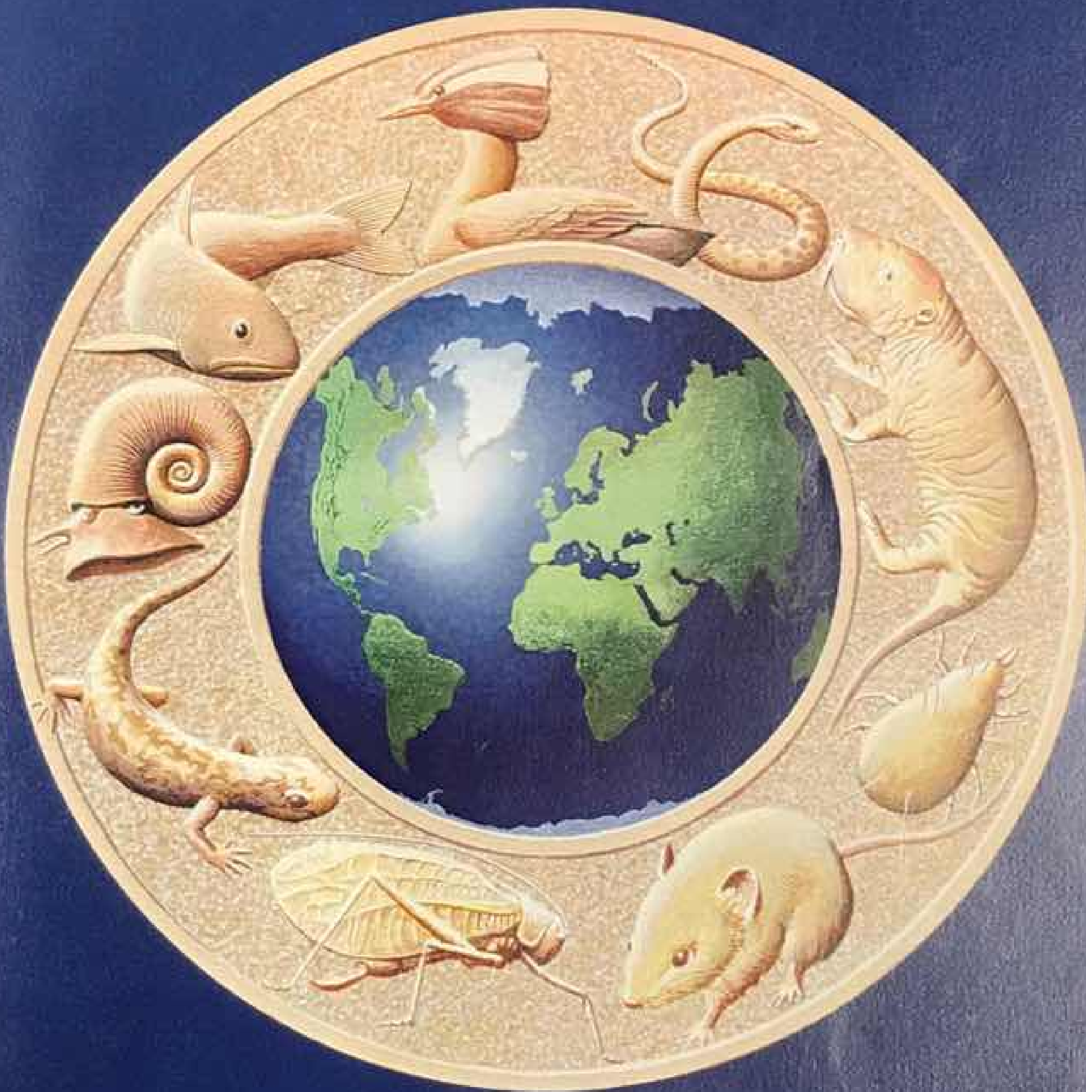
# The University of Michigan Museum of Zoology



## SPECIAL REPORT TO DEAN EDIE N. GOLDENBERG

4 June 1997

Richard D. Alexander, Director

Third Printing

*All observation must be for or against some view if it is to be of any service.*

-- Charles R. Darwin

# MUSEUM OF ZOOLOGY

COLLEGE OF LITERATURE, SCIENCE, AND THE ARTS
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4 June 1997

Dean Edie N. Goldenberg
LS&A College

Dear Edie:

This is my sixth report to you, and my third Special Report; it will be followed by my fourth Annual Report. I have compiled this special report because of my uneasiness about evidence that you have set a goal of reducing by some unknown quantity the number of curators in the Museum of Zoology (UMMZ), and therefore of diminishing and perhaps effectively destroying the nature and quality of the unit, and especially its administrative relationship with the Department of Biology. If this rumor is correct, I seek to change your mind by providing more and better information than has been available to you. Although this report concerns only the UMMZ, I believe quite strongly that the four research museums of the LS&A College are all centers of excellence that help make the University of Michigan distinctive and superior in both teaching and research in zoology, botany, anthropology, and paleontology. I am aware that there are people at Michigan who disagree. With regard to the UMMZ, I present this report to show that they are wrong.

To provide you with the necessary facts I am forced here to make comparisons between the Museum of Zoology faculty, half-time in the Department of Biology, and the full-time faculty in the Department of Biology. For obvious reasons I don't like to do that, and I apologize to anyone who may be affected negatively. But it seems to me indisputable that the current situation arose partly because others have made such comparisons to you. When inaccurate information seems to lie behind decisions that promise to affect the UMMZ negatively, then I see it as my duty to set the record straight. I have done my very best here to raise and consider every possible topic that might have influenced your decision, and your general attitude toward the UMMZ. Please tell me if there is any topic I have not considered that you think is relevant. If, after examining this report, you remain unconvinced, I am prepared to invest a great deal more effort, for example to provide for you a mass of opinions from alumni and others who can describe and evaluate the unique contributions of the Museum of Zoology to modern teaching and research in biology.

I have previously presented data on these issues in five different reports across the past four years (Appendix, p. 8, General Sources). Here I present, for the first time, data on the distribution of teaching, curating, and research effort that has been gathered under my supervision, and interpreted by me. I think these data demonstrate that the UMMZ is a substantial and, I daresay, elite unit *in all regards*. These data support my contention that the UMMZ has a particular importance to the whole of biology at Michigan, perhaps more so than any other academically connected biological research museum in the world to biology at its university. What applies to other museums, I therefore suggest, does not necessarily apply to us; biology at Michigan is unique, and uniquely outstanding, and the UMMZ itself is quite strong, not weak in any regard.

Unfortunately, and ironically for this issue, the teaching contribution of the UMMZ is not only a good part of what makes it unique, but also the reason you are unlikely to have obtained accurate opinions about the UMMZ's overall contributions from people associated with other biology research museums of the United States, whether their museums are university-connected or not. Thus, museum people are inclined to judge research museums by their perception of output in systematic research, often defined too narrowly to apply in our kind of academic setting, rather than by their teaching success and its general role in evolutionary biology. In this I include the museums you rank at the top of our "peers," Harvard and Berkeley: I do not believe they have competed seriously with evolutionary biology at Michigan in the teaching excellence that I document here. Also, as I have noted (1994 Special Report), only 25% of UMMZ graduate students become professional systematists; the other 75% work in related (and broadly significant) fields of evolutionary biology (for example, see later, research questions and illustrative publications of UMMZ faculty and former graduate students). The reason this situation is ironic is that you, as LS&A Dean, have repeatedly expressed your desire to improve teaching, yet the extent and quality of the UMMZ's teaching contributions, perhaps more than anything else, makes us unique among biology research museums. That this particular uniqueness occurs in a museum is because the underlying broad research topics are inexorably linked to the research collections that form a functional link and represent the intellectual common ground among all the biology research museums of the world. The quality and topical nature of the teaching that we do cannot be separated from the Museum of Zoology as a functional unit, just as our research cannot.

Because I see as potentially harmful any actions that might destroy the administrative relationship between the Museum of Zoology and the Department of Biology, which the data I review show has been remarkably successful for 41 years, I respectfully request that you compare the facts and numbers given here with any information or advice given to you by anyone else. I also hope that you will tell me, so far as you are willing or able, your impressions from this report, and your current thoughts about the future of the Museum of Zoology, so that I can continue to add to your knowledge on this topic. If, in the face of the data in this and my other reports taken together, you still find good reason for pursuing the course identified to me as representing your intent, then please tell me the reason(s) and allow me a chance to respond. Surely this is the best way to arrive at good decisions. Please know that I am willing to work extremely hard to inform you on any issue regarding the UMMZ, and to answer any questions you may have about the facts and arguments in this and my other reports. If necessary, I am prepared to document a widespread opinion, around the country and the world, as to the excellence of the UMMZ, and supporting the contention that it is to some large extent responsible for biology at Michigan consistently being ranked high nationally, in both teaching and research.

At the request of several biology faculty at a recent departmental retreat, I have sent copies of this report to the biology faculty, and to some other people that I think may be interested. I enclose 15 copies for your use. Additional copies are available. For easy referencing, I have attached to your copy all of the five other reports I have sent you since I became director.

Sincerely,

Richard D. Alexander

Richard D. Alexander, Director, Curator of Insects, and
Theodore H. Hubbell Distinguished University Professor of Evolutionary Biology

"In regard to the serious business of curating, over the past year I collected, and/or supervised the collecting of 6,354 specimens of amphibians, reptiles (and a few small mammals) in Madagascar, preserved them, wrote down detailed ecological and life history notes, recorded their localities with the use of a satellite global positioning device, photographed many to preserve color data, preserved tissue samples separately for molecular studies, wrapped specimens carefully in cheese cloth so that ectoparasites were meaningfully saved, recorded vocalizations with a tape recorder, fought hard for accords with the Malagasy government to obtain permission to do research in Madagascar and to get export permits, cleared the specimens through Fish and Wildlife at the U. S. port of entry, and supervised cataloguing the specimens into our collection. . . . A nearly equal number of specimens were collected and catalogued into the collections at the University of Antananarivo in Madagascar. The latter is my host institution in Madagascar, and our accord requires a 50:50 division of specimens collected by me and members of my research program. The collection in Antananarivo was established by me and [my postdoctoral associate] Christopher Raxworthy [more recently an assistant professor at Columbia University] and is now considered to be the National Museum of Natural History for the Republic of Madagascar. To date, there are about 15,000 specimens in the Madagascar Museum, most originating from my program funded by three successive NSF grants, a grant from the National Geographic Society, and several other grants from conservation agencies and intramural sources.

"I spent considerable time training graduate students and professors in Madagascar in the art of museum techniques, and we have contributed a computer to their museum, which allows them to manage their collection databases in the same manner that we do here in the Division of Amphibians and Reptiles. In addition, we now have two full-time Malagasy Ph.D. students in my research program and three others who just started working with us. These students are being trained in field biology and systematics."

— excerpt from Ronald A. Nussbaum's
1997 Report on Curating

# SPECIAL REPORT

## Contents



*Third printing, 1 July 1997*

# SPECIAL REPORT

## TEACHING, RESEARCH, AND CURATING EFFORT IN THE MUSEUM OF ZOOLOGY

### Summary

The data in this report: (1) indicate that Museum of Zoology curators make up a potent and perhaps irreplaceable unit in teaching, research, and curating; (2) suggest that to reduce or destroy the Museum of Zoology would take away one of the distinguished aspects of biology at Michigan and reduce dramatically the quality of biology here; and (3) challenge, therefore, the notion that there are legitimate reasons for interfering with the long-term and obviously effective administrative arrangement between the Museum of Zoology and the Department of Biology. An alternative is suggested: that weak units within Biology be strengthened by replacing positions lost from the Department of Biology in the last 25 years rather than by weakening one of biology's strongest units in such an effort.

