I. MISSION

The study of the diversity and evolution of life on Earth, specifically in the areas of:
- species exploration and discovery
- theory and practice of phylogenetic analysis
- biodiversity informatics

A. Our vision. The tangible importance of biodiversity to human society cannot be understated. We depend upon the plants, animals, fungi and microbes with which we share the planet for much of our food, shelter, and clothing. The miracle drugs that protect our health and extend our lives are largely derived from natural products produced by these species. Equally important, these organisms provide us with a wealth of “ecosystem services,” including production of the oxygen that we breathe, purification of water, and carbon sequestration. Conversely, biodiversity presents us with daunting challenges. Exotic species – alien invaders – pose dramatic threats to agriculture and forestry. Many of the major human diseases, including malaria and tuberculosis, are caused by pathogenic organisms. Such organisms, in turn, have their own natural enemies that act to mitigate and control their effects. In short, humans are part of an intricate web of relationships with other organisms. To understand them, perhaps even to rationally control and manage them, is critical to the health of society.

The intangible benefits of biodiversity may be measured on a different scale, but arguably are just as important. The intrinsic beauty of a flower and the warbling song of a thrush are just two examples of such aesthetic values. These touch not only our souls, but – through activities such as birdwatching, gardening, sport fishing, hiking, and a range of endeavors collectively labeled as ecotourism – they generate a substantial economic impact.

Understanding biodiversity – the richness of species, the pattern of relationships among organisms, and the processes by which biodiversity is generated – is the scope of the proposed Center for Biodiversity Research & Analysis (CEBRA). This field of study is in the midst of a fundamental transformation engendered by dramatic advances in molecular biology and information technologies. DNA sequences of individual genes and even entire genomes provide new data to address perennial questions. Vastly increased computational capacity and innovative methods of analysis provide deeper and more robust insights into the evolution and interrelationships of life on Earth. Database technologies, the Internet, and the Semantic Web are revolutionizing the analysis and dissemination of biodiversity information. These developments have led to substantially increased funding by the National Science Foundation, especially through new programs such as the Partnerships for Enhancing Expertise in Taxonomy, Revisionary Systematics, Assembling the Tree of Life, and the Planetary Biodiversity Inventories; as well as through international organizations such as the Global Biodiversity Information Facility.

The Ohio State University has had a long and illustrious tradition and commitment to research and training in biodiversity science. We have a core group of faculty with expertise that spans the length and breadth of the field. Until now, these strengths have been divided and diluted among departments and colleges within the University, and there has never been a single focal point for these efforts. This proposal, to create the Center for Biodiversity Research & Analysis within the Colleges of Biological, Mathematical and Physical Sciences, seeks to capitalize upon one of the primary strengths in the Departments of EEOB and Entomology and to provide the focus, structure, and plan for continued advancement in the future.

The mission of CEBRA touches upon each of the three primary missions of the University: research, teaching, and service. Our goals are (1) to foster fundamental, extramurally funded research in the three primary areas of species discovery, theory and practice of phylogenetic analysis, and in biodiversity informatics; (2) to deliver a comprehensive teaching and training program for students in biodiversity science that links the field to other disciplines and provides experience from the field to the laboratory, including a significant international component; and (3) to provide effective community service through the delivery of authoritative and verifiable information on biodiversity to audiences ranging from novices to experts.

Biodiversity science is inherently a multidisciplinary endeavor. The field integrates data derived from the study of molecular biology, anatomy and behavior. It embraces ecological studies of living species and geologic study of
How will a college center extend our capabilities and possibilities beyond those we have in the current administrative structure?

(1) A unified identity for biodiversity science at OSU will enhance our ability to recruit high quality students into our doctoral programs. Students searching for an appropriate graduate school are attracted to individual faculty, but those searching more generally for a program in biodiversity science do not even consider Ohio State. The only institutions in the U.S. with a comparable breadth in expertise and infrastructure are the University of Kansas and the University of California, Berkeley. Increasing our visibility to potential students should enlarge the pool of applicants and the quality of those students accepted. Finally, in the short term, the college center will establish a point of relative programmatic stability within the fluid context of existing departments and colleges.

