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Historical analysis of amphibian studies in Madagascar: an example for increasing research intensity and international collaboration

ABSTRACT

An analysis of a list of almost 1400 publications focused on Malagasy amphibians and reptiles revealed a clear trend of increasing research intensity, both in herpetological research in general, and in publications dealing with amphibians. Altogether, research on Malagasy amphibians has been less intensive as compared to reptiles, with 396 papers focusing on amphibians, 874 on reptiles, and 113 on both groups. Amphibian research intensity, measured as the number of publications dealing with these organisms (exclusively or together with reptiles) per decade, strongly increased from the 1970s on and reached maximum levels of 175 and (interpolated) 169 for the periods of 1990-1999 and 2000-2009. Most papers dealt with taxonomy, but phylogeny, biogeography and ecology/conservation are becoming increasingly important. The average number of authors per amphibian publications was 1 over most of historical times, and reached 3.3 in the current decade, with a current maximum number of nine authors in one paper. Malagasy authors increasingly participate in the research and publication process, with an average number of Malagasy authors per publication of 0.26 in the current decade. We suggest strengthening the increasingly collaborative nature of research on Malagasy amphibians by approaches that speed up data availability via appropriate cyber-infrastructure, and by further capacity building, in Madagascar, for the field of amphibian biology.

Key words: Amphibians, Collaboration, Conservation, Historical findings, Literature, Madagascar.

INTRODUCTION

As summarized by Andriamialisoa & Langrand (2003), the exploration of Madagascar's fascinating flora and fauna has since long attracted the interest of numerous explorers and scientists. For the amphibians, early works were taxonomic almost in their entirety, and started with the description of *Boophis*

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goudoti in 1838 (Tschudi, 1838). Until 1870 only eight frog species were described from Madagascar, but the subsequent years saw a large increase of research intensity, with the descriptions of 95 species by 1900, mainly by George Albert Boulenger from the British Museum in London, and Oskar Boettger in Frankfurt. After an intensified research activity in the 1970s, mainly due to the works of Jean Guibé and Rose Blommers-Schlösser, monographic accounts focusing on the Malagasy amphibians were published by Guibé (1978), Blommers-Schlösser & Blanc (1991), Glaw & Vences (1992, 1994, 2007), and Vences et al. (2006).

Historical analyses of herpetological research in Madagascar have so far used the number of species descriptions per decade as indicator for research intensity (Glaw & Vences, 1994, 2000). These works detected an extreme rise in research intensity since the 1990s, with more species described from 1990-1999 than in any decade before, both for amphibians and reptiles (Glaw & Vences, 2000). In fact, at least for amphibians, there is reason to assume that this high rate of species discoveries will be maintained or will even further increase. The trends in study intensity in other fields of amphibian biology, e.g., ecology, behaviour, physiology, biogeography, phylogeny comma and conservation, have so far remained unstudied. However, from collaborative efforts and meetings such as the Global Amphibian Assessment workshop for Madagascan amphibians in Geneva in 2003, and the ACSAM (A Conservation Strategy for the Amphibians of Madagascar) workshop in Antananarivo in 2006, both focusing exclusively on amphibian conservation in Madagascar, it is clear that also aspects beyond systematics are now receiving a high international attention.

For a long time, the participation of Malagasy researchers in the exploration work and publications of Madagascar's flora and fauna remained marginal, largely reflecting colonial history. However, this trend has been reversed, and the contributions of a flourishing generation of Malagasy scientists, especially to the exploration of remote areas of Madagascar, have strongly contributed to the enormous advances in knowledge on Madagascar's biota.

In this paper, we analyze the historical trends of faunal research in Madagascar from an amphibian perspective. We compiled a largely complete database of literature and analyze number of publications, numbers of authors per publication, and international collaboration over the decades and centuries, with the aim of detecting general trends and inferring suggestions for future research strategies.

MATERIALS AND METHODS

The basis for the analyses in this paper was the first version of a list of references prepared by two of us (FG and MV) for inclusion in the third edition of the "Field Guide to the Amphibians and Reptiles of Madagascar" (Glaw & Vences 2007; for the first and second editions, 1992, 1994). This list of references contains by far most historical and recent publications that focus on Malagasy amphibians. It is certain that the list is not complete, and we will

have missed both a number of historical publications of difficult access, and certainly some recent publications which use Malagasy amphibians and reptiles as model groups, especially in the fields of ecology, physiology and behaviour. Nevertheless, it is unlikely that the results of our analysis and our conclusions would be affected in any relevant way by the inclusion of these papers which certainly represent a minor proportion only.