### Teaching Effort of UMMZ Curators

In my 1994 Special Report I reported on quantity, quality, and breadth of teaching by UMMZ curators, using primarily figures compiled by others. That report was, in my opinion, quite favorable to UMMZ curators. The current report, however, the first one compiled under my supervision, is more detailed and accurate. It is also considerably more favorable to the UMMZ curators, indicating that, *despite their half-time teaching appointments, the UMMZ curators actually teach approximately as much as do full-time Department of Biology faculty.*

The 13 UMMZ curators teach in a broad array of different courses ranging from team-taught introductory biology to large individually taught undergraduate courses and graduate courses and seminars on a variety of topics (1994 Special Report, p. 32). On average, they evidently also teach approximately as much as do the full-time members of the Department of Biology -- in actual terms, not as weighted by their half-time appointments in the Department of Biology (Tables 1, 2, this report). The evidence is as follows:

*Formal Courses:* By two different measures, UMMZ curators teach almost 80% as much in formal courses taken primarily by undergraduates as do full-time Department of Biology faculty. Only 4 of the 36 full-time members of the Department of Biology (or 7, depending on method of calculation) teach more than the curator with the greatest teaching effort. Two full-time professors in the Department of Biology (or 5) teach less in biology than the UMMZ curator who teaches the least (again, ignoring the half-time teaching appointments of curators). One of these was department chair during the period analyzed, and the other teaches significantly outside biology; the curator, Ronald Nussbaum, however, also administers the Edwin S. George Reserve (see Tables 1, 2).

The methods of calculation employed here do not take into account numbers of courses. This omission probably discriminates against curators, because more effort is typically required to teach multiple courses under, say, 100 students, than is required to teach a single course above 100, particularly when administrative assistance is involved in the latter, as is usually true in biology.

*Individual Experiences for Undergraduates:* Curators tutor and interact individually with significant numbers of undergraduate students. This year there are approximately 50 undergraduate students in employment, honors theses, NSF Research Experiences for Undergraduates, and individual courses centered in the UMMZ (3.9 per curator); of these, 25 are additional to those included in the above quantitative judgment of more formal classroom teaching. Included are eight students in the National Science Foundation program, Research Experience for Undergraduates, one each with Barry OConnor and Priscilla Tucker, and five in a program in bioinformatics with William Fink. Involved is approximately $60,000 in NSF REU grants. Equivalent associations with undergraduates in the Department of Biology would require that 150 undergraduates be involved with the 36 full-time faculty, including 21 undergraduates in the NSF REU Program.

Biology 108, Animal Diversity, is a significant undergraduate teaching contribution by UMMZ curators involving considerable individual attention. It is organized and supervised by Curator Phil Myers and lectured by him and a team of UMMZ curators. This course involves an expanding "Animal Diversity" Web Site that provides information to 1000-1500 people per day from around the world, and is used by at least four U-M classes (http://www.oit.itd.umich.edu/projects/ADW). This course has been discussed in the *LS&A Magazine* and the *ITD Information Technology Digest* as an example of innovative use of technology in teaching. It has also received national attention in the *Chronicle of Higher Education* and through listing in several indices of useful natural history/biology resources.

*Field Experience:* Because of the nature and locations of their research, the UMMZ faculty -- more than those of any other unit in biology except the rest of the faculty in Ecology, Evolution, and Organismic Biology -- also tutor students in the field in many parts of the world (Maps 1, 2). Not incidentally, the UMMZ also supports financially and otherwise the work of approximately 13 graduate students on the Edwin S. George Reserve. From endowments, bequests, faculty contributions, and general operating funds, the UMMZ invests overall more than $50,000 per year in the thesis research of biology doctoral students (1996 Annual Report).

*Doctoral Committees:* On average, the UMMZ curators chair the committees of 1.7 doctoral students (2.1 if students from other units than biology are included), or approximately twice as many per faculty member as do the other full- and half-time members of the Department of Biology (Appendix, Footnote 1, p. 9). The 13 curators also train seven graduate students each year in systematic and curatorial activities, through the service of graduate students as UMMZ divisional assistants; this activity raises the curators' instructional contact with doctoral students by virtually an additional doctoral student for every two curators. During the past ten years, curators have chaired the committees of 75% more doctoral students than other biology faculty. Currently, the curators serve on 84 doctoral committees, for an average of 6.5 doctoral committees, including those chaired (see also, Appendix, Footnotes 1-3).

*Teaching of Graduates:* I feel as though someone has to remind people in LS&A administration continually that an outstanding feature of the University of Michigan has always been its unusually large and high quality body of graduate students. These people are trained by all of us to become the academicians, the undergraduate and graduate teachers of the next generations, all over this country and the world. The number and quality of graduate students make up perhaps the single most important feature causing the University of Michigan to be a great teaching and research institution. The UMMZ has always been outstanding in guiding doctoral students, graduating an extraordinarily high proportion of its doctoral students (Table 4) and placing them in first-rate academic positions across the United States and in many other parts of the world (Map 3; see also, 1994 Special Report, pp. 41-42).

Everyone who has ever served on the admissions committee that judges applicants for graduate work in biology at Michigan knows that across the past several decades more good students have consistently found the Museum of Zoology faculty attractive than is true for any other unit in biology. According to Department of Biology records, during approximately the past ten years only 21% of doctoral students who selected a UMMZ curator as chair or mentor have subsequently dropped out (Table 4). The corresponding figure for full-time members of the Department of Biology faculty is 34% (62% higher than for the UMMZ ). Map 3 shows where students with committees chaired by UMMZ curators have been hired in academic positions (see also, 1994 Special Report: Careers of UMMZ Graduates, p. 41). I suspect that no unit comparable in size to the UMMZ anywhere in the world supplies as many academic personnel to top-ranked universities and colleges. *Why should first-rate graduate students favor the UMMZ and first-rate institutions choose UMMZ graduates unless the curators are doing modern and highly significant teaching and research?*

I realize that no clear way has been developed for judging the "amount" of teaching involved in those particular activities above that are additional to formal courses taught primarily to undergraduates (for our effort to quantify them, see Table 3). It is surely folly, however, to suggest from this that they are unimportant or should be ignored in judging teaching (see also, Appendix, Footnotes 4-7). Thus, regardless of the amount one allows for teaching efforts involving doctoral students, undergraduate teaching by curators and the association of each curator, on average, with four undergraduates per year individually, alone make the UMMZ curators' informal contributions to undergraduates highly significant.

Despite their half-time teaching appointments, the current UMMZ curators have also received approximately one U-M teaching award for every two curators, an enviable record for any unit (1994 Special Report, p. 17).

(The 1994 Special Report, and Appendix Footnotes 1-8 of this report, further document and explain the teaching figures given here).

**Research Effort of UMMZ Curators**

Based on external judgments of research contributions, the UMMZ curators are as a unit unmatched in quantity and quality among biologists at Michigan. In recent years they have received over 150 significant awards and honors, including major prizes in the U.S. and the world, a dozen society presidencies, and 10 full editorships of scientific journals and periodicals (details in the 1994 Special Report, p. 38). Within the University of Michigan, most of the awards available for either teaching or research have been received by one or another UMMZ curator.

As demonstrated in this report, current UMMZ curators and their students have published on an extraordinarily -- I believe, uniquely -- broad array of topics important to all of biology: mites to humans, genes to culture, parasites to mutualists, sexuality to eusociality, ontogenies, phylogenies, and philosophy (e.g., see pp. 11-18). I can also document this breadth by bringing for your inspection sets of books and papers illustrating efforts relevant to the research questions of UMMZ curators. I will provide as many sets as you would like to see from the 163 books published by current curators and their former students.

Recent press has suggested that biologists who study taxonomic groups, behavior, life histories, evolution, and systematics do not have as many published "titles" as do biologists in other fields, particularly molecular biology. *This is not true at Michigan.* Comparing publications of the current UMMZ curators with those of other biologists at Michigan across a five-year period (1991-1996: Table 5, 6) shows that, when multiple authorship is taken into account, UMMZ curators have averaged 11% more titles and 37% more pages in scientific publications than their counterparts who are full-time in the Department of Biology. Current curators and active emeritus curators have across their lifetimes published collectively over 2000 titles, involving over 43,000 pages, and including 76 books and monographs (see also, Appendix, Footnote 8). Such quantitative facts may seem trivial as estimates of valuable productivity, but they take on special significance when placed in the context of the large number of research awards and other recognition UMMZ curators have received, the quality and numbers of their doctoral students, and the large amount of curating and teaching they do. (Note: there is no intent here to deprecate the significance of cooperative research, but it is surely a fact that, on average, in this particular trivial method of judging research effort, each author cannot derive as much credit from a multi-authored paper as from a single-authored one.)

Across the last 35 years, UMMZ curators have brought in over 15 million dollars in research grants. The present curators have received externally funded grants totaling over $8,000,000, and they currently operate with grants of approximately $2,600,000. Despite this evidence of success, the publication record suggests that the UMMZ curators accomplish more outstanding research on less money than any other unit in biology. In any world but one overwhelmed with cynicism and greed, it is difficult for me to believe that a great university that operates on public monies, during a time when nearly every level of government is threatened with financial disaster, would not regard this as a desirable goal.

## Curating Effort of UMMZ Curators

### Collections and Biological Diversity

The UMMZ collections are a huge, complex, and irreplaceable resource for biological research, and its vouchering, central to all systematic, evolutionary, and comparative investigations. Included are more than 15 million specimens, used each year by 1000 visiting investigators, with 60,000 specimens sent on loan for research use to more than 1000 investigators at other institutions. Curators add approximately 10,000 specimens and lots (groups of specimens) each year (1994 Special Report, pp. 12, 40; 1996 Special Report on Curating).

The UMMZ collections reflect a total biota of 15-50 million estimated species, each species including up to billions of individuals that vary spatially and temporally, and reflect in their genotypes and phenotypes climatic changes and a variety of human-induced environmental changes. The study of species and their formation, variations within and among species, and changes across time, all reflect the central usefulness of the collections (see Research Questions of Curators below).

Each academic subject has its own special features. Nevertheless, no other teaching or research topic of any kind has to deal with a diversity and complexity even remotely comparable to that of biology (1994 Special Report, p. 8). This is the reason why museums, collections, and systematic and evolutionary research are needed more in biology than in any other field, and why their value necessarily must increase indefinitely. It is also the main determinant of the minimal effective sizes of such units. There is an almost universal opinion among scientists that we will endanger increasingly the actual existence of life on earth unless we increase our efforts to understand the entire biota.

### Nature of Curators' Research and Curating

(See also, 1994 Special Report, and Topics and Questions in Curators' Research)

Curators are primarily systematists, and evolutionary and comparative biologists. They divide their research time among preserved collections of many sorts, indoor laboratories of the classical kind, living animal laboratories, and field research sites. Their experiments are most likely conducted in the field on natural populations. Current curators and curators emeritus, for example, have worked not only in the museum but also in 231 field sites around the globe (Map 1 sites are restricted to those from which publication has occurred or is expected soon, and/or from which significant additions to the research collections have been made). Current doctoral students of curators and emeritus curators have worked in 64 field sites (Map 2).

Field work is invariably a part of curating, as it is the only means by which the collections grow and improve. Every curator works part-time for the collections, and for all of biology, both when he or she is in the field and when in the museum. Collections are an integral component of nearly all research of UMMZ curators, and are used continually by curators and other biologists in both their research and their teaching.

