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

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Front cover illustrations

Recently described skinks from Madagascar. Above: Paracontias hafa (holotype; MRSN R1887, from Anjanaharibe-Sud Massif, Analabe Valley). Below: Amphiglossus mandady (holotype; MRSN R171, from Masoala Peninsula). Photographs by Franco Andreone. See article on page 7.

EDITORIAL

Changes to BHS Council

Clive Cummins has recently retired from his position as Receiving Editor for Herpetological Journal, which has been taken up by Wolfgang Wüster (address on inside back cover). Following their election at the Annual General Meeting held on 22nd March, Council has now also been joined by Jon Coote (Ordinary Member), Chris Gleed-Owen (Research Committee Chairman), and Rachel Urwin (Ordinary Member). A warm welcome is extended to all. Leigh Gillet has completed his three-year term of office as an Ordinary Member but will be continuing in his support role as Associate Editor with the Herpetological Journal. Ed.

Win a £25 book token

If you recognise this North American frog you could win a £25 book token (or cash equivalent if not a UK member). Answers on a postcard please to the Editor (address on inside front and back covers).



This competition is open to all members of the BHS who have paid a subscription by the closing date, 31st September 2003. With your entry please provide the complete species name - answers giving only the genus, or a common name, can unfortunately not be accepted. The winner will be the first correct entry to be drawn from a hat at the Autumn Council meeting (October).

British Herpetological Society Scientific Symposium

ECOLOGY AND CONSERVATION OF BRITISH SNAKES

Saturday 15th November 2003

Poorly understood and often persecuted, snakes in Britain are also increasingly caught in the crossfire between conservation and development of their habitats. In recent years, new technologies and field techniques have enabled new insights to be gained into their cryptic life styles. This symposium will review how far we have come in this direction and show how research can be used to address fundamental conservation issues. The programme will include contributions from snake experts from Britain and Europe, including Chris Reading, Tony Phelps, Chris Gleed-Owen and Luca Luiselli.



Further information will be available from Dr. Richard Griffiths, DICE, University of Kent, Canterbury, Kent, CT2 7NS, UK. E-mail: R.A. Griffiths@ukc.ac.uk

ORIGINAL ARTICLES

Daudin's Monitor (Varanus ornatus, Daudin 1803) and its association with Ubani (Bonny Island), Southern Nigeria

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DAUDIN'S Monitor (Varanus ornatus) is indigenous to the coastal mangrove and deltaic swamp forests of West and Central Africa (Bayless, 1997; Angelici & Luiselli, 1999; Luiselli et al., 1999; Akani & Luiselli, 2000; Bayless & Luiselli, 2000). Traditionally considered as a simple subspecies of the Nile Monitor (Varanus niloticus), Daudin's Monitor has been recently elevated to full specific rank (Böhme & Ziegler, 1997). In anticipation of definitive analyses on the V. niloticus species complex, our intention in this paper is to follow the nomenclature given in 1997 by Böhme and Ziegler.

In the past, V. ornatus enjoyed a considerable range across West Africa, as habitat partition seems not to have occurred at that time to the degree that it does today (Bayless, 1997). Currently in southern Nigeria, V. ornatus is prized for its meat and skin (Akani & Luiselli, 2000), and is thus vulnerable at the local level (Politano, 1998), yet this has not always been the case. Some two hundred years ago, in the delta region of the Niger River, on the Island of Bonny (more precisely at Ubani), V. ornatus and humans appear to have co-existed in a non-aggressive fashion. In this note we report briefly on the cultural interactions between local people and monitor lizards at Bonny, and attempt to draw parallels between the previous situation and that occurring today in the same area.

THE STUDY AREA

Today, Bonny Island has become one of the most important ports and commercial zones of southern Nigeria as a result of the enormous industrial activity which links it closely to the extraction of oil and to the production of derivatives such as petroleum, natural gas, etc (De Montclos, 1994). A highly developed and large town, with several satellite suburbs, Bonny has developed in an otherwise environmentally important area where coastal barrier forests and large mangrove formations are also to be found (Politano, 1998). Bonny Town, one of the most southerly centres in Nigeria, is located at the mouth of the Bonny estuary which empties into the Bight of Bonny (formerly the Bight of Biafra). The area is richly endowed with abundant natural resources. including petroleum, fish and fisheries, wildlife, as well as mangrove and freshwater forest resources. The extraction and processing of oil and its derivatives has in recent times attracted various companies and ancillary industries. Consequently, the town is becoming rapidly urbanised and the hub of activities for many firms and other enterprises. Bonny's strategic position along the coast makes it an important port of call for many ocean-liners. Indeed, the dredging of the estuary a few decades ago has turned Bonny into a major traffic artery within the Niger Delta, from which ocean-liners, seafarers and tourists alike are

directed into the hinterland via Port Harcourt, the capital of Rivers State. The Bonny Estuary is, however, not an exclusively separate system, but is linked to neighbouring estuaries by tidal creeks and channels. NEDECO (1959) noted that a beach originally separated the Bonny and New Calabar estuaries but, following repeated 'brace action', the beach gave way, thus creating one joint entrance to both rivers. Rainfall around Bonny is remarkably heavy. In some years as much as 4520 mm of rain is recorded while conventional rainfall is normal, even in the dry season, on account of the region's proximity to the ocean.

AN HISTORICAL ACCOUNT

In the early nineteenth century, Bonny was a wholesale market place for slaves, with no fewer than 20,000 slaves being sold and deported annually to the Americas and to Europe. The people of the Brass country (presently in Bayelsa State), called Allakoos, Ibbibbys (= Ibibio) or Quaw, and the Heebo (= Ibo) people constituted the majority of the slave-trade market. During the reign of King Opubo Fubara Pepple (1792-1830), himself originally of Ibo descent, as were many of the principal slave traders, life in Bonny was rigorous. In time, commodities such as salt, yams and trading in slaves grew in importance and commerce began to increase, both for the King and for the traders of Bonny. The once continuous block of flooded forest and mangrove forest was broken up by a crisscross of roads, especially along the main river courses which became crucial trading axes (the Rivers of Bonny, New Calabar, and Sombreiro). As a result of these environmental changes, people of different ethnic groups and traditions started to mix, with the result that a halfcaste culture grew up (De Montclos, 1994).

In 1823, Captain John Adams, trader, ship's captain and explorer, wrote down his impressions of all those aspects of native life that he had encountered in his travels along the West African coastline. In particular, Adams's very precise observations of Bonny, situated on the eastern side of the River Niger region and approximately five miles from the sea are invaluable. In the first decades of the nineteenth century, the Brass people

who inhabited the small town of Peterside, situated on the banks of the Bonny River, but on the opposite side of Bonny town, practised a cult which prescribed special veneration of the Rock Python (Python sebae), a large-sized (up to 9 m long) snake which is still present in the region to the present day (Luiselli, Angelici & Akani, 2001). This sacred reptile was permitted to roam freely throughout the huts and grounds of the villages. Should one of these snakes ever seize a small child, the grieving mother would display pride in the fact that such a sacred creature had taken her child (Adams, 1823; Johnston, 1923). This cultic snake worship was repulsive to the English sailors who thought of this savagery as utterly wretched. In Bonny, the Ibo natives had their own sacred reptile. Daudin's Monitor (V. ornatus). as their deity, referred to by King Opubo Pepple as his 'fetiche' [= fetish] or ju-ju [sometimes spelled jew-jew].

According to Kingsley (1897), neither fetiche nor ju-ju were native words. Fetiche comes from the word old portuguese explorers used to designate the objects they thought the natives worshipped, and in which they were wise enough to recognize a certain similarity to their own little images and relics of Saints, 'Feitico'. Ju-ju, on the other hand, is french and comes the word for toy or doll, while other scholars believe it to originate from 'gru-gru', a Mandingo word for charm. Fetiche is more precise and has more affinity to the image of a Saint, as it is not venerated for itself, or treasured because of its prettiness, but only because it is the residence, or the occasional haunt, of a spirit (Kingsley, 1897).

These monitor lizards were seen by Captain Adams and others crawling about the town, where they were caressed and fed by the Ibo natives. A widely held local belief was in circulation that anyone entering a house which had also been entered by a monitor would enjoy specially good fortune. Indeed, Captain Adams experienced a further demonstration of this 'lizard worship' and noted it; One day, thirty or forty canoes were surrounding a larger vessel in the river when a 'fetiche' or monitor lizard was observed in the centre of the river, swimming to Peterside, just across the river from Bonny. All the canoes left the larger vessel in pursuit of their fetiche to see who would reach it first and take it to the opposite shore. On their return to the shore on the Bonny side, Captain Adams asked the natives, 'What would have happened if the New Calabar fetiche, the shark, had reached their lizard fetiche first?' The natives apparently replied that the shark would never have dared to touch their deity! Thus, it seems that within one small region of the Niger Delta, the Brass in Peterside worshipped the Rock Python, the Ibo in Bonny, just across the river, worshipped Daudin's Monitor while, in New Calabar, the people worshipped the shark. Such fetiche worship was common throughout Africa. In the Kasai region of the Congo around Brazzaville, for example, the Lele people worshipped the Pangolin (Manis tricuspis), and persecuted the Nile Monitor (Varanus niloticus) (Douglas, 1957).

While theology was clearly not an important aspect of life in Bonny, Peterside, Calabar or elsewhere in the Niger Delta, King Opubo Pepple had shown Captain Adams the numerous Christian artifacts displayed on a table in the royal palace, used merely as ornaments and possessing no other significance for him which had been brought to Bonny decades before by Portuguese missionaries. According to Adams (1823), a cross, once the central symbol of the Portuguese church, appears to have still been in use as a sign at the cross roads in Bonny. By the time the slave trade had been abolished in Africa, the trade in other than human goods was vigorously pursued. After 1846, when the first missionaries were allowed to settle in West Africa, the towns of Calabar, Brass and Bonny experienced an increase in size, most markedly from 1861 to 1864, and particularly amongst immigrants and converts to Christianity (Ikime, 1980). By the 1860s, Christianity was becoming increasingly important. In 1869, a man named Peter Obonanta, was probably the first to renounce traditional animistic religion, and was baptized as a Christian (Isichei, 1982).

