obtained from eggs of 25 females in the laboratory. In addition, we regularly monitored the presence of newt larvae in 20 water bodies. However, we found no other similarly coloured specimen. Because we are unaware of other report of hypomelanism in *T. alpestris*, despite its frequent use as the model species in various research areas (e.g., Denoël & Joly, 2000; Van Buskirk & Schmidt, 2000; Garner & Schmidt, 2003), we suggest that the incidence of hypomelanism is quite rare phenomenon in this species.



Figure 1. Typically coloured larva of *T. alpestris*.



Figure 2. Hypomelanistic larva of *T. alpestris*.

ACKNOWLEDGEMENTS

This finding was realized during field work on the project ‘Phenotypic plasticity of thermal physiology traits in newts’ funded by the Czech Science Foundation (No. 206/06/0953). Permit to capture newts was issued by the Ministry of Environment of the Czech Republic (MŽP 8812/04-620/1483/04).

REFERENCES

- Bechtel, H. B. (1995). *Reptile and Amphibian Variants: Colors, Patterns, and Scales*. Malabar: Krieger.
- Denoël, M. & Joly, P. (2000). Neoteny and progenesis as two heterochronic processes involved in paedomorphosis in *Triturus alpestris* (Amphibia, Caudata). *Proc. R. Soc. Lond. B* **267**, 1481–1485.
- Dyrkacz, S. (1981). Recent instances of albinism in North American amphibians and reptiles. *Herpetol. Circ.* **11**, 1–32.
- Gamer, T. W. J. & Schmidt, B. R. (2003). Relatedness, body size and paternity in the alpine newt, *Triturus alpestris*. *Proc. R. Soc. Lond. B* **270**, 619–624.
- Grossenbacher, K. & Thiesmeier, B. (Eds.) (2003). *Handbuch der Reptilien und Amphibien Europas. Band 4/IIA, Schwanzlurche (Urodela) IIA*. Wiebelsheim: AULA.
- Herman, C. A. (1992). Endocrinology. In: *Environmental Physiology of the Amphibians*, pp. 40–57. Feder, M. E. & Burggren, W. W. (Eds.). Chicago and London: The Chicago University Press.
- Rose, C. S. (1999). Hormonal control in larval development and evolution – amphibians. In: *The Origin and Evolution of Larval Forms*, pp. 167–216. Hall, B. K. & Wake, M. H. (Eds.). San Diego: Academic Press.
- Thiesmeier, B. & Grossenbacher, K. (Eds.) (2004). *Handbuch der Reptilien und Amphibien Europas. Band 4/IIB, Schwanzlurche (Urodela) IIB*. Wiebelsheim: AULA.
- Van Buskirk, J. & Schmidt, B. R. (2000). Predator-induced phenotypic plasticity in larval newts: trade-offs, selection, and variation in nature. *Ecology* **81**, 3009–3028.
- Watson, S. & Russell, A. P. (2000). A posthatching developmental staging table for the long-toed salamander, *Ambystoma macrodactylum krausei*. *Amphibia-Reptilia* **21**, 143–154.

LUMÍR GVOŽDÍK¹, DANIEL STEJSKAL² & JAN DVORÁK^{1,3}

¹ Department of Population Biology, Institute of Vertebrate Biology AS CR, Studenec 122, 67502 Koněšín, Czech Republic.

E-mail: gvozdik@brno.cas.cz

² Czech Union for Nature Conservation, 58601 Jihlava, Czech Republic.

³ Masaryk University, Department of Zoology & Ecology, Kotlářská 2, 61137 Brno, Czech Republic.

CORALLUS HORTULANUS (Amazon tree boa): BAT PREDATION IN JAÚ NATIONAL PARK, BRAZIL. The Amazon tree boa, *Corallus hortulanus*, is a widespread neotropical boid, occurring throughout the Amazon region (Henderson, 1997). It is the most widely distributed member of the genus, and has one of the broadest known diets (see Henderson, 2002). Jaú National Park is situated some 220 km west of Manaus, Amazonas, on the south bank of the Rio Negro. The 2,272,000 ha of the Park are a mosaic of primary lowland rainforest (70%), swamps (17%), blackwater seasonally flooded forest (*igapó*, 12%), and white sand *campina* scrub and *campinarana* forest (Barnett *et al.*, 2006). *Corallus hortulanus* has previously been recorded from Jaú by Martins & Oliveira (1999) and by Neckel-Oliveira & Gordo (2004).

