Summarizing, a question arises: has all this academic incest, inbreeding, and backcrossing retarded the growth of systematic mammalogy in North America? The answer is a resounding and emphatic "no," a considerable tribute to the immediate academic descendants of Grinnell. North American mammalogy stands at the forefront of the discipline when viewed from a global perspective. Moreover, Grinnellian systematists have not necessarily agreed on solutions to the knotty problems of the times. Partly this results from the large number of academic centers at which they have been educated, and hence their contact with a variety of biologists with other interests and competencies. Partly, also, it results from their own proud intellectual tradition and drive to outdistance colleagues: "brothers" R. J. Baker and J. L. Patton have not always seen eye-to-eye about mammalian cytotaxonomy, and who has not disagreed with A. L. Gardner about some aspect of mammalogy? Consider the "brothers" Cockrum and Hoffmeister arguing over Arizona mammals. E. R. Hall himself was always embroiled in one controversy or another.

I never knew Grinnell—he died when I was 10 years old—but I have often wondered what he would think about the dynasty that he fostered, were he alive today. Probably he would view it with considerable awe and trepidation. Clearly, twentieth-century North American systematic mammalogists and many of their mammalogical relatives truly are the honored descendants of Joseph Grinnell.

SUMMARY

The academic dynasty established in mammalogy by Joseph Grinnell (1877–1939) is traced, particularly with reference to the subdiscipline of systematic mammalogy. The impact of Grinnell and of his academic descendants on mammalogy and on the American Society of Mammalogists is discussed and a general genealogy developed.

RESUMEN

Se reconstruye la dinastía académica establecida en mastozoología por Joseph Grinnell (1877–1939), particularmente en referencia a la subdiciplina de sistemática mastozoológica. Se discute el impacto que Grinnell y sus descendientes académicos han tenido en la mastozoología y la Sociedad Americana de Mastozoología, y se desarrolla una genealogía general.

CHAPTER 4

How Scientists Can Impede the Development of Their Discipline: Egocentrism, Small Pool Size, and the Evolution of "Sapismo"

MICHAEL A. MARES

The title of this chapter merits explanation. Generally, scientists work to support their discipline. Under certain conditions, however, they may engage in activities that hinder the development of their field. Complex personal, professional, political, and philosophical reasons may lead to this behavior. This topic is important to those who conduct research on Latin America's fauna, because these scholars comprise a small pool of scientists; actions that hinder their research have a disproportionately large negative impact on the development of their discipline. Before examining how progress in a discipline can be impeded, some relevant background in mammalogy is required. I use mammalogy as one example of a discipline that can be affected adversely by its practitioners, suggesting that the pattern discussed is similar for many reseach areas.

Latin America has fascinated biologists for centuries, but interest increased dramatically when Charles Darwin visited South America and the Galapagos (Darwin, 1839). Primarily from materials gathered and observations made on these visits, he formulated his theory of natural selection (Darwin, 1859), which in its present form is recognized as the unifying paradigm of biology (Naylor and Handford, 1985). From Darwin's time in the mid-1800s to the beginning of the 20th century, Latin American research involved mainly the description of especially rich or unusual ecosystems or new species, including both recent and fossil organisms (Baker, this volume; Hershkovitz, 1987; Simpson, 1980). In this century, the pace of research has quickened (Mares, 1982). Our ability to map habitats with satellites, and civilization's advance into all areas, have made it possible for scientists to have better access to previously unexplored regions.

Several giants in the field devoted their attention to this area. Some were native Latin Americans; others visited the region to carry out research; and one, Oldfield Thomas, never conducted field research in Latin America, yet was responsible for naming most of South America's mammalian taxa (Baker, this volume; Mares, 1982). Among the principal early workers in the field of Latin American mammalogy were W. Osgood, R. Philippi, O. Thomas, and A. Cabrera. They have subsequently been supported by a host of excellent re-

searchers who have dedicated a great deal of time and effort toward clarifying our understanding of Latin America's mammals. They include, but are not limited to, J. A. Allen, T. Alvarez, S. Anderson, R. H. Baker, R. J. Baker, G. Buffon, J. Contreras, J. Crespo, W. B. Davis, J. F. Eisenberg, H. H. Genoways, E. A. Goldman, G. G. Goodwin, E. R. Hall, C. O. Handley, Jr., P. Hershkovitz, A. M. Husson, E. Hooper, J. M. Huey, F. Jaksic, F. A. Jentink, J. K. Jones, Jr., I. Krumbiegel, O. Linares, G. Mann, E. Massoia, G. S. Miller, J. Moojen, E. W. Nelson, O. P. Pearson, W. Peters, J. Ramírez-Pulido, O. A. Reig, V. Roig, C. Sanborn, G. St. Hilaire, G. H. H. Tate, C. Vieira, B. Villa-R., G. Waterhouse, M. Wied-Neuwied, D. E. Wilson, and J. Yepes.

Several things should be noted in this list of names: First, although not complete, it is relatively short. Not many people have conducted extensive research on Latin American mammals. If we constructed a list of scientists who had published 50 or more research papers, or one fundamentally important monograph or more on the mammals of Latin America (as all of the above have), it would be a surprisingly short list, indeed. Second, the people who have studied Latin America's mammals are from countries throughout Latin America and Europe, and from the United States. The tremendous intellectual effort of providing the foundations of Latin American mammalogy has been borne by a diverse group of scientists whose primary unifying thread was curiosity about the remarkable fauna of mammals that has always characterized Latin America, and affection for Latin America itself.

THE GLOBAL NATURE OF ENVIRONMENTAL DETERIORATION

Latin America (including Mexico) contains approximately 27% of the world's mammal fauna (Corbet and Hill, 1980). No species, whether animal or plant, stands alone in an ecosystem, and the fine interconnections that tie ecosystems together are only now beginning to be understood. As data accumulate, we find that all ecosystems, and especially tropical ones, are constructed of a complex web of interspecific associations. Plants depend on insects for pollination or protection, and on mammals or birds for seed dispersal. Some species have been described as being keystone species, the demise of which would adversely affect whole assemblages within a particular ecosystem (e.g., Gilbert, 1980). The role of mammals in such systems has not yet been fully clarified, but a hypothesis advanced by Janzen and Martin (1982) on the relationship of the extinct mammalian megafauna to particular adaptations of present-day tropical forest plants underscores the importance of examining such coevolutionary linkages.

