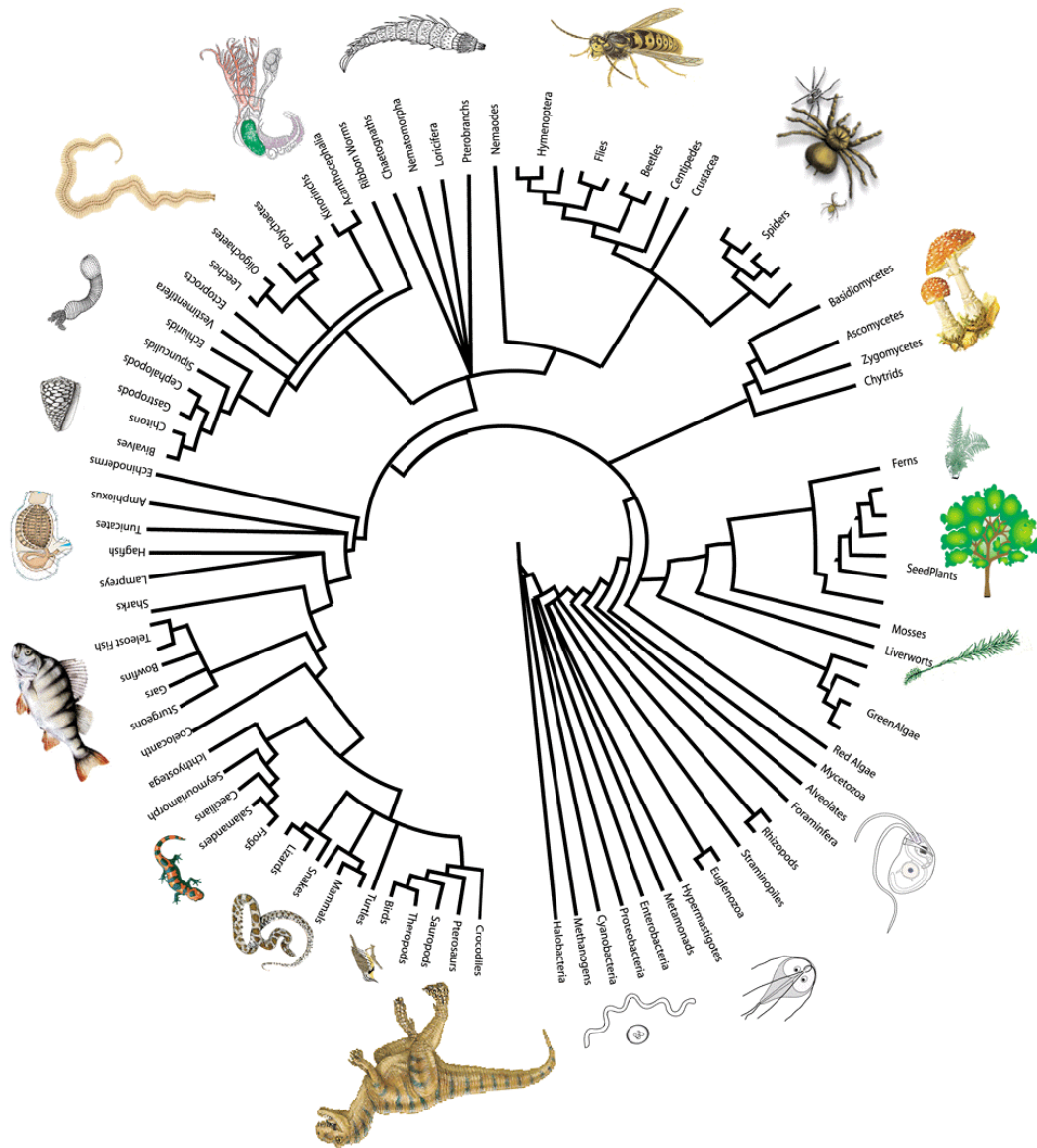


Annual Report
2003

The Weintraub Program in Systematics and Evolution



Department of Biological Sciences
George Washington University
Washington DC 20052

The Weintraub Program in Systematics and Evolution

One of the most profound ideas to emerge from modern science is that all of life, from the smallest microorganism to the largest vertebrate, is connected through genetic relatedness in a vast evolutionary tree. Systematics is the field of biology that discovers and describes new species and reconstructs the evolutionary tree of life. Systematics is, therefore, at the core of studies of biodiversity and the information gathered and organized in evolutionary trees underpins much of comparative biology. For example, systematics is critical to choosing experimental systems for biological research, tracking the origin and spread of emerging diseases and their vectors, bioprospecting for pharmaceutical and agrochemical products, preserving germplasm, targeting biological control of invasive species, and evaluating risk factors for species conservation and ecosystem restoration. Despite its importance, the patterns of relationship and the tempo and mode of evolutionary change remain unknown for most species on earth.

George Washington University has made a substantial commitment to education and research in systematics. Recently, GWU established the Robert Weintraub Program in Systematics and Evolution with 4 endowed professorships (to be expanded to five), involvement of several existing faculty at GWU and Smithsonian curators as adjunct faculty, and substantial funds for research and field work. Faculty and graduate students currently in the program work on a variety of organisms including bacteria, protists, angiosperms, cnidarians, mollusks, polychaete worms, arthropods, echinoderms, dinosaurs, mammals and lizards.

Dr. Robert L. Weintraub (1912-1996)

The Program is named in honor of Dr. Robert L. Weintraub who, through his vision for research and graduate education, and generous financial support, made it possible to strengthen our program in systematics and evolution.

In addition to his decades of association with GWU, as an alumnus and member of faculty, Professor Weintraub also was among the University's greatest benefactors. For many years he and Mrs. Weintraub, who is also a GWU alumna, supported graduate fellowships in the Department of Biological Sciences. In recent years, Professor Weintraub endowed five professorships in systematics in the Department of Biological Sciences. Four of these professorships are named for members of his family (the Ronald B Weintraub Professorship, the Louis Weintraub Professorship, the Ruth Weintraub Professorship, and the Grace B. Carnes Professorship). The fifth professorship is named in honor of Robert F. Griggs, a former member of the GWU faculty who was one of Professor Weintraub's mentors.

