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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).

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Front cover illustration. *Agama atricollis* (= *Acanthocercus atricollis*); a male photographed near the Kazinga channel at Queen Elizabeth National Park in Uganda, © Rhett A. Butler / mongabay.com. See article on page 2.

EDITORIAL

British Herpetological Society 2007 AGM

The 2007 Annual General Meeting of the British Herpetological Society will be held on 31st March at the Natural History Museum, London (Dorothea Bate Room, Dept., of Palaeontology). Following the official business of the Society, there will be a number of events including talks by Steven Spawls (*Sun, sand and snakes – herpetological adventures in Africa*) and Frances Baines (*The use of ultraviolet lighting in reptile husbandry*), and a photographic competition. Further details of the programme will be published nearer the time in the *Natterjack*, and circulated via the website. Numbers will be limited, and members wishing to attend will need

to register in advance. To register, please contact myself (herpbulletin@thebhs.org; other contact details available on inside back cover of this issue) preferably by e-mail by February 28th 2007, giving your membership number and (where applicable) the names of other family members wishing to attend. Owing to Museum security policy it will unfortunately not be possible to admit any person who arrives on the day without having registered beforehand.

We look forward to welcoming you at this meeting and also to the Natural History Museum. There are good rail links to South Kensington (nearest underground station to the Museum, served by the Distrct, Circle and Picadilly lines) from all the mainline London stations. *Ed.*

OBITUARY

James Derrick Judge, 1933–2006

After a long career at Vickers as a marine engineer Derrick was eventually promoted to seniormanager within the submarine design team. Derrick was one of a number of scientists of that era who were 'cross trained' in both nuclear physics and marine Engineering. He undertook further periods of postgraduate study at the Royal Naval College in Greenwich and Manchester University. Working as a member of some of the most sensitive design forums for the latest and future attack submarines, he spent a considerable amount of time with the propulsion and underwater noise teams at MOD and YARD.

Derrick eventually left Vickers and formed his own company as a Noise and Vibration Consultant. Chi-Delta acoustics kept him busy working on vibration analysis of industrial systems and acting as an expert witness in noise abatement cases.

Following his retirement, Derrick announced that his 'education was incomplete' and that he intended to undertake an Open University degree in biochemistry and genetics. He completed his degree in 1996. This introduction to the biological sciences sparked a keen interest in the application of his engineering and noise analysis skills to the study of animal vocalisation. He began his research work on the vocalisation of Natterjack toads at Nottingham University in 1999.

During the following years he was plagued with ill health, fighting both cancer and numerous heart attacks. However, he never lost his insatiable desire to learn, or his infectious awareness of the wonders of the natural world. Derrick was an utterly delightful man, with a wonderfully engaging personality and an immersing enthusiasm for his corner of biology. He was also a skilled acoustic technician who brought a commanding technical competence from his naval days to his work with anurans. His health conspired against him and he never completed his final study on Natterjack toads. However, for him, his work was never about the final piece of paper. It was all about the journey.

Julia Wycherley Merstham, Surrey, U.K.

Notes on the breeding behaviour of the Crocodile monitor (Varanus salvadorii) in captivity

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* Deceased; see foootnote on page 6

ARANUS salvadorii is the longest monitor lizard in the world, with some reports stating this species may reach 4.5 metres in total length (Schultze-Westrum, 1961; Redmond, 1980; Bayless, 1998; Horn, 2004a). The natural habitat of this large arboreal species consists of lowland dense jungle and tropical rainforest in New Guinea (Schultze-Westrum, 1961; Horn, 2004a), where the species occurs in both provinces of Papua and Iran Jaya (Bayless, 1998; Horn, 2004a). Crocodile monitors, as they are commonly known, are apex predators and, like many other large varanids, ambush hunters. Although their natural diet is not clearly understood, prey is likely to consist of mammals, birds, reptiles, fruit bats (flying foxes), and marsupials ('Cuscus') - prey is attacked both on the ground, and by dropping on it from above, causing severe and massive trauma before being eaten (Bayless, 1998). The largest known Crocodile monitor belongs to the Gladys Porter zoo in Brownsville, Texas - this individual, a longterm wild caught male in 2005 measured 3.4 m (Hairston Adams, pers. comm.). Approximately 7.6 to 15 cm of its tail is missing, and yet it is considered verifiably the longest known example of this species reported, in captivity or from the wild. As an arboreal species, even a 3.3 meter long specimen would probably not weigh very much, as two-thirds of its size is its tail. The average life span of captive specimens has varied from 18 years (H. G. Horn, pers. comm.) to 20 years (Bennett, 1998).

Breeding Group

From 1994 to early 1997, the principal author maintained a small (1:2) group of Crocodile monitors. The male, approximately 2 years old and about 1 metre long, was acquired in October 1994; the two females, acquired in late 1995, were long-

term captives and averaged 1.8 m in total length. All three lizards were taken to the local veterinarian to be x-rayed to determine their sex. Sexing Crocodile monitors, like most varanids, is not without complications. Many 'males' have consequently laid eggs, and combat occurs with no sexual bias (H. Adams, pers. com.). My original notion that I might have had a 1.2 group was based upon behaviour of the lizards, as both females rarely ventured to the ground for any length of time, were shyer, and would 'soak' in the water for an hour or more at a time (Horn, 2004b).

Rats were the only prey taken with eagerness by the females, as apposed to the male, which seemed more willing to feed on any prey available, with mice, rats, and chicks taken with equal eagerness. Hissing cockroaches were offered, but never accepted. The females slept in hide boxes, and basking occupied a majority of their day. The male however, was quite restless. Excursions to the ground were common, as was digging. In the wild, females of *Varanus* species tend to have smaller home ranges, appear to be shy, and may encounter limited prey (Phillips, 1995; pers. obs.). Our lizards are housed separately in individual cages measuring 2.6 m x 2.6 m x 1.3 m, and also given access to an outdoor enclosure (Figure 1).

For the purpose of breeding, a large cage was constructed in June 1996, measuring 3m x 2.6m x 1.3m. Introduction of the lizards to the new enclosure occurred in July 1996, and was without complication. All three were placed in the enclosure at the same time, thus reducing the possibility of territorial disputes. Their activity during the first hour consisted of exploring, with some digging. Shortly after, all three animals sought out the hide boxes created for them above ground. Wild Crocodile monitors have been noted to sleep in tree holes many metres above ground

(Philipp, 1999). Roughly one week later, all three lizards began sharing the same hide box, tightly squeezed together, and thereafter this became standard behaviour, only changing when I separated them after the first female was observed to be gravid. At no point did I witness any aggression, or fighting by any of these lizards. In general this was a perfect 1.2 group of V. salvadorii. Feeding was accomplished using 30.5 cm long hemostats, the diet consisting mostly of small rats, mice, and chicks. On average feeding occurred 3 times a week with small meals sufficient to maintian a healthy appetite. Food was usually placed near the monitor as this helped keeping each of them occupied with their own meal. Of the three animals, the females in particular would seize their food and climb to highest secure spot, before consuming it. Crocodile monitors process food faster than any monitor I have ever kept, with faeces usually being evacuated within 12 hours. Rats appeared to be their preferred prey and were consumed with much eagerness.

Breeding Conditions

During August 1996 I began to increase humidity, rainfall, and ambient air temperatures. The average temperature was 29°C (85°F) during the day, with a night time low of 21.1 to 24°C (70–75°F). Humidity was in the range of 80–85%. To stimulate breeding, I increased humidity to almost 100%. and increased night-time temperature lows to between 26.6 and 29.4°C (80–85°F). Average air temperature during the day was also increased to approximatley 35°C (95°F). Basking site temperatures remained the same throughout, from 43 to 49° C (110–120°F). Photoperiod was maintained on a constant 12/12hour on/off cycle, with lights switched on at 07:00 hr. Breeding activity began in September 1996, within 30 days after making these adjustments. It appeared to me that copulation only occurred in the hide boxes above ground - copulatory behaviour may have happened on the ground, but it was never observed there. When copulation was observed, it would usually last up to 60 minutes, and may have continued into the night due to the fact that on a few occasions, both the male and female would appear to be 'engaged' close to the time when lights were switched off, usually from 18:45–19:00 hrs.

Breeding behavior was a non-violent affair, with the male pursuing the female and tongueflicking her hindquarters (rear legs, tail base), neck, and the shoulder region – where pheromone pores are more frequent in the Varanidae (Andreas et. al., 1999). Head-bobbing was not observed, although a 'jerky' side-to-side lateral motion was. The male would also gently scratch the female's shoulders and hindquarters. Within 50 days, around mid-October, I awoke in the morning to find that one of the females (Figure 2) had constructed a large nest on the ground, and was lying on top of it - presumably a form of guarding behaviour - when the lights were turned on. The dimensions of the mound were roughly 1.3 m across and 0.6 m high. The male and other female were emerging from the hide box to bask and warm-up. When I entered the cage, the nesting female lunged at me immediately. This was the first and only time I witnessed any aggression from any of the animals in this group. I decided to remove the remaining female and male to their original cages. Unsure of what to do, I left the female. and cage conditions the same (temperature, humidity, etc.). Approximately 3-4 days later the female began to exhibit normal behaviour. She no longer showed aggression, and resumed her usual routine of basking and relative calmness, and it was at this time I entered the enclosure to retrieve the eggs.

By the time the eggs were removed, their general condition was poor. Mould was present, and a light tint of grey colouring was observed on the shells of all four. Each of them measured approximately 5 cm in length. Later that day I cut them open only to find a semi-solid yellow mass resembling a 'jelly like' substance. By the first week of November 1996, the second female had also laid a clutch of four eggs – however, these eggs were scattered about the cage, and were of a similar light grey colour. The second female did not show any signs of aggression, or maternal care of her clutch, as had the first female. Once again, when cut open, the same solid yellow mass was present. Both females began to feed within days of depositing their clutches.



Figure 1. Sub-adult *Varanus salvadorii* in naturally designed outdoor enclosure. Photograph © M. K. Bayless.

During late December of 1996 the first female was taken to the veterinarian for a check-up as I was planning to begin breeding them again in early January 1997. During the visit, x-rays showed a blockage in her oviduct, so surgery was necessary. Prior to the visit, nothing abnormal was observed with this female, diet, defecation, and general behaviour were all normal. Following surgery, this female failed to recover and died soon thereafter. By mid-January 1997, the remaining female and the male were maintained together in the breeding enclosure. For the next few months breeding behaviour was not observed, and temperatures were returned to pre-breeding conditions by mid-February 1997.

Initiaton of the breeding program was resumed during the first week of March 1997, with the same aforementioned temperature and humidity levels. Copulation was witnessed once during this month and lasted until around the middle of April, following which I began to look out for changes in behaviour of the female and indications of egglaying (e.g. digging, aggression). None of these were observed, so I decided to have the animal examined by a veterinarian. By this time, however, it was late April and well past the 30–40 day egglaying time line. The x-rays showed an oviductal blockage, and extensive liver damage. As with the other female, her behaviour appeared normal throughout, but by the first week of May this lizard had also died. Shortly thereafter, the male died as well. Necroscopy showed that both had extensive damage to the liver, identified by the veterinarian as possibly a form of cancer.

Whatever killed these three monitors was never observed in any of the other varanids I had in my collection at the time, which leads me to suspect that it might have been a species' specific illness. The abrupt end was a major loss, and left me with many unanswered questions.

DISCUSSION

Success in future breeding initiatives for V. salvadorii would seem to require individuals to be maintained in small groups, from a relatively early age. The 1.2 group I kept was ideal, although the addition of another male at some point may have introduced a possibly beneficial element of 'competition'. All three lizards were wild caught; the male, however, was still small when first imported. The females were wild caught at an older age, and had probably been maintained in captivity for at least a short time before I acquired them (despite assurances that they were both long term captives). Numerous authors have noted aggression between conspecifics; however when given ample room, and plenty of hide boxes this species can coexist with others without incident.

My own recorded observations of *V. salvardorii* indicate that females do not noticeably distend when gravid, as described for cerain other varanids (Bennet, 1995; Bayless, 1998; R. Faust, pers. comm.). Research has also stated that most reptiles from New Guinea breed year-round, with the possible exception of Boelen's python (*Morelia boeleni*), a species of the cooler highlands (O'Shea, 1996). Small clutch size presumably helps in enabling this arboreal species to continue moving around in trees, in contrast to the more stoutly-bodied terrestrial forms, in which clutch size is typcally larger. Hatchling Crocodile monitors are large, with total lengths in the range of 30.5 to 40.6 cm, and larger than those of *Varanus komodoensis*; a female may produce 15–25 eggs a year, but only lay 4–6 eggs every 3–4 months (Bennett, 1995, Hairston Adams, 1996; Horn, 2004a).

Breeding size is apparently key to the successful captive reproduction of *V. salvadorii*, with sexually mature animals in the 1.5 to 2.1 metre size range, provided they are obtained at a young age. Over-crowding will most likely lead to aggression and health problems, and expsoure to low humidity and

poor diet may result in kidney and liver problems. In our experience the UVB light radiation is an essential addition to the over-all health and condition of captive animals, as they naturally receive a higher level than terrestrial varanids. Relatively high temperatures would also seem important; in the wild, Crocodile monitors appear to live where the temperature never drops below 21.1°C.

The diet of wild Crocodile monitors is in much need of research (Brandenburg, 1983; Bayless, 1998; Horn, 2004a). Insects appear to be of no interest to either younger individuals or adults. All of the V. salvadorii I have maintained myself (8) refused insects as food, no matter what the age of the animal. Cockroaches, crickets, and even earthworms were never looked at twice. Rats, mice, chicks, and the 'turkey diet' (R. Faust, pers. comm.), however, were eaten without exception. The skull morphology and teeth of V. salvadorii would seem to suggest that this species kills its prey with maybe one or two well placed bites, with perhaps large marsupials and fruit bats forming a major part of the natural diet. Birds may also be accepted as prey, although in my experience only the male showed an interest in birds of any kind. Over-feeding is likely to cause problems. Dissected examples of wild-caught V. salvadorii



Figure 2. Adult female *V. salvadorii*; this individual laid 4 eggs in a constructed nest. Photograph © B. Waterloo.

have shown only small fat deposists (H.-G Horn, and R. Nye DVM, pers. comms.) whereas in captive animals fat accummulaitons are presumably larger. What does this say about captive husbandry and the proper diet of captive animals? In our opinion, V. salvadorii should always be kept a little hungry – although feeding responses can be 'exciting' for the keeper, it is best to keep this species a little more trim than would otherwise seem preferable. The weight of breeding females may be increased with the addition of more (1-3) prey items during the weekly feeding schedule. Keeping males also on the lean side, and females a little more 'heavy', should increase productivity, and consequently healthier offspring - as similarly noted by Auffenberg (1979) in Varanus bengalensis. The viability and health of the offspring is presumably based on the overall health of the female parent, as often seen in mammals.