Curating is a special activity of museums because the research done by curators is special; nevertheless, the facts I present here and elsewhere (especially the 1996 Special Report on Curating) show that curating is thoroughly integrated with all of the intellectual and academic activities of curator-professors. Supposing that collections could be administered by collection managers without curators is like supposing that college administrative offices could be managed by administrative assistants without deans; when this kind of change is instituted, the special kind of academic excellence that characterizes the UMMZ, and which I have been documenting here, simply disappears.

Amount of Curating Effort

With respect to their contracts the UMMZ curators are technically half-time curators during one term or one-fourth time curators during the entire year. Concern has been expressed about the proportion of overall effort exerted in curating in research museums in the LS&A College because it is interpreted as alternative to teaching. Figures given earlier in this report counter this argument effectively: how can UMMZ curators excel in both teaching and research if low level curating activities are devouring time valuable to those enterprises? To me such an argument about curating is as imperfect as the view, held by some, that research is adequately understood as alternative to teaching, or time taken away from it. It is impossible to separate good research and good teaching in the first-rate university, and it is impossible to separate growth, improvement, care, and world-wide use of collections from research and teaching in the first-rate, university-associated research museum that includes broad studies in comparative and evolutionary biology (1994 Special Report; 1996 Special Report on Curating).

With regard to distribution of effort in the lives of UMMZ curators, the data I have presented and referenced above show that curators do a minimum of 80% as much formal classroom teaching as full-time Department of Biology faculty, and overall approximately the same amount. If we consider only their 80% as much formal classroom teaching as full-time Biology faculty, then if they also exert at least 50% effort in research (strongly supported by all the data on their productivity and the quality of their research), they are using only 10% of their yearly effort in curating *that can reasonably be seen as separate from teaching and research efforts*. This amounts to 48 minutes per day, a remarkable testimony to efficiency when one considers the size, activity, and excellence of the UMMZ research collections. If, on the other hand, my argument above that curators actually teach about as much as full-time biology faculty is correct, we can only conclude, as I have already suggested, that their curating effort is integrated almost entirely as aspects of their teaching and research. To me, this is a reasonable conclusion (see also, 1996 Special Report on Curating), although some of my fellow curators would surely protest (as with other faculty, individual curators do not all march to the same drummer). In other words, it is true except to the extent that the overall academic effort of curators is exceptionally high. If the academic effort of curators is indeed high, then we have to ask why: I contend that it is because of the administrative and academic arrangements that I am here suggesting should not be disturbed.

(Note: it is not trivial that the above implication can be turned on its head: Observing the overall excellence of the UMMZ collections, their extensive and continuous use by investigators here and elsewhere, and their carefully managed growth and improvement in biologically valuable specimens, one might reasonably infer that curating in all its aspects actually does occupy the 50% of curators' time that their contracts specify. One must then conclude, again, that curating is potently synergistic with both teaching and research, in the curators' particular topics, *because curators excel at all three of these endeavors*.)

I submit that there is every reason for believing that curating effort contributes to the overall academic effort of faculty and students associated with the UMMZ. It follows that curating is in no way trivial, nonacademic, or superfluous in the pursuit of excellence in evolutionary biology. In view of the productivity of curators in *every* aspect of their academic lives, curating is an activity that deserves no interference (see also, Appendix, Footnote 9).

## APPENDIX TO REPORT ON EFFORT
## SOURCES AND NOTES

Data used in the current report were compiled at my request and under my supervision by Deborah Ciszek and Andrew F. Richards. Data on teaching of formal classes come from the CRAS database, and were provided by the Office of Academic Planning and Analysis. Numbers of publications were compiled from seven library databases as listed in Table 5. Graduate student candidacy status and attrition rates were obtained from the graduate coordinator in the Department of Biology office. All other information was provided by the faculty and staff of the UMMZ.

The teaching and research figures presented here are surely not complete, because information regarding the UMMZ has been easier for us to acquire and verify than information for the entire biological enterprise at Michigan. Even though we made special efforts to eliminate bias (e.g., using library databases for publications rather than relying upon curators' *curricula vitae*), and are aware of no errors, we have deleted names of full-time Department of Biology faculty in comparisons of effort partly because they cannot be verified without talking to each individual, and partly because the goal here is not to publicize distributions of effort by individuals full-time in the Department but to verify the amount and distribution of effort for UMMZ curators. The comparisons made I believe to be solid. They can require slight adjustment, here and there, and still show that no one can legitimately disparage the contributions and role of the Museum of Zoology in accounting for excellence in biology at Michigan. They demonstrate that it is inadequate to conclude that recent highly publicized trends in other universities with respect to research museums are appropriate guides for the future of biology at Michigan. I personally believe this to be true as well for the other research museums in LS&A.

### General Sources

October 1994: RDA's Special Report to the Dean

May 1994: RDA's Annual Report to the Dean

May 1995: RDA's Annual Report to the Dean

May 1996: RDA's Annual Report to the Dean

May 1996: RDA's Special Report on Curating to the Dean and the College Executive Committee

(for copies call 313-764-0476)

**Footnotes**

1. The 13 UMMZ curators currently chair the committees of 26.5 doctoral students who have achieved candidacy, averaging 2.04 per curator (one candidate has one UMMZ co-chair and one full-time departmental co-chair). Of the 26.5, four are students in the School of Natural Resources and one is in the Department of Geology; 21.5 are in Biology (1.65 per curator). In addition, one emeritus curator chairs one doctoral committee in Biology. The Department of Biology currently has enrolled 101 doctoral students, of which 64 have qualified for candidacy. This means that 36 full-time and 10 half-time biology professors other than UMMZ curators chair 41.5 Biology committees, an average of 0.90 doctoral committees each, or 54% of the figure for UMMZ curators chairing Biology committees. Thus, UMMZ curators currently chair the committees of doctoral candidates in Biology at almost twice the rate of full-time and other half-time professors in the Biology Department. These figures may be biased against UMMZ curators because, as with UMMZ curators functional in other units, several listed biology professors have only unsalaried appointments in Biology yet may chair doctoral committees there; thus, their students will be included here but they will not.

Full-time Biology Department faculty are taken to be those faculty members who had a full-time teaching appointment in the Biology Department for at least one of the terms they were present during the five regular terms from Fall 1994 through Fall 1996. There were 36 such faculty members; 29 were present all five terms (Table 2). Half-time Biology Department faculty are taken to be those faculty members who had a half-time (and never full-time) teaching appointment in the Biology Department for at least one of the terms they were present during the five regular terms from Fall 1994 through Fall 1996. There were 10 such faculty members.

2. In the past 28 years UMMZ curators have chaired the committees of 185 doctoral students. Of these, 166 (90%) are currently in biological positions, 7 in nonacademic positions. Of the 185, 148 worked under a current curator or active emeritus curator (for 1969-1994, see 1994 Special Report).

3. Current academic locations of former doctoral students with committees chaired by current and active emeritus curators include 17 different countries and 35 states in the United States (Map 3).

4. For primarily undergraduate teaching in formal courses we used the recent period: Fall 1994 through Fall 1996 (five Fall and Winter terms and two Spring and Summer terms).

5. Not counted in Tables 1 and 2 are guest lectures, unregistered students in formal seminars and classes, and time spent with GSIs, in laboratories and collection ranges, and in unofficial regular weekly discussions (Table 3). This collection of items is difficult to quantify, but, partly because of the large number of undergraduates and doctoral students in the UMMZ (see below), and the frequency of unofficial graduate student seminars there, it is reasonable to suspect that the numbers would be relatively high for UMMZ curators. Doctoral student seminars

are often unofficial, or include significant numbers of unregistered doctoral students, because the Graduate School allows only one course to be taken per term once candidacy has been achieved (without paying additional tuition).

6. New faculty often are given one term free of teaching (that is, they teach half-time the first year). Involved are two UMMZ curators (15%) and four full-time Biology faculty (11%). Teaching figures for these faculty reflect even more favorably on UMMZ faculty teaching effort. During the period analyzed, new UMMZ faculty taught an average of 167.8 "units" per term; new full-time Biology faculty only 53.8. *Thus, new UMMZ curators taught 312% more than new full-time people in the Department of Biology.*

7. The teaching effort of UMMZ curators would undoubtedly be larger if the Department of Biology were able to provide space, laboratory equipment, and GSIs for full enrollments in courses such as herpetology, mammalogy, and systematics. My own course in evolution and human behavior was closed and re-opened several times in the fall of 1996 during a series of discussions between me and the associate chair for curriculum about GSIs. I have to believe that this situation accounted for an enrollment lowered by approximately 65 students from the previous presentation of the course. The situation presumably occurred because the associate chair could not muster the required GSIs to keep the course continuously open during registration. I strongly suspect that a bias against what some people in the department of biology term "specialty" courses has also influenced the ability of UMMZ curators to teach courses in their own fields. It is difficult to understand how a course that deals with the entire array of life features special to a group of thousands or hundreds of thousands of species should be termed "specialty" in comparison with courses restricted to particular aspects of physiology or morphology exemplified by one or a few species. Any sizeable group of organisms illustrates all of the general principles of biology. As argued here, and in the 1994 Special Report (pp. 8-9), the two sets of "specialty" courses taught by UMMZ curators and other biology professors, respectively, represent complementary approaches to understanding life which are both essential: *this complementarity of teaching and research is really the issue addressed in the current document.*

Despite the half-time appointments of curators in the Department of Biology, if all of the kinds of problems just described could be solved, I believe that the UMMZ curators' average teaching, without any other changes, would exceed that of full-time department members.

8. For example, in 1996-7, curators published or put into press 70 titles.

9. In the 1996 Special Report on Curating, I suggested that the relationship among the different kinds of effort typical of academic individuals is somewhat elastic, so that if there is a reason for one kind to become temporarily reduced, or more crucial, the result is not a lessening of overall effort. Rather, the slack is taken up in another kind of effort. The fact that the UMMZ curators have been teaching approximately twice as much as their contracts specify is evidence of this accommodation.

## TOPICS AND QUESTIONS IN CURATORS' RESEARCH

UMMZ curators are systematists, comparative biologists, behavioral ecologists, ecological and evolutionary geneticists, and evolutionary biologists in general; as already noted, their students are 25% systematists and 75% all these other fields combined. Although such biologists are sometimes referred to as "traditional" biologists, this appellation applies legitimately only to the names of their fields. As the following summary of the research questions of current curators shows, the UMMZ's version of "traditional" biology is up-to-date in every respect, including questions asked, and techniques and methods. Progress in the following research areas provides the problems for every other kind of biologist, and, in the part of this process that is synthesis, utilizes all of the findings of all biologists. Many of the publications in the following lists are first-ranked world classics.

### Research Questions of Current and Emeritus Curators

The following list is RDA's interpretation and melding of a much longer list of research questions indicated by curators as characterizing their personal work. Although only a sample is provided, every major question and every curator is represented. I provide illustrative publications to demonstrate that curators engage questions of broad significance in biology, and that the research questions listed are indeed engaged by the UMMZ curators. I am also willing to provide for your inspection a set of books and papers by UMMZ curators or their students dealing with all of these questions.

1. Philosophy, Logic, and Science: What are the sources of information available to humans about the living and non living universe? How are probabilities established so that comparisons can be made? What is the relationship between reductionism and generality?

*Example Publications*

Fink, W. L. 1982. The conceptual relationship between ontogeny and phylogeny. *Paleobiology* 8:254-264.

Smith, G. R. 1990. Homology in morphometrics and phylogenetics. In: F. J. Rohlf and F. L. Bookstein (eds). *Proceedings of the Michigan Morphometrics Workshop. Univ. Mich. Mus. Zool. Special Publ.* 2: 325-338.