What then do we find when we examine Latin America's mammal fauna? We find a diverse but poorly studied group of organisms inhabiting one of the world's most threatened regions. There is much evidence (e.g., Alho and Lacher, this volume; Mares, 1986; Myers, 1980; Roig, this volume) that ecosystems throughout Latin America are threatened. As scientists, it is difficult for us to predict when particular communities or species will begin to disappear forever, but unless positive steps are taken to reverse species disappearance rates, species and habitats will ultimately be lost, whether in 20 or 200 years. The principal disagreements among conservationists concern the rates of species loss, not the likelihood of mass extinctions. We are confronted with a situation characterized by many unknowns (our knowledge of ecological systems in Latin America is quite limited), and involving the vagaries of the human species (with its rapid population growth, ever more sophisticated technological development, political instability, and its bellicosity). Attempting to formulate predictions based on these varying parameters promises a low probability of success.

We know several important things about the ecological systems of Latin America, however. The habitats of the region store a wealth of resources, assuming our scientific capabilities were sufficiently developed to take advantage of them (e.g., Oldfield, 1989). Even a partial list of materials harvestable from Latin America's ecosystems and potentially beneficial to people is impressive. There are possible biocides, alternative foods, new medicines, new building materials, and many other substances—some as yet undiscovered and others beyond our technological abilities for utilization. Moreover, our primitive understanding of genetics and genetic technology, compared with what might be expected over the next century, make the potential genetic riches of Latin America's flora and fauna very likely the greatest treasure possessed by humanity. Only a little more than a century ago Mendel conducted the first genetics experiments, and less than a century ago his work was rediscovered and understood. Progress in genetic research in the last two decades has been phenomenal. Imagine the potential benefits that could be reaped by people once the enormous data bank stored in the genes of the organisms of Latin America can be utilized. It could be possible to unlock the secrets of these informational storehouses to solve many of the problems that plague us today.

There is evidence that Latin America's ecosystems play a vital role in world weather patterns (e.g., Detwiler and Hall, 1988; Woodwell et al., 1983); the extensive Amazonian tropical forest could be considered the thermostat of the earth. Nevertheless, habitat conversion and overexploitation of wildlife are occurring at such high rates that scientists throughout the world are alarmed. This alarm is worldwide because these biotic resources are considered important to the entire biosphere, not merely to the geographic region in which they happen to occur. Ecosystem loss is thus a biospheric problem, and governments and scientists from throughout the world must cooperate in dealing with a problem of such magnitude (Mares, 1986).

SCIENTIFIC RESEARCH, WITHIN AND AMONG NATIONS AND DISCIPLINES

Cooperation among scientists is not always a simple matter. Science is a human endeavor and, as such, is subject to those unsavory traits which characterize human beings. Scientists, too, must contend with unrestrained ambition, bellig-

erence, arrogance, insecurity, sloth, egomania, paranoia, envy, jealousy, pettiness, anger, and vengefulness. Any of these can lead scientists to work against the development of their discipline, and it is my contention that these characteristics are more pronounced, or at least less attenuated, when the pool of scientists in a particular discipline is small.

Presently there are tens of thousands of scientific journals published each year throughout the world. Only a small percentage (perhaps only 0.1%) deal with subjects of interest to mammalogists and, among these few, an even smaller percentage publish research on Latin American mammals. Fewer people will read these papers than would read a paper dealing with better-known species occurring in North America or Europe. This is related to the fact that the pool of mammalogists who work with Latin America's fauna is small. Negative effects accrue passively as a direct result of the fact that we are dealing with a small pool of investigators, regardless of their nationality.

Effects of Small Pool Size on North American Mammalogists

There are relatively few mammalogists in North America concerned with Latin America's fauna, and their number includes ecologists, taxonomists, behaviorists, wildlife biologists, conservationists, physiologists, and other biologists. Presently the American Society of Mammalogists (ASM) has about 3,700 members. Probably no more than a few hundred have ever published a single paper on a species occurring only in Latin America, and probably fewer than 100 have published more than 30 research reports on the region's fauna.

An examination of some of the steps involved in a North American's being able to do research on Latin American mammals is instructive. By describing them, it will be easier to illustrate some of the problems encountered by the small pool of foreigners wishing to work in Latin America. First, one must have the initial interest in studying a Latin American species. This means that either one has read a published paper that has piqued one's curiosity, or one has been exposed in some manner to a particular species, taxonomic group, or geographic region. How does someone who has little experience with Latin America go about getting started? Contacts could be made with the few North American workers mentioned above, or with Latin Americans, but the latter are frequently not well known to the nonspecialist. (In many cases, the former are not well known, either). If a person already has managed to have some firsthand experience with the fauna of Latin America, through field trips or field courses, for example, these initial troublesome steps can be avoided.

Assuming a North American researcher has a strong interest in Latin American mammalogy, two major problems must be faced: the twin roadblocks of time and money. Foreign research often costs a significant amount of money, particularly in travel, equipment, and per diem expenses. Such research demands extensive time in the field, time that is not available for academic, administrative, or other professional duties, and time that is also taken from one's personal or family responsibilities. Indeed, for some, the time factor often becomes a larger obstacle to research than financial considerations. Nevertheless, money is needed

for research, and one difficulty of not having a large number of mammalogists familiar with Latin American research first becomes evident in this context.

Among the problems that face researchers working with Latin American mammals is the lack of adequate foundational research on the species in question. We know very little about the systematics or macrodistribution of the great majority of the mammals of Latin America, and even less about their microdistribution, natural history, population ecology, behavior, or any of the other topics that have become the basic givens in modern research in such well-studied geographical areas as the United States or Europe (Lacher, 1982; Lacher and Mares, 1986). Current research topics that are "hot" items (i.e., fundable) include patterns of optimal foraging, sexual selection, coexistence, coevolution, competition, and other questions that are difficult, if not impossible, to pursue if one lacks even a rudimentary understanding of the biology of a species. Modern mammalogical research as it is carried out in the United States is built upon a firm foundation of basic research. Without this foundation, the exciting questions now being asked would be difficult to formulate (Mares, 1982, 1985, 1988; Mares and Braun, 1986).