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REFERENCES

- Andreas, K.-H., During, M. & Horn, H.-G. (1999). Feinstrukturen der Schuppenhautdrusen und Praanaldrusen von Waranen. *Monitor* (DGHT) **7**, 30–31.
- Auffenberg, W. (1979). Intersexual differences in behavior of captive Varanus bengalensis (Reptilia, Lacertilia, Varanidae). J. Herpetol. 13, 313–315.
- Bayless, M. K. (1998). The Artellia: Dragon of the Trees. *Reptiles* 6, 32–47.
- Bennett, D. (1998). *Monitor Lizards*. 2nd edn. Chimaira. 352 pp.
- Brandenburg, T. (1983). *Monitors in the Indo-Australian Archipelago*. Leidenburg: Brill.
- Dryden, G. L. & Wikramanayake, E. D. (1991). Space and time sharing by *Varanus salvator* and *Varanus bengalensis* in Sri Lanka. *Mertensiella* **2**, 111–119.
- Hairston Adams, C. (1995). Crocodile or Papuan monitor. In: *Taxon Management Account*.Hammack, H. S. (Ed.). Fort Worth: Fort Worth Zool. Park, American Zoo and Aquarium Associaiton (AZA).
- Horn, H.-G. (2004a). Varanus salvadorii. In: Varanoid Lizards of the World, pp 234–243.
 Pianka, E. R., King, D. R. & King, R. A. (Eds.).
 Bloomington: Indiana University Press. 588 pp.
- Horn, H.-G. (2004b). Keeping monitors in captivity: a biological, technical, and legislative problem. In: *Varanoid Lizards of the World*, pp 556–570. Pianka, E. R., King, D. R. & King, R. A. (Eds.). Bloomington: Indiana University Press. 588 pp.
- King, D & Green, B. (1999). *Monitors. The Biology of Varanid Lizards*. NSWP and Krieger Publishers. 116 pp.
- Madsen, F. (1990). Varanus salvadorii. Nordic Herpetological Society **33**, 70–76.
- O'Shea, M. (1996). A Guide to the Snakes of Papua, New Guinea. Port Morsby: Independent Design. 238 pp.

- Phillip, J. A. (1995). Movement patterns and density of *Varanus albigularis*. J. Herpetol. **29**, 407–416.
- Philipp, K. M. (1999). Niche partitioning of *Varanus doreanus*, *V. indicus* and *V. jobiensis* in Irian Jaya: Preliminary results. *Mertensiella* **11**, 307–316.
- Pianka, E. R., King, D. R. & King, R. A. (2004). Varanoid Lizards of the World. Bloomington: Indiana University Press. 588 pp.
- Redmond, I. (1980). Pilgrims in Papua. *The Territorial Army Magazine* **50**, 8–9.
- Schultze-Westrum, T. (1961). Wasser und Baumreptilien auf Neuguinea. *Kosmos (Stuttgart)* **6**, 247–252.

Footnote: The Editor has been informed that following submission of this article, its co-author, Mark K Bayless, sadly passed away (November 1st 2006). Of his friend and colleague, the senior author (B. Waterloo) writes: "Mark's work with varanids was well-known and his articles have been referenced in numerous books. Mark was a great friend, apart from our mutual interest in varanid biology. He was friendly to anyone with an interest in varanids."

Barbourula kalimantanensis Iskandar, 1978 – a new record for central Kalimantan, Indonesian Borneo (Amphibia: Anura: Discoglossidae)

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ABSTRACT – The frog *Barbourula kalimantanensis* Iskandar, 1978, previously known only from two specimens from West Kalimantan, is recorded from a river in Central Kalimantan, approximately 124 km from the type locality. A mountain range, tertiary in origin, separates the two localities. A photograph of a live specimen is presented here for the first time.

THE Indonesian discoglossid Barbourula kalimantanensis was described by Iskandar (1978) based on one male specimen (holotype: Museum Zoologicum Bogoriense (MZB), Bogor, Indonesia, MZB Amph. 2330) collected by S. Wirjoatmodjo and T.R. Roberts. The species was then re-described based on a second (female) specimen (Zoological Reference Collection (ZRC), National University of Singapore ZRC 1.3219) collected by M. Kottelat (Iskandar 1995). Both are from the Melawi river basin area. West Kalimantan (male: 0° 44' S, 111° 40'E, female: 0° 36' 44" S, 111° 47' 22" E). Its only generic relative, B. busuangensis, occurs in the Philippine Islands of Palawan and Busuanga. Barbourula kalimantanensis is distinguished from the latter by diagnostic morphological characters, such as a straight margin to the web of the fingers (concave in B. busuangensis), a head that is flattened anteriorly (distinct nasal prominences giving a more rounded snout in *B. busuangensis*) and a more rugose skin (Iskandar, 1978). As there are only two published records, any new information on this species is desirable. Here we report the occurrence of B. kalimantanensis in Central Kalimantan for the first time, based on an individual from the Sungai [= river] Tengkalap, between the tributaries of the Sungai Autan (1° 26' 05.9" S, 111° 24' 31.8" E) and Sungai Kuli (1° 25' 25" S, 111° 25' 30.2" E).

MATERIALS AND METHODS

During a biodiversity survey expedition in an area of primary rain forest in the Belantikan River basin, Central Kalimantan, one of us (ES) captured a single individual of *B. kalimantanensis* (Figure 1). Its snout-vent length (SVL) was measured and photographs were taken before it was returned to the river. The specimen was not collected as the biodiversity inventory methods utilised were noninvasive. Minimal habitat disturbance in the Belantikan region was desirable as the area is known for its endangered species, including the third largest known population of the Bornean Orang utan (*Pongo pygmaeus wurmbii*).

The frog was found in 60 cm of water under pebbles in a 20 metre wide fast-flowing (riffle) area of the Tengkalap River, between the Autan and Kuli tributaries at an altitude of 200 m, 8th May 2005, 12:05 hr local time. An SVL measurement (to 0.1mm) was obtained using a digital caliper gauge. Photographs and descriptions of the holotype (Iskandar, 1978) and the second specimen (Iskandar, 1995, Inger & Stuebing, 2005) were used for identification. Specimens of B. busuangensis (1, ex., SVL: 40.6 mm, BMNH 1977.1202, 13 km SW Iwahig, ca. 300 ft, Palawan Island, Philippines, coll. Q. Alcala 29th April 1961; 1, ex., SVL: 47.2 mm., BMNH 1977.1203, 13 km. S.S.W. Iwahig, Palawan Island, Philippines, coll. Q. Alcala 1st May 1961; 1, ex., SVL: 85.7 mm, BMNH 1980.410, Dimaniang. Busuanga Island, Philippines, coll. H. Hoogstraal, 21st March 1947; 1, ex., SVL: 66.6 mm, BMNH 1982.410, Singai, Busuanga Island, Philippines, coll. A.W. Herre, 21st June 1940) in the collections of the Natural History Museum, London (BMNH) were examined for comparison by one of the authors (SS).



Figure 1. Dorsal view of *Barbourula kalimantanensis*, (SVL: 90mm) from Tengkalap River, Belantikan River basin, Central Kalimantan. © YAYORIN.

Examination and comparisons

The overall flattened appearance, extremely depressed head, skin folds along the sides of the body and lower limbs, completely webbed fingers

and rugose skin with tubercles and spinules on the dorsum indicated that the individual was unmistakeably a of Barbourula. When species compared to *B. busuangensis*, the lack of a concave excision in the web of the fingers and a more flattened snout without prominent nares showed it to belong to B. kalimantanensis. In alcohol, the colour of this species is uniform black dorsally; brownish black with brown (male) or yellow (female) mottling ventrally (Iskandar, 1995). The live specimen (Figure 1) was uniform black with brown mottling on the flanks and sides of the limbs. The underside was brown with brown mottling. An SVL of 90 mm is larger than either of the two other

Figure 2. Map of Borneo illustrating type locality (A): Melawi River basin, West Kalimantan and new locality (B): Belantikan River basin, Central Kalimantan.

known specimens (female 78.0 mm SVL, male 68.0mm SVL). The identification of the individual as *B. kalimantanensis* was confirmed by Prof. Djoko T. Iskandar.

DISCUSSION

A snout-vent length (SVL) of 90mm recorded for this individual is greater than that for either of the two known specimens. The female (ZRC 1.3219) at 78 mm SVL is the larger of the two. The size of the Belantikan individual indicates that it could possibly be female. However, proper assessments cannot be made about possible sexual size dimorphism, the presence/absence of anal claspers (the status of which is unknown for the Belantikan individual) and a lighter or darker ventral colouration as possible secondary sex characters in *B. kalimantanensis* (Iskandar, 1995) without more specimens.

The record of this species from the Belantikan region represents a range extension of approximately 124 km from the type locality (Figure 2). The Melawi (West Kalimantan) and Belantikan basins may represent distinct subpopulations. The Tengakalap River is situated in the foothills of the Schwaner Mountain chain, formed from continental basement rock tertiary in origin



(MacKinnon et. al., 1996). The potential 15 million year isolation of the Belantikan population from those of the Melawi basin has possible implications for the status of *B*. kalimantanensis in central Kalimantan. Further surveys to obtain specimens for systematic and ecological information (almost nothing is known of the habits of this species) are thus extremely desirable. Unfortunately, the Belantikan area has been designated a logging concession by the Indonesian government. Biodiversity surveys by organisations such as Yayorin (Orang utan Foundation Indonesia) can provide information on the presence of endangered and little-known species such as *B. kalimantanensis* that can be useful in conservation-related decisions. In this way it is hoped the Belantikan area will become a protected ecosystem in the future.

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REFERENCES

- Inger, R. F. & Stuebing, R. B. (2005). *A Field Guide to the Frogs of Borneo*. 2nd edn. Kota Kinabalu, Sabah, Malaysia: Natural History Publications.
- Iskandar, D. T. (1978). A new species of *Barbourula*: first record of a discoglossid anuran in Borneo. *Copeia* **1978**, 564–566.
- Iskandar, D. T. (1995). Note on the second specimen of *Barbourula kalimantanensis* (Amphibia: Anura: Discoglossidae). *Raffles Bull. Zool.* **43**, 309–311.
- MacKinnon, K., Hatta, G., Halim, H., & Mangalik,A. (1996). *The Ecology of Kalimantan*. Oxford,U.K.: Oxford University Press.

Recent observations of the Montserrat galliwasp, Diploglossus montisserrati

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THE Montserrat galliwasp *Diploglossus montisserrati* (Underwood, 1964) is a large skink-like lizard, endemic to the island of Montserrat, and the only representative of the Anguidae in the Lesser Antilles (Malhotra & Thorpe, 1999). It is considered critically endangered (Day, 1996) and extremely rare because it is only known from a single locality, and until recently had not been observed since the original specimen was collected (Censky & Kaiser, 1999). Due to the absence of sightings of the species, and the catastrophic impact of a volcanic eruption during the mid 1990s on the extent and quality of its forest habitat, the galliwasp was considered potentially extinct. However, on August 28th 1998, a specimen was opportunistically found in an area known as Woodlands Springs (62.2156E, 16.7269N) (P. Murrain and K. Buley, pers. comm.). This site lies on the western flank of the Centre Hills, a 12 km² forested area in the centre of Montserrat. Another galliwasp was seen at the same site in 2004 (R. Allcorn, *pers. comm.*) and three unconfirmed observations by local residents have been subsequently reported (L. Martin, *pers. comm.*). The concentration of sightings at one locality suggests the range of the Montserrat galliwasp is highly restricted. However, over the past few years search effort at this site has probably been disproportionately high compared with other Centre Hills sites. Because the Montserrat galliwasp is considered nocturnal and semi-fossorial, and has cryptic colouration, it is therefore possible that the species is more widespread and common than assumed.

In June-July 2005 and January-March 2006, a reptile and amphibian survey of the Centre Hills forest was conducted as part of a biodiversity assessment of this area. Line transects were walked at night and day at 30 sample points, distributed randomly throughout the Centre Hills forest. These surveys included intensive searching through leaf litter and refugia. In total, approximately 390 man hours of nocturnal fieldwork was conducted. On 26th January (19:15 hr), during a search of the Woodland Springs area, an adult Montserrat galliwasp was observed, confirming the continued existence of the species (Figure 1). Woodlands Springs is approximately 10 hectares of moist forest interspersed with a small number of houses, large gardens and agricultural plantations, and thus people and domestic animals, including cats and dogs, are present in the area. Topography is steep and rocky (approximately 240 metres asl), and recorded annual rainfall is roughly 1500 mm. The galliwasp was found under a stone and caught by hand, examined briefly, then measured and weighed. It had a snout-vent length of 18 cm, a tail length of 23 cm, and was 170 g in weight.

A second adult galliwasp was seen in Woodlands Springs on 5th February (18:30 hr), approximately 20–30 m from the location where the first individual was found (Figure 2). The animal was found within the roots of a tree with only its head visible but immediately retreated out of sight into the root system. It was observed again shortly afterwards and was followed for approximately 20 minutes walking across the forest floor in an attempt to examine its behaviour and to identify potential cues to aid its detection. The galliwasp appeared to be very sensitive to disturbance and would cease moving in response to any movement or noise made by the observer. Another sighting of what was presumed to be the same individual was made in exactly the same location on the 8th March (18:00 hr).

The reptile and amphibian survey covered the whole Centre Hills and the Montserrat Forestry Department have conducted regular nocturnal fieldwork throughout the area since 1998. However, the Montserrat galliwasp has only ever been recorded in one site. This lends weight to the hypothesis that the galliwasp has a highly restricted distribution and is therefore likely to be extremely rare. As Woodlands Springs does not appear to be markedly different in terms of topography, climate and habitat structure to other nearby forest areas, it is not clear why the galliwasp would be restricted to such a small site.

Data on the ecology and natural history of the Montserrat galliwasp are sparse. As a first priority, quantitative information on distribution and population abundance is required to evaluate its status and inform conservation action. An effective and systematic survey technique needs to be developed and tested. Although the species is detectable by sight (and the noise of them moving through leaf litter provides a cue to their presence), the cryptic nature of the galliwasp and their apparent sensitivity to human presence will result in low encounter rates, thus precluding meaningful sample sizes. Pit fall trapping has been used in surveys of other galliwasp species, e.g. Celestus crusculus and C. duquesnevi in Jamaica (Wilson & Vogel, 2000), but in the current field site, such capture methods may be problematic because of the presence of rats (Rattus rattus and R. norvegicus) and domestic cats and dogs, which may predate upon any trapped animals.

A conservation action plan for the Montserrat galliwasp needs to be implemented, including a programme of field research, habitat protection and potentially invasive mammal control. Rats are common in the Centre Hills and may strongly limit population growth of galliwasps and an





Figure 1 (above). The Montserrat galliwasp, *Diploglossus montisserrati*, observed on the 26th January 2006 in the Woodlands Springs area of Montserrat.