(2) A college center will enable us to consolidate, prioritize, and enhance our research and instructional infrastructure – including physical space, information technologies, and laboratory equipment. Such consolidation will immediately reduce redundancy and increase the efficiency in the use of available personnel and funds. This action should, as a result, increase our future competitiveness for extramural funding for research, instrumentation and training.

(3) A center will provide a unified, recognizable face to further bolster development efforts. We already have several endowments supporting individual units within the Museum of Biological Diversity, most prominently the Knoll Funds that support the operations of the C.A. Triplehorn Insect Collection. Additionally, through the generosity of Dr. John Moser, an alumnus of OSU, we have the planned gift of an endowed chair in Systematic Entomology. These existing investments in the quality in biodiversity science at Ohio State, the “branding” of a formal center, combined with the widespread appreciation and love of nature in the public can be effective in attracting further financial support.

B. Specific Action Plan.

1. Curriculum development. We will develop and implement a comprehensive and coordinated course of study in biodiversity science in the context of the academic departments of the core faculty. This will primarily be directed toward graduate students, but with the opportunity for participation by upper-level undergraduates. Our recently initiated program of undergraduate internships will be continued and enhanced. The new curriculum will incorporate some existing courses (with better coordination of their content) as well as the development of new offerings, e.g., a course in biodiversity informatics. The courses will encompass both theoretical and practical concerns; field and laboratory experience; and emphasize integration with other disciplines such as geography, molecular biology, and computer science. The goal at the end of five years will be to submit a full proposal to the National Science Foundation for an IGERT (Integrative Graduate Education and Research Traineeship) program.

2. Enhancement of informatics infrastructure. The research collections housed at the Museum of Biological Diversity represent a significant investment by the University in space, personnel, and operating budgets. It is imperative that these resources are used to support scientific investigations around the world and generate revenues to at least partially offset the cost of their maintenance. The most important action we can take now is to integrate the data associated with these holdings into the global federated biodiversity information network. To do this effectively requires (a) hiring of a full-time informatics specialist to bridge the gap between our domain specialists (faculty and staff) and the ever-changing technological landscape; (b) installation of a standby electricity generator to maintain operations at the Museum of Biological Diversity during the rather frequent power losses (this is also important for the equipment in the DNA lab, particularly the ultralow temperature freezers that are critical to that operation); (c) continual upgrading of computer hardware, software, and wiring.

3. Consolidation of DNA lab. Acquisition and analysis of DNA sequence data is now a standard operating procedure for biodiversity science. Our present configuration of equipment and space involves significant redundancy and obsolescence. The conduct of top-quality research as well as effective recruitment of the best faculty, staff and graduate students will be substantially enhanced by the consolidation and upgrading of our existing facilities into a
shared, first-rate DNA laboratory to be located in renovated space within the Museum of Biological Diversity. Coordination of space and equipment will be overseen by a faculty committee. Operating costs will be offset from external grant funds. The effectiveness of such an arrangement depends upon two critical points: the development of clear policies for use, and the hiring of a full-time, Ph.D.-level lab manager. This manager would be responsible for everyday supervision of the facility and the training of users (faculty, staff, students).

4. Formal international partnerships. The faculty, staff, and students in biodiversity science at the University already have extensive field, museum and laboratory experience with colleagues around the world. We will move beyond these individualized, ad hoc arrangements to establish a formal partnership with at least one foreign institution. This partnership will facilitate the short-term exchange of faculty and students between the two institutions, teaching of formal courses abroad, and the provision of a significant international experience for students. As an example, the University already has signed an agreement with the Universidad Central de Venezuela, the institution that operates a well-known biological research station in the cloud forest of the Andes in north-central Venezuela. This partnership could be expanded (politics allowing) into a more extensive and substantive collaboration in the next few years. The obvious next step is to offer field courses that take advantage of the environment and the field station. Other opportunities are available through our numerous contacts with other institutions around the world, many of which have OSU alumni on their faculty.

