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

FRANCO ANDREONE

Museo Regionale di Scienze Naturali, Via G. Giolitti, 36, 1-10123 Torino, Italy
E-mail: f.andreone@libero.it

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 completely 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. Furthermore, 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.
Eco- logical 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 epigean-oriented 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. macrocerus, was found under stones and boulders in its natural habitat, the altitude forests, as at Ankaraat (Vences et al., 2002). Indeed, A. tansoma 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. crennii. 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.

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

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

Amphiglossus tanysoma, paratype: MRSN R1865, from Antsirasira.

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

Paracontias tsararano, holotype: MRSN R1787, from Tsararano Forest, Campsite 1 (Antsarahany Tsararano).

Pseudoacontias menamainty, holotype: MRSN R1826, from Berara Forest, Sahamalaza Peninsula.
Ecology and conservation of Malagasy skinks

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= ± 2.35). The epigean species varied from 0 to 3 (1.71 ± 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 species were also divided according to their body size (snout-vent 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 Péritnet-Andasibe area). The other main north-eastern 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. *Rhomphophryne, Plbethodontohyla* spp.), and typhlolid 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;
Ecology and conservation of Malagasy skinks

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

*Amphiglossus splrostichus* — 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 reddish-copper, 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.

ACKNOWLEDGEMENTS

This paper is a continuation of work published by Andreone & Greer (2002). For his assistance in respect of this I am greatly indebted to A.E. Greer, who contributed with corrections and criticisms on an earlier draft. Fieldwork undertaken during the last few years has been in collaboration with several Malagasy institutions (PBZT, UADBA), and conservation organisations (WWF, WCS, AEECL). I also thank here the many individuals who accompanied me in the field and shared unforgettable moments of friendship, among them J.E. Randrianirina, G. Aprea, F. Mattioli, M. Vences, and D. Vallan.

REFERENCES


Mém. Soc. Biogéogr.
Rasolonandrasana, P. N. & Goodman, S. M. (2000). Importance du couloir forestier situé entre le Parc National d’Andringitra et la...