Professor Weintraub's outstanding philanthropy places him among the great benefactors of the University and has had enormous impact on the advancement of the Department of Biological Sciences. To honor his career and life, we have renamed the chairmanship in his honor to the Robert L. Weintraub Chair in Biology (this position is currently held by Dr. Robert Donaldson).

The Endowed Weintraub Faculty

Dr. Marc Allard - Louis Weintraub Associate Professor of Biology

Research in Dr. Marc Allard's lab focuses on evolutionary genetics, quantitative and molecular systematics of mammals, phylogenetics, molecular evolution, evolutionary theory, and conservation genetics. The work in the lab on conservation genetics focuses on the management of threatened and endangered populations by assessing the levels of genetic variation in both wild and captive populations of endangered organisms and their closest relatives. This research attempts to determine the ecological criteria necessary for preserving the species and often involves studying an organism's reproductive genetics and biology. Ongoing research includes using molecular markers for documenting hybridization between logger-head and Kemp's ridley turtles (*Caretta caretta* and *Lepidochelys kempii*) off the Carolina coast and examining the conservation management issues surrounding this phenomena. I am also studying the past (including using museum specimens) and present genetic variation found in solenodons (small insectivore mammals) from Hispaniola and Cuba by documenting the genetic variation and tying this to morphological variation. This will help develop a conservation management plan for these endangered species (Collaborators Dr. C. W. Kilpatrick, University of Vermont; and Dr. J. Ottenwalder, Dominican Republic).

The lab's forensic research involves collaborations with the U.S. Department of Justice, Federal Bureau of Investigation, FBI Academy, Counter-terrorism and Forensic Science Research Unit, as well as the Chem-Bio Sciences Unit in Quantico VA. Forensic scientists analyze control region mtDNA genetic variation to resolve identity in missing persons and criminal cases. When one cannot exclude, based on mtDNA analysis, an evidence sample and a reference sample as possibly originating from the same source, an inference on the rarity of the sequence is determined. Population databases are used to estimate the rarity of a mtDNA profile. The Scientific Working Group on DNA Analysis and Methods (SWGDM) has compiled a mtDNA reference database for this purpose. As a visiting Scientist at the FBI Academy Dr. Allard and his PhD student Kristen Gansberger works on DNA identification, SNP based analyses, and database structure with federal researchers (Dr. K. Monson, B. Budowle and M. Wilson). Ongoing research includes increasing the reference data sets and rapid SNP analyses of informative genetic variation for target groups, including humans, canines and microbes (this research is funded by DOJ/DOE/FBI).

The lab is at the forefront of research on the systematic relationships and comparative analysis of the Lipotyphla (shrews, moles, hedgehogs, and their relatives). Dr. Allard's and his PhD student Mike Malia's work has generated renewed interest in this mammalian order, largely due to the enigmatic nature of the results. These insectivores do not appear to be a natural group. However, it is not clear which order(s) they are closely related to, if any. They are collaborating with a morphologist (Dr. Asher, Berlin Museum) to provide a synthesis of the available comparative evidence. Future research will involve



building super-trees and large-scale analyses of mammals with particular emphasis on rodents and primates.

Dr. Allard is currently supervisor for 2 PhD students: Mr. Mike Malia (examining the evolutionary relationships of the insectivores) and Ms. Kristen Gansberger (studying forensic molecular biology through an analysis of the mitochondrial genetics of dogs to aid in identification of hairs found at crime scenes). Dr. Allard teaches 2 courses (Phylogenetic Systematics and Molecular Systematics) and is active in many university and scientific activities. Dr. Allard is especially active in the computational biology programs of the medical school and the Columbian College where he has helped secure funding for a state-of-the-art parallel computing system for analyzing genetic data.

Recent publications:

Malia Jr., M. J., D. Lipscomb, and M. W. Allard. 2003. Effects of composite taxa in molecular supermatrices. *Mol. Phylogenetics and Evol.* 27(3):522-527.

Budowle B., M. R. Wilson, and M. W. Allard. 2002. Characterization of heteroplasmy and hypervariable sites in HVI: Critique of D'Eustachio's interpretations. *Forensic Science International.* 130:68-70.

Allard, M. W., M. Wilson, K. Miller, K. Monson and B. Budowle 2002.

Characterization of the Caucasian haplogroups present in the SWGDAM forensic mtDNA data set for 1771 human control region sequences. *Journal of Forensic Sciences* 47:1215-23.

Malia Jr., M. J., R. M. Adkins, and M. W. Allard. 2002. Molecular support for Afrotheria and the polyphyly of Lipotyphla based on analyses of the growth hormone receptor gene. *Molecular Phylogenetics and Evolution.* 24:91-101.

Dr. James Clark - Ronald Weintraub Associate Professor of Biology

The research in Dr. Clark's lab focuses on the diversity and evolution of fossil land vertebrates, especially those from fossil deposits of the Age of Dinosaurs (the Mesozoic). One of the main projects in the lab is on dinosaurs and the evolution of



birds. The theropod dinosaurs and primitive birds collected by Dr. Clark on his expeditions to the Gobi Desert of Mongolia and China include numerous skeletons providing important new information on the relationships of birds to other dinosaurs. Among these are the first embryonic dinosaur skeleton from Mongolia and specimens of oviraptors sitting on nests in a bird-like position. The research focuses on the relationships among the closest relatives of birds, especially oviraptorids, dromaeosaurids, troodontids, the bizarre therizinosaurs, and the unusual basal bird *Mononykus*. Supported by a \$4 million NSF Tree of Life grant in 2002 (along with M., Norell, S. Hackett, and other colleagues), Dr. Clark and his colleagues are now developing an online database of theropod and bird

morphological characters including images of each character.