5. Enhanced recruitment. The University is in a global competition for the best faculty, students and staff. The individual accomplishments, reputations, and grant-funding of the faculty are the primary elements that attract new recruits. We believe that the establishment of CEBRA, in and of itself, will help to focus and enhance such efforts. Continued funding in three additional areas, however, will significantly increase our recruiting effectiveness: (a) a visiting scientist program to invite leading biodiversity researchers from around the world for short-term visits to the University; (b) postdoctoral fellow program, providing two years of support for a young Ph.D. in the laboratory of one of the Center’s faculty; (c) graduate research fellowship providing six months of support to doctoral students (after admission to candidacy) to concentrate on their research, travel to field or museum sites, etc. By bringing the best and brightest here to the University, we can significantly enhance the perception of Ohio State, both nationally and internationally.

6. Enhanced outreach. The faculty, staff, and students housed at the Museum of Biological Diversity annually organize an outreach event under the auspices of the Great Lakes & Ohio Biodiversity Education (GLOBE), traditionally called the Museum Open House. This one-day event regularly draws about a thousand visitors to the Museum and is now funded by the Battelle Endowment for Technology and Human Affairs and private philanthropy. The “open house” is being developed into a larger informal teaching program for the community. In 2008, an informational booklet based on the theme of invasive species was distributed to all 956 public schools in Ohio teaching the 7th and 8th grades. The booklet included a page on addressing the state science standards for these grades. This outreach effort will be further developed through proposals for external funding.

II. PERSONNEL AND RESOURCES

A. Faculty and staff (Appendix). We currently have ten faculty in the College of Biological Sciences who have agreed to make up the core faculty of the center. Their criteria for faculty in this category are that they are CMBS faculty with an active research program in the field of biodiversity science as evidenced by publications or external funding. Total research expenditures by core faculty and staff in the period 01/01/2006–12/01/2008 averages $862K, and should approach one million dollars in 2008. Six other faculty from other colleges have expressed their interest in being associated faculty. Additionally, five permanent Ph.D.-level staff and researchers are associated with the collections and core faculty.

B. Students and postdoctoral researchers. Core faculty and staff currently train approximately 15 graduate students whose primary research focus is biodiversity science. These students are among the best in their respective departments: those in our programs over the past ten years have included two NSF Predoctoral Fellows, two University Fellows, eight Presidential Fellows, and one Graduate Enrichment Fellow. These students have also received three NSF Doctoral Dissertation Improvement Grants, one National Geographic Society grant, and significant travel funding from a number of external sources. We have hosted ten postdoctoral researchers on extramural funds. Students and postdoctoral researchers have moved on to tenure-track positions at the American Museum of Natural History, Colorado State University, CONICET (Argentina), East Tennessee State University,
Sacramento State University, Sam Houston State University, Taiwan Agricultural Research Institute, Universidade Estadual do São Paulo, Universidade Federal do Espírito Santo, University of Akron, University of Florida, University of Kansas, University of Vermont, and Western Kentucky University. Others are currently in postdoctoral positions at Brigham Young University, CSIRO (Australia), Museu Nacional (Brazil), University of California Santa Barbara, University of California Davis, the University of Michigan and the University of West Virginia.

C. Facilities. The focal facility for CEBRA is the Museum of Biological Diversity (1315 Kinnear Road), located on West Campus near the Science and Technology Center. Six of the core faculty and all of the Ph.D.-level staff associated with the proposed center are located there. The Museum provides office and laboratory for those faculty, their students, staff, and postdoctoral associates. (An additional four faculty not included in the center proposal are housed at the MBD.) In the Museum are also two wet lab classrooms and an auditorium. Two core faculty (Abdul-Salim, Wolfe) are located in Aronoff Laboratories on Main Campus (311 W. 12th Ave.), and one (Kubatko) is housed in Cockins Hall (1958 Neil Ave.).

