

**CURRENT COUNTS OF SPECIES DIVERSITY AND ENDEMISM OF
MALAGASY AMPHIBIANS AND REPTILES**

Frank GLAW¹ & Miguel VENCES²

¹ Zoologische Staatssammlung, Münchhausenstr. 21, D-81247 München, GERMANY : email : frank.glaw@zsm.mwn.de

² Zoologisches Forschungsinstitut und Museum Alexander Koenig, Adenauerallee 160, D-53113 Bonn, GERMANY : email : m.vences@t-online.de

ABSTRACT.-The quality of biogeographic analyses strongly depends on the quality of the underlying data on taxonomy and distribution, but such data are not yet satisfying for the Malagasy herpetofauna. From 1990-1999 more new species of amphibians and reptiles were described from Madagascar than in any decade before, and an enormous amount of new data on species distribution has been collected. These data confirm the outstanding herpetological diversity of this island in comparison to other African countries. The ending millennium prompted us to provide an updated account on the current knowledge of species diversity and endemism of the Malagasy herpetofauna (as of 31.12.1999), knowing that numerous changes will occur in the near future. There are 333 described and valid reptile species, 305 (91.6%) endemic to Madagascar itself and 314 (94.3%) to the Malagasy region; 182 described and valid amphibian species, 179 (98.4%) endemic to Madagascar and 180 (98.9%) to the Malagasy region. Of the 65 genera of reptiles 53.8% (including 7 marine genera) and 60.3% (excluding marine taxa) and of the 18 amphibian genera 83.3% are endemic to Madagascar. At least 42-68 amphibian and 24-34 reptile species were already discovered and identified, but are still awaiting to be described or resurrected.

KEY-WORDS.- Amphibia, Anura, Reptilia, Squamata, Chelonia, Crocodylia, Madagascar, endemism, species diversity

RESUME.- La qualité de l'analyse biogéographique dépend fortement de la qualité des données taxonomiques et chorologiques disponibles ; cependant, de telles données ne sont pas encore satisfaisantes pour l'herpétofaune malgache. Entre 1990 et 1999, on a décrit de Madagascar plus d'espèces nouvelles d'amphibiens et des reptiles que pendant toute autre décennie antérieure, et beaucoup de données sur leurs répartitions ont été réunies. Ces données confirment la remarquable diversité herpétologique de l'île, en comparaison avec tout autre pays d'Afrique. Cette fin de millénaire nous pousse à fournir des données précises sur les connaissances actuelles de la diversité et de l'endémisme de l'herpétofaune malgache, sachant que des changements auront lieu dans le futur. 333 espèces valables de reptiles sont présentes à Madagascar dont 305 (91,6%) sont endémiques pour l'île, et 314 (94,3%) pour la région malgache ; pour les amphibiens 182 espèces valables dont 179 (98,4%) d'endémiques pour Madagascar et 180 (98,9%) pour la région malgache. Parmi les 65 genres de reptiles, 53,8% (dont 7 genres marins) ou 60,3% (non compris les genres marins), sont endémiques ainsi que 83,3% des 18 genres d'amphibiens. Entre 42 et 68 amphibiens et 24 à 34 reptiles déjà découverts et identifiés attendent d'être décrits ou revalidés.

MOTS-CLES.- Amphibia, Anura, Reptilia, Squamata, Chelonia, Crocodylia, Madagascar, endémisme, diversité spécifique

INTRODUCTION

Madagascar is well known for the high level of endemism of its fauna and flora. 103 (84%) of the 123 mammal species (Garbutt 1999) and 105 (41%) of the 256 bird species (Langrand 1990) are endemic. Endemism rates of more than 90% have been reported for amphibians and reptiles (Glaw & Vences 1994) who listed a total of about 170 described amphibian taxa. The last numeric account of Malagasy reptile taxa and their distribution was provided by Blanc (1971). Since then numerous changes in species numbers (descriptions of new species, new synonymizations, new resurrections from synonymy, one new record) and generic revisions have been published. We hereby give an updated account, knowing that numerous changes will still occur in the near future. We summarize the species counts in Glaw & Vences (1994) and include all new literature which appeared in the years between 1994 and 1999.