Most researchers in the United States are only familiar with well-studied faunas. Their knowledge of taxonomy may be minimal, but their experimental studies do not require such knowledge. The requisite taxonomic research that is fundamental to most experimental studies has been carried on for almost a century. Unfortunately, a limited appreciation of the taxonomic and ecological underpinnings required to do experimental research influences the way in which many modern biologists view science. Additionally, there is a lack of appreciation of the basic importance of the science of taxonomy itself (e.g., Chernoff et al., 1989; Disney, 1989; Ehrenfeld, 1989). Research that is not experimental in nature, or hypothetico-deductive in design, is viewed as unscientific (i.e., unfundable, see Redfield and Crowder, 1989), even though it is exactly the type of research that has permitted the very existence of the experimental theoretical phase in which field biology in developed countries finds itself today. This cause-and-effect relationship is unrecognized by most ecologists and other experimentally oriented biologists who have developed their views of nature by exposure to the ecosystems of the United States. However, it is these researchers who frequently act as reviewers of research grants and journal articles, and judge Latin American research by current North American standards. They are often as ill-equipped philosophically and educationally to judge a proposed Latin American research project as a field mammalogist would be to judge a biochemically oriented research proposal or publication.

An enumeration of what is required of a North American who wishes to work in Latin America with the support of a funding agency is illuminating. First, the broad idea of the research project must be formulated. This may take six months for library research, reflection, and study. Then a country in which to work must be selected. In some Latin American countries, such as Brazil, only cooperative research is permitted. This means that a worker must seek foreign contacts to act as co-principal investigators or sponsors. Frequently this necessitates an expen-

sive planning trip for which funds must be sought. A proposal for such a trip may be prepared for submission to the National Science Foundation (NSF) Latin American Cooperative Program, for example. (The procedure is similar for other funding agencies, but I use NSF to illustrate the point.) The writing of the proposal, the initial contacts with foreign colleagues, the proposal review and, if this initial step is funded, the trip to the foreign country, may take a year.

Following the assessment visit, a major proposal must be written and submitted to one of the funding agency's disciplinary programs. The writing and review process will take an additional year. At practically each stage of the process, one will encounter people having little familiarity with the special needs of Latin American research. Program officers may be unable to select reviewers who understand the difficulty of working with a fauna that is poorly known. Proposals will be sent to a group of reviewers, some of whom understand Latin American research, while others do not; the latter will likely predominate. At this point the great probability is that the proposal will not be funded. This is so because competition for grant funds is keen, with perhaps only 10–20 percent of submitted proposals being funded. However, with foreign research planned for a poorly studied area such as Latin America, there is an additional difficulty: lack of understanding of the importance of foundational research (e.g., systematic surveys, distribution, or natural history) on the part of the proposal's reviewers. Marginally negative or even weakly positive reviews of a research proposal will probably result in its not being funded.

Latin American research conducted by North Americans is thus in a vicious cycle of unfundability. Without basic data on systematics, distribution, and ecology, research that is judged exciting by current standards often cannot be formulated. Yet the funds to gather such data are unavailable because this type of basic research is not currently popular. If the proposal is rejected at this step, it could either be abandoned, or revised and resubmitted after a six-month to one-year lapse. If the proposal is funded as first submitted, the research can begin only after about 2.5 years have elapsed since the initial idea was developed.

There are many other roadblocks that can beset international research. If the field work involves students, these people must be sought shortly after funds have been awarded. Students from North America who wish to work in foreign countries are few in number, for many understandable personal and professional reasons. It is difficult to find students who wish to dedicate years of their lives (in the case of ecological field work, for example) to foreign research. A student may have a spouse who does not wish to spend an extended period of time in a foreign country living under field conditions, especially if there are young children involved. Living in foreign countries presents a number of challenges, and in many areas field research can be dangerous because of political instability or criminal activities (e.g., drug-related violence or banditry). In addition, that spouse may have career development plans which would make extended field work even more problematic.

If a three-year project is conducted, research reports will begin to be submitted for publication, at the earliest, four years after the project was first conceived.

Here again, the review process will be affected by ignorance of foreign research by editors and reviewers. The same factors that adversely affected the proposal now act on the resulting manuscripts—small pool size can lead to rejection regardless of the scientific merits of the papers. The review and publication process may take a year or more before a manuscript appears in print. Hence, an average elapsed time from project conception to publication of *initial* results may be five to six years!

Additional factors interact to make it difficult to continue Latin American research as a professional biologist, even if one conducted graduate research in a foreign country. Once the thesis is completed, a new set of problems arises. Most doctoral recipients (at least 70%) will be unable to find a professional research position in academia or in a research organization, such as a natural history museum (McCormick and Barrett, 1979). Of the fortunate few who do obtain academic appointments, most will be employed in small colleges or universities where research is neither expected nor encouraged, and where heavy teaching loads make foreign research difficult if not impossible.

As a student gets further away in time and emotional commitment from the dissertation research, it becomes increasingly difficult to develop a foreign research program. About half of dissertation recipients do not even publish their thesis research (Porter et al., 1982) and, of those who do, the majority do not conduct additional research. Should a young investigator attempt to establish a research program in Latin America, he or she will encounter the problems enumerated above. Furthermore, the budding faculty member in a North American university will find that colleagues and administrators do not appreciate an itinerant biologist whose research demands significant time away from ongoing faculty responsibilities. Because it is harder to get funded for Latin American research, because it yields a low rate of return of published papers when the time and effort invested are considered, and because the work that does result is read by fewer people, pursuing foreign research as a young scientist can prove detrimental on tenure decisions. Should tenure be denied, most research careers will be curtailed severely or suspended entirely.

