Costa Rica's national biodiversity inventory: the role of the parataxonomists and the experiences of the first two parataxonomist training courses, 1989 and 1990.

Daniel H. Janzen and Winifred Hallwachs, faculty

Department of Biology
University of Pennsylvania
Philadelphia, PA 19104

FAX 215-898-8780

and

Instituto Nacional de Biodiversidad (INBio)
3100 Santo Domingo
Heredia
Costa Rica

FAX 506-36-28-16

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Introduction

The National Biodiversity Institute (INBio) of Costa Rica has accepted the responsibility of undertaking a national inventory of Costa Rica's biodiversity in a ten-year period beginning in approximately 1993. The intent of this inventory is to render Costa Rica's wildland biodiversity more accessible and usable by society for intellectual and commercial purposes. Costa Rica's conserved wildlands, occupying about 25% of the country, thus become directly productive and a significant contribution to both their own costs of upkeep and to national productivity. Conservation per se thus becomes a highly desired byproduct as well as a goal.

Ten years was chosen as being long enough to do the job but short enough to allow the results to be a major contribution to saving Costa Rica's wildland biodiversity by using it non-destructively and sustainably. The intent is to increase the inventory expenditure and workforce to a level whereby the task can be conducted within ten years, rather than to imagine that current rates and traditional efforts can do the task in ten years (which they could not).

The task of the inventory is to tie Costa Rica's biodiversity to a relatively stable system of Latin binomial (and higher) nomenclature, and begin to know the location of this biodiversity within the country and within the greater body of scientific knowledge. With this framework beginning to take shape, all of the ecological, chemical, behavioral, genetic, etc. information to be gathered about Costa Rica's biodiversity can be organized, related, manipulated, and offered to the country, region and world through free distribution and/or sale. And rational decisions can be made about what more of it to save at what cost. Costa Rica's national biodiversity inventory formally begins when INBio receives a major block of funding for the inventory activities. At present, INBio is in the process of planning this inventory by conducting various parts of it, in effect as small scale "trial runs" and "pilot projects".

The parataxonomist program is one such pilot project. Unexpectedly, the parataxonomist program has caught the attention of a tropical international community confronted with wildland biodiversity management and use problems similar to those of Costa Rica. As such, the parataxonomist program has also become an unintentional pilot project for other countries as well as for INBio and Costa Rica.

Parts of Costa Rica's biodiversity inventory has been unofficially and irregularly in progress for more than a century by a wide variety of national and international biologists - largely but not exclusively taxonomists - working inside and outside of Costa Rica. In almost all cases, these efforts have been guided by the specific taxon-based interests of an individual or an institution, and to support the centuries-old traditions of academic/taxonomic science, rather than focused directly on facilitating the management and use of Costa Rica's biodiversity by society, today. However, the results from these initial efforts form the irreplaceable and essential base from which the national inventory begins, and are in large part responsible for the existence of a contemporary Costa Rican human resource and knowledge base from which to build the staff and abilities for a national biodiversity inventory.

A major component of INBio's ten-year inventory is the actual collection and preparation of the specimens (and associated information) in the field and getting them to INBio for subsequent processing by taxonomists, biodiversity information managers, and other users. This collection and preparation is carried out by a team of Costa Rican biologists termed "parataxonomists" who conform the "Parataxonomist Program" within the National Biodiversity Inventory at INBio. Dr. Alfio Piva, formerly the Director of the School of Veterinary Medicine of the National University, is the Director of the National Biodiversity Inventory.

Here we briefly describe the parataxonomists' training program, and what has been their role in the preparation for the national inventory through 1992.

Background

Costa Rica does not have the luxury of being able to take many decades and many millions of dollars to train a large number of Ph.D.s and university-graduate technicians to eventually inventory its biodiversity. Equally, it can not expect the international science community to drop all its other activities and come to Costa Rica and conduct her inventory. And certainly, Costa Rica's biodiversity cannot wait the several centuries that either option would demand.

If Costa Rica does not have its Conservation Areas - 25% of the national territory as wildlands conserved for their biodiversity - recognized as a firmly productive sector within 1-2 decades, these wildlands have little or no chance of withstanding the environmental onslaught from the pending major increase of the population during over the next ten years, the pending national social reorganization, the pending environmental contamination/change, and the acquisitional drive of clever individuals during that period. If Costa Rica's biodiversity is to survive, it must be made usable for both intellectual and economic gain of sufficient magnitude that Costa Rica's society will aggressively conserve it into perpetuity.

INBio has taken the route of planning to use Costa Rica's two abundant underutilized resources - the rural populace and wildland biodiversity - in collaboration with the international taxonomic community, to achieve a biodiversity inventory in a decade at a reasonable cash cost. The rural areas of Costa Rica are rich in highly capable adults who are, quite frankly, working at jobs far below their intellectual and energy levels. Additionally, the international scientific community, largely but not entirely of the developed world, has long overestimated the amount of training that is required for an individual to become a major participant in a task as complex as a thorough inventory of the species in a complex tropical wildland. Second, if properly offered, Costa Rica's biodiversity itself can be a powerful magnet for short term international technical and training assistance to gear up the Costa Rican human resource to where it can do the job itself.

A chronological history of the parataxonomists

A detailed examination of the historical roots of the parataxonomists is important in helping to undetstand some of the important ways that they differ from "collectors" and "biological technicians", occupations with which they are frequently confused. This distinction is in turn important because it underlines some of the subtilities that have proven to be very important in successful parataxonomists.

From 1974-1979 we hired Gerardo Vega as a field assistant to help with NSF-supported ecological field experiments and insect collecting in Corcovado National Park and Santa Rosa National Park. Vega had been a Costa Rican farmer, hunter, drunk, gold miner, squatter, liquor-smuggler, national park helper, etc. And he was smart, tough and very interested in the work, and had three years of formal education. His national park employers were eager to be rid of him because he always felt he knew how to do things better than his administrative superiors. His parents had been coffee pickers. From 1983 to 1989 we hired Roberto Espinoza for the same job, after Vega returned to gold mining. And Espinoza was also smart, tough and very interested in the work. Espinoza was from the small fishing town of Cuajiniquil in northern Guanacaste Province, on the north boundary of the Guanacaste Conservation Area (Figure 1). He had six years of formal education, and had been a machete swinger, cowboy, and fishing boat helper. His parents were ranch employees, cowboy and housewife. Both were chosen for extensive experience and capacity in the field, for being extremely curious, for being extremely tough physically, and for getting intensely involved with whatever they were doing.

As we worked alongside Vega and Espinoza, it became evident that they had the ability to be doing yet much more - especially with respect to accepting responsibility and learning complex tasks. Furthermore, we were receiving more assistance and enthusiastic involvement from them than we had ever observed from Costa Rican university students (volunteer and employee), and more field competence than I had encountered in all but the most exceptional of the enthusiastic US graduate students visiting and working in field biology in Costa Rica during the past several decades.

Simultaneously, we began the NSF-supported "Moths of Costa Rica" project in 1978, initially to get stable names on the adults of caterpillars being reared in herbivory studies in the GCA dry forest. This project employed Isidro Chacon and Maria Marta Chavarria - both quite exceptional students from the University of Costa Rica - to live in a single site (Estacion Carrillo, La Selva Biological Station, respectively) for a year and do nothing but collect and spread moths there. And Isidro taught his brother Abelardo Chacon to do the same. The quality of their work as unsupervised collectors was excellent, even under very trying field and administrative circumstances.

As the idea of the donor-supported "Guanacaste National Park Project", which was the recent ancestor of the Guanacaste Conservation Area, took root in February 1986, it became evident that an insect inventory of this 100,000 ha area of dry forest, cloud forest, rain forest, and intergrades would be of great value in understanding insect migrations, seasonality, micro-distributions and other ecological parameters that could affect direct management decisions. Such an inventory was visualized as building on the 10-year NSF-supported informal arthropod and plant inventory of the GCA region that had been initiated about 1968.

Therefore, in 1986-1988 we hired and began to train local rural adults from the boundary zone of the GCA (Figure 1). The emphasis was on producing people able to collect and prepare insects with minimal supervision. They taught each other, we taught them, and Angel Solis (today, the coordinator of the Arthropod Department at INBio) and Abelardo Chacón taught them. Most of these people - Roberto Espinoza, Elda Araya, Carlos Chaves, Calixto Morage, Petrona Rios - are among today's parataxonomists because they were obvious candidates for the first parataxonomist course. As of the end of 1992, along with Roger Blanco, who joined after graduation from the first parataxonomist course, they constitute the Biodiversity Inventory subprogram of the Research Program of the GCA.

The first parataxonomist course, January-July 1989.

However, in the fall of 1988 the GCA was suffering the anguish of attempted integration with the remainder of the Costa Rican National Park System. There was a very clear need for staff from other Costa Rican national parks to observe and understand the micro-revolution in administrative structure and philosophical attitudes that characterized the GCA. Simultaneously, US-AID made known that it would be supportive of any GCA educational effort that dealt with the environment, Costa Ricans and the other parks. The solution was to formalize the efforts to train people for the GCA inventory into a six month full-time course (January-July 1989) and include ten additional persons from the Costa Rican national park system. Since there were already five collectors beginning to work in the GCA, only one park service employee from the GCA was admitted, and the other nine park service employees were distributed among the national parks Corcovado, Amistad, Carara, Tortuguero, and Braulio Carrillo. Today, these national parks are core parts of the Costa Rican Conservation Areas (Table 1, Figure 2).

A six month full time course was deemed necessary because of the lessons learned with the subject matter during the process of producing high quality field research assistant and insect collectors in previous years.

training, supplies, equipment, and supervision (field liason and coordination from INBio) for a year of work (including the six months of the course), and the graduates' employers would provide their salaries and office/living space for ongoing work (during the course as well as after).

There was no formal contract as to this employer/training relationship, but rather there were various explicit and implicit agreements at the level of the directorate of the National Park Service, the Ministry of Natural Resources, Energy and Mines (MIRENEM), and the directors of the individual national parks. Ten of the first parataxonomists were therefore government employees and five were employees of the Guanacaste Conservation Area (then the Guanacaste National Park Project) under the fiscal administration of the Fundacion de Parques Nacionales. The latter is an NGO in spirit, if not entirely by definition. These institutions thus donated a given type of employee (rural collector, park ranger) and received a parataxonomist in return. It was understood by all concerned that the idea was to generate a new kind of vocation, populated by people who would take this on as a life-time occupation.