RESULTS AND DISCUSSION

In the decade between 1990-1999, more new species of amphibians (46 species and 1 subspecies) and reptiles (56 species and 6 subspecies) have been described from Madagascar than in any decade before (Figs. 1-2). Currently, 182 amphibian and 333 reptile species are known from Madagascar (Tab. I). More than 98% of amphibians and nearly 92% of reptiles are endemic to the island. Glaw *et al.* (1998) listed a total of 4970 amphibian species worldwide (4371 anurans, 436 urodeles, and 163 gymnophiones). The EMBL reptile database (Uetz & Etzold 1996; <http://www.embl-heidelberg.de/~uetz/LivingReptiles.html>) listed 7907 species in September 1999. Considering described taxa only, Madagascar harbours about 3.7% (amphibians) and 4.2% (reptiles) of the global herpetofaunal species diversity. 3.6% of the world's described amphibian species (4.1% of the anurans) and 3.9% of the reptiles are restricted to Madagascar.

A large number of new amphibian and reptile species have already been discovered and identified, but remain to be described. This is especially true for the amphibians in which 42-68 species await description or resurrection. Altogether 66-102 amphibian and reptile species are awaiting to be described or resurrected (Tab. II). Given the current state only speculations on the actual numbers of amphibian and reptile species on Madagascar are possible. An increasing number of newly described reptiles are very similar to already known species, indicating that the discovery of morphologically highly distinct species will become increasingly unlikely. On the other hand, many reptile species are only known from single specimens or single localities, indicating a generally poor state of knowledge. We believe that at least 10-20% additional new reptile species can be expected. This would result in a total number of around 400. The percentage of new amphibian species is probably higher, since surveys in the 1990 decade revealed (1) many more new amphibians than reptiles (including many undescribed species) and (2) an enormous amount of sibling species in amphibians which are only (reliably) recognizable by life colouration and/or advertisement calls. We believe that a total of 300 amphibian species can be expected in Madagascar.

The new species discovered during the decade of the 1990s included several highly distinct taxa like *Scaphiophryne gottlebei*, *Aglyptodactylus laticeps*, *Boophis lichenoides*, *Phelsuma klemmeri* or *Stenophis citrinus*, although most were morphologically similar to other, already described, species. Several of the new amphibians (especially *Boophis*) lose their characteristic colouration when preserved in alcohol and become indistinguishable from their sister species. Others (and even syntopic species) are almost exclusively recognizable by their advertisement calls. Even

some of the new reptiles (e. g. *Liopholidophis*, *Geodipsas*, and *Mabuya* species) are not recognizable by external morphological characters like simple scale counts. It is therefore no surprise that a remarkable number of the new species were already present but unrecognized in scientific collections (e. g. *Mabuya vato*, *Uroplatus malahelo*, *Geodipsas laphystia*, *Liopholidophis epistibes*). The discovery of new sibling species thus makes it necessary to revise numerous distribution maps which will provide a basis for more precise biogeographical analyses. In the case of amphibians, the attribution of tadpoles to adult stages must be verified in most cases. For this purpose, DNA sequencing is a new tool which will allow a very effective and precise determination of tadpoles also on a large scale. For future work it is crucial to collect material with precise and comprehensive data (exact locality data, colour photographs, call recordings, tissue samples for molecular analyses) rather than to collect large series.

From 1990-1999, 102 new species of amphibians and reptiles have been described from Madagascar. Assuming a continuous rate of species descriptions it would need still ten years to describe only those new forms which were already discovered. We estimate that another 20 years of work (if the intensity of research remains constant) will be necessary until the herpetofaunal diversity of Madagascar is inventoried to a satisfactory degree. During this period a large portion of the natural vegetation and numerous regional animal endemics will be lost if the prognoses of Green & Sussman (1990) proves to be correct. Thus there is an urgent need to accelerate the research intensity of the Malagasy herpetofauna and to intensify the attempts of protecting the remaining natural habitats.

