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THE HERPETOLOGICAL BULLETIN

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THE HERPETOLOGICAL BULLETIN

The Herpetological Bulletin is produced quarterly and publishes, in English, a range of articles concerned with herpetology. These include society news, full-length papers, new methodologies, natural history notes, book reviews, letters from readers 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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9. The significance and importance of some articles may be such that the Editor will offer the author a year's free subscription to the Society.

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Front cover illustration. Subadult *V. varius* on 19 November 2009 foraging on the pavement outside the recreation room in one of the buildings at ANSTO (which houses Australia's only nuclear reactor) Lucas Heights, at the southern edge of the greater Sydney metropolitan region, N.S.W., Australia. Photograph © John Murdo McLeod. See article on page 8.

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Herpetology at The Amphibian and Reptile Conservation Trust

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The Amphibian and Reptile Conservation Trust (ARC) is a non-government organisation (NGO) and registered charity dedicated to the conservation of wild amphibian and reptile populations for perpetuity. ARC was founded in 2009 from the Herpetological Conservation Trust (HCT) continuing and expanding the work of that organisation. ARC's primary objectives are:

1. To promote and advance the conservation of amphibians and reptiles, their habitats and the wider environment on which they depend.
2. To establish and maintain nature reserves and undertake habitat management favourable for amphibians and reptiles both within and outside the reserves.
3. To support, undertake and publish research pertinent to improved conservation of amphibians and reptiles.
4. To advance education of the public about amphibians and reptiles and how to conserve them.
5. To pursue these objectives in the British Isles, Europe, the British Overseas Territories and elsewhere as opportunities arise.

ARC collaborates actively with a range of partners to help fulfil its aspirations, including the UK's Governmental Departments and statutory conservation agencies (Natural England, Countryside Council for Wales and Scottish Natural Heritage), and a wide range of non-governmental bodies including the Amphibian and Reptile Groups (ARGs), The British Herpetological Society (BHS), The National Trust (NT), the County Wildlife Trusts, The Royal Society for the Protection of Birds (RSPB), Pond Conservation, the Mammal Society, Butterfly Conservation, the Wildfowl and Wetlands Trust (WWT) and many others. Constructive contacts are maintained and joint projects developed with academic researchers at universities and with sister organisations elsewhere, such as the European Herpetological Society (SEH) and RAVON (Reptile, Amphibian and Fish Conservation Netherlands). ARC is also a member of Wildlife & Countryside Link, a collective of NGOs that lobbies the government on conservation issues in England, and of Wales Environment Link, a similar coalition in Wales.

Proactive conservation

The great majority of ARC's work concerns active management of sites supporting amphibians and reptiles on both land it owns/leases and that managed by other people. ARC works actively with other interested parties in both the government and non-government sectors at national and local levels to plan conservation work and contribute to the development of biodiversity strategies and plans. ARC was 'lead partner' for all herpetofauna in the UK Biodiversity Action Plan, produced the species action plans and maintains a leading role as biodiversity conservation becomes increasingly devolved to separate countries. There has been a longstanding emphasis on the four rare British species: the sand lizard, smooth snake, natterjack toad and pool frog. These all occur on specialised habitats and much of ARC's physical work is focused in these places. Today, ARC's work also includes more effort for widespread species, most of which have been listed as priorities within the national biodiversity strategies.

Figure 1. A heathland management task (tea break) and (right) the target condition – a superb open heath vista.

The rare reptiles

Sand lizards (*Lacerta agilis*) and smooth snakes (*Coronella austriaca*) occur only on lowland heaths in the south of England and (in the case of sand lizards) on some coastal dune systems as far north as Merseyside. ARC staff manage scrub and invading pine trees on heathland sites during the winter months, create and maintain sandy tracks for sand lizard egg-laying in early spring and control bracken encroachment in summer. The teams also clear invasive scrub from dune sites where sand lizards occur. As well as maintaining sites owned or controlled by ARC, the team works on reserves managed by other organisations wherever such collaboration is possible. In addition to sustaining and expanding existing populations, ARC (and HCT and the BHS Conservation Committee before it) has managed a highly successful programme of sand lizard and smooth snake reintroductions in England and Wales, supported by a captive breeding programme for the sand lizard.

Heathland improvement is where it all started, forty years ago when the BHS Conservation Committee was formed. ARC's elder statesmen have (mostly) fond memories of cutting down encroaching pine and birch trees and dragging them to roaring bonfires on crisp winter days. This tradition continues: every winter ARC organises a series of Sunday tasks on heathland in Surrey and Dorset to assist its clearance and restoration programme. New volunteers are always welcome – please consult the ARC website for details. The work is hugely satisfying, after a single session large tracts of heather are saved from disappearing under a potential new forest to maintain (or recreate) excellent habitat for sand lizards and, indeed, all our other reptiles as well.

The rare amphibians

ARC staff promote and organise conservation management on sites in England, Wales and Scotland where natterjack toads (*Bufo calamita*) are found and also contribute to work on this species in Ireland. Most natterjacks live on coastal dunes and upper saltmarshes, with just a few populations surviving on heathlands. Once again scrub clearance is often the main job but pond creation or restoration is also regularly undertaken. As with sand lizards there have been some successful reintroductions, including a restoration of the species to Wales. ARC coordinates the conservation effort for the "northern clade" pool frog (*Pelophylax lessonae* - i.e. the form that is native to Britain and parts of Scandinavia) in England and has been one of the organisations leading in its re-establishment in East Anglia following their extinction at the last remaining site in the 1990s. ARC staff have been involved in all stages – from the early research on the history of this species through its reintroduction during the mid 2000s and now manage the re-introduction site. This has been an especially gratifying project. Twenty years ago a small team sat round a table planning the research project; seven years ago

those same people, and a few more besides, watched in anticipation as the first pool frogs arrived from Sweden and were released into the ponds specially prepared for them. For natterjacks and pool frogs, grazing the terrestrial habitat by domestic livestock is a crucial management tool and ARC is involved in developing and implementing the best methods for doing this.

Widespread species

In conjunction with the ARGs, ARC is developing conservation efforts for the more widespread British amphibians and reptiles. It is a leading contributor to national schemes such as the Million Ponds Project with Pond Conservation and to locally based projects including one in London and a programme of work across Wales focused on community engagement and pond creation. ARC's great crested newt conservation officer provides advice and support for managers of newt sites around the UK, including farmers (in both England and Scotland), and guidance on controlling fish (major predators of newt larvae). ARC is currently developing its focus across different scales: it contributes to national guidance on management of landscapes and designated sites and, at the other end of the spectrum, has produced a 'Dragons in your garden' booklet about how to make gardens amphibian and reptile-friendly. ARC is increasingly concerned about declines of adders and common toads. It is currently supporting a status assessment of the adder and providing a leaflet on 'Common toads on roads' aimed at planners.

Management publications

Two comprehensive booklets providing detailed advice on best practice for management of amphibian and reptile sites (for all UK species) have been produced by and are available as free downloads from ARC: the Amphibian Habitat Management Handbook and the Reptile Habitat Management Handbook.

Nature Reserves

ARC owns, leases or hold formal management agreements on more than 80 nature reserves covering over 1,400 ha, mostly parcels of heathland in southern England but also including two natterjack sites in Cumbria and a pool frog site in Norfolk. Most of these sites are designated as being of European importance for wildlife. Some were transferred to ARC courtesy of the BHS, which acquired them in the first instance. Most are open to visitors (see the ARC website). Though the sites were chosen because of their herpetological importance, they are managed for their habitats and a wide range of other, frequently rare, species.

Working across the UK

ARC is developing regional centres of activity and in addition to the Bournemouth Headquarters it now has offices in Surrey and South Wales. In the London area, ARC worked with ARGs, London Wildlife Trust and GiGL (Greenspace Information for Greater London) to produce London's first Amphibian and Reptile Atlas through the CLARE (Connecting London's Amphibian and Reptile Environments) project. Find the atlas at http://www.gigl.org.uk/Ourdatasets/LARA/tabid/217/Default.aspx. Successful bids for two grants, from CCW and the Welsh Government, will develop community involvement in herpetofauna conservation and create and restore amphibian and reptile habitats in South Wales. There is also good progress in identifying habitat management opportunities in the south in partnership with other NGOs such as the National Trust and Pond Conservation. These projects employ two ARC Officers in Wales. In Scotland ARC has maintained a programme of monitoring and providing conservation advice involving staff, contractors

Figure 2. Surveying for newts at ARC's Creech Heath Nature Reserve.

and volunteers, in particular for natterjack toads and great crested newts (*Triturus cristatus*). ARC also provides input to the development of Scotland's Biodiversity and Biodiversity Recording strategies as the basis for further developing its work in Scotland.

Research and monitoring

ARC puts great store in developing a sound evidence base for conservation. There are two main strands to ARC's scientific work.

Survey and monitoring

ARC maintains a programme of surveillance and monitoring to help understand the status and distribution of all British amphibians and reptiles and passes information from our database to the NBN (National Biodiversity Network) Gateway.

Rare species are monitored by a combination of ARC staff, nature reserve wardens and volunteers. The data are held electronically and made available by request. Natterjack information (population sizes, breeding success, conservation management) from all British sites is collated by ARC into the Natterjack Toad Site Register, published intermittently as hard copy.

Common frog (*Rana temporaria*), common toad (*Bufo bufo*), great crested (*Triturus cristatus*), smooth (*Lissotriton vulgaris*) and palmate (*L. helveticus*) newts, viviparous lizard (*Zootoca vivipara*), slow-worm (*Anguis fragilis*), adder (*Vipera berus*) and grass snake (*Natrix natrix*) are addressed under the National Amphibian and Reptile Recording Scheme (NARRS) widespread species surveys which were instigated in 2007. They rely on input from volunteers surveying ponds and reptile habitats at sites distributed all across Britain. More volunteers for this scheme are always welcome (see the NARRS website for details of the scheme and how you can help). Searching new places is an exciting experience, never knowing what you're going to find and at the same time making an important contribution to knowledge. Even if nothing turns up (rather less exciting), 'negative' results are a valuable indicator of the state of the nation's countryside. Over time this scheme is designed to show national trends for all the above species and thus identify conservation priorities. It has already indicated previously unrecognised adder declines. ARC also contributes to a range of other projects – such as the Great Easter Newt Hunt, Add an Adder and the BTO's Garden Herp Watch – which provide information about herpetofauna and offer opportunities for more people to get involved. ARC is currently working with Natural England to develop new projects including monitoring designated sites (SSSIs and SACs) in England.

Applied research for conservation

ARC has undertaken and assisted with a range of research projects aimed at improving our understanding of amphibian and reptile ecology, often in collaboration with academic institutions, with a view to optimising conservation management. These projects include statistical assessment of natterjack status trends, understanding the heathland ecology of natterjacks, investigating the historical status of pool frogs, analysing the robustness of earlier status investigations and investigating the distribution and status of common frogs in Ireland and of great crested newts in Scotland. Recently ARC scientific staff have developed sophisticated modelling tools for understanding and predicting the distribution of great crested newts. These support a wide range of practical applications (such as targeting conservation work and avoiding conflicts with development) as well as contributing to status assessments. Last but by no means least, ARC has provided co-supervision and assistance for PhD students (e.g. working on sand lizard ecology) and numerous undergraduates and masters students involved in conservation-oriented projects.

Scientific papers and reports

Many results from ARC projects are already published in peer-reviewed scientific journals and this aspiration will be pursued for all work still in progress or undertaken in future. Current papers with ARC (or HCT) accreditation are:

Buckley, J. & Beebee, T.J.C. (2004) Monitoring the conservation status of an endangered

amphibian: the natterjack toad *Bufo calamita* in Britain. *Animal Conservation* 7: 221- 228.

Beebee, T.J.C., Buckley, J., Evans, I., Foster, J.P., Gent, A.H., Gleed-Owen, C.P., Kelly, G., Rowe, G., Snell, C., Wycherley, J.T. & Zeisset, I. (2005) Neglected native or undesirable alien? Resolution of a conservation dilemma concerning the pool frog *Rana lessonae*. *Biodiversity & Conservation* 14: 1607-1626.

Beebee, T.J.C., Wilkinson, J.W. & Buckley, J. (2009) Amphibian declines are not uniquely high amongst the vertebrates: trend determination and the British perspective. *Diversity* 1: 67-88.

Beebee, T.J.C. (2011) Modelling factors affecting population trends in an endangered amphibian. *Journal of Zoology*, 284: 97-104.

Beebee, T.J.C. (2012) Impact of *Ranavirus* on garden amphibian populations. *Herpetological Bulletin* 120: 1-3.

Dingerkus, S.K., Stone, R.E., Wilkinson, J.W., Marnell, F. & Reid, N. (2010) *Developing a methodology for the National Frog Survey of Ireland: a pilot study* in C. Mayo. *Irish Naturalists' Journal* 31: 85-90.

In addition, ARC has produced a series of reports following research contracts. Examples are given below.

Arnell, A.P. & Wilkinson, J.W. (2011) *Pilot modelling to inform determination of Favourable Conservation Status for the great crested newt, 2011*. CCW Contract Science Report, Number 961.

Arnell, A.P. & Wilkinson, J.W. (2011) *Predictive Modelling of Key Herpetofauna Species in North Wales, 2011*. CCW Contract Science Report, Number 976.

Wilkinson, J.W., Wright, D., Arnell, A.P. and Driver, B. (2011). *Assessing population status of the great crested newt in Great Britain.* Natural England Commissioned Reports, Number 080.

Scientific meetings

ARC staff and trustees regularly present research results at international meetings. Recently these included the SEH meeting in Luxembourg (2011) and the World Congress of Herpetology in Vancouver (2012).