Kluge, A. (in press). Testability and the refutation and corroboration of cladistic hypotheses. *Cladistics*

2. Evolutionary Novelties: How have novelties come about during evolution? What are the backgrounds of changes in development (ontogeny), as in body shape or other aspects of morphology, and how important are they in understanding life? How do scientists analyze unique phenomena?

*Example Publications*

Bookstein, F. L., B. Chernoff, R. L. Elder, J. M. Humphries, G. R. Smith, and R. E. Strauss. 1985. Morphometrics in evolutionary biology. The geometry of size and shape change with examples from fishes. *Phila. Acad. Nat. Sci. Spec. Publ.* 15: 277 p.

Rohlf, F. J. and F. L. Bookstein (eds). 1990. *Proceedings of the Michigan Morphometrics Workshop. Univ. Mich. Mus. Zool. Special Publ.* 2: viii + 380 pp.

Kluge, A. G. 1990. Species as historical individuals. *Biology and Philosophy* 5:417-431.

Zelditch, M. L. and W. L. Fink. 1996. Heterochrony and heterotropy: stability and innovation in the evolution of form. *Paleobiology* 22:241-254.

Fink, W. L. and M. L. Zelditch. 1996. Historical patterns of developmental integration in piranhas. *American Zoologist* 36:61-69.

3. Species Formation: What are all the different ways species multiply? To what extent do correlates such as geographic separation, various kinds of life history changes, host shifts, disruptive selection, hybridization, and mate choice influence rates and likelihoods of speciation?

*Example Publications:*

Otte, D. and J. A. Endler (eds). 1989. *Speciation and Its Consequences.* Sunderland, Mass.: Sinauer Assoc. Inc. xiii + 679 pp.

Smith, G. R. 1992. Introgression in fishes: significance for paleontology, cladistics, and evolutionary rates. *Systematic Biology* 41:41-57.

Smith, G. R. and T. N. Todd. 1984. Evolution of species flocks in north temperate lakes. In: A. A. Echelle and I. Kornfield (eds). *Evolution of Fish Species Flocks.* University of Maine: Orono Press, pp. 45-68.

Patton, J. L., P. Myers, and M. F. Smith. 1990. Vicariant versus gradient models of diversification: the small mammal fauna of eastern Andean slopes of Peru. In: G. Peters and R. Huttered (eds). *Vertebrates in the Tropics.* Bonn: Museum Alexander Koenig. pp. 355-371.

Tucker, P. K., R. D. Sage, J. H. Warner, A. C. Wilson, and E. M. Eicher. 1992. Abrupt cline for sex chromosomes in a hybrid zone between two species of mice. *Evolution* 46:1146-1163.

Payne, R. B. and L. L. Payne. 1994. Song mimicry and species status of the indigobirds *Vidua*: associations with quail finch *Ortgospiza atricollis,* goldbreast *Amandava subflava* and brown twinspot *Clytospiza monteiri. Ibis* 136:291-304.

Smith, G. R., J. Rosenfield, and J. Porterfield. 1995. Processes of origin and criteria for preservation of fish species. In: J. L. Nielsen (ed). *Evolution of the Aquatic Ecosystem. Defining Unique Units in Population Conservation. American Fisheries Society Special Publ.* 17:44-57.

4. Species Monographs: Efforts to understand in evolutionary terms all of the traits of a species, including the life course and pattern, are invaluable to biological investigators of all kinds.

*Example Publications:*

Hoogland, J. L. 1995. *The Black-Tailed Prairie Dog.* Univ. Chicago Press. xiv + 557 pp.

Sherman, P. W., J. U. M. Jarvis, and R. D. Alexander (eds). 1991. *The Biology of the Naked Mole Rat*. Princeton, N. J.: Princeton U. Press. xvi + 518 pp.

Alexander, R. D. 1996. *Understanding Humanity. The Human Species in Evolutionary Perspective.* Ann Arbor, Mich. xviii + 732 pp. (Text Printed for Biology 494).

Payne, R. B. 1992. Indigo bunting. In: A. Poole, P. Stettenheim, and F. Gill (eds). *The Birds of North America*. Amer. Ornith. Union, pp. 1-24.

5. Systematic Monographs, Faunal Studies and other Analyses of Animal Groups: How many mites (cicadas, crickets, katydids, fishes, salamanders, lizards, bats, piranhas, snails, clams, birds, butterflies, dragonflies . . .) are there in the world? What are they all like? How do they live? How did they evolve? What can be done with them? How are their futures and ours intertwined?

*Example Publications:*

Nussbaum, R. A. E. D. Brodie, and R. M. Storm. 1983. *Amphibians and Reptiles of the Pacific Northwest.* Moscow, Idaho: Univ. of Idaho Press. 332 pp.

Burch, J. B. 1989. *North American Freshwater Snails*. Hamburg, Michigan: Malacological Publications. viii + 365 pp.

Robins, C. R., R. M. Bailey, Carl E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, and W. B. Scott. 1991. *World Fishes Important to North Americans.* Bethesda, Md.: American Fisheries Society. viii + 243 pp.

Otte D. and R. D. Alexander. 1983. *The Australian Crickets (Orthoptera: Gryllidae).* Phila. Penn.: Acad. Nat. Sci. Phila. Monograph 22: 447 pp. (376 new species, 36 new genera).

Huber, F., T. E. Moore, and W. E. Loher (eds). *Cricket Behavior and Neurobiology.* Ithaca, NY: Comstock Publ. Assoc. xiii + 564 pp.

Evans, H. E. and M. J. West-Eberhard. 1970. *The Wasps.* vi + 265 pp.

Connor, R. C. and D. M. Peterson. 1994. *The Lives of Whales and Dolphins*. NY: Henry Holt Co. xiii + 233 pp.

Myers, P. and R. M. Wetzel. 1983. Systematics and Zoogeography of the bats of the Chaco Boreal. *Univ. Mich. Mus. Zool. Miscell. Publ.* 165:59 pp.

Myers, P. 1977. Patterns of reproduction of four species of vespertilionid bats in Paraguay. *Univ. Calif. Publ. in Zool.* 107:41 pp.

Payne, R. B. 1982. Species limits in the indigobirds (Ploceidae, *Vidua*) of West Africa: mouth mimicry, song mimicry, and description of new species. *Univ. Mich. Mus. Zool. Miscell. Publ.* 162: 96 pp.

Alexander, R. D. and T. E. Moore. 1962. The evolutionary relationships of 17-year and 13-year cicadas, and three new species (Homoptera: Cicadidae, Magicicada). *Univ. Mich. Mus. Zool. Miscell. Publ.* 121:1-59.

6. Family Trees of Life: How can we detect the history of species, establish phylogenies of all life, develop the sequences of cladistic or speciation events that enable us to make the informed, controlled comparisons of features of modern organisms that are absolutely necessary if we are to understand living systems of major importance and how they came about?

*Example Publications*

Kluge, A. and S. J. Farris. 1969. Quantitative phyletics and the evolution of anurans. *Syst. Zool.* 18:1-32.

Fink, W. L. 1985. A phylogenetic analysis of the family Stomiidae (Teleosti, Stomiiformes). *Univ. Mich. Mus. Zool. Miscell. Publ.* 171:127, 127 pp., 70 figs.

Payne, R. B. and C. J. Risley. 1976. Systematics and evolutionary relationships among the herons (Ardeidae). *Univ. Mich. Mus. Zool. Miscell. Publ.* 150:115 pp.

Mindell, D. P. (ed). 1997. *Avian Molecular Evolution and Systematics*. NY: Academic Press, xx + 382 pp.

7. Parasitism and Mutualism: How do mites change from a parasitic to a non-parasitic existence? How is the parasite fauna of grebes related to their overall biology (ecology, morphology, diet, habitat, life history)? What are all of the different ways that individuals and species interact?

*Example Publications*

Connor, R. C. 1995. Benefits of mutualism: a conceptual framework. *Biol. Rev., Cambridge Philosophical Society* 70:427-457.

Payne, R. B. 1997. Avian brood parasitism. In: D. H. Clayton and J. Moore (eds). *Host-Parasite Evolution: General Principles and Avian Models.* Oxford: Oxford University Press, pp. 338-369.

OConnor, B. M. 1987. Host associations and coevolutionary relationships of astigmatid mite parasites of New World primates. I. Families Psoroptidae and Audycoptidae. *Fieldiana (Zoology) (n.s.)* 39:245-260.

OConnor, B. M. 1988. Coevolution in astigmatid mite-bee associations. In: G.R. Needham, R. E. Page, Jr., M. Delfinado-Baker and C. Bowman (eds). *Africanized Honey Bees and Bee Mites.* Chichester, England: Ellis-Horwood Ltd. pp. 339-346.

Storer, R. W. (ms.: in review). The metazoan parasites of grebes. *Univ. Mich. Mus. Zool. Miscell. Publ.* (320 ms. pp.).

<u>8. Animal Communication and Cultural Evolution</u>: How do insects (birds, frogs, mammals) communicate? How do bird song dialects come about? What is the role of culturally transmitted changes? How do parasitic birds acquire their species-specific behaviors? What patterns and timing of learning occur? To what extent is communication honest, and to what extent manipulative or dishonest? What, after all, are the actual functions of communication?

*Example Publications*

Payne, R. B. 1973. Behavior, Mimetic Songs and Song Dialects, and Relationships of the Parasitic Indigobirds (*Vidua*) of Africa. *American Ornithologists' Union Ornithological Monograph* 11:vi + 333 pp.

Payne, R. B. 1996. Song traditions in indigo buntings: origin, improvisation, dispersal, and extinction in cultural evolution. In: D. E. Kroodsma and E. H. Miller (eds). *Ecology and Evolution of Acoustic Communication in Birds.* Ithaca, NY: Cornell University Press, pp. 198-220.

Payne, R. B. and L. L. Payne. 1997. Field observations, experimental design, and the time and place of learning in bird songs. In: C. Snowdon and M. Hausberger (eds). *Social Influences on Vocal Development*. Cambridge: Cambridge University Press, pp. 57-84.

Otte, D. 1970. A Comparative Study of Communicative Behavior in Grasshoppers. *Univ. Mich. Mus. Zool. Miscell. Publ.* 141: 168 pp.

West-Eberhard, M. J. 1984. Sexual selection, competitive communication, and species-specific signals in insects. In: T. Lewis (ed). *Insect Communication.* NY: Academic Press, pp. 284-324.

Moore, T. E. 1993. Acoustic signals and speciation in cicadas (Insecta: Homoptera: Cicadidae). In: D. R. Lees and D. Edwards (eds). *Evolutionary Patterns and Processes.* London: Academic Press, pp. 269-284.

9. Sexual Selection: What are all the ways in which organisms interact sexually and parentally?

*Example Publications*

Thornhill, R. and J. Alcock. 1983. *The Evolution of Insect Mating Systems.* Cambridge, Mass.: Harvard Univ. Press. x + 547 pp.

West-Eberhard, M. J. 1983. Sexual selection, social competition, and speciation. *Quart. Rev. Biol.* 58: 155-183.

Alexander, R. D., D. C. Marshall, and J. Cooley. 1997. Evolutionary perspectives on insect mating. In: J. Choe and B. Crespi. (eds). *The Evolution of Mating Systems in Insects and Arachnids.* Cambridge: Cambridge University Press.

10. Social Systems: Why do organisms live in groups? How have the different forms of sociality evolved – e.g., eusociality (queen-worker forms), human nuclear families living (uniquely among mammals) in multi-male groups in which there is confidence of paternity and extensive paternal care? How are kin recognized? How is nepotism apportioned? What is an appropriate comprehensive arrangement of the different kinds of selection responsible for the attributes of life?