At 19:30 h on 28th April 2005 at the FVA-IBAMA floating research station (01°53.568"S, 61°41.842"W) above the Cachoeira do Jaú, we observed a juvenile *C. hortulanus* coiled in a corner of one of the station's rooms. The animal had just entered through a gap in the floorboards from the bat roost in the space between the station planking and the water below. The roost contained three or four species of bats of the genus *Artibeus*: *A. concolor*, *A. literatus*, plus *A. andersoni* and/or *A. cinereus*. The *C. hortulanus* individual measured 495 mm SVL, 698 mm TL. Some 270 mm along the body, the outline of a head, wing and body of a bat were clearly visible (see Figure 1). The head and body (H&B) was measured at 52 mm long and the forearm length (FA) was 41 mm. These measurements are characteristic of both *Artibeus andersoni* and *A. cinereus*. Both species have been reported from Jaú by Barnett *et al.* (2006). Though both are certainly valid species (Baker *et al.*, 2000; Wetterer *et al.*, 2000), *A. andersoni* and *A. cinereus* can only be separated by skull characters (Handley, 1987), and specimen collection was not permitted by our fieldwork license. However, we are confident it was one of these two partly because it was one of three/four species known to occur in the roost below the station and also because: 1) adults of all the other bat species recorded at the roost are bigger than the prey bat (*A. concolor*, H&B 61–64 mm, FA 47–48mm; *A. literatus* H&B 89–91 mm, FA 68–69 mm: see Emmons & Feer, 1997; Eisenberg & Redford, 1999); 2) breeding seasons in the region are strongly marked and occur between July–November and January–February for any of the *Artibeus* species larger than *A. andersoni/cinereus* (such as *A.*

concolor, *A. literatus*, *A. obscurus*, *A. platyrhinus*: see Bernard, 2002), making it unlikely that the ingested bat was a juvenile of region's larger *Artibeus* species which might also use such a roost; 3) roost preference excludes other bat species with a similar combination of body and fore-arm lengths as the ingested animal (such as *Anoura caudifer*, *Carollia* spp., and *Uroderma* spp.), which are highly unlikely to use a multi-species roost the underside of the floating pontoon on which the research station rests (see Eisenberg & Redford, 1999; Nowak, 1999).

In the Neotropics, predation on bats by native snakes has been recorded for a variety of species. Although Hopkins & Hopkins (1982) recorded an Amazon tree boa (*Corallus hortulanus*) catching a bat (probably *Phyllostomus bicolor*: see Martins & Oliveira, 1999) that was hovering in front of a *Parkia* inflorescence the bat had come to pollinate, and Northern pine snakes (*Pituophis melanoleucus*) have been observed plucking Mexican funnel-eared bats (*Natalus stramineus*) from the air as they exited a roost (Gillette & Kimborough, 1970), the majority of such predation events are recorded at the bat's roosting sites. Such records include bat predation by

Figure 1. Juvenile *Corallus hortulanus* with recently ingested *Artibeus* bat. The head and forearm are clearly discernible.



Boa constrictor and Puffing snake (*Pseustes poecilonotus*: Gillette & Kimborough, 1970); *Boa constrictor* feeding on *Atribeus jamaicensis* (Thomas, 1974) and on *Desmodus rotundus* (Villa & Lopez, 1966); the Cuban boa (*Epicrates anguillifer*) eating *Phyllonycteris poeyi* (Miller, 1904; Hardy, 1957), the Rainbow boa (*Epicrates cenchris cenchris*) eating *Carollia perspicillata* (Lemke, 1978), Puerto Rican boa (*Epicrates inornatus*) eating *Monophyllus redmani* and *Brachyphylla cavernarum* (Rodríguez, 1984), and Central American ratsnake (*Elaphe flavirufa*) eating *Rhogeessa tumida* and *Myotis* sp. (Rainwater & Platt, 1999).

