

**The Nyanza Project
1998 Annual Report**

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Executive Summary

This report summarizes the 1998 activities of the Nyanza Project, a research training program in tropical lake studies, funded by the US National Science Foundation and the Lake Tanganyika Biodiversity Project (LTBP). The Nyanza Project is run by the Department of Geosciences at the University of Arizona for the International Decade of East African Lakes (IDEAL) a research and training consortium, in partnership with LTBP. The Nyanza Project consists of a 6 week training program for American and African participants, based at Kigoma, Tanzania, on the shores of Lake Tanganyika. The Nyanza Project is run out of the Tanzanian Fisheries Research Institute (TAFIRI) field station in Kigoma, and enjoys a close working relationship with TAFIRI staff. The objective of the Nyanza Project is to provide a multidisciplinary research training program in the geological, limnological and biological aspects of tropical lakes to promising young students at an early stage of career. Our goal is to stimulate interest among these students in research and environmental management careers in aquatic sciences, through exposure to the world-class science opportunities afforded us by our location in Kigoma, Tanzania at Lake Tanganyika.

Nyanza Project scientific staff include the director, Dr. Andrew Cohen, and three scientific mentors representing the disciplines covered by the program: Dr. Ellinor Michel (Univ. of Amsterdam-evolutionary biology and ecology), Dr. Pierre Denis Plisnier (Royal Museum for Central Africa, Tervuren, Belgium-physical and chemical limnology) and Dr. Chris Scholz (Syracuse University, limnogeology). All mentors share a strong interest in research training in tropical lake sciences, a proven and strong track record of research on the Lake Tanganyika system, and a commitment to the philosophy of interdisciplinary research and training in tropical lake sciences. Eleven American and 9 African students participated in the project in 1998, as well as one US high school science teacher. African students in 1998 came from the four LTBP-affiliated countries (Burundi, Tanzania, Zambia and Dem. Rep. Congo).

The Nyanza Project comprises a combined classroom, field work and laboratory training module, followed by independent student research projects, conducted by the students under the supervision of Nyanza Project faculty mentors. In 1998, 3 weeks were devoted to the formal training period and 3 weeks to the research projects, although we anticipate changing this mix to 2.5 weeks formal training and 3.5 weeks research in upcoming years. Some students worked on individual research projects, while others worked as parts of groups. Student research project quality was very high, especially considering the logistical limitations inherent in working at a remote field station and the limited prior research experience of most participants. Group projects provided a unique opportunity for American and African students to interact closely and continuously over the study period. The mentors made a strong effort to instill a hypothesis-based approach to student research, data collection and analysis, which is evident in the attached abstracts. Although only 2.5 weeks were effectively available for student research projects, many will form the basis of ongoing projects that are expected to result in refereed-journal publications.

Recommendations and planned changes for upcoming Nyanza Project years include: increasing the proportion of time allotted to research projects relative to formal instruction, addressing special needs of African student participants identified below, improvement of computer facilities, capital equipment upgrades for improved sampling capabilities that can take advantage of the outstanding scientific opportunities afforded by our location and streamlining of recruitment and admissions procedures.

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Director's Report - Nyanza Project 1998

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Introduction

The Nyanza Project is a National Science Foundation Research Experience for Undergraduates (REU) Program that is focused on training students in tropical lake studies. It is run by the Department of Geosciences at the University of Arizona for the International Decade of East African Lakes (IDEAL) a research and training consortium, in partnership with the UN-funded Lake Tanganyika Biodiversity Program (LTBP). The Nyanza Project consists of a 6 week training program for up to 12 American and 12 African participants (9 African students attended in 1998). The objective of this program is to provide an integrated research training program in the geological, limnological and biological aspects of tropical lake studies to promising young students at an early stage of career. Our goal is to stimulate interest among these students in research careers in aquatic sciences, through exposure to the world-class science opportunities afforded us by our location in Kigoma, Tanzania at Lake Tanganyika. In addition to US undergraduates, one outstanding US high school science teacher is admitted to the program each year, to bring a message of excitement and interest in tropical lake sciences back to the secondary school classroom.

Participants in the Nyanza Project were selected in two ways. For American undergraduate students and the high school teacher slot, an open application procedure was conducted. The program was advertised nationwide by posters, direct mailings, journal and society newsletter announcements and internet website postings. Almost 200 applications were received, which were reviewed by the Nyanza Project staff and narrowed down to 11 students + 1 high school teacher admitted to the program and 12 alternates (all 12 people admitted to the program accepted and attended). African student participants were funded through the United Nations Development Programme's Lake Tanganyika Biodiversity Project, which involves the four riparian countries around Lake Tanganyika (Burundi, Tanzania, Zambia and Dem. Republic of Congo). Three students were selected from each country by that country's national LTBP coordinator. African participants included both students and professionals at very early stages of their careers.

Because both Burundi and Congo are francophone countries, the Nyanza Project was run on a quasi-bilingual basis. A full time translator (Dr. Gaspard Ntakimazi, Univ. of Burundi) who is also a well known ichthyologist investigating the fishes of Lake Tanganyika, was hired by LTBP for the first three weeks of the course, during the formal classroom and lab interval. Effective communication at other times was possible because Dr. Plisnier is fully bilingual (he did all translations during the final presentations), as is the program administrative assistant (Mr. Nicholas Mathieu) and both Drs. Cohen and Michel are relatively fluent in French.