*Example Publications*

Alexander, R. D. and D. W. Tinkle (eds). 1981. *Natural Selection and Social Behavior: Recent Research and Theory*. NY: Chiron Press. xii + 532 pp.

West-Eberhard, M. J. 1975. The evolution of social behavior by kin selection. *Quart. Rev. Biol*. 50:1-33.

Payne, R. B. 1991. Natal dispersal and population structure in a migratory songbird, the indigo bunting. *Evolution* 45:49--62.

Payne, R. B., L. L. Payne, I. Rowley, and E. M. Russell. 1991. Social recognition and response to song in cooperative red-winged fairy-wrens. *Auk* 108:811-819.

11. Evolution of Sexual Systems. Given obvious costs of sexuality, why are most organisms sexual? Why do variations such as hermaphroditism and parthenogenesis arise and persist?

*Example Publications*

O'Foighil, D. and M. J. Smith. 1996. Phylogeography of an asexual marine clam complex, *Lasaea*, in the northeastern Pacific based on cytochrome oxidase III sequence variation. *Journal of Molecular Phylogeny and Evolution* 6:134-142.

O'Foighil, D. and M. J. Smith. 1995. Evolution of asexuality in the cosmopolitan marine clam *Lasaea*. *Evolution* 49:140-150.

Moran, N. A. 1997. The evolution of aphid life cycles. *Ann. Rev. Ent.* 37:321-348.

12. Evolutionary and Developmental Genetics: How do genes evolve? How are they selected to live harmoniously by the hundreds of thousands in genomes that give rise to organisms? Do non-recombining genes (as on the Y chromosome) evolve differently from recombining genes (as on the autosomes)?

*Example Publications*

Tucker, P. K. and B. L. Lundrigan. 1995. The nature of gene evolution on the mammalian Y chromosome: lessons from *Sry*. *Philosophical Transactions, Royal Society of London* 350:221-227.

Myers, P., B. L. Lundrigan, and P. K. Tucker. 1995. Molecular phylogenetics of oryzomyine rodents: the genus *Oligoryzomys*. *Molecular Phylogenetics and Evolution* 4:372-382.

Nachman, M. W. and P. Myers. 1989. Exceptional chromosomal mutations in a rodent population are not strongly underdominant. *Proc. Natl. Acad. Sci.* 86:6666-6670.

Norton, R. A., J. B. Kethley, D. E. Johnston, and B. M. OConnor. 1992. Phylogenetic perspective on genetic systems and reproductive modes of mites. In: D. L. Wrench and M. A. Ebbert (eds). *Evolution and Diversity of Sex Ratio in Insect and Mites*. NY: Chapman and Hall. pp. 8-99.

13. Forms of Selection: How can Darwin's classification of selection (as natural and sexual) be improved so as to untangle and specify all the modes of co-evolutionary selection in which both beneficial and detrimental effects can pass between members of the same or different species?

*Example Publications*

West Eberhard, M. J. 1979. Sexual selection, social competition, and evolution. *Proceedings of the American Philosophical Society 123: 222-234.*

Payne, R. B. and D. F. Westneat. 1988. A genetic and behavioral analysis of mate choice and song neighborhoods in indigo buntings. *Evolution* 42:935-947.

14. Humans: How did our own species evolve? How can all of its special traits (altricial infant, long juvenile and adult life, huge brain, menopause, concealed ovulation, parental bond, paternal care, male cooperativeness, direct and indirect social reciprocity, nepotism, morality, and activities such as science, religion, arts, and the humanities) be understood in an evolutionary context?

*Example Publications*

Alexander, R. D. 1979. *Darwinism and Human Affairs*. Univ. Wash. Press, xxiv + 317 pp.

Alexander, R. D. 1987. *The Biology of Moral Systems.* Hawthorne, NY: Aldine DeGruyter. xxi + 301 pp.

Alexander, R. D. 1990. How did humans evolve? Reflections on the uniquely unique species. *Univ. Mich. Mus. Zool. Special Publ.* 1:1-38.

15. Public Policy Issues Regarding Biodiversity and Endangered Species

*Example Publications*

Fink, W. (and the Committee on Scientific Issues in the Endangered Species Act). 1995. *Science and the Endangered Species Act.* National Academy Press, 271 pp.

16. Textbooks

Kluge, A. G. 1977. *Chordate Structure and Function.* NY: Macmillan. x + 628 pp.

Gill, F. B. 1990. *Ornithology*. NY: Freeman and Co. x + 659 pp.

## Research Topics of Current UMMZ Doctoral Students

1. The role of the songs of humpback whales in their reproductive activities
2. Evolution and homology of plumages in emberizine sparrows
3. Reproductive behavior in the harem-polyandrous pheasant-tailed jacana in Thailand, and the phylogeny of jacanas
4. Cold acclimatization in black-capped chickadees
5. Female mate choice and communicative systems in 17-year and 13-year cicadas
6. The ecological impact of a parasitic mite on its host insect
7. Hybrid zones and speciation in true katydids
8. Effects of conflicts and confluences of interests on the life strategies of individuals in eusocial naked mole-rat colonies
9. Female social hierarchies, nepotism, and sex ratios of offspring in white-tailed deer at the E. S. George Reserve
10. The function of tent-making behavior of bats in Panama
11. Song and sexual selection in a "dart-poison" frog in Madagascar

12. Anatomy, muscular control, and biomechanics of vertebral bending in snakes
13. Molecular systematics of monitor lizards
14. Sexual selection, mate choice, and visual communication in chameleons
15. Phylogenies, life histories, and systematics of live-bearing Mexican fishes using morphology and mitochondrial DNA sequences
16. Molecular phylogeny, ontogeny, and gonad evolution in gobies
17. Evolutionary effects of mate choice in Mexican mollies
18. Ecology and functional morphology of food processing by catostomid fishes
19. Gene flow and diversification in Pacific anemone fishes
20. Phylogenetic relationships of characiform fishes
21. Phylogeny of endangered cichlid fishes endemic to Madagascar, using nuclear and mitochondrial DNA sequence data and morphology
22. Genetic control of vertebral variation in the three-spined stickleback
23. Phylogeny of basal teleost fishes
24. Interactions between parasitic freshwater mussels and their host fishes
25. The population genetics of *Daphnia pulex* in response to road salt pollution
26. Reproductive strategies in sphaeriid clams
27. Snail-parasite relationships in a human schistosome parasite
28. The role of small mammals as dispersers of fungal spores
29. Molecular phylogenetics of the native rodents of Madagascar
30. Co-evolution of viruses and their hosts
31. Phylogeny and biogeography of Bornean rodents
32. Evolution of sex chromosome-linked genes
33. Systematics and evolution of South American mammals
34. Morphometric and molecular phylogenetics of sphaeriid clams
35. Kin recognition and vocalizations in the common loon.

## WHY SHOULD THERE BE AN ADMINISTRATIVE THREAT TO THE MUSEUM OF ZOOLOGY? WHAT ARE THE ARGUMENTS?

Unpleasant as it may be, a confrontation of the sort occurring now within biology, and between the UMMZ and the Dean's office, requires that the arguments being bandied about be considered, one by one. I apologize for having to specify these arguments, and in some cases having to attribute them to their sources. If there are arguments I miss here, I would appreciate hearing them.

### Uneven Faculty Attrition?

Some of the arguments in the Biology Department for diminishing or effectively destroying the UMMZ come from the belief that, during the past 25 years, attrition of faculty positions -- cynics say as a mirroring of the remarkable multiplication of U-M administrative positions -- has hurt the Department of Biology more than the UMMZ. In fact, the UMMZ has gone from a maximum of 16 curators to 13 currently (including the director); thus, like biology, the UMMZ has lost about 3/16 of its faculty.

### Strengthening Cellular and Molecular Biology?

Departmental impetus for damaging or destroying the UMMZ seems to come largely from cellular and molecular biology (CMB), and from the past and current chairs, both chairs involved in and sympathetic to CMB. Current faculty in CMB view their unit as weak and needing the UMMZ positions, and they are willing to sacrifice the UMMZ by taking them if they can.

Perhaps turning UMMZ positions over to cellular and molecular biology would strengthen CMB; perhaps not. But I have rarely encountered an academic administrator who considers it wise to destroy the strongest portion of a unit in order to strengthen the weakest. If CMB is important (and it is), then I challenge the Dean to restore some of the Department of Biology's lost positions, allowing the biology faculty to use those positions where they think they will be most important. Biology, including the entire spectrum of its topical material, is often (and, I think, appropriately) described as the crucial field for the next century; why should it remain diminished at the U-M?

### UMMZ Curators are old-fashioned biologists?

Some biology faculty justify a negative attitude toward the UMMZ by regarding their own research area as the forefront of modern biology and the UMMZ's effort as "old-fashioned biology" (this phrase was actually used in this context by a CMB individual speaking at the biology faculty retreat). To speak most bluntly, this view can only be described as ludicrous, and the result of embarrassing ignorance. Imagine, for example, what the world would be like -- indeed, how long human life would even persist -- if we were restricted to merely molecular information about only a single species, the human one. We do not understand life solely by beginning with its smallest components and building upward. It is also ludicrous for an entirely different reason: Almost one-fourth of the UMMZ faculty have their own molecular laboratories, and 10 of 13 faculty use molecular information and techniques to answer research questions, either centrally or regularly in their research. Nearly all of the 34 doctoral students with UMMZ curators as chairs of their doctoral committees currently include molecular analyses in their thesis research, or have stated that they intend to. As director of the UMMZ, I have announced to the faculty my intent that no UMMZ doctoral student shall be excluded for financial reasons from using molecular techniques, including the new automated DNA sequencer secured with LS&A College assistance by the efforts of two young curators and one senior curator from the UMMZ, and one junior curator from the Herbarium. I doubt that the Department of Biology can match these proportions or this resolve.

As shown by (1) the research questions of curators, and publications resulting from attempts to answer them, (2) quality and numbers of doctoral students attracted to work with UMMZ curators, (3) teaching success of UMMZ curators, and (4) research awards and honors accorded UMMZ curators, it is irresponsible, especially for a biologist, to label the research conducted in the UMMZ as "old-fashioned." Questions exist because they are important and have not been answered; techniques for answering them change as new ones become available. Research questions and research techniques together make modern biology. The UMMZ has always been in the forefront of posing current and first-rate questions and using the best techniques to answer them.

Increasing or broadening biology teaching and research?

Among some departmental faculty there is a stated perception that UMMZ faculty positions are restricted by the six groups of organisms included in their expertise, and that this restriction weakens the overall effort of biology at Michigan. This perception has no reasonable basis, and certainly does not accord with the widely accepted role of the UMMZ in helping keep biology at Michigan nationally ranked, or the tendency of top-ranked doctoral students to choose UMMZ curators as their chairs. The six groups with which the curators are concerned include more than 95% of the known animal species of the world, and the curators study and teach about virtually all aspects of their lives and biologies. Repetition of the doubtful perception of restriction rouses my skepticism because certain faculty clearly wish to replace UMMZ faculty by new staff in their own fields, and have also expressed the opinion that by removing positions from the UMMZ their personal teaching "loads" will be reduced. This report shows that such a perception about current teaching loads, and what would happen to them if UMMZ positions were usurped, is false because it is based on the erroneous belief that UMMZ faculty do not teach nearly as much as other biology faculty. Complaints about teaching "loads" -- as well as assertions that UMMZ topics are restricted, "old-fashioned," or narrow -- both appear related to a wish to alter the nature of biology at Michigan by hiring faculty in CMB at the expense of other sub fields. Such complaints in my opinion also speak poorly of the relationship between teaching and research in biology, a criticism it is difficult to make of the UMMZ, given that its faculty teach essentially twice what is expected from their contracts.