Figure 3. Public events.

Education and public engagement

General involvement.

ARC office staff respond to public enquiries by telephone and email (its Wildlife Information Service) on a continuous basis. In addition, ARC organises and runs a range of training courses every year at various locations for people (volunteers, consultants, land managers) wanting to engage in amphibian and reptile surveys or habitat management. Staff work with school teachers and students and attend many events and country fairs every year where the animals and ARC's work are on display and explained to the public. These are supported by a range of information leaflets and posters. ARC provides an information service to people with snakes in gardens, developers, the press and many others. ARC staff are frequent contributors to television and radio programmes and magazine articles. ARC actively engages with the ARGs to provide opportunities for more people to become involved in herpetofauna conservation.

Two public meetings are organised each year:

(1) The Herpetofauna Workers Meeting, jointly with the ARGs, in late January or early February. This event, which rotates to different venues around the UK, focuses on practical experiences with amphibian and reptile

Figure 4. Example of a cover of *Hop Gossip*.

conservation and includes talks and workshops over a weekend. It's not all business; social events with quizzes are great fun on the Saturday night.

(2) The Scientific Meeting, jointly organised with the BHS, in December and always in Bournemouth, southern England. There is a single day of talks by researchers working on amphibians and reptiles primarily, but not exclusively, in the UK. Again, it's not all work. A social evening, usually at a local restaurant, is part of the deal. Both meetings are open to the public and have proved consistently popular over many years. ARC also contributes to regional meetings including those targeted at ARGs, the public and specialist audiences such as environmental consultants.

Friends and supporters

ARC runs a 'Friends' group which is open to everyone with an interest in herpetofauna conservation and encourages participation in volunteer-based activities. Details of how to join are on the ARC website. Specific projects run by ARC that benefit from volunteer support are conservation management work parties on our reserves and NARRS (see sections above) but also 'Make the Adder Count' and 'The Great Easter Newt Hunt'. Friends also receive free copies of ARC's regular glossy newsletter, *Hop Gossip*, an informative update of recent developments in all aspects of amphibian and reptile conservation in Britain.

Advocacy

ARC has a long history of advocacy work – influencing the development and implementation of policy and legislation at local, national and European levels. In particular ARC focuses on biodiversity policy and legislation to ensure that strong wildlife conservation measures benefit amphibians and reptiles. ARC also promotes wildlife-friendly farming, strong protection for the water environment and maximum opportunities for conservation in planning. ARC works closely with other bodies in both the Governmental and Non-Governmental sectors to achieve these objectives.

Future aspirations

There will undoubtedly be more of the same in the coming years because ARC is confident of its priorities and there is much yet to do in all its current work areas. In particular ARC wishes to expand its volunteer support and develop a broader income stream, including expansion of consultancy work. However, if opportunities (mainly money!) arise, there is scope for further commitments. By way of examples:

- All our native species occur in mainland Europe and often face similar threats there, so larger scale work with partners in the relevant countries would be very worthwhile. ARC is currently involved with the SEH Conservation committee and represents it at the European Habitats Forum (EHF) which is actively engaged with the European Commission, notably the Directorate General for the Environment and the member States of the European Union.
- The UK overseas territories harbour a wide range of very different species, many of them highly endangered, and it would be great to extend help in that direction. ARC is a member of the UK Overseas Territories Conservation

Forum, a network that brings together Non-Governmental Organisations and institutions involved with furthering conservation of the natural heritage in the Overseas Territories.

• Research requirements are by definition ever-changing but study of our largely neglected non-native species and their impact (if any) on native fauna, perhaps together with climate change effects, could be very worthwhile.

ARC: The Organisation

History: ARC came into being in 2009 after metamorphosis from its precursor organisation the Herpetological Conservation Trust (HCT). ARC is developing and expanding the work of the HCT, which was created in 1989.

Location: ARC's head office is at 655a Christchurch Rd, Boscombe, Bournemouth, Dorset BH1 4AP. Telephone: 01202 (or from abroad, 0044 1202) 391319; the Trust's website is at http://www.arc-trust.org.

ARC Trustees: Mr Jonathan Webster (Chair), Mr Howard Inns (Vice-chair), Prof. Trevor Beebee, Mrs Jan Clemons, Prof. Richard Griffiths, Dr Roger Mitchell, Mrs Phillippa Perry, Dr Chris Tydeman and Mr Bill Whitaker.

ARC Staff: There are more than 20 staff including Dr Tony Gent (CEO), Mr Jim Foster (Conservation Director), Mrs Helen Wraight (Administration and Finance Officer), Dr John Wilkinson (Research and Monitoring Officer), Species Conservation Officers including John Buckley, Nick Moulton and Dorothy Driver, and Reserves and Field teams managed by Gary Powell. Details are updated regularly on the ARC website.

Funding: ARC has a capital investment portfolio thanks to a generous private donor, the interest from which is used to support core activities. Additional resources mainly accrue from grant aid towards species and habitat conservation provided by the statutory government agencies and charities such as the Esmée Fairbairn Foundation, the Heritage Lottery Fund, Landfill Communities Fund and other funding bodies and private and corporate donors. ARC's annual turnover in recent years has been around £1 million.

The Herpetofauna of Nusa Penida, Indonesia

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ABSTRACT - The Nusa Penida group, three islands lying offshore of Bali, Indonesia, were systematically surveyed for the first time on behalf of the Friends of the National Parks Foundation, using timed searches in representative habitats. Ten species were newly recorded for the islands. In combination with previous data we record a total of 3 anurans, 11 lizards and 14 snakes. The herpetofauna is very strongly related to that of Bali, sharing only one species exclusively with Lombok and islands further east, the fossorial lizard *Dibamus taylori*. Richest habitats from a herpetological standpoint are remnant tropical rainforest and semi-deciduous forest, and these are priorities for conservation efforts.

The Nusa Penida group (herein referred to as NP) lie at –8.7389°, 115.5402°, 14 km SE of Bali, Indonesia, and are administered as a branch of Bali's Klungkung regency. The largest of the group is Nusa Penida island, around 207 sq km, comprised mostly of rolling hills, with a highest point of Gunung Mundi at 529 m asl, a narrow northern low coastal strip and cliffs to the south. Nusa Ceningan and Nusa Lembongan, nestled against their sibling's north-east corner, are a fraction of the size and have a similar geography on a smaller scale. Despite their proximity to volcanic Bali, the group are coralline islands. Their calcareous geology, coupled with comparatively low annual rainfall, make the soils very dry and the habitats relatively barren (Giambelli, 1999), and the semi-deciduous forests which once covered most of the islands (Whitten et al., 1996) have largely been cleared for agriculture. Tree-felling began 400+ years ago, by exiled convicts supplying timber to the mainland (Giambelli, 1999). Surviving mature forest is confined to valleys and ravines which have proved too difficult or costly to exploit (McKay, 2006a).

The known flora and fauna are Wallacean transitional assemblages with the majority of taxa being of the South East Asian Assemblage and secondarily species of Lesser Sundanese affinity. Bali and neighboring Lombok represent the eastern range limit of many Asian species and the western limit of a number of Lesser Sundanese organisms (Jonsson et al., 2008). Smaller size and limited mature habitat suggests NP harbours a small subset of the Bali-Lombok taxa. To date the wildlife of NP has been poorly documented and there is no definitive species database, an essential tool for future studies and the implementation of conservation programs. Previous herpetological research (McKay, 2006a) provides some information on species presence in a handful of areas. With the assistance of the Friends of National Parks Foundation, a conservation NGO recently lauded for success in re-establishing a wild population of the Bali Starling, *Leucopsar rothschildi*, and establishing an island-wide protected bird sanctuary under traditional law on Nusa Penida island, we aimed to conduct a more comprehensive assessment of the herpetofauna richness and habitat associations on NP, the overall objective being to not only create a herpetofauna database, but provide a better understanding of the islands' biodiversity.

METHODS

Seventeen vehicle-accessible sites were established across Nusa Penida island, each comprising a

Site	Site name	Altidude (m) asl	Location	Habitat Type	Vegetation composition	Vegetation diversity	Anthropogenic disturbance	Soil quality
1	Penangkidan	203	S 080 44' 27. 8" E 1150 28' 39. 3"	Scrub	Acacias, palms, grasses	Moderate	Moderate	Low - moderate
2	Penida	19	S 080 42' 59. 1" E 1150 27' 43. 1"	Wetland	Predominately aquatic vegetation, lillies, mangrove trees, palms	High	Low	High
3	Sebunibus	147	S 080 42' 28. 9" E 1150 29' 17. 7"	Tropical semi-deciduous forest/ scrub	Deciduous trees, vines, ferns, palms, Acacias	Moderate - High	Moderate	Moderate
4	Toya Pakeh	13	S 080 40' 58. 8" E 1150 29' 16. 2"	Plantation	Palms	Low	High	Low
5	Ped	7	S 080 40' 47. 8" E 1150 31' 05. 0"	Plantation/Scrub	Acacias, palms	Moderate	Moderate	Moderate
6	Pilah	182	S 080 41' 50 . 1" E 1150 32' 36. 0"	Plantation/ Tropical semi-deciduous forest	Deciduous trees, palms, Acacias	Moderate	Moderate	Moderate
7	Batumulapan	6	S 08040' 43. 2" E 1150 34' 20. 7"	Plantation	Palms	Low	High	Low
8	Karangsari	35	S 080 42' 35. 5" E 1150 34' 58. 5"	Tropical semi-deciduous forest	Deciduous/Evergreen trees, Acacias, ferns, vines	High	Low	High
9	Sumaya	8	S 080 43' 44. 0" E 1150 36' 03. 7"	Scrub /Plantation	Acacias, palms, grasses	Moderate	Moderate	Poor
10	Pejukutan	245	S 080 44' 52. 1" E 1150 35' 17. 0"	Tropical semi-deciduous forest	Deciduous/Evergreen trees, Acacias, vines, ferns	High	Low	High
11	Tanglad	442	S 080 46' 00. 8" E 1150 34' 53. 7"	Savannah	Predominantley grasses, Acacias, palms	Low	Moderate	Low
12	Sukartaji	234	S 080 47' 50. 3" E 1150 33' 45. 8"	Scrub/Plantation	Acacias, palms, grasses	Moderate - High	High	Moderate
13	Sebuluh	195	S 080 45' 19. 5" E 1150 29' 32. 8"	Scrub/Tropical semi-deciduous forest	Deciduous/Evergreen trees, ferns, vines, Acacias	High	Low	High
14	Tembeling	259	S 080 45' 38. 6" E 1150 30' 13. 2"	Tropical rain forest	Predominately evergreen trees, decidous trees, ferns, vines, palms, Acacias	High	Low	High
15	Mundi	530	S 080 43' 56.1" E 1150 31' 28.2"	Tropical semi-deciduous forest	Deciduous/Evergreen trees, ferns, vines, Acacias	High	Low	High
16	Pangalan	288	S 080 43' 19. 2" E 1150 33' 53. 9"	Plantation/ Tropical semi-deciduous forest	Deciduous trees, palms, Acacias	Moderate-High	Moderate	Moderate
17	Soyo	444	S 080 46' 06. 3" E 1150 34' 02. 6"	Savannah	Predominately grasses, Acacias, palms	Low	High	Low

Table 1. Location and habitat details of the sites surveyed on NP in 2011.

transect of approximately 500 m. Coordinates and elevation were logged with a Garmin Etrex GPS 12 Channel unit. Sites were distributed across six major habitats: scrubland, with a high diversity of *Acacia* spp, other shrubs and small deciduous trees; savannah, characterized by large quantities of grasses with little other vegetation except some *Acacias* and palms, and no 3+ m trees; plantation, areas of active agricultural activity with crops including bananas, palms, cassavas, corn and chillies, most often in monocultures; tropical semi-deciduous forest, comprising mostly deciduous trees, some intermittent evergreens and thick fern and shrub ground layers; tropical rainforest, diverse communities of primarily evergreen trees, deciduous trees, shrubs, ferns and epiphytes; and wetland, a freshwater spring with diverse aquatic plants. At each of these sites anthropogenic disturbance was scored in three categories: further than 150 m from an anthropogenically disturbed area - low; within 150 m of an anthropogenically disturbed area - moderate; site positioned within an anthropogenically disturbed area - high. Soil quality was also scored in three classes: less than 3 cm/little or no organic matter - low; 3-5 cm/ intermitent organic matter - moderate; > 5 cm/ predominatly organic matter - high. During August - September 2011 each site was visited three times (morning/afternoon/night), and walked for a duration of approx. 2 hrs, followed by searches of specific micro-habitats, recording any herpetofauna encountered. This method may not discriminate smaller or more agile species glimpsed momentarily by the observer who may not be experienced in differentiating between sibling species, in such case genus/species group was recorded.

The data was combined with records collected by JLM in 2002, 2007 and 2010, the results of opportunistic day/night searching on foot and vehicle, mostly in preparation for subsequent field guides (McKay 2006a, 2006b). We then comment on species richness in comparison to the known Balinese-Lombok fauna, and draw inferences for the significance of NP's herpetofauna and remaining habitat to conservation efforts on the islands.

Figure 1. Site 14, "Tembeling", a tropical rainforest gully, from which the greatest herpetofauna diversity was recorded. Photo by JL McKay.

RESULTS

The visual transects yielded three amphibian and 22 reptile species. Ten species were newly recorded for the NP group (two frogs, one lizard and 7 snakes). The maximum number of taxa recorded in a site was 10, from site 14, a relatively undisturbed tropical rainforest gully. Tropical semi-deciduous forests, and tropical semi-deciduous forest associated with scrub, yielded the next highest richness of taxa, between 9 and 7 taxa per site. Other habitats yielded a moderate number of species; the lowest diversity was from the savannah and wetland sites with zero or a single species. As would be expected, sites with greatest species richness had correspondingly high organic soil content and low anthropogenic disturbance.