By 1878, the fetish cult of iguanas, [used to designate monitors], a name imported from the West Indies into West Africa, and still widely used

in pidgin English by the people of the Delta (Angelici & Luiselli, 2000) was so considerable that the British Consular authorities of the deltaic Niger River, or 'Oil Rivers' region, lent it their sanction as well (Johnston, 1923). All Europeans under Consular jurisdiction were forbidden to kill the sacred fetiche of Bonny, or Rock Python of Brass. However, an incident occurred at Brass, in 1878, whereby an agent of the firm of Messrs Hatton and Cookson, discovering a large python in his house, had killed it outright. When this misdeed had become known to the Brass's Chieftain, the people descended on the factory of Hatton & Cookson, forcibly removing the agent who had killed their fetiche. They tied him down to the ground by his thumbs and toes, spat into his mouth and performed other indignities on his person. The Chieftain and followers broke into the nearby store owned by this agent, and took goods equal in value to twenty pounds' sterling as retribution. Consul Hopkins, learning of this disturbance in Brass, considered the case, and summarily fined the agent an additional twenty pounds' sterling! This was the usual punishment for any European sufficiently ignorant to harass, injure or kill a fetiche in Bonny, Brass, Calabar or elsewhere in Nigeria. But nowhere in deltaic Nigeria was the fetiche so strong as in Bonny.

In Bonny, the cult of monitor lizards had become a nuisance by early in 1878, for these reptiles devoured fowls, turkeys, ducks and geese belonging to the Europeans with impunity. It is reported in the original sources that these lizards would lie in the middle of the road or in doorways, and savagely lash the legs of those people walking a tail-length away, often leaving them bloodied by their assaults.

The Church Missionary Society, through its actions in converting the natives to Christianity, seem to have brought about changes from this absurd fetiche and associated practices in just one day! In March of 1882, a great 'infestation' of monitor lizards occurred at Bonny. There, they were to be found in every hut, house, garden, roof or churchyard. On Easter Sunday 1882, the missionaries convinced the converted Ibo people, including King George Oruigbiji Pepple I (1866-

83), to slaughter the saurian fetiche. So when the church bells sounded out that Easter Sunday morning upon Bonny, a large number of men and boys armed themselves with machetes, clubs and sticks and proceeded to slaughter the monitors, resulting in the slaughter of every Varanus they met with. The stench from the lizards' bloated bodies scattered throughout Bonny soon became unbearable. A similar slaughter had occurred two years' previously earlier in Brass, where all the fetiche pythons across the river from Bonny had been killed. This time the massacre had occurred in Bonny itself. Following this 'saurian holocaust', the people had left behind their animistic beliefs, and turned instead to Christian ones, in the shadow of the many hundreds of dead monitor lizards strewn across this small trading town (Johnston, 1923; Loveridge, 1949). Christianity has proved to be long lasting, for more than ninety per cent of the population of southern Nigeria remains Christian today (De Montclos, 1994).

The birth of Christianity in Bonny officially began on that Easter Morning of 1882, among the bloodshed of hundreds of monitor lizards, all in the Name of God replacing one Fetish for another, a man rather than a lizard.

THE CURRENT SITUATION

The presence of monitor lizards along both sides of the estuarine tract of the Bonny River, that is, both in Bonny Island and around Peterside, has been recently confirmed by Angelici & Luiselli (1999, see localities numbered 1 and 2 in Figure 2, at page 35). In the coastal area of the Bonny River, the monitors occur nowadays mainly around Peterside within pockets of freshwater habitat which mark the pipeline of the Shell Petroleum Developmental Company and of Manifold. Angelici & Luiselli (1999) also observed these lizards amongst the mangrove swamps. Many are trapped by the natives as they are relatively abundant there. Studies by two of us (LL and GCA) showed that no fewer than three adult monitors are caught bimonthly around the single village of Peterside. The monitor lizards are usually trapped using crabs as bait (mainly

Cardiosoma armatum, Uca tangeri, and Sersama huzardii, which abound in the place). It must be noticed that crabs are the main food type for freeranging V. ornatus from southern Nigeria (Angelici & Luiselli, 1999; Luiselli et al., 1999), and the fact that they are used as bait by natives is an indication of the fact that the crab-eating preferences of monitors are well known to local hunters. A few days after setting the bait, it begins to decay, supporting the growth of a large maggot population. The smell of putrifying crab attracts the monitor, which is then trapped. The decline in the monitor population finds an explanation in the legend that the monitor was only killed once it had eaten a child. Following this incident, the natives began killing and eating the reptiles and their numbers declined dramatically. Such legends aside, increased human activity and frequent oil spillages have contributed to the reduction in the population of monitors, caused by the destruction of eggs and the pursuit of adults for skin and meat. It is noteworthy that stuffed adult monitor lizards are frequently offered for sale as souvenirs in tourist shops in Port Harcourt, Aba, and Calabar, as well as in ju-ju markets throughout the region.

In a recent ethno-zoological survey, Akani & Luiselli (2001) found that veneration for monitor lizards is still alive in sectors of southern Nigeria, being specially concentrated in Delta State and Rivers State, whereas they are persecuted nearly everywhere in Bayelsa, Akwa-Ibom, and Cross River States. In particular, a tendency was observed toward respect for these animals by animistic people in Bonny island, although the mixed ethnic and cultural composition of this developing town has nowadays compromised the positive traditions towards monitors. Consequent killing of many specimens now occurs amongst those who observe Christian traditions, now dominant in the area.

Across West Africa, belief in *Varanus* and other reptilian Fetish is still present, at Bamako's Fetish Market in Mali (Eason & Attum, 2002) and at the largest Fetish market in all of West Africa, at Cotonou in Benin.

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The authors dedicate this paper to the Late Sean McKeown, Zoo Curator extraordinary. Current data on monitor lizards at Bonny was gathered during field expeditions supported by several companies, mainly the E.N.I.-AGIP group, and Award of the Linnaeus Fund (1999, 2000, 2001) by the Chelonian Research Foundation (Lunenburg, U.S.A.). Dr. Brenda Bolton (London) greatly improved the style of this manuscript.

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Complementary information on the ecology and conservation of Malagasy skinks, with notes on the colouration of some recently described species

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THE Madagascan herpetofauna is particularly rich and diverse. Many new species have been described recently as a result of intensive surveys in remote areas and the application of innovative methods, such as karyology and biomolecular analyses. Nevertheless, some groups remain poorly known, for a number of reasons, including their secretive habits and general difficulties of observation. Typical species associated with such problems are the skinks, which live in most of Malagasy rain and deciduous forests, but for which information on natural history remains almost completey lacking.

An example of this situation is the recent contribution by Andreone & Greer (2002), in which nine new species were described, and the collection held at the Museo Regionale di Scienze Naturali in Torino (Italy) was revised. In this paper five species belonging to the genus Amphiglossus (A. mandady, A. nanus, A. spilostichus, A. stylus, A. tanysoma) were described, together with three of the genus Paracontias (P. hafa, P. manify, and P. tsararano), and one species of the enigmatic genus Pseudoacontias (P. menamainty). This contribution suggests that many more undetected skink species still await description in Madagascar. Indeed, the use of pitfall traps and drift-fence systems have allowed ourselves and other recent authors (e.g., Raxworthy & Nussbaum, 1994; Ramanamanjato et al., 1999) to describe many new species in the last few years, and to increase the number of specimens of little known species.

Skinks are elusive lizards usually tied to pristine or semi-pristine forests, and have a variable range of adaptations to subterranean life. For example, in the long-bodied Amphiglossus crenni (until recently known as Androngo crenni), the degree of limb reduction and body elongation are particularly accentuated and represent specialisations for living within the forest leaf litter. As a consequence, this species is difficult to detect and observe. As pointed out by Andreone & Greer (2002), the collection of this species was until then limited, and only in recent surveys have there been opportunities to increase the number of observations. The same situation applies to many other Amphiglossus species, which were found occasionally using opportunistic research. From an ecological perspective it would be interesting to establish whether the rainforests of Madagascar sustain a more or less stable number of skinks, or if there are areas and forests which show conspicuous diversity.

In this paper I provide complementary information on diversity and abundance in Malagasy skinks, based on reviews of previously published contributions and additional field data collected at a number of localities. The composition of ecological and body size guilds at some of these localities is also discussed. Furthmore, an updated set of photographs is provided of eight species described recently in Andreone & Greer (2002) (Plate 1-6, see also front cover), together with a summary of their colour pattern features.



Figure 1. Box plots of the number of skink species per site (rainforests and transitional forests only), belonging to the three ecological guilds in the areas examined.

ECOLOGICAL NOTES

The composition of skink faunas in terms of species richness at several protected and unprotected localities is analysed in Appendix 1 page 15). This includes most rainforest and Sambirano sites (Manongarivo, Nosy Be, Montagne d'Ambre, Anjanaharibe-Sud, Ambolokopatrika, Marojejy, Tsararano, Masoala, Anjozorobe, Pic d'Ivohibe, Andringitra), dry-deciduous forest sites (Zombitse, Andohahela, Kirindy), one littoral forest (Tampolo), one transitional dry forest – Sambirano (Sahamalaza), and one transitional dry-rainforest (Malahelo).

Within the general species assemblage, three principal ecological guilds may be distinguished: (1) aquatic, (2) epigean, and (3) fossorial and semi-fossorial species (Fig. 1). The first includes the large aquatic *Amphiglossus* species: *A. astrolabi*, *A. waterloti*, and *A. reticulatus*. *Amphiglossus mandokava* is not included in this guild, since observations do not confirm its aquatic habits (Nussbaum & Raxworthy, 1994).