For these reasons, we North Americans who have persisted in working in Latin America form a small coterie of frequently stubborn, single-minded individuals who have often overcome personal and professional adversity to pursue a passion for research on the mammals of Latin America. We comprise a group of individuals accustomed to doing things the hard way, for the simple path was rejected when foreign research was begun. Such biologists are generally inured to criticism and professional barbs from colleagues at home and abroad, and are accustomed to ignorance from domestic and foreign bureaucrats. They are also accustomed to the hardships involved with field biology, including disrupted home lives, unsympathetic administrators, and frequent health problems. (A quick perusal of a half-dozen of my colleagues, for example, shows that field research has resulted in blackwater fever, leishmaniasis, typhus, histoplasmosis, malaria, dengue fever, plague, ascariasis, snakebite, and other serious maladies.) Field biologists do not suffer fools easily.

If the pool of North American mammalogists who study Latin American mammals is small, however, the overall pool of mammalogists in North America is large. With 3,700 ASM members, and with large scientific societies in ecology, physiology, genetics, paleontology, ornithology, herpetology, and other related specialty areas, it is difficult for a single individual to dominate a discipline. Both the era of the great natural history explorations and the days when a C. Hart Merriam or an E. Raymond Hall could have a preponderant influence on a particular field of science are gone. There are simply too many other good mammalogists, herpetologists, or ecologists around. The pool is large, competition is keen, and younger, better-trained scientists are arriving on the scene daily. It is a healthy situation that does not permit inordinate influence to reside in a single individual.

Effects of Small Pool Size on Latin American Mammalogists

Some of the effects of small pool size described above for North America also characterize Latin America; however, there are several differences. The scientific snobbishness that has infected a great many field researchers in North America is not reflected as strongly in Latin America. Foundational disciplines, such as taxonomy, natural history, distribution studies, and the like, are largely accepted by the local scientific community. Latin American journals are not characterized by the high rejection rates of journals published in the United States. Unfortunately, if Latin American research appearing in journals published in the United States is not widely read, that published in Latin American journals has an even smaller audience. Most Latin American journals have very limited distribution and often are not readily available outside the country in which they are published. Moreover, they generally are not regarded as journals of high quality. If such research is read at all, it will be by a portion of the extremely small pool of mammalogists who are Latin Americans, or by a subset of the foreign scientists who work in Latin America. However, since the latter often do not have ready access to Latin American journals, readership of most papers published in Latin America on mammals is very low.

Some Latin Americans attempt to publish in North American journals, but the number of those submitting manuscripts is small and special problems can be involved in the review process. From 1984 to 1988 I was one of the four associate editors for the *Journal of Mammalogy*, an international journal published by the ASM. During my tenure, I reviewed 302 manuscripts (submitted by scientists from throughout the world, but principally from mammalogists in the United States), of which 174 were accepted for publication—a 42% rejection rate, after resubmissions of initially rejected papers that were later accepted are counted. With papers submitted by Latin American authors, I attempted to have at least one of the reviewers be someone who had worked in, or was familiar with, the field of Latin American mammalogy. I would select reviewers who were likely to understand that the papers submitted from Latin America frequently had problems due to language difficulty, format, and writing style. While these problems may have made a paper more challenging and time-consuming to review, they did not necessarily compromise its scientific value. Efforts were made by the reviewers and by me to edit such manuscripts heavily before returning them to the authors. I would frequently send detailed instructions as to how a manuscript should be revised for reconsideration.

Of the 34 manuscripts I received from Latin Americans, 15 were eventually accepted (a 56% rejection rate). Several editors of the *Journal of Mammalogy* took similar special steps to review manuscripts submitted by foreign mammalogists. During the four years that manuscripts I edited appeared in print (1985–89), the journal published 532 articles or notes, 24 of which (4.5%) were authored only by Latin Americans or senior-authored by Latin Americans. In the four years prior to this period, 19 of 504 articles (3.8%) were authored by Latin Americans. The 18% increase in publications by Latin Americans during my tenure may not be a significant increase over the earlier period, but the number of manuscripts accepted for publication would have been lower had not special care been taken with the review process. Examination of the data indicate that rejection rates of papers written by Latin Americans are roughly comparable to the overall rejection rate for the journal. The major factor limiting publication is not the rejection rate, but the submission rate. Efforts need to be made by journals and scientific societies to encourage Latin American scientists to submit their manuscripts for consideration. I know several Latin American biologists who feel that they are differentially selected against in the review process and thus choose not to submit their manuscripts to North American journals. Other than the problems inherent in preparing a manuscript in a foreign language, using unfamiliar editorial styles, and submitting single observation papers that are primarily of local or regional value, the difficulties in publication that are faced by Latin Americans are effectively the same as those faced by all authors. All scientists are subject to occasionally unfriendly reviews or manuscript rejection. My own view is that Latin Americans take manuscript rejection more personally than do North Americans. They are less likely to revise and resubmit a rejected manuscript.

Obtaining research grant support in Latin America is in many ways more difficult than obtaining research funds in the United States. While there is no philosophical disagreement from Latin American funding agencies or research institutes as to the necessity of doing field-oriented foundational research on mammals, Latin American mammalogists have equally difficult hurdles to surmount: lack of adequate financial and infrastructure support. Research support from Latin American governments is minimal, and the costs of basic field equipment and supplies, such as vehicles or gasoline, can prove prohibitive. Moreover, the Latin American bureaucracy can act to stifle field research by Latin Americans as effectively as it stifles the work of foreign biologists. Examples of these difficulties abound. Two of my Latin American colleagues were awarded a $20,000 (U.S. dollar equivalent) grant from their national funding agency to conduct field research on mammalian ecology. Because of the time lag between proposal submission and the availability of the grant funds, and because major currency devaluations occurred in the interim, the final award, when it arrived, had a value of $400 (U.S. dollar equivalent). In Argentina, a four-wheel-drive pickup

truck costs $28,000 (U.S. dollar equivalent)—46 times more than the yearly average wage and 12 times more than a professor's annual salary. Twenty-five gallons of gasoline cost the same as the average monthly salary of a worker in Argentina; a foreign reference book may cost twice a monthly salary. The list of similar examples is endless, and can be demonstrated throughout Latin America. Poor salaries, low levels of grant support, and high costs of journals, books, and field equipment are a crushing burden that must be borne by Latin America's scientists, a burden that is stifling research of all types. It lowers morale for professors, researchers, and students, and can lead to the cessation of research activities.