We asked ourselves "What does a non-biologist rural adult really need to learn to conduct a serious inventory, get started and continue through on-the-job training, working essentially by oneself with no supervision in the field and only occasional feedback from INBio when specimens are brought in"? In essence we tried to remember all the aspects of those "old-fashioned" university courses (ornithology, herpetology, entomology, cryptogamic botany, field botany, algology, etc.) that are pertinent to conducting an inventory - techniques, basic natural history, basic taxonomy, basic evolution and ecology, conservation rationale, etc. The course became these things plus innumerable footnotes and detours to pick up the basic details of genetics, math, natural products chemistry, physiology, anatomy, etc. These things were mixed with theory and practice of how to drive a car and chain saw, care and use of horses, how to use a computer and a topographic map, how to use a field guide in a foreign language, how to manage a budget and petty cash fund, how to interpret and tolerate foreigners, what is administration and why, structure and content of environmental legislation and conservation propaganda, funding for research, personal relationships, how to feel self-confident in the face of depreciatory assault, how to teach, etc. Associated with being able to do the above things are more personal things, such as getting one's first pair of eye-glasses and learning how to use them, learning how to work alone at night in the forest without fear, losing excess weight, learning how to receive and absorb criticism, etc.

We also asked ourselves what kind of person would be best for this new vocation. A notice briefly describing the course and the parataxonomist's vocation/responsibilities was by the course coordinator (Isidro Chacon) among the headquarters of the Costa Rican national parks in late 1988. It had a form asking for standard biographical information (education, present job, etc.) and a request for the applicant to write a short essay about why he or she wanted to become a parataxonomist. In this first course, only personnel of the GCA (legally, employees of the Fundacion de Parques Nacionales) and the National Park Service could apply. From the 28 completed application forms that arrived, 22 of the best were selected for interview by the content of the form, with some bias introduced by the reputation of the individuals within the National Park Service. The interviewees were invited to come to the GCA by bus for individual interviews with the course faculty, the course coordinator, and at least one member of the GCA Administration. Ten new people and the five GCA insect collectors were selected for the course after the interviews and after gaining final approval for the selection by the employee's administrators. Employer approval of candidate selection was essential, since the employer was experiencing the exchange of one kind of staff member for a parataxonomist, a new and unknown kind of staff member.

The final candidates were chosen almost entirely on the subjective evaluation of all involved of enthusiasm for the challenge, basic intelligence, frustration with the status quo of their current jobs,

years since the selection of the candidates for both courses, it has been discovered that many of the successful candidates were previously viewed by their employers as "problem persons", famous for not fitting very well into their unchallenging civil service work regime as National Park personnel.

While two women were present in the first parataxonomist course and have since proved to be outstanding parataxonomists, they were among the five collectors contributed by the GCA. No other women applied for either of the first two parataxonomist courses (see below, third course).

The term "parataxonomist" was borrowed from "paramedic". It has been clear from the beginning that the goal in the training program was to prepare a person for an highly independent vocation, rather than to lay the first steps for progression to advanced degrees and university employment. However, a few parataxonomists have and will undoubtedly go on to more complex training due to the impulse that has been given to them by starting out as parataxonomists (see discription of the parataxonomists who have moved on, below). The parataxonomists are not called "barefoot taxonomists" both because they are not barefoot and because of the lack of respect that is implied by that term. The parataxonomists are not called "technicians" (though Costa Rican society, and especially civil service evaluations, have a strong tendency to do so) because the stress is on ability to work independently and to understand the philosophy behind what they are doing (neither of which are characteristic of technicians in this society).

The Costa Rican course coordinator and teaching assistant, Isidro Chacón, was at that time on leave from the Museo Nacional served in this capacity until graduation, at which time Maria Marta Chavarría assumed responsibility for the parataxonomist program. She has continued ever since as field liaison between the parataxonomists (and their administrations), and the INBio central facility.

This kind of course only works with total immersion by all involved. Formal lectures, discussions, lab work and field activities were opportunistically intermingled and continuous from 7 am to 6 pm (one hour for lunch) for 10-15 day periods, followed by 3-4 day breaks during which students left the ACG to visit families and attend to other obligations. Many nights were also spent in the field in actual collecting activities.

Much of the content of the course was guided by preparing the parataxonomists for questions such as the following, both with respect to being able to begin to answer them and how to continue developing understanding of them:

1. How can one use a list of the species of moths, beetles, wasps, butterflies, etc. occurring in a national park? How does one use other kinds of biodiversity information (e.g., numbers and kinds of habitats and climates, numbers and kinds of plants)? How does biodiversity information help in the conservation, management and development of a national park?
2. How does one know when enough collecting of a group has been done so as to stop and work on a different group? How many specimens of a "species" should be collected from the taxonomist's viewpoint and from the park's viewpoint?
3. How can one know if a sample of species is representative of what species are actually there? How does one decide in which habitats to collect?
4. What can one do to encourage professional taxonomists and other kinds of biologists to work on the specimens you are collecting rather than those from other places?
5. How does one justify the production of local field guides (fast) for national parks when the taxonomists like to do revisions (slow) of all the species in large geographic areas? What are the steps to producing a field guide, and what material is needed? What does the public

6. How can one determine if a particular kind of collecting will damage the biology of a national park? How does one integrate collecting and other biodiversity survey activities with other kinds of research and management in a national park?

7. How are scientific names produced, why do we have them, how can they be used to locate other scientific information? What is a research collection and what is a national museum? What is a species? What is a population?

8. What are the basic natural histories of the different groups of animals and plants that are encountered and how does this relate to a biodiversity survey?

9. How can the gathering of biodiversity information best be coordinated with a national park's management needs?

10. Why should specimens be viewed and treated as international property, and distributed broadly among responsible users? How does one integrate actual collecting activities with other park users, including other collectors?

11. What are the collector's responsibilities to the questions from the observant public? Should there be specimen displays in a national park? Who should take care of them? How should they be taken care of?

12. Why are national parks and other conserved areas critical for the maintenance of biodiversity?

13. Why do we want to conserve and maintain a very large portion of the diversity of the earth's organisms and habitats?

14. Why should Costa Rica be particularly concerned about the conservation of its biodiversity, and how does this relate to the biodiversity of the remainder of the world?

After two months of this very intense activity, the students were sent back to their "home" parks to work independently for a month, practicing what they had learned. They then returned to the GCA for two more months of intense training like that in the first part of the course.

International taxonomists and Costa Rican university and museum personnel were opportunistically invited to visit and talk about their specialty, and how to collect their specialty taxa.

The buildings, vehicles, and field stations of the Guancaste Conservation Area provided the logistic support for the course (the GCA was actually decreed at the end of the course, as the Guanacaste Regional Conservation Unit). The staff of the GCA provided diverse administrative and moral support to the course, a course that was viewed by all as a giant experiment in Costa Rican conservation sociology.

Insects and higher plants received the heaviest emphasis as pedagogical tools during the course because a) they are where the most intense need is at present in Costa Rican biodiversity inventory (both in numbers of species (Table 3) and potential novel uses), and b) they offer a huge number of easily accessible examples of evolution, ecology, development, mimicry, protective chemistry, complex life cycles, etc. Additionally, the inventory of Costa Rican vertebrates is essentially done (except for some special work yet in small reptiles and amphibians), and inventory of micro-organisms, fungi, diatoms, etc. will be best conducted by parataxonomists with training in addition to the basic training described here.

Upon graduation, it was intended that the parataxonomists would return to their source national parks, establish Biodiversity Offices (Figure 2), and go to work. They did.

Training in scientific and practical matters has continued on a less formal basis since the end of the course, particularly through the field liaison, the INBio curators and staff, and some visiting scientists. There have also been formal short courses specializing on particular groups of organisms, taught by

questions below).

As soon as the first course was in progress in early 1989, the students (the first group of parataxonomists) began to generate very large amounts of high-quality mounted specimens. There were far more specimens than the facilities of the Museo Nacional could even imagine storing or processing. At about the same time (February-March 1989) the idea of an INBio was born through the convergence of many similar conservation-related currents and actions in Costa Rica, a convergence that began in MIRENEM about October 1988. This idea was realized in the form of the first INBio building in Santo Domingo in May of 1989, just in time to offer shelter and custody to the collections and curators of the Department of Natural History of the Museo Nacional. The latter department had just been evicted by the remodeling of the western face of the Museo Nacional building. With no place to go, they (and the huge volume of work being done by the Missouri Botanical Garden "Manual of the Flora of Costa Rica" project) quite literally moved from the bulldozer blade to the still wet floor of the new INBio building. This building also opened just in time to receive the first large bulk deliveries of insects and plants from the first parataxonomists course.

In summary, the first parataxonomist course was generated by

- need for the beginning of an inventory of the Guanacaste Conservation Area,
- expression of interest by US-AID in supporting something similar on a national level,
- willingness (not described here) of the US National Science Foundation to informally and opportunistically support inventory development in the nascent INBio,
- awareness that parataxonomists could be drawn from rural Costa Rica, and
- willingness of the administrations (and government) of Costa Rica's conserved wildlands to provide salary lines for this activity.

To us, as faculty, it appeared as an interesting teaching challenge and something that satisfied our feeling that at this stage in history we academics cannot afford the luxury of continuing with business as usual. Also as faculty, we found it to be enormously stimulating, since the students reminded us of the enthusiasm and moral idealism of the university body of the late 1960's and 1970's in the US.

The second parataxonomist course, May through August 1990.

In May-August 1990, a second and quite similar parataxonomist course was taught, financed again by US-AID, but this time via the Biodiversity Support Program, administrated by a consortium of WWF-US, TNC, and WRI (Table 5). The Course Coordinator and Teaching Assistant this time was Manuel Zumbado, a parataxonomist graduated from the first course. As with the first course, the entire course was taught in the GCA, making use of its field stations located in almost all of the kinds of habitats that are represented in Costa Rica's conservation areas (Figure 1). However, it was now clear that the parataxonomists have an institutional home at INBio, no matter that they work all over the country and are paid by a variety of employers.