Corallus hortulanus is known to be active at night on vegetation along river margins, including those of blackwater rivers (Martins & Oliveira, 1999). It has a wide prey base including fish, frogs (*Elachistocleis*, Microhylidae; unidentified Hylidae), lizards (*Anolis*), and birds (kingfishers, nightjars, parrots, songbirds). However, mammals made up nearly 60% of the diet items recorded by Henderson (2002). A sit-and-wait predator, it will often hang suspended from low vegetation facing the ground or higher up facing into bat flyways (Martins & Oliveira, 1999; Henderson, 2002). Such flyways often run clear to the ground where they are used by terrestrial mammals, including rodents and marsupials. Accordingly a number of rodent taxa (rats, porcupines and spiny rats) have been recorded in its diet (note: Martins & Oliveira, 1999 also reported mice, squirrels and small marsupials in the diet of *C. hortulanus* but, Robert Henderson [pers. comm.] points out that these records come from individuals which at the time were under the taxonomic umbrella of *C. hortulanus*; in fact they belong to *C. ruschenbergerii* [see Henderson, 1997, 2002]). A number of bats have also been recorded, including *Phyllostomus bicolor*, *Myotis* sp., and an unidentified bat of 55 mm head & body length (see Martins & Oliveira, 1999; Henderson, 2002), and an *Artibeus* (see below).

The record from Jaú is the second known occurrence of a member of the chiropteran genus *Artibeus* in the diet of *C. hortulanus*, Henderson (2002) having reported an instance of *C. hortulanus* capturing an *Artibeus jamaicensis* in Perú. Adults of *A. jamaicensis* are significantly larger than either *A. andersoni* or *A. cinereus*, with females averaging 81.8 mm in total length and weighing 43.2 g (Eisenberg & Redford, 1999: for comparison, respective measurements for *A. andersoni* and *A.*

cinereus are 55 mm and 13 g). Henderson (2002) reports *C. hortulanus* capturing bats at a variety of locals, including the inflorescence of a flowering tree, and in the roof of a house. Other Neotropical boids are known to actively forage for bats and to make repeat visits to roosts (see summary in Henderson, 2002). Given the sit-and-wait nature of foraging in *C. hortulanus* (see above), it is most likely that the observed individual was treating the restricted space between the floor of the research station and the water in the flooded forest as a profitably constricted flight path from which bats could be plucked, rather than feeding on the roosting individuals themselves. Thus, while unusual because it is man-made, the nature of the feeding locale is still consistent with the known foraging ecology of the species (see Henderson, 2002).

The presence of a bat in the diet of an individual of this size is concordant with the ontogenetic shifts in diet observed for this species (see Henderson, 1993, 1997): younger individuals ate small lizards, frogs, birds and bats, while older larger individuals above 750 mm SVL birds become less important and mammals more so, with non-volant mammals predominating after 927 mm SVL (Henderson, 2002). A similar size-related transition in diet-composition has been reported for Australasian boids by Shine & Slip (1990).

ACKNOWLEDGEMENTS

Robert Henderson (Milwaukee Public Museum) and Richard Vogt (INPA) commented on the *Corallus* identification, Erica Sampiao (Smithsonian Institution) on that of the roosting bats. Robert Henderson also critically improved an earlier draft of this note and provided pers. comms. We thank Eduardo and Maria de Souza for help in the field and, for help in Manaus, the staff of the Fundação Vitória Amazônica and Eliana Andrade. Rebecca Shapley helped with the manuscript. This observation was made during fieldwork conducted under IBAMA (Manaus) technical visit permit number 193220. American Society of Primatologists Conservation Fund, Columbus Zoo Conservation Fund, LCB Leakey Foundation, Leakey Fund (UK), Margot Marsh Biodiversity Foundation, Percy Sladen Memorial Fund, Pittsburgh Zoo Conservation Fund, Primate Conservation Inc. and Wildlife Conservation Society provided funds for the field study.