Other research in the lab includes study into the evolutionary diversity and locomotion in Pterosaurs. Brian Anders, a masters student now in the PhD program at Yale, has been involved in the Chinese field work and completed his thesis last year on two new Chinese pterodactyls. Analysis of locomotion (done in conjunction with J. Hopson of the University of Chicago) especially on the capacity for walking and running in these animals was uncovered in an exquisite skeleton of a primitive pterosaur from Huizachal Canyon in Mexico. In particular, the joint at the base of the toes (the metatarsal-phalangeal joints) are nearly flat, preventing them from bending back into a posture in which the animal walked or ran on its toes, rather than on the ball of its foot.

In all of the research, fundamental scientific problems involved in the study of extinct organisms preserved in the fossil record are explored. Fossils offer important information about evolutionary relationships, but they also are difficult to study because of they are invariably incomplete. My research explores the limitations and advantages of information from fossils, especially regarding the effect of missing data and the inference of non-morphological features of fossils.

Dr. Clark is currently supervisor for 2 PhD students: Mr. Sayantan Biswas who is examining the evolutionary relationships within two skink genera from southeast Asia, and Ms. Rosario Castaneda who is studying the phylogeny of Anoles from northern South America. Dr. Clark teaches 2 courses (Vertebrate Phylogeny, and Morphological Systematics) and is active in many university and scientific activities. Much of his time is spent as the Department's Graduate Advisor, supervising all of the department's graduate students, overseeing their progress, and making sure they complete all their requirements on time. He often gives talks to the public and at meetings, such as at the annual meeting of the Society of Vertebrate Paleontology in Minnesota last month.

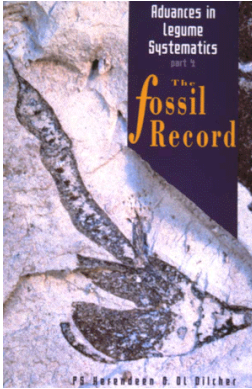
Recent publications:

- Clark, J. M. , M. A. Norell, and T. Rowe 2002. Cranial anatomy of *Citipati osmolskae* (Theropoda, Oviraptorosauria), and a reinterpretation of the holotype of Oviraptor philoceratops. American Museum Novitates 3364, 1-24.
- Clark, J.M., M. Norell, and P. Makovicky. 2002. Cladistic approaches to the relationships of birds to other theropods. Pp. 31-64 in: "Mesozoic Birds: Above the Heads of Dinosaurs," L. Chiappe and L. Witmer, editors, University of California Press.
- Kearney, M. and J. Clark. 2003 Problems due to missing data in phylogenetic analyses including fossils: a critical review. Journal of Vertebrate Paleontology 23: 263-274.



Dr. Patrick Herendeen - Robert Griggs Assistant Professor of Biology

The research in Dr. Herendeen's lab focuses on two main topics – early evolutionary history of flowering plants through study of the early fossil record of angiosperms, and evolutionary history of the legume family. For both projects, Dr. Herendeen, his students, and collaborators use both living and fossil plants to investigate present and historical patterns of systematic diversity, morphological and anatomical complexity, and biogeographic distribution patterns. The early angiosperm study involves fossil material from numerous Cretaceous age fossil localities along the Atlantic Coastal



Plain from southern Georgia to New Jersey, plus other localities in the western US, southern England, Japan, Portugal, and other regions. Together with collaborators at several institutions in the US, Mexico, and England they are studying fossil flowers and other reproductive structures preserved in these sediments. This past summer, Dr. Herendeen conducted preliminary field work in England on some Jurassic age fossil sites. These localities pre-date flowering plants and are known to contain some very interesting gymnospermous seed plants that may be closely related to the angiosperms. If the methods work for these deposits, they expect some very significant discoveries in the next year.

Dr. Herendeen's work on the evolutionary history of the legume family involves both paleobotanical work on a variety of significant fossil legumes and work on living legumes to produce a comprehensive phylogeny for all genera of caesalpinioideae legumes. This project requires field work in the tropics of Madagascar, Indonesia, Malaysia, Brazil, Guyana, and other countries to collect specimens of genera that are not well represented in herbarium collections. Dr. Herendeen recently received a grant from the National Science Foundation to fund this research project and several graduate students are involved in aspects of this work.



In addition to being an academic advisor for undergraduates, Dr. Herendeen is the primary supervisor for three PhD students: Mr. John Clark (researching the plant family Gesneriaceae, a distinctive component of the understory vegetation especially in South America), Ms. Vineta Gowda (researching the evolution of the ginger family Heliconiaceae and its pollination biology), and Ms. Karen Redden (researching the morphological and genetic evidence for the evolution and biogeography of tropical legumes of South America). Undergraduate Solomon Stonebloom, is conducting independent research on Jurassic age fossil plants and is assisting with laboratory work in the legume study.

Dr. Herendeen teaches 3 courses (Biogeography and Coevolution, Diversity and History of Plants, and Angiosperm Diversity and Phylogeny) and is active in many university and scientific activities. This includes being editor-in-chief for the journal *Systematic Botany*, which is a leading journal in the field of plant systematics. In recognition for all of his accomplishments and hard work, Dr. Herendeen was awarded

tenure in Spring 2003 and promoted to the rank of associate professor (effective July 2004).

Recent Publications:

- Herendeen, P. S., G. P. Lewis, and A. Bruneau. 2003. Floral morphology in caesalpinoid legumes: testing the monophyly of the “*Umtiza* clade.” *International Journal of Plant Sciences* 164(5 Suppl.): S393-S407.
- Doyle, J. A., H. Eklund, and P. S. Herendeen. 2003. Floral evolution in Chloranthaceae: implications of a morphological phylogenetic analysis. *International Journal of Plant Sciences* 164(5 Suppl.): S365-S382.
- Herendeen, P.S., A. Bruneau, G. P. Lewis. 2003. Phylogenetic Relationships in Caesalpinoid Legumes: A Preliminary Analysis based on Morphological and Molecular Data. Pp. 37-62 in B. B. Klitgaard and A. Bruneau, Editors. *Advances in legume systematics*, part 10. Royal Botanic Gardens, Kew.
- Lupia, R., P. S. Herendeen, and J. A. Keller. 2002. A new fossil flower and associated coprolites: evidence for angiosperm-insect interactions in the Santonian (Late Cretaceous) of Georgia, U.S.A. *International Journal of Plant Sciences* 163: 675-686.