The second guild includes all of the *Mabuya* species. These lizards, are active on the ground surface and are conspicuous in rocky and grassy areas. They are able to colonise degraded and

anthropogenic habitats, such as urban gardens, and grassy areas along roads. Almost all the other skinks are more closely associated with natural habitats. Within the genus Amphiglossus, only A. melanopleura appears to show a similarly epigeanoriented activity pattern (e.g., Andreone & Randriamahazo, 1997). For this reason it is considered here as a unique epigean-oriented Amphiglossus, although it also shows certain tendencies to fossoriality and lives within the forest leaf litter. During the surveys I did not find any other Amphiglossus species active during the day, although one species, A. macrocercus, was found under stones

and boulders in its natural habitat, the altitude forests, as at Ankaratra (Vences et al., 2002). Indeed, *A. tanysoma* was found in a coffee cultivation next to Ambanja. However, this kind of cultivation represents (as do a few other types) an ecological replacement for the natural rainforest, especially where coffee is not cultivated intensively and the plants intergrade with secondary rainforest (Andreone et al., in press).

The other scincid species of Madagascar show a tendency to fossorial life. Among rainforest species, this underground existence is probably restricted mostly to the thin forest litter, composed by dead leaves and other organic debris. It is likely that none of the species dig in the often hard underlying lateritic soil. Instead, they move under (or within) the forest litter during the day but become more active and evidently epigean during the night. Furthermore, some of them show marked adaptations to fossoriality, such as reduced or missing limbs. This is evident with Paracontias species and also Amphiglossus stylus and A. crenni. The recently described Pseudoacontias menamainty, as well as the other species of this genus, show a reduction of fore and hind-legs, and the head is pointed with reduced eyes (Nussbaum & Raxworthy. 1995). Similarly, fossorial adaptations are also evident in the genus Voeltzkowia, which is more typical of sandy areas

Ecology and conservation of Malagasy skinks



Amphiglossus spilostichus, holotype: MRSN R1737, from Tsararano Forest, Campsite 2 (Andatony Anivo). All photographs by the author.



Amphiglossus tanysoma, paratype: MRSN R1865, from Antsirasira.



Paracontias tsararano, holotype: MRSN R1787, from Tsararano Forest, Campsite 1 (Antsarahan'ny Tsararano).



Amphiglossus stylus, holotype: MRSN R1732, from Masoala Peninsula, Campsite 5 (Menamalona).



Paracontias manify, holotype: MRSN R1887, from Antsahamanara, Manarikoba Forest, RNI de Tsaratanana.



Pseudoacontias menamainty, holotype: MRSN R1826, from Berara Forest, Sahamalaza Peninsula.



Figure 2. Box plots of the number of skink species per studied rainforest and transitional forest sites in relation to their snout-vent length (A, SVL < 40 mm; B, SVL = 40-60 mm; C, SVL = 60-80 mm; D, SVL = 80-100 mm; E, SVL > 100 mm).

of southern and western Madagascar but not unknown in rainforest. The other species of *Amphiglossus* have a more typical lizard morphology, with legs varying from moderate to well developed. They all are very difficult to observe during the day and become active (or more active) at night. This is confirmed by the rate of capture using pitfall traps: all of the specimens belonging to the genus *Amphiglossus* and reported by Andreone & Greer (2002) were captured at night.

The number of fossorial and semifossorial species at the localities studied (excluding the species from dry forests, clearly representing a different community type) ranged from 1 to 10, with a mean value of 4.82 (SD= \pm 2.35). The epigean species varied from 0 to 3 (1.71 \pm 0.77). In terms of aquatic only one species is likely typical of each forest site. It does not seem that there are cases of syntopy of two (or more) species. Of the sites reported in Table 1, an aquatic *Amphiglossus* was found at four sites only. It cannot be excluded that one aquatic species is usually present at (almost) all the sites. The

'absence' at some places, such as Manongarivo, Anjanaharibe-Sud, and Andringitra can be interpreted as an objective difficulty to observe in nature this species. In fact, the species in the group are closely tied to the aquatic environment (where they often move and search for preys) aquatic, and mostly nocturnal. Further surveys will likely demonstrate the presence of at least an aquatic species for each forest block.

The species were also divided according to their body size (snoutvent length). Those from dry-forests were excluded. The box-plot graphics are given in Fig. 2, from which it is evident that the most represented

species are included in category C (60-80 mm). Another well represented guild is the 'D', which corresponds to 'giant' species. These ecological and size distributions are likely the result of a resource partitioning (Toft, 1995).

The total number of species per site ranged from 3 (Ambolokopatrika, Anjozorobe, Ankaratra) to 13 (Marojejy) for rainforest and transitional sites, and from 4 to 7 for dry-forest sites. The high scincid diversity at Marojejy can be explained by the fact that this massif is a 'megadiversity' hotspot in Madagascar, and the survey work here led to the discovery of a very high number reptiles. This diversity has not yet been matched at other sites (with the possible exception of the hyper-studied Périnet-Andasibe area). The other main northeastern massif, the Anjanaharibe-Sud (which also makes part - together with Marojejy - of the articulated Andapa montane system), which has a lower altitudinal range, had nine species. The low number of species found at Ambolokopatrika (3) is quite 'anomalous', since at this forest the survey period was relatively long (17 days in June, and 22 days in November-December 1997). Three explanations may be proposed to account for this situation: (1) a less favourable ecological status for Ambolokopatrika, (e.g. greater humidity or rainfall, and a lower mean temperature), (2) an unfavourable temporary (climatic) regime, due to the heavy rainfalls and low temperature, that did not favour the activity of lizards and other reptiles, (3) a different general situation due to human alteration. I cannot, however, exclude the possibility that the low diversity is due to past forest exploitation, with a consequent loss of biological diversity (not yet recovered).

CONSERVATION CONSIDERATIONS

Looking at the number and composition of species in the areas studied it is evident that the greater majority of species is represented by fossorial and semifossorial species, which mostly depend on the presence of a rather thick forest litter. This is much the same for other forest and fossorial species, such as some cophyline microhylid amphibians (e.g. Rhombophryne, Plethodontohyla spp.), and typhlopid snakes. The forest alteration is followed by the disappearance of such forest litter, and denudation of the soil, with the well known erosive phenomena (Andreone, 1991). This causes the decline or even local extinction of species living in the forest litter, which are usually sensitive to habitat alteration (Andreone & Luiselli, in press). Thus, the forest alteration may lead to significant impoverishment of the scincid diversity. This was confirmed during the study at two forest corridors in the Masoala Peninsula (Andreone & Randrianirina, 2000). In the Ambatoledama and Ilampy corridors, the number of skinks captured with pitfalls was lower than in nearby areas where the forest was still mostly intact. In such degraded areas, the only skinks I found were species of Mabuya. These lizards can adapt to even small natural parcels or 'naturalised' habitats within towns. This ability is well known, for example, in Mabuya gravenhorsti, which is sometimes common even in urban gardens (Andreone, 1991). At Nosy Tanikely, the introduced population of Mabuya comorensis is now well established (Andreone et al., in press) and not affected by the presence of tourists, who often leave food debris. In this respect, they behave very similarly to the syntopic Zonosaurus madagascariensis.

The only other species found in open areas are the aquatic forms, such as *Amphiglossus astrolabi*. In some areas, e.g. Ranomafana, these can also be found near to urban settlements. Evidently – as with aquatic amphibians (e.g., *Mantidactylus lugubris*, *M. grandidieri*) – these reptiles are more resistant to habitat alteration, since their principal requirement for life is a suitable water course and nearby habitat (Andreone & Luiselli, in press).

Also, it must be stressed that our knowledge of natural history traits in Malagasy skinks is still in a preliminary phase, and that data on which to draw important conservation considerations are lacking. As pointed out on previous occasions, (Andreone, 1991; Andreone & Greer, 2002) only the conservation of rainforest and other original forest types can ensure their continued survival. Most of the newly-described species, and also many other skinks referred to in this paper, are restricted to unaltered habitats.

COLOURATION OF NEW SPECIES

Descriptions of the nine new taxa published by Andreone & Greer (2002) were based upon original information, drawings and black/white pictures of preserved specimens. At the time of publication it was not possible to include photographs of these species showing their colouration in life. Aside from morphometric data and scale counts, colour photographs are useful for an initial (although necessarily preliminary) taxonomic determination. For the purpose of complementing their formal description, colour photographs are therefore included here of all the new species except Amphiglossus nanus (Plates 1-6, see also front cover). A general colour description follows summarising information given in the full descriptive work.

Amphiglossus mandady – dark brown-reddish dorsally, with a small pale spot or dash in the centre of each scale; belly is likely pale yellowish.

Amphiglossus nanus – although there are no photographs of living specimens, the colouration of this species in preservative appears to be similar: the dorsum of head, body and tail medium brown, variegated with pale brown; dark brown on the body tending to aggregate in centres of scales;

underparts of head and body pale; venter of tail brown.

Amphiglossus spilostichus – ground colour of body dark brown dorsally grading to greyish brown on the flanks and dirty pale brown ventrally. Most dorsal and lateral scales with a pale brown central spot confined to base of each scale on dorsum, becoming a central dash on flanks, resulting overall in a pattern of longitudinal pale spots dorsally, transforming into a series of strong longitudinal dashes laterally. On head, scale edges are dark brown and scale centres tend to be medium to pale brown. Venter pale and without markings.

Amphiglossus stylus – dorsum reddish-brownish, with small, rather indistinct dark spots, sometimes becoming almost iridescent. Venter much paler than dorsum and almost translucent.

Amphiglossus tanysoma – dorsal background brownish shading to pinkish. Flanks with background pale yellowish brown and darker brown speckling; belly almost whitish.

Paracontias hafa – ground colour of the dorsum reddish-copper, with small darker spots in the centre of each scale; anterior part of body paler than posterior part. Venter paler than dorsum and somewhat translucent.

Paracontias manify – dorsal colour brown-reddish, grading to copper, with a darker area in middle of each scale, producing impression of a reticulate network on the back and flanks. Head and posterior part of the body darker than rest of dorsum. Venter a little lighter than the back, and translucent.

Paracontias tsararano – dorsum almost reddishcopper, with a smaller darker area in centre of each scale, giving the impression of an ill-defined 'striped' pattern on back. Tail slightly darker than body. Venter paler than dorsum and translucent.