Figure 2 (below). *Diploglossus montisserrati* observed on the 5th February 2006 in the Woodlands Springs area of Montserrat.

experiment to quantify their impact is likely to prove informative. A management plan for the conservation of the Centre Hills forest and its biodiversity is currently being developed, with the ultimate aim of establishing Montserrat's first national park, which may provide Woodlands Spring protection from further development. However, given the probable vulnerability of the Montserrat galliwasp direct intervention to save the species, such as captive breeding, may be necessary. The observations reported here provide evidence of the continued existence of the Montserrat galliwasp which we hope will help secure the funding to facilitate the field research and conservation action that is urgently needed to ensure the long term survival of this species.

REFERENCES

- Censky, E.J. & Kaiser, H. (1999). The Lesser Antillean Fauana. In: *Caribbean Amphibians and Reptiles*. Crother, B. I. (Ed.). San Diego: Academic Press.
- Day, M. (1996). *Diploglossus montisserrati*. In: IUCN 2006. 2006 IUCN Red List of Threatened Species. <<u>www.iucnredlist.org</u>>. Downloaded 10th May 2006.
- Malhotra, A. & Thorpe, R.S. (1999). *Reptiles and Amphibians of the Eastern Caribbean*. London: Macmillan Education Ltd.
- Underwood, G. (1964). An anguid lizard from the Leeward Islands. *Breviora* **200**, 1–10.
- Wilson, B.S. & Vogel, P. (2000). A survey of the herpetofauna of the Hellshire Hills, Jamaica, including the rediscovery of the Blue-tailed galliwasp (*Celestus duquesneyi* Grant). *Caribb. J. Sci.* **36**, 244–249.

Some aspects of nest digging and egg laying behaviour in the arboreal agamid lizard, *Agama atricollis* Smith 1849 (= *Acanthocercus atricollis* Smith 1849)

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ETAILS of nest digging and egg laying behaviour in agamids are poorly documented in the literature, partly due to the secretive behaviour of the female, but also due to the care taken to camouflage the nest. Cott (1934, 1957) and Loveridge (1953) refer to the concealing and often cryptic coloration of Agama atricollis, which made them very difficult to see in the natural state. A description of nest digging behaviour in oriental agamids has been reported by McCann (1937) and Taylor (1951). Fitzsimmons (1943), in his description of some South African lizards, reported on the egg laying habits of Agama atra. The female was stated to have laid eggs one by one and carefully covered each with sand until the hole was filled in. Harris (1964) gave a detailed description of egg laying in the African agamid, Agama agama. The nest digging and egg covering behaviour of this lizard and Agama atricollis appear to be the same but they differ in their behaviour during egg laying. Agama agama is reported to straddle the nest during egg laying, to remain motionless with tail erect and head up, and to inspect each egg after laying. The account which follows gives a detailed description of nest digging, egg laying and the subsequent camouflage of the nest in Agama atricollis, based on a PhD study conducted between September 1968 and December 1973 (submitted 1976). Since the type specimens of Agama atricollis were identified by staff at the Natural History Museum in London (BMNH), this name will be retained in this study, and the recent name changes will be bracketed.

Agama atricollis is essentially an arboreal lizard confined to the tropical grassland-scattered woodland vegetation belts of east and southern Africa. At Kisumu (Kenya) the lizard was associated with certain features of the habitat, notably trees within the study area and the ground between them. Both the male and female lizards are territorial. In the study area, the ecological requirements were considered by an examination of the two main features of the habitat selected for daily activity, namely, those on the ground and those above ground level. Analysis of the daily activities suggest that the maintenance requirements like food, suitable temperature and rest, are attained by the provision of trees, hedges, and bushes which provide basking and resting facilities for these lizards. In addition it is from such sites that the lizard is able to observe prey on the ground and above ground. Trees, bushes and raised structures like fence posts provide vantage points which enable a lizard to keep an eye on other lizards, and to display its presence to other conspecifics of either sex to the full. Nest construction egg laying and incubation require soil, if the entire reproductive effort is to be maintained.

The Study Area

The main study area was centred at Kisumu, a town in Kenya, situated 0 .06S and 34.45 E, on the NE shores of the Kavirondo Gulf of Lake Victoria (Figure 1). In altitude it extends from 1.135 m on the Kavirondo Gulf shore to 1.146 m in the town itself. The areas where this study was made were all much disturbed by man. Those areas on which I concentrated were artificial gardens on the Kisumu Boys High School compound, roadside hedges and trees. The area chosen was covered with stone buildings, pathways and playing fields. Trees of Jacaranda, Cassia, Delonix, Allamanda and Markhamia species are planted at fairly regular intervals along the main tracks and the edges of the compound. Ornamental shrubs and hedges line the paths. The Kisumu area falls within Ecological Zone III, as defined by Pratt et al. (1966) with a climate from dry to sub-humid to semi-dry. Sunshine hours, rainfall and temperature

for Kisumu for a 40 year period, is shown in Figure 2. Diurnal variations for temperature are in the range 7–9°C. Kisumu is situated in an area with at least some rain throughout the year, with peaks from March to June (long rains). A slightly smaller rainfall peak occurs in August.

METHODS

Binoculars of magnification 8 x 30 were used for observation in the field. Details of actual nest construction, egg laying and post depositional behaviour were observed and recorded on film, both cine and still and in note form. Many 'observed nests' were dug up using both hard and soft bristle brushes, so that data on nest dimensions, shape, the number of eggs and egg arrangement, could be obtained. All sites were observed daily. Eggs were put back into the nest after weighing and covered with soil. Every tree in the area studied had painted half metre height marks from the base to six metres up its trunk, so that the vertical distance up the tree at various times of the day could also be measured. At the same time temperature measurements were taken of the immediate environment using an automatic Grant Thermister recorder. The temperature of the substratum and shaded air temperature one, two and six metres above ground level was measured. It was thus possible to analyse the percentage time spent by lizards for various activities and to assess those structures of the habitat which were ecologically important to an egg laying lizard.

Adult females selected the ground for 21.9% of the daily activity, and 78.1% was spent on trees. Males spent 40.4% on the ground and 59.6% above ground (Mendes, 1976). Both males and females have a preferred activity site, usually a tree in their territory, on which they spend most of the day's activity. The males have a number of trees in their territories and therefore a number of activity sites. The preferred site of the female is a static one. The preferred activity site of both males and females were located between one and two metres above the ground on trees such as *Jacaranda*, *Cassia*, *Delonix* and *Markhamia* species which were planted in the urban and suburban areas of the town.



Figure 1. Map showing region of study (above) and geology and soil cover (below).

RESULTS AND DISCUSSION

Nest Site Selection

The relative frequency of nesting activity including pseudo nesting increases with time so that the peak of nest digging activity occurs near the end of the daily activity cycle (between 16:00 and 17:00 hr). After that, nest digging activity ceases as the maintenance activities of basking, resting and some feeding take priority in preparation for sleeping. Females are active for longer periods during the day (mean = 8.95 hours), emerging earlier and retreating later than the males. The nest digging activity reaches peaks in mid and late afternoon. This activity may or may not result in egg laying. Gravid females spend more time in site selection and they can postpone egg laying for a considerable length of time (several days). This can influence the daily pattern of diurnal activity as the females concentrate on nest digging (and trial digs) soon after midmorning basking,



Figure 2. Climatological data for Kisumu.

Behaviour of the gravid female

The female lizard is entirely responsible for the excavation of the nest. As the time approaches for egg laying, the heavily pregnant female makes frequent excursions to the ground, generally moving short distances from the base of the tree, which has been used as an activity site. During these excursions, the attention of the female focuses on ground suitable as a nesting site. At first there may be a few desultory scratches made on the ground with one fore-leg only or with alternate fore-legs, resulting in the excavation of a very shallow depression, At this stage the female is easily distracted and interrupts her work to feed or move to a new nest site, or to her preferred activity site (usually a tree) one to two metres above the ground. If disturbed she will quickly climb higher. During any one session, the female keeps to a general type of site with similar characteristics, usually near cleared ground, and not too far from the preferred activity site. Later the same day (or sometimes in the next day or two), usually from 11:00 hr to 17:30 hr with a peak from 12:00 15:00 hr, nest digging to activities become more marked. The female is found concentrating on nest digging on a particular site. When serious nest digging has begun the female is rarely distracted by food and returns unerringly to her partly excavated nest, and recommences digging after a quick look round. Many such depressions may be dug before the eggs are finally laid, at a depth of 8 cm and the nest covered. Pseudo- nests are always left uncovered and are the result of shallow depressions of varying depth left in the ground. Bellairs (1969), writing on the Bengal monitor, reports it as excavating several additional pits over or near the nest which may have the object of

misleading the predator. Harris (1964) writing on *Agama agama*, expresses the view that 'after spending so much energy on digging,.....the hole may not be used at all'. With a view to throwing some light on this subject, an examination of pseudo-nests was made to find out the following:

a) whether the pseudo-nests dug were ' decoys' to detract attention from the actual nest sites, or

b) whether the sites were unsuitable in any way,

Pseudo-nests and case history notes

The nesting activities of 10 females are given in Table 1. It appears that most attempts at nest construction took place a short distance from the nearest cover, usually in bare soil, exposed to the sun from five or more hours a day. In fact the data obtained for pseudo-nests closely parallels the data for actual field nesting sites, suggesting that some other factor or factors may contribute to the female abandoning the hole or nest site. From the data in Table 1, it appears that in a number of cases

Nest Site	e Measureme	ents (cm; mea	n±SD)							Nest Si	te Requiren	nents (%))					
	Depth	Surface	Distance from pageaget		Cover		Soi	l Moistur	e		Soil Surface			Sub-soil		Shade	S	un
		Diameter	cover	Bare	Low grass	High grass	Dry	Damp	Wet	Loose	Compact	Rocky	Loose	Compact	Rocky		Half day	Full day
Final Nest (<i>n</i> = 10)	8.0±0.52	5.18±0.44	122.1±87.32	40.0	60.0	-	-	100.0	-	-	100.0	-	-	100.0	-	-	20	80
Pseudo-nests $(n = 31)$	2.3±1.99	3.2±1.31	142.2±23.14	61.2	38.7	-	-	100.0	-	6.4	93.5	-	12.9	41.9	45.2	19.3	54.8	25.8

underlying immovable stones or rock, hindered further digging and caused the female to move to another site, and start digging anew. This suggests that these pseudo-nests were just unworkable sites which were abandoned. Yet, on the other hand pseudo-nests were dug and abandoned, in soil that appeared to have all the characteristics of a suitable site. Harris (1964) suggests that the female may experience an 'inward drive' to start digging holes as the time for egg laying approaches, although she may not be ready to lay her eggs.

The following case history reports are observations on female lizards and throw some light on this issue:

Case History 5 (10th March 1971) – A heavily pregnant female was seen to begin digging at 10:30 hr and was kept under observation until 16:30 hr. During this time she dug 7 pseudo-nests.

 Table 1. Analysis of the nest site and site requirements

 of ten adult female A. atricollis.

As they were dug their positions and order of digging were noted on a map of the area. Her nesting activities ceased at this time when the air temperature began to drop and the sky became overcast. It was very windy and finally started to rain. The reaction of the female was to move 2 metres away from the nest site and towards cover provided by a tree where she remained until the rain began to fall. She then disappeared from view. On 11th March 1971, the pseudo-nests were examined again at 07:00 hr. Hole 7 was found to be filled slightly with soil as the sides of the nest

Figure 3. Sequence of nest digging from start to final egg laying. Hatched lines indicate depth of nest and site of final egg laying. Encircled numbers (1-10) depict the case histories of 10 nests between 1970–1973, with depth of nest dug given on the vertical scale, and number of nesting attempts on the horizontal scale.





Figure 4. Nest structure and egg arrangement, showing single layer of eggs as positioned by the female.

collapsed inwards after the showers of the previous night. By 10:00 hr no eggs had been laid and my observations then ceased until about 12:30 hr when the nest site was examined again and hole 7 was found to be completely covered with soil and camouflaged. Seven eggs were found at the bottom of the nest at a depth of 8.5 cm. The 7th hole was obviously the correct depth for egg laying the previous day, and had the environmental conditions not drastically altered she would have undoubtedly laid her eggs between 16:00 and 18:00 hr on 10th March 1971. This implies a postponement of egg laying by 18–20 hours.

	Condition	Number of nests				
		Observed	Pseudo-nests			
Soil Surface:	Loose / disturbed / cultivated	1	2			
	Compact / undisturbed	25	29			
	Hard / rocky	0	0			
Sub-soil:	Loose	1	4			
	Compact	25	13			
	Hard / rocky	0	14			
Soil moisture:	Dry	0	0			
	Damp	25	31			
	Wet / waterlogged	0	0			
Sunshine:	Complete shade	0	6			
	Sun – half day	13	8			
	Sun – fill day	13	17			
Cover:	Bare soil	11	19			
	Scanty / low grass	15	12			
	Moderate - high grass	0	0			
Distance to	< 1 metre	19	13			
nearest cover:	1 – 2 metres	6	10			

Table 2. Characteristics of nest sites.

> 2 metres

Other

Facing away

Facing towards

Direction of nest

entrance from

nearest cover:

Case History 3 (9th August 1973) – On 9th August 1973 a nest hole was discovered in the garden in an area of scattered low grass and bare soil. No pseudo-nests were found and neither was the female seen. The nest was 7 cm deep and 5.5 cm wide. The nest was observed at 12:35 hr. At 15.00 hr the site was examined again and was found to be undisturbed. No other pseudo-nests were found in the area.

On 11th August, at 10:00 hr and again at 12:30 hr the female was observed at the site digging. She proved to be one of my marked lizards. She was extremely wary and retreated into the hedge 3.5 metres away, when she caught site of me. The nest was then 7.5 cm deep. At 15:00 hr the female returned to the nest site and was observed with binoculars until signs of egg laying were evident (see Egg Laying Behaviour, page 20), after which the female made no attempt to escape on closer approach. Data from field notes are given below:

15:22 hr. Nest digging complete. Female enters nest.

15:23 hr. Sinuous posterior body movements alternate with brief rest periods. The mouth open panting posture assumed.

15,30 hr. First egg laid.

15:37 hr. Sixth egg (final egg of clutch).

15:40 hr. Emerges from nest and surveys surroundings.

15:42 hr. Inspects the eggs and prods them.

15:45 hr. Soil pushed back into nest. Packing and camouflage of the nest begins. Uses the forelimbs and sometimes the hind limbs to push soil into the nest.

An estimated postponement of egg laying by 48 hours is indicated in this case and it suggests that females of this species are capable, under adverse environmental conditions of postponing egg laying for much longer. Observations on the digging activities of females in sequence from the start of nest digging (pseudo-nests) to actual egg laying is given in Figure 3.