Program Structure And Mentors

The Nyanza Project comprises a classroom, field work and laboratory training module, followed by independent student research projects, conducted by the students under the supervision of Nyanza Project faculty mentors. In 1998, 3 weeks were devoted to the formal training period and 3 weeks to the research projects, although we anticipate changing this mix to 2.5 weeks formal training and 3.5 weeks research in upcoming years. Some students worked on individual research projects, while others worked as parts of groups. Extended abstracts of all student projects appear at the end of this volume. All students were required to present their preliminary results as an oral 15 minute (professional meeting style) presentation during the last week of the program, and to submit both a preliminary 1 page research proposal and an extended abstract with data summarizing their research findings.

The Nyanza Project is run out of the Tanzanian Fisheries Research Institute (TAFIRI) field station in Kigoma. TAFIRI provides the Nyanza Project with office, lab and storage space, in exchange for a long term commitment by the Nyanza Project to laboratory and office space upgrades on the premises. During our first year of operations, the Nyanza Project established a permanent office facility at TAFIRI, had a large amount of classroom and office furniture built, constructed a secure storage facility for long-term equipment storage, built a roof-over shed for its shipping container and put security doors on several key lab and office spaces. Additionally, the Nyanza Project benefits from its close association with the LTBP, through access to LTBP field and lab equipment, and use of the LTBP/TAFIRI research vessel *R/V Echo*. Students and some faculty are housed and take their meals at the Lake Tanganyika Beach Hotel for the duration of the program.

Faculty mentors for the Nyanza Project in 1998 (all are anticipated to return in 1999):

Dr. Ellinor Michel (Univ. of Amsterdam). Evolutionary biology of ancient lakes, especially Lake Tanganyika. Evolutionary ecology and phylogeny of gastropod molluscs.

Dr. Pierre-Denis Plisnier (Royal Museum for Central Africa, Tervuren, Belgium). Physical and chemical limnology of tropical lakes, especially Lake Tanganyika. Interrelationship of climate change and limnological change in large lakes. Interconnections between limnological processes and fisheries.

Dr. Christopher Scholz (Univ. of Miami-Rosensteil School of Marine and Atmospheric Sciences during 1998 course. Dr. Scholz is moving to Syracuse University as of fall 1998). Limnogeology of the African Great Lakes, geology of continental rift systems, lake sedimentology and geophysics.

I selected the mentors for the Nyanza Project based on three criteria:

- 1) A strong interest in research training in tropical lake sciences
- 2) A proven and strong track record of research on the Lake Tanganyika system
- 3) A commitment to the philosophy of interdisciplinary research and training in tropical lake sciences espoused by the Nyanza Project.

In addition to the regular faculty mentor lectures, guest lectures by myself, Dr. Gaspard Ntakimazi (Univ. of Burundi), Dr. Kelly West (LTBP), Ms. Beatrice Marwa (LTBP) and Ms. Simone Alin (Univ. of Arizona) provided additional perspectives to the students on research activities at Lake Tanganyika.

1998 Nyanza Project Schedule Formal class and lab exercises are held Monday through Saturday, with Sundays off. Students are given every Wednesday afternoon during the first 3 weeks to work on the development of their research projects in consultation with their faculty mentor.

May 27-May 31 Student/Instructor Travel to Kigoma

June 1-June 6. Classroom and field exercises in limnogeology: C. Scholz-Instructor. Structure and formation of the African rift lake basins. Interpretation of geophysical (reflection seismic) data from lake deposits. Depositional systems associated with tropical rift lakes. Interpretation of paleoclimate history from rift lake deposits. Field trip studies of rift basin geomorphology and tectonics.

June 8-June 13. Classroom, field and laboratory exercises in limnology: P.D. Plisnier-Instructor. Physical and chemical structure of tropical lakes, with special attention to the structure of Lake Tanganyika. Thermal and chemical stratification of the water column and seasonal cycles in that structure. Relationship of physical structure to nutrient dynamics and patchiness in plankton communities. Long term changes in limnological structure associated with climate change. Field and laboratory exercises in measurement of limnological parameters and thermal stratification.

June 13. Preliminary research proposals due.

June 15-June 20. Classroom, field and laboratory exercises in aquatic biology: E. Michel-Instructor. Evolution and ecology of ancient lake biotas with special reference to Lake Tanganyika. Phylogenetic relationships and origins of Lake Tanganyikan species flocks. Species interactions and the origin of community structure in Lake Tanganyika. Laboratory exercises in allozyme electrophoresis, identification of planktonic and benthic invertebrates and field investigations of rocky habitat community structure and diversity.

June 22-July 8. Students work on research projects.

July 9. Oral presentations of student research projects.

July 10. Written extended abstracts due. Cleanup of facilities.

July 11. Students and staff depart Kigoma.

Evaluation Of Student Research Project Quality. Student research project quality was very high, especially considering the logistical limitations inherent in working at a remote field station and the limited prior research experience of most participants. The group projects were particularly successful in meeting their goals of data acquisition. Furthermore, they provided a unique opportunity for American and African students to interact closely and continuously over the study period. The mentors made a strong effort to instill a hypothesis-based approach to student research, data collection and analysis, which is evident in the appended abstracts. Although only 2.5 weeks were effectively available for student research projects, many will form the basis of ongoing projects that are expected to result in refereed-journal publications.