REFERENCES

- BLANC, C. P., 1971. Les reptiles de Madagascar et des îles voisines. *Annales de la Université de Madagascar (Sciences)*, 8: 95-178.
- GARBUTT, N., 1999. *Mammals of Madagascar*. Pica Press, Sussex. 320 pp.
- GLAW, F., J. KÖHLER, R. HOFRICHTER & A. DUBOIS, 1998b. Systematik der Amphibien. Liste der rezenten Familien, Gattungen und Arten. Pp. 252-258, *In*: R. Hofrichter (Ed.), *Amphibien*. Naturbuch Verlag, Augsburg.
- GLAW, F. & M. VENCES, 1994. *A Fieldguide to the Amphibians and Reptiles of Madagascar*, 2nd edition, including mammals and freshwater fish. Vences and Glaw, Köln. 480 pp.
- GREEN, G. M. & R. W. SUSSMAN, 1990. Deforestation history of the eastern rain forest of Madagascar from satellite images. *Science*, 248: 212-215.
- LANGRAND, O., 1990. *Guide to the birds of Madagascar*. Yale University Press, New Haven, London. 364 pp.
- UETZ, P. & T. ETZOLD, 1996. The EMBL/EBI Reptile Database. *Herpetological Review*, 27 (4): 174-175.
- VENCES, M., F. GLAW, J. KOSUCH, I. DAS & M. VEITH, 2000. Polyphyly of *Tomopterna* (Amphibia: Ranidae) based on sequences of the mitochondrial 16S and 12S rRNA genes, and ecological biogeography of Malagasy relict amphibian groups. Pp. 227-240, *In*: W.R. Lourenço & S.M. Goodman (Eds.), *Diversity and Endemism in Madagascar*. Mém. de la Soc. de Biogéographie, Paris.

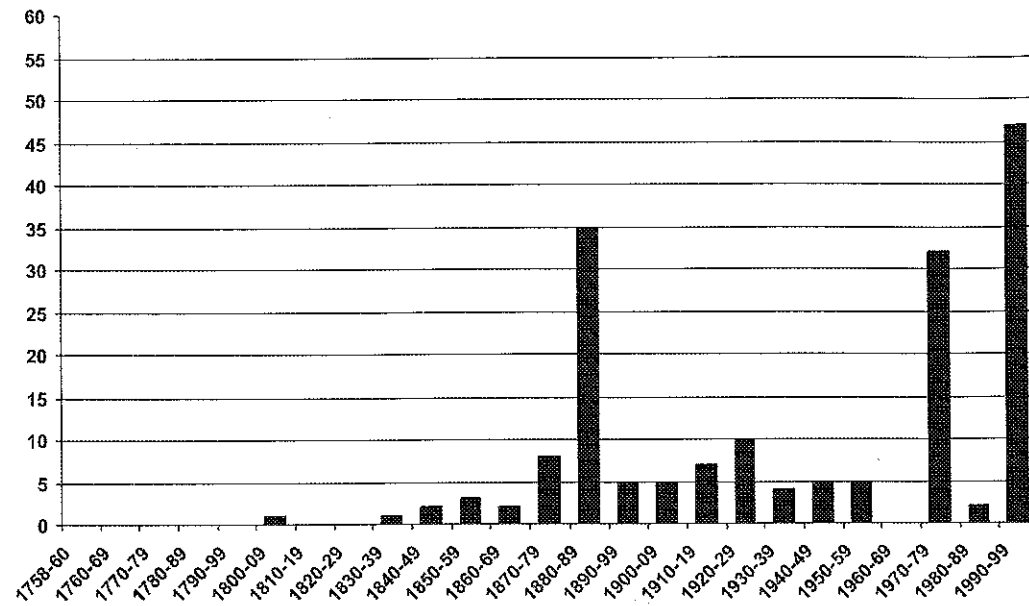


Fig. 1. Number of valid Malagasy amphibian species and subspecies described per decade.

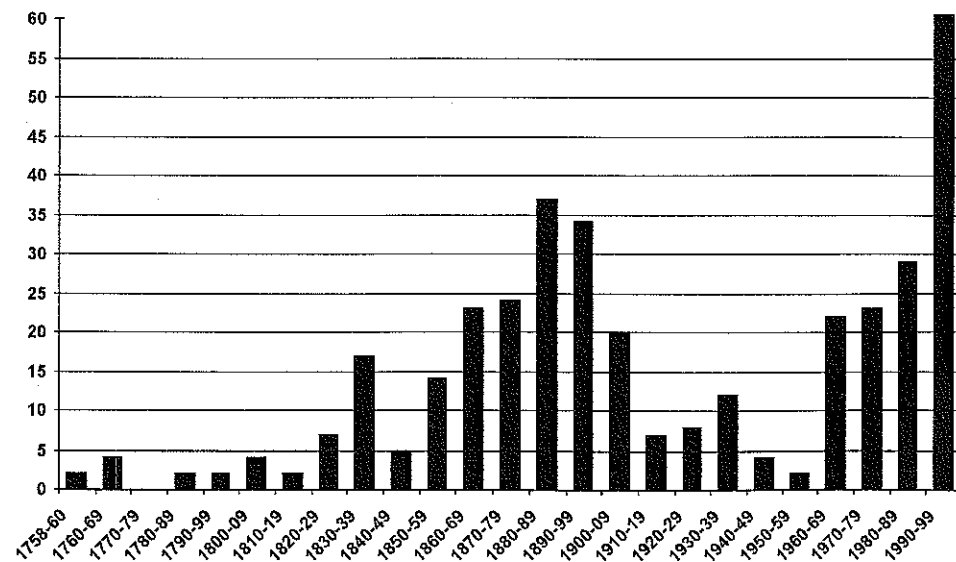


Fig. 2. Number of valid Malagasy reptile species and subspecies described per decade.