All references were classified into a number of exclusive thematic categories: (1) taxonomy, (2) phylogeny, (3) biogeography, (4) ecology and behaviour, (5) physiology, and (6) monographic accounts and books. We furthermore noted the year of publication, language, number of authors, and (as far as discernible) number of different nationalities of the authors. Data were summarized for decades, from year 0 to 9 of each ten years; e.g., works published in the 1890s would be those with publication dates from 1st January 1890 to 31 December 1899. Publications on Malagasy amphibians, as summarized in the following, comprise two categories, namely (1) papers focusing only on Malagasy amphibians plus (2) papers focusing on Malagasy amphibians as well as reptiles. When talking about all herpetological publications, we refer to amphibian publications as defined above, plus those focusing exclusively on Malagasy reptiles.

RESULTS

Our database contained a total of 1383 herpetological references. Of these, 396 had as main focus Malagasy amphibians, 874 focused on Malagasy reptiles, and 113 were equally focused on Malagasy amphibians and reptiles.

The historical trends of research intensity on Malagasy amphibians (Fig. 1) indicate a constantly low number of publications from the 1830s to the 1960s, with 1-21 amphibian publications per decade, thus maximum average numbers of 2 published papers per year. A fast increase is visible since, with 39, 46, 175 and 110 publications in the 1970s, 1980s, 1990s and 2000s. Interpolating the value for the current decade (only publications until mid-2006 were considered in our database) gives an estimate of 169 amphibian publications, thus a publication intensity similar to that in the previous decade. The corresponding values for reptile research, as a whole, show similar trends, with average values of less than 20 publications per decade until 1960, 292 publications in the 1990s, and a drop to 148 papers (interpolated estimate: 227) in the current decade.

For an analysis of research categories of the published works, we first considered all herpetological papers together. The bulk of these dealt with taxonomy: altogether 736 (53%). Papers with a main focus on ecology, biogeography, physiology and phylogeny were almost not represented before 1960. Since then, these themes have gained importance, and in the present decades, ecological research is highly represented in the publications analyzed. The strongest categories, in this period, are still taxonomy (38%), and, newly, phylogeny and biogeography (together 35%). Ecology makes up for 29% of all