Dr. Gustavo Hormiga – Ruth Weintraub Associate Professor of Biology

The research in Dr. Hormiga’s lab focuses on the systematics and evolution of one of the most diverse orders on the planet, spiders. With the help of funding from two large NSF PEET grants, Dr. Hormiga and his students concentrate on the evolution and diversity



several spider families: the sheet weaving Linyphiidae, the cob weavers (Theridiidae) and the orb weaving Tetragnathidae and Mysmenidae. Current knowledge of non-orb web architectures is extremely poor. Most of what is known about spider web architecture is derived from orb weaving species, despite the fact that there are more non orb weaving than orb weaving species. The research of Dr. Hormiga and his students on web diversity and architecture and their studies on the phylogenetic relationships of web building spiders is changing our understanding of web evolution.

The research on the family Tetragnathidae focuses on the higher level systematics of this orb weaving lineage, especially the phylogeny of the subfamily Nephilinae. Species of *Nephila* and *Nephilengys* are the most

conspicuous web-spinning spiders in the tropics. The colorful females are huge and their large orb webs (> 1 m. diam.) are frequently seen in noticeable places. *Nephila clavipes*, as well as other congeneric species, are among the most intensely studied arachnids and are often used as a model organisms to study ecology, behavior, silk and venom chemistry, and sexual selection. Despite their importance, the taxonomy (including identification) of *Nephila*, and nephilines in general, lacks a modern revision and a phylogeny. Until both obstacles are removed it will be difficult, if not impossible, to

place most of the available biological data on nephilines in a comparative and evolutionary context. Dr. Hormiga and his students are revising the genera and species of World Nephilinae (summarizing as well their geography, natural history, and web architecture).

Another line of research in Dr. Hormiga's lab is to expand our knowledge about the diversity of spiders. Dr. Hormiga has recently discovered a genus, *Orsonwelles*, which represents a radiation of Hawaiian endemics and a genuine case of island gigantism; these spiders are the largest linyphiids known. They have remained unstudied since initial description of two species at the turn of the century. These Hawaiian linyphiids seem to be the result of a single colonization event of the archipelago. This radiation is richer than originally described and includes no less than thirteen species (all but two are new to science). At least one species lives on every major island (Kauai and Oahu have six and three species, respectively); all the species are single island endemics. In collaboration with Miquel Arnedo, he is currently studying the phylogenetic relationships of these taxa using both morphological and molecular characters, to infer the biogeographic pattern of this radiation and contrast it with the known historical geology of the archipelago. The cladistic patterns of these spiders are consistent with the old-to-young island progression that has been documented for many Hawaiian endemics (this research is funded in part by a grant from the Committee for Research and Exploration of the National Geographic Society). More recently Dr. Hormiga has studied and described a new genus of pimoid spiders from Japan, which he named after Dr. Weintraub. *Weintrauboa* (right picture) spiders belong to an ancient and relictual group, the pimoids, whose study is revealing important clues about the evolution of linyphiids (the largest lineage of web-building spiders).



Dr. Hormiga has recently started work on a large scale, multi-investigator project to reconstruct the phylogeny of all spider families. This ambitious project, funded by the National Science Foundation, is part of an initiative to "Assemble the Tree of Life" and involves participants from about a dozen institutions in four countries.

In all of his research, Dr. Hormiga emphasizes the importance of reconstructing the history of evolutionary changes for addressing comparative questions. His research on sexual size dimorphism in spiders (size differences between males and females) reconstructs the cladistic patterns underlying the diversity of sexual size dimorphism in orb weavers and aims to identify and distinguish the independent evolutionary histories that have generated those patterns. Me and his colleagues results show that the extensively studied "male dwarfism" of nephiline spiders (Tetragnathidae), when placed in a phylogenetic context, is in fact a case of female gigantism and that there have been several independent origins of dimorphism within Araneoidea, and several reversals to monomorphism. Dimorphism has been attained in different ways (e.g. female gigantism or male dwarfism) and cannot be treated as a homologous trait across all spiders.

Dr. Hormiga is currently the primary supervisor for four PhD students: Mr. Ingi Agnarsson (researching the social spiders of the genus *Anelosimus*), Mr. Matjaz Kuntner

(researching the nephiline spiders of the world), Mr. Fernando Alvarez Padilla (researching the metine spiders) and Ms. Lara Lopardo (researching the mysmenid spiders).

Dr. Hormiga teaches 3 courses (Phylogenetic Systematics, The Phylogenetic Basis of Comparative Biology, and Descriptive Systematics: Documenting Biodiversity) and is active in many university and scientific activities. With financial support from an NSF-INT award, Dr. Hormiga is on sabbatical this year at the Zoological Museum of the University of Copenhagen where he is a guest researcher.

Recent Publications:

- Scharff, N., J. A. Coddington, C. E. Griswold, G. Hormiga, and P. Bjørn. 2003. When to quit? Estimating spider species richness in a northern European deciduous forest. *Journal of Arachnology* 31:246-273.
- Hormiga, G. 2003. *Weintrauboa*, a new genus of pimoid spiders from Japan and adjacent islands, with comments on the monophyly and diagnosis of the family Pimoidae and the genus *Pimoida* (Araneoidea, Araneae). *Zoological Journal of the Linnean Society* 139:261-281.
- Hormiga, G., M.A. Arnedo, and R. Gillespie. 2003. Speciation on a conveyor belt: sequential colonization of the Hawaiian Islands by *Orsonwelles* spiders (Araneae, Linyphiidae). *Systematic Biology* 52(1):70-88.
- Hormiga, G. 2002. *Orsonwelles*, a new genus of giant linyphiid spiders (Araneae) from the Hawaiian islands. *Invertebrate Systematics* 16:369-448.