The research collections of the Museum of Biological Diversity provide the physical core for CEBRA and are key resources for faculty, staff, students, and visiting scientists. The collections currently are organized as seven independent units, each with their own budget and policies. The units are the (1) Acarology Laboratory (mites, ticks, etc.); (2) the C.A. Triplehorn Insect Collection; (3) the Ohio State University Herbarium, the Museum of Zoology which includes the Divisions of (4) Fishes, (5) Molluscs, and (6) Higher Vertebrates; and (7) the Borror Laboratory of Bioacoustics. Several of the collections already have initiated efforts to database their holdings. The Herbarium and the Divisions of Molluscs and Fishes function as official collections for the State of Ohio. These facilities are involved not only in our research efforts, but also in the teaching and service missions: they are the focus of the Museum Internship program for undergraduates, the laboratory components of several courses, and in the annual GLOBE outreach event.

III. ADMINISTRATION

In organizing the administrative structure for CEBRA, we have followed the University guidelines for academic centers. Therefore, the two principal elements described here are the Director and the oversight committee.

A. Director. The primary responsibilities of the Director, in consultation with all relevant parties, will be to develop and implement priorities for collaborative research, teaching, and outreach activities of CEBRA personnel; supervise day-to-day operation of common facilities and personnel; represent CEBRA and its members’ interests to the department and college administrations; and regularly meet and consult with center committees and personnel. The Director shall be the Principal Investigator or Co-Principal Investigator on grant applications to external funding agencies for coordinated Center activities.

The Director is appointed by and serves at the pleasure of the Dean of the college; the standard period of appointment is three years. The position should normally be held by a tenured member of the core faculty. The position of Director is a 11-month appointment.

B. Oversight Committee. This committee shall be formed of the Director and four members of the core faculty. Its responsibilities are to assist in the development and implementation of center priorities. The members, other than CEBRA Director, will serve on the committee for two years, with staggered appointments (two appointments terminating each year).

Additional committees with responsibilities for specific tasks will be formed, as needed, by the Director.

IV. BUDGET/FUNDING

1. DNA lab renovations within Museum of Biological Diversity (reconfiguration of Rooms 1500 and 1700 blocks of rooms) : $500K cash
2. DNA-lab manager salary/benefits: $75K continuing funds
3. Standby generator: $50K cash
4. Informatics specialist salary/benefits: $75K continuing funds
5. Postdoctoral, visiting scientist, graduate fellowship programs: $100K continuing funds  
7. Classroom renovations within Museum of Biological Diversity (1110 suite of rooms, auditorium): $100K cash  
8. Director, off-quarter salary/benefits: $25,000 continuing funds

V. EVALUATIVE CRITERIA AND BENCHMARKS

Evaluation of the progress of the center as well as the participation of individual members of the center may be made using the same set of criteria. These are (1) number of extramural grants and amount of funding; (2) amount of F&A costs recovered; (3) number of publications; (4) number of external presentations; (5) enrollments in new and existing courses and curriculum; (6) number of undergraduate internships; (7) number and profile of applications and admissions of graduate students; (8) graduate student outcomes, including publications, presentations, placement; (9) extent and impact of outreach activities; (10) diversity of faculty and students.

VI. RELATION OF CEBRA TO UNIVERSITY PRIORITIES

A. Academic Plan. The focus on and resulting visibility of biodiversity science at OSU will significantly enhance our ability to recruit and retain high quality faculty, postdoctoral researchers, and graduate students. This would directly impact on the Academic Plan strategies to Build a World-Class Faculty and Enhance and Better Serve the Student Body. The development of a curriculum in biodiversity science, undergraduate internships, and special workshops will set the University apart as one of only three institutions (and the only one in the eastern U.S.) with comprehensive expertise in this area, thus addressing the charge to Develop Academic Programs that Define Ohio State as the Nation’s Leading Public Land-Grant University.