On three occasions, pregnant females were seen to lay eggs in the first hole dug (Cases 6, 9, and 10 Figure 3). A search for pseudo-nests in the area was unsuccessful. It is possible that the females were more mature and experienced with a good knowledge of the habitat and substrata for egg

20

6

8

	Mean	Distance	(Cover (%	6)	Soil C	ondition (9	6)	Soil	Moistur	e (%)	Shade	Sı	ın
	Depth (cm)	from nearest cover (cm)	Bare	Low grass	High grass	Loose / Cultivated	Compact	Rocky	Dry	Damp	Wet	Whole Day	Half day	Full day
Observed Nests (<i>n</i> = 26)	7.96±0.40 (7.5-9.0)	97.73±67.66	42.3	57.6	-	3.8	96.1	-	-	100.0	-	-	50	50
Pseudo- nests (<i>n</i> = 31)	Varies	142.2	61.2	38.7	-	6.4	93.5	-	-	100.0	-	19.3	54.8	25.8

laying. Perhaps the onset of nest digging and the urge to lay eggs could be associated with different hormonal levels.

Forty-five percent of the pseudo-nests had large stones and underlying rocks which could have hindered digging. Often, the final nest has been dug in the close vicinity of the pseudo-nests (see Fig.). Some females dig a number of pseudo-nests and abandon them. They later return to an earlier pseudo-nest to complete their nest digging and egg laying (see Cases 1 and 2).

Characteristics of nest sites

Nest digging usually begins just after a shower of rain when the soil is moist. Both pseudo-nests and observed nests were examined to determine those factors that might be important in nest site selection (Table 2). This is analysed further in Table 3 and discussed below.

Proximity to nearest cover

86.1 % of the nests examined were less than two metres away from the nearest cover - a hedge, trees, or tall grass, suggesting that either the females or hatchlings are vulnerable to predation. Although there are a number of known natural

Table 3. Analysis of conditions for nest-site selection.Data recorded as mean \pm SD (range).

predators on the adults, predation is not high in this habitat due to the activities and presence of man. On the other hand, mortality rates of hatchlings are very high. It is suggested that proximity of nest sites to areas affording cover is to allow hatchlings to escape predation and possible overheating. The natural shyness of the female and her vulnerability while nest digging are other possible considerations.

Soil conditions

Since both pseudo-nests and the final nest site are constructed in the same general area, females appeared to be consistent in their choice of nest sites. Nintey percent of attempted pseudo-nests and final nests occurred in compact, undisturbed soil. Since nest digging activities commenced soon after the rains, the role of moisture as a factor in nest siting appears significant. Loose soil, while having excellent aeration, has insufficient moisture retention properties. Field observations

 Table 4. Analysis of measurements taken of observed nest sites.

Number of observed	Depth (cm) mean±SD	Width (cm) mean±SD (range)			% ((relat	Drientation ive to cover)
nests	(range)	Mouth / Entrance	Tunnel	Egg Chamber	Facing away	Facing towards	Other
26	7.96±0.46 (7.5–9.0)	7.38±0.83 (6.5–9.0)	5.0±0.40 (4.5–5.8)	6.0±0.33 (5.0–6.0)	76.9	-	23.1



Figure 5. A female pauses during the course of nestdigging to survey her surroundings.



Figure 6. Typical nest-digging posture.



Figure 7. Egg-laying posture of *A. atricollis*. Two eggs are visible in the nest.



Figure 9. Female replacing soil in the nest after egglaying (early stage). Note packing posture.



Figure 8. Panting is shown by female during the course of egg-laying.



Figure 10. Female camouflages the completed nest.

Mature Fema	le (mean ± SD)	Eggs when lai	d (mean ± SD)	Embrionic Stage ¹	Clutch Size (mean)
S-V length (mm)	Weight (g)	Length (cm)	Weight (g)	27 (mean)	7
90-99 ^{2,3} to 120-129 ³	29.30±3.0 to 50.98±7.64	2.00±0.05 (<i>n</i> =78)	1.82±0.21 (<i>n</i> =78)	24-30 (range)	

on the care and packing of the soil by the female into the nest, further stresses the importance of moisture retention by compact soils. Eggs that are in water logged soil quickly develop fungi on them. Fifty percent of the nests were dug in bare soil, the rest between patches of low grass cover. All nests were sited so that they had 5 hours or more of sunshine.

Nest digging (Figures 5 and 6)

Nest construction is performed exclusively by the female. The fore legs are used in turn for excavating a hole, and in pushing away earth which collects at the rim of the hole. The hind limbs are also used in pushing soil away. During the final stages of nest digging (Figure 6) the female's head is well within the nest and the action of the forelimbs is one of scratching and also scooping of the soil out of the nest. During this activity the female frequently stops and surveys the surrounding area. When a sufficient depth has been reached the female enters sideways into the nest. A suitable nest depth appears to be one where her forelimbs and head just extend above the rim of the nest with the hind limbs just touching the bottom (Figure 7).

A pregnant female is extremely wary when on the ground. From the onset of nest digging until just prior to egg laying, the female will retreat at the slightest signs of movement or disturbance. It is only when she enters the nest for the purpose of egg laying that escape tendencies are replaced by guarding and aggressive behaviour.

A vertical section of a typical nest (Figure 4) shows it as a slightly inclined tunnel, approximately 8 cm in depth, with the entrance to the nest wider than the rest of the tunnel and almost circular measuring 6.5–9 cm in diameter. The base of the nest or egg chamber is slightly rounded, being only slightly larger than the diameter of the tunnel. Table 4 shows measurements taken at 26 observed nest sites. **Table 5**. Aspects of egg laying in *A. atricollis* (¹ Dufaure & Hubert, 1961, and ²Reaney & Whiting, 2002; ³Mendes, pers. data). S-V length: 90-99 = minimum size of ovigerous females; 100-119 = size at which females were most prolific in terms of egg production and clutch size; 120-129 = very large females showing a slight decline in clutch size.

The nest is orientated in such a way that its mouth faces away from the direction of nearest cover (Table 4). While digging the female invariably faces the direction of nearest cover. Her digging activities result in one side of the rim of the nest having a more gradual slope than the rest. Consequently, measurements taken at the rim varied.

During egg laying, the female enters the nest, and in a head up position, peers over the rim of the nest, her fore limbs gripping the gently sloping sides. At this time she is facing away from the direction of cover.

This behaviour of the female indicates that during the actual digging of the nest the safety of the female herself is of prime importance, and hence she faces the direction of cover to enable her to make a hasty retreat. During the actual laying of the eggs, the defence of the nest is of prime concern. This defensive attitude is so strong that only rarely will she leave the nest even when approached to within a metre by the observer. This behaviour is totally different from the normally shy and wary behaviour of these animals.

Peak egg laying (Figures 7 and 8)

The correlation of breeding activity in lizards and rainfall has been suggested by a number of workers. Harris (1964), Daniel (1960), Inger & Greenberg (1966) showed that constant egg production was maintained by lizards in a relatively unvaried equatorial climate. At Kisumu there is usually some rain in every month, though this pattern can vary from year to year. During 1972 more then 50 mm of rain fell in eleven months of the year. In 1973 there were only seven months when the rainfall was 50 mm or more. Females with eggs in the oviduct are easily discernible. In the field observations on known territorial females were made to ascertain the times of egg laying. In all cases, nest digging and subsequent egg laying occurred within days after the first rains, following a drier period and also with the cessation of rain following a rainy period. Nineteen egg laying instances were observed in the years 1972–73. In the majority of cases, actual egg laying coincided with the end of the dry season and onset of the rains, or just after the end of the rains

The timing of egg laying in *Agama atricollis* varies from year to year depending on annual variations in rainfall and suggests that the species while potentially capable of egg production all the year is responding to local climatic conditions.

The presence of oviducal eggs only indicates a readiness to lay but the actual egg laying may be postponed until suitable environmental conditions prevail. While the mechanism by which changes in the environment are transmitted to reproductive organs is incompletely understood other evidence supports the view that egg laying is moisturedependent. Egg laying therefore occurs at the onset or end of the rains when the moisture content of the soil is sufficient to allow for nest digging and egg development.

Development stage at egg laying

In order to find out at what stage of development eggs were laid, at least one egg was opened from a newly laid clutch. An entire clutch was also opened to check the stage of development and note differences within a clutch. In every case embryological development had started before the egg was laid. At deposition the embryo was at a slightly advanced stage corresponding to stage 27 of the table of development as defined and illustrated by Defaure & Hubert (1961). In any given clutch all the embryos were in a similar stage of development. However, between clutches the stages of development at egg laying ranged from stage 24 to stage 30, providing further evidence concerning postponement of egg laying or enhancing the case for egg retention.

Egg laying behaviour (Figures 7 and 8)

Egg laying commences after the female has entered the nest .The head juts out of the nest, and the forelimbs are used to grip the rim of the nest. This is the position for egg laying to commence. During egg laying, the mouth opens, and panting alternates with frequent swallowing movements. The tail may be raised or placed to one side. Sinuous movements of the posterior part of the body occur as each egg is laid. The following observations record egg laying in a marked female initially on the 9th August 1973 and continued on 11th August 1973 (See Case 3).

Packing and camouflage of the nest (Figures 9 and 10) Once the eggs have been laid, the female arranges and pack them in the nest using her snout. She then starts to replace the soil using the forelimbs and sometimes the hind limbs to push soil into the nest.

Egg arrangement

Eggs are packed tightly in a single layer in the nest. Generally the eggs lie with their long axis horizontally placed on the floor of the egg chamber-only occasionally is the long axis of the egg in a vertical or obliquely placed position. In no cases have I recorded eggs being one on top of the other or in layers. This single layer arrangement would thus give all the hatchlings equal chances of scrambling out of the nest, which would otherwise be difficult if other eggs above them had not yet hatched. The pliable nature of the egg allows the close fit and packing of the eggs against one another and the walls of the chamber.

At frequent intervals during this packing process, the female puts her head and forelimbs into the nest and proceeds to pack the soil on top of the eggs using her snout and lower jaw. At the same time a rapid packing movement using the forelimbs occurs (Figure 11) which involves scooping soil towards the snout to facilitate packing. Rapid forelimb movements (drumming) compact soil into the nest. The entire body may whirl in a clockwise and anticlockwise movement during this packing process. Packing movements alternate with brief periods of rest and surveying of the surroundings. The female urge to protect her nest is very strong during the filling and packing stages. On the approach of another lizard, the mouth opens and the gular pouch is extended, a characteristic of aggression. If the female is removed and displaced a short distance from her nest, she will on being released immediately returns to her nest site and continues to pack and cover the nest. As the nest is filled the urge to protect the nest wanes and gradually moves further away from the nest site, still scratching away at soil until she returns to her preferred activity site. On completion of nest packing, the female displays no further interest in the nest site.

The Kisumu population of *Agama atricollis* has a mean clutch size of seven. Fitzsimons (1943) in South Africa records a clutch size of 8–14, while Robertson *et al.* (1965) at Lake Rukwa (Tanzania) where the annual climate is characterised by one dry and one wet season, obtained a mean of about eleven eggs per clutch. This wide range of clutch sizes emphasises further the potential reproductive variability of *Agama atricollis* and no doubt accounts for its wide geographic distribution and success. This also supports Tinkle's (1967) contention that small clutch sizes indicate that a species reproduces more often, and that a large clutch size may be indicative of a drop in the number of clutches.

The eggs of Agama atricollis when first laid are creamy white in colour with a pliable and parchment-like shell. The shape of the egg is ovoid with rounded ends. The largest egg recorded from a clutch measured 2 cm long, and 1.2 cm wide when first laid. The mean measurement of eggs from observed nest sites were as follows: length 2.00 ± 0.05 cm. Further aspects of egg-laying are indicated in Table 5.

Gordon (1956) suggested that captive lizards could be induced to oviposit by spraying them with water. Stamp (1976) reported on an experiment that was performed, in which small patches of ground 5m x 5m each, were watered with 5 litres of water and how several lizards (*Anolis aeneus*) came to the watered site and laid eggs. Females in non-watered areas continued to dig holes, but did not lay eggs. Stamp (1976) also noticed that female inserted the tip of the snout into a nest hole site and this occurred during hole digging.

Females appear to sense the moisture content of soil and choose to lay in moist areas. It is possible



Figure 11. Nest-packing movements of A. atricollis.

that during nest digging, periodic probing of the soil in the nest or pseudo-nest allows the female to gauge soil moisture content (Stamp, 1976).

Workers involved in the pet trade are aware that terrarium lizards could be induced to oviposit by spraying the lizards with water (Manthey & Schuster, 1996). It is possible that the pseudo–nests encountered in the field were unsuccessful attempts at finding the right amount of moisture for their eggs to develop. Laying eggs in dry soil led to problems of desiccation. According to Stamp (1976), it is rainfall which induces digging and sensing moisture by snout probing which induces egg laying.

Hatching of agamid eggs in the laboratory in soils of different percentage saturation was attempted after the method of Lewis & Taylor (1967). In soils of 0.5% saturation, all the eggs desiccated within a few days. Excess moisture resulted in the spoilage of the eggs. Hatching success ocurred in soils with percentage saturation of 1-3% saturation (Mendes, pers. obs.).

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REFERENCES

- Bellairs , A. d'A. (1969). *The Life of Reptiles*, Vol. 1&2. London: Weidenfelld and Nicolson.
- Cott, H. B. (1934). The zoological expedition to the Zambezi, 1927, No. 5. *Proc. Zool. Soc. London*.
- Cott, H. B. (1957). *Adaptive Coloration in Animals*. London: Methuen.
- Daniel, P. M. (1960). Growth and cyclic behaviour in the West African lizard, *Agama agama africana*. *Copeia* **1960**, 94–97.
- Dufaure, J. P.. & Hubert, J. (1961). Table de development du lezard vivipare: Lacerta (Zootoca vivipare). Archs. Anat. Microsc. Morph. Exp. 50, 309–28.
- Fitzsimmons, V. (1943). The Lizards of South

Africa. Transvaal Mus. Mem. No. . 528 pp.

- Harris, V. A. (1964). *The Life of the Rainbow Lizard*. Hutchinson Trop. Monograph.
- Inger, R. F. & Greenberg, B. (1966). Annual reproductive patterns of lizards from a Bornean rain forest. *Ecology* **47**, 1007–1021.
- Lewis, T. & Taylor, L. R. (1967). *Introduction* to Experimental Ecology. London: Academic Press Inc.
- Loveridge, A. (1953). Zoological results of a fifth expedition to East Africa, 111. Reptiles from Nyasaland and Tete. *Bull. Mus. Comp. Zool. Harvard* **110**, 143–322.
- McCann, C. (1937). Notes on *Calotes versicolor* (Deudin) Jerdon. *Bombay Nat. Hist. Soc.* **39**, 843–848.
- Manthey, U. & Schuster, N. (1996). *Agamid Lizards*. U.S.A.: T.F.H. Publications Inc.
- Mendes, A. J. (1976). The Ecology and Reproductive Biology of the lizard *Agama atricollis* (Smith, 1849). University of Nairobi, Kenya: Unpublished Ph.D thesis.
- Pratt, D. J., Greenway, P. J. & Gwyne, M. D. (1966). A classification of East African Rangeland, with an appendix on terminology. *J. Appl. Ecol.* **3**, 369–382
- Reaney L. T. & Whiting M. J. (2002). Life on a limb: ecology of the tree agama, *Acanthocercus atricollis atricollis*. J. Zool, London 257, 439–448.
- Robertson, I. A. D., Chapman, B. M. & Chapman, R.E. (1965). Notes on the biology of the lizards *Agama cyanogaster* and *Mabuya striata* collected at Rukwa Valley, S.W. Tanganyika. *Proc. Zool. Soc. London* 145, 305–320.
- Stamps, J. A. (1976). Egg retention, rainfall and egg laying in a tropical lizard, *Anolis aeneus*. *Copeia* **1976**, 759–764.
- Taylor, E. H. (1951). Egg laying behaviour of an oriental agamid lizard. *Herpetologica* **7**, 56–60.
- Tinkle, D.W. (1967). The life and demography of the side blotched lizard *Uta stansburiana*. *Publ. Univ. Michigan*, No. 132.