Of the amphibia, *Duttaphrynus melanostictus* was by far the most prevalent, not only detected in the study areas but also observed throughout the island between sites. *Polypedates leucomystax* was found at only two sites, in tropical semi-deciduous forest/scrub, and tropical rainforest. *Fejervarya cancrivora* occurred only in the wetland.

With the exception of *Varanus salvator bivittatus*, all the lizards on NP are small insectivores, with four Gekkonidae, three Scincidae species and one Dibamid. The three most widespread and abundant are *Gecko gecko*, *Cyrtodactylus fumosus* and *Eutropis multifasciata*, which all inhabited a wide range of habitats throughout the island. *C. fumosus* appeared to be the most abundant of these, and was highly

Order : Sub order	Family	Species	Site																	Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Anura	Bufonidae	*Duttaphrynus melanostictus*	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	6
	Dicroglossidae	*Fejervarya cancrivora*	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	Rhacophoridae	*Polypedates leucomystax*	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	2
Squamata: Lacertilia	Dibamidae	*Dibamus taylori*	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	2
	Gekkonidae	*Crytodactylus fumosus*	X	X	X	X	-	X	X	X	X	X	-	X	X	X	X	X	-	14
		Gekko gecko	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	-	15
		Hemidactylus frenatus	X	-	X	-	-	-	X	-	X	-	-	-	-	-	-	-	-	4
		Hemidactylus platyurus	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	2
	Scincidae	*Eutropis multifasciata*	X	-	X	-	X	X	-	X	X	X	X	X	X	X	X	X	-	13
		Eutropis rugifera	-	-	-	-	X	-	X	-	-	-	-	-	X	-	-	-	-	3
		Lygosoma bowringii	-	-	-	-	-	-	-	-	-	X	-	X	-	-	X	-	-	3
	Varanidae	*Varanus salvator*	X	X	-	-	-	-	-	-	-	-	-	-	X	X	X	X	-	6
Squamata: Serpentes	Colubridae	*Ahaetulla prasina*	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Boiga multomaculata	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	1
		Coelognathus radiates	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	1
		Dendrelaphis pictus	-	-	X	-	X	-	-	X	-	-	-	X	-	X	-	-	-	5
		Lycodon aulicus capucinus	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	3
		Lycodon subcinctus	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-	-	-	2
		Pareas carinatus	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	1
		Psammodynastes pulverulentus	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	1
		Ptyas korros	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Rhabdophis chrysargos	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	1
	Crotalidae	*Cryptelytrops insularis*	-	-	-	-	-		-	-	-	X	-	-	X	-	-	-	-	2
	Elapidae	*Naja sputatrix*	-	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	2
	Typhlopidae	*Ramphotyphlops braminus*	-	-	-	-	X	-	X	-	X	X	-	-	-	-	-	-	-	4
Total			6	6	9	4	7	4	5	8	5	8	1	5	7	10	7	4	0	

Table 2. Herpetofauna recorded at the 17 sites surveyed on NP in 2011 (data collected on behalf of the Friends of the National Park Foundation).

detectable as a result of its active terrestrial lifestyle. *Hemidactylus frenatus* and *H. platyurus* were found predominately around human habitation, hunting invertebrates around artificial lights. *Lygosoma bowringii* and *Eutropis rugifera* were found at various sites throughout the island

Figure 2. An unusual red-nosed variant of *E. multifasciata* found on Nusa Penida. Photo taken at site 14 by J.L. McKay.

Figure 3. *Dibamus taylori* from Lombok. Photo by J.L. McKay.

where deep leaf litter had accumulated. *Dibamus taylori* was found at only two sites (both tropical semi-deciduous forest) in subterranean microhabitats. *D. taylori* presents an interesting case as it was the only specimen found during the study which is not a part of the south-east Asian assemblage. *D. taylori* is a lesser Sundanese species, inhabiting the seasonally drier areas of eastern Indonesia and New Guinea (Hallerman, 1998). Our *D. taylori* specimens conformed with anatomical characteristics of other populations in their range.

Thirteen species within four families of snake were recorded. Despite this high diversity, few species were recorded regularly, with the majority of observations made of single individuals. Three species measuring over a metre were found during the study: *Naja sputatrix*, *Pytas korros* and a large unidentified colubrid. Snake records came almost entirely within tropical semi-deciduous and rain forests and their adjacent habitats. The most abundant and widespread species were: *Dendrelaphis pictus*, *Ramphotyphlops braminus*, *Lycodon aulicus capucinus* and *Lycodon subcinctus*. These, with the exception of *R. braminus*, are active foragers, which no doubt increases their detectability. *R. braminus* is the most ecologically distinct of NP's snakes, its ecology and morphology more closely resemble that of *D. taylori* than any of the other snake species. Specimens of this fossorial nocturnal snake were only found via microhabitat searches.

DISCUSSION

The results of this study form the most definitive herpetofauna list for the Nusa Penida group. Our recent fieldwork increases the known number of species present by 55%, and to date four anurans, 11 lizards and 14 snakes are known from NP. Indonesian herpetofauna in general is very poorly known and even the most intensively studied areas, such as Bali, are still underestimated in terms of diversity (McKay & Lilley, 2012). We expect future work to uncover the presence of more taxa on NP, and the use of traps and surveys in varying seasons would likely to be fruitful.

From our data we infer the composition of NP's herpetofauna to essentially be frogs adapted to xeric habitats, and close-canopy forest squamates. None of the taxa associated with relictual drier open woodland were recorded, such as *Python molurus* or *Psammophis condanarus*. This fits with our understanding of modern pre-agricultural NP as receiving low and highly seasonal rainfall, and being covered with tropical semi-deciduous and evergreen forest. In comparison with its close and grander neighbour Bali, NP is predictably a smaller subset with (one exception) the same fauna. Approximately half of Bali's squamates are known from NP (11 vs 21 lizards, 14 vs 32 snakes); and only a third of Bali's frogs (four vs 13 species). Amphibian diversity on NP is likely to have been historically depauperate, as the island receives significantly lower rainfall than mainland Bali, coupled with calcareous soil of little to no water holding ability, meaning streams run only for a

Figure 4. *D. pictus* consuming a *Polypedates leucomystax*, site 3. Photo by S Asad.

short period after heavy rainfall (McTaggart, 1989). Penida was the only wetland habitat found on the island, with other bodies of water being significantly smaller and of lesser quality. As such, the habitat is also unsuitable for freshwater turtles and none of the three turtles known from Bali are recorded on NP. We observe that many large forest snakes are notably absent on NP, species such as *Ptyas mucosa*, *Gonyosoma oxycephalum* and *Bungarus candidus*, and postulate that the size of NP is not great enough to support a richer assemblage of high-ranked predators. Scrutinising the fauna of Lombok absent from NP we find that taxa associated with the Lesser Sundas, including *Lamprolepis smaragdina*, *Cyrtodactylus darmandvillei*, *Ramphotyphlops polygrammicus* and *Coelognathus subradiatus* (de Lang, 2011; Mertens, 1930) have not colonised NP. The only exception is *D. taylori*, known from Lombok and further east, but not Bali. Biogeographic barriers in the faunal transition zone termed Wallacea have been much discussed (e.g. How et al., 1996b; Kitchener & Suyanto, 1996), and the effects of changes in sea level, sea beds, and land masses in the Sundas is complex and far from precisely known (see Auffenberg, 1980). That some taxa, including large mammals such as pygmy stegodonts, dispersed eastwards into the Lesser Sundas, yet reptiles of Lesser Sunda affiliation have almost entirely failed to disperse west beyond Lombok suggests climatic factors are more important and/or these taxa have evolved in recent times, when the Lombok Strait has been an effective barrier (e.g. How et al., 1996a). The presence of *D. taylori* on NP is yet another demonstration of the region's complexity of biogeographic evolution.

Evidently the majority of areas on NP have been altered by past and present anthropogenic activity. Most habitats are secondary growth, few if any support primary vegetation. This lack of forest is attributed to felling activity initiated by convicts exiled to the island by the king of Bali more than four centuries ago, after which regrowth has been severely hindered by further felling, agricultural activity and the islanders' "slash and burn" farming practices (Giambelli, 1999). The result has been fragmentation of the island's former forests, with the remaining areas serving as biodiversity "islands" for NP's wildlife and housing the greatest remaining reptile and amphibian species richness. It is likely that they also harbour the richest caches of mammals and other vertebrate families. Therefore these resevoirs of diversity, in particular the sites at Karangsari, Tembling, Pejukutan and Mundi, are of high value for conservation. However, quantifying species richness is only one way of calculating biodiversity, for example Schmidt et al. (2000) found NP populations of *E. multifasciata* to be the most genetically divergent within the Lesser Sundas. Generalist species occupying a wide range of habitats, such as *E. multifasciata*, *G. gekko* and *Crytodactylus fumosus*, are a notable biomass and their management should not be ignored, as can be seen in the recent many-fold increase in *G. gekko* harvest for the medicine trade, a trend which easily results in local exctinction (Caillabet, 2011).

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APPENDIX

A comprehensive list of herpetofauna species found on the Nusa Penida group. Compiled from field surveys and secondary research. *denotes taxa newly recorded by the 2011 survey.

Amphibia

Anura:

Bufonidae:

Duttaphrynus melanostictus

Microhylidae:

Kaloula baleata

Dicroglossidae:

*Fejervarya cancrivora**

Rhacophoridae:

*Polypedates leucomystax**

Reptilia

Squamata: Lacertilla

Dibamidae:

*Dibamus taylori**

Gekkonidae:

Crytodactylus fumous

Gekko gecko

Gehyra mutilata

Hemidactylus frenatus

Hemidactylus platyurus

Scincidae:

Cryptoblepharus renschi

Eutropis multifasciata

*Eutropis rugifera**

Lygosoma bowringii

Varanidae:

Varanus salvator bivittatus

Squamata: Serpentes

Colubridae:

Ahaetulla prasina

*Boiga multomaculata**

*Coelognathus radiatus**

Dendrelaphis pictus

Lycodon aulicus capucinus

*Lycodon subcinctus**

*Pareas carinatus**

*Psammodynastes pulverulentus**

*Pytas korros**

Rhabdophis chrysargos

Crotalidae:

*Cryptelytrops albolabris**

Elapidae:

Naja sputatrix

Pythonidae:

Broghammerus reticulatus

Typhlopidae:

*Ramphotyphlops braminus**

Diversity and conservation of amphibians and reptiles in North Punjab, Pakistan.

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ABSTRACT - Amphibians and reptiles are the most neglected and least studied wildlife groups in Pakistan. The present study was conducted in the selected areas of districts Rawalpindi, Islamabad and Chakwal, North Punjab, Pakistan, to obtain data on herpetofaunal species richness and abundance from February, 2010 to January, 2011 using area-constrained searches. A total of 35 species of amphibians and reptiles (29 genera, 16 families, four orders) were recorded from the study area. Of the recorded species, 30 were reptiles (25 genera, 13 families, three orders) and five were amphibians (four genera, three families and a single order). A total of 388 individuals belonging to 11 recognizable taxonomic units (RTUs) with a population density of 0.22 individuals/ ha. and 4.10 encounters were recorded. Of the recorded RTUs, two (lacertids and skinks) were rated as uncommon, seven (hard-shell turtles, soft-shell turtles, agamids, gekkonids, medium and large-sized lizards, non-venomous snakes and venomous snakes) as frequent and two (toads and frogs) as common. Districts Rawalpindi/ Islamabad had higher species richness while District Chakwal had relatively higher species diversity and evenness. Threatened species of the area included the Narrow-headed Soft-shell Turtle (*Chitra indica*), Indian Soft-shell Turtle (*Nilssonia gangetica*), Peacock Soft-shell Turtle (*Aspideretes hurum*), and Brown River Turtle (*Pangshura smithii*). Threats to the herpetofauna are noted and conservation measures are discussed.

In Pakistan, amphibians are represented by a single order (Anura), while four categories of reptiles (Testudines, Sauria, Serpentes, Crocodilia) are recognised. Although inventories of the herpetofauna of Pakistan have been documented, more exploratory research on bio-ecological aspects are required. Boulenger (1890) described reptiles and amphibians of India, Pakistan, Burma and Ceylon (Sri Lanka), which was later updated by Smith (1931, 1935, 1943). Two classical and accurate records of the herpetofauna of Pakistan are by Mertens (1969) and Minton (1966). Khan (2006) also gave a detailed account of the amphibians and reptiles of Pakistan. A few notable studies from the North Punjab region of Pakistan are also available (Akbar et al., 2006; Khan, 1986; Tabassum et al., 2011; Yousaf et al., 2010), but there has been no comprehensive study of the region's herpetofauna.

Worldwide declines in amphibian and reptile populations have caused great concern in the scientific community in recent years, and regional accounts are invaluable tools for informing ecological knowledge and conservation. Around 28% (470 out of 1678) assessed reptiles (IUCN, 2009a) and 30% (1895 out of 6285) of the assessed amphibians of the world are threatened (IUCN, 2009b). The most common causes of their population decline include climate change, increased exposure to ultraviolet radiation, pathogens, introduced species, habitat destruction and modification, acid rain, and chemical stressors such as pesticides and fertilizers (Blaustein et al., 1994; Blaustein et al., 2003; Boone & Bridges, 2003; Bridges, 1997, 1999, 2000; Gibbons et al., 2000).

