BIOTROPICA
THE JOURNAL OF TROPICAL BIOLOGY AND CONSERVATION

BIOTROPICA 40(4): 397–404 2008 10.1111/j.1744-7429.2007.00393.x

The Geographical and Institutional Distribution of Ecological Research in the Tropics

Gabriela Stocks[1,5], **Lisa Seales**[2], **Franklin Paniagua**[2], **Erin Maehr**[3], and **Emilio M. Bruna**[4]

[1]Department of Anthropology & Land Use and Environmental Change Institute, University of Florida, P.O. Box 117305, Gainesville, Florida 32611-7305, U.S.A.

[2]The School of Natural Resources and Environment, University of Florida, P.O. Box 116455, Gainesville, Florida 32611-6455, U.S.A.

[3]School of Forest Resources and Conservation, University of Florida, P.O. Box 110410, Gainesville, Florida 32611-0410, U.S.A.

[4]Department of Wildlife Ecology and Conservation & Center for Latin American Studies, University of Florida, P.O. Box 110430, Gainesville, Florida 32611-0430, U.S.A.

ABSTRACT

We reviewed 1333 papers published in *Biotropica* and the *Journal of Tropical Ecology* from 1995 to 2004. Only 62 percent of tropical countries were represented in our survey, with 62 percent of the publications based on research conducted in only ten countries. Sixty-two percent of papers had lead authors that were based at institutions outside the country where the research was conducted. Cross-national collaboration was limited, accounting for only 28 percent of papers with multiple authors. To evaluate if our choice of focal journals could have biased our results, we also reviewed 652 papers published in *Ecology*, *Oecologia*, *Conservation Biology*, and *Biological Conservation* for five randomly selected years from the same time period. While some differences in authorship and the geographic distribution of research existed, the results from these journals generally mirrored patterns observed in the two focal ones—almost 54 percent of publications were based on research conducted in only ten countries, and most studies had lead authors from a developed country. The results of our review suggest that the geographical distribution of research in the tropics is unequal, and that some important regions remain understudied. The results also suggest a need for a greater focus on establishing collaborative relationships with scientists from tropical countries.

Abstract in Spanish is available at http://www.blackwell-synergy.com/loi/btp.

Key words: capacity building; conservation; development; north–south collaboration; scientific productivity; tropical ecology.

TROPICAL ECOSYSTEMS ARE RESERVOIRS OF BIODIVERSITY, SOURCES OF PRODUCTS consumed locally and globally, and home to the majority of the Earth's people (Kricher 1997, Whitmore 1998, U.S. Census Bureau 2005). They are also increasingly threatened by deforestation, habitat fragmentation, climate change, and other human-induced environmental changes (*e.g.*, Bermingham *et al.* 2005; Laurance & Peres 2006). By elucidating the structure and functioning of these ecosystems, the research conducted by tropical scientists plays a key role in identifying and ameliorating these threats. However, the scientific community's conclusions about the functioning of tropical ecosystems may be biased if research is limited to a small number of regions or countries, since these locations may not be broadly representative. Furthermore, these potential disparities in our biological knowledge of different tropical regions could influence how we identify and prioritize conservation targets (*e.g.*, Schiesari *et al.* 2007).

The close relationship between scientific research and socioeconomic development (Annan 2003) has also spurred an interest in identifying not only where research is being conducted, but also by whom. For instance, a recent review demonstrated that per dollar invested by their nations in research and development, scientists in Latin American countries produced a greater number of scientific publications than did their counterparts in the Unites States and Canada (Holmgren & Schnitzer 2004). However, scientists from Latin America produce fewer total publications and rarely contribute to the premier scientific journals. Consequently, they only infrequently achieve the status necessary to become regularly cited (Holmgren & Schnitzer 2004), which could minimize the impact of their research in the international community. Similar results were found by Galvez *et al.* (2000), who found that Western Europe, North America, and Asia accounted for 85 percent of all papers listed in the Science Citation Index from 1991 to 1998. In contrast, countries in Africa contributed only 1 percent of total publications, and Latin America ranked low in terms of total productivity despite steady growth in scientific output resulting from high rates of publication by scientists in Argentina, Brazil, Chile, and Mexico.

Trends in the geographical and institutional distribution of scientific research are particularly relevant to the study of tropical ecosystems, which are primarily found in the developing world (*sensu* Sobboutina 2004). Although attempts to quantify these patterns are rare (*e.g.*, Clark 1985, Braker 2000), the results of previous reviews have been telling. After surveying the articles published in the journals *Biotropica* and *Ecology* in 1983 and 1984, Clark (1985) concluded that 66 percent of global tropical studies were conducted in only eight countries in Central and South America. Costa Rica and Panama led the way with 17.2 percent and 16.3 percent of studies, respectively, while studies conducted in Africa accounted for only 5.7 percent of publications. These results were echoed by Braker (2000), whose review of the 1989 and 1999 volumes of *Biotropica* indicated that a majority of studies were conducted in a

Received 24 May 2007; revision accepted 29 October 2007.
[5]Corresponding author; e-mail: gstocks@ufl.edu

limited number of countries and that Central and South America (including Mexico) were again the most productive regions. Braker also found a trend toward decreased inclusion of local coauthors by foreign scientists working in the tropics (based on a comparison of the 1989 and 1999 volumes of *Biotropica*).