'Fasting male-feeding female' behaviour in *Bombina orientalis* during amplexus

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ABSTRACT – The feeding and reproductive behaviours of *Bombina orientalis* pairs were observed in captivity for approximately one month. Pairs performed amplexus irrespective of their reproductive states. In reproducing pairs, the males rejected food, but the females ate. This particular sexual dimorphic behaviour is termed 'fasting male-feeding female' (FM-FF), and it contrasts strikingly with the behaviour of non-reproducing amplectic pairs, in which both the male and female continued to feed.

THE term amplexus literally describes a sort of coupling posture by a male and a female, and in amphibians such behaviour is particularly associated with reproduction. The amplexus of amphibians has been extensively studied since the early observations by Spallanzani in 1786 (Aronson & Noble, 1945), chiefly to elucidate triggering factors and underpinning neurological mechanisms. Very few studies have examined amplexus in the context of its association with feeding behaviour.

Savage (1932) first noticed females' active feeding during amplexus in the discoglossid frog Bombina variegata, although he did not mention instances of feeding by amplectant males. Later, Birkenmeier (1954) clarified the presence of two kinds of amplexi in *B. variegata* and *B. bombina*: the real (echt) amplexus, and the false (scheinbar) amplexus. The real amplexus is restricted to the reproductive season (spring) and the amplectic female actively swims around without leaving the water, or trying to free herself from the male. The amplextant male remains on the female's back without attempting to feed (Birkenmeier, 1954). The false amplexus takes place any time during the remaining seasons (from summer to winter). The amplectic female swims sluggishly, trying to get out of the water and free herself from the male. Eating and male-avoidance are reported to be common in females involved in this type of amplexus (Birkenmeier, 1954).

In this and other studies, however, no systematic descriptions were made on the occurrence of feeding behaviour in both sexes and for the two kinds of amplexi. We here describe these issues on the basis of captive observations. In November and December (spring in the Southern Hemisphere) five pairs of adult males and females of *B. orientalis* were housed in individual aquaria. Each of these frogs had been kept under room conditions, and fed a standard diet of insects. Each aquarium was a glass cube of 0.4 m-side with an open top, and was filled with 0.1 m depth of tap water; its bottom was covered with a layer of gravel. A piece of tree bark and a few aquatic plants were placed on the gravel.

During the study period (28–29 days) water temperature was 22°C during the day and 19°C at night. Food items consisted of live insects, *Tenebrio, Zophobas*, or *Acheta*, offered with tweezers daily to each individual frog at ca. 15:00 hr during 28 or 29 consecutive days, except on weekends and holidays. On every occasion, the frogs were persistently stimulated to eat, until they rejected the offered insects.

We recorded the following data: (a) the number of feeding occurrences in each individual; (b) the number of individual insects consumed by each frog at each feeding; and (c) the number of eggs laid by the female of each pair during the observational period. Statistical significances in observed differences were tested using Mann-Whitney Utest. Type I error probability was set at 0.05.

After about 5 to 10 minutes of being housed with a female in an aquarium, each male clasped the female by its groin with his forelimbs, thus initiating amplexus (inguinal). This lasted almost throughout the entire observation period. Occasionally, however, the female freed herself from the male's grip for relatively brief periods. On such occasions, both the male and the female either alternately approached or withdrew from each other; otherwise the male clamped the female between his forelegs. This free-state of a pair ended when the male was in close proximity to the female and carried out two sequentially linked actions: (a) rejection of food (b) resumption of amplexus with the female.

The females of four pairs (CII-CV) laid 171–423 eggs during the observation period (Table 1); we refer to these as 'fertile pairs'. During amplexus in these fertile pairs, males invariably firmly pressed their jaws against the females' backs. Bodies of the males were curved in such a way as to locate their cloacae close to the female's cloacae. Males of these fertile pairs consistently rejected the insects offered during the amplexus. In contrast, females readily accepted and ate insects ad libitum every time they were offered to her.

When the fertile pairs (except pair III) were not in amplexus – between 1 to 3 days during the 29 days of observation – both males and females ate the offered insects, and no statistically significant difference due to sex was found in terms of the number of insects eaten (Table 1). The number of insects consumed per feeding event by non-

Table 1. Frequency of feeding occurrences, number of insects eaten, and number of eggs laid in *Bombina orientalis* couples either out of or in amplexus. CI: infertile pair; CII-CV: fertile pair. * = number of times insects were accepted by a frog.

amplectant females was not statistically different from the number of insects consumed per feeding event by amplectant females.

The female of pair 1 did not lay eggs. At variance with the other pairs, the male's body was in a rather horizontal position, being away from the female's body. The male's head did not seem to be pressed firmly against the dorsum of the female.

A week after the beginning of observations, the clasping male of this pair showed an unusual form of behaviour when offered with food: although the male initially avoided insects by pushing them away (using its hindlimbs and/or swimming away), it started to accept them after persistent stimulation (as performed with all males) to accept them. When the male accepted an insect, the female could easily free herself from him; however when the male clasped the female again, he started to reject any food offered to him. From that day on, the male in amplexus ate about one insect every second day until the end of the observational period. The day when the male was out of amplexus he ate one insect, whilst the female ate two.

Although amplectic clasping is necessary for reproduction in most anurans it is not essential, because the false amplexus illustrates the case of the physical embracing of male and female without reproduction.

Pair	Length of observation period (days)			Pair bel	haviour			Total number of laid eggs
		Out o	of amplexi	IS	In	amplexus		- Cggs
		Feeding occurrences*	Number ea	of insects of insects	Feeding occurrences*	Number ea	of insects ten	
		•	male	female	-	male	female	-
				Fertile pairs	<u>8</u>			
C II	29	3	7	13	15	0	67	423
C III	29	-	-	-	16	0	67	384
C IV	29	2	5	4	14	0	41	148
C V	29	1	5	6	11	0	59	171
Х		1.5	4.3	5.8	14.0	0.0	58.5	281.5
SE		0.65	1.49	2.72	1.1	0.00	6.1	71.0
				Infertile pair	<u>rs</u>			
CI	28	1	1	2	10	17	57	0

Despite the low number of frog pairs observed, they show the two kinds of amplexus previously described by Birkenmeier (1954) for *B. bombina*. One is the real amplexus, in which the male firmly grasps the female whatever the kind of stimuli is given to him to free her, and results in ovulation and fertilization. The other is the false amplexus, in which the male releases his grasp on the female when he is stimulated to eat, and no eggs are produced by the female.

Real amplexus in *B. orientalis* is characterised by a reproducing pair in which the male fasts and the female eats. This fasting behaviour of the male seems to be constitutive of the phenomenon because males reject food during the amplexus stage, even when they had been fasting for one whole month (observed in pair III). We propose to call this behaviour 'fasting male-feeding female' (FM-FF), which, when demonstrated by an amplectant pair, is indicative of their reproductive state.

One may wonder what the proximal and ultimate factors are compelling the amplectic male to abstaining from taking food. There are two factors among many possible ones that may explain such behaviour: (a) stress provoked by retaining a firm grasp on the female in order to defend her from other males which presumably would take his position if given the opportunity to do so; (b) Mechanical hindrance to mouth opening due to the firm pressing of his head against the female's back during ovulation.

The fact that the female does not discontinue feeding during the reproductive period could possibly be to offset the expenditure of energy for gametogenesis, which in females is much greater than in males, as found in many reptile species (Bonnet *et al.*, 2001, Aubret & Bonnet, 2002, Schneider *et al.*, 2002, Lagarde *et al.*, 2003). In natural conditions egg-laying in *B. orientalis* takes place many times during a single reproductive season (spring and summer: Kawamura *et al.*, 1972). For this reason, the false amplexus during the reproductive period in the couple CI would be an exceptional event, that deserves to be studied with particular detail.

There are no other published reports of FM-FF in Amphibia. However, one of us (ITM) also observed this behaviour in the leptodactylid frog *Ceratophrys ornata* in captivity. Behaviour analogous to the FM-FF was reported for the rat. In this mammal the presence of a receptive female inhibited food intake in males, but not their sexual behaviour. The latter was neither affected by the offer of food (Saito *et al.*, 1999). In the light of the similarity between proteins and hormones on the one hand, and of the general mechanisms of organic functions in vertebrates on the other hand, the FM-FF behaviour in *Bombina orientalis* seems to be a suitable experimental model for the investigation of the complex linkages between feeding behavior and the liberation of sexual hormones in higher vertebrates.

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REFERENCES

- Aronson, L. R. & Noble, G. K. (1945). The sexual behavior of Anura. *Bull. Amer. Mus. Nat. Hist.* 86, 86–139.
- Aubret, F. & Bonnet, X. (2002). Fat is sexy for females but not males: The influence of body reserves on reproduction in snakes (*Vipera aspis*). *Horm. Behav.* 42, 135–147.
- Birkenmeier, E. (1954). Beobachtungen zur Nahrungsaufnahme und Paarungsbiologie der Gattung *Bombina. Verh. Zool. Ges.*, Wien **94**, 70–81.
- Bonnet, X., Naulleau, G., Shine, R. & Lourdais, O. (2001). Short term versus long term effects of food intake on reproductive output in a viviparous snake, *Vipera aspis. Oikos* 92, 297–308.
- Kawamura, T. Nishioka, M. & Ueda, H. (1972). Reproduction of the oriental fire-bellied toad, *Bombina orientalis*, with special reference to the superiority of this species as a laboratory animal. *Sci. Rep. Lab. Amphibian Biol., Hiroshima Univ.* **1**, 303–317.
- Lagarde, F., Bonnet, X., Henen, B., Corbin, N. J. Lacroix, A. & Trouve, C. (2003). Plasma steroid and nutrient levels during the active season in wild *Testudo horsfieldi. Gen. Comp. Endocrinol.* 134, 139–146.
- Saito, T. R., Moritani, N., Hashimoto, H., Arkin, A. & Takahashi, K. W. (1999). Simultaneous observation of ingestive and copulatory behavior of the male rat. *Ex. Anim.* **48**, 285–288.
- Savage, R. M. (1932). The spawning, voice and sexual behaviour of *Bombina variegata variegata*. *Proc. Zool. Soc. London* 3, 889–898.
- Schneider, J. E., Buckley, C. A., Blum, R. M., Zhou, D., Szymanski, L., Day, D. E. & Bartness, T. J. (2003). Metabolic signals, hormones and neuropeptides involved in control of energy balance and reproductive success in hamsters. *Eur. J. Neurosc.* 16, 377–379.

Reproductive cycle of the Striped legless skink, *Typhlosaurus lineatus* (Squamata: Scincidae) from Southern Africa

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THE Striped legless skink, Typhlosaurus *L lineatus* occurs in the Kalahari region of southern Africa extending from the Northern Cape Province through most of Botswana and adjacent Namibia with isolated races in western Zambia and the Limpopo Province of South Africa (Broadley, 1968). They are common in heaps of wind-blown sand, at the base of grass tufts and bushes and desert dune streets and sand ridges (Branch, 1998). Typhlosaurus lineatus is fossorial and viviparous (Huey et al., 1974). Information on the reproductive biology of T. lineatus is in Huey et al. (1974). Anecdotal information reproduction is in Broadley (1968) and a mean brood size is in Pianka (1986). The purpose of this note is to add additional information on the reproductive biology of T. lineatus from a histological examination of museum specimens.

METHODS

One-hundred and thirty three T. lineatus (82 females, mean snout-vent length, SVL = 133 mm \pm 7 SD, range = 116–149 mm; 51 males, SVL = 129 mm \pm 9 SD, range = 103–148 mm from southern Africa were examined from the herpetology collection of the Natural History Museum of Los Angeles County, LACM, Los Angeles, California (Appendix). Lizards were collected by Eric R. Pianka during 1969-1970. Gonads were dehydrated in ethanol, embedded in paraffin, sectioned at 5µm and stained with Harris hematoxylin followed by eosin counterstain. Enlarged ovarian follicles (> 5 mm length) were counted; no histology was done on them. Male and female mean body sizes (SVL) were compared with an unpaired t test using Instat (vers. 3.0b, Graphpad Software, San Diego, CA).

RESULTS AND DISCUSSION

Data on the testicular cycle is presented in Table 1. Typhlosaurus lineatus males follow a distinctly seasonal testicular cycle where spermiogenesis (sperm formation; seminiferous tubles lined by several rows of metamorphosing spermatids and/or spermatozoa) occurs in spring. Epididymides contained sperm. The exact duration of the period of spermiogenesis is unknown since no specimens from October were examined. All males from November-December contained regressed testes in which the seminiferous tubules contained spermatogonia and occasional primary spermatocytes. Testicular recrudescence in which there is a proliferation of germ cells in the seminiferous tubules (primary, secondary spermatocytes, spermatids) begins in summer and is completed by spring (Table 1). The smallest reproductively active male (spermiogenesis in progress) measured 103 mm SVL and was from August (LACM 83833). This is smaller than the estimate of 112 mm SVL in Huev et al. (1974).

Huey et al. (1974) plotted seasonal testicular volumes for T. lineatus and reported testes began enlarging in mid-autumn and reached maximum sizes in late winter; testicular regression was completed by mid-summer. My histological analyses support their morphological data. Mating is thought to occur in August and September (Huey et al., 1974). The timing of the testicular cycles of T. lineatus and Typhlosaurus gariepensis are similar (Huey et al., 1974). The testicular cycle of T. lineatus with distinct periods of regression and recrudescence differs markedly from those of two other species of African skinks, Mabuya quinquetaeniata (= Trachylepis margaritifera) and Mabuya striata (= Trachylepis wahlbergii) from Zambia in which spermiogenesis was continuous (Simbotwe, 1980).

Month	Ν	Regression	Recrudescence	Spermiogenesis
February	1	0	1	0
April	1	0	1	0
May	10	0	10	0
July	13	0	10	3
August	5	0	0	5
September	9	0	2	7
November	6	6	0	0
December	6	6	0	0

Table 1. Monthly conditions in the testicular cycle of51 Typhlosaurus lineatus from southern Africa.