As in the first course, the general structure was intense 7-10-day periods of study and field work at this or that field station, interspersed with 2-4 day vacation periods to visit family and travel. After two months of this, each parataxonomist returned to his "home" park and worked for a month on his own. The parataxonomists of the first course set up the first Biodiversity Offices during this mid-course trial, and the parataxonomists of the second course used the established Biodiversity Offices while their occupants were off taking an advanced parataxonomist course in Microlepidoptera in mid-1990. The students of the second course then returned to the GCA for another period of a month of intensive study. At the end of the second course, all parataxonomists from both courses conducted a 3-day field workshop

In the second course, the student source pool was broadened to also include employees of the National Forest Service and two conservation-oriented NGOs. A private lumbering company was also invited to support a parataxonomist, but voided its contract after three months when it discovered that the parataxonomist would answer to INBio, rather than to the company. The parataxonomist, however, was incorporated into the budget of the nearby Tortuguero Conservation Area.

In retrospect, there were three major errors made with the second course. First, it was two months shorter than the first (4 months versus 6 months). This two month delay - and attempted compression of many of the teaching activities - occurred because of administrative disagreements about the availability of the government-employed students that were selected for the course, and chaos in Costa Rica's conservation efforts as fallout from the change in political parties following the early 1990 presidential election. Second, we relied too heavily on the outstanding course coordinator for too much of the teaching. A second-year parataxonomist, no matter how good, does not have the pedogogical stamina and a strong enough grasp of the basic material be able to carry a major teaching role. Third, we allowed other persons to select three of the participants. All three of these participants failed as parataxonomists following graduation, and are no longer with the program. It is extremely difficult for other persons to choose good candidates because they are not truly aware of what characteristics are of greatest importance, and what is expected of the graduates.

The third parataxonomist course, January-June 1992.

No course was offered in 1991 for three reasons. First, it was necessary to raise sufficient funds for a third course. A pledged donor reniged, and three years are required for the Pew Teaching Endowment to generate enough interest to cover a major part of the cost of a course. Second, it was decided to allow time for the first parataxonomists to function, and then use feedback from that function to determine how the course should be modified. Third, it was useful to allow a respite for the faculty from the stress of teaching a parataxonomist course. Also, an intensive NSF-supported two-month advanced course in Hymenoptera was taught to the parataxonomists during the first half of 1991.

During late 1991 INBio received a grant from the Liz Claiborne and Art Ortenberg Foundation for three years of salary and operations costs for 10 female parataxonomists. The ensuing 1992 course is supported by the National Fish and Wildlife Foundation, the Moriah Fund, the Conservation, Food and Health Foundation, SIDA of the Swedish government, and INBio's Pew Teaching Endowment. It contains 18 women and 3 men. What it has produced will be the subject of a different report. Suffice to say that the serious male sex bias among the parataxonomists has substantially corrected.

Questions commonly asked about the parataxonomists.

One of the characteristics of total immersion in the reality of conservation development in a tropical country is that it does not leave time for academic analysis of all processes deserving of such analysis. At this time we do not have the time to generate a fully considered synthetic analysis of the parataxonomists and their courses to date. Instead, for the purposes of introduction to the topic, we briefly reply to some of the most commonly asked questions about the parataxonomists and their program.

1. What are the goals of the parataxonomists?

A parataxonomist's present-day goal is to initiate and conduct an inventory of the fauna and flora in the vicinity of his or her respective Biodiversity Office, emphasizing those taxa that the curators and

emphasis is an essential ingredient both because certain taxonomic groups require little or no further national-level inventory (e.g., birds, mammals, large snakes, macrobutterflies, sphingid and saturniid moths, many groups of macromoths), because the parataxonomists have not yet received specialized training for collection or observation of certain taxa (e.g., diatoms, mites, algae/lichens, fungi, mosses), or because INBio does not yet have the facilities to handle the specimens (e.g., small reptiles and amphibians, spiders, marine invertebrates, microbes, living cultures).

The site-specific emphasis is necessary so as to insure sampling at all times of year and to insure collection of those species that can be collected only in certain years. Superficial "collecting trips to the field" have been the basis of most tropical inventory activity for more than a century, and the year-round presence and intensive re-working of an area is intended to avoid this problem. Site-specific emphasis is also very important for the parataxonomist to gain species-level familiarity with a given fauna and flora so as to avoid wasting time on excessive collecting of the same species and, on the other hand, so as to be able to do repeated collection on later dates if so directed by INBio.

Finally, through frequent contact with many species at different times in the year and in different circumstances, the parataxonomist learns first-hand a substantial amount of natural history and behavior. This information is now beginning to be tapped by INBio and other biodiversity managers for biodiversity prospecting, conservation management, ecotourism, education programs, etc. This ecological and natural understanding by the parataxonomist is also critical to maintaining a high personal interest and involvement by the parataxonomist in the work itself. Simple collecting of unknown and un-understood specimens quickly becomes a boring task, one that does not lend itself to independent work in the isolation of a field station. Finally, this understanding is critical to further employment and intellectual involvement by the parataxonomist once the inventory is completed and more human resources are needed in the "use" phase of biodiversity conservation.

Long term residence in an area is also essential to knowing, developing and managing all of the logistic and social threads that characterize 1) successful survival of the parataxonomist in the administration and microsociety of the Conservation Area, and 2) strong flow of his or her influence and knowledge into the surrounding general community. The latter is inextricably intertwined with the fact that more and more of the parataxonomists have families at the site and will spend major portions of their lives in the area.

The last two decades of intensive collecting at particular Costa Rican sites by individual taxonomists or ecologists working on a specific major taxon has often shown that almost all of a major habitat's fauna can eventually be found at one site, if the site is studied year round and for several years. For example, a single light placed in the right place in Santa Rosa National Park in the Guanacaste Conservation Area will get at least 99% of the entire macro-moth fauna of this 10,500 ha park in about five years. Such a survey can be conducted even faster with multiple lights, and by moving lights around within the park. Fifteen sites of about 5,000 ha each in Costa Rica's Conservation Areas could be chosen so as to yield 90% of the country's fauna and flora in ten years of collecting. As a site becomes well-inventoried, the parataxonomist will (and does) range further afield to locate concentrations of species not yet collected, both because this is more efficient than waiting for the species to eventually be encountered at one small site, and in order to maintain personal interest in the task.

The feedback from INBio as to which groups to collect varies among the Conservation Areas according to

- the perceived need of particular Conservation Areas,
- variation among individual parataxonomists in their personal circumstances and abilities,
- what kinds of emphases are being placed on what taxa by what specialists (taxonomists or other kinds

- the species richness of the area, and
- the number of person-years that have been invested in a particular Biodiversity Office. For example, when a new Biodiversity Office is first established in a Conservation Area, the first year is spent on intense general collecting of all groups of insects and plants.

There is a second, more subjective and global, goal of a parataxonomist. Attaining this goal is often viewed as a byproduct by the working scientist, but is a primary goal of the parataxonomists program when viewed in the context of the larger goal of conserving Costa Rica's biodiversity. The parataxonomists have substantial contact with their associates in the park service, with family members, and with the neighborhood. The latter includes Costa Rican apprentices, school groups, tourists, ecotourists, businessmen, neighbors and associates on the street. To all these people, the parataxonomist legitimizes the study and understanding of wildland biology, and directly and indirectly promotes biological literacy in a multitude of ways. This promotion is done at a level of language and socialization at the very core of the rural populace that have long been the direct attackers in the age-old human war against wild tropical nature.

The current parataxonomist has a third goal of extreme contemporary importance to INBio. This goal is to illustrate the problems and strengths of this way of approaching a national inventory of a very large and complex biodiversity (Table 3). When the ten-year national inventory officially gets under way in 1993, it is anticipated that the parataxonomist staff will grow to one hundred or more working throughout the country, with frequent replacements and upgrading being a continuous process. Many of fully-operative parataxonomists from the first two courses (and the current 1992 course) will likely be examples, teachers, coordinators and facilitators of the actions of this entire team. Today's parataxonomists are a giant experiment in training, institution building, and goal-directed science. The methods of teaching and guiding these 100+ (mostly new) parataxonomists will be shaped by our experiences from 1989-1992. This is what INBio means by "planning by doing". The science public has already come to view the millions of specimens accumulated to date by the parataxonomists as a marvelous product, but in fact INBio and Costa Rica are still in the planning stages.

2. What is the goal of the inventory?

The goal of the inventory is to

1) get Costa Rica's biodiversity as nomenclatorially stable as is reasonably possible, and

2) have a first approximation of where it is (in the sense of being able to relocate it for use, and begin to know what is necessary to be able to use it witout destroying it).

The first goal is necessary so that
- i) biodiversity information can be organized and managed at the level of species,
- ii) the very powerful inferential tools offered by taxonomy can be used in biodiversity prospecting and management inference, and
- iii) Costa Rica (INBio) can gain access to the vast amount of information that already exists in the international scientific literature about Costa Rican biodiversity, information derived from studies that have been conducted both inside and outside of Costa Rica. It is, for example, little appreciated that easily 60% of Costa Rica's half million species range over 10-20 degrees of latitude and many of them have been studied, albeit sketchily, in other regions (this applies, incidentally, to a very large number of tropical species, no matter what country is viewed as their "home" country).

The non-scientist, who has generally never suffered the consequences of [illegible]

and complex body of information without having a stable nomenclature for the basic parts, does not intuitively attribute this first goal to a national inventory. However, in fact it must either predate or go hand in hand with the efforts toward the second goal.

The second goal is necessary so that genes, tissues, seeds, adults, products, etc. can be offered to user processes - whether these be the production of field guides for ecotourists (school groups, OTS courses, holiday visitors, etc.), computerized "literature" for grade schools, genes for biotechnologists, chemicals for the pharmaceutical industry, seeds for reforesters and agriculture, or whatever. A reinforcer of this second goal is that as the sources for specific things of value become associated with specific conserved wildlands, there is a quite human Costa Rican response to want to save a specific wildland because of that association. This reinforcement is underlined by actual income flow into Costa Rica for biodiversity goods and services, and some day it will even be part of the magnet for the movement of industries that use biodiversity materials to Costa Rica.