Quantitative data are lacking in Pakistan. The present study was therefore conducted to obtain data on herpetofaunal species richness and abundance in the districts Rawalpindi, Islamabad and Chakwal, North Punjab, Pakistan. The results present data on abundance, conservation status and encounter rates for the first time from the area,

Figure 1. Map of the study area showing locations of the selected sites within Rawalpindi, Islamabad and Chakwal Districts.

which could serve as the basis for detailed studies in the future.

MATERIALS AND METHODS

Study area

We conducted the present study in selected areas of the districts of Rawalpindi, Islamabad (Loi Bher Wildlife Park, Rawal Lake and Simly Dam) and Chakwal (Kallar Kahar Lake, Dharabi Dam and Chumbi Surla Wildlife Sanctuary) (Figure 1). The districts experience a humid subtropical climate with long and very hot summers, a short monsoon and mild wet winters. The wetlands of the area comprise of Rivers Kurrang and Soan with slow-flowing water during most part of the year; and water storage reservoirs such as the Rawal Dam, Simly Dam, Nikka Dam, Dharabi Dam and several other small dams with associated marshes (Ashraf et al., 2007; Chaudhry & Rasul, 2004). The area represents a typical arid landscape with hard substrate and scrub vegetation. The dominant trees include: *Acacia modesta*, *Acacia nilotica*, *Albizia lebbeck, Morus nigra*; *Malvastrum coromandelianum*, *Parthenium hysterophorus*; shrubs like *Dodonaea viscosa*, *Maytenus royleanus*, *Lantana camara*; and sedges such as *Calotropis procera*; and grasses *Cynadon dactylon*, *Phragmites karka*, *Sacchrum benghalense*, and *Setaria pumila*.

The Loi Bher Wildlife Park is situated in the Loi Bher forest on Islamabad Highway at a distance of 16 km from Rawalpindi City. The surface soil of the forest consists of alluvial deposits of sand and clay mixed with boulders, generally of small size (Ahmad & Ehsan, 2012). Simly Dam is an earthen embankment dam on the Soan River located 30 km east of Islamabad city. The water stored in this dam is fed by the melting snow and natural springs of the Murree Hills. It has a rocky bottom, and scrub vegetation dominates the area. The Rawal Dam is built on the Kurrang River, the main source of water to the Rawal Lake, having an area of 19 km^2 (Hussain et al., 2001; PEPA, 2004).

Kallar Kahar Lake is located 25 km north of Chakwal City. It is a permanent saline/brackish lake. There is an abundant growth of aquatic vegetation such as *Phragmites* and *Typha* along the margins especially in the south-east and eastern side (Rais et al., 2011). Dharabi Dam is situated around 4 km north-west of the Bulkasar motorway interchange. The area features mountainous terrain with some sandy areas. The Chumbi Surla Wildlife Sanctuary occupies an area of over 55,000 ha. The area features mountainous terrain with rock base consisting predominantly of sand stone and patches of red sandy clay. Small dams are built inside the sanctuary. The core area consists of natural subtropical thorn scrub forests (Chaudhry et al., 2001).

Study design

We surveyed the selected sites from February 2010 to January 2011. We made a total of 46 survey visits made up of 947 field hours. We randomly selected three sampling units within each site (total 18). Within each unit, we systematically searched an area of 100 ha. (total sampled area: 1800 ha.) and recorded the presence/absence of species, number of individuals and time spent, following established procedures (Campbell & Christman, 1982; Corn & Bury, 1990; Fellers & Freel, 1995; Heyer et al., 1994; Sutherland, 1996). We searched beneath logs, within leaf litter, and under stones by turning them over. Reptiles were observed by eye, and using binoculars. Amphibians were detected using torchlight at night (on land and in water), and collected by hand or using a dip net. Dead specimens found during the surveys or by local people were brought to the laboratory. Live specimens were anesthetised using chloroform,

Species	Rawalpindi/ Islamabad			Chakwal			Study area		
	Number	Relative Abundance	Abundance Rank	Number	Relative Abundance	Abundance Rank	Number	Relative Abundance	Abundance Rank
Order Testudines, Family Emydidae									
1. Brown River Turtle (*Pangshura smithii*)	21	20.19	1	06	7.4	3	27	14.59	1
2. Saw-back Turtle (*Pangshura tecta*)	02	1.92	7	0	0	8	2	1.08	11
Family Trionychidae									
3. Indian Soft-shell Turtle (*Nilssonia gangetica*)	04	3.84	6	01	1.23	7	5	2.7	8
4. Indian Flapshell Turtle (*Lissemys punctata andersoni*)	17	16.34	3	06	7.4	3	23	12.43	3
Order Squamata, Sub-order Sauria, Family Agamidae									
5. Common Tree Lizard (*Calotes versicolor versicolor*)	09	8.65	4	11	13.58	1	20	10.81	4
6. Black Rock Agama (*Laudakia melanura melanura*)	0	0	9	02	2.46	6	2	1.08	11
7. Field Agama (*Trapelus agilis pakistanica*)	0	0	9	01	1.23	7	1	0.54	12
Family Eublepharidae									
8. Fat- tail Gecko (*Eublepharis macularius*)	02	1.92	7	0	0	8	2	1.08	11
Family Gekkonidae									
9. Spotted Barn Gecko (*Hemidactylus brookii*)	18	17.3	2	08	9.87	2	26	14.05	2
10. Common Tuberculate Ground Gecko (*Cyrtopodion scabrum*)	04	3.84	6	02	2.46	6	6	3.24	7
Family Lacertidae									
11. Blue-tail Sand Lizard (*Acanthodactylus cantoris*)	0	0	9	02	2.46	6	2	1.08	11
12. Rugose Spectacled Lacerta (*Ophisops jerdonii*)	01	0.96	8	0	0	8	1	0.54	12
13. Smooth Spectacled Lacerta (*Ophisops elegans*)	0	0	9	06	7.4	3	6	3.24	7
Family Scincidae									
14. Earless Snake-eyed Skink (*Ablepharus grayanus*)	01	0.96	8	01	1.23	7	2	1.08	11
15 Spotted Garden Skink (*Lygosoma punctata*)	01	0.96	8	0	0	8	1	0.54	12
Family Varanidae									
16. Bengal Monitor Lizard (*Varanus bengalensis*)	04	3.84	6	08	9.87	2	12	6.48	5
17. Yellow Monitor Lizard (*Varanus flavescens*)	0	0	9	02	2.46	6	2	1.08	11
Family Uromastycidae									
18. Indus Valley Spiny-tailed Lizard (*Sara hardwickii*)	02	1.92	7	06	7.4	3	8	4.32	6
Order Squamata, Sub-order Serpentes, Family Typhlopidae									
19. Brahminy Blind Snake (*Ramphotyphlops braminus*)	01	0.96	8	0	0	8	1	0.54	12
Family Colubridae									
20. Spotted Keel Back (*Amphiesma platyceps*)	01	0.96	8	02	2.46	6	3	1.62	10
21. Banded Kukri Snake (*Oligodon arnensis arnensis*)	01	0.96	8	03	3.7	5	4	2.16	9
22. Streaked Kukri Snake (*Oligodon taeniolatus taeniolatus*)	01	0.96	8	01	1.23	7	2	1.08	11
23. Plains Racer (*Platyceps ventromaculatus*)	01	0.96	8	02	2.46	6	3	1.62	10
24. Dhaman (*Ptyas mucosus mucosus*)	02	1.92	7	03	3.7	5	5	2.7	8

25. Blotched Diadem Snake (*Spalerosophis diadema diadema*)	0	0	9	02	2.46	6	2	1.08	11
26. Checkered Keel Back (*Xenochrophis piscator piscator*)	06	5.76	5	0	0	8	6	3.24	7
Family Elapidae									
27. Common Krait (*Bungarus caerulus caerulus*)	01	0.96	8	0	0	8	1	0.54	12
Family Viperidae									
28. Saw-scaled Viper (*Echis carinatus*)	02	1.92	7	05	6.17	4	7	3.78	6
29. Russell's Chain Viper (*Daboia russelii russelii*)	02	1.92	7	01	1.23	7	3	1.62	10
Total	**1/04**			**81**			**185**		

Table 1. Abundance of reptiles recorded from Rawalpindi, Islamabad and Chakwal Districts from February 2010 to January 2011.

Species	Rawalpindi/ Islamabad			Chakwal			Study area		
	Number	Relative Abundance	Abundance Rank	Number	Relative Abundance	Abundance Rank	Number	Relative Abundance	Abundance Rank
Order Anura									
Family Bufonidae									
1. Hazara Toad (*Duttaphrynus hazarensis*)	14	12.72	4	11	11.82	4	25	12.31	4
2. Indus Valley Toad (*Bufo stomaticus*)	29	26.36	2	18	19.35	3	47	23.15	2
Family Microhylidae									
3. Ant Frog (*Microhyla ornata*)	02	1.81	5	0	0	5	2	0.98	5
Family Ranidae									
4. Skittering Frog (*Euphlyctis cyanophlyctis cyanophlyctis*)	49	44.54	1	38	40.86	1	87	42.85	1
5. Bull Frog (*Hoplobatrachus tigerinus*)	16	14.54	3	26	27.95	2	42	20.68	3
Total	110			93			203		

Table 2. Abundance of amphibians recorded from Rawalpindi, Islamabad and Chakwal Districts from February 2010 to January 2011.

and later preserved in formalin (10%) solution. Amphibians and reptiles were identified using Daniels (2002) and Khan (2006). For taxonomy, www.amphibianweb.org, www.reptile-database.org and www.iucnredlist.org were followed.

The recorded amphibians and reptiles were grouped into 11 recognizable taxonomic units (RTUs) (modified from Oliver & Beattie, 1995 and 1996). These RTUs do not represent any strict taxonomic rule; rather they represent a simplified categorisation with two benefits. Firstly, it helped to avoid taxonomic complications and misidentification, for several amphibian and reptile species were elusive, less conspicuous and less abundant in the wild. Secondly, abundance data such as population density and status could be grouped, analysed and presented in a more meaningful way. The RTUs were:

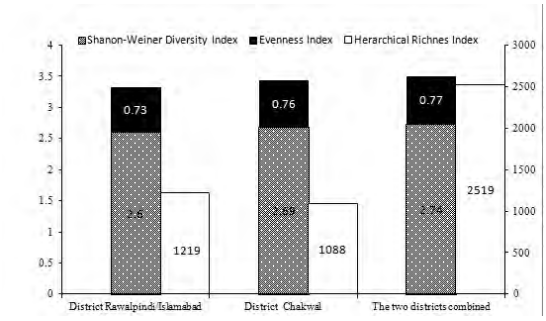

Figure 2. Comparison of indices of herpetofauna species diversity, richness and evenness recorded from Rawalpindi, Islamabad and Chakwal districts and the study area.

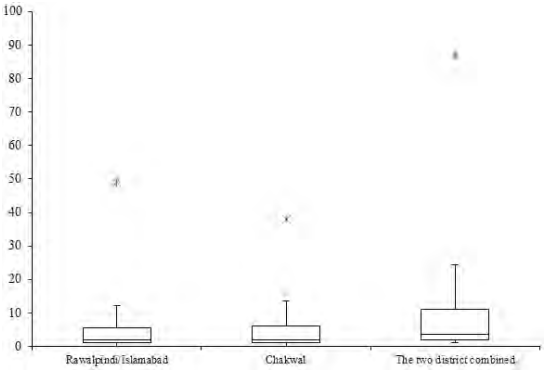

Figure 3. Box plots showing comparison of abundance of amphibians and reptiles recorded from Rawalpindi, Islamabad and Chakwal districts and the study area.

hard-shell turtles (family Emidydae), soft-shell turtles (Trionychidae), agamids (Agamidae), gekkonids (Gekkonidae, Eublepharidae), lacertids (Lacertidae), skinks (Scincidae), medium and large-sized lizards (Varanidae, Uromastycidae), non-venomous snakes (Typhlopidae, Colubridae), venomous snakes (Elapidae, Viperidae), toads (Bufonidae) and frogs (Ranidae, Microhylidae).

Several key metrics were calculated: relative abundance (total number of individuals per species, divided by total number of individuals of all species, multiplied by 100), population density (number of individuals/area) and encounter rate (number of individuals per 10 hours of survey) = number of individuals multiplied by 10, divided by total field hours. On the basis of number of individuals recorded, species were also given an integer abundance rank, with 1 being the most abundant. Species with an encounter rate of 0.00 - 0.01 were rated as scarce; 0.02 - 0.10 as uncommon; 0.11 - 0.50 as frequent; and over 0.50 as common. The Shanon-Weiner Diversity Index (H)= $\sum$pi ln pi was calculated, where pi is the number of individuals of a species as a proportion of total individuals of all species, and ln is the log of pi. The Evenness Index (E) = H/ ln (S) was also calculated, where H is the Shanon-Weiner Diversity Index and S is the number of species and Hierarchical Richness Index (for calculation details see French, 1994). Based on the data, non-parametric tests were applied using SPSS 17.0. The abundance data were plotted as box plots, and medians were compared using Wilcoxon test.

RESULTS

A total of 35 species of amphibians (examples in Figure 6) and reptiles (29 genera, 16 families, four orders, see examples shown in Figures 4 & 5) were recorded from Rawalpindi, Islamabad and Chakwal districts during the present study. Of the recorded species, 30 (86%) were reptiles (25 genera, 13 families, three orders) and five (14%) were amphibians (four genera, three families and a single order) (Table 1 & 2). A total of 185 individuals of 29 reptile species, and 203 individuals of five amphibian species, were recorded. Brown River Turtle (*Pangshura smithii*) (14.59%) and Skittering Frog (*Euphlyctis cyanophlyctis cyanophlyctis*) (42.85%) were recorded as the most abundant reptilian and amphibian species, respectively (Tables 1 & 2).