Though they focused on only two journals and a 2-yr time frame, the surveys by Clark (1985) and Braker (2000) strongly suggest there are disparities in the geographical distribution of ecological research in the tropics. Nevertheless, it is possible their results reflect a potential bias in the journals selected toward research conducted in the Neotropics (Clark 1985), or that limited sample sizes in some years masked important patterns (Braker 2000). To elucidate the geographical and institutional distribution of research in the tropics, we reviewed a decade's worth of research published in the two leading journals in the field of tropical biology (*Biotropica, Journal of Tropical Ecology*), as well as subset of studies published during the same time period in four other highly ranked publications (*Ecology*, *Conservation Biology*, *Oecologia*, and *Biological Conservation*). We addressed the following three questions: (1) In which tropical countries has ecological research been conducted? (2) Is the home institution with which the lead author is affiliated based in the country where the work was carried out? (3) Are multiauthor papers written by teams composed entirely of scientists based at local or foreign institutions, or are they written collaboratively by multinational teams? We then explore some of the mechanisms responsible for our results, with an emphasis on the factors influencing the development of science in tropical countries. In a key departure from previous studies, we evaluate trends in productivity by individual countries rather than continents or regions (*cf.*, Braker 2000), allowing us to elucidate potentially critical within-region variation (Galvez *et al.* 2000).

METHODS

The core of our review is composed of all papers published in *Biotropica* (BT) and the *Journal of Tropical Ecology* (JTE) from 1995 to 2004. We chose these sources because they are the principal international journals focusing on tropical ecosystems; they attract a large and international readership; and they are not limited to studies of specific biomes, taxonomic groups, or subdisciplines. For each study published during our focal period, we recorded the country in which the fieldwork was conducted and the country in which the lead author's home institution was located. For studies with two or more authors, we also recorded the number of authors and the country where the institution with which they were affiliated was located. When authors listed multiple addresses, we used the primary address to make assignments.

Studies conducted in political units such as territories, commonwealths, or overseas departments were recorded as having occurred in those locations, rather than in the country with governmental authority (*e.g.*, studies conducted in French Guiana and French Polynesia were tabulated separately from each other and not attributed to France; studies conducted in Puerto Rico or Guam were tabulated separately from those conducted in the tropical regions of the U.S.A. [*i.e.*, Hawai'i]). Field studies conducted in multiple countries were assigned to all of those countries, while greenhouse studies (1.8%) and laboratory studies (1.8%) were assigned to the country in which the material was collected. No book reviews, letters, theoretical studies, or reviews based on previously published work were included in our analyses. Sample sizes occasionally differ among categories because a single study could be assigned to multiple countries but always has only one primary author.

For all countries in which research was conducted, we also recorded each of the following five metrics: total land area and population size (Central Intelligence Agency 2005), Average Gross Domestic Product (GDP) from 1995 to 2004 (United Nations Statistics Division 2005), Human Development Index (HDI) in 2003 (United Nations Development Programme 2005), and Education Index (EI) in 2005 (United Nations Development Programme 2005). We chose these metrics because they incorporate many of the factors that influence a country's likelihood or ability to invest in scientific research: GDP is an indicator of economic capital available for scientific investment, while HDI, EI, and population size reflect the social capital available for conducting scientific research. In addition, total land area reflects the diversity of ecosystems and species in a country (reviewed in Rosenzweig 2005). Although none of these metrics directly measures scientific productivity or financial investment in science, they are indicative of potential investments, the availability of human resources for addressing ecological questions, and the ecological diversity of the countries being compared.

We then used Spearman rank correlations to test for associations between each of these metrics and: (1) the total number of papers published in BT and JTE that were based on research in that country; and (2) the proportion of these papers whose primary authors were based in-country. For the four countries in which the most studies had been conducted, we also tested for differences in the frequency of lead authors from domestic and foreign institutions using χ^2 tests. Finally, we tested for differences in the frequency of studies conducted in Paleotropical vs. Neotropical field sites using χ^2 tests. All analyses were conducted using Statview for Windows (v. 5.0.1).

To evaluate whether our choice of focal journals could bias our results (*e.g.*, because certain subdisciplines are underrepresented in BT or JTE, or because authors from certain countries preferentially publish in other journals), we also reviewed papers published in four highly ranked journals: two whose scope includes all aspects of ecological research (*Ecology, Oecologia*), and two that publish conservation-related research conducted worldwide (*Biological Conservation, Conservation Biology*). We randomly selected 5 yr from the same 1995–2004 time period (1996, 1997, 1998, 2000, and 2004), identified all studies conducted in tropical countries, and recorded the same information as for articles published in BT and JTE. When studies were conducted in countries that were only partially within the tropics (*e.g.*, U.S.A., Australia, Brazil), we identified the study sites and disregarded any studies conducted outside the tropical portions of the country.