Pseudoacontias menamainty – reddish orange (venter paler than the back), with thin longitudinal black lines on the back, each running through centre of a longitudinal scale row, mid-lateral area unpatterned, but three or four poorly defined black lines through the centres of each longitudinal scale row on ventrolateral surface; venter without pattern; tail with black line through centre of each longitudinal scale row, dorsal-most lines most distinct; ocular region and front limb crease darkly pigmented.

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Appendix 1.

Site-by-site listing of skink species found in Madagascar. Taxa given as 'sp.' may represent new species. PN = Parc National (National Park); RS = Réserve Spéciale (Special Reserve); RNI = Réserve Naturelle Integrale (Strict Nature Reserve). Sites listed between brackets without annotations refer to rainforests.

TOT. N	SITE	AQUATIC SPECIES	FOSSORIAL AND SEMIFOSSORIAL SPECIES	EPIGEAN SPECIES	REFERENCES
6	Berara (Sahamalaza) (transitional Sambirano-Dry)	Amphiglossus reticulatus	Amphiglossus mandady, A. stumpffi, Pseudoacontias menamainty	Mabuya gravenhorsti, M. elegans	Andreone et al., 2001
7	Manongarivo (Sambirano)		Amphiglossus macrocercus, A. melanurus, A. minutus, A. mouroundavae, A. stumpffi	Amphiglossus melanopleura Mabuya gravenhorsti	Rakotomalala, 2002
7	Nosy Be (Sambirano)		Amphiglossus stumpffi, A. elongatus, A. n.sp., Paracontias hildebrandti	Mabuya gravenhorstii, M. lavarambo, Cryptoblepharus cognatus	Andreone et al., 2003
7	PN de la Montagne d'Ambre		Amphiglossus melanurus, A. mouroundavae, A. stumpffi, Paracontias brocchii, P. hildebrandtii	Amphiglossus melanopleura, Mabuya elegans	Raxworthy & Nussbaum, 1994
9	RS d'Anjanaharibe-Sud		A. crenni, A. melanurus, A. minutus, A. mouroundavae, A. punctatus, A. melanurus, Paracontias hafa	Amphiglossus melanopleura, Mabuya gravenhorstii	Raxworthy et al., 1998
3	Ambolokopatrika		Amphiglossus crenni, A. mouroundavae	Amphiglossus melanopleura,	Andreone et al., 2000
13	PN de Marojejy	Amphiglossus astrolabi	Amphiglossus macrocercus, A. mandokava, A. melanurus, A. minutus, A. mouroundavae, A. ornaticeps, A. praeornatus, A. punctatus, Paracontias holomelas, Pseudoacontias angelorum	Mabuya gravenhorstii A. melanopleura	Raselimanana et al., 2000
9	Tsararano	Amphiglossus astrolabi	Amphiglossus melanurus, A. mouroundavae, A. nanus, A. praeornatus, A. punctatus, A. spilostichus, Paracontias tsararano	Amphiglossus melanopleura	Andreone et al., 2000; Andreone & Greer, 2002
9	Masoala	Amphiglossus astrolabi	Amphiglossus crenni, A. mandady, A. melanurus, A. nanus, A. praeornatus, A. stylus, Paracontias holomelas	Amphiglossus melanopleura	Andreone & Greer, 2002
4	Tampolo		Amphiglossus frontopartetalis, A. ornaticeps, A. sp.	Mabuya gravenhorsti	Raselimanana et al., 1998
3	Anjozorobe		Amphiglossus crenni, A. macrocercus, A. sp.		Raselimanana, 1998
3	Ankaratra		Amphiglossus macrocercus	Mabuya boettgeri, M. madagascariensis	Vences et al., 2002
9	PN d'Andringitra		Amphiglossus anosyensis, A. melanurus, A. macrocercus, A. punctatus, A. frontoparuetalis, A. sp.1, A. sp.2	A. melanopleura, Mabuya gravenhorsti	Raxworthy & Nussbaum, 1996
6	Corridor Andringitra-Ivohibe		Amphiglossus anosyensis, A. macrocercus, A. melanurus, A. minutus, A. sp.	Amphiglossus melanopleura	Rasclimanana, 1999; Rasolonandrasana & Goodman, 2000
8	RS Pic d'Ivohibe		Amphiglossus anosyensis, A. frontoparietalis, A. macrocercus, A. melanurus, A. minutus, A. sp.	Mabuya gravenhorsti, Amphiglossus melanopleura,	Raselimanana, 1999; Rasolonandrasana & Goodman, 2000
7	PN d'Andohahela		Amphiglossus anosyensis, A. macrocercus, A. ornaticeps, A. punctatus, A. Sp.	A. melanopleura, Mabuya gravenhorsti	Nussbaum et al., 1999
5	Malahelo and nearby sites (transitional Dry-Rainforest)		Amphiglossus ornaticeps, A. splendidus	Amphiglossus melanopleura, Mabuya gravenhorsti, M. vato	Ramanamanjato et al., 2002
4	Kirindy (Dry)		Amphiglossus mouroundavae	Mabuya aureopunctata, M. elegans, M. gravenhorsti	Bloxam et al., 1996
7	PN d'Andohahela 2 (Dry)		Amphiglossus igneocaudatus, A. ornaticeps	Mabuya aureopunctata, M. dumasi, M. elegans., M. gravenhorsti, M. vato	Raxworthy & Nussbaum, 1994
5	PN de Zombitse (Dry)		Amphiglossus macrocercus, Voeltzkowia rubricaudata	Mabuya elegans, M. gravenhorsti, M. vato	Raxworthy et al., 1994

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Ecology and conservation of Malagasy skinks

Common Frogs in a Cambridgeshire garden over a twenty year period

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ABSTRACT — Breeding by Common Frogs, *Rana temporaria*, was studied from 1983 to 2002 in two ponds in a garden in Ramsey, Cambridgeshire. During this time, annual spawn output increased from a single clump to 148 clumps. There was no significant trend in spawn date. Frogs laid earlier and laid more spawn in the warmer of the two ponds. Although the population increased, reproduction frequently failed, with predation, cold weather, fungal infestation, non-viable spawn, poor water quality and a leaky liner being implicated.

IN Britain, garden ponds have become important for several species of amphibians, especially the Common Frog *Rana temporaria* (e.g. Beebee, 1979; Cooke & Scorgie, 1983; Hilton-Brown & Oldham, 1991; Beebee & Griffiths, 2000). Indeed the increase in garden ponds since the 1960s provided the Common Frog with an essential refuge during the time when its more natural habitats were being rapidly destroyed.

Despite the fact that breeding by frogs is relatively easy to observe in garden ponds, few articles on this subject have been published. The studies of Ashby (1969) and Beebee (1986, 1996) are notable exceptions. This short paper describes the establishment of a large population of Common Frogs in a garden over 20 years, beginning at a time when frogs were rare in this part of the country. While there have been few publications specifically on garden populations, literature on the ecology of this species is extensive; references quoted here are highly selective.

THE SITE

Although the garden is in a suburban area, it is in a part of Ramsey, Cambridgeshire, where gardens and other green space far exceed the area of buildings and roads. The property (grid reference TL 283846) extends to 0.53 ha; the house and other buildings occupy 0.04 ha, the remainder being formal and informal gardens (Figure 1). The main change in the garden since 1983 has been in the herbaceous borders; in the early 1980s, they contained few plants and were frequently hoed, but they now have dense and diverse vegetation. Frog reproduction has been monitored in the spring and summer in two ponds in the garden. Frogs have not been studied at other times of year, but are frequently encountered on land.

The 'concrete' pond ('Co' in Figure 1) had been in existence for many years when my wife and I bought the property in 1982. It is 2.1 m in diameter with a uniform depth of 0.45 m. Initially, no water plants occurred in the pond, but various species have been introduced over the years, and are now controlled so they cover about 50% of the surface area. This pond is shaded by mature trees. Goldfish *Carassius auratus* have been kept in the pond intermittently, and Smooth Newts *Triturus vulgaris* regularly breed.

The 'plastic' pond ('Pl' in Figure 1) was created with a vinyl liner, specifically for frogs, in the winter of 1983/4. It is sheltered, yet can receive the full sun for much of the day. This pond is 65 m from the concrete pond. It measures 2.9×1.8 m with a maximum depth of 0.25 m. Most of the pond is 0.05-0.15 m in depth. Variable amounts of aquatic vegetation have been planted in pots. Smooth Newts also breed in this pond. The original liner sprung a slow leak in 1990, and was eventually replaced in December 1991.

Ornamental ponds have been created in three of the domestic properties that border the garden. To the north, a small pond existed 35 m to the north



The concrete pond.

west of the plastic pond. Frogs bred there regularly, but spawn clumps were never counted. The pond was destroyed in the winter of 1992/3. To the west, another pond has existed throughout the study period about 60 m to the south west of the plastic pond. Small numbers of frogs breed there each year (13 clumps in 2002), as do Smooth Newts. To the east, a deep pond was created in 1999 about 40 m south east of the concrete pond. Although 21 clumps of frog spawn were laid there in 2002, the open nature of the pond and the presence of large ornamental fish makes any survival of frog tadpoles unlikely.

AMOUNTS OF SPAWN LAID

On 18th March 1983, a submerged stone shelf was put in the concrete pond to create a shallow zone and make the pond more attractive to breeding frogs. Up until then no frogs had been seen in the garden, but, by the next day, a single clump of spawn had been laid.

The following year, five clumps of spawn were introduced from the pond in our previous garden in

Figure 1. A map showing the positions of the two ponds in the garden (black dots, with 'Co' for the concrete pond and 'Pl' for the plastic pond) and those in adjacent gardens (black triangles). Buildings in the study garden are stippled, but those in adjacent gardens are omitted. The property is surrounded by gardens except for: 'PF' playing field; 'HP' horse pasture; and the road to the south. Apart from the access point to the road, the garden is entirely bordered by mature hedges.



The plastic pond

Ramsey into the newly-created plastic pond. No clumps were laid naturally that year in either of the two ponds. Since 1984, spawn has been laid in each of the 18 years in the plastic pond, and in 14 years in the concrete pond (Table 1). During those 18 years, at least four times as many clumps have been laid in the plastic pond, except in 1992. Replacement of the pond's vinyl liner in December 1991 may have partially deterred the frogs in the following spring.