Species richness was high in Rawalpindi and Islamabad districts (Hierarchical richness index = 1219). Chakwal District had high species diversity (Shannon-Weiner diversity index = 2.69). Chakwal District also showed a slight even distribution in the number of individuals (Evenness index = 0.76) (Figure 2). However, Wilcoxon test showed that the difference between the medians of the total number of individuals recorded from Rawalpindi, Islamabad districts and Chakwal District was not-significant ($Z = -0.67$; $P = 0.498$). We therefore attribute the observed difference in species richness and diversity to chance encounter with the species and individuals. Box plot of District Rawalpindi and Islamabad districts showed bunched data while

Figure 4. Examples of snake species recorded during the survey. A: Dhaman (*Ptyas mucosus mucosus*) (Juvinile); B: Saw scale Viper (*Echis carinatus*).

District Chakwal data showed relatively higher spread (Figure 3).

A total of 388 individuals belonging to 11 recognizable taxonomic units (RTUs) with a population density of 0.22 individuals/ha and 4.10 encounters were recorded. Of the recorded RTUs, two (lacertids and skinks) were recorded as uncommon; seven (hard-shell turtles, soft-shell turtles, agamids, gekkonids, medium and large-sized lizards, non-venomous snakes and venomous snakes) as frequent; and two (toads and frogs) as common (Table 3).

As per IUCN red list of threatened species the status of one species viz. Narrow-headed Soft-shell Turtle (*Chitra indica*) is Endangered; two viz. Indian Soft-shell Turtle (*Nilssonia gangetica*) and Peacock Soft-shell Turtle (*Aspideretes hurum*) are Vulnerable while one Brown River Turtle (*P. smithii*) is Near Threatened. The majority of the recorded species (n = 21; 60%) are unprotected under territorial laws (Punjab Wildlife Acts and Rule, 1974; and Islamabad Wildlife Protection, Preservation, Conservation and Management Ordinance, 1979) while species belonging to families Emydidae, Trionychidae, Varanidae, Uromastycidae and Colubridae and the genus *Naja* enjoy protection under law (Khan & Mahmood, 2004).

Hunting and trapping of turtles (particularly soft-shell turtles), trapping of snakes by snake charmers, killing of snakes out of fear, varanid roadkill, and aquatic pollution due to organic matter and pesticides were recorded as the main threats to the herpetofauna.

DISCUSSION

A relative dearth of literature precludes a detailed discussion on herpetofauna species abundance and conservation status in these districts of Pakistan, and this study adds significantly to the available knowledge. Khan (1986) reported one species of toad, three frogs and nine species of lizards and snakes each from the District of Mianwali which is located 164 km from Chakwal District, North-western Punjab. Of 24 previously-reported species (Khan, 1986), 12 were recorded during the present study. The difference in species number is attributed to different study sites. Akbar et al. (2006) reported eight species of freshwater turtles from the Punjab province with Brown River Turtle (*P. smithii*) as the most abundant species. During the present study, Brown River Turtle was also reported as the most abundant (14.59%).

By comparison, Khan and Mahmood (2004) collected 215 individuals of reptiles belonging to two agamid species from Karachi in Sindh, with Common Tree Lizard (n = 187) as the most abundant species. Common Tree Lizard was found to be the fourth most abundant reptile in our study (Abundance Rank = 4; 10.81%). It is therefore concluded that Brown River Turtle is the most abundant freshwater turtle, and Common Tree Lizard is the most abundant arboreal lizard in much of the country.

An estimated 13,000 metric tonnes of live turtles were traded in 1999 from different countries of Southeast Asia of which soft-shell turtles constitute the major proportion (Anonymous, 2001; Lau & Shi, 2000; McCord, 1997; Salzberg, 1998). Data relating to the trade of testudines, particularly freshwater soft-shell turtles, are lacking in Pakistan. Based on field observations during the present study, it is maintained that freshwater turtles, particularly soft-shell turtles, are being

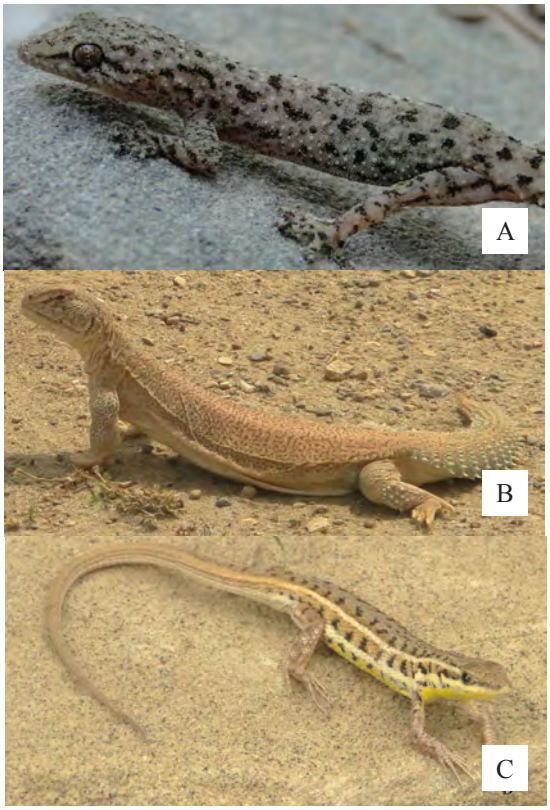

Figure 5. Examples of lizards recorded during the survey. A: Spotted Barn Gecko (*Hemidactylus brookii*); B: Indus Valley Spiny-tailed Lizard (*Sara hardwickii*); C: Rugose Spectacled Lacerta (*Ophisops jerdonii*).

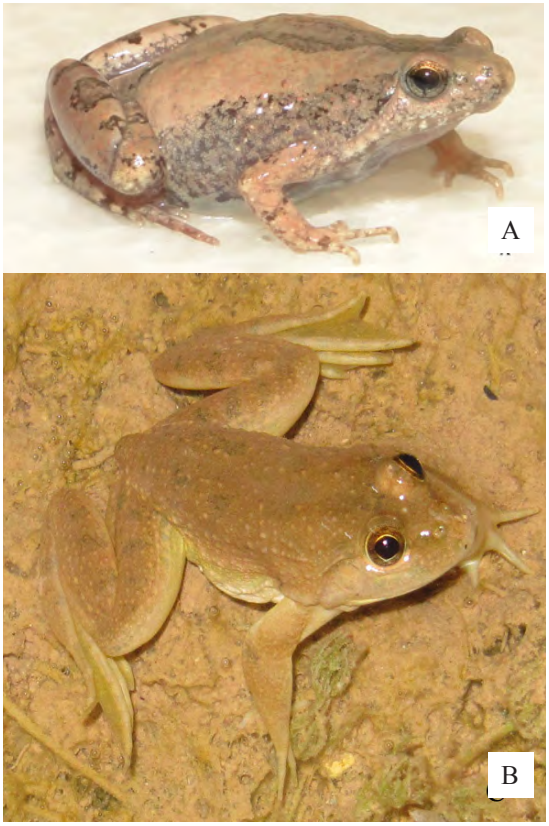

Figure 6. Examples of anurans recorded during the survey. A: Ant Frog (*Microhyla ornata*); B: Skittering Frog (*Euphlyctis cyanophlyctis*).

trapped and traded to be smuggled out of Pakistan. It is of great concern, as the turtle species such as Indian Soft-shell Turtle (*Nilssonia gangetica*) involved in the trade are not as common as that of hard-shell turtles, which do not fall victim of illegal trade. Although all freshwater turtle species are now protected and have now been included in the Third Schedule of the Punjab Wildlife Acts and Rule (1974) and Islamabad Wildlife Protection, Preservation, Conservation and Management Ordinance (1979), but still weak law enforcement encourages poachers to capture turtles in large numbers. Globally, large lizards account for over 50% of all lizards which are considered threatened (IUCN, 2009a). Many populations of monitor lizards are threatened due to habitat destruction and fragmentation (Pianka, 1969). Of all the lizard species we found, the varanids and the Indus Valley Spiny-tailed Lizard (*Uromastyx hardwickii*) were found to be threatened by killing and trapping respectively. Quantitative data regarding amphibian population are lacking in most southeast Asian countries with Pakistan having almost no amphibian experts at present (Molur, 2008). The present study revealed low amphibian population densities. Frogs belonging to family Ranidae were recorded as common with 0.07/ha.

An important conservation measure would be stricter implementation of existing wildlife protection laws (Punjab Wildlife Acts and Rule, 1974; Islamabad Wildlife Protection, Preservation, Conservation and Management Ordinance, 1979). Although the situation is better in Islamabad, reports of freshwater turtle trapping were still obtained. Inhabitants of the area need to be counselled regarding the values of different herptile

	Rawalpindi/Islamabad					Chakwal					Study area				
	Numbers	Relative frequency	Population density	Encounter rates	Status	Numbers	Relative frequency	Population density	Encounter rates	Status	Numbers	Relative frequency	Population density	Encounter rates	Status
Hard-shell Turtles	23	10.75	0.03	0.32	F	6	3.45	0.01	0.27	F	29	7.47	0.02	0.31	F
Soft -shell Turtles	21	9.81	0.02	0.29	F	7	4.02	0.01	0.31	F	28	7.22	0.02	0.30	F
Agamids	9	4.21	0.01	0.12	F	14	8.05	0.02	0.63	C	23	5.93	0.01	0.24	F
Gekkonids	24	11.21	0.03	0.33	F	10	5.75	0.01	0.45	F	34	8.76	0.02	0.36	F
Lacertids	1	0.47	0.00	0.01	S	8	4.60	0.01	0.36	F	9	2.32	0.01	0.10	U
Skinks	2	0.93	0.00	0.03	O	1	0.57	0.00	0.04	O	3	0.77	0.00	0.03	U
Medium and Large-sized Lizards	6	2.80	0.01	0.08	O	16	9.20	0.02	0.71	C	22	5.67	0.01	0.23	F
Non-venomous Snakes	13	6.07	0.01	0.18	F	13	7.47	0.01	0.58	C	26	6.70	0.01	0.27	F
Venomous Snakes	5	2.34	0.01	0.07	O	6	3.45	0.01	0.27	F	11	2.84	0.01	0.12	F
Toads	43	20.09	0.05	0.59	C	29	16.67	0.03	1.29	C	72	18.56	0.04	0.76	C
Frogs	67	31.31	0.07	0.93	C	64	36.78	0.07	2.86	C	131	33.76	0.07	1.38	C
Total	214		0.24	2.96		174		0.19	7.77		388		0.22	4.10	

Table 3. Number, relative frequency, population density and status of the recorded Recognizable Taxonomic Units of herpetofauna recorded from Rawalpindi, Islamabad and Chakwal Districts during February 2010 to January 2011. *Status C = Common = 0.5 and above; F = Frequent = 0.11 to 0.5; U = Uncommon = 0.02 to 0.10; S = Scarce = 0.00 to 0.01.

species, to lessen the pressure of indiscriminate killing of snakes, varanids and other lizards. A few steps that could be taken in this regard include: i) 'roadshows' of herptiles to familiarise people with different species, ii) distribution of brochures containing information on occurrence and identification of venomous and aggressive vs non-venomous and harmless species, and iii) educating people what to do if they encounter such species. Encouraging people to take up herpetoculture of a few economically-important species such as frogs, freshwater turtles and venomous snakes might be difficult, but is highly recommended. We suggest provision of tunnels under roads in all construction projects would reduce road mortality of anurans migrating to breeding ponds.

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Influences of microhabitat and light level on great crested newt *Triturus cristatus* capture in bottle-traps

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ABSTRACT - Bottle-trapping is an important surveying method for the European protected species *Triturus cristatus*, yet little is known of factors affecting capture. Influences of light level and trap proximity to plants were investigated in a garden pond in Surrey England, using video-records and comparing night counts with trap success. In shallow water (15 cm) males were highly sensitive to light levels; compared with females, 70% avoided capture. In small, 0.05 m^2, shaded spaces for both sexes catches were proportional to the number present. Proximity of egg substrate material appeared conducive for female capture.

Surveying and monitoring are key elements of nature conservation; data is required for determination of the conservation status of target species, to support research, inform policy makers and implement conservation measures (Beebee & Griffiths, 2000; Sutherland, 2000; Gleed-Owen et al., 2005). For newts this is undertaken when they are concentrated in ponds for the breeding season, a two month period during March to May (English Nature, 2001). Of the four methods used (egg-searching, netting, night-time counts and bottle-trapping (Griffiths, 1985)), only counts and trapping are considered suitable for assessment of population status (Griffiths et al., 1996). Visual detection is impaired by rain, wind (English Nature 2001) water turbidity and vegetation (Griffiths & Inns, 1998), but for both of these methods detection is enhanced with increasing water temperature above 5°C (Sewell et al., 2010). Further factors influencing capture appear to be unknown (Jehle et al., 2011) beyond negative effects of moonlight (Deeming, 2008) and increasing amounts of aquatic vegetation (Oldham et al., 2000). However, illumination within bucket traps might be beneficial for catching breeding crested newts (Beckham & Göcking, 2012). Identification of further factors affecting the probability of newt detection could benefit conservation effort (Foster & Beebee, 2004; Schmidt, 2004).

This study aims to identify microhabitat features that influence the likelihood of newt capture. Specific objectives are to determine any effects of a light intensity gradient and the extent of vegetation-free water either side of a trap. Behaviour close to bottle-traps was studied in a garden pond using video-recording. Without the artificial lighting necessary for this, visual observations were used to assess newt presence to compare with catches from overnight bottle-trapping and determine behaviour characteristics throughout the pond. A possible effect of trap orientation was also investigated.