Evaluation Of Program Performance In 1998. Overall, I was extremely pleased with the results of the first year of the Nyanza Project. Not only was exciting and significant scientific research conducted by the students and faculty mentors involved, but this was done in a safe working environment. No serious injuries or illnesses of any kind occurred. Interpersonal relationships among the staff and students were excellent, as attested to by the uniformly high marks given the course and instructors by the students in the end of course evaluations (summarized separately). I felt particularly gratified by the successful way in which

American and African students worked together to solve research problems and their general camaraderie, this despite significant language and cultural barriers facing such a rapport at the beginning of the program.

Planned Changes And Recommendations For Upcoming Nyanza Project Field Seasons

Instructional Program And Schedule

As alluded to above, it was a general consensus among both instructors and students that the research interval of the course should be lengthened at the expense of the formal classroom/lab training period. Accordingly, we will move to a 2.5 week training: 3.5 week research project split starting in 1999. Weekly topical presentations of 1-2hr duration by the mentors during the latter 4 weeks of the course will be added to offset the loss of formal training time. The addition of an extra 4 days of research time will allow us to separate the student presentations from the due date for extended abstracts, which created problems this year given our limited computer lab capacity (7 PCs and 2 printers for 21 students). Additionally we will institute a 1-2 day training module at the beginning of the program on research design, the testing of hypotheses, and general philosophies and methods of data acquisition. In 1998, we discovered that student's prior understanding of these topics varied widely and tended to be transmitted to the students on an informal basis of variable quality.

In order to better accommodate the academic calendars for both African and American universities, the starting dates of the Nyanza Project will be moved forward several weeks starting in 1999 (exact dates are not yet determined but the start will be in late June).

Beginning in 1999, we will offer informal training modules in small craft handling and knots, (both critical skills for field work on lakes) on weekends for those students requiring such knowledge.

Capital Equipment Upgrades For Improved Research Capabilities

The Nyanza Project requires additional capital resources in order to take full advantage of the tremendous research opportunities afforded us by working at Lake Tanganyika, and to access both deep and distant sampling locations. Underbudgeting for capital equipment resulted for several reasons, including the unforeseen cancellation of a planned charter of the *R/V Tanganyika Explorer* (discussed further below), assumptions about equipment access, and higher than anticipated costs for key (and expensive) items, such as the project vehicle, and various pieces of field and lab equipment. Several key items are highlighted below:

Winch System And Retrofit Of R/V Echo A planned and budgeted charter of the *R/V Tanganyika Explorer* had to be canceled at the last minute in 1998 because the ship was impounded in Bujumbura port as a result of a financial dispute between the ship's owners and their loan agency. Even assuming this issue is resolved, there is a remaining uncertainty about the long term fate of the ship's excellent winch and hydraulics system. Because the *R/V Tanganyika Explorer's* future use by the Nyanza Project cannot be assured, it is critical for both the geological and limnological sampling programs that an alternative platform for retrieving heavy samplers and corers be obtained. Retrofitting of the *R/V Echo* will be required because it is a fiberglass vessel requiring the installation of steel plating to support a winch.

Maintenance Of Electronics Problems with the erratic and spiky power supply in Kigoma were anticipated in our original budget, but the total electrical power load (and simultaneous demand) was underestimated. Consequently, we are in need of several larger UPS systems, better and larger voltage step-down transformers (for US 110V equipment to local 220V power) and additional field generator capacity (to maintain operations during power failures or off premises). LTBP's large 44Kva generator proved invaluable during power outages, but it also suffers from erratic voltage output, potentially very damaging to some of our more sensitive electronics.

Air Compressor Almost all of the important evolutionary biology, behavioral ecology and community ecology research done to date on the fantastically rich endemic biota of Lake Tanganyika has involved some SCUBA diving. It is the consensus of both myself and the instructors that the Nyanza Project should have strong capability to conduct this type of work, because it has proven so fruitful and central to our own research efforts. At present I maintain one small air compressor plus dive equipment for the research needs of my own graduate students in Kigoma. However, this compressor is inadequate for regular use by the Nyanza Project, both because it is too small to fill tanks quickly and because of the setbacks that might occur for ongoing research efforts in the event of the mechanical breakdown of a single compressor

Additional Computer/Printer Capability Student progress was impeded during the critical final week of the program in 1998 by the relatively limited access students had to computers and printers. Both printers currently in Kigoma are laser printers, which are susceptible to irreparable damage given the erratic power conditions prevailing in Kigoma. We would like to also purchase a scanner or other means of digitizing image information from various sources. Finally, the large amount of electronic data collection we are doing aboard small craft necessitates regularly bringing a laptop out onto the lake, where it could be easily damaged. It would be very desirable to obtain a waterproofed laptop for such purposes.