The goal of INBio's biodiversity inventory, and therefore that of the Costa Rican parataxonomists, is explicitly not to make decisions about what major areas of wildlands to conserve in Costa Rica. On the large scale, Costa Rica's system of conserved wildlands is for all intents and purposes established. When further fine-tuning is required or desired, there are usually far more rapid and effective ways to arrive at a general decision as to whether to conserve pieces of habitat than by conducting detailed and time-consuming inventories to add to what is already known through the past decades of exploration of Costa Rican field biology. Additionally, virtually all conservation decisions in Costa Rica hinge on the interplay of political and social power, not on complete inventories of biodiversity. For example, it should be made clear that the decision to decree and maintain Braulio Carrillo National Park as a traditional "conserved" national park does not require any further inventory knowledge than that which is already common knowledge among Costa Rican and international field biologists. Whether the Santa Elena Peninsula falls prey to real estate developers and speculators in 1992 will not depend on a detailed list of the species there, and even if that would be helpful, there is no time to gather it.

Equally important, the goal of the inventory is explicitly not to manage a given national park in the traditional sense of direct protection from the neighbors and commercial interests. A list of the 20,000 species of beetles or the 4,500 species of plants present in Guanacaste National Park (Figure 1) is not necessary for direct protection management, any more than a fireman needs a card catalogue to extinguish a fire in a library. However, we must simultaneously note that certain kinds of species-specific information will be needed for protective management (analogous to knowing where the Rare Book Section of the library lies and what special visitor conditions should apply to it). For example, the inventory-acquired knowledge that dry forest insects from Santa Rosa National Park migrate to Guanacaste National Park's rainforest refuges in the dry season was used to justify the establishment of Guanacaste National Park.

Had the parataxonomists program been initiated in the 1970's and early to mid-1980's, much of the information generated by the biodiversity inventory might have been used for mega-conservation decisions. Additionally, in a limited way, the parataxonomists and their data do still play a role determining some of the fine details as to whether this or that set of a few thousand hectares should be included or excluded from a given Conservation Area.

But today, in Costa Rica, the parataxonomist does not derive his or her primary scientific or budgetary justification from being an essential tool in Costa Rican big-picture conservation boundary planning. However, when it comes to using the area in a manner that does not permanently damage its biodiversity, and therefore generate a powerful counterforce to future wildland elimination by society, the inventory and its associated information is of very great management and budgetary value.

The goal of the inventory, and therefore the daily field work of the parataxonomists today, is deliberately narrowly defined and highly focused by INBio so as to exclude the simultaneous intensive and extensive search for random natural history ("ecology") information about a few species. To be blunt, the time consumed in collecting most kinds of natural history information is directly competitive with the two primary goals of the inventory itself: taxonomy and location of the species.

It should be noted also that random collection of natural history data is even less useful than is random specimen collecting. There is no reason to discard easily-recorded information (e.g., labeling material as to whether it was collected in malaise traps, yellow pan traps, etc. or noting that a long series was taken from a drying pool in a dry river bed). However, there is a fine distinction between this kind of activity that takes virtually no time of the parataxonomist, and individual labeling of specimens and note recording, an activity that becomes extremely costly in field time and laboratory processing and generates information of very limited value (e.g., " sitting on leaf in sun at 10 am in treefall clearing").

Much of such "natural history" information is traditionally viewed as highly desirable to the taxonomic science community, but it is very difficult to defend the expenditure of major time and dollar resources to gather it when both are in extremely short supply, and the relative value of the information is highly questionable, given the large amount of work to be done in simple collecting of hundreds of thousands of species. To render the gathering of such information cost-effective by field personel requires an additional kind of training, a training that is quite feasible but not yet funded (see below under "paraecologist").

The parataxonomists opportunistically and incidentally learn an enormous amount of natural history information that can be tapped on occasion. The more taxonomically astute and experienced they become, the more natural history information they accumulate on the side, and the more useful the parataxonomists can be at offering useful replies to ecologically directed questions. But it is one thing to reply to "Have you noticed any species of wild juicy fruits that lie on the forest floor and do not rot", and quite another thing to respond to "Please starting collecting field notes on aspects of plant biology that might offer phytochemical leads". The simple act of rearing a single species of caterpillar can easily absorb an hour a day for several weeks if reasonable field notes are kept on that rearing.

It is evident that another kind of person, a sort of "paraecologist", needs to be developed in parallel with the national inventory. The paraecologist would glean the forest with the same "directed vacuum-cleaner behavior" as the parataxonomist but specialize on sets of questions and on ways of accumulating information for which the specimens are by-and-large vouchers or being collected in bulk for chemical analysis. Such a person can work very profitably in collaboration with a parataxonomist, and will depend very heavily on field guides, identification reference services, etc. that flow from the inventory. However, it is critical that the parataxonomist does not become subverted into doing very mediocre ecology (as is often the case when when Ph. D. taxonomists become entranced with field ecology) as well as vice versa (this occurs less frequently, but is a risk when a paraecologist is confronted by a frustrating ecological question).

3. Collecting permits?

Each parataxonomist carries an INBio identification card that identifies him to any authority as a legitimate INBio employee and parataxonomist, covered by the appropriate national permits for collecting inside a national park and Conservation Area, and for transporting biological specimens. As national biodiversity legislation and regulation become more ordered, as is occurring on a monthly basis in Costa Rica, such formal identification is critical.

4. What will happen to the parataxonomists when the inventory is completed?

The experienced parataxonomist will always be a hot item on the Costa Rican job market, irrespective of whether the inventory has been completed. Their high level of biological literacy makes them ideal for positions within the agricultural and forestry industries (government or private), and for positions as teachers, ecotourist guides, environmental educators and environmental consultants (government or private). As INBio grows, it also has strong needs for increasingly specialized biologists working in the field. The role of INBio is already broadening to include far more than the inventory. INBio itself could today easily hire ten of its own parataxonomists to work as part of the biodiversity prospecting teams if the parataxonomists were interested, and not needed for the inventory. By the time that the inventory is relatively complete ten years from now, there will be many parataxonomists who have moved into other areas of biodiversity management (some within INBio), gone on to obtain higher degrees, and (even) moved on to other countries as doers and advisers.

It should be emphasized that becoming a parataxonomist is not a terminal vocation, though some individuals will find it to be a pleasant life-long vocation and show all signs of making it just that. Becoming a parataxonomist is an opening to a diverse set of opportunities in biodiversity management, as well as giving a philosophical background that can be the springboard for development into quite different areas in science and society.

5. What are a parataxonomist's obligations to the program?

It costs approximately $15,000 train a parataxonomist and support his or her operations for the remainder of the year. As mentioned above, such a trained person is immediately a potential candidate for other jobs in administration, education, public relations, planning, etc. While it would be a major contribution to Costa Rican conservation and society to continually train parataxonomists and then have them leave to take other positions, it might be more effective to train them initially and directly for these other positions. Equally, if all parataxonomists leave with a short time after they are trained, the inventory will take much longer because it will be primarily conducted by relatively inexperienced persons. Being a quality parataxonomist is very much a product of continuous on-the-job training and experience.

From the beginning, the parataxonomist is asked to view himself or herself as joining a long-term vocation program, a vocation in which many years of involvement in the national biodiversity inventory are expected. Successful applicants for the program make a moral commitment at the time to work for a minimum of three years. When temptations to leave appear, INBio makes a serious effort to convince the parataxonomist to stay on as a parataxonomist. However, if the person does leave the program amicably, INBio encourages the person to remain in contact, and does not view the person as a loss either personally or to Costa Rican society.

The work schedule of a parataxonomist is 24 working days per calendar month, for which he or she receives a monthly salary, two weeks of paid annual vacation, an extra month of pay on 1 December, social security benefits, health insurance, free medical services, and a variety of other social benefits as normal for any Costa Rican employee. A "working day" tends to be 6-16 hours distributed through the night and day. The details of the distribution of hours, working days and non-working days is set by the parataxonomist according to his or her perception of the biological characteristics of the focal organisms, and other activities for which society has a calendar. The annual cost to the employer of a parataxonomist is 1.46 X the annual salary. At the time of this writing, the annual salary of a beginning parataxonomist is approximately $3,000, and the most experienced parataxonomists receive

20-30 year age bracket with a grade school to high school education in a rural environment.

6. What has been the response of the academic community to parataxonomists?

The response of the academic community to parataxonomists and the concept of parataxonomists has been highly variable. Academic and museum administrators generally say "of course, why not?", but are not inclined to think in terms of facilitating their appearance in the actual field operations that they are concerned with. Many older international Ph.D. taxonomists view them as mediocre field collectors who could not possibly do the specialized collecting necessary in "their groups". However, once these people get to know the parataxonomists or see their collections, there is a strong change in attitude. They tend to respond to the parataxonomists as individuals and focus on getting their specimens, and on teaching them how to do their particular kind of specialized collecting. Most younger international Ph.D. taxonomists display an immediate response of wanting to work with them in the field "if only they could find the money to go to Costa Rica and do so".

The academic community of the developed world has definitely complained "under the table" about the INBio inventory program overall, and specifically about the parataxonomists. "How could they possibly do a ten-year inventory when we have been trying to do inventory that for decades, and it is clearly a task of several centuries and demands far more resources being put into systematics." "Inventory, faunistics and taxonomy is out of fashion and no one will fund that." "Oh, we have been using native collectors for years, they are very useful but do not solve 'the problem' which is a lack of funding in systematics". In addition, there is resentment that this aspect of the inventory program does not seem to solve the problem of a shortage of employment opportunities for young taxonomists in the developed-world, and that the inventory does not directly address the strong emphasis on cladistics in modern systematics. Taxonomists have for so long been unaccustomed to having to justify their existence to society that they often do not immediately see that inventories and parataxonomists are a way to cause society to be more, rather than less, interested in their profession. Even more frustrating to the development of the Costa Rican biodiversity inventory is the often felt but rarely openly stated resentment-filled comment that "systematics is not the handmaiden of ecology".

Within the community of workers and institutions in foreign development aid, a community that depends heavily on academics as advisors and for new staff members, there have been the somewhat contradictory responses of "oh, that is 'science' and we don't fund science" paired with "oh, you mean a museum. Museums offer nothing to development, social problems or natural resource management and therefore we are not interested in funding that." On the other hand, there have also been a few far-sighted individuals in this community who have been quick to grasp the development potential in explicit biodiversity management for use, and recognize the parataxonomists as an essential and integral part of that use-oriented process.