MATERIALS AND METHODS

The study site

The eight square metre garden pond (Figure 1), supports natural populations of all three native urodeles, the great crested newt *Triturus cristatus*, the smooth newt *Lissotriton vulgaris* and the palmate newt *L. helveticus* besides the common frog *Rana temporaria*. It has a flat floor 50 cm deep, steep sides and a marginal shelf at 20 cm depth and width 25 cm (Figure 2). Plants on the shelf, in black plastic baskets with vertical 20 cm sides, are some emergent *Iris* and *Carex* species beside egg-deposition plants, *Myosotis scorpioides*, *Ranunculus flammula* and *Veronica beccabunga*, that trail over the basket edges into the water. Further egg-deposition plants fill regions at the east and west ends of the pond. The floor is covered in *Ceratophyllum demersum*, and baskets

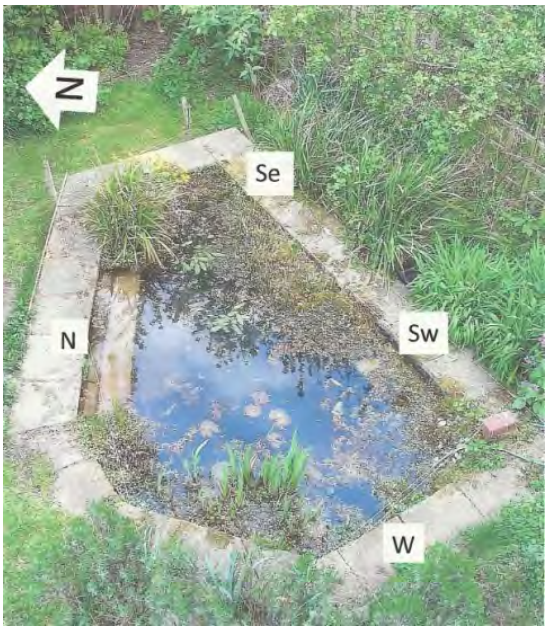

Figure 1. The garden pond (3.9 x 2.6 m), depth 0.5 m. The four spaces on the marginal shelf, N, W, Sw and Se were in length 155 or 80 cm and three 22 cm long respectively. Trailing plants partially mask the smaller spaces.

contain *Aponogeton distachyos* and a Nuphar lily.

Environmental conditions and experimental design

Experiments were conducted under favourable weather conditions during the newt breeding season in 2001 and 2002. Spaces for bottle-traps, 155 or 80 cm and 22 cm long, were created on the pond shelf between plant baskets (Figure 1). Traps, constructed from green transparent two litre drinks bottles (Figure 2), on paving slabs at a depth of 15 cm, 10 cm from the deeper water faced the pond centre. Video-recording equipment (Figure 3) was set up over the 155 or 80 cm length with a laminate sheet on the paving slabs defining the recorded area (Figures 3 & 4). Traps were set just before sunset and removed shortly after sunrise the following morning. Video-recording commenced at sunset as newt nocturnal breeding activity commences at dusk (Dolmen, 1983; Zuiderwijk & Sparreboom, 1986). Records of three hours duration captured representative samples of behaviour (Zuiderwijk

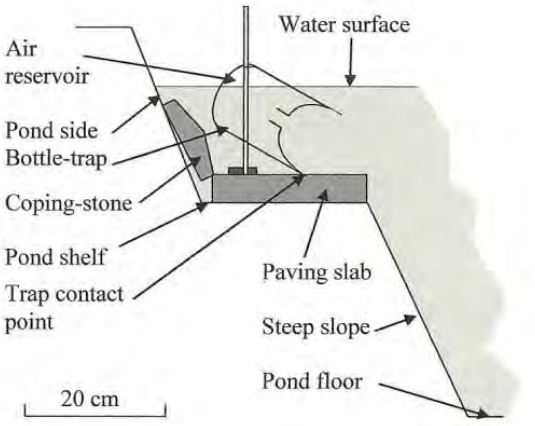

Figure 2. Bottle-trap design, pond profile and trap location. Traps tilted at 30º to the horizontal were held in place by a cane passing through the trap and inserted in a section of tile on the substrate. To give a uniform horizontal substrate, depth 15 cm, paving slabs were placed on the shelf. Coping-stones resting on the slabs formed a straight edge at the pond side (Figures 3 & 4).

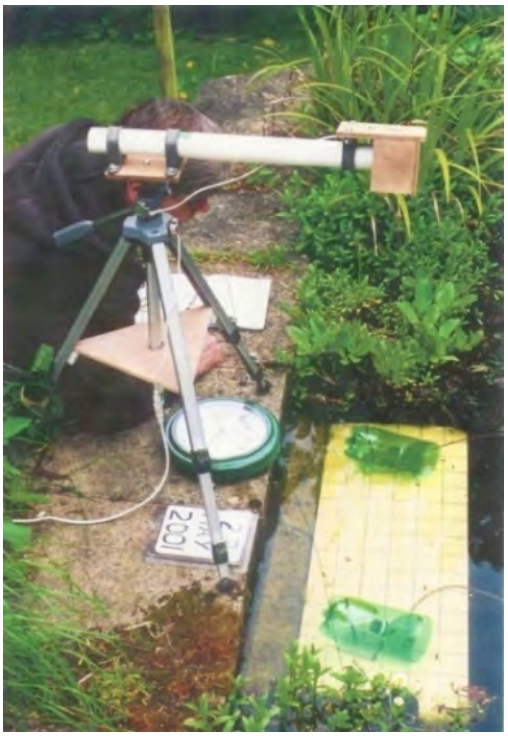

Figure 3. The video-recording set-up with a 30 x 80 cm laminate sheet defining the recorded area and the camera mounted over the area centre.

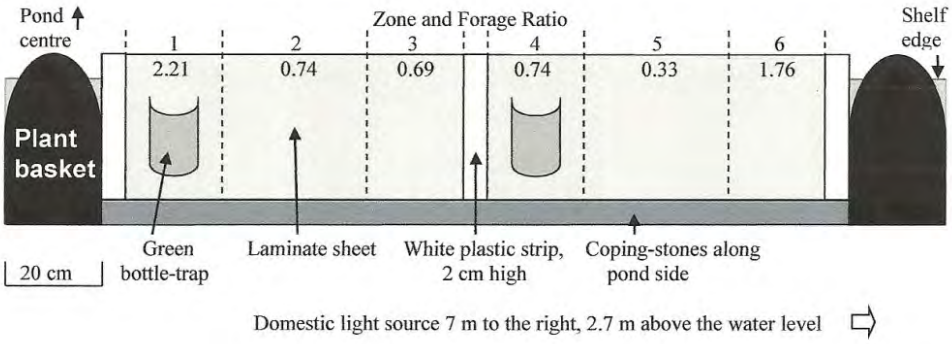

Figure 4. Plan view of the first video-recorded area, the 155 x 30 cm laminate sheet. Three white plastic strips define the side boundaries of two identical trap microhabitats 70 x 30 cm. Traps were 10 and 60 cm from the nearest basket. Zone 1 of six was most distant from the light source to the right. Forage Ratio is defined in the text, values greater than one indicate a greater than expected newt presence.

& Sparreboom, 1986; Lehner, 1996). Visual observations and a night count took place about two hours after sunset on nights when no traps were in place.

Light intensity gradient

The illumination required when recording was from domestic lighting shining along the length of the area from the right (Figure 4), so with a slight reduction in light strength from Zone 6 to Zone 1. Light intensity, measured 25 cm above the centre of Zone 2 and Zone 5, was five lux in each case using a light meter with a resolution of one lux. Forage ratios (Krebs, 1989), the observed/expected time spent in each zone were compared. The observed time was obtained from eight video-records and the expected time derived from the proportion of the recorded area taken up by the zone.

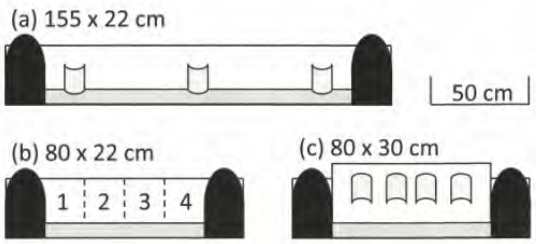

Figure 5. Areas of spaces between baskets and trap locations: (a) used for comparison with results obtained on video-recording nights; (b) the 80 cm long space treated as four 20 cm sections, 1 – 4; (c) four traps, 5 cm apart, facing and 10 cm from the coping-stones; to ensure trap stability they were placed on a laminate sheet.

Extent of vegetation-free water either side of the trap

In 2001, traps were placed 10 or 60 cm from the nearest plant basket on video-recording nights (Figure 4 eight sessions and Figure 3 four sessions). The shorter length (Figure 3) increased the chance of newts in the recorded area encountering traps. After three hours of recording the domestic lighting was switched off and traps remained in place until the following morning. Numbers of newts recorded entering a trap funnel, then either retreating or passing through the funnel neck into the trap were compared with trap proximity to plants. In the absence of any artificial lighting three traps were set on five further nights using the same 155 cm long space; two 10 cm from the nearest basket, the third 72.5 cm (Figure 5a). The results were compared with the overnight catches obtained when there had been video-recording.

Results from 2001 showed a difference in susceptibility to capture between the sexes and also the proximity of plant baskets influenced trap success. The effects on capture for traps in smaller spaces were explored in 2002; the 80 cm space being used with three 22 cm spaces, at respectively N, W, Sw and Se (Figure 1). Presence in each space of each sex was assessed from night

Period of collection	Space length (cm)	Video record	Number of sessions	Funnel entries						Captures					
				L		C		R		L		C		R	
				♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
12.4 -20.5	155	Yes	8	20	2	5	1	*	*	1	2	0	0	*	*
3.5 -13.5	80	Yes	4	14	3	*	*	5	4	0	0	*	*	0	2
12.4 -20.5	155	No	8							2	3	0	2	*	*
3.5 -13.5	80	No	4							2	3	*	*	0	6
10.4 –8.5	155	No	5							8	4	1	1	4	2

Table 1. Numbers of video-recorded funnel-entries and captures and overnight catches compared for traps 10 cm from plant baskets (L & R) with those ≥60 cm (C) distant (Figures 4, 3 & 5a). *No trap present.

Space			Total count			Total catch	
Length (cm)	Section	Location	♂	♀	*	♂	♀
80		N	57	6	4	17	10
	1		22	3	3	2	2
	2		13	1	0	6	0
	3		5	0	0	4	3
	4		17	2	1	5	5
22		W	23	11	10	19	15
22		Sw	15	7	4	19	7
22		Se	19	1	1	17	1
Elsewhere in the pond			51	54	37		

Table 2. Count and catch totals in four spaces (Figure 1), also for each 20 cm section (Figure 5b) of the 80 cm space. Counts were extended to include all newts visible in the pond. *Number of sightings of egg laying females.

counts (32 sessions) and compared with catches (15 sessions). During counts a possible bias due to plant proximity in the 80 cm space was investigated by treating it as four 20 cm long sections (Figure 5b). In this longer space traps faced the pond side (Figure 5c) where video-records showed relatively high newt presence, to explore the influence of trap orientation.

Behaviour characteristics

With excellent water clarity the expectation was that a high proportion of newts above the floor vegetation would be visible, so the count survey was extended to cover the whole pond. To determine behaviour characteristics of the active population, sex, habitat and activity were recorded for each sighting.

RESULTS

Light intensity gradient

Any influence due to trap or plant proximity was expected to be identical in Zones 2 and 5 (Figure 4). The forage ratios of 0.74 and 0.33 respectively suggest negative phototaxis, further suggested by the highest forage ratio, 2.21, being in Zone 1 most distant from the light source. Shading from the trap, and plant basket in Zones 4 and 6 respectively were seen to be attractive to newts on the video records resulting in the relatively higher forage ratios in these zones. Since 84% of newt sightings were male, this preference for places with lower light levels may be sex related.

Extent of vegetation-free water 155 or 80 cm

Video-records of 54 newt entries into a trap funnel were obtained (Table 1). Only five resulted in capture; these all occurred in a trap 10 cm from a basket. As too did 22 (79%) funnel-entries, compared with 7 (21%) at the trap 60 cm from a basket. Funnel-entrants were predominantly male (81%), but four of the five captives were female.

In the complete absence of any video-recording illumination there was still a tendency for higher trap success near plant baskets with 12 of 13 males (Table 1) in the two end traps of the 155 cm long space (G_{adj} = 4.697, df = 1, P < 0.05). The female total in these traps, six of seven captures, suggests a similar bias. Possible influence of three hours of artificial lighting on the overnight catch of each sex was examined by comparing the mean catch/trap of traps 10 cm from a basket. For males with and without lighting these were 0.25 and 1.2 respectively and 0.7 and 0.6 for females.

Newt capture and activity at traps was greater near vegetation baskets and males compared with females were avoiding capture. This avoidance was far greater when there was or had been period of elevated light level (intensity 5 lux). This lighting had no effect on female capture.

Extent of vegetation-free water 80 or 22 cm

Along the 80 cm length there were 22, 13, 5 and 17 male sightings in sections 1 to 4 respectively (Table 2), indicating a bias towards sections 1 and 4, those closer to plants (G_{adj} = 7.853, df = 1, P < 0.01). Also five of six female sightings were in these sections. For each of the four spaces count/catch ratios were similar in all spaces for females, 0.6 - 1.0 (Table 2). For males this was also the case in the three short spaces, 0.8 - 1.2. However in the larger space, the total number of male sightings was 57, and much lower for catches: 17, 30% of the count.

A preference was shown for being less than 20 cm, rather than 20 to 40 cm, from plant baskets. Where traps were within 10 cm of plant baskets on both sides and partially shaded by floating vegetation, the catch of both sexes was representative of the number present, but in the larger space much depressed for males.