Microscope and Aquarium Capability. Students had difficulty obtaining sufficient time on the Project's one high quality research binocular microscope in 1998 and a second scope would be very desirable. A camera lucida or digital camera/trinocular head would also vastly improve our ability to produce publishable microscopic images in the field (this is critical as many biological projects revolve around live specimens which cannot be brought back to the US intact or alive). Similarly, aquarium space for the storage of live specimens or for conducting limnological experiments was at a premium in 1998 and additional aquaria and aquarium supplies would be very useful.

Additional Limnological Field Instrumentation and Equipment. LTBP's CTD proved to be very erratic in 1998 operations and data acquisition from this instrument could not be relied upon. A CTD is a key piece of equipment for large lake data acquisition and it is important for the future success and long term data continuity that the Nyanza Project purchase its own instrument.

A small auxiliary echosounder is needed for use by the limnology team, since the large high quality echosounder we have already purchased is in almost continuous use by the geology team. Finally, we would like to augment our limnological sampling capabilities with the purchase of additional thermistors, a field pH/conductivity meter, phytoplankton nets, and a small (5hp) auxiliary outboard engine.

Freight costs must also be anticipated for the shipment of all of the above equipment.

Teaching Assistants

The Nyanza Project was extremely fortunate in 1998 in having access to graduate student assistance at no cost to the project, as a result of both Cohen's and Scholz' ability to bring their students into the field on separate funds. No T.A.-type assistance is budgeted for in the project but in fact it would have been very difficult for the project to have been as successful as it was in 1998 without such assistance. A skilled T.A. would not only provide an additional source of information for students, but can also take on the critical task of lab manager (for which we are currently understaffed). It is critical for the Project to identify possible sources of support for such an assistant (airfare, room and board and a modest stipend) in future years. An ideal solution to this problem would be to bring back an exceptional Nyanza student from a previous year, who would already know the training program and equipment as well as the general logistical environment.

Admissions Procedural Changes

The application deadline for the Nyanza Project for 1999 will be moved forward to Dec. 15, 1998, to insure adequate time for application review. The large number of applications received for the 1998 field season significantly delayed the decision process and we anticipate a similar or larger number of applicants for next year.

Physical Plant And Infrastructure

The Nyanza Project should continue to upgrade its physical plant environment at Tanzania Fisheries Research Institute, to insure both the security of our operation and for ease of operations. TAFIRI has a very limited operations budget, so it is unlikely that such improvements will be made without active participation on our part. However, it is possible that some of these improvements could be made in partnership with LTBP. Several key upgrades need to be addressed in the near future:

1. An improved security fence surrounding the compound. In many places the fence is damaged or trampled and needs replacement or repair.
2. Upgrade of a planned boat storage facility. An open shed near the laboratory block is currently available for this purpose, but it must be closed in. Currently, inflatable boats and motors are stored in one of the laboratories at night, which is extremely inconvenient and, with the manhandling of large boats, potentially risky to lab equipment

3. Outdoor steps to the laboratories need repair.

Special Instructional Needs Of African Student Participants

Based on our 1998 experience we have several recommendations for LTBP concerning the African student contingent of the Nyanza Project.

1. **Student Selection And Disciplinary Scope.** In order to balance the work load among the project mentors it is important that they each have approximately the same number of student interns working with them. This did not occur in 1998 because the vast majority of the African students worked with Dr. Plisnier on limnology projects. It is important that LTBP insure that the students sent to the Nyanza Project approximate a 4 geology: 4 biology: 4 limnology student mix. It is also important that the students be identified earlier and their names, addresses and areas of interest be forwarded to the University of Arizona well in advance of the course, so that they can be put in contact with faculty mentors (for project planning) on about the same schedule as the American students.
2. **Translation Services.** The translations provided by Dr. Ntakimazi were excellent and his work for the project was greatly appreciated. It would be very useful if the translator in 1999 could be hired not only for the formal instructional period but also for the student presentations and periodic lectures during the second half of the program.
3. **Computer Workshop Prior To The Nyanza Project.** Most of the African students arrived with little or no prior formal training in the use of computers. It was a fairly simple matter to bring these students up to speed within a few days in basic operational functions of Microsoft Word and Excel, but this definitely ate into our training time for our primary mission. A several day computer workshop (perhaps one in French and another in English) for each year's African Nyanza students immediately prior to the course would alleviate this problem.
4. **Swimming Training Prior To The Nyanza Project.** Very few of the African trainees knew how to swim prior to the project. This skill is essential for success as a Nyanza Project team member, both for the sake of safety and also for several lab exercises that involve snorkeling observations. In 1998 we were able to quickly teach these students how to swim (almost all took it up avidly) but again a significant amount of time had to be invested in this when other training could have been occurring. LTBP should explore the possibilities of paying for swimming lessons for designated Nyanza participants who cannot already swim prior to the course. It should be clear that we do not advocate restricting the applicants to those who can swim, but once an individual is accepted into the program swimming should be considered an important preliminary skill to acquire.
5. **Follow-up Opportunities For African Student Research.** Because only ~3 weeks are available for research work during the Nyanza Project, most American students who were involved in 1998 anticipate a continuation of their work at their home institutions. This was a source of some resentment among the African students (as indicated in course evaluations), since most of their home departments or institutions cannot afford to provide resources to allow them to continue their work to completion. LTBP may wish to address this problem in future years, perhaps by providing small stipends for research supplies to Nyanza alumni.
6. **Francophone Teaching Assistant.** It would be immensely valuable to the Francophone students if a Burundian or Congolese alumnus from a prior Nyanza Project year could be chosen to return as a teaching assistant. This would cost relatively little and would be very beneficial not only to the new students but also to the returning individual.
7. **Financial Inequalities Between American And African Students.** This is a somewhat sticky problem since the financial terms of participation by both American and African students are constrained by their separate funding sources. NSF stipulates a particular rate of pay for REU students and LTBP has a set Daily Supplementary Allowance for Kigoma. Unfortunately these amounts are quite different, with the result that resentment on the part of the African students was inevitable (although the Nyanza staff made no mention of salaries directly to students it was inevitable that students would discuss this among themselves). This unhappiness was manifest in small ways that LTBP may be able to alleviate simply however (for example, by providing funds for soft drinks or laundry services directly to the hotel, which the African students could not afford).
8. **Certification For African Students.** Several African students indicated that some form of certificate, indicating that they had successfully completed the Nyanza Project, was important for their future career. LTBP, in consultation with the Program Director and the country coordinators, should determine an appropriate form for such a certificate and forward a design to the project director.