Females were significantly larger than males (unpaired t test, t = 3.1, df = 131, P = 0.003). Monthly stages in the ovarian cycle of T. lineatus are in Table 2. Females with oviductal eggs or developing young were found between September and February. Females with enlarging follicles (> 5 mm length) occurred in June, September and from November to December (Table 2). Mean clutch (= brood) size for 60 gravid females was 1.3 \pm 0.45 SD, range: 1–2. This is close to the 1.5 \pm 0.1 SD value for 90 T. lineatus in Pianka (1986). The smallest reproductively active female measured 117 mm SVL (LACM 84256) and was collected in December 1969. This is slightly smaller than the value of 123 mm SVL for the smallest reproductively active female in Huey et al.

Table 2. Stages in seasonal ovarian cycle of 82*Typhlosaurus lineatus* from southern Africa.

(1974). Branch (1998) reported 1–2 babies were born mid-January through early March after a gestation period of five months. There was a report of two gravid female *T. lineatus* from Twee Rivieren, Kalahari Gemsbok Park, collected on 20th February (Brain,

1959) but they were subsequently found to be specimens of *T. gariepensis* which both contained a single young (Broadley, 1968). By having parturition occur in summer, young are presumably assured a plentiful supply of termites which are their major food source (Huey *et al.*, 1974). Female *Typhlosaurus* produce one litter per year (Huey *et al.*, 1974). The small litter size (1–2, very rarely 3; see Broadley, 1968) of *T. lineatus* is likely the result of space constraints of the narrow body width of this species which is needed for a fossorial life.

Branch (1998) lists nine species in the genus *Typhlosaurus* but gives reproductive information on only three of them: *T. gariepensis, T. lineatus* and a report of three eggs and presumed viviparity in *Typhlosaurus vermis.* Subsequent studies on reproduction in other species of *Typhlosaurus* will be needed to ascertain whether the reproductive pattern shown by *T. lineatus* and *T. gariepensis* (testicular cycle with spring spermiogenesis, summer regression; ovarian cycle with 5 mo

Month	Ν	Inactive	Early yolk deposition	Enlarging follicles > 5 mm length	Oviductal eggs
January	4	0	0	0	4
February	3	2	0	0	1
May	3	2	1	0	0
June	4	2	1	1	0
July	7	6	1	0	0
August	1	1	0	0	0
September	7	0	3	2	2
October	1	0	0	0	1
November	15	1	0	6	8
December	37	2	0	3	32

gestation period and young born in summer) is shared by other species.

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REFERENCES

- Brain, C. K. (1959). Note on the breeding of the South African skink, *Typhlosaurus lineatus* Boulenger. *Copeia* **1959**, 70–71.
- Branch, B. (1998). Field Guide to Snakes and other Reptiles of Southern Africa. 3rd edn. Sanibel Island, Florida: Ralph Curtis Books. 399 pp.
- Broadley, D. G. (1968). A revision of the African genus *Typhlosaurus* Wiegmann (Sauria: Scincidae). *Arnoldia* (Rhodesia) **3** No. 36, 1–20.
- Huey, R. B., Pianka, E. R., Egan, M. E. & Coons,
 L. W. (1974). Ecological shifts in sympatry:
 Kalahari fossorial lizards (*Typhlosaurus*). *Ecology* 55, 304–316.
- Pianka, E. R. (1986). Ecology and Natural History of Desert Lizards. Analyses of the Ecological Niche and Community Structure. Princeton, New Jersey: Princeton University Press. 208 pp.
- Simbotwe, M. P. (1980). Reproductive biology of the skinks *Mabuya striata* and *Mabuya quinquetaeniata* in Zambia. *Herpetologica* **36**, 99–104.

Appendix

Specimens of *Typhlosaurus lineatus* from southern Africa examined from the Natural History Museum of Los Angeles County (LACM): BOTSWANA, Kgalagadi District, 11 km S Tsabong, 26°08'S, 22°28'E, LACM 83792, 83815-6, 83825, 83833, 83835-6, 83842-4, 83760, 83765, 83770, 83774; Kgalagadi District, 9 km N, 11 km E, Twee Rivieren, 26°23'S, 20°43'E, LACM 83867, 83881, 83900, 83905, 83918, 83921, 83932, 83936-7, 83942-4, 83947, 83949, 83951-3, 83957, 83960, 83969, 83975; Kgalagadi District, 131 km N Tsabong, 25°32'S, 22°18'E, LACM 84001, 84005-6, 84011; Kgalagadi District, 80 km S. Tsane, 21°90'S, 24°03E, LACM 84382-3, 84392, 84397, 84405, 84409, 84410-1, 84414, 84428, 84436, 84441, 84445, 84451-3, 84455, 84465-6, 84469, 84471; Kgalagadi District, Mabuasehube Pan, 24°90'S, 22°00'E, LACM 84201, 84205, 84210, 84214-5, 84219, 84222, 84225-6, 84230, 84241, 84252, 84256, 84265, 84267, 84269, 84275-6, 84279-80, 84287, 84290, 84299-300, 84302, 84305, 84310, 84314, 84318, 84320, 84330-3, 84336, 84342, 84354, 84358, 84361, 84364, 84369, 84371. NAMIBIA: Karas Region, 28 km N, 20 km E Aroab, 26°35'S, 19°50'E, LACM 84015; Karas Region, 46 km N, 17 km E Aroab, 26°22'S, 19°49'E, LACM 83723, 83742: REPUBLIC OF SOUTH AFRICA. Northern Cape Province, 18 km S, 22 km E Witkoms, 27°58'S, 21°32'E, LACM 83756; Northern Cape Province, 29 km S, 40 km E. Rietfontein, 27°00'S, 20°27'E, LACM 92456, 92461, 92464; Northern Cape Province, 120 km N, 54 km W Upington, 27°22'S, 20°43'E, LACM 83621, 83626, 83631, 83635-7; Northern Cape Province, 121 km N, 16 km E Upington, 27°22'S, 21°25'E, LACM 92481, 92483-4, 92491, 92500, 92503, 92508; Northern Cape Province, Kalahari-Gemsbok National Park, 26°26'S, 20°37'E, LACM 83753; Northern Cape Province, Kalahari-Gemsbok National Park, 25°45'S, 20°44'E, LACM 83668, 83674, 83685, 83696, 83701, 83703, 83708, 83710-11, 83719.

A partially neotenous Great crested newt, Triturus cristatus

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NEOTENY (or paedomorphosis) refers to the retention of juvenile features into sexual maturity (e.g. Smith, 1964; Beebee & Griffiths, 2000; Pough et al., 2004). It can occur in Palmate, Smooth and Great crested newts, although it is an unusual condition in these species (e.g. Smith, 1950; Smith 1964; Dolmen, 1980; Banks, 1985). Neoteny encompasses a range of forms, including larvae that grow to adult size and otherwise normal-looking adults with gills, and it includes individuals lacking in pigmentation (Beebee & Griffiths, 2000). Among the three newt species that occur in Britain, neoteny seems to occur least frequently in the Great crested newt. It has been observed in this species in continental Europe (e.g. Dolmen, 1980), but neotenous Great crested newts do not seem to have been recorded in Britain (Smith, 1950; Smith, 1964; Beebee & Griffiths, 2000).

The current note describes a pale coloured, neotenous Great crested newt. As it is not fully grown, it is unlikely to be sexually mature. Hence it may be better described as an example of partial neoteny, a term used by Smith (1964) to refer to the prolongation of the larval state, even though sexual maturity is not achieved. Smith (1964) notes that partial neoteny is known in all the British species of newts, but he does not cite specific instances of its occurrence in the Great crested newt and it seems sufficiently unusual to merit reporting.

A single specimen was found during the course of monitoring ponds as part of a legally authorised (licenced by the Department for Environment, Food and Rural Affairs) development mitigation scheme. The specimen was found in a pond in Norfolk (TM 19 99). The site is a well-vegetated, shallow pond, which was approaching complete desiccation when the specimen was discovered (31 August 2005). The larva was captured while netting a small pool of remaining water, which contained many Smooth newt larvae. Normally coloured Great crested newt larvae were found earlier in the year, but these were assumed either to have completed metamorphosis and left the pond by the time of the survey visit in question, or to have been stranded and killed as other parts of the pond dried.

The partially neotenous specimen was the size to be expected of a normal Great crested newt larva in the later stages of development (approximately 55 mm total length). However, it was unusually coloured, being almost entirely devoid of dark pigmentation. There were a few black spots on the dorsal surfaces, primarily of the tail, but also the body. The tail fin was heavily spotted, as in normally developing Great crested newt larvae. Most of the body was devoid of other pigmentation except for pale yellow areas, primarily dorsally, but also on the lower edge of the tail. The eyes were normally coloured, so that the specimen is more accurately described as leucistic rather than albino (the latter has pink eyes). Similar coloration among other neotenous specimens has been described in Smith's 1964 publication which contains a photograph of such a neotenous Smooth newt.

Neoteny in newts is sometimes regarded as a response to specific environmental conditions, especially cool environments and where escape from the water may be difficult (Smith, 1964; Banks, 1985). However, neoteny can also occur in situations where it is regarded as a developmental aberrance. As both the process of metamorphosis and the development of pigmentation are controlled by the pituitary gland, then pale or albino neotenes may be the result of a malfunction in pituitary action (Beebee & Griffiths, 2000). Since the currently described individual originated from a temporary pond, it seems unlikely that neoteny would confer any advantage. In fact, the animal would have died as its pond dried. Hence, it seems that this specimen is an example of a failure of pituitary action.





Figure 1 (above). Partially neotenous Great crested newt, approximately four months old.

Figure 2 (centre). Partially neotenous Great crested newt, one year old.

Figure 3 (left). Close-up of head, at one year old.

The newt was removed from the pond and maintained in captivity (under licence from English Nature) to observe its further development. At just over one year old, it measured approximately 80mm long. Curiously, the largest right-hand gill, which was absent at the time of capture, had not regenerated during ten months in captivity (newt larvae normally show considerable regenerative powers). The black spotting had increased on the head, flanks and tail, but the animal had shown no signs of transformation into the normal postmetamorphic form. The extent of further development of dark pigmentation remains to be seen. Smith (1950) observed that pale neotenous specimens (either Smooth or Palmate newts) were small, whereas adult sized neotenous animals were normally coloured, which is consistent with increasing pigmentation as individuals grow. Whether this animal attains sexual maturity in its current form – hence becoming fully neotenous – also remains to be seen.

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REFERENCES

- Banks, B. (1985). Observations on neoteny in the smooth newt. *Brit. Herpetol. Soc. Bull.* 12, 37–38.
- Beebee, T. J. C. & Griffiths, R. A. (2000). Amphibians and Reptiles. A Natural History of the British Herpetofauna. London: The New Naturalist Library, HarperCollins.
- Dolmen, D. (1980). Distribution and habitat of the smooth newt, *Triturus vulgaris* (L.), and the warty newt, *T. cristatus* (Laurenti), in Norway. In: *Proceedings European Herpetological Symposium*, pp. 127–139. Coburn, J. (Ed.). Oxford: Cotswold Wildlife Park.
- Pough, F. H., Andrews, R. M., Cadle, J. E., Crump, M. L., Savitsky, A. H. & Wells, K. D. (2004). *Herpetology*. 3rd edn. Upper Saddle River: Pearson Prentice Hall.
- Smith, M (1950). Neoteny in British newts. *Brit. J. Herpetol.* **1**, 91–92.
- Smith, M. (1964). *The British Amphibians and Reptiles*. 3rd edn. London: Collins.

A review of the records of the Sand boa (Eryx jaculus) in Romania

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ABSTRACT – An account of the records of the Sand boa (*Eryx jaculus*) in Romania is presented, together with a review of the relevant literature. Preserved specimens in the collection of the "Grigore Antipa" National Museum of Natural History, in Bucarest (MGAB) and Museum of the Martin-Luther University Halle-Wittenberg (IZH) are listed. The distribution of *Eryx jaculus* and its conservation status in Romania is discussed.

THE Sand boa (*Eryx jaculus*) is one of the rarest reptiles within the European herpetofauna. It is distributed on the continent only in extreme southern Albania, Macedonia, Greece, on many Aegean islands (especially the Cyclades), in southeastern Romania, southern Bulgaria, as well as in Turkey (Tokar & Obst, 1993). Its occurrence in

Romania, as well as the existence of preserved individuals housed in museum collections, is scarcely known. The purpose of this short note is to give an account of the records from the literature, the specimens in museum collections, to comment on the distribution of the species in Romania, and to discuss its conservation status.



Figure 1. Records of *Eryx jaculus* in Romania (1-Cernavodă, 2-Cãrpiniș-Giuvegea, 3-Cochirleni, 4-Mahmudia).

Locality records

The species occurrence in southeastern areas of Romania, namely Dobrogea, without citing precise locality records, was mentioned several times in the herpetological literature (Schreiber, 1912; Călinescu, 1931; Mertens, 1923; Mertens & Müller, 1940; Mertens & Wermuth, 1960). One individual was collected at Cernavodă, Constanța District, in 1903 by R. Dombrowski and described in detail by Kiritescu (1903). This record was later adopted by Kiritescu (1930), Călinescu (1931), Fuhn & Vancea (1961), Fuhn (1969), Vasiliu & Sova (1968), Otel (1992), Kotenko et al. (1993) and Tokar & Obst (1993). The individual is housed in the Herpetological collection of the "Grigore Antipa" National Museum of Natural History, in Bucarest (MGAB 7944; adult female; total length 455 mm; discoloured; leg. Dombrowski R. 1903; det. Kiritescu). The habitat was destroyed by the construction of the Danube-Black Sea Channel (Iftime, 2001; G. Negrean, pers. comm.).

In the same year, 1903, Dombrowski collected four specimens at the village of Cărpiniș-Giuvegea, Constanța District. These were also described by Kiritescu (1903). His record was adopted by Kirițescu (1930), Cãlinescu (1931), Fuhn & Vancea (1961), Fuhn (1969), Vasiliu & Şova (1968), Otel (1992) and Kotenko et al. (1993). Of these four specimens only two are still present (MGAB 7945; juvenile male; total length 330 mm; discoloured; leg. Dombrowski R. 1903; det. Kiritescu; and MGAB 600015; adult male; total length 480 mm: eviscerated; leg. Dombrowski det. R. 1903; Kiritescu). Nowadays Cărpiniș-Giuvegea is part of the town of Băneasa, consequently this population is also probably now extinct.

Some individuals have been found at the village of Cochirleni, Constanța District (Bãcescu, 1941). One specimen was illustrated by Fuhn (1964, 1969) and Fuhn & Vancea (1961), and the record was quoted as: M. Băcescu, pers. comm. The record was adopted by Vasiliu & Sova (1968), Otel (1992) and Kotenko et al. (1993). Three specimens from Cochirleni have been conserved and are housed in the Herpetological collection of the "Grigore Antipa" National Museum of Natural History, in Bucarest: MGAB 7220; adult male; total length 370 mm; leg., det. et don. M. Băcescu; MGAB 600016; adult female; total length 400 mm; eviscerated and deteriorated; leg., det. et don. M. Băcescu 1935, and MGAB 500841; adult male; total length 400 mm; very well preserved; leg. et don. N. Gavrilescu August 1934, det. M. Băcescu. The last mentioned specimen was depicted in the works by Fuhn (1964, 1969) and Fuhn & Vancea (1961).