RESULTS

A total of 1333 studies that met our criteria were published in *Biotropica* and the *Journal of Tropical Ecology* during 1995–2004 ($N = 705$ and $N = 628$, respectively). Collectively, JTE and BT published the results of research conducted in 99 countries. Sixty-two percent of these studies were based on research carried out in 10 countries: Brazil, Costa Rica, Mexico, Panama, Malaysia, Puerto Rico, Australia, French Guiana, Venezuela, and Ecuador (Fig. 1A). Studies conducted in Brazil or Costa Rica accounted for 27.8 percent of all papers published ($N = 370$), while 20 countries were represented by only one publication. Both journals published significantly more studies conducted in Neotropical than Paleotropical field sites ($\chi^2 = 65.7$, $P < 0.0001$), though the bias was particularly pronounced for *Biotropica* (BT: 77.4% Neotropical vs. 22.6% Paleotropical; JTE: 56.5% Neotropical vs. 43.5% Paleotropical).

Total productivity (*i.e.*, by both domestic and foreign-based authors) was positively correlated with the size of the country ($\rho = 0.47$, $P < 0.0001$), population size ($\rho = 0.39$, $P < 0.0012$), HDI ($\rho = 0.42$, $P = 0.001$), EI ($\rho = 0.37$, $P = 0.004$), and average GDP ($\rho = 0.60$, $P < 0.0001$). However, the proportion of papers whose lead authors were based in-country was positively correlated only with country area, population size, and GDP (Area: $\rho = 0.46$, $P < 0.0001$; Population size: $\rho = 0.53$, $P < 0.0001$; GDP: $\rho = 0.54$, $P < 0.0001$; HDI: $\rho = 0.16$, $P = 0.20$; EI: $\rho = 0.13$, $P = 0.33$).

In 828 of the studies surveyed (62%), the lead authors were based at institutions outside of the country in which the research was conducted. Forty-five percent of the studies surveyed were written by scientists based in only two countries: the United States and Brazil (34% and 11%, respectively; Fig. 2A). Of the 1047 papers written by two or more authors, 39 percent were written by teams of foreign-based authors and 33 percent were written exclusively by authors based in the country where the research was conducted. International collaborators, *i.e.*, teams of foreign- and domestic-based coauthors, accounted for 28 percent of multiauthored papers. When comparing the countries from which most publications emerged—Brazil, Costa Rica, Mexico, and Panama—two distinct patterns of authorship were apparent. Most studies conducted in Mexico and Brazil had lead authors from institutions in those countries (73% and 67%, respectively). In contrast, the vast majority of publications based on studies conducted in Costa Rica and Panama were written by authors from foreign institutions (92% and 74%, respectively). Most of these authors were based in the U.S.A. (Costa Rica: 66%, Panama: 57%; Fig. 3).

For the 5 yr we surveyed, 652 studies conducted in tropical countries were published in *Ecology* ($N = 129$), *Oecologia* ($N = 204$), *Conservation Biology* ($N = 139$), and *Biological Conservation* ($N = 180$). Mirroring the patterns observed for JTE and BT, a majority of the studies (53.9%) were conducted in only 10 countries (Fig. 1B). While many of these countries were the same as those identified in our surveys of BT and JTE, there were some notable differences in the rank orders. For instance Australia—ranked seventh in our survey of BT and JTE—emerged as the country in which the most studies were conducted when combining the results from the other four journals (9.4% of studies, $N = 71$). The U.S.A. also moved up in rank order, from eleventh in BT/JTE to fifth in the non-tropical journals (5.1%, $N = 39$). Finally, there was increased representation of African countries (*e.g.*, Kenya: seventh; 4%, $N = 30$; Tanzania: tenth; 2.6%, $N = 20$). Interestingly, Brazil, Costa Rica, Mexico, and Panama retained their rank order as the four developing countries in which the most research was conducted (Fig. 1B).

In terms of authorship, we found similar shifts in the relative frequency of authors from different countries when comparing BT and JTE to the other journals. Sixty-six percent of the papers published in *Ecology*, *Conservation Biology*, *Oecologia*, and *Biological Conservation* also had lead authors that were based at institutions outside the country in which the research was conducted. While over 40 percent had lead authors based in the U.S.A. (Fig. 2B), authors based in Australia, and the UK were now the second- and third-most common (11.7% and 7.8% of papers, respectively). Authors from Brazil and Mexico were again the most productive from among developing countries (4.3% and 4.1%, respectively). Patterns of coauthorship were also similar to those for our focal journals. Of the 536 papers written by two or more authors, 45 percent were written by teams of foreign-based authors and 28 percent were written exclusively by authors based in the country where the research was conducted. Papers with both in-country and foreign coauthors accounted for 27 percent of multiauthored papers.

DISCUSSION

There are 159 countries, territories, commonwealths, and overseas departments that are at least partially within the area bounded by the Tropics of Cancer and Capricorn (ESRI 2003). However, only 62 percent of tropical countries were represented in our survey, and almost two-thirds of the publications we reviewed were based on research conducted in a mere ten countries (Fig. 1). Africa contains the world's second-largest expanse of tropical wet forest, the largest savannas, and one of the largest wetland networks in the world. In terms of research productivity, however, no African country was among the leaders in either *Biotropica* or *Journal of Tropical Ecology*. Even when considering journals with a broader disciplinary focus, the three most-studied African countries—Kenya, Tanzania, Uganda—collectively represented less than one-tenth of the studies published. Furthermore, we found only a limited number of publications based on research conducted in the major island groups in the Pacific or large and biodiversity-rich Asian countries such as Myanmar and Vietnam. In addition to limiting our ability to generalize about the structure and functioning of tropical ecosystems, this limited geographical perspective may complicate the task of accurately assessing conservation priorities.