Maintenance Of African Student Participation After 2000

African student participation in the Nyanza Project is a unique and critical element in the great success we enjoyed in our first year of operations. Unfortunately, LTBP funding participation in support of African

students attending the Nyanza Project is only projected through the year 2000, whereas the NSF funding stream runs through 2002. To maintain African student participation after 2000, and ideally to maintain the program after the current NSF grant expires, alternative sources of funding must be sought. I met briefly in Dar es Salaam with Ms. Flora Majabele, the environmental education officer for USAID-Tanzania, to explain our program and see what options might exist for USAID participation in the Nyanza Project. Ms. Majabele provided me with some information and contacts for her counterparts at other USAID offices in East, Southern and Central Africa. I have also made preliminary contacts with Dr. Henry Nsanjama Vice President for sub-Saharan Africa for the World Wildlife Fund (WWF) to determine their possible interest in participation. Both individuals expressed an interest in opening a dialog on this matter. Given the long lead time, I am optimistic that we will be able to solve this problem in time for the 2001 Nyanza Project field season.

Geology Mentor's Report

Christopher Scholz
Syracuse University

Introduction

This report summarizes the limnogeology component of the 1998 Nyanza Project, the IDEAL-affiliated NSF-REU training program in tropical limnology. Here I report on the lecture and independent research components of the course then conclude with a discussion of recommendations for the training program in forthcoming years.

Lecture

The one-week limnogeology lecture/field trip section was the lead-off component of this REU, setting the basic framework for the following limnology and biological modules. Despite the inevitable fatigue and jet lag brought on by two intercontinental airline flights and 36 hours of train/bus travel across Tanzania, the students took to the material and study area with remarkable enthusiasm and focus. Key concepts stressed in the lecture included the mechanical processes of continental rifting, the resulting structural geometries prevalent in an East-African type extensional system, the depositional environments found on different tectonic margins of rift valley lakes, controls on rift-lake stratigraphy, and global change in the continental tropics on a variety of time scales.

Field trips were conducted daily, and took advantage of the spectacular geological setting of Kigoma, situated near the tip of a major half-graben border fault system, and adjacent to a major platform area with several large river deltas. Field trips were typically conducted along the shoreline in hired passenger ferries, but also made use of the Research Vessel Echo operated by the Tanzania Fisheries Research Institute.

Computer and laboratory exercises augmented the field and lecture material. Of the 21 students enrolled in the program, five were geology majors (4 U.S. and 1 Tanzanian), one was a chemical oceanographer with additional geological background, and most of the remaining U.S. and African students had no prior course work or training in the geosciences. This disparity in disciplinary background was more pronounced than in either the limnology or biology modules of the course. Despite the obvious differences in prior training, the geologists took this opportunity to help bridge the gap between the limited geoscience backgrounds of some students and advanced aspects of the lecture material.

Independent Research Projects

Five students conducted geologically oriented independent research projects. Projects were originally designed around a field sampling program to be conducted during several day-long cruises aboard the R/V Tanganyika Explorer, a modern 26 m, steel-hulled research vessel privately owned and operated from Burundi, and well-equipped with winches and ancillary gear for deep-water geological sampling. Unfortunately, the cruise was canceled approximately 10 days after the start of the Nyanza Project, apparently due to political and/or financial difficulties in Burundi. Because the Explorer is the only vessel on the lake currently suitable for deploying and recovering deep water (150 m) corers and samplers, the cruise cancellation resulted in a total revamping of the sampling design for the geological research projects. Rather than several coring transects to water depths of 900 using mechanized winches, the students collectively conducted several strike and dip transects with a hand-line grab sampler, mostly in water depths <100 m in the vicinity of Kigoma Bay. In addition, one student used a digital echosounder coupled to a GPS system and laptop computer aboard an inflatable dinghy for bathymetric mapping of Kigoma Bay. Several samples were also obtained via SCUBA to depths of 30 m. Analytical efforts on recovered sediment samples included grain size analysis by wet and dry sieving, inspection of diatom assemblages by compound microscope, inspection of fish fossil remains, and abundance of organic matter and carbonate by loss on ignition measurements in a muffle furnace. Results of the various projects are summarized in the student project abstracts. A number of interesting results were generated and additional work on collected samples is planned by almost all the students at their home institutions during the fall semester. In addition, these initial studies are providing important baseline information for forthcoming student projects.