Additional Faculty in the Weintraub Program

John Burns – The research in Dr. Burn's lab focuses on the comparative morphology and evolution of fishes, specifically on the reproductive biology of teleost fishes, including both physiological and anatomical studies. He and his students have been concentrating on the morphology of reproductive tissues using advanced microscopical analysis. They have been carrying out these analyses principally on inseminating and/or viviparous species within the Cyprinodontiformes and Beloniformes (Atherinomorpha), and Characiformes and Siluriformes (Ostariophysi). The data thus far have revealed a tremendous diversity in the adaptations correlated with fascinating reproductive habits. In addition to providing information on the basic reproductive biology of these species, the results are providing morphological characters that are proving useful in hypothesizing possible phylogenetic relationships among these fishes.

Recent publications:

- Burns, J. R., A. D. Meisner, S. H. Weitzman and L. R. Malabarba. 2002. Sperm and spermatzeugma ultrastructure in the inseminating catfish, *Trachelyopterus lucenai* (Ostariophysi: Siluriformes: Auchenipteridae). *Copeia* 2002:173-179.
- Bushmann, P. J., J. R. Burns and S. H. Weitzman. 2002. Gill-derived glands in glandulocaudine fishes (Teleostei: Characidae: Glandulocaudinae). *Journal of Morphology* 253:187-195.
- Menenezes, N.A., S.H. Weitzman and J. R. Burns. 2003. A systematic review of *Planaltina* (Teleostei: Characiformes: Characidae: Glandulocaudinae: Diapomini) with a description of two species for the upper Parana, Brazil. *Proceedings of the Biological Society of Washington* 116(3). In press.

Patricia Hernandez – Research in Dr. Hernandez's lab focuses on developmental Biology, Functional Morphology, and Evolution of Vertebrates, specifically focusing on uncovering the developmental mechanisms involved in vertebrate head formation using the zebrafish model system. The relative simplicity of these embryonic structures in these fish affords an ideal situation in which to study the molecular mechanisms involved in the interactions among germ layers in these structures. In addition, the lab is investigating the evolutionary developmental biology of fishes. Together with doctoral student, Nathan Bird, Dr. Hernandez is examining the development and evolution of the Weberian apparatus, a novel bony connection between the inner ear and swim bladder, which characterizes the Otophysi. They believe that this probable key innovation has led to a major radiation (~27% of all fish species) within this group and they are mapping a number of gene expression patterns, as well as larval and adult morphological characters unto a known phylogeny to better understand how this complex structure has developed and evolved.

Recent publications:

- Barresi M.J.F., D'Angelo J.A., Hernandez L.P., and Devoto S. H. 2001. Distinct mechanisms regulate slow-muscle development. *Curr. Biol.* 11 (18): 1432-1438.
- Hernandez, L. P., M. J. F. Barresi and S. H. Devoto. 2002. Functional morphology and developmental biology of zebrafish: reciprocal illumination from an unlikely couple. *Integrative and Comparative Biology*, Volume 42(2): 222-231.

Robert Knowlton – Research in Dr. Knowlton's lab focuses on the ecology (marine, physiological), and the endocrinological mechanisms that control development of crustacea using larvae of the "snapping shrimp" *Alpheus heterochaelis* as a model system. In addition laboratory and field studies analyzing life histories and behavioral responses of various species of the "grass shrimp" *Palaemonetes* to differences in salinity, substrate, and cover (submergent vegetation). These differences could contribute to habitat partitioning, allowing the sympatric estuarine species *P. pugio* and *P. vulgaris* to coexist.

Recent publications:

- 2001. [with H. C. Merchant and R. N. Khan] The effect of macrophytic cover on survival of *Palaemonetes pugio* and *P. vulgaris* (grass shrimp) in the presence of predatory *Fundulus heteroclitus* (killifish). *Contributions to Zoology*, 70: 61-71.
- 2002. [with H. H. Ganz] Reproductive differences among Delmarva grass shrimp (*Palaemonetes pugio* and *P. vulgaris*) populations, *Virginia Journal of Science*, 53: 35-49.
- 2002. [with P. S. Gross] Morphological variations among larval-postlarval intermediates produced by eyestalk ablation in the snapping shrimp *Alpheus heterochaelis* Say. *Biological Bulletin*, 202: 43-52.

Diana Lipscomb – In addition to serving as the director for the Weintraub program, Dr. Lipscomb has recently returned to GWU after a 2 year stint at the National Science Foundation where she was a program director for systematic biology and head of the Assembling the Tree of Life program. Research in Dr. Lipscomb's lab focuses on the systematics and evolution of protists and invertebrates. The work over the past year has focused on two areas - acquiring molecular sequence data from eukaryote microorganisms that could not be maintained in laboratory culture, and identification and distribution of amphibian parasites. Working with graduate student K. Kivimaki, undergraduates M Kujukian (currently in medical school at NYU), S. Huff (currently in graduate school at Harvard) and a colleague (and former graduate student) from Trinity College (B. Bowditch) the lab has developed a procedure for isolating individual ciliate cells from marine waters, extracting DNA, and sequencing DNA. The lab is now in the process of submitting papers for publication and preparing an NSF proposal for research into the molecular diversity of ciliated protists (phylum Ciliophora). Working with colleagues Dan Jansen (U Pennsylvania) and D. Brooks (U Toronto) the lab project is cataloging the diversity of protozoan symbionts in frogs from Costa Rica. The disappearance of amphibians from many parts of the world is alarming to many biologists and it is hoped that a better understanding of their parasites and associated symbionts will help us understand the phenomenon. Other graduate students working in the lab focus on systematics of various invertebrate groups including cnidarians, polychaetes, and nemertenes.

Recent publications:

- Daly, M., D. L. Lipscomb and Marc W. Allard. 2002. A simple test: evaluating explanations for the relative simplicity of the Edwardsiidae (Cnidaria: Anthozoa). *Evolution*, 56: 502-510.

Lipscomb, D.L., N. Platnick, and Q. Wheeler. 2003. The intellectual content of taxonomy: a comment on DNA taxonomy. *Trends in Ecology and Evolution* 18: 65-66.

Lipscomb, D.L. and K. Kivimaki. 2003. The Protists. *In* Invertebrates 2nd edition R. Brusca and G. Brusca, Sinauer Press, Sunderland, MA.