REFERENCES

- Baker, R. J., Porter, C. A., Patton, J. C. & Vandenbusche, R. A. (2000). Systematics of bats of the family Phyllostomidae based on RAG2 DNA sequences. *Mus. Texas Tech Univ., Special Publ.* **202**, 1–16.
- Barnett, A. A., Sampaio, E., Kelko, E., Shapley, R. L., Fischer, E., Camargo, G. & Rodriguez-H., B. (2006). Bats of Jaú National Park, central Amazonia, Brazil. *Acta Chiropterol.* **8**, 103–128.
- Bernard, E. (2002). Diet, activity and reproduction of bat species (Mammalia, Chiroptera) in Central Amazonia, Brazil. *Rev. Brasil. Zool.* **19**, 173–188.
- Eisenberg, J. F. & Redford, K. H. (1999). *Mammals of the Neotropics, Vol. III: The Central Neotropics: Ecuador, Peru, Bolivia, Brazil*. Chicago University Press, Chicago, x + 609 pp.
- Emmons, L. H. & Feer, F. (1997). *Neotropical rainforest mammals: a field guide. 2nd edition*. Chicago: University of Chicago Press. vii + 396 pp.
- Gillette, D. D. & Kimbrough, J. D. (1970). Chiropteran mortality. In: *About Bats*, pp. 262–283. Slaughter, B. H. & Walton, B. W. (Eds.). Dallas, TX: Southern Methodist University Press.
- Handley, C. O., Jr. (1987). New species of mammals from northern South America: fruit-eating bats, genus *Artibeus* Leach. In *Studies in Neotropical Mammalogy: Essays in Honor of Philip Hershkovitz Fieldiana (Zoology)* **39**, 163–172. Patterson B. D. & R. M. Timm (Eds.).
- Henderson, R. W. (1993). On the diets of some arboreal boids. *Herpetol. Nat. Hist.* **1**, 91–96.
- Henderson, R. W. (1997). A taxonomic review of the *Corallus hortulanus* complex of Neotropical tree boas. *Caribb. J. Sci.* **33**, 198–221.
- Henderson, R. W. (2002). Neotropical Treeboas: Natural History of the *Corallus hortulanus* Complex. Malabar, FL: Krieger Publ. Co.
- Hardy, J. D. (1957). Bat predation by the Cuban boa, *Epicrates anguifer* Bibron. *Copeia* **1957**, 151–152.
- Hopkins, H. C. & Hopkins, M. J. G. (1982). Predation by a snake of a flower-visiting bat at *Parkia nitida* (Leguminosae: Mimosoideae). *Brittonia* **34**, 225–227.
- Lemke, T. O. (1978). Predation upon bats by *Epicrates cenchris cenchris* in Colombia. *Herpetol. Rev.* **9**, 47.
- Martins, M. & Oliveira, R. E. (1999). Natural History of forest snakes of the Manaus region, central Amazonia. *Herpetol. Nat. Hist.* **6**, 78–150.
- Miller, G. S., Jr. (1904). Notes on bats collected by William Palmer in Cuba. *Proc. US Nat. Mus.* **27**, 377–348.
- Neckel-Oliveira, S. & Gordo, M. (2004). Anfíbios, lagartos e serpentes do Parque nacional do Jaú. In: *Janelas para a biodiversidade no Parque Nacional do Jaú: uma estratégia para o estado da biodiversidade na Amazônia*, pp. 161–176. Borges, S. H., Iwanaga, S., Durigan, C.C. and Pinheiro, M.R. (Eds.). Manaus: WWF-FVA-IBAMA.
- Nowak, R. M. (1999). *Walker's Mammals of the World. 6th edition*. Chicago: Chicago University Press. Vol. 1, li + 836 pp.
- Rainwater, T. R. & Platt, S. G. (1999). *Elaphe flavirufa* (tropical rat snake). Predation and diet. *Herpetol. Rev.* **30**, 46.
- Rodriguez, G. A. (1984). Bat predation by the Puerto Rican boa, *Epicrates inornatus*. *Copeia* **1984**, 219–220.
- Shine, R. & Slip, D. (1990). Biological aspects of adaptive radiation of Australasian pythons. *Herpetologia* **46**, 283–290.
- Thomas, M. E. (1974). Bats as a food source for *Boa constrictor*. *J. Herpetol.* **8**, 188.
- Villa, B. & Lopez, W.F. (1966). Cinco casos de predación de pequeños vertebrados en murciélagos de México. *Anals Inst. Biol. Univ. Nac. México* **37**, 187–193.
- Wetterer, A. L., Rockman, M. V. & Simmons, N. B. (2000). Phylogeny of phyllostomid bats (Mammalia: Chiroptera): data from diverse morphological systems, sex chromosomes, and restriction sites. *Bull. Amer. Mus. Nat. Hist.* **248**, 1–200.

ADRIAN BARNETT¹, VERENA SCHIEL² & ADRIAN DEVENY³

¹Centre for Research in Evolutionary Anthropology, School of Human and Life Sciences, Roehampton University, Holybourne Avenue, London SW15 4JD, UK. E-mail: adrian.barnett1@gmail.com

²Coordenação do Curso de Ciências Biológica, Universidade Federal da Paraíba, Cidade Universitária- Campus I, Cep: 58059-9, João Pessoa, PB, Brazil.

³Yale School of Forestry and Environmental Studies, 205 Prospect Street, Yale University, New Haven, CT 06511, USA.