Within the community of Latin American Ph.D.s and/or university professors, the response to the parataxonomist idea or person has been generally a mixture of fear, contempt and resentment. These feelings are often expressed as "why should you give such a good job to some poorly-educated rural person when there are Latin American university students and graduates in biology without a job, and who have worked so hard to get their university degree?"

There are both practical and philosophical replies to this question. With respect to the free market, the parataxonomists generally come to INBio with their salaries paid by a government agency or NGO, a commercial interest, or an explicit donor grant (such as that for the female parataxonomists from the Claiborne and Ortenberg Foundation). Any Costa Rican university graduate who shows up wishing to really be a parataxonomist - that is to say, comes with a salary - is quite welcome. Equally pertinent is the fact that a rural person with less than a university level formation

more capable and more comfortable in the field than is the (usually urban) university graduate. In this context, the university graduate often does not take to the rigors, privations, isolation, irregular and long working hours and days, and primitive working conditions with good humor and a shrug of the shoulders. On average, rural people are also more effective at sharing their knowledge with others in rural areas.

Philosophically, the parataxonomists are clearly a form of affirmative action for the decentralization that is clearly essential for the further development of a country like Costa Rica, where 80% of the power, trained intellect, and decision-makers are concentrated in the Meseta Central (urban zone around the capital city, San José). If there ever was a government sector that is by its very nature decentralized, it is the management for use of a system of conserved wildlands. Costa Rica will never successfully manage its wildlands as absentee landlords. What better caretakers than those people with their social, psychological and financial roots in the very area to be protected?

However, it should be recognized that promoting ruralization of the decision-making processes and facilitating upward mobility of rural peoples encounters strong conscious and unconscious opposition in the capital city and the upper classes. The appearance of a group of parataxonomists of rural origin, a group that can perform many of the same technologies and understand many of the same philosophies as can university-level faculty and senior institutional representatives, has been highly threatening to some Costa Rican professors and mid-level government administrators. Careful politicking by INBio staff and INBio supporters in other institutions has been able to only partially defuse this time bomb, and it is not surprising to find that the strongest upper-level support for the parataxonomists and related activities has come from upper level government and university officials rather than the staff per se.

7. Why are only Costa Ricans allowed to be parataxonomists?

INBio itself is a Costa Rican national institution, and carries with it all the motivation that comes from "pride of ownership" and national identification. As such, it would be highly inappropriate to fill parataxonomist slots with international volunteers (there have been many inquiries to this effect) or employees. Additionally, such activity might speed the inventory, but it would definitely slow the rate at which the Conservation Areas and their Zones of Influence come to feel responsible for the fate of their biodiversity.

However, it is also clear that INBio will gradually grow at the ground level to come to be something like an "Instituto Mesoamericano de Biodiversidad", to nestle its activities up against the bottom of some sort of Mexican INBio to the north (which was decreed on 15 February 1992). This growth will clearly involve the Mesoamericanization of the parataxonomists and their activities, as well as other aspects of INBio.

In fact, INBio is psychologically prepared to begin to admit parataxonomist students from other Central American countries to its courses, provided that there are funds for their support. This immediately begs the question of what insititution will receive and process the material from Nicaragua and Panama. Parataxonomists cannot function without a "mother institution" to receive and process the results of their efforts, and to give them the monthly feedback that they need (see below). INBio is willing to consider receipt and incorporation of material collected by parataxonomists from other Central America, but this implies a massive increase in funding for the remainder of the INBio specimen and data management process. It also implies an additional major challenge (and cost) in the administration and legislative aspects of biodiversity management, since the solutions being found in Costa Rica cannot be simply and easily transplanted into the social systems of other Mesoamerican

8. How are parataxonomists and their work evaluated?

There are two relatively distinct aspects to the evaluation of the parataxonomist's performance. One is based on the parataxonomist's response to professional feedback about the quality of material, taxa to emphasize, collecting techniques, sampling patterns, etc. This feedback activity is a major responsibility of the
- INBio curators,
- international visitors to INBio and to the Biodiversity Offices (taxonomists, chemists, ecologists, etc.),
- field liaison between the parataxonomists in their offices and INBio, and
- professors in their courses.

This feedback ranges from direct comments on specimens to telling natural history and taxonomic stories about the species that they are collecting. Short courses, inter-office visits and stays, and maximizing the flow of books and technical papers to parataxonomists in the Biodiversity Offices are all part of the process.

Associated with this feedback needs to be a strong element of encouragement and stimulation to continually probe their own limits with respect to quantity of work, quality of work, self-teaching, learning from associates, and taking full advantage of the short courses that INBio offers. The parataxonomists have generally made a shift out of a long-established friendship circle into a socially as well as technically new world. This is a difficult move, and they need substantial contact with other parataxonomists, other biologists, and biodiversity users so as to not feel isolated in their new vocation. They also need to be treated as professionals, even when they still, understandably, display many of the traits that were adaptive under their former employment pattern. This pattern was generally much more that of a wage-earning employee in a autocratic administrative system than that of a professional who designs his or her daily and monthly activities in accordance with a goal-oriented framework. With some very notable exceptions, it has also proven particularly difficult for international taxonomists accustomed to working with university and graduate students to learn how to develop effective feedback between them and the parataxonomists.

Much of the feedback at the INBio facility occurs during a three day period every 2-3 months, when all parataxonomists gather at the INBio and their recently collected material is gone over by the various curators and any visiting scientists that are present and can communicate in Spanish. An evening lecture of general interest also occurs at this time, as well as group discussions of policy and techniques. Parataxonomists also visit INBio opportunistically to leave specimens and get supplies or information.

A program to involve them more directly in the curation process is currently being developed by the INBio curators. Since the curators are themselves new at all of this, and in the process of defining and developing their own non-conventional modus operandi, they have been slow to come to grasp the many ways that they can manage their interactions with the parataxonomists to the benefit of all. However, it has been very striking to watch the curators grow from bystanding observers of the parataxonomist in 1989 to true leaders of them through one-on-one feedback over the specimens that the parataxonomists bring in at present.

INBio constructed a small 32-bed "hotel" and meeting facility next to the other INBio buildings for the express purpose of hosting the parataxonomists (as well as working visitors to INBio) in these sessions and during short courses. They are not charged for the use of this facility, and it is available to them at any time that they come to San Jose for any purpose.

In the field there is opportunistic, pointed and strategic feedback from the parataxonomist-INBio liason. This position is absolutely critical to the parataxonomist program. In addition to serving as a messenger and materials deliverer between INBio and remote Biodiversity Offices, this liason is the person who sees on the ground just what the parataxonomist is doing. This person has to be an individual and group psychologist, very robust to personal conflicts, understand with absolute clarity the specific goals and general strategy of the inventory and INBio, and enjoy an extremely irregular schedule of long difficult trips, miserable living conditions and uncoordinated crises. Currently this position is filled by the first proto-parataxonomist, Maria Marta Chavarria. She is a University of Costa Rica graduate in biology, the Costa Rican specialist in Gesneriaceae, bilingual, began with a year of unsupervised moth inventory at the La Selva Biological Station, and fulfills all of the above traits.

Throughout the evaluation process and the examination of the material brought in from the field, an impression is formed, person-by-person, as to the relative quality of the work of the parataxonomist. The field liason person also forms an impression of how well the parataxonomist is doing in relations with administrators, neighbors, apprentices, etc. (the liason person is often the first person to flag a potential problem with a parataxonomist, since many problems are less evident in the somewhat academic atmosphere of the INBio facilities). All of these subjective impressions are pooled by the INBio administration and taken into consideration for merit pay raises in addition to pay raises that are automatic with inflation and seniority.

The second aspect of evaluation is that of determining salaries of the parataxonomists. This is an extremely complex issue:

a) Many of the current parataxonomists have worked for many years as civil servants. When they move into this more professional job climate, the questions of merit pay, individual evaluation by quality of individual work, soft money, intangible benefits (e.g., freedom of full access to INBio facilities, real training programs, independence in the workplace, opportunity for advancement) are new and confusing issues. However, they are well aware of the value of worker's health insurance purchased for the parataxonomists by INBio. This benefit was not easy for INBio to obtain because the government unions do not want to allow the parataxonomists to have what they viewed as favored treatment as compared to other government-employed national park guards.

b) Since different parataxonomists have different employers and different employment histories, it is commonplace for two persons work side-by-side and doing exactly the same parataxonomist tasks to receive quite different salaries. INBio is directly powerless to change this, but has a very large responsibility to attempt to do so. As a stop-gap measure, it has been possible to come to a temporary agreement with the government to be able to give a "sobre-sueldo" (salary add-on) to a government worker to get him up to the INBio salary for parataxonomists. INBio is also very active in suggesting to directors of the Conservation Areas what should be the salary for their parataxonomists, especially when they have access to NGO funds to employ part of their staffs. This aggressive behavior by INBio is very important for all parataxonomists because the Conservation Area staffs are not, at this stage, generally technically capable of evaluating the monthly contribution to the inventory by the parataxonomists.

c) It is standard in Costa Rican society for a person to be paid more if he accepts more responsibility. A basic tenet of being a parataxonomist is working independently, handling his own budgets and funds, setting his own working hours, etc. All of these are traditionally viewed as the symbols of "accepting greater responsibility". However, the particular employment structure in which most parataxonomists are imbedded has no interest in recognizing this "greater responsibility" with a salary increase. The outcome is a parataxonomist getting up at 4 am to collect insects at a light while his park ranger colleague snores peacefully in a warm bed, with both of them receiving the same salary.

d) Costa Rican salaried wage-earners commonly belong to real or informal unions. A basic tenet of these unions is that if the salary of one person rises, the salary of all rises. For the first year of the parataxonomists, they steadfastly maintained as a group that they did not want pay raises for one if it could not be achieved for all. INBio argued that the best it could do would be to work on those employers where it could cause salary raises. The parataxonomists finally broke their own informal "union" and came to agreement on that policy. This decision carries with it, however, the moral obligation that INBio be extremely dilligent in its efforts to equalize salaries - in effect to become its own union.

e) Costa Rican institutions as a whole have their Directorates centered in an economic class that is not accustomed to having to fight for higher salaries for persons in the economic class from which most parataxonomists are drawn. INBio has long recognized this problem and worked very hard to counter it, but it is an uphill struggle.