The most recent known specimen was found in 1986 between the villages of Bestepe and Mahmudia, in Tulcea District (Zinke & Hielscher, 1990). It was an adult, 526 mm long, female with eight embryos found dead on a road. The record was adopted by Kotenko *et al.* (1993), Tokar & Obst (1993) and Iftime (2001). The individual is now preserved in the scientific zoological collection of the Museum of the Martin-Luther University Halle-Wittenberg (IZH). Collection data: IZH R-993; Mahmudia, Rajon Tulcea, Romania; leg. et don. Olaf Zinke, 31st July 1986. This was the northernmost record of the species in Europe.

Tokar & Obst (1993) mentioned the species occurrence at Constanta, with reference to Călinescu's 1931 work, but this was merely a misinterpretation of the almost incomprehensible table containing the locality records from this work. Buresch & Zonkow (1934) erroneously marked one locality at the Black Sea side on the map 18 found on page 123 of their work. Vaucher (1975) mentions observing one dead specimen in advanced decomposition at Letea forest, Danube Delta, a record which was not later adopted by subsequent workers; given the circumstances, and the lack of verifiable evidence (the specimen, a photograph) it may likely have been erroneous. The position of the locality records presented above is shown in Figure 1.

Conservation status

Fuhn (1964) drew attention to the necessity of the conservation of the species, and argued that as soon as a locality is found where it may occur in any density, this should be protected as a natural reserve. Also, according to Appendix II of the Bern Convention (Law No. 13/1993) *Eryx jaculus* is a strictly protected species in Romania. Furthermore, it is nominated by the Law 462/2001 (Protected areas and wildlife conservation law) as a species which needs strict protection, by CITES (Annex II) and by EU Habitat and Species Directive, Annex IV (strictly protected).

Cogălniceanu & Venczel (1993) and Gasc *et al.* (1997) considered *Eryx* probably extinct from the country, while Iftime (2001) deemed it to be critically endangered or possibly extinct. It is also included in the Romanian Red Data Book of Vertebrates as critically endangered (Iftime, 2005). Possible threats for the species are urbanization, traffic, expansion of agricultural fields, and pesticide poisoning. As mentioned above, one of the habitats has already been destroyed by the building of the Danube-Black Sea Channel, while another is now a part of an urban area.

The present distribution of *Eryx* in Romania is not known, and further surveys have to be carried out at its known localities, and also in the entire area of Dobrogea. There is a lack of thorough surveys in the area, thus the species may have survived until the present anywhere in the Dobrogea region (with the exception of the Danube-delta). This possibility is further endorsed by the 'recent' observation of Zinke & Hielscher (1990).

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REFERENCES

- Băcescu, M. (1941). Năpârca. Ce animale înțelege poporul prin acest cuvânt? *Natura* **30**, 97–104 [in Romanian].
- Buresch, Iw. & Zonkow, J. (1934). Untersuchungen über die Verbreitung der Reptilien und Amphibien in Bulgarien und auf er Balkanhalbinsel. *Mitt. Kgl. Naturw. Inst. Sofia* **7**, 106–188.
- Călinescu, R.I. (1931). Contribuțiuni sistematice și zoogeografice la studiul amphibiilor și reptilelor din România. *Mem. Sect. Știint. Acad. Rom. Seria III* **7**, 119–291 [in Romanian].
- Cogălniceanu, D., Venczel, M. (1993). Considerații privind ocrotirea și conservarea populațiilor de amfibieni și reptile. *Ocrot. Nat. med. înconj.* **37**, 109–114 [in Romanian].
- Fuhn, I. E. (1964). Situația actuală a faunei noastre de Amfibii şi Reptile şi ocrotirea ei. Ocrot. Nat. 8, 231–248 [In Romanian].
- Fuhn, I.E. (1969). *Broaște, șerpi, șopîrle*. București: Ed. Natura și Omul. 246 pp [In Romanian].
- Fuhn, I.E. & Vancea, Şt. (1961). *Reptilia (Testoase, Şopîrle, Şerpi)*. In: *Fauna RPR*. Vol. 14(2). Bucureşti: Edit. Academiei RPR. 338 pp. [in Romanian].
- Gasc, J.-P., Cabela, A., Crnobrnja-Isailovic, J., Dolmen, D., Grossenbacher, K., Haffner, P., Lescure, J., Martens, H., Martínez-Rica, J.P., Maurin, H., Oliveira, M.E., Sofianidou, T.S., Veith, M. & Zuiderwijk, A. (Eds.) (1997). Atlas of Amphibians and Reptiles in Europe.

Paris: Societas Europaea Herpetologica Muséum National d'Historie Naturelle (IEGB/SPN). 496 pp.

- Iftime, A. (2001). Lista roșie comentată a amfibienilor și reptilelor din România. *Ocrot. Nat. med. înconj.* **44-45**, 39–49 [in Romanian].
- Iftime, A. (2005). Reptile. In: *Cartea Roşie a vertebratelor României*, pp. 173–196. Botnariuc, N. & Tatole, V. (Eds.). Bucureşti: ed. Curtea Veche. [in Romanian].
- Kirițescu, C. (1903). Sur la présence d'*Eryx jaculus* en Roumanie. *Bull. Soc. Sci. Bucarest* **11**, 620–626.
- Kiriţescu, C. (1930). Cercetări asupra faunei herpetologice a României. Bucuresti: Cartea Românească. 117 pp.+2 Pls. [in Romanian].
- Kotenko, T., Otel, V. & Fedorchenko, A. (1993). Herpetological investigations in the Danube Delta Biosphere Reserve in 1992. *Anal. Știint. Inst. Delta Dunării*, pp. 99–107.
- Mertens, R. (1923). Beiträge zur Herpetologie Rumäniens. *Senckenbergiana* **5**, 207-227.
- Mertens, R. & Müller, L. (1940). Die Amphibien und Reptilien Europas. (Zweite Liste, nach dem Stand vom 1. Januar 1940). *Abh. Senck. Naturf. Ges.* 451, 1–56.
- Mertens, R. & Wermuth, H. (1960). *Die Amphibien und Reptilien Europas*. (*Dritte Liste*,

nach dem Stand vom 1. Januar 1960). Frankfurt am Main: Verlag Waldemar Kramer. 264 pp.

- Otel, V. (1992). Investigații herpetologice în Rezervația Biosferei Delta Dunării (RBDD) în anul 1991. *Anal. Știint. Inst. Delta Dunării* pp. 159–162 [in Romanian].
- Schreiber, E. (1912). Herpetologia europaea. Eine systematische Bearbeitung der Amphibien und Reptilien welche bisher in Europa aufgefunden sind. Jena: Verlag von Gustav Fischer. v-x+960 pp.
- Tokar, A.A. & Obst, F.J. (1993). Eryx jaculus (LINNAEUS, 1758) – Westliche Sandboa. In: Handbuch der Reptilien und Amphibien Europas. Band 3/1. Schlangen (Serpentes) I. (Typhlopidae, Boidae, Colubridae 1: Colubrinae), pp. 35–53. Böhme, W. (Ed.). Wiesbaden: Aula.
- Vasiliu, G.D. & Şova, C. (1968). Fauna Vertebratica Romaniae. *St. Com. Muz. Jud. Bacău Secţ. Ştiinţ. Nat.* II, 296 pp. [in Romanian].
- Vaucher, Ch. (1975). Notes sur les vertebres et les milieux du Delta du Danube et de la Dobroudja. Raport. Geneve: Privately edited. 55 pp.
- Zinke, O. & Hielscher, K. (1990). Nachweis der Westlichen Sandboa (*Eryx jaculus turcicus* [Olivier]) in Rumänien (Reptilia, Serpentes: Boidae). *Faun. Abhandl. Staatl. Mus. Tierk. Dresden* 17, 191–192.



NATURAL HISTORY NOTES

STRIATICEPS TROPIDODRYAS (Vinesnake): REPRODUCTION. Snakes of the genus Tropidodryas occur exclusively in the Atlantic rainforests of southeastern and southern Brazil (Amaral, 1937; Thomas & Dixon, 1977), and also Bahia state (Argôlo, 1999a,b). Two species are currently recognized: Tropidodryas serra (Schlegel, 1837) and Tropidodryas striaticeps (Cope, 1869), the first found at sea level, and the latter at higher altitudes (Sazima, pers. com.; in Marques, 1998). They have semiarboreal habits and diurnal activity patterns, feeding on lizards, amphibians and rodents (Thomas & Dixon, 1977; Sazima & Puorto, 1993). The young are known to use caudal luring to attract prey (Sazima & Puorto, 1993). This paper presents information on oviposition, hatching, clutch size, relative clutch mass, size and sex ratio in newborn T. striaticeps, a snake with broad distributional range in Brazil including ES, MG, PR, RJ, SC e SP states (Amaral, 1937), with a recent record from RS (Puorto & Albuquerque, 2000; Puorto et al., 2001) and BA (Argôlo, 1999b). This species appears on the Red List of Threatened Species of Rio Grande do Sul (www.mat.pucrs/br/livrovermelho/princip.htm).

One female *T. striaticeps* (IB 65086: 840 mm in snout-vent length (SVL), 225 mm in tail length



Figure 1. Hatching of *Tropidodryas striaticeps* after 162 days of incubation.

(TL) and 150 g after oviposition) collected in Arujá, São Paulo (23°24'S; 46°20'W), was brought to Instituto Butantan (IB) and laid 8 eggs on 16th January 2002. The eggs averaged 39.6 mm in length (range = 37.0-43.0 mm), 19.0 in width (range = 16.9–20.8 mm) and 8.5 in mass (range = 7.3–10.1g). The RCM (relative clutch mass) was 0.40. The eggs were incubated in a box with soil as substrate, at room temperature varying from 20 to 27°C. Hatching occurred after 162 days, there being a period of 13 days between the first and the last neonate to hatch. Male newborns (n = 5)averaged 250 mm SVL (range = 230–270 mm), 77 mm TL (range = 75 - 80 mm) and 7.7 g mass (average = 6.4-8.7 g). Female new-borns (n = 3) averaged 238 mm SVL (range = 220–250 mm), 75 mm TL (range = 70-80 mm) and 7.3 g mass (average = 6.7-8.0 g). No still-borns were observed. Sexual dimorphism did not occur in the SVL, TL and mass. It would be interesting to compare measurement data for adult specimens to verify the possibility of ontogenetic variation in morphometric data. This is the first report about egg-laying and hatching in T. striaticeps. Three of the newborn snakes have been deposited in the Coleção Herpetológica do InstitutoButantan (IB67862; IB67957; IB68054).

REFERENCES

- Amaral, A. (1937). Contribuição ao Conhecimento dos Ophidios do Brasil. 9. Nova especie de Colubrideo opisthoglypho confundivel com *Philodryas serra* (Schlegel, 1837). *Mem. Inst. Butantan* 11, 205–211.
- Amaral, A. (1937). Contribuição ao Conhecimento dos Ophidios do Brasil, 10. Redescrição de *Philodryas serra* (Schlegel, 1837). *Mem. Inst. Butantan* 11, 213–215.
- Argôlo, A. J. S. (1999a). *Tropidodryas serra*. Brazil: Bahia. *Herpetol. Rev.* **30**, 55.
- Argôlo, A. J. S. (1999b). *Tropidodryas striaticeps*. Brazil: Bahia. *Herpetol. Rev.* **30**, 56.
- Marques, O. A. V. (1998). Composição Faunística, História Natural e Ecologia de Serpentes da Mata Atlântica, na Região da Estação Ecológica Juréia-Itatins, São Paulo, SP. Tese de Doutorado, Dep. Zoologia, Instituto de Biociências, Universidade de São Paulo. 135 pp.
- Puorto, G. & Albuquerque, C. C. (2000). Preliminary data on geographic distribution of the genus *Tropidodryas* (Serpentes: Colubridae). *Reunião Científica Anual do Instituto Butantan*, p. 101, n. 1.24.
- Puorto, G., Albuquerque, C. C. & Ramos, D. P. (2001). O gênero *Tropidodryas* (Serpentes: Colubridae): distribuição geográfica e dimorfismo sexual. 1º Simpósio da Sociedade Brasileira de Herpetologia, Instituto Butantan, n. 56.
- Sazima, I. & Puorto, G. (1993). Feeding technique of juvenile *Tropidodryas straticeps*: probable caudal luring in a colubrid snake. *Copeia* **1993**, 222–226.
- Thomas, R. A. & Dixon, J. R. (1977). A New Systematic Arrangement for *Philodryas serra* (Schlegel) and *Philodryas pseudoserra* (Amaral) (Serpentes: Colubridae). The Pearce-Sellards Series, *Texas Mem. Museum* **27**. 20 pp.

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Laboratório de Herpetologia, Instituto Butantan, Av. Vital Brazil, 1500, CEP 05503-900, São Paulo, SP, Brazil. *TRITURUS ALPESTRIS* (Alpine newt): **POLYMELY**. Extra-numerary limbs in free-living amphibians have long aroused scientific attention and curiosity (e.g. Colton, 1922; Bishop & Hamilton, 1947). Potential causes of polymely – as well as other kinds of limb deformities – encompass genetic factors, injuries and developmental disturbances, which can also derive from environmental contamination with biocides, retinoids, increased exposure to ultraviolet-B and parasitic infection (Ouellet, 2000; Blaustein & Johnson, 2003).

Polymely has been reported in many species of amphibians, although more frequently in anurans than in urodeles. In particular, only a few cases have been described to date for the family Salamandridae (see Recuero-Gil & Campos-Asenjo, 2002 and references therein). In the present note we document the first occurrence of polymely in the Alpine newt, *Triturus alpestris* Laurenti. The species is a medium-sized newt widely distributed over central and south-central Europe (Gasch *et al.*, 1997), inhabiting a variety of both deep and shallow water bodies and showing a wide altitudinal distribution (Griffiths, 1996).

The studied individual was found on 21^{st} May 2005 near a pond located in a woody area dominated by beeches (*Fagus sylvatica*), close to the Camaldoli Hermitage (northern Apennines, Italy; latitude: 43° 48' 24" N; longitude: 11° 49' 11" E; altitude 1080 m a.s.l.). The existence of an Alpine newt population at this site was first reported by Lanza (1965), and it is considered of

phenotype. It presented an extra-numerary left hind limb, pointing backward, between the normal hind limb and the base of the tail. This extra limb appeared a little underdeveloped, with a total length (18 mm) which was 82% of the normal one (22 mm), and a generally thinner shape. Apart from this, it was normally shaped, and was provided with a foot with five toes. The movements of this extra limb appeared to passively follow those of the normal limb, without contributing to the animal's terrestrial locomotion. Thus, the extra limb appeared non-functional, and did not seem to worsen the general conditions of the individual, whose body size was at the upper bound of that observed for adult females of its species (e.g. Lanza, 1983), and which was otherwise healthy.