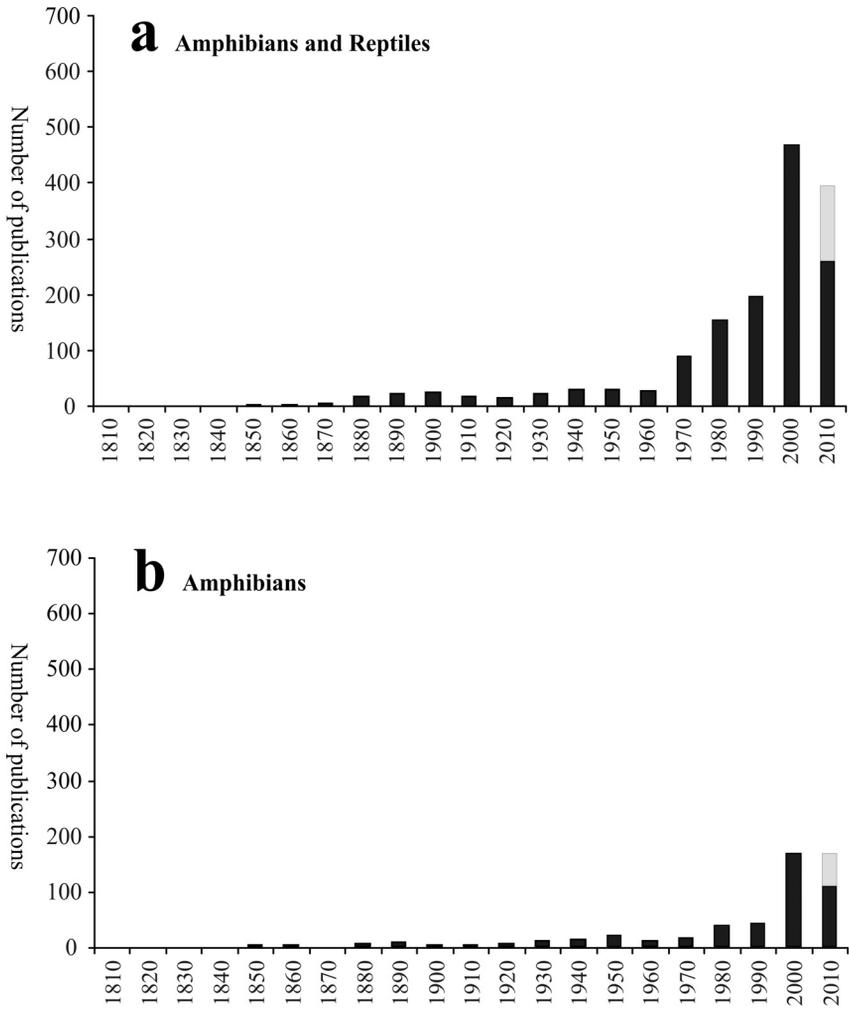


Fig. 1. Historical trends of herpetological research in Madagascar, indicated by numbers of scientific publications per decade focusing mainly on (a) either amphibians or reptiles, or both, and (b) on amphibians only, or on amphibians and reptiles. The grey bars are interpolated estimates for the period from 2000-2009. Each year given on the x-axis corresponds to the scale bar to its right, respectively.

herpetological papers published since 1960. A very similar situation is found if only publications on amphibians are considered: out of 396 publications, 190 dealt with taxonomy and systematics (48%). This proportion is similar for the period since 1960: 41% of amphibian papers published in this period deal with taxonomy and systematics; the categories of next highest representation are phylogeny and biogeography (together 16%), and ecology (10%).

The language of the herpetological publications, as well as of the amphibian publications analysed, was relatively equally distributed among English, German and French until 1930. From 1930 to 1980, French was the predominant language, making up for the largest proportion of publications (from 87% in the 1940s to 43% in the 1970s for all herpetological publications and from 100% in the 1950s to 41% in 1980s for amphibian publications). From the 1980s on, English became the predominant language, and in the current decade, 74% of all herpetological publications were in English, 23% in German, and only 3% in French, with an even stronger bias if only amphibian publications were considered: 94% of these were in English.

The average number of authors per amphibian publications was about one over most of historical times, and started to continuously increase from the 1980s on (Fig. 2a), reaching 3.3 in the current decade, with a current maximum number of 9 in the paper of Andreone et al. (2005). In parallel, also the number of authors of different nationalities increased strongly since 2000, to an average of 1.7.

Malagasy researchers were not involved as authors in any amphibian publication before the 1960s and 1970s, when M. Razarihelisoa, partly in collaboration with J. Arnoult, provided some work on the larval stages of Malagasy frogs (e.g. Arnoult & Razarihelisoa, 1966, 1967; Razarihelisoa, 1969, 1970). A sharp rise of the number of publications with Malagasy participation is noticeable in the 1990s, with 16 papers, and since 2000, with already 19 papers. The proportion of papers with Malagasy participation was 17% and 10% in the 1960s and 1970s, at a time of altogether few publications dealing with amphibians, dropped steeply to 2% in the 1980s, and is since then rising, with 9% in the 1990s and 17% in the current decade. The average number of Malagasy authors per publication was 0.16 in the 1990s and is 0.26 in the current decade.

DISCUSSION

On a global scale, the number of yearly published scientific papers is known to increase constantly (e.g., Mabe & Amin, 2001). The overall publication output between 1981 and 1992 increased by 41.5%, i.e. by 3% annually (Okubo et al., 1998). However, the enormous increase in research intensity on Madagascar's fauna and flora certainly represents more than just a reflection of this global trend. The intensified research activities have led to a relatively advanced state of knowledge on the Malagasy amphibian fauna with respect to their morphology (Blommers-Schlösser & Blanc, 1991; Glaw & Vences, 1994, 2007), advertisement