Year		Plas	tic pond		Concret	e pond
	Date of spawning	Spawn clumps	Clumps hatching normally	Froglet emergence	Date of spawning	Spawn clumps
983					19.3	1
1984		[5]*	5	+		0
1985	5.3	5	5	+	8.4	1
986	17.3	12	12	+	23.3	2
987	2.3	25	25	<u> </u>	NR	1
988	23.2	50	48	-	NR	6
989	19.2	40	40		5.3	9
1990	21.2	66	9		12.3	3
991	26.2	69	9		16.3	6
992	2.3	26	5	-	18.3	23
993	18.2	83	45	-	16.3	5
994	19.2	87	50	(+)	6.3	8
995	16.3	32	17	1	25.3	7
996	24.3	44	10	(+)	13.4	2
997	27.2	28	28	+	NR	1
998	24.2	18	18	+		0
999	22.2	24	24	+		0
2000	28.2	58	58	+		0
2001	7.3	140	140	+	1.12	0
2002	19.2	142	91	(+)	19.3	6

Table 1. Dates of first spawning and numbers of spawn clumps laid in the plastic and concrete ponds, 1983-2002. *Five clumps were introduced in 1984. NR = not recorded. Also shown for the plastic pond are numbers of clumps hatching normally (after deducting those translocated and those that failed) and froglet emergence: + good, (+) poor, - failed. For the concrete pond, the number of clumps hatching normally was the same as the number laid except for: 8 clumps in 1992, 3 in 1993 and 0 in 1997. No froglets emerged from spawn laid in the concrete pond.

The size of the frog population breeding in the garden has been followed by counting spawn clumps laid in both ponds (Figure 2). Number of clumps increased steadily up until 1991. In 1992, a reduction occurred, either because the frogs found the plastic pond with its new liner less attractive or because breeding failure in the previous five years (Table 1) was beginning to affect adult numbers. Destruction of the pond in the neighbouring garden to the north in the winter of 1992/3 may have been the reason behind the increases in spawn laid in 1993 and 1994. Following that, amounts of spawn decreased to a minimum in 1998 after ten years of poor breeding or total failure, 1987-1996 (Table 1). Amounts of spawn began to increase again in 1999, two years after successful breeding occurred in 1997.

Successful breeding 1997-2001 has seen the frog population increase to its highest level so far in 2002.

In 2002, the spawn production in our garden and the neighbouring ones was 182 clumps. This suggests an adult population of several hundred in the vicinity of the garden, at a density probably approaching 100 per ha.

DATE OF SPAWNING

Dates when spawn was first seen in the two ponds are given in Table 1. For neither pond was there a significant trend in date over the 20

years (plastic pond, $r_s = -0.106$, n = 18; concrete pond, $r_s = 0.084$, n = 12). Spawn was always laid in the plastic pond first (paired t test, P < 0.01), the average difference being 18 days. Spawning in the plastic pond was often exceptionally early for this area, with spawning in the concrete pond occurring at a much more typical time (Cooke, 1976).

To test whether the difference between spawn dates for the two ponds (and amounts of spawn laid) might be due to differences in water temperature, a maximum/minimum thermometer was maintained in each pond at a depth of about 10 cm for eight weeks from 6th February until 3rd April 2002. The thermometer in the plastic pond was in the centre, while that in the concrete pond was situated in the sunniest and warmest edge. There were no differences between mean daily minimum temperatures for any of the eight weeks. For maximum temperatures, however, the plastic pond was warmer for each week apart from the first one (t test or paired t test, P < 0.01), despite siting the thermometer in the warmest part of the concrete pond. Weekly differences in mean daily maximum temperatures between the two ponds varied from 0.7 to 3.8°C.

FATE OF SPAWN AND TADPOLES

In total, 225 spawn clumps were translocated from the plastic pond to sites elsewhere. Most were moved during the period 1990-1994, in part because of concern about the potential effect of tadpoles being over-crowded. Seventeen spawn clumps were translocated from the concrete pond in 1992 and 1993.

No froglets were ever seen emerging from the concrete pond that were considered to have originated from naturally-laid spawn. Predation by fish and newts, particularly on newly-hatched tadpoles, was the most likely reason for this failure. When larger, free swimming tadpoles were moved to the concrete pond from the overcrowded plastic pond, froglet emergence was often good. As frog tadpoles grow, so predators such as Smooth Newts find it increasingly difficult to catch them (Cooke, 1974).

In the plastic pond, froglets were abundant in eight of the 19 years (Table 1); in three other years, very few froglets emerged, while in eight years there was total failure. In two years (1990 and 1991), failure was readily explained because the liner leaked and the pond dried out. Failure or near failure in the remaining nine years appeared to result from a variety of causes.

Spawn failure in the plastic pond

In four years, there was a significant amount of spawn failure. Many clumps were infested with fungus in 1994, 1995, 1996 and 2002, and these subsequently suffered low or zero hatch. It is not clear whether the fungus involved in such events is saprophytic or harmfully parasitic. Elsewhere cold weather has been blamed for fungal infestations (e.g. Greenhalgh, 1974), and the plastic pond was covered in ice after spawning in 1995 and 1996. However, very cold weather does not necessarily precede fungal

Figure 2. Total numbers of spawn clumps laid in the garden, 1983-2002.

infestation (Cooke, 1985). Early spawn in 2002 was briefly locked in ice on 2nd March, but spawn laid later in the spring also suffered infestation, despite there being no further hard frosts. On 24th February 2002, a typical fresh clump was divided and kept in pond water or rain water; both parts failed to develop and became infested, indicating either the effect of the frost on 2nd March or that the spawn was not viable. When a similar trial was undertaken in 1994, the spawn in rain water hatched normally, but that in pond water became infested with fungus and had a low hatch, pointing to problems with the pond water rather than with the spawn. Predation around hatching was not thought to be as important as in the concrete pond, because no fish were ever present and the ratio of spawn clumps to newts was probably much greater.

Tadpole failure in the plastic pond

Tadpoles that hatch from spawn that has had low hatching success because of fungal infestation or other reasons, have low survival rates, often dying soon after hatching (Cooke, 1981, 1985). The few tadpoles that hatched from the part-clump kept in pond water in 1994 all died within 20 days, whereas those in rain water survived normally. Of



the four years with fungal infestation: in 1994, a few tadpoles survived when heavy rain diluted the pond water above a dense mat of aquatic vegetation; in 1995, no tadpoles were seen; in 1996, a few tadpoles survived; in 2002, dead and dying tadpoles were noted during the month after hatching until very few were left. Problems were, however, not restricted to those years with spawn failure. Dead and dying tadpoles were seen in 1989; while in 1988, 1992 and 1993, tadpoles hatched satisfactorily, but disappeared completely soon after. Poor water quality might be implicated; for instance, decaying spawn and algae may have produced anoxic conditions in 2002.

Predation by newts will have contributed to losses, but, in this context, froglet success or failure was unrelated to the number of clumps hatching normally in the pond (Table 1). If newt predation was the main reason for tadpole losses, one might expect failure to have occurred more frequently when fewer tadpoles hatched. In the summer of 2002, there was no evidence of newt tadpoles in the pond; newt reproduction apparently failed, perhaps for the same reasons that precipitated large losses for the frog spawn and tadpoles. Over-crowding of tadpoles may also have contributed by reducing growth and development rates (eg in 1988, 1989 and 1993). However, over-crowding alone cannot fully explain failure in any one year, as all 140 clumps hatched successfully in 2001 yet froglet emergence was good. Conversely, tadpole losses occurred in 1992-4 despite translocation of much of the spawn. In summary, the factors responsible for spawn failure probably also had direct or delayed effects on the tadpoles.

CONCLUSIONS

The garden population which is the subject of this paper seems to have originated from the small number of frogs already present in 1983 and the spawn introduced in 1984. Since 1984, spawn has been laid every year in the plastic pond, and in 14 years out of 18 in the concrete pond. Despite the current concerns about global warming, spawn dates in neither pond showed a significant trend to be earlier in response to higher spring temperatures. Although frogs may have the potential to spawn earlier in a warmer environment, Beebee (1995) also found his frogs did not spawn significantly earlier during 1979-1994. Spawning was always earlier in the plastic pond, and more spawn was deposited there. This may be explained by the water in the plastic pond attaining higher daily temperatures before and during the spawn season. Similarly, Beebee (1986, 1996) reported that frogs tended to spawn in the warmest pond in his garden.

Among the factors considered to be responsible for failure of spawn or tadpoles were predation, cold weather, fungus, non-viable spawn, poor water quality and a leaking liner. Over-crowding of tadpoles may also have contributed. As in the plastic pond, Beebee (1996) found almost total breeding failure from the late 1980s until the mid 1990s, blaming predation by newts. The main concern arising from this new study is the inability to explain fully the frequent breeding failure in the plastic pond, making it difficult to rectify the problem.

The population has fluctuated since the study began 20 years ago, but the total of 148 clumps laid in 2002 can be favourably compared with the single clump in 1983. The decline experienced during the 1990s has been reversed, but conclusions would have been different had this paper been written four years ago (Figure 2).

Common Frogs have recovered dramatically in this area since the 1970s, largely as a result of garden pond conservation. In 1973, I knew of only one garden with frogs in Ramsey, and, together with Peter Ferguson, estimated the breeding population of the old County of Huntingdonshire to be only 1500 frogs (Cooke, 1999). In 2002, in contrast, the breeding population in the vicinity of our garden will have numbered several hundred. Changes in the composition and structure of the herbaceous borders will have helped the garden support this number of frogs.

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Colour and pattern polymorphism in Eleutherodactylus johnstonei on Grenada

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THE genus *Eleutherodactylus* is the most species-rich vertebrate genus in the world, including more than 143 species currently known from the West Indies (Powell et al., 1996; Powell & Henderson, 1999). Two species occur on Grenada, one endemic (*E. euphronides*) and one introduced (*E. johnstonei*). The latter is a well-adapted coloniser and a resource generalist (Kaiser & Hardy, 1994). In addition to Grenada, this species is established on all of the major Lesser Antillean islands except Dominica. Other colonies are well established in various locales in Central and South America (Kaiser & Hardy, 1994).