Trap orientation

With traps facing the pond centre (Figure 5a) the mean catch per night was four newts (Table 1) and when facing the much smaller region (Figure 5c) at the pond side 1.8 (Table 2). The proportion of sightings that were male was 84% and 90% and of captures 65% and 63% respectively. Newts on the substrate at the pond side were susceptible to capture and with a similar proportion of each sex caught, capture appeared unaffected by trap orientation.

Behaviour characteristics

From the night counts throughout the pond, 69% of the male sightings (n = 165) were within the four spaces created for placing traps and typically on the substrate (Table 2); these were used as display areas. In total 85% were in a display area and or interacting with other newt(s). For female sightings (n = 79) only 32% were within the spaces and 89% were among plants many egg-laying. In the four spaces egg substrates were more abundant where catches and counts of females were highest, space W, and little was available in space Se where there was a single capture and sighting. This suggests female presence and capture is related to the availability of egg substrate material close by.

DISCUSSION

In this study as in others (Zuiderwijk & Sparreboom, 1986; Hedlund & Robertson, 1989) the proportion of newts that were male in open water and usually on the pond floor was high; this being the microhabitat they use for displaying to other newts. Preferred regions of open water appear to be where they could be less conspicuous (Cooke, 1986; Oldham & Nicholson, 1986; Zuiderwijk & Sparreboom, 1986; Grusser-Cornehis & Himstedt, 1976; Gustafson et al., 2006), at edges such as plant boundaries or a steep pond side or shaded by vegetation. Displaying males could attract predators and their nocturnal breeding habit and these preferences suggest anti-predator behaviour (Endler, 1986, 1987). They appear to behave as unthreatened in water at a depth of 50 cm (Hedlund & Robertson, 1989). In my study, in a water depth of 15 cm, a high proportion of males avoided capture, a trait not observed for females even with

a raised light level. Females in fulfilling their egg-laying role could be attracted to lighter regions of a pond beneficial for plant growth (Cooke et al., 1994) and where egg-laying occurs (Sztatecsny et al., 2004).

With males concentrated in display regions bottle-trap success might benefit by placing traps on the pond floor facing into open water and beside edge features or in shaded open water. With female capture apparently associated with egg-laying setting traps amongst egg deposition plants is also recommended. Placing these traps near the water surface may be beneficial (Miaud, 1995; Langton et al., 1994). Further work including video-recording might allow a fuller understanding of factors influencing the capture of crested newts.

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Notes on reproduction of the snake-eyed skink, *Ablepharus kitaibelii* (Squamata: Scincidae) from Israel

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The snake-eyed skink, *Ablepharus kitaibelii* is widely distributed in the Old World including most of eastern and southern Europe, Turkey and middle eastern countries (Uetz & Hosek, 2012). Reports on its reproduction include clutches of 2-4 eggs in Bulgaria and Greece (Beshkov & Nanev, 2006; Valakos et al., 2008); 4-5 eggs in Romania (Fuhn & Vancea, 1961), 2-5 eggs in Turkey (Baran & Atatür, 1998) and a maximum of 3 eggs per clutch in Israel (Bar & Haimovitch, 2011). The purpose of this paper is to present data on reproduction of *A. kitaibelii* in Israel, including the first histological information on the testicular cycle. Minimum sizes for male and female reproductive activity in Israel are presented. Information on the reproductive cycle including period of sperm production, timing of yolk deposition and number and sizes of clutches provides important information in formulating conservation policies for lizard populations.

Due to the difficulty in justifying collections of monthly lizard samples, utilization of museum collections for obtaining reproductive data has become increasingly important.

A sample of 46 adult *A. kitaibelii* was borrowed from the herpetology collection of the National Collections of Natural History at Tel Aviv University (TAUM), Tel Aviv, Israel consisting of 21 males (mean SVL = 30.2 mm ± 3.9 SD, range = 23-38 mm), 21 females (mean SVL = 33.7 mm ± 2.8 SD, range = 31-42 mm) and 4 sub-adult females (mean SVL = 27.5 mm ± 0.58 SD, range = 27-28 mm) collected during 1942-2003 was examined (Appendix).

Lizard body sizes (snout-vent length) were measured to the nearest mm using a plastic ruler. For histological examination, the left testis was removed from males and the left ovary was removed from females. Enlarged follicles (> 3 mm length) or oviductal eggs were counted (in situ). Tissues were embedded in paraffin and cut into sections of 5 µm. Slides were stained with Harris' hematoxylin followed by eosin counterstain (Presnell & Schreibman, 1997). The slides of testes were examined to determine the stage of the spermatogenic cycle while the slides of ovaries were examined for the presence of yolk deposition or corpora lutea. Histology slides were deposited in TAUM. An unpaired t-test was used to compare *A. kitaibelii* male and female mean body sizes (Instat, vers. 3.0b, Graphpad Software, San Diego, CA).

Three stages were noted in the testicular cycle (Table 1): (1) regressed in which the seminiferous tubules contain mainly spermatogonia with interspersed Sertoli cells; (2) recrudescence in which the proliferation of germ cells for the next period of sperm formation has commenced. Primary spermatocytes predominate; (3) spermiogenesis in which the lumina of the seminiferous tubules are lined by sperms and/or clusters of metamorphosing spermatids. Spermiogenesis occurs during the spring and was also observed in one male from November (Table 1). Two males from March had not commenced spermiogenesis and exhibited recrudescence. Epididymides were not sectioned but all were enlarged in males undergoing spermiogenesis and presumably contained sperm. The smallest reproductively active male (spermiogenesis in progress) measured 23 mm SVL (TAUM 2967) and was collected in March. Twenty-three mm may be an approximation for minimum reproductive size as no males smaller than this size were examined.

The mean SVL of *A. kitaibelii* females was significantly larger than that of males (unpaired t-test, t = 3.1, df = 38, P = 0.004). Four stages were observed in the ovarian cycle (Table 1): (1) quiescent, in which there is no yolk deposition; (2) early yolk deposition, in which vitellogenic granules are accumulating within some follicles; (3) enlarged pre-ovulatory ovarian follicles > 3 mm; (4) oviductal eggs (eggs in oviducts). Reproductively active females were present in March, April and

Males

Month	N	Regression	Recrudescence	Spermiogenesis
February	1	1	0	0
March	9	0	2	7
April	9	1	0	8
May	1	0	0	1
November	1	0	0	1

Females

Month	N	Quiescent	Early yolk deposition	Follicles > 3 mm	Oviductal eggs
February	1	1	0	0	0
March	5	4	1	0	0
April	12	6	2	2	2
May	1	1	0	0	0
July	1	1	0	0	0
September	1	1	0	0	0

Table 1. Monthly stages in the testicular cycle of 21 *A. kitaibelii* males and 21 females from Israel.

Month	N	Quiescent	Early yolk deposition	Follicles > 3 mm	Oviductal eggs
February	1	1	0	0	0
March	5	4	1	0	0
April	12	6	2	2	2
May	1	1	0	0	0
July	1	1	0	0	0
September	1	1	0	0	0

Table 2. Monthly stages in 21 *A. kitaibelii* females from Israel.

June. There was no evidence (oviductal eggs or corpora lutea and concomitant yolk deposition in the same female) to indicate *A. kitaibelii* produces multiple clutches. Mean clutch size (n = 4) is 1.5 ± 0.58 SD, range = 1-2. The smallest reproductively active female (TAUM 2530) measured 33 mm SVL (enlarged ovarian follicle > 3 mm) and was collected in June. I arbitrarily selected 30 as the minimum size for reproductive maturity in females and considered 3 females of 27, 27 and 28 mm SVL as subadults.

My sample size is too small for a definitive description of the *A. kitaibelii* reproductive cycle in Israel. Nevertheless, some conclusions can be made. Reproduction occurs in the spring in Israel as has also been reported to occur in Northern Cyprus (Göcmen et al., 1996), Bulgaria (Stojanov et al., 2011) and Greece (Valakos et al., 2008). Sperm formation commences in late autumn in Israel as one male from November was undergoing spermiogenesis. There was no evidence that females produce multiple egg clutches in the same reproductive season, although this may have resulted from my small sample size. In view of the

extensive range of *A. kitaibelii* (Uetz & Hosek, 2012) subsequent study of populations from other areas in its range are warranted to ascertain if there is geographic variation in reproduction.

I thank Shai Meiri (TAUM) for permission to examine *A. kitaibelii*, Erez Maza (TAUM) for facilitating the loan and the National Collections of Natural History at Tel Aviv University for providing samples of *A. kitaibelii* for this study.

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APPENDIX

Ablepharus kitaibelii from Israel examined by District: Center, (TAUM) 736, 11436; Haifa, (TAUM) 746, 4936, 5154, 5155, 13789; Jerusalem, (TAUM) 12372, 14869; Northern, (TAUM) 732, 734, 739, 740, 743, 747, 749, 1437, 2528-2531, 2904, 2966- 2968, 3859, 3883, 6026, 6057, 6060, 6062, 11143, 12073, 12371, 12688, 12968, 13406, 15710; Southern, (TAUM) 5980, 8504, 8951, 12960, 13781; Tel Aviv, (TAUM) 3957, 3958, 9375.

Body-bending behaviour: a new instance in a terrestrial snake from Brazil

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Snakes exhibit a wide range of antipredator tactics including cryptic colouration, immobility, struggling, cloacal discharging, sound production, S-coil posture, vibrating the tail, actively breaking the tail, exuding blood from the eyes, feigning death, biting and spitting venom (Greene, 1997). In addition, a defensive behaviour called body-bending has been described for the first time for two species of arboreal colubrids, *Pseustes poecilonotus* and *P. sulphureus* (Beebee, 1946; Abuys, 1986). This behaviour was then interpreted as a defensive tactic in which, by bending its body, a snake can increase the resemblance it may already have to some portions of its habitat as bent sticks and lianas that are often found among branches in the canopy or on the forest floor,

Figure 1. View of "Restinga" habitats at Lençóis Maranhenses National Park, Maranhão state, Northeastern Brazil.

Figure 2. *Psomophis joberti* from Lençóis Maranhenses National Park, Maranhão state, Northeastern Brazil, exhibiting body-bending behaviour.

hence escaping potential predators (Beebee, 1946; Abuys, 1986). In recent years, new instances of body-bending behaviour have arisen: Marques et al. (2006) reported the body-bending behaviour for two species (*Philodryas viridissimus* and *Spilotes pullatus*) from Brazil and Doherty-Bone (2009) reported it for *Pantherophis spiloides*, a species from North America. Considering that until then body-bending behaviour was known only for arboreal snake species, Marques et al. (2006) suggested that it could have evolved independently in the Xendontinae and Colubrinae as an adaptation to arboreal life. However, Maddock et al. (2011) described body-bending behaviour in another two species from Northwest Ecuador: the terrestrial *Coniophanes fissidens* and the semi-arboreal *Chironius monticola*. Maddock et al. (2011) argued that body-bending behaviour in Neotropical snakes could be more widespread than previously thought and that the adaptive value of that behaviour could extends further than the arboreal life style.

Herein, we provide a new instance of body-bending behaviour in *Psomophis joberti* (Sauvage, 1884) from Northeastern Brazil, which is the first report of this behaviour in a terrestrial species which lives in open habitat. The genus *Psomophis*, in the subfamily Dipsadinae, has three species that are found in South America (Myers & Cadle, 1994). *P. joberti* is a diurnal and terrestrial species distributed in central and northeastern Brazil, with a disjunct population in Marajó Island, Pará (Myers & Cadle, 1994; França et al., 2006). On June 23rd 2005 at 16:00 h, we observed an individual of *P. joberti* (Male, SVL: 236 mm) moving on sand in an open area of "Restinga" in Lençóis Maranhenses National Park (LMNP), Maranhão, Northeastern Brazil (02° 32' 31.7"S and 43° 11' 28.3" W, SAD69). "Restinga" habitats in LMNP are mosaics of open areas with herbaceous and shrubby vegetation (Figure 1). Initially, the snake was in a normal posture, but upon our approach it began to display the body-bending behaviour (Figure 2). We took a picture and collected the individual, which kept its bending posture even after collection and handling. On March 10th 2006 at 16:01 h, we observed another individual of *P. joberti* (Male, SVL: 292mm) in the same park (02° 36' 27.8" S and 45° 05' 10.4" W, SAD69) and upon our approach it performed the body-bending display too. However, this later individual stopped bending its body after collection and immediately began to press its tail spine against the hand of the collector, a typical defensive behaviour of *P. joberti*, known as spine-press behaviour (Lima et al., 2010).

Our observations strengthen the hypothesis that body-bending behaviour is not an adaptation to arboreal life (Maddock et al., 2011) and that even snake species from open areas, where lianas are uncommon, can benefit from this kind of behavioural trait. We expect that as fast as new examples of body-bending behaviour were reported, we may improve our knowledge about it and decipher the real meaning of this interesting behaviour in snakes.

The specimens of *P. joberti* cited here are

deposited in Coleção Herpetológica "Claude d'Abbeville", Museu de História Natural do Leste Maranhense at Universidade Federal do Maranhão (CCAA/UFMA), Maranhão state, Brazil (CHMA 500 and CHMA 501, respectively).

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TRACHYCEPHALUS TYPHONIUS
(amazon milk frog): PREDATION**.** The genus *Trachycephalus* includes twelve species distributed across the lowlands of Mexico, Central and South America where they can be found east of the Andes, south to northern Argentina and eastern Brazil (Frost, 2011). These species are known to produce a secretion that can be irritating to skin and mucous membranes (Rodríguez & Duellman, 1994).