The Latin American educational system is not designed to foster research by professors or students. Salaries are low, almost no money is set aside by universities to support research, and research is often not encouraged by administrators. In fact, research is sometimes *discouraged* by administrators. Few governmental or private organizations have sufficient support funds to cover the costs of field research, which may demand per diem charges for field assistants, costs of field supplies and specialized research equipment. Thus the general milieu that surrounds Latin American scientists is one that discourages personal research, graduate student training, research proposal submission (due to lack of available funds), and publication.

Like their North American counterparts, newly trained professionals in Latin America face many problems in obtaining employment. Unlike their counterparts in the United States, they may find political considerations playing a role in their obtaining a particular position, whether in a private institute or state university. Similarly, the probability of appointment to a governmental position may be politically influenced; such positions are accompanied by little in the way of financial support for research. The financial burdens of high inflation, general economic hardships within the country as a whole, low salaries, poor libraries, and the general lack of support for research can appear to be insurmountable obstacles at times. Additionally, there are employment practices that discourage a concerted research effort by a scientist. Merit pay does not exist; salaries proceed in lockstep depending on academic titles and length of employment. Productivity in research is not often financially rewarded, and much effort is spent in the internal politics of maintaining one's position in an institution that is subject to the uncertainties of constantly changing local or national politics. A change in the political party of the president in some countries will result in a new university chief executive, new deans, new faculty, and new support personnel, including office workers and janitors. Research institutes and governmental agencies are affected in a similar manner. This periodic upheaval in one's administrators and assistants leads to the necessity for increasing the time committed to forming closely knit peer groups that can withstand political restructuring. Finally, since there is no monetary reward for excellence in research, and since one may be subjected to professional problems caused by inept—but politically astute—colleagues who may envy an active researcher's accomplishments, it is often easier to fall into the pattern of reducing the amount of time spent in research, an activity that yields little in the way of gratification. Indeed, as a rule, it is at times more difficult for Latin Americans to do research in Latin America than it is for non-Latins; the roadblocks to research productivity are more effective in Latin America than they are elsewhere.

Effects of Small Pool Size on Individuals and the Roots of "Sapismo"

Both foreigners and Latin Americans who work on South American mammals are subject to the negative psychological effects of small pool size. Some of these effects are included in the colloquialism, "a big toad (frog, or fish) in a small pond." All of us are affected by this syndrome occasionally. The small number of mammalogists working on the fauna of Latin America forms a very small pool indeed, if we consider the pool as being composed of the researchers themselves.

A comparison of numbers of mammalogists in North and South America is illustrative. Latin America contains the richest, and probably the most poorly known, fauna of any region on earth. There are 20.5 million square kilometers of land in Latin America, one-seventh of the earth's surface. The United States, by comparison, contains 9.4 million square kilometers. If we assume that all mammalogists in the United States are members of the ASM, we would have one mammalogist per 2,500 square kilometers in that country. However, there is probably at least an equal number of people trained in mammalian biology who work for governmental and private agencies or corporations, or who belong to societies in their areas of specialization (e.g., biochemistry, ecology, wildlife biology, genetics) and are not members of the ASM. For example, each state has wildlife biologists trained to work with mammals. Some are employed by state, county, or local governments, or by federal agencies. Some work for private industry. Many may not be actively engaged in science, but in fact do a great deal of practical work with mammals. Assuming that there are at least 3,700 more mammal-oriented workers in the United States (and the actual number is probably higher than this), there is about one mammalogist per 1,250 square kilometers in the United States. Relatively few of these, perhaps two percent, work with Latin American mammals, however.

It is difficult to obtain exact data on the number of Latin Americans who regularly work with mammals. The Mexican Mammal Society has 150 members, while the Argentine Mammal Society has about 100 members. If we limited our analyses only to those biologists who hold doctoral degrees, the number would be extremely low; Dr. Fabian Jaksic, for example, suggests that there are only about 20 dedicated and professional mammalogists in Chile (pers. comm.). Colombia, Venezuela, Brazil, and Chile have mammal societies, but I am not aware that most other countries have organized active societies as yet. There are probably no more than 1,000 workers who regularly deal with mammals in Latin America, and this number may be a significant overestimate. Thus there is, perhaps, one mammalogist per 20,500 square kilometers of land area in Latin America. This means that, on the average, each Latin American mammalogist would be responsible for a land area 16 times greater than would a U.S. counterpart.

Another way to examine the differences in numbers of mammalogists between

the United States and Latin America is to express them on a per capita basis, as well as to compare the number of mammalogists to the number of mammal species occurring in each geographic region. The population of the United States is about 230 million, whereas for Latin America it is about 400 million. Considered from this standpoint, there is one mammalogist per 31,000 people in the United States, but only one per 400,000 people in Latin America. If mammal species numbers are considered, we arrive at the following situation: there are about 350 species found in the United States, which means there are about 21 mammalogists per species. In Latin America, where some 1,100 mammal species are found (Corbet and Hill, 1980), there is less than one mammalogist per mammal species.

No matter how these data are examined, there are many more mammalogists in the United States than there are in Latin America. Depending on which comparisons are used, there may be 10–20 times as many mammalogists in the United States. This is not to imply that there are too many in that country. On the contrary, the field of mammalogy is in a stage of rapid growth and development. More biologists are needed to work with all aspects of mammalian biology. In particular, as pointed out by Mares (1988) and Braun and Mares (this volume), people with a background in mammalogy, or other natural history disciplines, are needed at all levels of society. These comparisons do, however, illustrate the magnitude of the problem confronting research on mammals in one of the earth's most threatened and important biological areas.