Many species of *Eleutherodactylus* exhibit considerable colour and pattern polymorphism (e.g., Savage & Emerson, 1970; Sifers et al., 2001). Published descriptions of *E. johnstonei* include such phrases as: 'dorsal ground color brown to grayish tan; dorsal pattern variable but usually with at least 1 chevron (sometimes followed by a second) in scapular region; often with prominent dorsolateral stripes and/or pale median dorsal hairline; single crural crossbar bordered with paler color; no red on hindlimbs or groin ... venter creamy, often with stippling on throat; postanal triangle frequently present'

(Schwartz & Henderson, 1991) and 'dorsal coloration is brown to grayish-brown, with a great variety of dorsal patterns. Most specimens have a scapular chevron, often in combination with one or more other pattern elements, such as a second chevron, a pale median hairline, or prominent pale dorsolateral stripes ... single crural crossbar, hidden surfaces of hindlimbs and groin irregularly patterned, but never colored red' (Kaiser & Hardy, 1994). Herein we quantify colour and pattern polymorphism from an ecological perspective.

We collected 146 *E. johnstonei* from nine different localities of varying elevations and habitats on Grenada from 5th-22nd June 2002. We examined eleven pattern characteristics: dorsal ground colour (quantified from pale to dark brown using a scale of 1-4), mottling on dorsum

Figure 1. Map of Grenada showing collecting localities. Contour lines are at 120 m, 365 m, and 610 m.

Colour and pattern variation in Eleutherodactylus johnstonei

(present or absent), middorsal line (present or absent), dorsolateral lines (present or absent, and colour on a scale of 1-4), number of scapular chevrons (0, 1, or 2), colour of chevrons in shades of (quantified brown from 1-4), interorbital bar (absent, broken, or full), canthal line (present or absent), supratympanic line (present or absent), ventral colour and pattern (light or dark and stippled or not), and colour of iris. We measured snout-vent length (SVL) to the nearest 0.5 mm. For those characters with three character states. we compared presumed genotypic frequencies to those expected at Hardy-Weinberg equilibrium. Most frogs were released at the exact site of collection, but voucher specimens from each locality were deposited in the Bobby Witcher Memorial Collection (BWMC) at Avila University (06880, 06884-06910, 06916-7, 06940-1, 06960, 06962-7). For all statistical tests, we used Statview 5.0 (SAS Institute, Cary, North Carolina); for all tests, $\alpha = 0.05$.

Collecting sites (Fig. 1) were: Site 1, a mixed agricultural/residential area at Westerhall Estate, 18 m above sea level (ASL); Site 2, a dry forest at Mt. Hartman Point, <5 m ASL; Site 3, a

public beach area at the Rex Grenadian resort, <10 m ASL; Site 4, an urban area with decorative plantings and a weed-overgrown boundary fence at the Lazy Lagoon Guest House in St. George's, 9 m ASL; Site 5, a residential area, Beausejour Estate, 46 m ASL; Site 6, a relatively undisturbed rainforest at Grand Etang Forest Reserve, 544 m ASL; Site 7, a banana/nutmeg/cacao plantation at Spring Gardens Estate, 447 m ASL; Site 8, a cacao plantation monoculture near L'Esterre, 169 m ASL; and, Site 9, an area of mixed agriculture and forest remnants near the abandoned airport at Pearls, 12 m ASL. Because samples from sites 2 and 3 were very small, site-specific data are included in totals but were omitted from comparisons with other sites.

Pattern Element		Site Number (see Text), Sample Sizes in Parentheses									
		l (13)	2 (2)	2 3 (2) (1)	4 (12)	5 (30)	6 (19)	7 (29)	8 (32)	9 (8)	Total (146)
Dorsal Colour	Light	0	0	0	1	2	0	1	1	0	5
	Medium-	7	2	0	6	20	17	14	20	4	9 0
	Medium- Dark	3	0	1	5	3	2	13	10	4	46
	Dark	3	0	0	0	0	0	1	1	0	5
Number of Chevrons	0	T	0	0	2	2	3	7	4	0	17
	1	5	0	0	7	22	10	17	20	4	87
	2	7	2	1	3	6	6	3	8	4	40
Chevron	Light	0	0	0	0	0	0	0	0	0	0
001001	Medium-	0	0	0	0	2	0	0	0	0	2
	Medium- Dark	7	2	0	4	17	15	12	19	4	80
	Dark	5	0	L	7	9	1	8	9	4	44
Interorbital Bar	Full	9	2	1	6	26	13	17	21	6	101
	Broken	3	0	0	2	3	3	5	7	2	25
	Absent	L	0	0	4	1	3	5	4	0	18
Dorsolateral Lines	Absent	9	2	I	9	22	14	20	27	8	112
	Present	4	0	0	3	8	5	7	5	0	32
Mottled Dorsum	No	13	2	1	7	29	19	26	32	8	136
	Yes	0	0	0	5	1	0	1	0	0	7
Middorsal Line	Absent	12	0	1	12	3	5	20	27	8	115
	Present	I.	2	0	0	0	14	7	5	0	29
Dorsolateral Line Colour	Light	2	0	0	1	5	2	1	0	0	11
	Medium- Light	I.	0	0	2	2	1	ł	2	0	9
	Medium- Dark	0	0	0	0	0	0	1	1	0	2
	Dark	1	0	0	0	I	2	4	2	θ	10

 Table 1. Colour and pattern polymorphism in

 Eleutherodactylus johnstonei from Grenada.

Dorsal colour and pattern in *E. johnstonei* are extremely variable (Table 1, Fig. 2). Dorsal colour ranges from light to dark brown, and pattern elements change in colour, type, and distribution. Few characteristics are invariable: all of the frogs examined had dark brown canthal lines, dark brown supratympanic lines, a bronze upper iris, a pale and stippled venter, and all scapular chevrons were darker in colour than the dorsum. However, dorsolateral lines could be either lighter or darker than the dorsal ground colour, in contrast with statements in Kaiser & Hardy (1994). In the absence of scapular chevrons, dorsolateral lines

Figure 2. Representative pattern polymorphism in Eleutherodactylus johnstonei from Grenada (note that individuals are not figured in the same scale): A. site 4, SVL 24.0 mm, dorsal colour medium-dark, 1 dark chevron, interorbital line full, mottled dorsum; B. site 4, SVL 24.5 mm, dorsal colour medium-dark, chevrons absent, interorbital line absent, medium-dark dorsolateral lines; C. site 7, SVL 22.0 mm, dorsal colour medium-light, chevrons absent, interorbital line broken, medium-dark dorsolateral lines; D. site 4, SVL 17.5 mm, dorsal colour medium-light, 1 dark chevron, interorbital line full, medium-light dorsolateral lines, mottled dorsum; E. site 4, SVL 21.0 mm, dorsal colour light, 1 medium-dark chevron, interorbital line full; F. site 1, SVL 21.5 mm, dorsal colour medium-light, 1 medium-dark chevron, interorbital line full; G. site 1, SVL 19.5 mm, dorsal colour medium-light, 2 mediumdark chevrons, interorbital line full, middorsal line present.

were always present, although both were present in some individuals.

Only two characters were suitable for comparisons with expected Hardy-Weinberg frequencies. For number of chevrons, all frogs ($\chi^2 = 10.6$, P = 0.05) and frogs from sites 5 ($\chi^2 = 15.0$, P = 0.0006), 7 ($\chi^2 = 15.4$, P = 0.0005), and 8 ($\chi^2 = 7.0$, P = 0.03) differed significantly from expected values. For interorbital bar, all frogs ($\chi^2 = 24.4$, P < 0.0001) and frogs from sites 1 ($\chi^2 = 12.7$, P = 0.002), 5 ($\chi^2 = 19.0$, P < 0.0001), 6 ($\chi^2 = 20.4$, P < 0.0001), 7 ($\chi^2 = 10.0$, P = 0.007), and 8 ($\chi^2 = 18.1$, P < 0.0001) differed significantly from expected values.

An ANOVA revealed no significant variation (all P > 0.05) between animals collected at different sites, although pairwise comparisons (Fisher's PLSD) indicated that dorsolateral line colour frequencies at Beausejour and Pearls differed significantly (P = 0.03). Contingency test comparisons of frequencies for each character state at each site with those for all sites suggested that significant differences were associated with small sample sizes, i.e., small samples were much more likely not to include rare character states. For example, two frogs at site 5 had light chevrons, which were not found at any other site. Frogs with pale markings also were pale in dorsal colour, suggesting the presence of a causative gene present only in the population at this site. Similarly, mottling as the primary pattern element was found only at site 4 (in five individuals), although indistinct mottling in addition to other primary pattern elements was present in two specimens from other sites.

Eleutherodactylus johnstonei is likely native to the Antigua Bank (Kaiser, 1997), but has occurred on some other Lesser Antillean islands for over a century. Grenada is the type locality for the species, but, according to Barbour (1914), it was introduced there from Barbados in about 1885. Thus, with the exception of Barbados, E. johnstonei has had a longer history on Grenada than on any other West Indian island onto which it has been introduced. Individuals on Grenada are extremely variable, and variability does not appear to be associated with habitats at various elevations and subjected to varying degrees of human disturbance. We have no basis for suggesting that populations Grenadian originated as a consequence of a single or of multiple invasion events, but the ecological versatility of the species has allowed it to exploit essentially all available habitats. During audio surveys conducted while driving from Pearls (site 9), over the central mountain range at elevations exceeding 500 m (site 6), to St. George's (site 4) and from Westerhall Estate (site 1) to St. George's, we were out of earshot of calling *E. johnstonei* for only 20 sec as we passed through an all-concrete area of the city. Its ubiquity on the island (Germano et al., 2003) precludes any restriction of gene flow between populations that could result in local variation responding to localised selective pressures.

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Feeding behaviour in monitor lizards and snakes; does direction of prey ingestion influence prey handling time?