f) As the parataxonomist develops, he or she becomes thoroughly exposed to the life style, thoughts, issues, and ways of analysis commonplace to decision-makers in Costa Rican society. He or she logically applies these new tools to his or her own circumstance, and applies it to what has been a primary preoccupation for all his or her life - the monthly paycheck. The parataxonomists are at a salary and life style level whereby changes in monthly pay of as little as $20-$50 are relatively large changes and can strongly affect performance. Parataxonomists are chosen for their (generally unrealized) ability to be thinkers, act independently, and chart their own course. It only takes about two seconds to come to the partly correct conclusion that if the parataxonomist is doing the field work that is normally done by university graduate, then a parataxonomist should be rewarded accordingly. This quite justifiable attitude means that INBio has an obligation to be continually in search of funds to increase parataxonomist salaries over and above the costs of training and employing yet more parataxonomists. This phenomenon is a particular case of the general case that in tropical conservation development, what initially appear to be quite low management costs increase very rapidly as an undeveloped country begins to develop.

g) For numerous parataxonomists, this is the first time that they have worked for a salary or an employer. These parataxonomists are more inclined to accept whatever is the pay structure as a fact of life, and INBio generally has the opportunity to set that structure at a reasonable level from the beginning. For these persons, however, the concept of being responsible and responsive to INBio, in return for a paycheck as well as a host of intangibles, is a new living experience. It creates quite amazing mixes of people putting in 18-hour days until they drop from exhaustion combined with being perplexed when they find that they cannot take off for several days on the dark of the moon - a particularly important time for collecting with lights - for their mother's birthday. Equally, the concept that one really has to listen to some unpleasant criticism of the quality of one's work, instead of being able to simply shrug it off as "my way of doing things", falls as a quite strong shock to some.

h) Costa Rica is an extremely poor country in comparison with the developed world (per capita GNP is 10% of that of the US, the national budget is $1 billion, or about that of a good US university). Its population is currently about 6 times as great as the carrying capacity for persons with a developed world standard of living. There is simply no fat Costa Rican government budget somewhere that can be asked to pick up the cost of bringing the trained parataxonomist up to what he or she should be paid. Worse, there is no way to then simultaneously raise the salaries of the others who work in the same biodiversity management structure (curators, coordinators, directors, and other major decision-makers). The start-up capital may come from the international development community, but the long-term operation is going to have to be covered by biodiversity user fees in one format or another.

9. What is the function of the short courses for the parataxonomists?

The basic six-month parataxonomist course is designed to give an overview understanding of how to conduct the base of the entire inventory process, and get the parataxonomist to where continued on-the-job training will provide the needed upgrading. Detailed and very specific knowledge learned in the basic course is generally to illustrate a particular process or technique, rather than to be everything one needs to know for intense collecting and understanding of a particular large taxon. Additionally, there are many species-rich groups of organisms that demand an intense short course in collecting and preparation techniques, methods of distinguishing among species, natural history, etc. To date, short courses of 2-60 days duration have been held in marine invertebrates, beetle families, Chrysomelidae, microlepidoptera, Hymenoptera, spiders, Tachinidae and Syrphidae, plants, aquatic insects. Mites, Diptera, families of small beetles, lower plants, protozoa, fungi and small reptiles and amphibians are evident candidates for additional short courses.

The short courses also, however, are also an opportunity for the parataxonomists to work together, to see more intensely how international scientists work and think, and be in direct contact with INBio for periods of weeks. During this time, in addition to taking the course, they also converse much with the curators, look up things in the collections, and generally participate in the atmosphere of INBio as a central information clearing house. The short courses are taught both in INBio, and in one or more Areas de Conservación.

The short courses also serve as a mechanism for an intense field and laboratory exposure of the parataxonomists to collaborating international taxonomists and vice-versa. To date, these collaborators have expressed strongly positive reactions to their experiences of working with the parataxonomists. INBio has been extremely fortunate that there have been a small number of international taxonomists willing to give up their field research time and deviate from their more traditional taxonomic pursuits to teach in the advanced courses. It has been even more fortunate that their administrators have let them.

The length and location of short courses depends strongly on the particular group to be studied and on the particular taxonomists doing the teaching. For large and diverse groups such as Hymenoptera and microlepidoptera, the most satisfactory structure appears to be three faculty members over two three-week periods, with one faculty member present throughout and the other two each visiting for one of the three-week periods.

10. How does INBio get international taxonomic cooperation for the training of the parataxonomists?

INBio recognizes that for a taxonomist to feel free to participate in training of parataxonomists in Costa Rica, there must be some kind of clearance from the directorate that pays his salary and evaluates his performance. In this case, a major INBio task is communicating with that directorate, or helping the taxonomist communicate with that directorate. There is no free lunch. But there are many coinages.

Second, one has to recognize that only a select subset of the international taxonomic community will want to come to Costa Rica and spend time teaching in Spanish what amounts to a high school class, rather than going off and collecting some favorite group of organisms. The trick is to focus on those high-yield individuals who express serious interest, and facilitate them. This of course means that the particular groups of organisms that receive emphasis at present will represent the accidents of which taxonomists are interested in participating, rather than moving systematically down a mind-numbing list of taxa to be covered. So be it. There is an excess of things to do now with the groups where there are enthusiastically interested international taxonomists, and over time specialists in other groups will

appear.

Third, the specimens and knowledge that is accumulated by the parataxonomists become bait for the interested taxonomist today, and create the interested international taxonomist in the future. When it becomes known that there is a body of parataxonomists here ready to be told how to collect mirid and lygaeid bugs, for example, and that they have already collected thousands of specimens of them, there will magically appear a person who decides that mirid and lygaeid bugs of Costa Rica are more interesting than the pentatomid bugs of the US on which he works at present.

Fourth, when the taxonomist comes to Costa Rica to collect on his own group, with no interest in being involved with the parataxonomist, INBio should welcome him with open arms anyway. But INBio should also 'accidently' leave a lot of specimens belonging to his group, collected by the parataxonomists, in plain view, so to speak.

Fifth, approach the international taxonomist with the offer of an INBio search for a curator to work with him or her, in return for guidance in his or her group for that new curator. This strategy, however, demands a financial source to cover the costs of more Costa Rican curators, a source that INBio has not yet located. Today's INBio curators are barely surviving on a miscellany of soft money from NSF and AID grants, and private donations.

11. How are the courses funded?

As mentioned previously, US-AID funded, through the Biodiverisity Support Program, the first two courses and the costs of establishing the parataxonomists for their first year of work. The University of Pennsylvania has donated Janzen's salary. Winnie Hallwachs, numerous visiting entomologists and botanists, and curators of INBio have donated their time. The GCA has donated a wide variety of goods and services. In 1990, the Pew Charitable Trust donated $300,000 to establish a parataxonomists teaching endowment. This donation was converted through a debt swap to $1,321,171 in dollar-denominated 20-year government bonds (paying 3%/yr in dollars, converted to colones at the current rate of exchange before payment). This debt swap was conducted by INBio and Solomon Brothers with fiscal and advisory assistance from the Fundacion de Parques Nacionales, the Central Bank, the Swedish Government, MIRENEM, The Nature Conservancy, WWF-US, and the Biodiversity Support Program of US-AID. This fund generates about $35,000 per year. The interest income and principal are exclusively dedicated to teaching the basic parataxonomist courses.

As mentioned earlier, the funding for the third parataxonomist course (Table 6), currently in session, comes from the National Fish and Wildlife Foundation, the Moriah Fund, the Conservation, Food and Health Foundation, SIDA of the Swedish government, and INBio's Pew Teaching Endowment.

INBio clearly needs substantial additional funds for teaching the basic courses to the new cohorts of parataxonomists over the next few years (Table 2).

When discussing the costs of the basic course, the question often arises as to whether it really needs to be six months in length. We have two reasons for responding with an emphatic no. First, it was tried with the second parataxonomist course and did not work. Second, as we come to understand the many very different things necessary for the course content - technology, personal adjustments, theoretical understanding, philosophical understanding, supervised practice, all of these things in a number of habitats and two seasons - it is clear that six months is an absolute minimum. It must be remembered that the course takes people who have completely abandoned the formal education track and all that implies, and moves them back into what it demands at a much later age. Every single student turns out to have major and different debilitating personal, technical and/or physical weaknesses for being a

parataxonomist. These weaknesses exist, and to some degree may even be the causes, in spite of extreme competence and enthusiasms in other areas of their lives. Often these weaknesses were the very traits that took the student out of the formal education track and moved him or her into a daily labor job or home responsibility. Each of these weaknesses has to be rectified or adjusted to be compatible with a parataxonomist's performance. This takes both substantial amounts of group time and absolute time. Equally difficult is that some of the weaknesses do not make themselves evident until the student has advanced to a substantial degree. This is not so much because weaknesses are deliberately hidden, but rather that one has to have developed a certain package of skills before one discovers that some other seemingly quite unrelated trait impedes the further development of those skills. Finally, there is enormous heterogeneity in the rate at which any given student advances in any particular capability.

The 2-month advanced courses were funded by the National Science Foundation as supplemental awards to the "Moths of Costa Rica" inventory grant, and were focused on two groups of central importance to Costa Rican Lepidoptera - microlepidoptera and Hymenoptera (as major parasitoids of Lepidoptera). However, faculty salary and time were donated for these two courses by the British Museum (Natural History), Systematic Entomology Laboratory of the USDA (at the US National Museum of Natural History), and the University of California at Berkeley. Supplies and equipment for the courses was donated by US-AID, NSF, University of Pennsylvania, University of California, University of Minnesota, Cornell University, British Museum (Natural History), USDA, Wege Foundation, Pew Charitable Trust, MacArthur Foundation, W. Alton Jones Foundation, Noyes Foundation, The Nature Conservancy, WWF-US, SIDA (Sweden), private donors, and the government of Costa Rica (GCA and MIRENEM).

Funding for the various shorter advanced courses has been cobbled together from private donations and scraps out of other project budgets.

Funding for future advanced courses is desperately needed.

12. What are the parataxonomists actually producing today?

A representative unspecialized parataxonomist generates during the course of a month 20-50 plant collection numbers, 2,000-5,000 properly pinned and mounted insects, and large uncountable numbers of insects in alcohol from Malaise traps, interception traps, yellow-pan traps, etc. When the parataxonomist is instructed to focus on particular groups, the overall number of specimens declines to some degree, but the needs of the inventory are more strategically met.