Between the various pressures that affect the community structure of frogs, predation is considered an important factor (Duellman & Trueb, 1994). Although predation events are difficult to observe, we believe that they are frequent, as potential predators are logged and must be fed with some regularity (Pombal Jr., 2007).

Amphibians are a relevant component of the trophic chain in natural ecosystems, being common prey for a great variety of vertebrates (fishes, reptiles, birds and mammals), arthropods (ants, beetles, water bugs, spiders and crabs), and even carnivorous plants (Duellman & Trueb, 1994; Toledo, 2005; Toledo et al., 2007). Here we report the predation of an adult amazon milk frog, *T. typhonius* by the wolf fish, *Hoplias* sp.1 (see Graça & Pavanelli, 2007).

On September 2011, an adult of *Hoplias* sp.1 (25 cm TL) was collected during field work of the project PELD (Pesquisas Ecológicas de Longa Duração, "A Planície Alagável do Alto Rio Paraná" - site 6) in the upper Paraná river basin floodplain, state of Paraná, Brazil. The fish was sacrificed with an overdose of anaesthetic Benzocaine, which we then dissected. A medioventral incision was made to expose the stomach, which was sectioned longitudinally. The stomach content was removed and we observed a prey already in an advanced stage of digestion. We identified this item as an adult of *T. typhonius* (Figure 1).

Previous records of amphibian predation by species of the genus *Hoplias* are scarce. Haddad & Bastos (1997), reported the predation of *Rhinella ornata* by *Hoplias cf. malabaricus*; Queiroz (2012), on predation of *Physalaemus biligonigerus*

Figure 1. Example of *Trachycephalus typhonius*.

by *Hoplias* sp and *Andrade* et al. (2012), on predation of *Leptodactylus macrosternum* by *Hoplias malabaricus*. Most reports of amphibian predations by fishes available in the literature are members of the family Angillidae, Centrarchidae, Characidae and Salmonidae (see Toledo et al., 2007).

The wolf fish is an ambush predator, with a "sit-and-wait" strategy when hunting (Winemiller, 1989; Sabino & Zuanon, 1998; Petry et al., 2010). It prefers benthic habits, being found in rivers and lakes, especially in shallow water environments and near submerged or marginal vegetation (Bistoni et al., 1995; Resende et al., 1996; Sabino & Zuanon, 1998). We hypothesized that predation of T. *typhonius* by *Hoplias* sp.1 occurred opportunistically, by the presence of the treefrog floating in the water near or inside the bank of aquatic macrophytes.

The diet of species of the genus *Hoplias* is composed mainly of fish prey (Loureiro & Hahn, 1996; Carvalho et al., 2002; Corrêa & Piedras, 2009). However, this is the first record of *T. typhonius* in its diet.

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VARANUS VARIUS (Lace Monitor, Common Goanna): DIET. Reports of diets in the large eastern Australian lizard *Varanus varius* (White, ex Shaw ms., 1790) (Reptilia: Sauria: Varanidae) are of carnivory on a wide array of endemic and exotic mammals, birds, and reptiles, and scavenging of carcasses (e.g. Mansergh & Huxley, 1985; Weavers, 1989; Crew & Sadlier, 1997; Cogger, 2000; Guarino, 2001; Jessop et al., 2010), principally by day. However there is a recent report of predation on a large active arboreal mammal prey item (brush-tail possum, *Trichosurus vulpecula*) at night (Metcalfe & Richards, 2009). This note reports a case of apparent frugivory in *V. varius*.

On 5 April 2006, ~0830 h (Australian Eastern Standard Time), a small ~1 m total length *V. varius* was observed by the second author for ~2 minutes consuming partially rotted exotic pumpkin (*Cucurbita maxima*, 'Queensland Blue' cultivar, Cucurbitaceae) in the household compost heap (resident family all vegetarians) adjacent to the northeast edge of the buildings platform on the eastern aspect near the top of a coastal hill at "Avocado Heights", a fruit-growing property near Emerald Beach, north of Coffs Harbour, New South Wales (NSW), Australia, at 30°09'52.45"S 153°09'31.68"E (WGS84 grid), ~63 m elevation. It is possible the lizard was consuming insects and their larvae in or around the pumpkin, since unidentified larval Coleoptera, Diptera, and Lepidoptera, as well as unidentified adult Mantodea, Orthoptera, and spiders (Arachnida: Aranea) have been reported as inclusions in diets of wild adult *V. varius* (Weavers, 1989; Jessop et al., 2010). However inspection of the remaining pumpkin did not reveal adult insects or larvae, and soft partially rotted pumpkin flesh was the only intake observed, taken in some quantity prior to the approach of the observer to within 10 m, when the lizard fled from view; it is possible the pumpkin may have served as a source of moisture for the lizard but also considered unlikely as several sources of free-standing freshwater were locally available in near-vicinity of observations.

The first author observed several large adult *V. varius* scavenging on barbeque scraps left by a large crowd of campers and visitors at Ginghet Swamp in the Macquarie Marshes Nature Reserve, NSW, 5 September 1993, ~1030 h, and one subject avidly consumed 7-8 items of the savoury cheese-flavoured packaged dry 'food' product 'Twisties'™, which is largely highly processed corn starch carbohydrate, although in this case it is possible that the high salt content was an attraction. Two pieces of pizza left outside a tent in a camping ground at Station Creek in Yuraygir National Park ~60 km north of Coffs Harbour, NSW, were taken and consumed by an adult *V. varius* in the summer of 2005-2006 (M. Thandi and T. Topfer, pers. comm.), probably initially attracted by meat among the topping. It would therefore appear that *V. varius* will occasionally deliberately consume some plant materials. In the case of the flesh of rotten fruit it is unlikely to be detected by visual inspection of faecal samples, examination of gut contents of dissected specimens, or in stomach flushes. However if seeds (such as those of pumpkin) were ingested, they would be expected to be observed in scats and dissected gut contents; further investigation via observation of wild subjects is required to confirm if frugivory in this species is more widespread. Bennett (2002) reported seeds of *Azadirachta indica* (Meliaceae) in the stomachs of adults of the African cogenor *V. niloticus* from the Black Volta River, Ghana. Otherwise, the only hitherto reported frugivory in the typically obligate carnivorous/scavenging Varanidae is for the three members of the *Varanus olivaceus* species-group of the Philippines, *V. bitatawa*, *V. mabitang*, and *V. olivaceus*, which feed in the wild extensively, near exclusively on ripe fruit, although molluscs and crustaceans are occasionally consumed, indicating omnivory (e. g. Auffenburg, 1988; Bennett, 2011; Gaulke, 2010; Welton et al., 2010).

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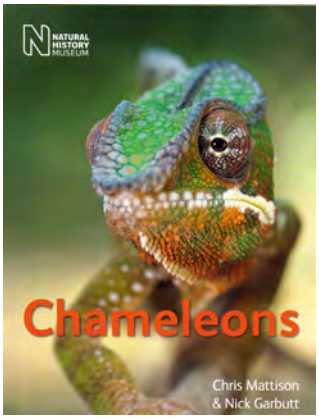
Chameleons

Chris Mattison & Nick Garbutt 2012.

Natural History Museum, London, 112 pp



On receiving 'Chameleons' I was taken aback by the striking photograph of the male panther chameleon (*Furcifer pardalis*) on the front cover. The photographer has produced a crisp focus on the animal's eye, which almost jumps out of the page. This coupled with the brief but informative introductory page, produces a good insight into the book's potential and would compel any wildlife lover to pluck the book off the shelf and be delighted by its content.

The book is comprised of seven chapters; however, within this review it is difficult to detail every section to its full extent. Therefore I will single out the more significant chapters.

Chapter one concerns `Evolution and classification' giving insight into the rise of chameleons. It flows into a transitory explanation of defining chameleon characteristics that separate them from all other lizard species, for example, their fused toes that produce a pincer-like structure that bestows on them great agility. The authors continue with the origins of chameleons, highlighting the distinct characters that have allowed them to adapt and survive, and the divisions between the smaller, drab, floor-dwelling species (leaf chameleons) and their more arboreal, brighter coloured relatives ('true' chameleons). A table on page eleven breaks down the subfamilies.

Chapter one provides details of chameleon species distribution and their habitats. The authors emphasise the abundance of species that thrive on the island of Madagascar and their ability to integrate themselves into many ecological niches on the island, producing an array of shapes, sizes and behaviours. A nice contrast are the species on the African mainland, where the authors explain a variety of adaptations to a mosaic of environments. For instance, the varying altitudes, in the case of the large Meller's chameleon which occurs from sea level in Tanzania to 1,500 m in Malawi. The gem in this chapter is the Namaqua chameleon (*Chamaeleo namaquensis*), which has abandoned an arboreal lifestyle and adapted to the harsh environment of the Namib Desert.

The immediately noticeable aspects of chapter two 'Size and shape, colour and markings' are the pictures shown of Parson's chameleon (*Calumma parsonii*) on page eighteen and the pygmy leaf chameleon (*Brookesia minima*) on page nineteen, that demonstrate the conformed body shape of chameleons and the startling size differentiation that occurs. The chapter brings together pertinent information that covers the exceptional qualities and attributes that have evolved within this unique reptile. These range from their bizarre independently rotating eyes to their outstandingly accurate long tongue. The chapter as a whole is very informative, but there are two sections that stand out the most, namely 'Head ornamentation' and 'Colours'. The only addition that could have enhanced the chapter more would have been to insert some detailed annotated diagrams within the eye and colour sections, which would give a visual aspect to the information provided.

Chapter five 'Reproduction and development' provides some of the most interesting pictures and educational information within the book. The authors highlight the chameleons' general antisocial behaviour in the majority of species and that the only time these magnificent creatures come together is when it is time to breed. Emphasised further is the communication through colour and body language during this sensitive time, with females advertising their receptiveness, for instance, on pages 64 and 65. Two photos give an

elaborate contrast of colours between a receptive female (page 64) and a non-receptive female (page 65) that has already mated and has developing eggs. The reader is taken through the various courtship behaviours of chameleon species and the reproductive section is particularly informative, providing details such as the lack of parental behaviour within chameleons, the various clutch sizes and the differing gestation periods between species. Of interest here is the rapid growth and time to maturity within many chameleons, often only taking a few months to reach breeding age. In contrast, Labord's chameleon (*Furcifer labordi*), has an extremely short life cycle.

Chapter 6 'Chameleons and humans' is a chapter crammed with pertinent information. The chapter begins with amusing and enlightening information on the folklore surrounding chameleons within various cultures. However, the chapter moves onto the constraints of living around humans, including the devastating habitat loss due to agriculture, coupled with their often specific habitat needs and lack of adaptability to change. This section makes the reader aware of the difficulties these lizards face in the wild.

The authors also describe some of the least known effects of humans activities, such as the manipulation of chameleons by natives for ecotourism but also the equally devastating pet trade that may have a serious impact on many of the specialised species. On a lighter note, the chapter moves on to describe many of the hotspots to find chameleons. This section dominates the chapter and gives information on specific places to visit within Madagascar (heavily sub-categorised into parks and reserves), East Africa, Southern Africa and other areas and the likely species to be seen there. This section is especially informative for Madagascar. However, the reader is warned, and I whole heartily agree, that undue disturbance of the chameleons within their habitat is unacceptable and should be avoided at all cost.

The chapter ends with a short but precise section on chameleons as pets; the authors underline the fact that the section is not a detailed account, just a brief guide on the needs of chameleons in captivity. The authors emphasize correct husbandry and the use of captive bred animals rather than wild caught species. The book ends with a chapter detailing 'Chameleon genera' giving an `overview` of the subject but it is crammed full of information.

Chris Mattison, Nick Garbutt and associated authors have excelled themselves by putting together a sound piece of work with balanced information. However, the book is not without a few minor omissions. In chapter 4, 'and Oustalet's' is duplicated on page 57 from page 55 and on page 89, the number of species is different in the main text (shown as 31) compared to the side box where the number of species is shown as 26. Even so, this book is a marvel to read and will encourage others to delve deeper into the lives of chameleons.

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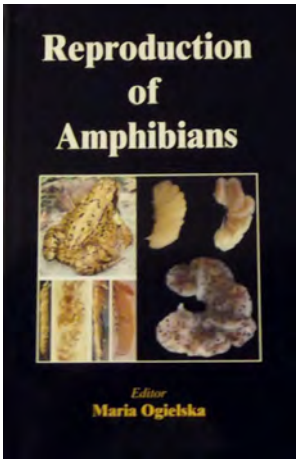
Reproduction of Amphibians

M. Ogielska (2009)

Enfield, NH: Science Publishers. 422 pp. ISBN 978-1-57808-307-7 (hardcover).



I can't think of any other books in my library with pictures of developing ovaries on the cover… but this one has exactly that. So if you're expecting limpid pools, happily amplectant frogs and frolicking tadpoles think again! This is a book about the physiology of amphibian reproduction: anatomy, histology, cytology and regulation of gametogenesis. There are eight sections, beginning with *The Undifferentiated Amphibian Gonad*, progressing through descriptions of the structures and functions of the reproductive systems of male and female amphibians, and ending with a section on *Species, Hybrids and Polyploids*.

You'll already have picked up, then, that generalists and ecologists are unlikely to be especially interested, though reproductive biologists will no doubt find this book a useful reference. Indeed, the language throughout is geared towards those who already understand the associated terminology. Each section contains a dedicated list of references, which is perhaps better than a single long list for a book of this type. I would have found a glossary (or glossaries!) useful but perhaps that's indicative that this book isn't really intended for humble conservation biologists such as me. If, however, it's your desire to delve deeply into the squishier bits of amphibians, you may find this book of considerable interest. I'd suggest getting a nice pot of coffee on though.

JOHN W. WILKINSON