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ABSTRACT — Food ingestion was studied in Rat Snakes *Elaphe obsoleta*, Corn Snakes *E. guttata*, King Snakes *Lampropeltis getulus*, Hognose Snakes *Heterodon nasicus* and in monitor lizards (*Varanus* sp.). In most instances the prey items were ingested headfirst except in the Hognose Snake (*H. nasicus*) where direction of ingestion was more random. In all cases headfirst ingestion was shown to be the most efficient method in terms of the time taken to consume the prey item.

EEDING dynamics in reptiles may be Γ influenced by many factors, for example the size of the prey item, its shape, the body temperature of the reptile at the time of feeding and apparently even experience in prey handling (e.g. Halloy & Burghardt, 1990). One of the many similarities between snakes and monitor lizards is the development of cranial kinesis and subsequent capacity to swallow, proportional to their head and body size, large food items, particularly in snakes. However, feeding on large prey items is time consuming and fraught with problems in respect to risk of injury from predators or from the food animal itself. It might therefore be expected that evolutionary adaptation should have been in a direction that maximises rate of consumption whilst simultaneously minimising risk of injury. In this paper we give details of observations on prey handling in a group of captive snakes and monitor lizards. The study was designed to address the following questions: 1) what is the frequency of headfirst ingestion, and 2) does headfirst ingestion reduce prey-handling time? The results presented here were part of a first year Higher National Diploma research project at Huddersfield Technical College that was undertaken between September 2001 and June 2002.

METHODS AND MATERIALS

Three individual African monitor lizards of three species, Varanus niloticus, V. albigularis and V. exanthematicus were used in the project. All attain large adult size feeding on any animal matter (including carrion) they can overpower (Bennett, 1998). The lizards were fed a series of dead rats and mice presented at right angles to the body of the lizard - in the sense that neither head nor tail was in closer proximity to the reptiles head. The snakes species used in the project were, with numbers of individuals in parenthesis, King Snakes Lampropeltis getulus (n = 2), Rat Snakes Elaphe obsoleta (n = 4), Corn Snakes Elaphe guttata (n = 4) and Hognose Snakes Heterodon nasicus (n = 2). All are North American forms (Conant, 1975). They were offered dead mice of varying sizes, again presented at right angles to the long body of the snake with both the direction and time taken for ingestion recorded using a stopwatch, which commenced when the subject seized the prey and ceased when the prey was swallowed and out of sight, including the rodent's tail. Direction of ingestion was recorded as either head or tail first. The results for the monitor lizards were recorded using the same method.

The food animals were weighed on digital scales with an error of + 0.1g. This was recorded just before being offered to the reptiles. The body masses of the food animals was: *Elaphe* sp. 10.1-39.7g (mean = 23.5g); *H. nasicus* 3.3-31.8g (mean = 8.9); *L. getulus* 16.30-24.5g (mean = 19.4g); *V. albigularis* 5.3-305g (mean = 165.9g); *V. exanthematicus* 15.3-47.6g (mean = 29.2g); *V. niloticus* 19.1-307.0g (mean = 193g).

Statistical analysis. Percentage frequencies of direction of ingestion in each reptile group were compared using an h-test of corresponding percentage x values by finding,

$$h = x_1 (n_1) - x_2 (n_2)$$

where x_1 and x_2 are the x values of the observed percentages of samples n^1 and n^2 . When the compared sample sizes were uneven, degrees of freedom (N') were found from,

$$N = (2n_1n_2) / (n_1 + n_2)$$

where n_1 and n_2 are the sample sizes for the respective data sets. For N in even sample sizes degrees of freedom was simply obtained from, $N = (n_1 + n_2)/2$. To correct for different prey sizes on the time to ingest food the simple formula was applied,

$$C_{ll} = (M_1 / (M_2)M_{2l})$$

where C_{It} the corrected ingestion time was calculated from M_1 the body mass of the largest prey item ingested in each sample, M_2 the body mass of the prey animal being consumed and M_{2t} the time taken to consume M_2 .

RESULTS

Snakes – Rat and corn snake (Elaphe spp.) data were pooled on the basis that the species have similar lifestyles and feeding habits (Conant, 1975). Figure 1 shows that this group ingested prey items headfirst 82% and hognose snakes (*H.* nasicus) head first 30% of the time with the difference between the two highly significant (h =1.099, P < 0.01, 31.7d.f.). The king snakes *L.* getulus, showed a 57% head first ingestion which was not significantly different either from Elaphe spp. (h = 0.5540, P > 0.05, 11.6 d.f.) or *H.* nasicus (h = 0.552, P > 0.05).

Monitor lizards – Frequency of headfirst ingestion of prey in monitor lizards is also shown in Fig 1. Headfirst ingestion was observed in V. albigularis 50% (n = 10) and in V. niloticus 70% of the time (n = 14). The percentage difference between the two was not significant (h = 0.4110, P > 0.05, d.f. = 11.66). Bosc's monitor V. exanthematicus,



Figure 1. Histogram showing comparative frequencies of headfirst food ingestion in snakes and monitor lizards. The data are expressed as percentage frequencies of headfirst ingestion as opposed to either tail or mid body first ingestion. The x-axis labels are E. sp = Elaphe obsoleta and E. guttata, H. n = Heterodon nasicus, L. g = Lampropeltis getulus, V. a = Varanus albigularis, V. n = Varanus niloticus and V. e = Varanus exanthematicus. See text for further details.

swallowed headfirst 65% of the time (n = 39)which was not significantly different from either *V. albigularis* (h = 0.304, d.f. = 20.6) or *V. niloticus* (h = 0.107, d.f. = 15.9). A test for possible influences of Q_{10} effects on prey handling time in *V. niloticus* and *V. albigularis* using a multiple regression, with body temperature and prey size treated as independent variables and the time taken to consume the prey as the dependent variable, showed that in both species prey size was found to be of greater significance in determining handling time (*V. niloticus*, P < 0.02; *V. albigularis*, P <0.002) than body temperature (*V. niloticus*, P =0.27; *V. albigularis*, P = 0.91).

Comparing head and tail first ingestion

Snakes – When corrected for size effects the mean time taken to consume prey head first in *H. nasicus* was 32.5 seconds (SD = 47.1 seconds), with the tail first mean 139.1 (SD = 164.2) with the difference significant at the 90% interval ($F_{1,18}$) = 3.14, *P* = 0.09). In *E. obsoleta* and *E. guttata* mean time taken to consume food head first was 158.1 seconds (SD = 113.9) with the

mean for tail first 290.4 seconds (SD = 288.5). The difference between means was significant at the 90% interval ($F_{1,27} = 2.91$, P = 0.10). Headfirst ingestion was quicker in *L. getulus* (mean = 32.5, SD = 47.1) than tail first (mean = 139.1, SD = 164.2) and significant at the 90% interval $F_{1,18} = 3.14$, P = 0.093.

Monitor Lizards – When corrected for size, mean time to ingest food head first in V exanthematicus was 0.24 ± 0.57 seconds and when taken tail first 0.26 ± 0.21 seconds. Analysis of variance showed no significant difference between the data sets $F_{1,37} = 0.03$, P > 0.05. In V albigularis mean time to consume food headfirst was 0.62 ± 1.7 seconds and tail first 1.11 ± 1.0 seconds with the difference not significant $F_{1,9} = 0.20$, P > 0.05.

DISCUSSION

The results of this study have shown that in most of the animals under observation there was a strong preference for headfirst ingestion, which resulted in shorter handling time. The exception was in the Hognose Snake, H. nasicus, which appeared to ingest in a more random fashion but even in this species swallowing prey head first reduced handling time. Headfirst ingestion should be adaptive for several reasons, particularly if the prey is a mammal with fur or a bird with feathers, since swallowing headfirst must reduce resistance and hence energy cost. Faster ingestion should also render the animal less vulnerable in a chance encounter with a predator - a reptile with a large object in its mouth has little means of defence, and also reduce the risk of accidental damage with headfirst ingestion since the limbs of the prey species are at an angle less likely to cause damage. In general our results were in good agreement with Loop (1974) who found significantly shorter feeding times with headfirst ingestion at the 90% interval and with one of the few studies undertaken in the field, where the gopher snake (Pituophis catenifer) was observed to consume most prey items (88.5%) headfirst (Rodriguez-Robles, in press).

The direction of ingestion in snakes may be influenced by the direction of attack (Diefenbach & Emslie, 1971; Cooper, 1981) and vary with the size and/or the age of the snake (Mori, 1996). The more random direction of ingestion in H. nasicus possibly involves a natural diet of frogs and toads, which are almost spherical in shape and may inflate with air in an attempt to prevent ingestion. Therefore there may be no pre-adapted behaviour for dealing with fur or feather direction in this species. Evolutionary considerations have been cited as an influence on feeding behaviour in other snake species. For example, Mori (1996) found that snakes that are generalist feeders are less efficient in rodent feeding than endothermic prey specialists. Mori further suggested that prey handling in young snakes is learnt and becomes more proficient as they grow to adulthood. Several studies have indicated that prey type may influence the way snakes consume their food (e.g. Loop & Bailey, 1972; de Queiroz, 1984) and have a cost benefit basis. In the Viperine Snake (Natrix maura), the cost of capturing and handling the prey - which increases exponentially with fish size, and the energy value of the prey - which increases linearly with fish size, results in prey with the highest profitability being selected (Davies et al., 1980). Direction of ingestion in some snakes may be related to prey type and the number of items consumed in succession (Stafford, in press) whilst the direction of scale overlap apparently acts as a cue for prey ingestion in ophiophagus snakes (Greene, 1976).

Prey handling time has been found to increased exponentially with decreasing body temperature in the lizard Lacerta vivipara (Avery & Mynott, 1990) and a similar relationship was observed in certain skinks (e.g. Andrews, et al., 1987; de Queiroz et al., 1987; de Queiroz & de Queiroz 1987) although interestingly not in Chalcides chalcides (de Queiroz et al., 1987). The somewhat limited body temperature ranges experienced by our monitor lizards during the project may explain the lack of a significant association between food consumption and temperature - a wider body temperature range might have produced different results. It is also important to remember that all prey items used in this project were dead when offered to the reptiles, live prey might have produced significantly different responses.