All specimen preparation is done in the field. That is to say, pinnable (or point-mountable) insects are delivered to INBio mounted and ready to be labeled (labeling is done by labelers trained for this routine task at INBio). The parataxonomists are trained to discard material for which there is no time to mount in the field. Such a philosophy is a dramatic departure from the time-honored tradition of bulk-preservation of large samples in the field during a collecting "expedition", samples that are later slowly mounted in the home institution at great cost in technician time (major museums in developed countries have very large deposits of such samples dating from as far back as the turn of the century). Alcoholic samples from traps are sorted at the Biodiversity Offices to whatever degree is requested by the INBio insect-processing system, and then delivered to INBio for freezing until they are further sorted by a specialist.

In September 1991, the decision was made to ask 8 of the parataxonomists (at that time) to specialize on plant collecting, to facilitate the termination of the "Manual of the flora of Costa Rica project" being jointly conducted by the Missouri Botanical Garden, INBio and the Museo Nacional. The remaining 15 (at that time) parataxonomists began on that date to specialize for a year on 12 major

groups of insects, as a way of facilitating the work of a set of international taxonomists who have agreed to put a substantial effort into "doing" these groups for Costa Rica.

INBio has just finished a modern earth-quake proof building to house the arthropod collections and herbarium, and working space for the arthropod and plant processing systems. Given this facility, the primary need for the parataxonomists in their daily activities is providing them with the minor personal supplies and specimen processing supplies, and then supporting sufficient processing and curational activity at INBio to handle the in-coming specimens.

The parataxonomists are now also producing apprentices drawn either from school groups that visit their biodiversity offices or enthusiastic individuals living in the immediate area. These persons generate more specimens today (with an associated cost in minor equipment, supplies and time) but more importantly, will be future sources of parataxonomists. Three such persons are among the students in the third parataxonomist course.

13. What will be the actual cost of the parataxonomist component of the Costa Rican biodiversity inventory?

A rough calculation of what it will cost to get the specimens and associated information for Costa Rica's half million species into a standard inventory format and into the front door of INBio is $21,927,050 spread over ten years ($2,192,705/yr; Table 2). This is based on the actual costs and experiences during the past 2.5 years of operations of the program, and certain non-inflationary cost rises that are happening in Costa Rican society (e.g., current salaries in Costa Rica are far below what an educated and cosmopolitan society demands on the free market). This is $43.85 per species, for roughly 4% (500,000) of the species contained within the world's biodiversity. Once the material and information has arrived at INBio, the further processing, identification, and information management cost is roughly 1-2 times that of the cost of obtaining them. Perhaps for sake of discussion, this can be rounded off to a minimum of $100/species.

14. Why expend funds on the vocation of parataxonomist, when the same funds could be used to fund taxonomists to get on with their taxonomic revisions?

First, this is not an either or situation. There needs to be a body of curators, taxonomists, and other kinds of information processors generated to handle the parataxonomists' output. Second, the international taxonomist (systematist) has had centuries to get the world's biodiversity in nomenclatorial order. While he has done much, there are still many centuries worth of work left to do if we continue at that pace, style and tradition. While this document is not the place to analyze this topic, it is clear we must have a partial shift from a taxonomist who spends an entire lifetime monographing a group from Alaska to Argentina, to some kind of a combination of monographic work with regional or local faunal and flora works. Without these regional works, all the rest of the biodiversity user community has its hands tied. And if there are to be regional works, then one needs an inventory of what is there to know what to put in the regional work. To use Ph.D. taxonomists for the basic muscle and brains of this inventory is to ask a mouse to gnaw down a tree instead of using a beaver colony. Even if enough funds were available to train a very large cohort of Costa Rican Ph.D.s in systematics to handle first Costa Rica and then the rest of Central America, the many decades that it would require are not available. And even these Ph.D.s would quickly decide that their time was better spent on detailed and background-demanding systematics per se, leaving the time-consuming field inventory work to people who are the equivalent of parataxonomists.

Second, the act of using the very populace that threatens tropical biodiversity to inventory it and put it to work, is to take a serious step in the direction of both putting the fate of tropical biodiversity in the

hands of those who own it and causing them to understand what it is. What is the probability that university professors will suggest pulping university libraries the next time there is a paper shortage in the US? Biological literacy by the general populace is probably the only really long-term solution to tropical conservation problems.

15. What characterizes the persons who have left the parataxonomist program?

There have been too few to leave the program to characterize them easily, so the 12 parataxonmists who have left (out of an original 32) are listed individually below:

1. After three months in the course, a period that occurred during school vacation, she left the course to return to continue high school.
2. Resigned several months after graduating because he found that he preferred the freedom of his former farmer's life over the fairly well-defined life of being employed.
3. Resigned several months after graduating because he found that the isolation of working continually in the field did not give him the social contacts that he desired (this parataxonomist was accepted from an urban population).
4. Removed from the program by INBio because of continual marginal technical performance and because of frequent social disruption within the program despite high intellectual potential (this person was drawn from the drifter portion of an urban population).
5. Resigned a year after graduating to take a substantially higher paying job in Environmental Education in the same Conservation Area, at the same time that this Conservation Area's payroll system for its parataxonomists decomposed after several months of uncertain existence.
6. Resigned two years after graduating to take the postion of INBio collections manager, at the same time that this Conservation Area's payroll system for its parataxonomists decomposed after several months of uncertain existence; after resigning the INBio collections manager position to become a field station manager, returned to INBio as the first parataxonomist to become a curator.
7. Resigned one year after graduating following continuous criticism of low quality and quantity of work.
8. Resigned 1.5 years after graduating, following continuous criticism of low quality and quantity of work.
9. Resigned 2.5 years after graduating to attempt to enter graduate school in wildlife management at the University of California, Berkeley.
10. Resigned a year after graduating to take a job as plant collector, at the same time that this Conservation Area's payroll system for its parataxonomists decomposed after several months of uncertain existence; today is continuing as plant collector, attempting to become the curator of mammals at INBio, and visiting the USNM on scholarship.
11. Resigned a year after graduating to take a job as botanical illustrator, at the same time that this Conservation Area's payroll system for its parataxonomists decomposed after several months of uncertain existence.
12. Resigned 2.5 years after graduating to become the field research coordinator for the Guanacaste Conservation Area.

There is virtually no chance that the 20 experienced parataxonmists will be fired by INBio or leave this area of work. Perhaps as many as half, however, may well move upward or laterally at some time into higher education, administration, taxonomy or teaching positions.

16. Why are there not more female parataxonomists?

Every woman who has applied to the first two parataxonomist courses - all three of them - were accepted. One then went on to high school and the other two are still outstanding parataxonomists. There is a major problem in that there are very few salaried women in the rural labor pool from which the

parataxonomists are chosen (as said above, the parataxonomists are recruited from people who are paid by other sources).

As mentioned previously, owing to a generous grant from the Claiborne and Ortenberg Foundation, this situation is now being rectified. All signs are, at the mid-point of the course, that rural Costa Rican women will be excellent parataxonomists.

17. What will be future major problems with the parataxonomists?

As Costa Rica's biodiversity management program reaches maturity, it will be viewed as a serious competitor by some sectors of the developed world. These sectors will both compete with and aggressively attempt to destroy or retard the program (as some are already doing). As biodiversity management programs become commonplace in the tropics, this reaction will also become more widespread and intense. A truly efficient and sustainable tropical biodiversity management program threatens traditional national park concepts, biodiversity ownership or use hegemonies, foreign aid traditions, and many other favorite sons of the developed world. The developed world will not sit back calmly and watch its place in the limelight be taken away from it (witness the arguments over the Yucatan to Yukon trade barrier readjustment).

At present, INBio in general and the parataxonomist program specifically depend on financial and some political support from international aid agencies, developed world foundations, and private donors in the developed world. All of these funding sources become progressively less interested in helping, the more a program builds itself and the more a program narrows the socioeconomic gap between the donor and the recipient. INBio walks the razor edge of demonstrating extreme need out of one side of its face and extreme success out of the other. The donor community demands that INBio be extremely needy yet be extremely successful with what it is given, a success which in turn automatically lowers its neediness in the eyes of the donor. The parataxonomist program has had to live with this reality from the day of its inception, from the level of the individual park guard who is denied a pay raise because "he has received the enormous freedom of work bestowed on the parataxonomist" to the entire program being denied funding for operations because it is not "grass roots agriculture" but rather "scientific".

18. What has been the single largest obstacle to the development of the program as a whole?

Lack of understanding of what the parataxonomists are and what they represent by people of all levels - from they themselves to their former peers to the highest decision makers.

19. What has been the single largest obstacle to the training, development and professionalization of the individual parataxonomist?

Leaving behind, or being allowed to leave behind, their former life and fully enter this new vocation and the broad social ambit that comes with it.