Recommendations for forthcoming years

In the limnogeology lecture section of the course I anticipate reorganizing sections of the lecture to better accommodate students with no geological background. Whereas this will inevitably lead to a reduction in the amount of advanced material that can be introduced during the main lecture section, I hope to still include advanced topics for the geoscientists, perhaps during topical lectures in weeks 3-5. An expanded glossary will also be offered for students with limited geoscience backgrounds. Students preferred the opportunities to get out and explore the coastline first hand, rather than listen extensively about the geology in lecture format. I anticipate revamping certain lectures to be run completely in the field off large posters.

For both the lecture and independent research components of the course it is essential to ensure the capability for deep water sampling and extended offshore surveying of the lake bottom. More than 90% of Lake Tanganyika covers areas more than 100 m deep. It is also in these deep localities where some of the most interesting and challenging questions are to be addressed, such as questions pertaining to carbon cycling in large lakes and tropical climate change. The best way to ensure geological sampling over the greater lake is to charter the R/V Explorer for an extended period and/or acquire a deep-water winch capability for the smaller vessels immediately available within Kigoma (e.g. R/V Echo) Given the logistical effort involved in sending such a large group of students and instructors to this remote, but unique and spectacular lake, the additional costs for an "oceanographic-style" cruise and for deep-water sampling equipment are minimal. This will ensure a truly cutting edge sampling/research experience.

Biology Mentor's Report

Ellinor Michel
Dept. of Zoology
University of Amsterdam

Contents of 1998 course:

Lectures:

Rift Lakes as Model Systems for Understanding Evolution

I. Patterns of evolution in the major ancient lakes of East Africa, with comparisons from other ancient lakes: Tanganyika, Malawi, Victoria, Edward/Albert & Turkana; similarities and differences in the endemic radiations

II. Processes of Evolution, with examples from each of the African rift lake faunas:

Allopatric speciation (geologic effects), dispersal & life history sexual selection: female mate choice and male-male competition, coevolution: predator-prey systems and brood parasites, trophic differentiation and adaptive radiation: character displacement, extinction

Ecology of Tanganyikan Organisms:

I. Examples of ecological processes from the Tanganyikan cichlid fauna: habitat specificity, alternative reproductive strategies, feeding relationships: food webs, trophic partitioning on ecological scales, competition & territoriality, commensalism & mutualism

II. Overview of diversity across Tanganyikan taxa: from algae through mammals

III. Methods of quantifying diversity and overview of metrics

Practical exercises:

Field lab on evolution:

Objective: Demonstrate methods and potentially contribute field data to study by West & Cohen of coevolution of gastropods and crab predators.

Methods:

- 1) Students collected samples in the rocky littoral zone using snorkel and developed search images for different species of gastropods (emphasizing non-destructive sampling techniques);
- 2) Students noted distributional differences of different species, collecting basic ecological data;
- 3) Students discussed issues of appropriate sample sizes and collected morphometric data for later (potential) multivariate analysis and quantified shell scars from crab attacks.

Field lab on ecology:

Objective: Develop appreciation of species differences among fishes and demonstrate methods for biodiversity assessment

Methods:

- 1) Students learned to identify fishes based using literature and initial swimming survey;
- 2) Students set out transect lines, swam transect on snorkel, counted fish abundance by species in a rocky and sandy habitats;
- 3) Students used diversity and abundance data in computer calculations of different diversity metrics at the end of the week.

Laboratory practical on genetics

Objective: Learn a lab technique that quantifies genetic variation between organisms using (allozyme) electrophoresis, a technique that is fundamental to most current molecular applications, and discuss influence of genetics on ecology and evolution.

Methods:

- 1) Students prepared tissue from several different species, ran extracts across an electrophoretic gradient and stained for allele differences

Laboratory practical on micro & meiofauna

Objective: Observe diversity of small organisms with a microscope, including plankton and benthic meiofauna.

Methods:

- 1) Students learned to identify zooplankton that they had collected during limnology cruises;

- 2) Students collected benthic meiofauna in several habitats near the station during the lab, observing interstitial gastropods, ostracods and insects.

Guest lectures

Dr. Kelly West, LTBP scientific liaison officer: Coevolution of gastropods and crab predators -

Beatrice Marwa, LTBP special fisheries officer: Fisheries biology of Lake Tanganyika - (including field trip to several landing sites)

Dr. Gaspard Ntakimazi, Professor. Univ. Burundi: Ecology of Tanganyikan cichlids -

Dr. Andrew Cohen, Professor. University of Arizona: Evolution and extinction in the Lake Tanganyika fossil record

Simone Alin, University of Arizona: Spatial and temporal variation of Tanganyika

Paper discussion: an evening discussion of a recent Science paper on extinction in Victoria cichlid fishes due to sedimentation and limnological changes allowed comments from students in all 3 disciplines.