Why is there this disparity in the amount of research emerging from different tropical countries? First, we found that a country's 'total productivity,' as well as the number of papers produced by in-country scientists, is positively correlated with population size.

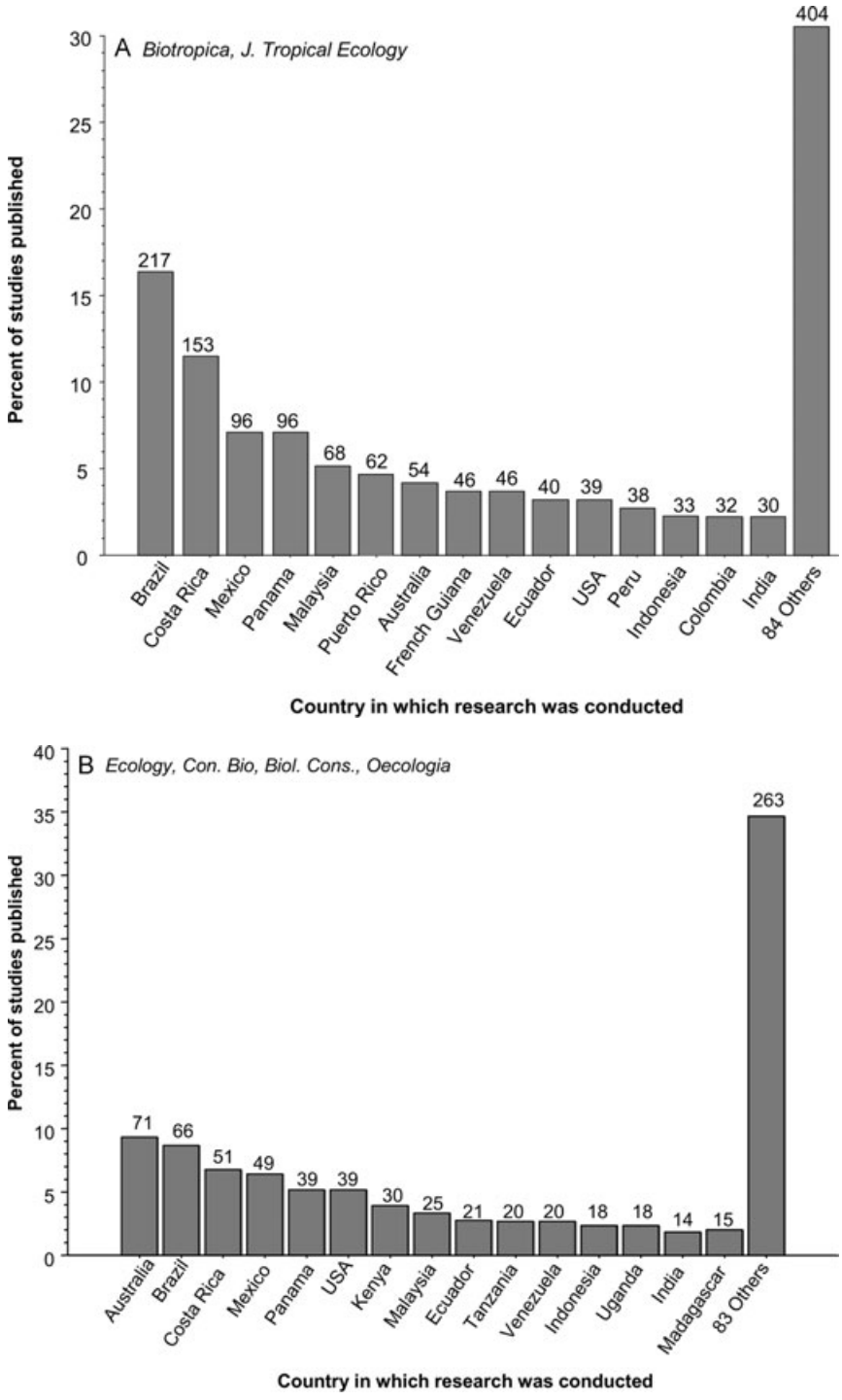

FIGURE 1. Percentage of studies published in (A) *Biotropica* and the *Journal of Tropical Ecology* (1995–2004) and (B) *Ecology*, *Conservation Biology*, *Oecologia*, and *Biological Conservation* (1996, 1997, 1998, 2000, 2004) that were conducted in different tropical countries. Numbers above the bars indicate the number of studies. Note that studies conducted in political units such as territories, commonwealths, or overseas departments were recorded as having occurred in those locations, rather than in the country with governmental authority.