Table I. Numbers and endemism of Malagasy amphibians and reptiles as of 31.12.1999 (species and genera).

The three non-endemic amphibian species are: *Hoplobatrachus tigerinus* (introduced on Madagascar from Asia); *Ptychadena mascareniensis* (also Africa, Seychelles and Mascarene Islands); *Mantidactylus granulatus* (also Mayotte Island?!). *Tomopterna* is not considered as present in Madagascar; the Malagasy species is being transferred to a separate genus *Laliostoma* by Vences *et al.* 2000). *Boophis* is considered as endemic to Madagascar, although it possibly occurs on the Comoro Islands as well. The 28 non-endemic reptile species are: *Crocodylus niloticus* (also Africa); *Kinixys belliana domerguei* (only subspecies considered endemic, species also in Africa); *Pelomedusa subrufa* (also Africa); *Pelusios castanoides* (also Africa and Seychelles); *Pelusios subniger* (also Africa and Seychelles [introduced on Mauritius and other islands]); *Lepidochelys olivacea* (marine); *Dermochelys coriacea* (marine); *Caretta caretta* (marine); *Chelonia mydas* (marine); *Eretmochelys imbricata* (marine); *Ophurus c. cuvieri* (only subspecies considered endemic, species also occurs on Grande Comoro); *Ebenavia inunguis* (also Comoros, [the records of Pemba Island and Mauritius require verification]); *Geckolepis maculata* (also Comoros); *Gehyra mutilata* (cosmopolitan); *Hemidactylus frenatus* (cosmopolitan); *Hemidactylus mabouia* (cosmopolitan); *Hemidactylus mercatorius* (cosmopolitan); *Phelsuma abbotti chekei* (only subspecies considered endemic, species also on Seychelles (Aldabra and Assumption Islands)); *Phelsuma l. laticauda* (also Comoros and Seychelles); *Phelsuma cepedianana* (also Mauritius); *Phelsuma dubia* (also Comoros, Zanzibar Island, and single localities in Tanzania); *Zonosaurus m. madagascariensis* (only subspecies considered endemic, species also on Glorioso and Cosmoledo Islands); *Cryptoblepharus boutonii* ssp. (only two subspecies considered endemic, species cosmopolitan); *Mabuya comorensis* (also Comoros); *Pelamis platurus* (marine); *Enhydryna schistosa* (marine); *Ramphotyphlops braminus* (cosmopolitan); *Leioheterodon madagascariensis* (introduced on Grande Comoro).

Madagascar is here defined as the island itself and its immediate offshore islets (e. g. Nosy Be, Nosy Mangabe, Nosy Boraha). The Malagasy region includes Madagascar, Comoros, Seychelles and Mascarenes.

	Amphibians	Reptiles (including marine genera)	Reptiles (excluding marine genera)
<i>Number of described species</i>	182 (100%)	333 (100%)	326 (100%)
<i>Endemic to Madagascar</i>	179 (98.4%)	305 (91.6%)	305 (93.6%)
<i>Endemic to Malagasy region</i>	180 (98.9%)	314 (94.3%)	314 (96.3%)
<i>Number of genera</i>	18 (100%)	65 (100%)	58 (100%)
<i>Endemic to Madagascar</i>	15 (83.3%)	35 (53.8%)	35 (60.3%)
<i>Endemic to Malagasy region</i>	16 (88.8%)	45 (69.2%)	45 (77.6%)

Table II. Proportion of described and undescribed amphibian and reptile species in Madagascar.

During the 1990s, two amphibian species were originally described as subspecies (*Boophis albipunctatus sibilans*, *Boophis luteus septentrionalis*) but were subsequently upgraded to species rank and therefore counted here as species.

	Amphibians	Reptiles	Amphibians and reptiles
<i>Number of described species</i>	182	333	515
<i>Number of species awaiting description or resurrection</i>	42-68	24-34	66-102
<i>total number</i>	224-250	357-367	581-617
<i>Number of species described 1990-1999</i>	46	56	102