STEFANIA EVANSI (Groete Creek carrying frog): FROGLET CARRYING. The neotropical genus *Stefania* was recently removed from the family Hylidae and placed in the family Cryptobatrachidae, together with *Cryptobatrachus*, by Frost *et al.* (2006), mainly on the basis of molecular data. *Stefania evansi*, the most widespread member of the genus, is endemic to Guyana and is found below 900 m. The highland species *S. scalae* was synonymised with *S. evansi* by Duellman and Hoogmoed (1984), but the two species were separated by Señaris *et al.* [1997 ("1996")]. The reproductive biology of *Stefania* remains poorly understood, although females carry their eggs and neonates on their back. In a recent paper, Kok *et al.* (2006) reported a large female (97.5 mm SVL) *Stefania evansi* carrying 25 eggs. Until now this record remained the maximum known number of eggs or juveniles carried by a female *S. evansi*. As pointed out by Kok *et al.* (2006), very little data exists on female *S. evansi* carrying eggs or juveniles, and the authors cited the only four known literature records. We report here two more cases of juvenile brooding in *S. evansi*.

Three large females carrying juveniles on their back were caught at night in March 2006 on the banks of the Elinkwa River in the southeastern part of Kaieteur National Park, west-central Guyana (5°08'09"N, 59°25'28"W, ca. 500 m elevation). All three were on the ground close to a slow moving stream. One female escaped, but the two others, with their carried juveniles, were captured and deposited in the herpetological collections of the Institut Royal des Sciences Naturelles de Belgique (IRSNB). All the juveniles remained attached to the back of the females when captured, and remained there until the following morning. IRSNB 13934, a striped female [Morph B of Duellman & Hoogmoed (1984)], 95.1 mm SVL, collected on 23rd March 2006 at 20:00 hrs, carried the remarkable number of 30 near-term juveniles (16.0–18.3 mm SVL, mean = 17.4 mm) (see cover). Five juveniles (16.7%) conform to the plain colour morph [Morph A of Duellman and Hoogmoed (1984)] while 25 juveniles (83.3%) conform to the striped colour morph. IRSNB 13933, another striped female, 77.7 mm SVL,

collected on 22nd March 2006 at 21:20 h, carried 15 near-term juveniles (14.9–17.4 mm SVL, mean = 16.3 mm). Seven juveniles (46.7%) conform to the plain colour morph while eight juveniles (53.3%) conform to the striped colour morph. This observation confirms that a same individual can produce different colour morphs (MacCulloch *et al.* 2006).

The next day, following handling for photography, some juveniles began to leave the mucus layer of the females, breaking the gill stalks by their movements. This premature 'hatching' due to disturbance and stress does not appear to be detrimental to the juveniles and could be interpreted as an antipredator defence. Juveniles that left IRSNB 13934 still had yolk-filled bellies and residual gill stalks attached at the base of forearms. Jungfer & Boehme (1991), speculated that juveniles might leave the mother's back when the resorption of the gill stalks is complete, which should coincide with the consumption of all yolk (see MacCulloch & Lathrop, 2002). This is congruent with our observations of four independent juveniles collected on 2nd December 2005 along a tributary of Muri Muri Creek in the central part of Kaieteur National Park. The juveniles (IRSNB 13929–32) were close together on leaves and branches (up to 120 cm above ground) not far from a slow moving stream and measured 16.7–18.0 mm SVL; the gill stalks were completely resorbed and no yolk was visible through the belly skin. MacCulloch & Lathrop (2002) found juvenile *S. evansi* on female's back, with only a small amount of yolk remaining, SVL 18–19 mm.

ACKNOWLEDGEMENTS

These observations were made during a study funded by grants from the Belgian Directorate General for Development Cooperation through the Belgian Focal Point to the Global Taxonomy Initiative. Specimens were collected under Permit Number 030605BR006 and exported under Permit Numbers 191205SP011 and 040406SP014 issued by the Guyana Environmental Protection Agency (EPA). We thank Ross MacCulloch (Royal Ontario Museum, Canada) for helpful comments on an earlier version of this manuscript.