Future Changes

Lectures: Students need a better introduction to hypothesis testing, statistics and experimental design. A day spent on this topic at the beginning of the course would prepare them to be more critical listeners to the lectures and to design better projects. There should be more integration of the biology, geology and limnology lectures, with a greater parallels in presentation format. Students felt that the pace of the lectures was generally appropriate, but that they wanted more time for projects, thus lecture material will have to be compacted or cut. The lecture translation was surprisingly effective in that Dr. Ntakimazi, who is a scientist working on Lake Tanganyika himself, was able to synthesize the information succinctly and clearly. In addition, the francophone students commented that it helped them enormously to have a complete lecture text in advance so they could prepare- they frequently asked good questions indicating an involvement in the lectures.

Because of time constraints, I could not give 3 lectures on specialized topics of pelagic ecosystems (some of which I incorporated into the ecology lectures), genetics and morphometrics. In future years, we should give a team lecture on the pelagic zone from an ecological, evolutionary and limnological perspective. Discussions with Dr. Plisnier revealed that many of the current controversies could be addressed in a multi-disciplinary context with the students sorting through evidence for a very topical lecture. The other topics of genetics and multivariate morphometrics would be useful to offer as special topics days, as an elective attendance for students who are interested. My original plan of teaching a multivariate analysis lab would be useful for students across disciplines, and I will try to develop computer exercises for use with their field practical data or as part of the introduction to research methods unit to give them hands on experience with this material. The lecture on diversity of Tanganyikan organisms suffered from lack of visuals (primarily slides) and will be completely revamped for the future.

Practicals

The field exercises were very successful, with all of the students excited about what they were seeing, learning how to observe carefully and understanding the importance and difficulties of field work. Some of the students could not swim before these labs, but we spent several of our days off teaching them to snorkel, which was perhaps one of the most gratifying aspects of the labs. (One student of ichthyology had never seen fish in their natural habitat before, and came up sputtering Latin names with excitement on his first snorkel. After learning to breathe and do science at the same time, he was able to do some of his research using snorkel.) The swimmers helped the non-swimmers, and during the lab exercises everyone participated, learned search images, and was able to collect reasonable data. The data analysis for both of the field labs should have been more structured - I suggested possibilities for analysis and gave them access to original papers with the request that they make their own choices on what to present in a write up, and they were guided through computer analyses for the diversity metrics, however this was too loose for most of them and the final syntheses were not well presented.

The students enjoyed the microscope lab, however the American students seemed less excited about the genetics lab, perhaps having had exposure to similar labs in the past. I had designed this to introduce genetics as a unifying methodology in biology, to give African students more experience with these lab techniques (who did appreciate the lab greatly) and to encourage a student to do a genetics project. As the preparation time and costs for reagents for this lab are very high, I may relegate it to an elective demonstration next year

Independent Research Projects

Details of the independent projects are given by the paper summaries - my comments here will focus on equipment needs for improved research capabilities by the students.

- 1) Ecological studies are limited by the fact that diving with SCUBA was difficult due to slow and unreliable air supply. As the lake's ecological interactions span a wide range of depths, data collection with SCUBA is critical for some projects (though will only be undertaken by highly qualified and tested divers). Improved equipment (compressor and dive gear) will alleviate this enormously.
- 2) With only one compound microscope, there were some problems of time budgeting for the students who needed it - another microscope will help.
- 3) We need image acquisition capabilities (a digital camera and a scanner) on the microscopes - this year we discovered 5 completely unknown trematode parasites and were not able to make publication quality illustrations or even acquire images to be sent to specialists.
- 4) We need another laptop computer for fieldwork and for later analysis work. Computer access was difficult for students during peak research times. This was especially a problem for the students who have had little computer experience, thus worked more slowly and were likely to be displaced by others.

Limnology Mentor's Report

**Pierre-Denis Plisnier
Royal Museum for Central Africa
Tervuren, Belgium**

The limnology training module of the Nyanza Project (chemistry, physics and climate change aspects) occupied the second week of the program. Training consisted of the following program: 10 hours of theory in class supported by about 200 overheads (figures and tables) and two manuals (class and lab).

In addition to classroom activities, sixteen hours were devoted to sampling with students split into 4 different groups of 5 or 6 students per group. Sampling was conducted in the pelagic area of the lake at a site 4km from the Kigoma station. Student groups rotated between field sampling, analyzing samples in the lab, processing samples and interpreting the data. The remainder of the formal training time involved four different exercises: 1) PC training, 2) Model lake (aquarium) observation of stratification and internal wave periodicity, 3) primary production of epilithic algae in the coastal area, and 4) measurement of light extinction coefficients in different areas of Kigoma Bay. In addition to formal class and lab exercises, supplementary reading were assigned to students. The entire class commented on these readings. Finally, a discussion of the limnological sampling made by the four teams was held at the end of the limnology week.

There were no particular problems in implementing the above program. The students showed a great deal of interest and participated fully into the program, which was very rewarding to me considering the effort that went into its preparation.

The last three weeks were used for individuals limnology projects. Five teams were organized, each dealing with a different project and working on a different sampling schedule. This allowed all 10 limnology students to use the limited materials available. The meteorological station and the automatic thermistors deployed by the limnology team worked particularly well. A joint experiment dealing with limnology and fisheries was also very successful.

The materials and supplies available to my team were just barely adequate. However, a quantity of material had to be borrowed from other projects, which proved very helpful.