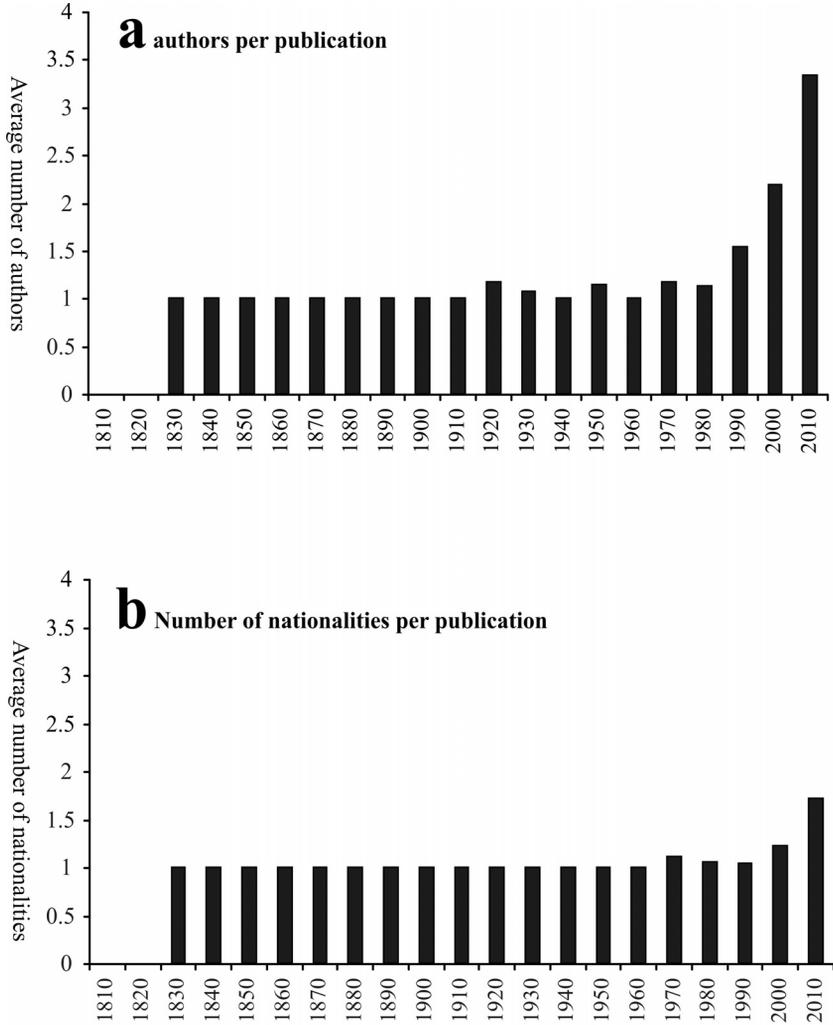
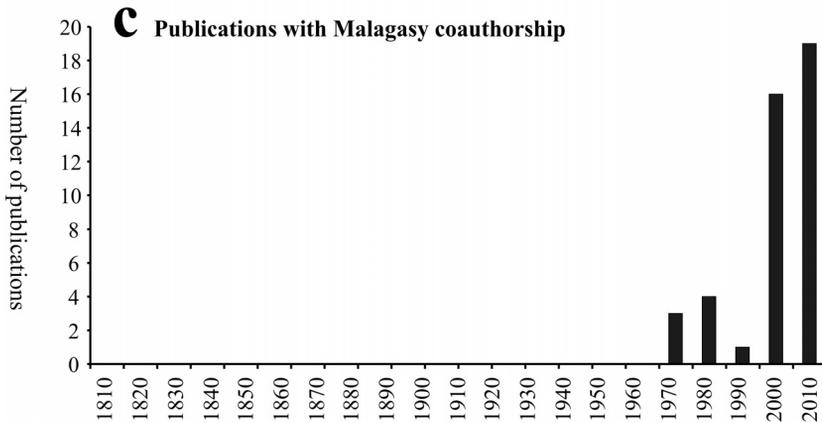


Fig. 2. Historical trends of collaboration in herpetological research in Madagascar, indicated by (a) the average number of authors per publication in each decade, (b) the average number of different nationalities of co-authors per decade, and (c) the number of publications with participation of at least one Malagasy co-author. Each year given on the x-axis corresponds to the scale bar to its right, respectively.



calls (Vences et al., 2006), conservation status (Andreone et al., 2005) and genetic divergences (Köhler et al., 2005). Most importantly, due to the intensive exploration work of Madagascar's habitats, all species of Malagasy amphibians have been confirmed in the wild during the past 15 years (Andreone et al., 2005), indicating that probably no extinctions have occurred in recent times.

Continuation of fundamental survey activity in concert with taxonomic and phylogenetic studies is crucial to identify priorities for conservation of biodiversity. Our analysis gives a number of indications for future developments of a research strategy on Malagasy amphibians.