REFERENCES

- Duellman, W. E. & Hoogmoed, M. S. (1984). The taxonomy and phylogenetic relationships of the hylid frog genus *Stefania*. *Misc. Publ. Mus. Nat. Hist. Univ. Kansas* **75**, 1–39.
- Frost, D.R., Grant, T., Faivovich, J., Bain, R., Haas, A., Haddad, C.F.B., de Sa, R.O., Donnellan, S.C., Raxworthy, C.J., Wilkinson, M., Channing, A., Campbell, J.A., Blotto, B.L., Moler, P., Drewes, R.C., Nussbaum, R.A., Lynch, J.D., Green, D. & Wheeler, W.C. (2006). The amphibian tree of life. *Bull. Am. Mus. Nat. Hist.* **297**, 1–370.
- Jungfer, K-H. & Boehme, W. (1991). The backpack strategy of parental care in frogs, with notes on froglet-carrying in *Stefania evansi* (Boulenger, 1904) (Anura: Hylidae: Hemiphractinae). *Rev. fr. Aquariol.* **18**, 91–96.
- Kok, P.J.R., Bourne, G.R., Benjamin, P. & Lenglet, G.L. (2006). *Stefania evansi*. Reproduction. *Herpetol. Rev.* **37**, 212–213.
- MacCulloch, R.D. & Lathrop, A. (2002). Exceptional diversity of *Stefania* (Anura: Hylidae) on Mount Ayanganna, Guyana: three new species and new distribution records. *Herpetologica* **58**, 327–346.
- MacCulloch, R.D., Lathrop, A. & Khan, S.Z. (2006). Exceptional diversity of *Stefania* (Anura: Cryptobatrachidae) II: six species from Mount Wokomung, Guyana. *Phyllomedusa* **5**, 31–41.
- Señaris, J. C., Ayarzagüena, J. & Gorzula, S. [1997 (“1996”)]. Revisión taxonómica del género *Stefania* (Anura: Hylidae) en Venezuela con la descripción de cinco especies. *Publ. Asoc. Amigos de Doñana* **7**, 1–57.

PHILIPPE J.R. KOK¹ and PAUL BENJAMIN²

¹ Department of Vertebrates, Royal Belgian Institute of Natural Sciences, 29 rue Vautier, B-1000 Brussels, Belgium.

E-mail: Philippe.Kok@naturalsciences.be

² Chenapou Village, Upper Potaro River, Region 8, Guyana.

TRITURUS CRISTATUS (Great crested newt): PREDATION BY BIRDS. I am fortunate enough to have a pond with a large colony of Great crested newts on my land and, over a number of years, have been able to observe the extensive predation that the colony suffers from birds (the pond is in the High Weald of Kent and lies about half a mile from the River Teise).

I have only been able to find very limited references to the fact that this predation occurs and have to assume that it has not been adequately recorded or documented in the past. My observations and identification of the prey are made easier by the fact that there are no fish in the pond other than a few large grass-eating carp and no other newts are resident. It is also clear that adult newts are not a problem for some birds despite the belief that toxicity affords some protection.

Firstly, Moorhens (*Gallinula chloropus*). It is perhaps surprising but Moorhens will catch and consume adult Crested newts. Although they spend most of their day pecking away at plants in the pond eating mainly vegetable matter they are omnivores and will also eat insects, worms and snails. As far as catching newts is concerned, Moorhens are opportunistic hunters in that, as far as I have seen, they do not actively seek them out. However, if an adult crested newt comes up for air in the path of a Moorhen, it becomes a target and, if possible, will be caught. When this happens it creates a great deal of excitement among the other Moorhens on the pond who chase the lucky bird hoping to share in the spoil; an indication that they would eat more if they could catch them. They do not appear to swallow them whole but peck them into smaller bits before eating them.

As far as I am aware it is not generally known that Mallards (*Anas platyrhynchos*) are also predators and more successful ones than Moorhens. They hunt the adult newts much more systematically and I have watched them patrolling the pond actively looking for the newts coming to the surface. A female Mallard I observed caught and consumed at least five fully-grown crested newts in the space of an hour. Having webbed-feet and better diving skills clearly makes the ducks more adept at catching them than the Moorhens and when the newts are caught they are swallowed whole, toxins clearly being no discouragement.

Predation by ducks and Moorhens pales into insignificance when compared with the predation

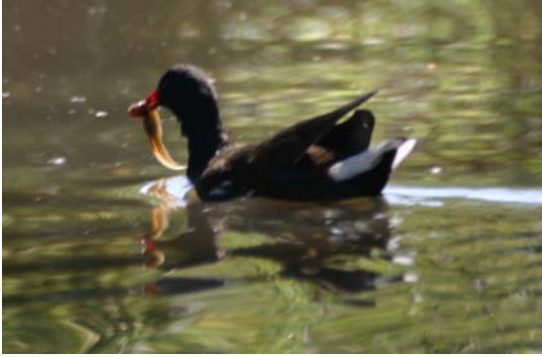


Figure 1. Moorhen having just caught an adult Great crested newt.

by Kingfishers (*Alcedo atthis*) and it is absolutely astonishing how voraciously these birds attack the colony. One is torn between the pleasure of being able to watch these spectacular birds and the devastation they are causing to the newt population.