Recommendations

It is necessary to have access to a working CTD probe (the existing CTD in Kigoma is not reliable). This would allow a vastly improved training and research program dealing with the stratification of the lake. An attempt should be made to increase the available laboratory space next year. It is also critical to hire a teaching assistant for the limnology training module next year, since one team is working on the lake while another is analyzing water in the lab. The temporary solution of 1998 (employing Catherine O'Reilly, a graduate student of Dr. Cohen's who happened to be working in Kigoma during the 1998 Nyanza Project) will not be possible in 1999, as Ms. O'Reilly will not be in Kigoma at that time. It is of course indispensable to split the 24 students more equitably among the three mentors. For the research projects, the number of students working with any one mentor should be about the same. I had 10 students and could not follow fully all of them, as I would have wished. A maximum of 8 students would be reasonable, especially if teams are made so that students with prior knowledge of computer data entry and manipulation can be grouped together with less trained students.

Somebody is also needed full time for translation work (not only during the class) to insure better support of the French speaking students from Congo and Burundi.

All told, I think that this experience was very positive, not only for the students but also for the staff, as intensive science (multidisciplinary; training and research aspects) could be carried out under very good working conditions, especially considering the remoteness of the place. The enthusiasm of the students make me think that this experience was not only interesting but really necessary and fills an ecological niche in the study of Ancient and Great Lakes. I would highly recommend it.

Administrative Assistant's Report

**Mr. Nicholas Mathieu
The University of Arizona**

Electricity

The presence of a 44kV generator in the TAFIRI/LTBP compound negated many of the problems expected from the Tanzanian Electrical Company (TANESCO). There is also a small 4kV generator that can provide power during a time of emergency or when neither TANESCO nor the 44kV is available. Spikes in the line power were not been bad enough to damage either the transformers or the UPS systems purchased for Year 1, providing an adequate safeguard for the equipment. The quantity of the electrical devices and the number of adapters have proven to be the biggest problem thus far. Knowing what plugs equipment will come with and relevant electrical information (amps, voltage draw, etc...) allows for a better estimate of how many adapters and regulators are needed for a given year. An assortment of the more common fuses, a voltage meter and a of basic international wiring schematic book would be valuable since electrical parts are scarce in Kigoma.

Office equipment

Ink jet printers are cheaper than laser printers and the differences in quality and performance are marginal at best. There is a strong argument that because of the color capabilities of inkjet printers, they are in fact more useful than laser printers. In addition, the lower cost of inkjets make them appealing because of their lower replacement costs, a factor well worth considering in a climate that is not friendly towards electronic devices.

Among the more frequently suggested improvements is the addition of more computers. As it stands the project office does not have a desktop computer or a printer. This is inconvenient on a number levels. First, it means that all printing has to be done in the computer lab, an area reserved primarily for instruction and one that only has two printers to begin with. There is also no set machine for email transmission. In the future the computers should have linked printers, either in the form of a mechanical switch or as part of a network setup.

Other equipment

Equipment purchased and shipped in advance for the project appeared to be fairly adequate. There were a number of items that had not been ordered or ordered in insufficient quantities but nothing that proved to be critical. In addition, the demands placed on certain items were much higher than anticipated. Given that all parties concerned now have a much better understanding of how the Nyanza Project will run, it should be possible to greatly reduce the number of "last minute" items that need to be shipped over for next year and to ensure that equipment is not subject to excessive wear. The availability of a quality electrician in Kigoma also made repairing damaged equipment much more cost and time effective than had been thought possible. An inventory count conducted at the end of the course showed levels of loss and breakage well within expected ranges.

Facilities

The facilities for the Nyanza Project were in need of electrical upgrades in order to accommodate the computer lab and other electrical equipment brought to Kigoma for the course. Despite the improvements made in preparation of the 1998 field season, the Tanzanian Fisheries Research (TAFIRI) station is in need of further work. In addition to electrical work, structural improvements were made to the storage facilities assigned to the project and to the restrooms at the TAFIRI compound. Chief among improvements needed to the actual facilities in Kigoma are ones that would improve access to the water. A boathouse for zodiacs, outboard motors, life jackets, petrol and such somewhere near the water would be ideal. The laboratories were crowded despite an earnest attempt to keep them as orderly as possible. To facilitate laboratory work and help control potential shrinkage and equipment loss, use of laboratory space should be given a much higher priority than it received initially.

Spare Parts

The outboard motor, the generator, the computers, the fax machine, all of these will break down in year 2 or 3. This is inevitable and should be planned for accordingly. As such, getting spare parts out to Kigoma at the beginning of the Year 2 course will ensure that any equipment breakdown can be dealt with promptly and with nominal downtime.

Budget

As of the writing of this report, exact numbers are not available for the project budget. However, initial financial statements suggest that the project will miss its Year 1 budget. It is also apparent that given the structural nature of a significant portion of the overruns that this will also be the case in Year 2. There do exist a number of possibilities for cost savings and these are being explored in an attempt to meet the existing budgetary restraints. This said, the Year 1 shortfall coupled with additional capital expenditure requests and the withdrawal of Lake Tanganyika Biodiversity Project (LTBP) support after Year 3, make for a compelling argument for the need of additional funding.

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