A first crucial step could be to foster the participation of Malagasy researchers in the process of actually publishing research results. Our results indicate an increasing trend in this respect, but still more than 80% of all studies on Malagasy amphibians are published without participation of Malagasy researchers. This agrees with a general trend in science: publications in high-profile journals are dominated by authors from developed countries who in 1997 produced 88% of all scientific and technical publications registered by the Science Citation Index (UNESCO, 2001). In the time period 1981-1992, 48 countries or regions with the highest publication output covered over 97.9% (6,582,457 publications) of the total world production (Okubo et al., 1998). One key factor may be that more local journals from developed regions are listed by the SCI than similar journals from developing regions (Gibbs, 1995). Consequently, there are more high-profile regional publication opportunities available to scientists from the developed region, whereas much of the research published locally in the developing world is overlooked. However, it appears critical for the developing world to promote, through research and publications, those areas of concern that are having a proportionally greater scientific and social impact upon them (Holmgren & Schnitzer, 2004).

According to our own observations, many excellent and highly relevant results, often obtained by Malagasy researchers and students, remain buried in unpublished reports. The publication series “Recherches pour le Developpement - Serie Sciences Biologiques” and the recent creation of the new journals “Malagasy Nature” and “Madagascar Conservation and Development” represent encouraging steps to overcome this situation. Further potential actions could involve the creation of a series of rapid online publications in the field of the natural history of Madagascar which would, on one hand, allow for the publication of short notes on novel distribution records or behavioural or ecological observations, and on the other hand, allow for the publication of monographical reports and surveys, including lists and photos of voucher specimens to increase verifiability of results.

Several authors have, in the past years, argued for the need of a general change of approach in research in the field of taxonomy, and, in general, biological sciences (e.g., Schram, 2004; Wheeler et al., 2004). Rhee (2004) proposes a seamless connection of community databases, public repositories and journals. A crucial component is to make results of research timely available by appropriate cyber-infrastructure and building a digitally connected network of knowledge rather than isolated, specialized and difficult-to-find papers. Data would be published electronically and made instantly available. Databases of names and conservation status of species, geo-referenced distribution records, DNA barcode sequences, images of specimens, and real-time satellite surveys of habitat changes could provide a direct feedback of research into conservation. Working towards this vision requires a high degree of collaborative effort, as exemplified by a recent initiative to elucidate taxonomy and phylogeny of southern African reptiles for conservation purposes (Branch et al., 2006). Whether such concepts can be applied to research on Malagasy amphibians will depend on the interest of all involved researchers. The increasing number of authors and nationalities involved in the publication analyzed here (Fig. 2) shows that research on Malagasy amphibians is becoming a collaborative endeavour. Continuing these first steps would likely be of benefit for all involved researchers and, above all, for the conservation of the amphibians of Madagascar.

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RÉSUMÉ

Analyse historique des études sur les amphibiens à Madagascar: un exemple pour l'amélioration de l'intensité de la recherche et la collaboration internationale.

Une analyse sur une liste de presque 1400 publications orientées sur les amphibiens et les reptiles malgaches révèle une claire tendance à l'augmentation de l'intensité des recherches, en recherches générales d'herpétologie et en publications qui traitent des amphibiens. Globalement, la recherche sur les amphibiens malgaches a été moins intensive comparée aux reptiles, avec 396 articles sur les amphibiens, 874 sur les reptiles, et 113 concernant les deux groupes. L'intensité de la recherche sur les amphibiens mesurée en tant que nombre de publications traitant ces organismes (exclusivement ou avec les reptiles) par décennie, est fortement en hausse à partir des années 70, atteignant un volume de 175 et (interpolés) 169 sur les périodes 1990-1999 et 2000-2009. Beaucoup d'articles traitent de la taxonomie, mais la phylogénie, la biogéographie et l'écologie/conservation commencent à augmenter fortement. La moyenne du nombre d'auteurs par publication sur les amphibiens était de plus ou moins 1 sur l'ensemble de la période historique, avant d'atteindre 3,3 pour la décennie actuelle, avec actuellement un nombre maximum de neuf auteurs pour un article. Les auteurs malgaches participent de plus en plus à la recherche et au processus de publication, avec un nombre moyen d'auteurs malgaches par publication de 0,26 pour la décennie actuelle. Nous suggérons d'intensifier l'augmentation de la nature collaborative des recherches sur les amphibiens malgaches par des approches qui accélèrent la disponibilité des données à travers des infrastructures cybernétiques, et par la conduite de capacités accrues, à Madagascar, dans le champ de la biologie des amphibiens.

Mots clés: Amphibiens, Collaboration, Conservation, Données Historiques, Littérature, Madagascar.

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