At the site where the polymelic Alpine newt was found, we also observed several hundred individuals of both the same species and two other newt species: *Triturus carnifex* (Italian crested newt) and *T. vulgaris* (Smooth newt). No other individuals were found showing the same or any other evident morphological abnormalities.

Since the studied individual was released a few after being found and examined, causal factors underlying the observed morphological anomaly cannot be indicated unequivocally. Nevertheless, the absence of chemical contamination at the study

Figure 1. Pelvic region of the polymelic Alpine newt individual. A: dorso-lateral view; B: ventro-lateral view.

particular interest due to the abundance of paedomorphic individuals, and also because of recent conservation concerns (Tedaldi & Scaravelli, 1994). The studied individual (Figure 1) was a 108 mm long adult female (total length, measured with steel calliper; ± 0.1 gravid, mm), and showing a metamorphic



site (unpublished data), its overall structure with abundant shields against direct UV-B radiation, both in terrestrial and aquatic habitats, and the lack of further malformed newts among the several hundred examined at this site, lead us to regard environmental factors or parasitic infections as unlikely, and to favour endogenous causes or injuries as the most likely explanations. In particular we cannot rule out the possibility that the extra-numerary limb derived from an abnormal regeneration process. Newts and salamanders are able to regenerate a wide range of complex structures, such as limbs (reviewed in Nye et al., 2003), after their removal. During the regeneration process a sub group of stem cells migrates to cover the wound surface. Many different cell types accumulate under the wound epidermis and dedifferentiate, leading to the formation of a regeneration blastema. This structure gradually grows and proliferates, and the cells that compose it differentiate and reproduce the missing structure. It is possible to speculate that repeated injuries occurring during this process could lead to an abnormal regeneration process and eventually to an extra-numerary limb (Nye et al., 2003).

REFERENCES

- Bishop, D.W. & Hamilton, R. (1947). Polydactyly and limb duplication occurring naturally in the tiger salamander, *Ambystoma tigrinum*. *Science* **106**, 641–642.
- Blaustein, A. R. & Johnson, P. T. J. (2003). The complexity of deformed amphibians. *Front. Ecol. Envir.* 2, 87–94.
- Colton, H. S. (1922). The anatomy of a five legged frog. *Anat. Rec.* **24**, 247–253.
- Gasc, J.-P., Cabela, A., Crnobrnja-Isailovic, J., Dolmen, D., Grossenbacher, K., Haffner, P., Lescure, J., Martens, H., Martinez Rica, J. P., Maurin, H., Oliveira, M. E., Sofianidou, T. S., Veith, M. & Zuiderwijk, A. (1997). *Atlas of Amphibians and Reptiles in Europe*. Paris: Societas Europaea Herpetologica & Muséum National d'Histoire Naturelle. 496 pp.
- Griffiths, R. A. (1996). *Newts and Salamanders of Europe*. London: Poyser Natural History. 188 pp.
- Lanza, B. (1966). Il Triturus alpestris (Laurenti) e la

Rana temporaria L. sull'Appennino. Arch. bot. biogeogr. ital. **10**[1965], 261–272.

- Lanza, B. (1983). Anfibi, Rettili. CNR, Rome. 196 pp.
- Nye, H., Cameron, J.A., Chernoff, E.A. & Stocum, D.L. (2003). Regeneration of the urodele limb: a review. *Dev. Dyn.* **226**, 280–294.
- Ouellet, M. (2000). Amphibian deformities: current state of knowledge. In *Ecotoxicology of amphibians and reptiles*, pp. 617–661. Sparling D. W., Linder, G. & Bishop C.A. (Eds). Pensacola, FL: Society of Environmental Toxicology & Chemistry.
- Recuero-Gil, E. & Campos Asenjo, O. (2002). *Triturus marmoratus* (Marbled Newt): Polymely. *Herpetol. Bull.* **82**, 31–32.
- Tedaldi, G. & Scaravelli, D. (1994). Primo contributo alla conoscenza degli anfibi e dei rettili delle Foreste Casentinesi. *Parchi* **13**, 70–79.

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ZONOSAURUS LATICAUDATUS (Western girdled lizard): SEMIAQUATIC DEFENSIVE BEHAVIOUR. *Zonosaurus laticaudatus* is a medium sized lizard with an average SVL of 135mm (Glaw & Vences, 1994) which can be identified by the presence of a lateral fold of skin which runs along the neck terminating at the inguinal region, dorsolateral stripes that begin behind rather than on the head, strongly keeled dorsal scales and the possession of prefrontal scales that are clearly in contact with each other (Glaw & Vences, 1994).

This species belongs to the family Gerrhosauridae and is one of 17 genera endemic to Madagascar. Members of this genus have been divided into one of three different categories dependent upon their distribution across the island: those with very restricted distributions, those occurring across regions within well-defined bioclimatic areas and those with very broad distributions across bioclimatic zones (Raselimanana, 2003).

Zonosaurus laticaudatus fits into the third of these categories as it is found in three separated areas located in the northwest, west, and south (Raselimanana, 2003). Two possible explanations have been forwarded to explain this current distribution. The first suggests that at some point this species must have possessed a continuous distribution over Madagascar and that the current disjunct range is the result of local extirpation in certain zones or separation of populations associated with ecological change (Raselimanana, 2003). The alternative theory is that populations originated in the southeast with subsequent expansion into the west and north (Raselimanana, 2003).

This relatively large and conspicuous species has been the focus of numerous studies that have resulted in detailed behavioural observations (see Avery, 1979; Brygoo, 1985; Glaw & Vences, 1994, Henkel & Schmidt, 2000; Raselimanana, 2003 and Raselimanana et. al., 2005). These observations have highlighted certain aspects of its ecology that may be responsible for its current distribution. Firstly, this species is highly adaptable with regard to structural microhabitat as rupicolous, terrestrial and arboreal behaviour has been documented (Raselimanana. 2003). Secondly, it does not appear to be limited by the physical factors of temperature and humidity as populations have been found in dry, humid, and transitional forest (Raselimanana, 2003). Finally, Z. laticaudatus is a generalist, opportunistic feeder with a varied diet which is known to include invertebrates and fruit (Urbani & Bels, 1995).

This paper intends to add to this current knowledge by documenting the behaviour of individuals from a population located in the south of the island. In particular, it draws attention to previously undocumented observations and highlights how (together with the existing ecological knowledge detailed above) they may have contributed to the current wide and disjunct distribution of this species across Madagascar.



Figure 1. *Zonosaurus laticaudus*. Spet Lacs, 2005. Photograph © N. D'Cruze.

In January 2005 The Frontier-Madagascar Forest Research Programme conducted a biodiversity survey in the Sept Lacs region (S 23° 28' - S 23° 31', E 44° 04' - E 44° 10'), which is a core area of gallery forest found in the Parc Regional de Belomotse, southeast Madagascar. Behavioural observations of this species were made between 14th January and 28th January, during the wet season.

Members of this population appeared terrestrial in nature as all sightings occurred on the forest floor. Individuals typically selected exposed rocks in open areas amongst vegetation on which to bask and were observed displaying typical 'heliotherm shuttling' behaviour as described by Avery (1979). This behaviour was responsible for the majority of sightings which occurred between 10:00 and 12:00 hr in the morning and 14:00 and 16:00 hr in the afternoon when the sun was at its strongest.

Interestingly, of the 11 lizards observed during this period, 4 individuals were missing forelimbs. Although limb regeneration has been observed in both *Z. ornatus* (Brygoo, 1985) and *Z. haraldmeieri* (Raselimanana, 2000) this is a phenomenon which has not been recorded in populations of this species before. Predators such as snakes of the genus *Leioheterodon* and birds of prey such as *Falco eleonorae*, which were also observed in the area, are most likely responsible for these injuries.

Additionally, during this study one individual displayed a previously undescribed semi-aquatic defensive flight response. When disturbed while basking on a rock adjacent to a medium sized pool, this individual dived into the water in an attempt to escape. Once in the water this lizard swam for approximately 50 cm before diving down to a depth of around 20 cm, submerging itself in the layer of leaf litter substrate located at the bottom. It remained there for approximately three minutes before surfacing for air and returning once again to the bottom of the pool. This type of behaviour has been previously observed in *Zonosaurus maximus* (known locally as the 'petite caiman') which is renowned for its semi aquatic nature (Glaw & Vences, 1994). However, until now it was the only member of this genus that has been known to flee into water in times of danger.

In conclusion this paper details two new observations regarding the behavioural ecology of this species. Firstly this lizard is able to survive serious injuries resulting from predation events that might prove fatal for other organisms. Secondly it documents semi aquatic behaviour which may have allowed this species to overcome hydrographic dispersal barriers (e.g. the Onhilay River in the south) which are believed to be responsible for the highly restricted ranges of other closely related species such as *Z. trilineatus* (Raselimanana, 2003).

If considered in conjunction with the current knowledge regarding the ecology of this species these observations have far reaching implications with regards to the ubiquitous distribution of this species. Upon crossing hydrographic dispersal barriers the generalist attitude of this species towards structural microhabitat, microclimatic conditions, and its diet would have been instrumental in allowing it to survive in widely contrasting habitats. This information suggests that range extensions into the west and north of the island are a feasible explanation for the current distribution of this species.

Although this paper has served to highlight previously unrecorded aspects of the ecology of this endemic Malagasy lizard, further research into its behavioural ecology are required in order to ascertain conclusive evidence regarding its role in the distribution of this species.

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REFERENCES

- Avery, R. A. (1979). Lizards a study in thermoregulation. *Studies in Biology* **109**, 1-56.
- Brygoo, E. R. (1985). Les Gerrhosaurinae de Madagascar (Sauria: Cordylidae). Mémoires du Muséum National d'Histoire Naturelle, Paris, série zoologie 134, 1–65.
- Glaw, F. & Vences, M. (1994). A Fieldguide to the Amphibians and Reptiles of Madagascar. 2nd edn. Germany: Moos Druck.
- Henkel, F. & Schmidt, W. (2000). Amphibians and reptiles of Madagascar and the Mascarene, Seychelles, and Comoro Islands. Florida: Krieger Publishing Company.
- Raselimanana, A. P., Raxworthy, C. J. & Nussbaum, R. A. (2000). Herpetofaunal species diversity and elevational distribution within the Parc National de Marojejy, Madagascar. In: A Floral and Faunal Inventory of the Parc National de Marojejy, Madagascar: With Reference to Elevational Variation. Goodman, S. M. (Ed.). Fieldiana: Zoology, NS 97, 157–74.
- Raselimanana, A. P. (2003). Gerrhosauridae, plated lizards. In: *The Natural History of Madagascar*. Goodman, S. M. & Benstead, J. P. (Eds.). Chicago: The University of Chicago Press.
- Yoder, A. D., Olson, L. E., Hanley, C., Heckman, K. L., Rasoloarison, R., Russell, A. L., Ranivo, J., Soarimalala, V., Karanth, K. P., Raselimanana, A. P. & Goodman, S. M. (2005). A multidimensional approach for detecting species patterns in Malagasy vertebrates. *Proc. Nat. Acad. Sci.* **102**, 6587–6594.
- Urbani, J. M. & Bels, V. L. (1995). Feeding behaviour in two scleroglossan lizards: *Lacerta viridis* (Lacertidae) and *Zonosaurus laticaudatus* (Cordylidae). *J. Zool., London* **236**, 265.

NEIL C. D'CRUZE

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The Amphibians and Reptiles of the Honduran Mosquitia

James R. McCranie, Josiah H. Townsend, and Larry David Wilson

Krieger Publishing Company, Malabar, Florida. 2006.

ISBN 1-57524-270-2; US\$63.50. x + 291 pp.

The Mosquitia of Honduras forms one of the largest remaining tracts of tropical lowland forest in Middle America. In herpetological terms, while not a significant area of endemism, it is also one of the most diverse. Almost half of the entire compliment of amphibian and reptile species known from Honduras occur in this region and its coastal waters (156 out of 347), distributed among some 91 genera and 38 families. As more of the area is explored it is likely that still others will be revealed – until comparatively recently the Mosquitia was mostly inaccessible, and travel in the region today is still largely by foot or traditional dugout canoe.

As outlined in its introduction, the purpose of this book is to discuss the composition, distribution, natural history, biogeography, conservation status, and wellbeing of the Mosquitia herpetofauna within Honduras (the boundary of this region extends for some considerable distance into eastern Nicaragua). In all of these objectives it succeeds admirably, and given the clear ecological importance of the Mosquitia we can only hope that it also triumphs in achieving its other stated goal to increase awareness of the value of amphibians and reptiles in maintaining this unique complex of ecosystems, both among the indigenous peoples of the region and the policy makers on whose decisions its future ultimately depends. The book's three authors are well known specialists in Middle American herpetology. McCranie and Wilson in particular have a long and distinguished record of herpetological research in Honduras, between them spanning almost 70 years, and much of what is known today regarding the amphibians and reptiles of this country stems directly from their efforts.

A large part of the book is devoted to descriptions of the actual species. These are sufficiently detailed for identification purposes without being overly technical, and are complemented by fully illustrated keys, drawings, and colour photographs. The remaining chapters provide a wealth of other useful information on the herpetofauna of the Mosquitia (history of survey work, distribution patterns, ecological and biogeographic relationships of species, conservation status of species, future of the Mosquitia herpetofauna, and species of probable occurrence) as well as the region itself, including the environment, its peoples and social history, and protected areas. *The Amphibians and Reptiles of the Honduran Mosquitia* is thus much more than a standard account of amphibian and reptile diversity in this area – rather a framework for the conservation and welfare of its herpetofauna. Accordingly, it deserves the highest recommendation.

The Amphibians and Reptiles of El Salvador

Gunther Köhler, Milan Veselý and Eli Greenbaum

Krieger Publishing Company, Malabar, Florida. 2006.

ISBN 1-57524-252-4; US\$49.50. ix + 238 pp.

Produced in the same vein as the Honduran title, this is an equally authoritative account of the amphibians and reptiles inhabiting El Salvador - the most comprehensive since Mertens' original checklist published in 1952 (Abh. Senckenb. Naturf. Ges. 487). The book opens with an introduction, materials and methods section, a description of the environment of El Salvador, and chapter on its herpetofaunal composition. Accounts follow of the 130 recorded species (many with type localities in the country), their descriptions based entirely on Salvadorian specimens examined personally by the authors, each accompanied by a colour photograph and excellent distribution map. The species accounts are first class; in addition to descriptions of morphological variation and colour pattern, they include detailed notes on synonomy, geographic and ecological distribution, vocalisation (anurans), taxomomy, natural history, and conservation status. Dichotomous keys to the identification of species (duplicated in Spanish) and a literature cited section are also provided. The Amphibians and Reptiles of *El Salvador* is the definitive modern work on the herpetofauna of this country and will be an invaluable addition to the library of anyone interested in neotropical herpetology.

Peter Stafford, Editor

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