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 Intégrale (Strict Nature Reserve). Sites listed between brackets without annotations refer to rainforests.
<table>
<thead>
<tr>
<th>TOTAL</th>
<th>SITE</th>
<th>AQUATIC SPECIES</th>
<th>FOSSORIAL AND SEMIFOSSORIAL SPECIES</th>
<th>EPIGEAN SPECIES</th>
<th>REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Berara (Sahamalaza) (transitional Sambirano-Dry)</td>
<td><em>Amphiglossus reticulatus</em></td>
<td><em>Amphiglossus mandady, A. stumpffi, Pseudoacontias menamainty</em></td>
<td><em>Mabuya gravenhorsti, M. elegans</em></td>
<td>Andreone et al., 2001</td>
</tr>
<tr>
<td>7</td>
<td>Nosy Be (Sambirano)</td>
<td><em>Amphiglossus macrocercus, A. melanurus, A. minutus, A. mouloundvaoe, A. stumpffi</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>PN de la Montagne d’Ambre</td>
<td><em>Amphiglossus melanurus, A. mouloundvaee, A. stumpffi, Paracontias brocchi, P. hildebrandtii</em></td>
<td></td>
<td><em>Amphiglossus melanopleura, Mabuya gravenhorsti</em></td>
<td>Rakotosomalala, 2002</td>
</tr>
<tr>
<td>9</td>
<td>RS d’Anjanahare-Sud</td>
<td><em>A. crenni, A. melanurus, A. minutus, A. mouloundvaee, A. punctatus, A. melanurus, Paracontias hafa</em></td>
<td></td>
<td><em>Amphiglossus melanopleura, Mabuya gravenhorsti</em></td>
<td>Andreone et al., 2003</td>
</tr>
<tr>
<td>3</td>
<td>Ambolotopatra</td>
<td><em>Amphiglossus crenni, A. mouloundvaee</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>PN de Marojejy</td>
<td><em>Amphiglossus astrolabi</em></td>
<td><em>Amphiglossus macrocercus, A. mandady, A. melanurus, A. minutus, A. mouloundvaee, A. ornaticeps, A. praecornatus, A. punctatus, Paracontias holomelas, Pseudoacontias angolorum</em></td>
<td><em>Mabuya gravenhorsti A. melanopleura</em></td>
<td>Andreone et al., 2000</td>
</tr>
<tr>
<td>9</td>
<td>Tsararano</td>
<td><em>Amphiglossus melanurus, A. mouloundvaee, A. namus, A. praecornatus</em></td>
<td></td>
<td><em>Amphiglossus melanopleura</em></td>
<td>Andreone et al., 2006; Andreone &amp; Greer, 2002</td>
</tr>
<tr>
<td>9</td>
<td>Masoala</td>
<td><em>Amphiglossus crenni, A. mouloundvaee, A. namus, A. praecornatus, A. stylis, Paracontias holomelas</em></td>
<td></td>
<td><em>Amphiglossus melanopleura</em></td>
<td>Andreone &amp; Greer, 2002</td>
</tr>
<tr>
<td>4</td>
<td>Tampolo</td>
<td><em>Amphiglossus frontoparatalis, A. ornaticeps, A. sp.</em></td>
<td></td>
<td><em>Mabuya gravenhorsti</em></td>
<td>Raselimanana et al., 1998</td>
</tr>
<tr>
<td>9</td>
<td>PN d’Andringitra</td>
<td><em>Amphiglossus anosyensis, A. melanurus, A. macrocercus, A. punctatus, A. frontoparatalis, A. sp. 1, A. sp.2</em></td>
<td></td>
<td><em>Mabuya melanopleura, Mabuya gravenhorsti</em></td>
<td>Raselimanana et al., 1996</td>
</tr>
<tr>
<td>6</td>
<td>Corridor Andringitra-Ivohibe</td>
<td><em>Amphiglossus anosyensis, A. macrocercus, A. melanurus, A. minutus, A. sp.</em></td>
<td></td>
<td><em>Amphiglossus melanopleura</em></td>
<td>Raselimanana, 1999; Rasolonandrasana &amp; Goodman, 2000</td>
</tr>
<tr>
<td>7</td>
<td>PN d’Andohahela</td>
<td><em>Amphiglossus anosyensis, A. macrocercus, A. ornaticeps, A. punctatus, A. sp.</em></td>
<td></td>
<td><em>Mabuya melanopleura, Mabuya gravenhorsti</em></td>
<td>Raselimanana et al., 1999</td>
</tr>
<tr>
<td>5</td>
<td>Malahelo and nearby sites (transitional Dry-Rainforest)</td>
<td><em>Amphiglossus ornaticeps, A. splendidas</em></td>
<td></td>
<td><em>Amphiglossus melanopleura, Mabuya gravenhorsti, M. tavo</em></td>
<td>Ramanamanjato et al., 2002</td>
</tr>
<tr>
<td>4</td>
<td>Kirindy (Dry)</td>
<td><em>Amphiglossus mouloundvaee</em></td>
<td></td>
<td><em>Mabuya aureopunctata, M. elegans, M. gravenhorsti</em></td>
<td>Bloxam et al., 1996</td>
</tr>
<tr>
<td>7</td>
<td>PN d’Andohahela 2 (Dry)</td>
<td><em>Amphiglossus ignoecaudatus, A. ornaticeps</em></td>
<td></td>
<td><em>Mabuya aureopunctata, M. dumasi, M. elegans, M. gravenhorsti, M. tavo</em></td>
<td>Raselimanana et al., 1994</td>
</tr>
<tr>
<td>5</td>
<td>PN de Zombitse (Dry)</td>
<td><em>Amphiglossus macrocercus, Voeltzkovia rubricauda</em></td>
<td></td>
<td><em>Mabuya elegans, M. gravenhorsti, M. tavo</em></td>
<td>Raselimanana et al., 1994</td>
</tr>
</tbody>
</table>