The breadth of teaching topics handled by UMMZ faculty (previous reports), their amounts of teaching, and the breadth and significance of their research questions (this report), show that, far from being hindered by the UMMZ, the U-M's effort and reputation in biology has always been supported potently by the UMMZ. Again, is there wisdom in weakening a strong unit to buoy a weak one? The CMB unit currently has 22 members (there are 37 in molecular, cellular, and developmental biology combined; 30 in evolution, ecology, and organismal biology combined; 8 people on both lists). CMB has had great difficulty in securing outstanding doctoral students. *Does anyone believe difficulties of this sort will disappear if a few halves of positions are acquired through diminishing or destroying the UMMZ? Even if this were a significant possibility, would it be a reasonable goal or outcome? Everything in this report suggests that the answer has to be an emphatic no.*

Surely the data in this report settle the question whether hiring people to fill UMMZ positions has been hampered by inadequate quality of the candidates, whether gauged by inadequate numbers of candidates or in any other fashion. This could only be true if there were evidence of lower quality in the UMMZ than in biology in general, or evidence of narrowness in the research and teaching of UMMZ curators. The evidence in this document suggests the opposite.

It is not reasonable for someone who spends his or her life working on one or a few aspects of the life, development, neurobiology, or physiology of one or a few well-known species to denigrate research aimed at introducing and characterizing the lives of the incredibly diverse biota of the world to the rest of biology, including those who work only on "well-known" species. Generalizations in biology are not restricted to the molecular or cellular level of life. The tasks of evolutionary biology are unmatched in their breadth and complexity in any other discipline in academia (see also, 1994 Special Report, p. 8-9). Overall life patterns of organisms -- the collectives of their traits -- evolve, and this evolution can be understood through comparative biology in ways that enable us, for example, to use songbirds and rodents and maggots to help understand the evolved helplessness of the human baby; turtles and octopi to help understand senescence and the human life course; and sweat bees and ground squirrels to help understand that human children necessarily bond with their parents through social interactions and learning rather than through some mysterious response that because of the nature of its genetic mediation can only be directed at genetic parents or relatives. All such questions abound from the research of UMMZ curators, which is by no means restrictive or narrow. I believe that no broader or more integrative biological research is being accomplished at the University of Michigan.

It is entirely fitting that research aimed at understanding how neurons or kidneys or DNA work be balanced by research aimed at understanding how organisms work when they are whole: how different organisms work differently; and how not only special traits but general or universal themes -- such as ontogeny, senescence, phenotypic plasticity, parental care, and communication -- can be understood; how competition works, how selection operates at different levels in the hierarchy of organization of life from gene to organism, and to social group, species, and community. These are things systematists and evolutionary biologists do. Everything anyone else in biology does is informed by evolutionary biologists' insights, and everything discovered by any other kind of biologist is inescapably returned for ultimate understanding to the integrative analyses of evolutionary biologists, including the systematists who work out phylogenies and thus the necessary framework for *all* comparative biology. It will always be so.

Either changing many or all positions half-time in research museums to full-time positions in the related department, or, in our case, requiring a full-time teaching load administered by the Department of Biology (as with your alteration of the recent opening in the Herbarium), removes the significance and *esprit de corps* of the museum as a cohesive and functional unit in both teaching and research. It would eliminate the constant (and obviously successful) flow of ideas among people with like interests in a broad section of biology and render the directorship ineffective and unattractive. Evidence from other institutions indicates that the result would be appointments for which the attached curatorship is incidental and even inappropriate. The important kinds of teaching and research for which this museum is invaluable thus languish and disappear. There are indications that the trend is typically irreversible: when collections go, so do their unique kinds of teaching and research, and the excellent people associated with them.

*The University of Michigan is fortunate to have distinguished science research museums that have given it a good deal of its international reputation in biology, anthropology, and paleontology. It will be exceedingly unfortunate if this important feature of science in the LS&A College is destroyed by a temporary attitude driven by the perception that different units within fields are in zero-sum games that demand the weakening or disappearance of small, harmonious, meritorious units that are vulnerable solely because of their size. Destruction of research museums tends to be irreversible. Ours are unique, and outstanding. Let's not endanger them at a time when other institutions may be starting, some belatedly, to realize their essential nature.*

– of their grants

# BIOLOGICAL RESEARCH AND ADMINISTRATION OF BIOLOGY UNITS: INTERNATIONAL AND NATIONAL TRENDS

Several decades ago, a trend began across the world that reduced attention to systematics, biodiversity, behavior, ecology, and evolutionary biology. Indeed, in most countries of the world serious evolutionary biology never became prominent or modern, and systematics largely remained in the form of an old-fashioned kind of taxonomy. A few countries until recently remained exceptions in all of this, in particular the United States, Great Britain, Canada, and Australia. Revolutionary refinements of theories of natural and sexual selection in the 1960's by William D. Hamilton and John Maynard Smith (British) and George C. Williams and Robert L. Trivers (Americans) were followed by enormously increased attention to understanding the traits of organisms as cumulative products of the process of evolution, guided principally by selection (all four of the listed individuals have worked for significant periods in the UMMZ: Hamilton was a faculty member from 1978 to 1984, Maynard Smith and Williams have been visiting faculty for several months, and Trivers has visited repeatedly as speaker in seminars and symposia). More recently, a revolution in thinking about the long-term patterning of evolution via reconstruction of phylogenies occurred, and has resulted in very extensive efforts to understand the history of speciation events and the precise sequential relationships of living organisms; this revolution in large part was originated in the 1960's by Curator Arnold Kluge and graduate student Steven Farris (and from the research of Warren H. Wagner, Biology Professor and Herbarium Curator). Both of these efforts are crucial to modern biology. Thus, efforts to understand the whole repertoire of traits and the patterns of life shown by individual species such as humans, prairie dogs, whales and porpoises, naked mole rats, grasshoppers, and indigobirds (see books accompanying and illustrating this report) depend on viewing traits as cumulative consequences of natural, sexual, and social selection. Efforts to reconstruct the specific changes by which traits have come about (therefore, to characterize them and study them effectively) in turn depend on accurate comparisons of the sequential history by which different species have come about. Attempting to do any kind of biology without these two sources of comparative perspective is certain to result in serious roadblocks and misinterpretations.

The rise of techniques that expanded cellular and molecular biology during the past two decades caused the flourishing of what to many has seemed an entirely alternative approach to biological questions. There has been a parallel to the optimism that prevailed when chemical insecticides were invented in the 1940's, causing a widespread belief that life can be quickly and thoroughly understood for the solving of medical, conservation, and social issues by beginning with molecules and proceeding "upward" to the whole organism. Just as difficulties arose with the simple view that pest problems would be solved forever just by applying chemicals, so must they arise with the view that life can be most efficiently and quickly understood solely by striving from the molecular level upward. As Richard Lewontin pointed out recently, the problem of using molecular information in practical ways is much more difficult than has been widely understood because, among other things, it depends on developmental information, for gene effects cannot be introduced or replaced usefully except in specific locations and at specific times or stages in the life of the organism: "We do not yet have a single case of a prevention or cure arising from a knowledge of DNA sequences . . ."

Inductive analyses of living forms that begin with the genes founder on a profound difficulty, specified by the evolutionary geneticist, Theodosius Dobzhansky, more than a third of a century ago: "Heredity is particulate, but development is unitary. Everything in the organism is the result of the interactions of all genes, subject to the environment to which they are exposed. What genes determine are not characters, but rather the ways in which the developing organism responds to the environment it encounters." The developmental biologist, Charles Waddington, acknowledged the same barrier almost a half century ago by referring to its intellectual consequences as "The Great Gap" in biology. Bridging this gap consists of transforming knowledge about the finite, particulate units of heredity into knowledge about unified organisms functioning continuously across lifetimes with tens or hundreds of thousands of different genes in their genomes; this remains today as the central, massive problem of modern biology. The goal is to understand organisms, or to know enough to identify and utilize whatever levels of organization are crucial to us, as organisms. The investigation is continually informed by evidence from every direction -- from the study of organisms themselves and their interactions, as well as the study of genes and their interactions. As we favor diversity in human culture for reasons of ethics, practicality, and enrichment, so must we favor it in biology, and thereby incorporate the extraordinary potential of comparative analyses into our efforts to achieve the goal of broadly useful explanations of life.

The three or four countries that alone in the world retained significant efforts in evolutionary and systematic biology have also experienced reductions in these fields within the past decade or two, as cellular and molecular biology correspondingly expanded. In my opinion, a reverse trend is virtually certain, and may already have begun. Thus, at Yale University a large bequest has been employed by the provost, Alison F. Richard, to rebuild the Peabody Museum of Natural History and revitalize the once famous ecology and evolutionary biology unit. At the University of Illinois, May Berenbaum, National Academy member and Chair of the Department of Entomology, was instrumental in convincing her University to abandon its intent to eliminate "taxon-based" research, thereby saving and rebuilding the entomology department. At George Washington University a major bequest is being used to hire evolutionary biologists. The Ohio State University has unified its natural history research museums into a Museum of Biological Diversity that virtually mimics the University of Michigan Museum of Zoology. Included are acoustical laboratories and sound collections, paralleling those of the UMMZ, and a herbarium. The University of Texas has just hired as director a former U-M postdoctoral associate who has been charged to expand the natural history museum there. The University of Oklahoma is expanding and renovating its science museum, including a new building, the 37-million dollar Sam Noble Oklahoma Museum of Natural History, which will house both public exhibits and scientific collections. A number of countries, such as South Korea, Paraguay, Pakistan, Thailand, and Slovenia are establishing natural history museums that include research units and the study of biodiversity. Thailand is as well initiating a special Institute of Biodiversity. John

B. Burch, a UMMZ curator, has played a significant role in the development of the Pacific research museums. The Democratic Republic of Madagascar has also just started a National Museum of Natural History, under the direction and assistance of Ronald Nussbaum, UMMZ curator, and his postdoctoral associate, Chris Raxworthy.

I see these evidences of reversals as part of a long-term trend. Life – indeed, as we know well, any one species of life such as ourselves – is far too diverse and complex to be understood through investigations that omit any level of organization. We have known this forever, as in our introductory biology courses, where we acknowledge it by repeated efforts to select, arrange, and emphasize diverse topics at all levels.

The University of Michigan Museum of Zoology has long been a leader in biology at Michigan and in the world. Its tradition appears, currently as well as in the past, to remain on the crest of new and predictable directions of change with respect to evolutionary and systematic biology, and all study of how organisms function.

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# OF COLLECTIONS, MUSEUMS, AND CURATORS

## A *Somewhat* Light-Hearted Comment

A biological research collection is an internationally significant data base that, if it is curated appropriately and uninterruptedly, will be used, sooner or later, in the research and teaching of biologists all over the world.

A biological systematist, if he or she enjoys a reasonably normal and active career, will use in his or her research and teaching, sooner or later, collections from all over the world.

Every biological curator thus belongs to a world-wide consortium which locates, captures, identifies, preserves, organizes, husbands, and interprets biological material that comprises an enormous, irreplaceable, and increasingly valuable research tool and voucher, available to investigators everywhere.

Systematists and systematic collections provide the explanatory framework that underlies the organization and understanding of all biological information, hence are permanently essential, not only to all biologists and all biological research, but to all people everywhere whether they know it or not.

Everyone is fortunate when biological systematists and their collections arrive together in academic teaching and research museums, where all of their relationships are nurtured and elevated to the highest levels of intellectual contribution by university administrators, who might be called Curators of the Faculty.