Sapismo.—The above discussion shows that when it comes to mammal research in general, the pool of North American mammalogists is large. In such a large pool, no toad (*sapo*, or *sapão* in Brazil) can be dominant. Though some may try to achieve the status of *sapo grande*, or master of the pool, there are just too many other mammalogists to permit control of an entire discipline. In a field of perhaps more than 7,000 mammalogists, even the leaders in the field are relatively numerous. Moreover, if one is a mammalian ecologist, the pool within which one is compared includes not only the mammalogists, but the ecologists; there are more than 6,000 members of the Ecological Society of America, and perhaps twice that many ecologists in the United States. If one's field is mammalian evolutionary biology, there are more than 2,500 members of the Society for the Study of Evolution. Clearly, in such a large and complex system of pools, almost everyone is a *sapito* or *sapinho* (small toad), or even a *renacuajo* or *girino* (tadpole).

In Latin America, the situation is quite different. There are at most 1,000, principally master's level, mammalogists who are Latin Americans scattered among 21 countries, and an additional 100–200 mostly Ph.D. level North American mammalogists who study Latin American mammals: very few toads in the pond, despite enormous land area and species diversity available for research. Long ago, MacArthur and Connell (1966) spoke of the "jack-of-all-trades, master-of-none" pattern, whereby one cannot be a specialist in all areas, but rather must lose specialization (e.g., expertise) as one extends one's niche to

cover an ever broader range of niche dimensions (e.g., topics). One negative effect of having only a small number of workers available in a particular discipline is the necessity of practitioners extending their expertise into areas where their experience is limited. Latin American mammalogists, by virtue of the fact that they are so few in number, must frequently step well beyond the limits of their training to advise on topics that may be only peripherally related to their area of expertise. Moreover, since there are few vertebrate biologists in general in Latin America, these workers must often be the major source of information for decisions on research support, publication support, or consulting on major national governmental conservation or wildlife projects for any research dealing with vertebrate biology in general, or even with other fields of science.

Another problem of having only a small pool of researchers is that opportunities arise for people with little or no training in a discipline to achieve positions of importance dealing with all matters mammalogical, even though their competence in many areas of the discipline may be questionable. This is especially true in governmental agencies where political considerations weigh heavily in appointments to agency leadership positions. Of course, political considerations can sweep aside competency factors, regardless of pool size—for example, in my opinion, James Watt's appointment as Secretary of the Interior during Ronald Reagan's tenure offers a good example of a person's questionable competence in the area of conservation of natural resources having no bearing on his ability to be appointed to a position that should require some understanding of environmental biology. Nevertheless, if a pool of scientists is large enough, there may be trained people of the proper political stripe to fill senior bureaucratic psotions below that of major political appointments. If the pool is small, however, one may be unable to find enough qualified individuals to fill the many positions that demand some familiarity with environmental biology, wildlife matters, or vertebrate biology. In this situation, the way is clear for the untrained charlatan to enter a discipline in an influential post and subsequently to wreak havoc on the discipline.

What is true for individuals is also true for groups, and the territorial feelings can be abetted by nationalistic undertones. Thus the small pond (e.g., country X) can effectively set limits (i.e., prohibit research) to interloping foreign sapitos. This is not uncommon in Latin America, where wildlife regulations or national laws pertaining to research by foreign biologists can be so restrictive in their application that their main effect is to make doing research in Latin America even more difficult than it already is. Parenthetically, the restrictive wildlife laws may do very little to protect wildlife—most commercially marketable species are taken by professional poachers whose activities are not affected by laws, regardless of how restrictive they may be (e.g., Mares and Ojeda, 1984; Ojeda and Mares, 1982).

In such a situation, it is easy for a local sapo to envision himself as a very large sapo, indeed—a veritable master of the pool of scientists in their own, or related, disciplines. This is the behavior I term "sapismo." From this point, it is only a small step to seeing the larger pond—the field of Latin American mam-

malogy, or even Latin America itself—as one's private preserve. Smaller sapos must respect the sapo grande's presence and remain in only a small portion of the pond (i.e., area of research) where they are not a threat to the big sapo's dominance.

Sapitos and renacuajos must always approach the sapo with extreme caution and inordinate respect, or even awe, lest the sapo grande use his considerable influence to dry up the poor sapitos. Grant proposals, permission to travel abroad, membership on committees, positions within scientific societies, or opportunities for graduate research could be denied because of actions taken by the sapo. Moreover, salary increases, or even one's very employment, could depend on the sapo's support. It is a situation fraught with very real dangers.

As might be expected, sapos at the height of their influence are frequently surrounded by sycophants who are constantly feeding the sapo's enormous ego. Sapos must, in fact, be quite gifted to achieve their position of dominance, which often requires national and even international prominence. Isolation from large numbers of other equally gifted individuals, and power over the scientists in their own discipline, lead to a greatly overblown self-image. As egocentrism progresses, the sapo begins to view himself (there are few female sapos in Latin America) as more and more the giant surrounded by intellectual pygmies. Once this view develops, the sapo directs attention to bettering his position, even at the expense of sacrificing a few sapitos or renacuajos in the process; everything must revolve about the sapo grande.

This is an unhappy situation for science in general, and for the sapitos, who may find it difficult to coexist with the sapo, especially if they themselves are talented and, while respecting the sapo, do not feel that he is any better than most other good scientists. Sapos are intolerant of this view and will attempt to eliminate sapitos who think along these lines.

How to Recognize a Sapo.—Sapos can be easily recognized. They are, by and large, good scientists, perhaps even outstanding. They have strong personalities. They are often politically astute, and may achieve influential positions in government. They say they work for their discipline, but they work primarily for themselves. They generally will not have supported the training of many graduate students—why put more sapitos in the pond?—and those they did train will frequently be sycophants. A sapo will support cooperative research only if it benefits the sapo directly, and the sapo may be expert at whipping up nationalistic fervor to oppose any efforts at international cooperation that may involve a local sapito, especially one who does not pay homage to the sapo. Sapos may be "anti-yanqui" or "anti-European" (anti-colonial), or even opposed to other Latin Americans, unless the sapos, themselves, are seeking foreign grants, fellowships, or jobs. They are never anti-sapo! They must be the leader, founder, *jefe*, director, president, or ruler of every committee, society, department, institute, or other organization with which they are associated, with sycophants in lesser positions or as successors. Sapos are merciless and vindictive; they will not forget a slight, real or imagined. Finally, sapos from different disciplines or different

countries often become friends—it is lonely at the top, and one can only befriend a sapo from another pond.