Larger countries may simply have more in-country scientists, the development of which can be stifled in smaller countries by limited investments in education, financial resources, or opportunities to employ students once they are trained (Rudran *et al.* 1990, Adams & McShane 1992, Luukkonen *et al.* 1992, Barnard 1995, Sodhi & Liow 2000). Second, understudied countries may have limited financial resources to allocate to basic ecological, systematic, or behavioral research (Holmgren & Schnitzer 2004), a conclusion

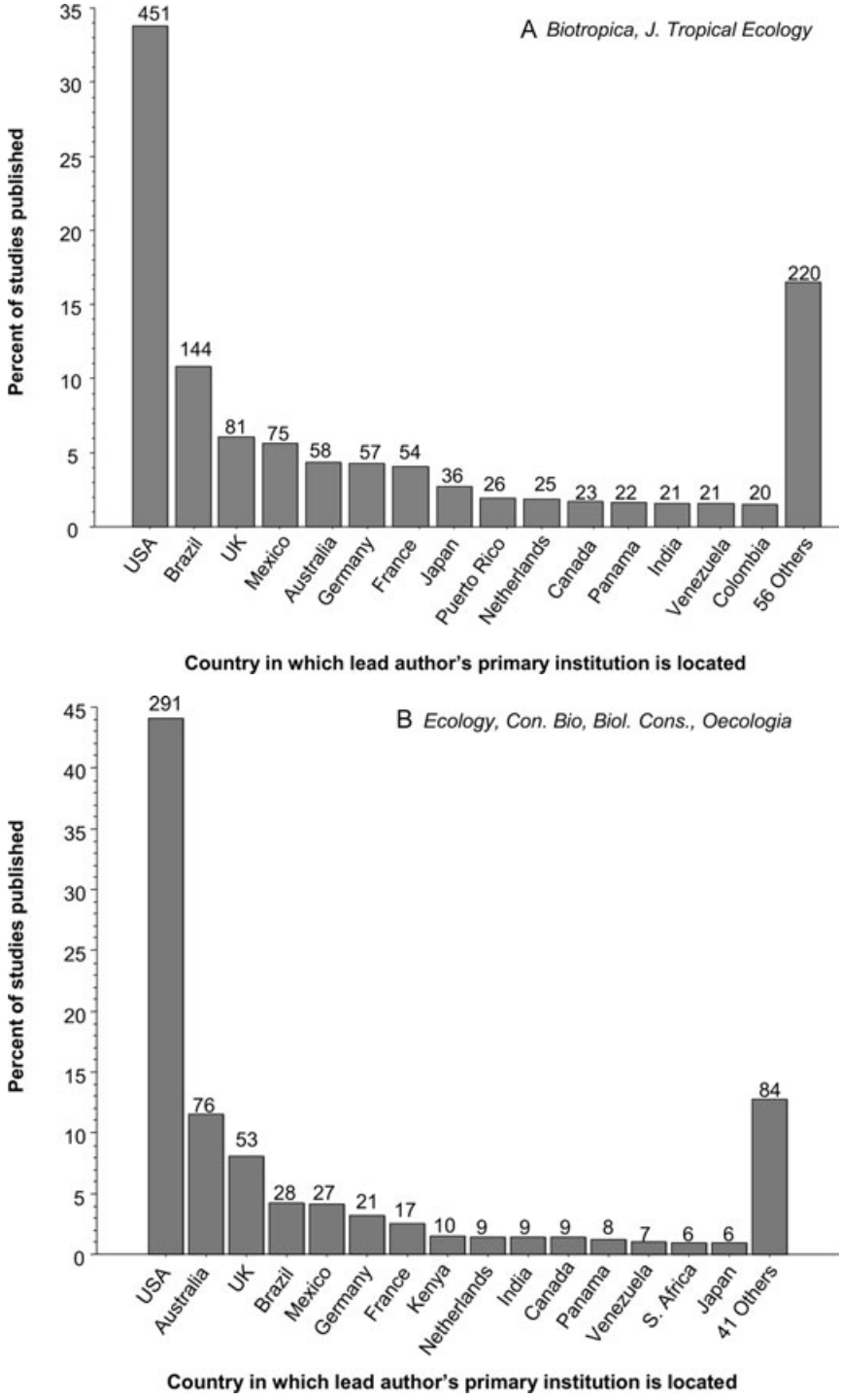

FIGURE 2. Country in which the lead author's primary institution was located for studies published in (A) *Biotropica* and the *Journal of Tropical Ecology* (1995–2004) and (B) *Ecology*, *Conservation Biology*, *Oecologia*, and *Biological Conservation* (1996, 1997, 1998, 2000, 2004). Bars indicate the percentage of studies with authors based in each country; numbers above the bars indicate the number of studies.

bolstered by our finding that GDP and scientific productivity are also positively correlated. Finally, larger countries may attract more foreign researchers with their greater diversity of species and ecosystems, while limited infrastructure (*e.g.*, field stations, universities, transportation and communication networks), political unrest, and the cost of travel could discourage foreign scientists from establishing research programs in some of the lesser-studied countries (Clark 1985, Adams & McShane 1992, Braker 2000, Galvez *et al.* 2000).