The great value, and difficulty, of the responsibilities of administrators in curating the faculty are recognized by unusual elevations of monetary compensation, and sometimes by relief from all other university obligations.

Of course, the faculty is not even remotely as diverse as the rest of life and it suffers from more rapid turnover; moreover, increasing value of the faculty is at best a doubtful assumption . . .

# Table 1: Teaching by Museum of Zoology Faculty Curators

*For Biology (and Honors independent study) courses*
*Fall 1994 through Fall 1996.*

| Faculty | # Terms Present[1] | # Hours Attributed[3] X Enrollment[4] | Average per term[5] | # Credit Hours X Enrollment[7] | Average per term |
|---|---|---|---|---|---|
| Alexander, Richard D. | 5 | 1423.8 | 284.8 | 2162.0 | 432.4 |
| Burch, John B. | 5 | 231.0 | 46.2 | 265.0 | 53.0 |
| Fink, William L. | 5 | 547.0 | 109.4 | 645.0 | 129.0 |
| Kluge, Arnold G. | 5 | 401.0 | 80.2 | 510.0 | 102.0 |
| Mindell, David P. | 5 | 549.4 | 109.9 | 847.0 | 169.4 |
| Moore, Thomas E. | 5 | 744.0 | 148.8 | 834.0 | 166.8 |
| Myers, Philip | 5 | 521.6 | 104.3 | 728.0 | 145.6 |
| Nussbaum, Ronald A. | 5 | 98.0 | 19.6 | 215.0 | 43.0 |
| O'Connor, Barry M. | 5 | 916.3 | 183.3 | 981.3 | 196.3 |
| O'Foighil, Diarmaid | 3 | 677.0 | 225.7 | 677.0 | 225.7 |
| Payne, Robert B. | 5 | 489.0 | 97.8 | 489.0 | 97.8 |
| Smith, Gerald R. | 0[2] | 325.6 | 65.1 | 325.6 | 65.1 |
| Tucker, Priscilla K. | 5 | 392.4 | 78.5 | 578.0 | 115.6 |
| **Total** | **58** | **7316.0** | **126.1**[6] | **9256.8** | **159.6**[8] |

[1] Of the five terms Fall '94-Fall '96, the number in which the individual had an appointment in the Biology Department. Cases in which a person's appointment was partially administrative (and partially a teaching appointment) are not exempted.

[2] Smith teaches in Biology (and Geology) but is salaried only in the Museums of Zoology and Paleontology.

[3] Number of hours attributed to a professor for teaching a course is a value assigned by the University. It reflects the course credit hours, number of weekly contact hours, and number of individuals sharing responsibility for the course.

[4] This column is calculated by multiplying the number of hours attributed by the course enrollment, then for each individual summing those values for every course they taught from Fall 1994 through Fall 1996.

[5] The average per term is calculated by dividing the number in the previous column by their number of terms present. Example: for Alexander, 1423.8 / 5 = 284.8.

[6] 126.1 = 7316.0 / 58

[7] The second method of calculating amount of teaching is simply to multiply the credit hours times the enrollment for each class an individual taught, and sum the results. (Number of credit hours is divided by the number of professors teaching a co-taught course.) Exception: Since Introductory Biology courses have a full-time staff to run the lab sections, those courses were only calculated using the "number of hours attributed" value, not using the full number of credit hours.

[8] 159.6 = 9256.8 / 58.

Note: Two (15%) of the Museum faculty (Burch and Smith) also do a significant amount of teaching in non-Biology Department courses.

## Table 2: Teaching by Full-Time Department of Biology Faculty

*For Biology (and Honors independent study) courses*
*Fall 1994 through Fall 1996.*

| Faculty | # Terms Present | # Hours Attributed X Enrollment | Average per term | # Credit Hours X Enrollment | Average per term |
|---|---|---|---|---|---|
| 1 | 5 | 599.8 | 120.0 | 895.0 | 179.0 |
| 2 | 5 | 1356.4 | 271.3 | 2222.6 | 444.5 |
| 3 | 1 | 23.3 | 23.3 | 23.3 | 23.3 |
| 4 | 5 | 280.0 | 56.0 | 280.0 | 56.0 |
| 5 | 5 | 595.5 | 119.1 | 593.5 | 118.7 |
| 6 | 5 | 80.0 | 16.0 | 80.0 | 16.0 |
| 7 | 5 | 142.4 | 28.5 | 142.4 | 28.5 |
| 8 | 5 | 1039.8 | 208.0 | 1040.0 | 208.0 |
| 9 | 1 | 84.0 | 84.0 | 84.0 | 84.0 |
| 10 | 5 | 317.8 | 63.6 | 433.2 | 86.6 |
| 11 | 3 | 113.9 | 38.0 | 161.4 | 53.8 |
| 12 | 5 | 603.8 | 120.8 | 1221.0 | 244.2 |
| 13 | 5 | 318.0 | 63.6 | 507.0 | 101.4 |
| 14 | 5 | 566.6 | 113.3 | 721.0 | 144.2 |
| 15 | 5 | 962.0 | 192.4 | 1458.4 | 291.7 |
| 16 | 5 | 1904.6 | 380.9 | 2101.8 | 420.4 |
| 17 | 5 | 712.0 | 142.4 | 1099.0 | 219.8 |
| 18 | 5 | 1365.0 | 273.0 | 1365.0 | 273.0 |
| 19 | 5 | 924.5 | 184.9 | 1197.5 | 239.5 |
| 20 | 5 | 1748.6 | 349.7 | 2648.6 | 529.7 |
| 21 | 5 | 1899.9 | 380.0 | 2355.8 | 471.2 |
| 22 | 5 | 457.7 | 91.5 | 457.7 | 91.5 |
| 23 | 5 | 764.0 | 152.8 | 764.0 | 152.8 |
| 24 | 4 | 279.5 | 69.9 | 351.0 | 87.8 |
| 25 | 5 | 264.0 | 52.8 | 546.0 | 109.2 |
| 26 | 5 | 1641.0 | 328.2 | 1679.0 | 335.8 |
| 27 | 5 | 176.0 | 35.2 | 185.8 | 37.2 |
| 28 | 5 | 1497.8 | 299.6 | 1757.9 | 351.6 |
| 29 | 5 | 877.2 | 175.4 | 1304.0 | 260.8 |
| 30 | 5 | 1430.9 | 286.2 | 1631.9 | 326.4 |
| 31 | 5 | 1402.8 | 280.6 | 2198.0 | 439.6 |
| 32 | 5 | 1504.4 | 300.9 | 1504.4 | 300.9 |
| 33 | 5 | 536.4 | 107.3 | 536.4 | 107.3 |
| 34 | 5 | 259.0 | 51.8 | 259.0 | 51.8 |
| 35 | 5 | 546.8 | 109.4 | 906.2 | 181.2 |
| 36 | 5 | 73.5 | 14.7 | 73.5 | 14.7 |
| **Total** | **169** | **27348.9** | **161.8** | **34785.2** | **205.8** |

Column headings and methods of calculation are as in Table 1.
Note: Four (11%) of the Biology faculty also do a significant amount of teaching in non-Biology Department courses.

## Table 3: Informal Teaching by Museum of Zoology Faculty Curators

*For Academic Year 1996-97*

| Faculty | Number of guest lectures given | Estimated number of unregistered students attending classes | Hours per week spent with GSIs or attending lab or discussion sections |
|---|---|---|---|
| Alexander, Richard D. | 7 | 20 | 4 |
| Burch, John B. | 3 | 1 | 2 |
| Fink, William L. | 3 | 3 | 3 |
| Kluge, Arnold G. | 4 | 14 | 7 |
| Mindell, David P. | 3 (1) | 9 | 2 |
| Moore, Thomas E. | 3 (2) | 13 | 6 |
| Myers, Philip | 10 | 2 | 4 |
| Nussbaum, Ronald A. | 0 | 0 | 4 |
| O'Connor, Barry M. | 5 | 3 | 5 |
| O'Foighil, Diarmaid | 5 | 12 | 3 |
| Payne, Robert B. | 5 (1) | 0 | 0 |
| Smith, Gerald R. | 4 (2) | 1 | 0 |
| Tucker, Priscilla K. | 2 | 0 | 2 |
| **Total** | **54 (6)** | **78** | **42** |

Numbers in parentheses in the left-hand column refer to guest lectures given in courses in departments other than biology.

The thirteen curators also train seven graduate students each year in systematic and curatorial activities through the service of graduate students as UMMZ divisional assistants.

Numbers in the middle column are high partly because the Graduate School allows only one course (rather than, say, three hours of credit -- as in three one-hour seminars) to be taken for credit by a candidate without additional tuition.

**Table 4: Doctoral Student Attrition and Graduation Rates**

| Year Entered | Museum | | | Full Time Department | | |
|---|---|---|---|---|---|---|
| | Left | Graduated | Current | Left | Graduated | Current |
| 1987 | | 5.5 | | 3 | 7 | 1 |
| 1988 | | 4 | | 6 | 1.5 | |
| 1989 | 2.5 | 4 | 1 | 3 | 5 | 1 |
| 1990 | 3.5 | | 4 | 12.5 | 6.5 | 3 |
| 1991 | 2 | 1 | 4.5 | 2 | 3 | 4.5 |
| 1992 | 1 | | 1 | 3 | 2 | 6 |
| 1993 | | | 6 | | | 5 |
| 1994 | | | 3 | | 1 | 12 |
| **Total** | **9** | **14.5** | **19.5** | **29.5** | **25** | **32.5** |
| **Attrition Rate** | **21%** | | | **34%** | | |
| **Graduation Rate** | | **33%** | | | **29%** | |

Doctoral students who entered the program from 1987 through 1994, and who had selected a chair or mentor, are categorized as having left the program before graduation, having graduated with a doctoral degree, or being current students (as of end of May 1997). Full-time departmental faculty are defined in Footnote 1.

Fractional values occur in the table as a result of students having thesis committees that are co-chaired. If one chair is a museum curator and the other is full-time in the department, one half a student is assigned to the museum and one half to the department. If one chair is a museum curator and the other is half-time in the department, one half a student is assigned to the museum. If one chair is full-time in the department and the other is half-time in the department, one half a student is assigned to the full-time departmental faculty.

Attrition rate is considered to be the number of students that left divided by the total number of students, hence 9 / (9+14.5+19.5) X 100 = 21%.

One currently emeritus curator had two students in the time period considered (one graduated, one current). These two students are not counted in any category. One adjunct curator (full-time in the department) had one student in the time period considered (current). This student is counted in the full-time departmental total.

Two former UMMZ curators during the time period considered had one student each (one graduated, one left). These two students are counted in the museum total.

## Table 5: Publications by Museum of Zoology Faculty Curators

*1991-1996*

| Faculty | # Publications[1] | Adjusted # Publications[2] | # Pages Authored[3] |
|---|---|---|---|
| Alexander, Richard D. | 10 | 7.9 | 103.3 |
| Burch, John B. | 9 | 5.7 | 215.8 |
| Fink, William L. | 10 | 5.1 | 90.2 |
| Kluge, Arnold G. | 21 | 14.2 | 362.4 |
| Mindell, David P. | 18 | 9.9 | 85.1 |
| Moore, Thomas E. | 12 | 5.2 | 115.5 |
| Myers, Philip | 3 | 1.1 | 15.4 |
| Nussbaum, Ronald A. | 29 | 14.2 | 193.5 |
| O'Connor, Barry M. | 13 | 7.9 | 149.7 |
| O'Foighil, Diarmaid | 5 | 1.9 | 19.8 |
| Payne, Robert B. | 15 | 10.3 | 112.4 |
| Smith, Gerald R. | 13 | 6.0 | 117.6 |
| Tucker, Priscilla K. | 12 | 3.8 | 29.8 |
| **Total** | **170.0** | **93.2** | **1610.5** |
| **Curator Average** | **13.1** | **7.2** | **123.9** |

Table 5 summarizes all of the curators' publications which are listed in any of the following seven library databases: MCAT, Biological Abstracts, Wilson, Psychology, Agricola, Zoological Record, and the Science Citation Index. Any publications not listed in at least one of these indexes are not included in the table.