What Can One Do About a Sapo?—If the pool of researchers in a country is especially small, there is little that can be done about a sapo in the short term. Because sapos have many enemies, real and imagined, they generally feel threatened by someone. As time goes by and they continue to mistreat sapitos, they eventually *are* threatened, for sapitos are ever-increasing and some may achieve positions of prominence or importance because of their own efforts and abilities, or as a result of shifting political winds. A mistake is made, a line is crossed, and the sapo is removed from power. The surest antidote to sapismo is people. The more students and professionals there are in the sapo's discipline, the harder it is for the sapo to be dominant. Eventually so many sapitos will develop that the sapo will be forced to step aside and become what in reality he always was—just another sapito.

Is Sapismo Inevitable?—Sapismo is not uncommon in Latin America or in other parts of the world. Basic requirements include a politicized preponderant scientist working during the early stages of the development of a particular discipline. Political alliances may permit the sapo to extend power rapidly across disciplines. The slow process of training sufficient young scientists who will counterbalance the authority and expertise of the sapo, thus placing him in perspective, offers great opportunity for the sapo to solidify his political and scientific bases. Nevertheless, since a sapo must be from the correct political party, must have a good deal of scientific talent and political acumen, and must have developed these abilities at a chronologically propitious moment, the evolution of sapismo is clearly not inevitable.

Do Sapos Perform a Service?—Sapos, by virtue of their prominence, ability, and unchallenged leadership in a scientific field, can assist with the development of a discipline. Funds can be channeled from government agencies to support research that the sapo considers important. It goes without saying that a sapo is almost always generously funded. By moving monetary and other resources into a discipline, sapos can mobilize research in areas allied with their own interests. A sapo's international reputation may attract foreign collaborators. In a sense, therefore, a sapo can play an important role in getting a discipline on its feet. Over the short term, this can be a positive step in the development of a field of study. Indeed, the very eminence of the sapo will lend visibility and importance to fields of research that are associated with the sapo's work. This can mean that a discipline can receive more attention (monetary and other support) from the higher levels of government or from universities and institutes. The discipline becomes bound to the reputation of the sapo.

Clearly, this can be a difficult period during the development of a discipline. Science is too complex to be carried out by a chosen few—chosen by the sapo. For a discipline to flower, many scientists are needed, their very diversity adding a richness of breadth and depth to a field of research. In the entire development of

the interesting phenomenon of sapismo, it is this stage that can be viewed as inevitable, the dynamic tension that occurs as a sapo's influence wanes and a field of scholarship expands.

If a discipline has inherent importance, it will attract practitioners. Some will come from abroad to assist in its development; others will receive their training within a particular country. Some young scientists may travel to other countries to study for advanced degrees. They will form linkages with foreign students and professors, some of whom may formulate cooperative research or training programs in Latin American countries. Gradually at first, and then ever more rapidly, the numbers of researchers interested in a field of study expands. Soon the pool is filled with sapitos. They will find that the pool, which seemed so confining to the sapo grande is, in fact, immense, expanding to meet the growing curiosity of the many new sapitos. At this point, further opportunities for the development of sapismo are gone. Any sapo grande who might remain is doomed to lose his influence. His time is past. The discipline has grown beyond an individual sapo's ability to control it, and science profits from this transition.

SUMMARY

Mammalogy is a developing scientific discipline in Latin America. Due to the efforts of Latin American biologists and foreign researchers who are dedicated to clarifying the biology of mammals in this especially diverse region, much progress has been made in recent decades in laying the foundation for the next century's mammal research. Foreign research is difficult for those who are not residents of Latin America for logistic, professional, and personal reasons, whereas it is at least equally as challenging for Latin Americans to carry out research in their own countries because of financial instability, political difficulties, lack of professional opportunities, and few colleagues. Through cooperative efforts, these foreign and resident workers can enhance the value and impact of their research on mammals of this threatened region. A discussion of the psychosocial effects of a scientific discipline's developing in a region supporting few scientists is also presented. This phenomenon, termed sapismo, can act to stimulate disciplinary development in its initial stages, but then shifts toward being an impediment to further development of a discipline until the dominant and politicized scientist (sapo grande) declines in authority and influence. After this point, a discipline can truly flourish.

RESUMEN

La mastozoología en Latinoamérica es una disciplina científica en desarrollo. Debido a los esfuerzos de los biólogos latinoamericanos e investigadores extranjeros, quienes se dedican a estudiar la biología de los mamíferos de esta región especialmente diversa, mucho se ha progresado en las décadas recientes para establecer los cimientos de la investigación mastozoológica del próximo siglo. La investigación por extranjeros es difícil para aquellos que no son residentes de Latinoamérica, debido a problemas logísticos, profesionales, o razones personales, y es por lo menos igual de difícil para los latinoamericanos hacer investigación en sus propios países, debido a inestabilidades financieras, dificultades políticas, carencia de oportunidades profesionales, y al pequeño número de colegas activos. A través de esfuerzos cooperativos, los investigadores tanto extranjeros como residentes pueden aumentar el valor e impacto de sus investigaciones mastozoológicas en esta región tan amenazada. Se presenta también una discusión de los efectos psicosociales del desarrollo de una disciplina científica en una región que mantiene un pequeño número de investigadores. Este fenómeno, referido como "sapismo", puede actuar como estimulante del desarrollo científico en su estado inicial, para luego converstirse en un impedimento para el continuo desarrollo de la disciplina, hasta que el investigador dominante y politizado (sapo grande) declina en autoridad e influencia. Es después de este momento que una disciplina científica puede realmente florecer.

ACKNOWLEDGMENTS

I thank Janet K. Braun for assistance in preparing this article. The manuscript benefited from critical readings by Drs. T. E. Lacher, Jr., Michael R. Willig, Ricardo Ojeda, Rubén Barquez, Fabian Jaksic, and David J. Schmidly. Discussions with Lynn Mares and Dr. Paul Handford were also helpful.