We also found that most papers published in our focal journals had lead authors that were based at institutions outside the

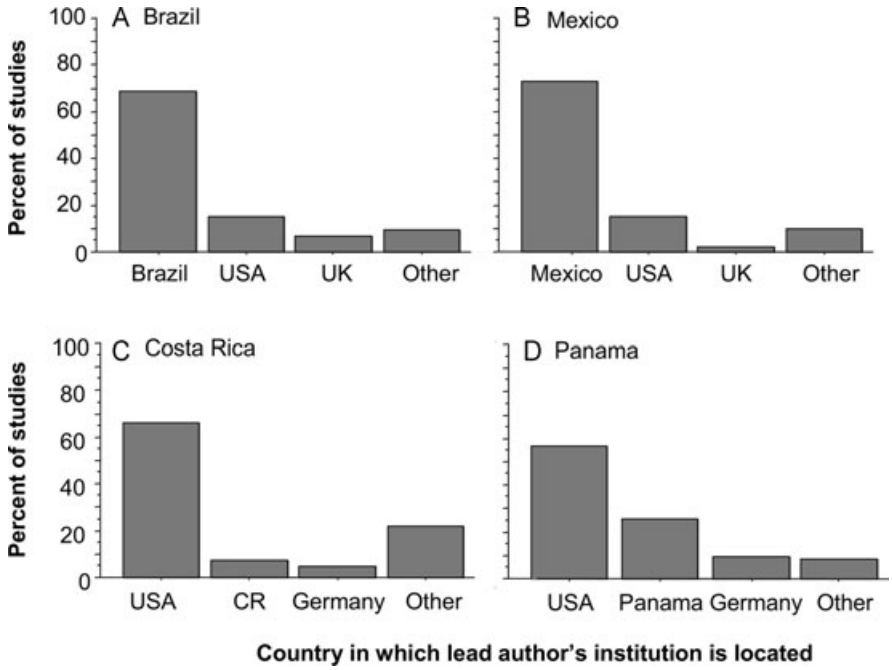

FIGURE 3. Percentage of studies published in *Biotropica* and the *Journal of Tropical Ecology* that were conducted in (A) Brazil, (B) Mexico, (C) Costa Rica, and (D) Panama with lead authors from either those or foreign countries.

country where the research was conducted (Figs. 2 and 3). Sodhi and Liow (2000) argue that Southeast Asian scientists might not be publishing in international conservation journals because many governments do not or cannot make basic science a priority, but instead invest primarily in potentially lucrative applied research. Furthermore, professional advancement, salary increases, or grant funding may not be directly linked to productivity or journal quality, therefore there may not be incentives for publishing in international journals (Sodhi & Liow 2000) such as those we reviewed. Research conducted in some developing countries may not be of interest to international journals because it is descriptive or focused on local management problems (Sodhi & Liow 2000). Finally, the increasing cost of journal subscriptions and other scientific resources prevents scientists in countries with limited financial resources from accessing current information (see also Gómez-Pompa 2004). All of these factors could be influencing the productivity of scientists based in developing countries in other parts of the tropics.

Why then has so much scientific productivity emerged from several smaller and less populous countries, most notably Costa Rica and Panama? The first reason is that they are able to attract large numbers of foreign researchers—most papers emerging from both of these countries were written by scientists based in the United States. Both countries are home to well-established networks of biological field stations (*e.g.*, the Organization for Tropical Studies (OTS) and the Smithsonian Tropical Research Institute (STRI), respectively) that attract hundreds of international scientists annually. In fact, of the 203 studies conducted in Costa Rica (all journals combined), 40 percent were conducted at an OTS station. Similarly, 60 percent of the 134 studies conducted in Panama were conducted at a STRI facility. In addition to the logistical support provided to researchers by these facilities, the political stability of these countries makes them attractive locations for establishing long-term research projects (Clark 1985). They also have relatively well-established and streamlined procedures in place for foreigners to obtain permission to conduct research (OTS 2007, STRI 2007). Second, when population size is taken into account, Costa Rican- and Panamanian-based scientists actually produced more papers per capita than many larger and more populous countries (*e.g.*, Panama: 5.8×10^{-6} publications *per capita*; Costa Rica 2.4×10^{-6}, Brazil: 7.3×10^{-7}, Mexico 6.3×10^{-7}), although it is possible that many of these articles were written by foreign scientists based at the STRI and OTS facilities.

The pattern of dominance by foreign-based authors for Costa Rica and Panama stood in sharp contrast to that for Mexico and Brazil, for which in-country scientists produced the largest total number of publications. Both are large countries with investments in scientific research and infrastructure that may place local scientists in an advantaged position relative to other developing nations. Mexico and Brazil are home to 64 percent of the academic programs in conservation biology that have been established in Latin America (10 and 17 of 42, respectively; Rodríguez 2005), and both have benefited from the efforts of academic visionaries that worked to strengthen graduate education and the caliber of scientific research in these countries during the 1960s and 1970s (*e.g.*, José Sarukhan, Warwick Kerr). Their domestic funding agencies also emphasize research conducted in-country, thus contributing to the large number locally led research projects (E. Andresen, pers. comm.). Finally, complex regulations for obtaining research

permits and visas may also dissuade many foreign researchers, thereby increasing the relative productivity of in-country scientists (Clark 1985, Gómez-Pompa 2004).