The Kingfishers visit the pond periodically throughout the year but the serious visits start towards the end of June and carry on with great frequency through to the end of August and into September.



Figure 2. Male Mallard having just caught a Great crested newt. The head can just be seen the other side of the beak.

The timing coincides with the presence of the juvenile newts in the pond and it is these that are consumed by the Kingfishers in vast quantities. During a typical visit by a bird at least ten juveniles can be caught and consumed and these visits, particularly in the early weeks, take place throughout the day. I estimate that up to 100 juveniles can be taken from the pond on a daily basis and this attack goes on day after day.

The Kingfishers very rarely make mistakes but I have observed one young bird catching a more



Figure 3. Newt hurriedly rejected by a young kingfisher.

mature newt and dropping it like a hot potato as soon as it realised what it was. The picture (Figure 3) was taken a few seconds after this happened. This would indicate that, unlike Mallards and Moorhens, Kingfishers are not able to deal with the toxins. Despite looking completely traumatised the newt swam away when I returned it to the water.



Figure 4. Kingfisher about to consume a juvenile Great crested newt.

It is difficult to determine if the Kingfishers that visit are members of the same family. Young are certainly brought to the pond by adults and the pond seems to be the preserve of one adult male Kingfisher since I have seen rivals hide when it arrives and then be chased away. I initially thought that visits to the pond might occur when water conditions were not favourable in the nearby river but given the consistency of the visits in all weather conditions and the vast quantities consumed one has to assume that juvenile newts are part of the preferred Kingfisher diet.

JOHN WEBLEY

Ash Oast, Schoolhouse Lane, Horsmonden, Kent, TN12 8BJ. Email: webley@btinternet.com
www.15acresinkent.com

BRITISH HERPETOLOGICAL SOCIETY COUNCIL 2007/2008

Society address: c/o Zoological Society of London, Regent's Park, London NW1 4RY

Website: <http://www.thebhs.org>

President:	Prof. T.J.C. Beebee	Dept. of Biochemistry, School of Life Sciences, University of Sussex, Falmer, Brighton BN1 9QG. <i>E-mail: t.j.c.beebee@sussex.ac.uk</i>
Chairman:	Mr. J. Coote	<i>E-mail: chair@thebhs.org</i>
Treasurer:	Mrs. P. Pomfret	15 Esk Way, Bletchley, Milton Keynes MK3 7PW. <i>E-mail: treasurer@thebhs.org</i>
Membership Secretary:	Mr. T. Rose	11 Strathmore Place, Montrose, Angus DD10 8LQ. Tel: +44 (0)1674 671676; Mob: 07778 830192. <i>E-mail: baankulab@yahoo.co.uk</i>
<i>The Herpetological Journal</i>		
Receiving Editor:	Dr. W. Wüster	School of Biological Sciences, University of Wales, Bangor LL57 2UW. <i>E-mail: herpjjournal@thebhs.org</i>
Managing Editor:	Dr. E. Price	International Training Centre, Durrell Wildlife Conservation Trust, Les Augrès Manor, La Profonde Rue, Trinity, Jersey JE3 5BP. <i>E-mail: eldom@jerseymail.co.uk</i>
<i>The Herpetological Bulletin</i>		
Editor:	Dr. P. Stafford	Dept. of Botany, The Natural History Museum, Cromwell Road, London SW7 5BD. <i>E-mail: herpbulletin@thebhs.org</i>
Reviews Editor:	Mr. N. D'Cruze	The World Society for the Protection of Animals, 89 Albert Embankment, London SE1 7TP.
<i>The Natterjack</i>		
Editor:	Ms. M. Lock	262 Lyall Place, Farnham, Surrey GU9 0EQ. <i>E-mail: natterjack@thebhs.org</i>
Co-editor:	Mr. T. Rose	See Membership Secretary above.
Librarian:	Mr. D. Bird	Jacaranda Cottage, New Buildings, Spetisbury, Blandford Forum, Dorset DT11 9EE. <i>E-mail: drbird.herpl@virgin.net</i>
Development Officer:	Mr. M. Hollowell	<i>E-mail: markh22@btinternet.com</i>
Webmaster:	Mr. P. Pote	262 Lyall Place, Farnham, Surrey GU9 0EQ. <i>E-mail: webmaster@thebhs.org</i>
Trade Officer:	Mr. P. Curry	90 Brook Crescent, Chingford, London E4 9ET. <i>E-mail: peter.curry@euorep.co.uk</i>
<i>Captive Breeding Committee Chairman:</i>		
	Dr. S. Townson	103 Chancellors Road, Stevenage Old Town, Hertfordshire SG1 4TZ. <i>E-mail: simon.townson@ntlworld.com</i>
<i>Conservation Committee Chairman:</i>		
	Mrs. J. Clemons	34 Montalt Road, Cheylesmore, Coventry CV3 5LU. <i>Email janclemons@wartsoc.co.uk</i>
<i>Education Committee Chairman:</i>		
	Mr. D. Freeman	272 Whaddon Way, Bletchley, Milton Keynes MK3 7JP.
<i>Research Committee Chairman:</i>		
	Dr. C. Gleed-Owen	c/o The Herpetological Conservation Trust, 655A Christchurch Road, Boscombe, Bournemouth, Dorset BH1 4AP. <i>E-mail: research@thebhs.org</i>
<i>North-West England Conservation Officer:</i>		
	Mr. R. Parkinson	317 Ormskirk Road, Upholland, Skelmersdale, Lancashire. <i>E-mail: northwest@thebhs.org</i>
<i>Scottish Groups Liaison Officer:</i>		
	Mr. F. Bowles	37 Albany Terrace, Dundee DD3 6HS. <i>E-mail: frankdbowles@hotmail.com</i>