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NATURAL HISTORY NOTES

Natural History Notes features short articles documenting original observations made of amphibians and reptiles mostly in the field. Format details and other guidelines are available in *Herpetological Bulletin* No. 78, Winter 2001.

CHALCIDES CHALCIDES (Three-toed Skink): COMMUNAL HIBERNACULA. Several aspects of the ecology of *Chalcides chalcides* are poorly known (but see Rugiero, 1997), and indeed there is almost no data available on the hibernation phase of these animals (see, e.g., Corti & Lo Cascio, 2002).

During field surveys conducted in the winter at a study area situated around the village of Castel di Guido, approximately 15 km north of Rome ('Malagrotta-Castel di Guido', Latium, central Italy), we made some noteworthy observations on communal hibernacula of Chalcides chalcides. These data were gathered in February 2000 during an environmental impact assessment of a site designated for the construction of a rubbish incineration facility (Azienda Municipale Ambiente). This area is characterised by open grassy fields interspersed with bushes of Rubus spp., growing especially along a small stream ('Fosso Galeria'). The local climate is Mediterranean-temperate, with cold winters (without snow), rainy springs and autumns, and dry and hot summers (hypomesaxeric subregion type B, according to Tomaselli et al., 1973). The fauna is depauperate; among reptiles, apart from the species studied here, the following species are found: Vipera aspis, Natrix natrix, Coluber viridiflavus, Elaphe longissima, Lacerta bilineata, Podarcis sicula, P. muralis, and Testudo hermanni (Filippi, 2000).

While excavating the clay foundations during the morning of (6th, 17th and 18th February), some of the AMA engineering staff called for our attention to show us what they had found: on four occasions, always at a depth of about 30-35 cm below ground, they had unearthed groups of hibernating Chalcides chalcides. Although obviously sluggish, the lizards were able to make slow movements while handled. The groups were comprised of, respectively, 4 (1 male with 3 females), 3 (all females), 6 (3 juveniles, 1 male, and 2 females), and 3 (2 males, and 1 female) indivuduals. All specimens excavated from the latter hibernaculum were accidentally killed during the excavations; they were subsequently preserved in alcohol, and are now stored in the collections of the Museo Civico di Zoologia, Rome. On no occasions were specimens of C. chalcides found hibernating singularly at a site. The linear distance between hibernacula is presented in Table 1. The body size (SVL) of all the specimens, divided by hibernaculum, is presented in Table 2. Males were slightly smaller than females, and most females had an average SVL of 120 to 130 mm, which is in full agreement with data reported by Rugiero (1997) for another population of Chalcides chalcides living at about 20 km linear distance from our study area.

Our observations, although opportunistically collected, demonstrate that *Chalcides chalcides* may hibernate communally, at least on clay substrates in central Italy. We do not have firm (experimental) data about this phenomenon, but it seems

> reasonable to assume that the use of communal hibernacula by this species is usual for populations in this region.

Table 1. Linear distance (m) between four hibernacula of *Chalcides chalcides* at the study area ('Malagrotta-Castel di Guido', Latium, central Italy).

	Hibernaculum B	Hibernaculum C	Hiberna culum D
Hibernaculum A	122.7	310.1	342.0
Hibernaculum B	***	214.4	270.0
Hibernaculum C		***	88.6

	Males	Females	Juveniles
Hibernaculum A (n = 4)	108	124; 125; 129	****
Hibernaculum B $(n = 3)$	****	131; 122 128	***
Hibernaculum C (n = 6)	120	125; 129	64; 66; 66
Hibernaculum D $(n=3)$	Not measurable	Not measurable	****

Table 2. Body size (SVL, mm) of the various specimens of *Chalcides chalcides* at the study area ('Malagrotta-Castel di Guido', Latium, central Italy), divided by hibernaculum. Note that the specimens from hibernaculum D were not measured as they were seriously damaged by the excavating operations. Their sex was, however, identified.

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³ F.I.Z.V., via Olona 7, I-00198 Roma, Italy; E-mail: lucamlu@tin.it **CYNOPS PYRRHOGASTER (Japanese** Newt): PREDATION BY INTRODUCED *RANA CATESBEIANA* (Bullfrog). Japanese Newts, *Cynops pyrrhogaster*, have tetrodotoxin in their skin, muscle, digestive organ and gonads (Tsuruda et al., 2001). This chemical blocks sodium channels of nerve and muscle (Narahashi, 2001). Therefore, their predators require resistance to this.

We captured Bullfrogs, Rana catesbeiana, at a field of iris in Higashi-Hiroshima, Hiroshima Prefecture, Japan (34°24'N, 132°43'E, 210 m above sea level) from 1999 to 2001, and studied their dietary habits by examining regurgitated stomach contents. From seven of these we obtained predated specimens of the Japanese Newt (Table 1). The condition of the nine newts ranged from near whole to merely bones. Other stomach contents included larvae of the Japanese Brown Frog, *R. japonica*, 10 types of aquatic invertebrates and 12 types of terrestrial ones.

On 21st June 1999 at 10:32 hrs, we tested for susceptibility of R. catesbeiana to tetrodotoxin by intraperitoneal injection. The tested individual was a female (123 mm SVL, 300 g body weight) captured on 15th June 1999 at ca. 00:00 hrs from the same site where Bullfrogs ate newts. The injected tetrodotoxin was 10 ml solution extracted from males of C. pyrrhogaster in Isahaya, Nagasaki Prefecture, and this toxicity was 1000 MU, corresponding to the level of toxin present in approximately two males (Tsuruda et al., 2001). One MU (mouse unit) is defined as the amount of toxin required to kill a mouse (20 g body weight) in 30 min after intraperitoneal injection (Kawabata, 1978). At 5 minutes after the injection, the frog lowered its head. At 17 minutes, she closed her nictitating membranes, and showed immobile hindlimbs and loss of righting reflex. At 28 minutes, her snout was touching the bottom of the container. At 203 minutes after injection, she jumped, and we considered her to have recovered.

Therefore, levels of tetrodotoxin as contained by two *C. pyrrhogaster* may not be enough to kill *R. catesbeiana* by digestion or even intraperitoneal injection. In previous reports, *R. catesbeiana* died after swallowing *Taricha granulosa* in an

	Time	R. catesb	elana		C. py	rrhogaster	
Date	(h, ca.)	Sex	SVL (mm)	Sex	SVL (mm)	Digested part	Other Content
1999-05-17	0220	Female	142	Male Female	42 46	Whole skin of both newts	Hirudinea sp. (1), Geathelphusa dehaani (1) and Scolopendra subspinipes japonica (3)
2000-04-20	0350	Female?	112	Female	50	Skin of limbs and tail	Physa acuta (2), Hirudinea sp. (3), Chilopoda sp (1), Tipula sp. larva (1), Tipulidae sp. adult (1) and Pterostichinae sp. adult (1)
2000-05-06	0120	Unknown	106	Maic	40	Whole skin	Araneae sp. (1), Orthetrum albistylum nymph (1), Gryllotalpa fossor adult (1) and Carabus sp. adult (1)
2000-07-04	2110	Female	132	Unknown	-	All except for parts of bones (skull, vertebrae, mandibula, pelvic girdle and femora)	Dolomedes sp. (2), Thomisidae sp. (1), G. dehaani (2) and Holotrichia sp. adult (1)
2000-08-17	2230	Male	133	Female	41	Whole skin	Oligochacta sp. (1), D. sp. (1), Asellus hilgendorfi (1), Homorocoryphus lineosus adult (1) and T. sp. larva (1),
2001-05-17	0230	Female	133	Female	47	Skin of head, limbs and tail	P. acuta (7), Austropepta ollula (1), Ceriagrion melanulum nymph (1), Anax parthenope nymphs (2), Anisoptera sp.(parts of Anax?) nymph (1), Laccotrephes japonensis adults (2), Holotrichia sp. adult (1) and Rana japonica larvae (56)
2001-06-04	0000	Female	121	Male Female	44 49	Whole skin of both newts	Laccotrephes japonensis adults (1) and Holotrichia sp. adult (1)

Table 1. Capture date and stomach contents of *Rana* catesbeiana. Snout-vent length (SVL) of Cynops pyrrhogaster was measured from the snout to the posterior end of the cloaca. In 'Other Contents', the number in parentheses following each animal represents the number of individuals.

experiment (Brodie, 1968), and have regurgitated predated individuals of Notophthalmus viridescens (Hurlbert, 1970) and T. torosa torosa (Jennings & Cook, 1998). Taricha granulosa was more toxic than T. torosa, N. viridescens and C. pyrrhogaster (Brodie et al., 1974). The Bullfrog was introduced from North America in 1918, and is now distributed in various parts of Japan (Maeda & Matsui, 1999). The present observation is similar to the observed predation on T. torosa torosa by Bullfrogs introduced into the American West (Jennings & Cook, 1998). Exotic Bullfrogs can therefore become a new predator on endemic newts. We noticed ponds where many Bullfrogs and few newts live, and have suspected influence of Bullfrogs on Japanese newts. We conclude that the predation pressure of Bullfrogs on Japanese Newts may cause population declines.

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THE HERPETOLOGICAL BULLETIN

Number 83, Spring 2003

Daudin's Monitor (Varanus ornatus, Daudin 1803) and its association with Ubani (Bonny Island). Southern Nigeria
Mark K. Bayless, Godfrey C. Akani and Luca Luiselli
Complementary information on the ecology and conservation of Malagasy skinks, with notes on the colouration of some recently described species <i>Franco Andreone</i>
Common Frogs in a Cambridgeshire garden over a twenty year period <i>Arnold S. Cooke</i>
Colour and pattern polymorphism in Eleutherodactylus johnstonei on
Grenada Jennifer M. Sander, Jennifer M. Germano, Robert Powell
and Robert Henderson
Feeding behaviour in monitor lizards and snakes; does direction of prey
ingestion influence prey handling time?
Claire Brown, Claire Foster, Jane Spivey-White and
Judson Heseltine
NATURAL HISTORY NOTES
Chalcides chalcides (Three-toed Skink): communal hibernacula



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