International collaboration can take many forms, of which co-authored publications are only one. Nevertheless, co-authored publications are often cited as the measure by which institutions gauge the success of collaborative activities (Leclerc *et al.* 1992, Toni & Velho 1996). Our results suggest that collaboration between foreign-based and home-country researchers—measured as the number of coauthored publications—continues to be limited (Braker 2000), despite efforts by the Association for Tropical Biology and Conservation (ATBC) and other organizations to emphasize its importance (ATBC 2004). Most papers we reviewed were written entirely by teams of foreign or local researchers, with only 28 percent involving collaboration between these groups (see Wishart and Davies 1998 for similar results based on patterns of authorship in limnology journals). A number of authors have suggested that the benefits of participating in international collaborative activities can be myriad. For instance, enhanced north–south collaboration can help scientists from developed nations to better understand the social, political, and economic context in which their research is embedded (Wishart & Davies 1998, Gómez-Pompa 2004). Because scientists in developing countries often lack funding for basic ecological research, participating in collaborative research allows them the opportunity to participate in projects with advanced analytical or instrumentation needs (Galvez *et al.* 2000). Additionally, international collaboration enhances the educational experiences of students from both countries, which can better prepare them for the demands of a changing job market (Kainer *et al.* 2006). Finally, international collaboration minimizes what Wishart and Davies (1998:563) call 'intellectual export,' which occurs when research is conducted in developing countries without the participation of local scientists. International collaborations can be challenging to establish—they may be frustrated by policy or institutional complexities, a limited number of researchers with whom to collaborate, the difficulty in remotely advising students, or simply a lack of interest, time, or necessity on the part of local scientists. Nevertheless, collaboration can ultimately strengthen the quality of basic science by providing financial and intellectual support for scientists in less-developed countries, and increased access to species-rich environments for scientists in developed countries (Barnard 1995). Collaboration also improves the training activities of participating institutions (Kainer *et al.* 2006; also see Wemmer *et al.* 1993) as well as the development, implementation, and success of conservation policies (Barnard 1995, Gómez-Pompa 2004).

While we argue that collaboration can have a positive impact on science in developing countries, it would be naïve to ignore its sometimes significant drawbacks, particularly at the institutional level. Even in highly regulated collaborative agreements, copublication often occurs less than would be expected due to high staff turnover and a lack of incentives for publication on the part of the developing country partner (Toni & Velho 1996). Furthermore, the financial support provided by more affluent partners can give them a powerful role in the decision making of the organizations with which they are affiliated, often at the expense of local control over the allocation of staff and resources (Toni & Velho 1996). Consequently, there is an increasing effort on the part of some graduate programs in the developed world to train students in collaboration skills in order to promote the establishment of mutually beneficial collaborative activities (Kainer *et al.* 2006).

Several important caveats to our conclusions bear discussion. First, it is important to note that we conducted our analyses using institutional addresses rather than author nationality. Some of the ecological research conducted in tropical countries that we attributed to foreign institutions was undoubtedly done by home-country scientists studying or working abroad, which may have caused us to over-attribute research to foreigners. However, such a bias could also inflate the numbers of studies by 'local' scientists, if institutions in those countries are home to large numbers of foreign researchers (*e.g.*, STRI). Second, our review did not include foreign language journals (*e.g.*, *Revista de Biologia Tropical, Revista Brasileira de Ecologia*) or those with a more specialized geographical focus (*e.g.*, *African Journal of Ecology, Austral Ecology*). In addition, much tropical research, especially that emphasizing observations of natural history and taxonomy, is conducted by home-country scientists and published in local or specialized journals. While some tropical nations publish journals that are respected internationally (*e.g.*, *Current Science*, *Malaysian Forester*), much locally published research remains overlooked at the international level (Holmgren & Schnitzer 2004). Furthermore, publication in journals with high impact factors is becoming increasingly important in the evaluation process for scientists in the developing world (Sodhi & Liow 2000, Holmgren & Schnitzer 2004, Conselho Nacional de Desenvolvimento Científico e Tecnológico 2006), and many students in developing countries submit the results of their research to international journals. Finally, scientists may simply conduct research in the tropical regions nearest to them or with which their countries have a historical legacy, as well as preferentially submit publications to journals with high impact factors, which are based in their home-countries (Holmgren & Schnitzer 2004). Nevertheless, the journals we selected publish papers on a broad range of disciplines, systems, and approaches, and we believe they accurately gauge not only trends in tropical ecology, but also changes in academia in the developing world.

ACKNOWLEDGMENTS

We would like to thank E. Andresen, J. Ewel, H. Covert, F. Putz, R. Chazdon, J. Ghazoul, and two anonymous reviewers for helpful discussions and comments on the manuscript. Assistance with data collection was provided by T. Bogle, M. Samson, and E. Hamm; H. Castaneda assisted with GIS analysis. Financial support during the completion of this project was provided by a University of Florida Alumni Fellowship (G.S.), graduate assistantships from The School of Natural Resources and Environment (L.S., F.P.) and the Tropical Conservation and Development Program (F.P.), and a graduate assistantship from the Florida Institute of Phosphate Research (E.M.).