Ordinary Members

Mr. D. Willis	<i>E-mail: davewillis54@hotmail.com</i>	(2 nd year)
Ms. E. Daw	Strathmore Veterinary Clinic, 6 London Road, Andover, Hampshire SP10 2PH. <i>E-mail: reptilevn@yahoo.co.uk</i>	(2 nd year)
Mr. J. Pickett	84 Pyrles Lane, Loughton, Essex IG10 2NW	(3 rd year)

Past Presidents (retiring date)

Dr. M.A. Smith (1956), Dr. J.F.D. Frazer (1981), The Earl of Cranbrook (1990), Prof. J.L. Cloudsley-Thompson (1996), Dr. R. Avery (1997), Dr. H. Robert Bustard (2005)

THE HERPETOLOGICAL BULLETIN

Contents

HUSBANDRY AND PROPAGATION

- Successful keeping and breeding – the Collared lizard (*Crotaphytus collaris*)
Richard Harling3

RESEARCH ARTICLES

- Albino Common toads (*Bufo bufo*)
S. Pash, J. Spooner and J. P. Sumpter8
- Occurrence of an albino newt and albino Common toads (*Bufo bufo*)
in the same garden pond
J. Spooner, S. Pash and J. P. Sumpter11
- Recent distribution records of Estuarine crocodiles (*Crocodylus porosus*)
in northern Sulawesi, Indonesia
*Steven G. Platt, Johnny S. Tasirin, Iwan Hunowu, Stephan Siwu
and Thomas R. Rainwater*13
- Distribution and habitat use of *Sordellina punctata* (Serpentes, Colubridae),
with a new record from São Paulo state, Brazil
*Donizete Neves Pereira, Fernanda Stender-Oliveira, Murilo
Guimarães Rodrigues and Renato Silveira Bérnils*18
- Non-lethal injury in Hermann's tortoise, *Testudo hermanni*, in Croatia
and Montenegro
Roger Meek23
- New opportunities and hazards brought by humans to the island habitat
of the skink *Euprepis atlanticus*
João Luiz Gasparini, Pedro Luiz Peloso and Ivan Szizima30
- NATURAL HISTORY NOTES
- Triturus alpestris* (Alpine newt): hypomelanism
Lumír Gvozdík, Daniel Stejskal and Jan Dvořák33
- Corallus hortulanus* (Amazon tree boa): bat predation in Jaú National Park, Brazil
Adrian Barnett, Verena Schiel and Adrian Deveny35
- Stefania evansi* (Groete Creek carrying frog): froglet carrying
Philippe J. R. Kok and Paul Benjamin38
- Triturus cristatus* (Great crested newt): predation by birds
John Webley39