This literature search was performed in December, 1996. Any publications not appearing in one of the above indexes as of that month are not included in the table.

[1]Total number of publications, not adjusted for number of authors. Includes papers, book chapters, and authored and edited books.

[2]Adjusted for number of authors. For example, if two people co-author a paper, each is considered to have produced 0.5 publications.

[3]For each publication the number of pages is divided by the number of authors. These values are then summed for each curator. For example, if an individual published a 10-page singly authored paper and a 10-page paper with a co-author, that individual is said to have published 15 pages. Pages in an edited volume are not attributed to the editor unless the editor also authored the pages.

Note: Number of pages published, not adjusted for number of authors, averages 199 for the curators and 125 for full-time biology faculty.

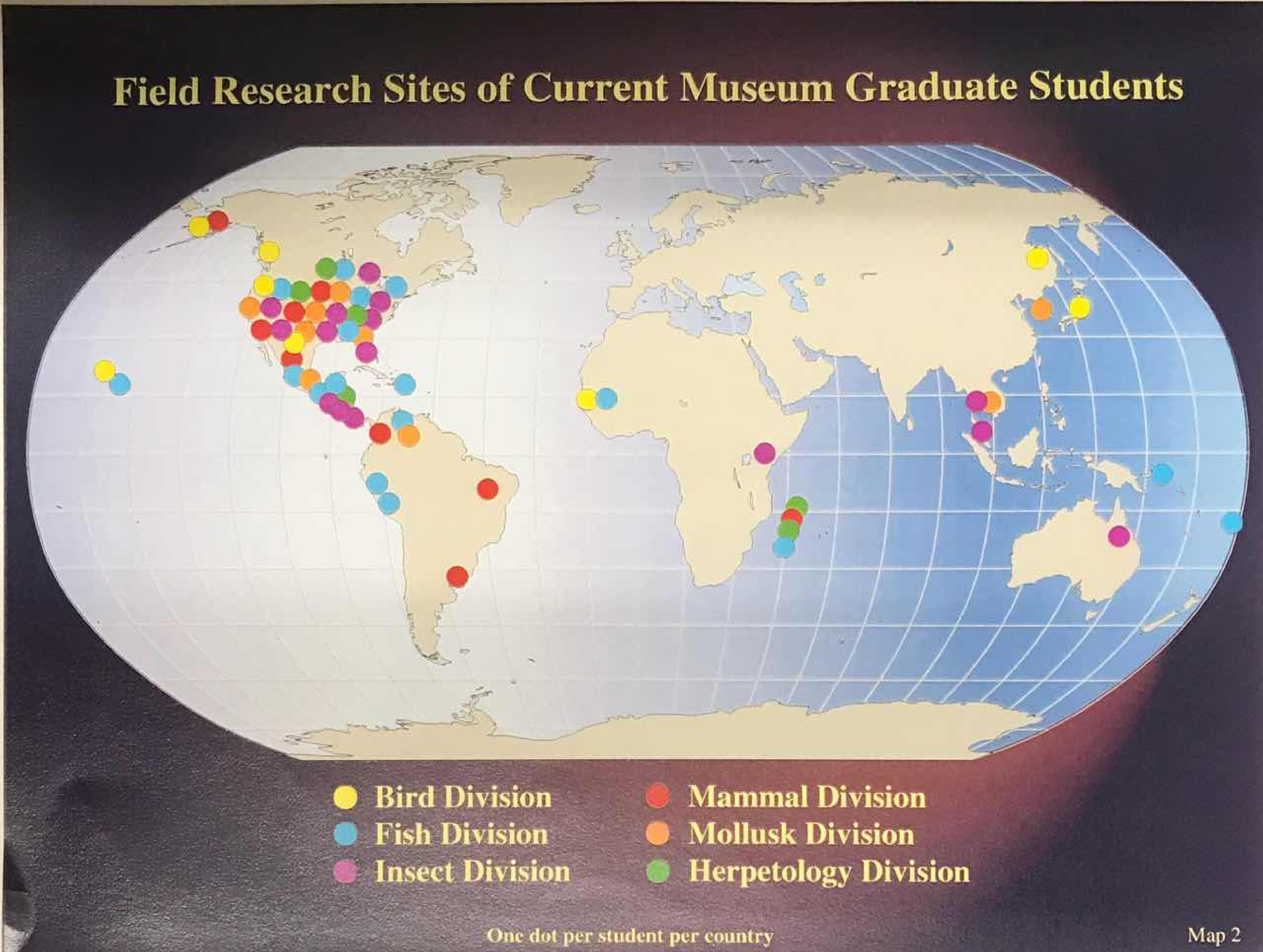
**Table 6: Publications by Full-Time Department of Biology Faculty**

*1991-1996*

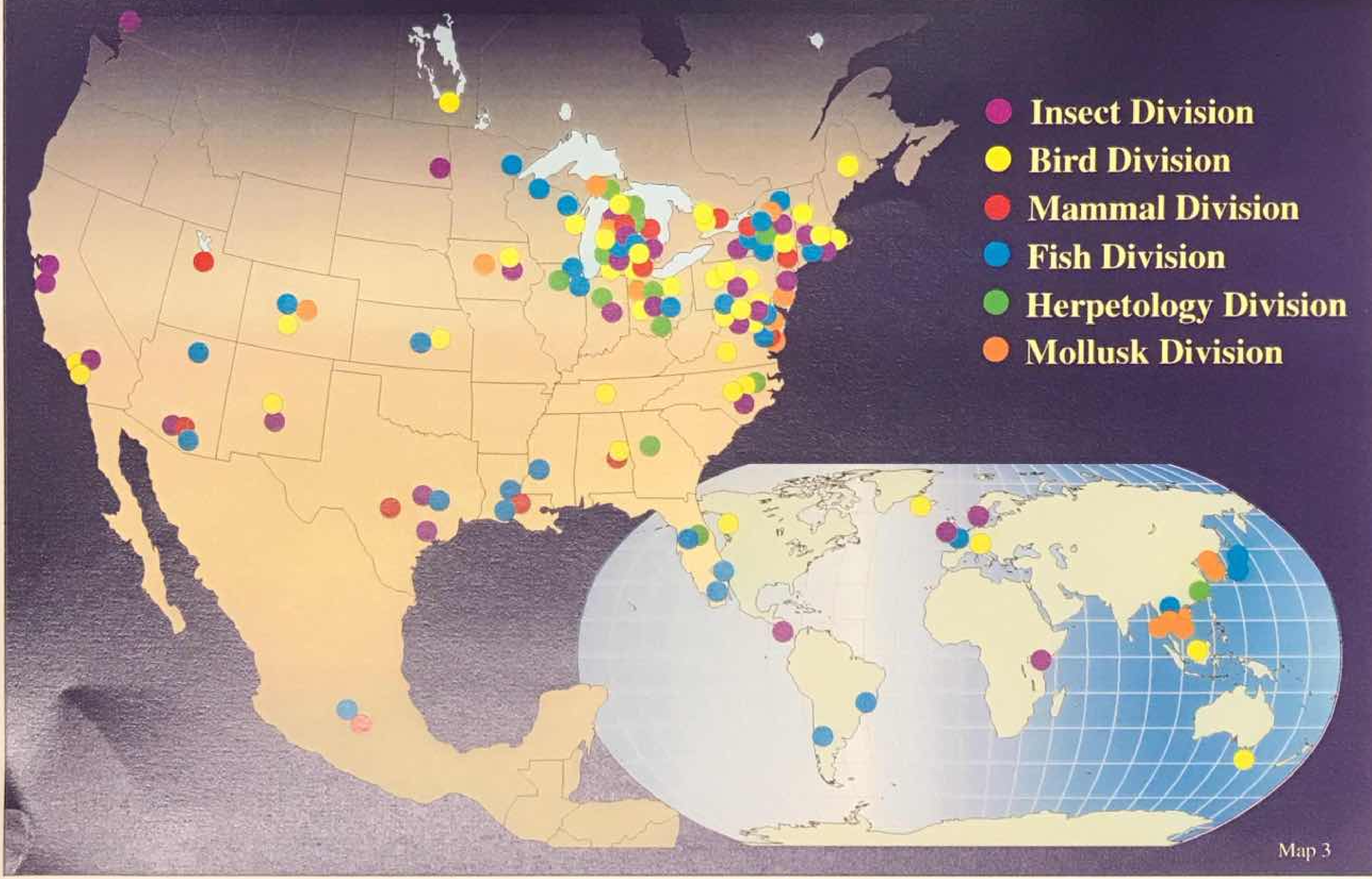
| Faculty | # Publications | Adjusted # Publications | # Pages Authored |
|---|---|---|---|
| 1 | 13 | 6.0 | 55.8 |
| 2 | 2 | 0.8 | 7.5 |
| 3 | 9 | 3.2 | 20.0 |
| 4 | 12 | 5.6 | 39.8 |
| 5 | 20 | 8.7 | 64.6 |
| 6 | 23 | 8.1 | 87.1 |
| 7 | 8 | 2.7 | 25.8 |
| 8 | 8 | 4.6 | 44.1 |
| 9 | 23 | 8.5 | 63.3 |
| 10 | 24 | 12.0 | 104.7 |
| 11 | 8 | 3.6 | 45.9 |
| 12 | 9 | 7.2 | 53.8 |
| 13 | 39 | 27.8 | 287.3 |
| 14 | 4 | 2.7 | 41.8 |
| 15 | 10 | 5.9 | 68.5 |
| 16 | 15 | 11.6 | 96.9 |
| 17 | 4 | 2.5 | 9.8 |
| 18 | 12 | 4.9 | 40.3 |
| 19 | 0 | 0.0 | 0.0 |
| 20 | 27 | 9.3 | 162.1 |
| 21 | 1 | 0.5 | 405.0 |
| 22 | 14 | 6.2 | 81.8 |
| 23 | 12 | 5.4 | 50.3 |
| 24 | 20 | 9.8 | 84.7 |
| 25 | 10 | 5.8 | 59.2 |
| 26 | 8 | 2.8 | 22.3 |
| 27 | 16 | 7.5 | 75.3 |
| 28 | 6 | 3.0 | 19.3 |
| 29 | 36 | 10.4 | 76.9 |
| 30 | 5 | 2.8 | 38.7 |
| 31 | 20 | 6.7 | 54.3 |
| 32 | 0 | 0.0 | 0.0 |
| 33 | 14 | 6.8 | 83.2 |
| 34 | 20 | 14.2 | 695.6 |
| 35 | 12 | 8.0 | 134.7 |
| 36 | 28 | 8.7 | 54.2 |
| **Total** | **492.0** | **234.2** | **3254.6** |
| **Average** | **13.7** | **6.5** | **90.4** |

Column headings and sources of publication records are as in Table 5.

# Field Research Sites of the Present Curators


Field Research Sites of Current Museum Graduate Students
Bird Division
Fish Division
Insect Division
Mammal Division
Mollusk Division
Herpetology Division
One dot per student per country
Map 2

# Current Academic Positions of Former Doctoral Students of the Current Curators and Active Emeritus Curators




Map 3