LITERATURE CITED

Adams, J. S., and T. O. McShane. 1992. The myth of wild Africa: Conservation without illusion. W.W. Norton, New York, New York.

Annan, K. 2003. A challenge to the world's scientists. Science 299: 1485.

Association for Tropical Biology and Conservation. 2004. Beyond paradise: Meeting the challenges in tropical biology in the 21st century. Association for Tropical Biology and Conservation, Washington, DC.

Barnard, P. 1995. Scientific research traditions and collaboration in tropical ecology. Trends Ecol. Evol. 10: 38–39.

Bermingham, E., C. W. Dick, and C. Moritz. 2005. Tropical rain forests: past, present and future. University of Chicago Press, Chicago, Illinois.

Braker, E. 2000. The changing face of tropical biology? Tropinet 11: 1–2.

Central Intelligence Agency. 2005. The world factbook. http://www.cia.gov/cia/publications/factbook/index.html.

Clark, D. B. 1985. Ecological field studies in the tropics: geographical origin of reports. Bull. Ecol. Soc. Am. 66: 6–9.

Conselho Nacional deDesenvolvimento Científico e Tecnológico. 2006. Critérios de julgamento para bolsas de produtividade em pesquisa (PQ). http://www.cnpq.br/sobrecnpq/instanciasdecisorias/ca/ca-el.html.

ESRI Data & Maps [CD-ROM]. 2003. Environmental Systems Research Institute, Redlands, California.

Galvez, A., M. Maqueda, M. Martinez-Bueno, and E. Valdivia. 2000. Scientific publication trends and the developing world. Am. Sci. 88: 526.

Gómez-Pompa, A. 2004. The role of biodiversity scientists in a troubled world. BioScience 54: 217–225.

Holmgren, M., and S. A. Schnitzer. 2004. Science on the rise in developing countries. PLoS Biol. 2: e1.

Kainer, K. A., M. Schmink, J. R. Stepp, H. Covert, E. M. Bruna, J. L. Dain, S. Espinosa, and S. Humphries. 2006. A framework for graduate education for tropical conservation and development. Conserv. Biol. 20: 3–13.

Kricher, J. 1997. A Neotropical companion: an introduction to the animals, plants, and ecosystems of the new world tropics, 2nd edition, Princeton University Press, Princeton, New Jersey.

Laurance, W. F. and C. A. Peres, Eds. 2006. Emerging threats to tropical forests. University of Chicago Press, Chicago, Illinois.

Leclerc, M., Y. Okubo, J. Frigolettq, and J. F. Miquel. 1992. Scientific co-operation between Canada and European community. Sci. Public Policy 19: 15–24.

Luukkonen, T., O. Persson, and G. Sivertsen. 1992. Understanding patterns of international scientific collaboration. Sci. Technol. Human Values 17: 101–126.

Organization for Tropical Studies. 2007. http://www.ots.duke.edu/en/research/permits_detail.shtml.

Rogríguez, J. P., J. A. Simonetti, A. Premoli, and M. A. Marini. 2005. Conservation in austral and Neotropical America: building scientific capacity equal to the challenges. Conserv. Biol. 19: 969–972.

Rosenzweig, M. L. 1995. Species diversity in space and time. Cambridge University Press, Cambridge, UK.

Rudran, A., C. Wemmer, and M. Singh. 1990. Teaching applied ecology to nationals of developing countries. *In* R. Goodland (Ed.): Race to save the tropics: Ecology & economics for a sustainable future, pp. 125–140. Island Press, Washington, DC.

Schiesari, L., B. Grillitsch and H. Grillitsch. 2007. Biogeographic biases and their consequences for linking amphibian declines to pollution. Conserv. Biol. 21: 465–471.

Smithsonian Tropical Research Institute. 2007. http://stri.org/english/research/applications/permits/index.php.

Sodhi, N. S., and L. H. Liow. 2000. Improving conservation biology research in Southeast Asia. Conserv. Biol. 14: 1211–1212.

Soubbotina, T. P. 2004. Beyond economic growth: An introduction to sustainable development. The World Bank, Washington, DC.

Toni, F., and L. Velho. 1996. A presença Francesa no Instituto Nacional de Pesquisas da Amazônia – INPA. Interciencia 21: 25–30.

United Nations Development Programme. 2005. The human development report. http://hdr.undp.org/.

United Nations Statistics Division. 2005. National accounts main aggregates database. http://unstats.un.org/unsd/snaama/selectionbasicFast.asp.

U.S. Census Bureau. 2005. http://www.census.gov/ipc/www/idbrank.html.

Wemmer, C., R. Rudran, F. Dallmeier, and D. E. Wilson. 1993. Training developing-country nationals is the critical ingredient to conserving global biodiversity. BioScience 43: 762–767.

Whitmore, T. C. 1998. An introduction to tropical rain forests. Oxford University Press, Oxford, UK.

Wishart, M. J., and B. R. Davies. 1998. The increasing divide between First and Third Worlds: Science, collaboration and conservation of Third World aquatic ecosystems. Freshwater Biol. 39: 557–567.