Courtney Smith – Research in Dr. Smith's lab focuses on the molecular evolution of the immune system specifically by studying the innate immune system of the purple sea urchin, *Strongylocentrotus purpuratus* (a member of the most primitive phylum in the lineage leading to vertebrates). She and her gstudents have been focusing on the immune cells, or coelomocytes (cells found in the coelom) of the sea urchin that become activated in response to injury or infection. They have identified a number of genes that are expressed by activated coelomocytes including homologues of complement proteins. A second line of investigation centers on a large set of putative antimicrobial proteins that are induced by challenge with lipopolysaccharide. By employing proteomics, genomics and molecular biology, the members of the lab are currently working to understand the functions of these proteins, the number of genes in the genome, and the mechanisms for generating this high level of diversity in an invertebrate immune response.

Recent publications:

Smith, LC, LA Clow & DP Terwilliger. 2001. The ancestral complement system in sea urchins. *Immunological Reviews*, 181:16-34.

Shah, M, KM Brown & LC Smith. 2003. The gene encoding the sea urchin complement protein, SpC3, is expressed in embryos and can be upregulated by bacteria. *Developmental and Comparative Immunology*, 27:529-538.

Smith, LC. 2002. Thioester function is conserved in SpC3, the sea urchin homologue of the complement component C3. *Developmental and Comparative Immunology*, 26:603-614.

2002-2003 Field Work of the Weintraub Program

An important part of systematic research includes redescription (using modern microscopical and genetic techniques) of species and the discovery of new species. Therefore, one of the major parts of our research involves field expeditions. With the help from funding from the National Geographic Society and the National Science Foundation, in 2002-2003, Weintraub faculty and students traveled throughout the world to catalog the Earth's biodiversity:

Asia:

James Clark: Xinjiang, China – Late Jurassic deposits in northwest China to collect theropod dinosaurs.

Gustavo Hormiga: Thailand - Northern and Southern Thailand, to collect spiders in connection to the Tree of Life project.

Australia:

Gustavo Hormiga: Queensland -to collect spiders and behavioral data.

Africa:

Diana Lipscomb: Western Cape, South Africa – the Langebaan Lagoon and De Hoop nature reserve to collect protozoa.

Europe:

Marc Allard: Russia - Site reviewer for 10 Russian Universities in the Research and Education Centers grant competition for US Civilian Development Foundation. Travel and site visit review throughout Russia (May 11-27, 2002). Also, Travel and site visit review to St. Petersburg Russia (Sept. 6-12, 2003).

Patrick Herendeen: England - Jurassic deposits to collect plants from a time before flowers evolved.

South and Central America:

John Clark (Herendeen graduate student): Spent nearly one year in Ecuador collecting plants for his dissertation study, as well as several short trips to Panama, Venezuela, and Bolivia to collect plants for his research.

Karen Redden (Herendeen graduate student): spent three months in Guyana collecting plants for her dissertation research.

North America:

Diana Lipscomb: Bodega Marine Lab, California – the Bodega harbor and surrounding wetlands to collect protozoa.

Patrick Herendeen: James River, Virginia and Elk Neck Peninsula, Maryland – explored 10 miles of the James River east of Richmond and several bluff exposures on the Elk Neck Peninsula for Cretaceous age fossil sites containing plant fossils.

New Species Discovered (2002-2003):

Arthropods:

Spiders:

- Hormiga, G. 2003. *Weintrauboa*, a new genus of pimoid spiders from Japan and adjacent islands, with comments on the monophyly and diagnosis of the family Pimoidae and the genus *Pimoida* (Araneioidea, Araneae). *Zoological Journal of the Linnean Society*, 139, 261–281. (Named in honor of Dr. Robert Weintraub).
- Hormiga, G. 2002. *Orsonwelles*, a new genus of giant linyphiid spiders (Araneae) from the Hawaiian islands. *Invertebrate Systematics* 16:369-448.

Vertebrates:

Fish:

- Menenezes, N.A., S.H. Weitzman and J. R. Burns. 2003. A systematic review of *Planaltina* (Teleostei: Characiformes: Characidae: Glandulocaudinae: Diapomini) with a description of two species for the upper Parana, Brazil. *Proceedings of the Biological Society of Washington* 116(3). In press.(2 new *Planaltina* species)

Crocodiles:

- Clark, J.M. and H.-D. Sues. 2002. Two new species of basal crocodylomorphs and the status of the Sphenosuchia. *Zoological Journal of the Linnean Society* 136:77-96.

Dinosaurs:

- Clark, J., M.A. Norell, and R. Barsbold 2001. Two new oviraptorids (Theropoda: Oviraptorosauria), Late Cretaceous Djadokhta Formation, Ukhaa Tolgod, Mongolia. *Journal of Vertebrate Paleontology* 21:209-213.
- Xu, X., X. Zhao, and J. Clark 2001 A new therizinosaur from the Lower Jurassic lower Lufeng Formation of Yunnan, China. *Journal of Vertebrate Paleontology* 21(3):477-483.

WEINTRAUB GRADUATE FELLOWSHIPS

One of the initial gifts the Weintraubs made to the Department of Biological Sciences was to establish two graduate student research fellowships. In 1993, when the Weintraub Faculty positions were created, the University assumed financial responsibility for these fellowships and eventually expanded them from 2 to 7. These fellowships, which are available to all Ph.D. students in the Department are awarded to exceptional incoming students or to our best students who are entering the research phase of their Ph.D. program.

Recent Graduates who received support from a Weintraub Graduate Fellowship

Marymegan Daly, PhD 2001. Recently appointed Assistant Professor, Department of Ecology and Evolution, Ohio State University (Currently completing a postdoctoral fellowship at the University of Kansas).

Dr. Daly studies the comparative anatomy, molecular diversity, systematics and evolution of Cnidarians. Her current research focuses on the evolution of sea anemones and the corals. Like many marine animals, the diversity and evolution of these invertebrates is poorly known. Dr. Daly is conducting fieldwork around the world including the deepsea trenches through dives in the deep sea submersible, *the Alvin*.