LITERATURE CITED

Alho, C. J. R., and T. E. Lacher, Jr. 1991. Mammalian conservation in the Pantanal of Brazil. Pp. 280–294, *in* Latin American mammmalogy: history, biodiversity, and conservation (M. A. Mares and D. J. Schmidly, eds.). Univ. Oklahoma Press, Norman, 480 pp.

Baker, R. H. 1991. The classification of Neotropical mammals: a historical resume. Pp. 7–32, *in* Latin American mammalogy: history, biodiversity, and conservation (M. A. Mares and D. J. Schmidly, eds.). Univ. Oklahoma Press, Norman, 480 pp.

Braun, J. K., and M. A. Mares. 1991. Natural history museums: working toward the development of a conservation ethic. Pp. 431–454, *in* Latin American mammalogy: history, biodiversity, and conservation (M. A. Mares and D. J. Schmidly, eds.). Univ. Oklahoma Press, Norman, 480 pp.

D. S. Wood. 1989. Commentary on the place of systematics. Assoc. Syst. Coll. Newsl., 17:1–2.

Corbet, G. B., and J. E. Hill, 1980. A world list of mammalian species. British Museum (Natural History), London, 226 pp.

Darwin, C. R. 1839. Journal of researches into the geology and natural history of the various countries visited by H. M. S. *Beagle*, under the command of Captain Fitzroy, R. N., from 1832 to 1836. Henry Colburn, London, 615 pp.

———. 1859 (1917). The origin of species by means of natural selection. 6th ed., John Murray, London, 432 pp.

Detwiler, R. P., and C. A. S. Hall. 1988. Tropical forests and the global carbon cycle. Science, 239:42–47.
Disney, R. H. L. 1989. Does anyone care? Conserv. Biol., 3:412.
Ehrenfeld, D. 1989. The next environmental crisis. Conserv. Biol., 3:1–3.
Gilbert, L. E. 1980. Food web organization and the conservation of Neotropical diversity. Pp. 11–33, *in* Conservation biology: an evolutionary-ecological approach (M. E. Soulé and B. A. Wilcox, eds.). Sinauer Assoc., Sunderland, MA, 395 pp.
Hershkovitz, P. 1987. A history of the Recent mammalogy of the Neotropical region from 1492 to 1850. Pp. 11–98, *in* Studies in Neotropical mammalogy. Essays in honor of Philip Hershkovitz (B. D. Patterson and R. M. Timm, eds.). Fieldiana, Zool., 39:1–506.
Janzen, D. H., and P. S. Martin. 1982. Neotropical anachronisms: the fruits the gomphotheres ate. Science, 215:145–164.
Lacher, T. E., Jr. 1982. Behavioral research in South America. Pp. 209–230, *in* Mammalian biology in South America (M. A. Mares and H. H. Genoways, eds.). Univ. Pittsburgh, Pymatuning Lab. Ecol., Publ. No. 6, Linesville, PA, 539 pp.
Lacher, T. E., Jr., and M. A. Mares. 1986. The structure of Neotropical mammal communities: an appraisal of current knowledge. Rev. Chilena Hist. Nat., 59:121–134.
MacArthur, R. H., and J. H. Connell. 1966. The biology of populations. John Wiley and Sons, New York, 200 pp.
Mares, M. A. 1982. The scope of South American mammalian biology: perspectives on a decade of research. Pp. 1–26, *in* Mammalian biology in South America (M. A. Mares and H. H. Genoways, eds.). Univ. Pittsburgh, Pymatuning Lab. Ecol., Spec. Publ. No. 6, Linesville, PA, 539 pp.
———. 1985. Mammal and museum literature: an international survey. Acta Zool. Fennica, 170:57–60.
———. 1986. Conservation in South America: problems, consequences, and solutions. Science, 233:734–739.
———. 1988. The need for popular natural history publications concerning mammals. Proc. Wkshp. Mgmt. Mammal. Colln. Tropical Environ., Calcutta, 1984:439–452.
Mares, M. A., and J. K. Braun. 1986. An international survey of the popular and technical literature of mammalogy. Ann. Carnegie Mus., 55:145–205.
Mares, M. A., and R. A. Ojeda. 1984. Faunal commercialization and conservation in South America. BioScience, 34:580–584.
McCormick, J. F., and G. W. Barrett. 1979. Ecological manpower and employment opportunities. BioScience, 29:419–423.
Myers, N. 1980. Conversion of tropical moist forests. Natl. Acad. Sci., Washington, D.C., 205 pp.
Naylor, B. G., and P. Handford. 1985. In defense of Darwin's theory. BioScience, 35:478–484.
Ojeda, R. A., and M. A. Mares. 1982. Conservation of South American mammals: Argentina as a paradigm. Pp. 505–522, *in* Mammalian biology in South America (M. A. Mares and H. H. Genoways, eds.). Univ. Pittsburgh, Pymatuning Lab. Ecol., Spec. Publ. No. 6, Linesville, PA, 539 pp.
Oldfield, M. L. 1989. The value of conserving genetic resources. Sinauer Assoc., Sunderland, MA, 379 pp.
Porter, A. L., D. E. Chubin, F. A. Rossini, M. E. Boeckmann, and T. Connolly. 1982. The role of the dissertation in scientific careers. Amer. Sci., 70:475–481.
Redfield, G. W., and L. B. Crowder. 1989. Suggestions for grantsmanship in ecology. Bull. Ecol. Soc., 70:185–189.
Roig, V. 1991. Desertification and distribution of mammals in the southern cone of South America. Pp. 239–279, *in* Latin American mammalogy: history, biodiversity, and conservation (M. A. Mares and D. J. Schmidly, eds.). Univ. Oklahoma Press, Norman, 480 pp.
Simpson, G. G. 1980. Splendid isolation: the curious history of South American mammals. Yale Univ. Press, New Haven, CN, 266 pp.
Woodwell, G. M., J. E. Hobbie, R. A. Houghton, J. M. Melillo, B. Moore, B. J. Peterson, and G. R. Shaver. 1983. Global deforestation: contribution to atmospheric carbon dioxide. Science, 222:1081–1086.