B. Institutional Priorities. The Provost’s presentation in the strategic planning workshop in 2007 listed six institutional priorities. Continued development and expansion of our internship program will contribute to the undergraduate research effort. Doctoral program quality should be enhanced by an improved recruitment effort. Outreach and engagement is addressed by the GLOBE program. Members of CEBRA are already closely affiliated with work in the Mathematical Biosciences Institute, one of the centrally funded Targeted Investments in Excellence. Our faculty and students are already deeply engaged with international experiences; our goal to develop a close and long-term collaboration with a foreign institution (such as the Universidad Central de Venezuela) will provide a context to expand this component through reciprocal exchanges of faculty, staff and students and offering of formal courses abroad.
APPENDIX. CEBRA FACULTY AND STAFF.

Core faculty.

Dr. Kobinah Abdul-Salim (Assistant Professor, EEOB) – Angiosperm systematics, especially Clusiaceae; African biogeography.

Dr. Richard Bradley (Associate Professor, EEOB) – Diversity and behavior of spiders of North America and Australia.

Dr. Marymegan Daly (Assistant Professor, EEOB) – Diversity and evolution of marine invertebrates, especially Cnidaria.

Dr. John V. Freudenstein (Associate Professor, EEOB) – Angiosperm systematics, especially Orchidaceae and Ericaceae; theory of systematics.

Dr. John P. Hunter (Assistant Professor, EEOB) – Paleontology; mammal evolution.

Dr. Norman F. Johnson (Professor, Entomology) – Systematics of Hymenoptera; biodiversity informatics.

Dr. Laura Kubatko (Associate Professor, Statistics and EEOB) – Statistical genetics, including the estimation of phylogenetic trees from nucleotide sequence data, linkage and QTL analysis, and the analysis of microarray data.

Dr. Hans Klompen (Associate Professor, Entomology) – Systematics of mites and ticks; evolution of host-parasite associations.

Dr. John W. Wenzel (Professor, Entomology) – Evolution of complex behavior in insects, especially wasps.

Dr. Andrea D. Wolfe (Associate Professor, EEOB) – Molecular systematics and molecular evolution of parasitic plants and Penstemon.

Associated Faculty (Those either in colleges, or with secondary interest in this area).

Dr. William Ausich (Professor, School of Earth Sciences) – Paleontology; crinoid evolution.

Dr. Daniel Janies (Associate Professor, Biomedical Informatics) – Comparative genomics in disease organisms.

Dr. Brian Joseph (Professor, Linguistics) – Phylogenetic reconstruction of origin and evolution of Indo-European languages.

Dr. Dennis Pearl (Professor, Statistics) – Statistical analysis of nucleotide sequences and phylogenetic trees; simulation-based estimation and modeling of biological phenomena.

Dr. Paul A. Fuerst (Professor, EEOB) – Population genetics; molecular phylogenetics.

Dr. Lisle Gibbs (Professor, EEOB) – Population genetics; phylogeography.

Research Staff.

Dr. Alpana Chaudhuri (Research Associate, EEOB) – Molecular genetics technical expert.

Dr. Cynthia Dassler (Curator of Lower Plants, EEOB) – Systematics of ferns, mosses, and lichens.

Dr. Luciana Musetti (Research Associate, Entomology) – Systematics of Hymenoptera; biodiversity informatics.

Dr. Mesfin Tadesse (Curator of Higher Plants, EEOB) – Systematics of flowering plants, particularly Asteraceae.

Dr. G. Thomas Watters (Curator of Molluscs, Adjunct Assistant Professor, EEOB) — Systematics and conservation of bivalves.