Email: dalym@ku.edu

Web: <http://web.nhm.ku.edu/inverts/meg/index.htm>

Maureen Kearney, PhD 2001. Currently Assistant Curator, Amphibians and Reptiles, Department of Zoology of the Field Museum of Natural History, Chicago Illinois.



Dr. Kearney studies the comparative anatomy, systematics and evolution of reptiles and amphibians. Her current research focuses on the comparative morphology and evolution of various groups of burrowing reptiles (including certain lizards, amphisbaenians, and basal snakes). The inability to resolve the relationships of these highly transformed, burrowing animals, all converging onto similar, snakelike body plans, is a classic problem in vertebrate systematics.

Email: mkearney@fieldmuseum.org;

Web: http://fm1.fieldmuseum.org/aa/staff_page.cgi?staff=mkearney

Ellen Strong, PhD 2000. Currently Assistant Professor, University of Minnesota, Saint Paul, Minn.

Dr. Strong studies the higher order systematics of gastropod mollusks and the evolution of their feeding biology. Her current research focuses on the evolution of snails in ancient lakes and the invasion of freshwater by marine species. In addition, Dr. Strong serves as a curator for the Bell Museum of Natural History and monitors the spread of invasive species of mollusks in Minnesota.



Email: stren016@umn.edu

Web: <http://www.fw.umn.edu/Personnel/staff/Hove/Bell.Museum/people/default.html>

Ginny Emerson, PhD 2002. Currently



Dr. Emerson used genetic evidence to study the systematics and evolution of insectivore mammals (hedgehogs, shrews, and their relatives) while at GWU. She is currently a Oak Ridge Institute for Science postdoctoral researcher at the Food and Drug Administration (Little Rock, Ark.) working on the genetics of prostate cancer.

Current Weintraub Fellowship Graduate Students

Shiva Bakisubramanian – Characterization of ionotropic glutamate receptor-like genes in *Arabidopsis thaliana*.

Sayantana Biswas – Lizards and frogs from southwestern India.

Kristen Gansberger – Forensic molecular biology. Analysis of the mitochondrial genetics of dogs to aid in identification of hairs found at crime scenes.

Vinita Gowda – Evolution of the ginger family Heliconiaceae and its pollination biology.

Karen Redden – Morphological and genetic evidence for the evolution and biogeography of tropical legumes of South America.

David Terwilliger – Evolution of the immune system. Analysis of how the immune cells, or coelomocytes (cells found in the coelom) of the sea urchin that become activated in response to injury or infection.

Joana Zanol Silva – Evolution of the polychaete family Eunicidae, especially the evolution of the developmental system.

Graduate Student Publications of the Last 5 years (1999-2003)

Allard, M.A., M. Kearney, K.L. Kivimaki, and E. Strong, 1999. The random cladist: a review of the software program RANDOM CLADISTICS. *Cladistics*. 15:183-189

Allard, M. W., S. D. Baker, G. Emerson, J. Ottenwalder, and C. W. Kilpatrick. 2001. Characterization of the mitochondrial control region in *Solenodon paradoxus* and the implications for biogeography, systematics, and conservation management. Pp. 329-332 in C. A. Woods and F. Sergile (eds.). *Biogeography of the West Indies: New Patterns and Perspectives*. CRC Press LLC, New York.

Buckley, L., M. Kearney, and K. de Queiroz, 2000. Slowly-evolving protein loci and higher-level snake phylogeny: a reanalysis. *Herpetologica*. 56:324-332

Daly, M. 2002. A systematic revision of Edwardsiidae (Cnidaria, Anthozoa). *Invert. Biol.* 121: 212-225.

Daly, M. 2002. Taxonomy, anatomy, and histology of the lined sea anemone, *Edwardsiella lineata*. *Proc. Biol. Soc. Wash.* 115: 868-877.

Daly, M., D.L. Lipscomb, and M.W. Allard. 2002. A simple test: evaluating explanations for the relative simplicity for the Edwardsiidae. *Evolution* 56: 502-510.

- Emerson, G., C. W. Kilpatrick, B. McNiff, J. Ottenwalder, and M. W., Allard. 1999. Phylogenetic relationships of the order Insectivora based on complete 12S rRNA sequences from mitochondria. *Cladistics* 15:221-230.
- Kearney, M., 2003. Diet in the amphisbaenian *Bipes biporus* *Journal of Herpetology*. 37:404-408
- Kearney, M. and J. M. Clark, 2003. Strategies for resolving ambiguity resulting from missing data in the phylogenetic analysis of extinct and living taxa: a critical review. *Journal of Vertebrate Paleontology*. 23:263-274
- Kearney, M., 2003. The phylogenetic position of *Sineoamphisbaena hexatabularis* reexamined. *Journal of Vertebrate Paleontology*. 23:394-403
- Kearney, M., 2002. Fragmentary taxa, missing data, and ambiguity: mistaken assumptions and conclusions. *Systematic Biology*. 51:369-381
- Kearney, M., 2002. The appendicular skeleton in amphisbaenians. *Copeia*. 2002(3):719-738
- Lipscomb, D.L. and K. Kivimaki. 2003. The Protists. *In* Invertebrates 2nd edition R. Brusca and G. Brusca, Sinauer Press, Sunderland, MA.
- Lu, Hua. 2000. *Ophryotrocha lipscombae*, a new species and a possible connection between ctenognath and labidognath-prionognath eunicean worms (Polychaeta *Proc. Biol. Soc. Wash.*, 113: 486-492.
- Malia Jr., M. J., R. M. Adkins, and M. W. Allard. 2002. Molecular support for Afrotheria and the polyphyly of Lipotyphla based on analyses of the growth hormone receptor gene. *Molecular Phylogenetics and Evolution*. 24:91-101.
- Malia, M.J., D. L. Lipscomb and M. W. Allard. 2003. The misleading effects of composite taxa in supermatrices, *Molecular Phylogenetics and Evolution*, 27: 522-527.
- Maslakova, S. A. 2001. Phylogenetic study of pelagic nemerteans (Pelagica, Polystilifera). *Hydrobiologia*, 456: 111-132.
- Schwartz, M.L. 2001. Problems inferring heteronemertean phylogeny from available morphological data. *Hydrobiologia*, 456: 165-174.
- Strong, E. and D. Lipscomb. 1999. Character coding and inapplicable data. *Cladistics* 15: 363-371.
- Strong, E.E. 2003. Refining molluscan characters: morphology, character coding and phylogeny of the Caenogastropoda (Gastropoda). *Zoological Journal Linnean Society*, London, 139.

Courses Taught in the Weintraub Program

Current Topics in Systematic Biology (BiSc 207) - A weekly seminar on current topics in systematic biology, including readings of recent literature, presentation of new research ideas by faculty and students, and presentation of practice talks by students (co-taught by Allard, Clark, Herendeen, Hormiga, and Lipscomb).

Principles and Mechanisms of Organic Evolution (BiSc 209) - Current problems and issues in evolution; speciation, macroevolution, biogeography, and topics of special interest to participants (Lipscomb).

Phylogenetic Systematics (BiSc 210) – A lecture and laboratory course that provides a rigorous and up-to-date treatment of the theory and methods of systematics, including phylogenetic inference and its applications in evolutionary biology (co-taught by Allard, and Hormiga).

Biogeography and Coevolution (BiSc 211) – Survey of methods and techniques used in biogeography. Geological and paleontological aspects of biogeography; large-scale biogeographic patterns; coevolution (Herendeen).

Descriptive Systematics: Documenting Biodiversity (BiSc 213) - Study of those aspects of systematic biology concerned with description and inventory of biodiversity (Hormiga).

The Phylogenetic Basis of Comparative Biology (BiSc 214) - The use of phylogenetic hypotheses to study questions in evolutionary biology and ecology (Hormiga).

Vertebrate Phylogeny (BiSc 215). A lecture and laboratory survey of vertebrate phylogeny, emphasizing the basic relationships among major groups and their fossil records (Clark).

Morphological Systematics (BiSc 216). Principles and methods of phylogenetic analysis of organismal morphology, organized around the concept of homology, and the testing of homology provided by phylogenetic analysis (Clark).

Immune Systems in Plants and Animals (BiSc 218) - Defense functions in higher plants and immune mechanisms in sponges through lower vertebrates, with evolutionary and functional comparisons to immune responses in mammals (Smith).

Diversity and History of Plants (BiSc 222) – A lecture and laboratory detailed investigation of the diversity, phylogeny, morphology, and fossil history of plants for advanced undergraduates and graduate students (Herendeen).

Angiosperm Diversity and Phylogeny (BiSc 223) – A lecture and laboratory detailed investigation of the diversity and phylogeny of flowering plants. Lectures focus on morphological, anatomical, and molecular evidence for relationships within angiosperms. Laboratories focus on structural characteristics of families and higher groups (Herendeen).

Mammalian Evolution (BiSc 223) - A review of mammalian diversity will be explored in a phylogenetic framework. Natural history, identification of mammals, and their numerous evolutionary adaptations will be discussed (e.g. evolution of eusociality, evolution of flight) (Allard).

Molecular Evolution (BiSc 224). A review of the diversity, organization and evolution of genomes with an emphasis on interpreting this variation in a phylogenetic perspective.

All major structures of molecules including, coding and non-coding regions will be reviewed (Allard)

Molecular Phylogenetics (BiSc 225) - A review of applying comparative evolutionary techniques to molecular data. This will include an introduction to all of the major aspects of analyzing genetic data in a phylogenetic framework including: obtaining information from the various data banks, alignment of sequences, tree building methods, coding data, weighting effects, and general theory of quantitative systematics (Allard)

Evolutionary Developmental Biology (BiSc 249) – a seminar-style course on the developmental mechanisms involved in morphological change during evolution (Hernandez).

Undergraduate Courses in Systematics and Evolution:

Comparative Vertebrate Anatomy (BiSc 132) – Lecture and lab investigating the evolution and comparative morphology of Phylum Chordata, stressing recent forms (Hernandez).

Organic Evolution (BiSc 150) - Synthetic theory of organic evolution, including population biology, speciation, adaptation, macroevolution, systematics, biogeography, and the geologic record (Lipscomb).

History of Life (BiSc 151) - A review of the origin of life, the geologic record, and the evolutionary history of the major groups of organisms, including the evolution of bacteria, origin of animals and plants, evolution of invertebrates and vertebrates, adaptations of mammals, and the evolution of flowering plants (Lipscomb).

Diversity and History of Plants (BiSc 182) – A lecture and laboratory detailed investigation of the diversity, phylogeny, morphology, and fossil history of plants for advanced undergraduates and graduate students (Herendeen).

Undergraduate Research (BiSc 171) – Independent research in the laboratory of a Weintraub faculty member.

Independent Study in Genetic and Evolutionary Biology (BiSc 175) - Prescribed reading and consultations with Weintraub faculty member culminating in a written report and/or examination.

Funding for teaching activities:

We have recently submitted a proposal to the Teaching Initiatives program at GWU and are preparing a proposal for the National Science Foundation to develop undergraduate courses in evolution that will provide our undergraduate students with a laboratory experience in investigating the patterns and processes underlying evolution. If funded this will be one of the few such courses in the world to provide college students with hands-on experience in phylogenetic analysis.

Affiliated Program: The Human Evolutionary Biology Program

The Human Evolutionary Biology Doctoral Program (<http://www.gwu.edu/~hebdp/>) is a graduate program linking paleoanthropology with molecular and organismal biology, chemistry, engineering and geology to promote interdisciplinary research emphasizing experimental and comparative methods for studying human evolutionary history. In order to encourage and equip students to explore and develop new ways of constructing and testing evolutionary hypotheses about humans, this program combines training and research in disciplines traditionally taught in different departments. The Weintraub program courses are taken by these students and the Weintraub faculty serve as student advisors and committee members, as well as collaborators to our colleagues involved in human evolutionary research. We are also active in committees that oversee and govern the program, including job searches and evaluations reviews.