Figura 1

Area de Conservación Guanacaste

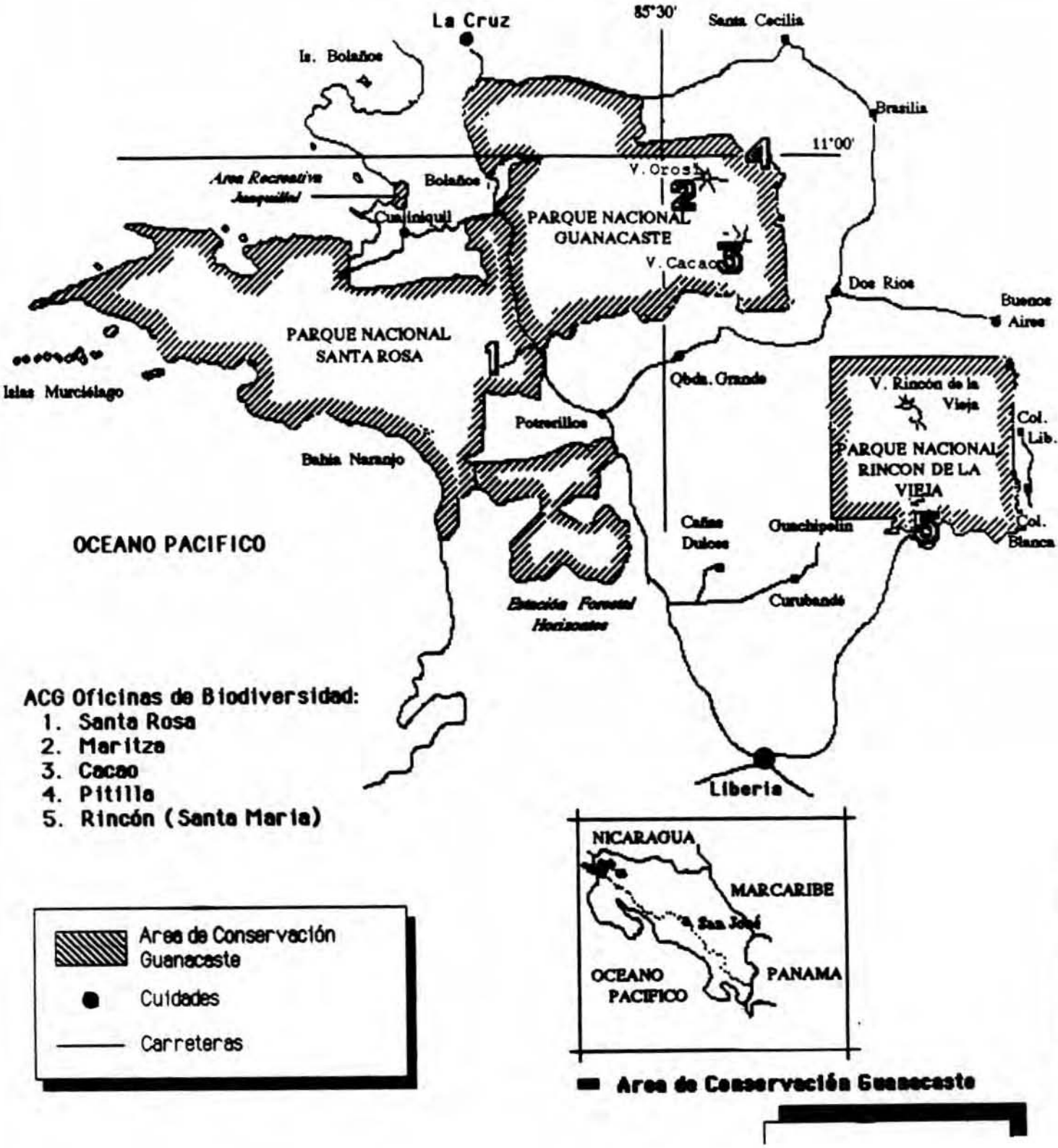
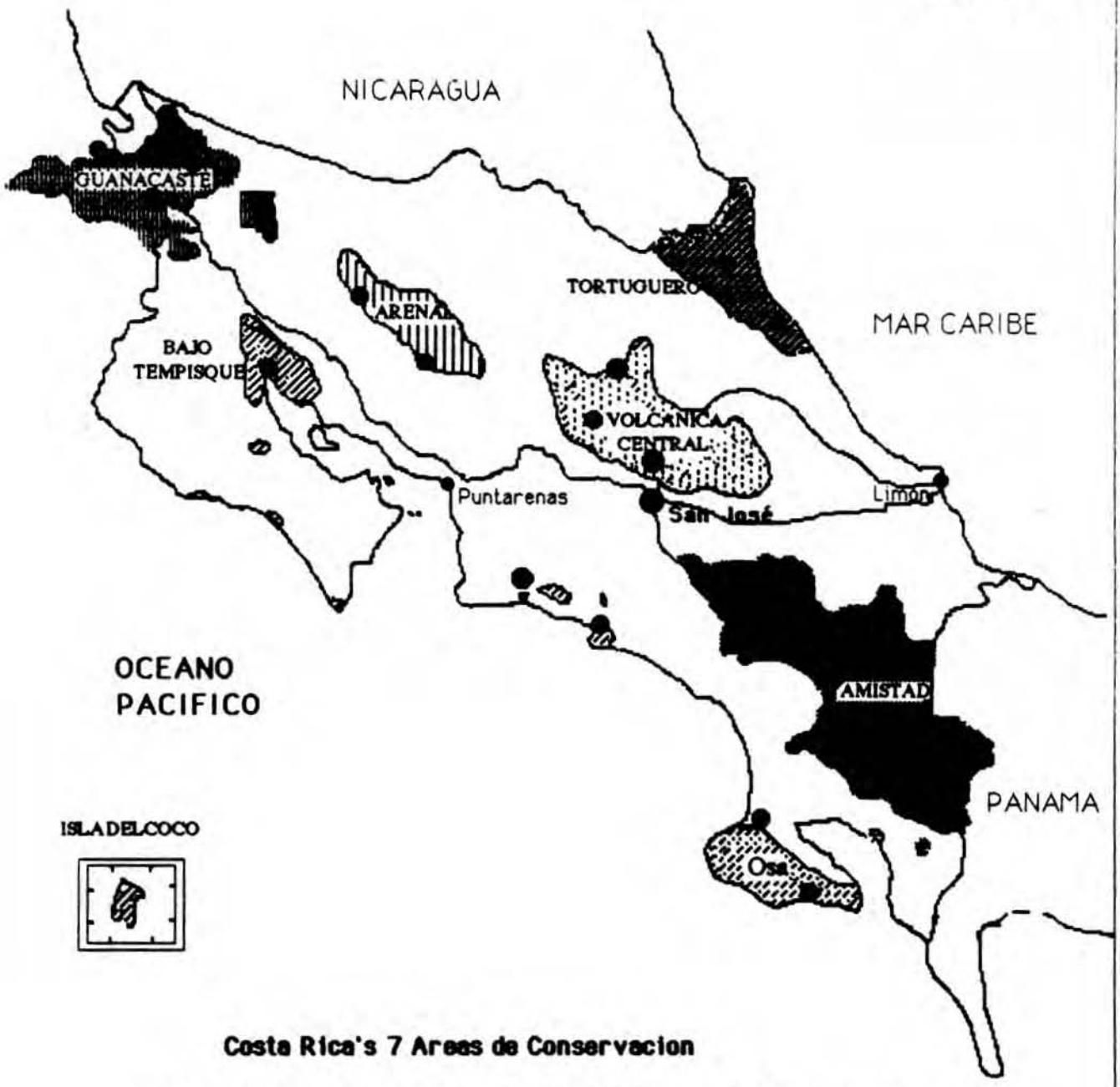


Figure 2.



Costa Rica's 7 Areas de Conservacion

● **The 20 Biodiversity Offices as of May 1991**

Ministry of Natural Resources, Energy and Mines (MIRENEM)

May 1991

Table 1. Costa Rican Conservation Areas and their Biodiversity Offices with parataxonomists as of 1 Jan 1992 (see text for description of fate and locations of the other 12 parataxonomists). The numbers of parataxonomists operating out of each Biodiversity Office will be 2-3 after the next basic parataxonomist course in the first half of 1992, and there will be more Biodiversity Offices.

	Age	Formal education	Former occupation
1. Arenal Conservation Area			
Tenorio Biodiversity Office			
Sr. Celso Alvarado Murillo	25	finished high school	forest inspector
Monteverde Biodiversity Office			
Sr. Erick Bello Carranza	30	Universidad Nacional	grade school teacher
Sr. Norman Obando Arguedas	19	finished grade school	farm helper
2. Bajo Tempisque Conservation Area			
Palo Verde Biodiversity Office			
Sr. Ulises Chavarría García	30	finished high school	park guard
3. Guanacaste Conservation Area			
Pitilla Biodiversity Office:			
Srta. Petrona Ríos Castro	24	finished high school	farmer
Sr. Calixto Morage Medina	19	finished high school	evangelical preacher
Santa Rosa Biodiversity Office:			
Sr. Roberto Espinoza Obando	25	2 years of high school	farmer
Sra. Elda Araya Martínez	29	finished high school	housewife
Cacao Biodiversity Office:			
Sr. Carlos Chéves Obando	39	3 years of high school	bartender
4. Cordillera Volcánica Conservation Area			
Volcan Poas Biodiversity Office:			
Sr. Gerardo Rivera Elizondo	38	finished high school	park guard
5. Tortugero Conservation Area			
Tortugero Biodiversity Office			
Sr. Roberto Delgado Retana	33	finished high school	park guard

Cuatro Esquinas Biodiversity Office			
Sr. José Elías Solano Marín	23	1 year tech. univ.	park guard
Barra del Colorado Biodiversity Office			
Sr. Elias Rojas Mora	33	finished grade school	farmer
6. Osa Conservation Area			
Rancho Quemado Biodiversity Office			
Sr. Francisco Quesada Quesada	25	one year university	park guard
Sirena Biodiversity Office			
Sr. Gilberto Fonseca C.	31	finished high school	park guard
7. Amistad Conservation Area			
Hitoy Cerere Biodiversity Office			
Sr. Gerardo Carballo Carvajal	37	finished grade school	hunter, park volunteer
Las Tablas Biodiversity Office:			
Sr. Marvin Ramírez Alvarado	24	finished high school	park guard
Tapanti Biodiversity Office:			
Sr. Gerardo E. Mora	21	2 years high school	park guard
Carara Biodiverity Office:			
Sr. Juan Carlos Saborío	21	finished grade school	park volunteer
Manuel Antonio Biodiversity Office:			
Sr. Gerardo Varela Cordero	29	2 years UCR	park guard

Table 2. A rough calculation of what it will cost to get the specimens and associated information for Costa Rica's half million species into a standard inventory format to the front door of INBio, if a standing crop of 100 parataxonomists are adequate. Once they have arrived at INBio's doors, the specimens have a processing, identification, and information management cost that is roughly 1-2 times that of the cost of obtaining them.

A. Personnel

1. Salary of 100 parataxonomists, full time, ten years, at an average salary and benefits of $10,000/yr	$10,000,000
2. Field liason, one per 20 parataxomists, full time, ten years, at an average salary and benefits of $20,000/yr	$1,000,000
3. Program subcoordinator, full time, ten years, at an average salary and benefits of $25,000/yr	$250,000
4. Program coordinator, full time, ten years, at an average salary and benefits of $35,000/yr	$350,000

B. Training

1. Basic training of 100 parataxonomists, six month course, $10,000 each	$1,000,000
2. Additional basic training to replace parataxonomists that leave the program, average of ten per year, $10,000 each	$1,000,000
3. Advanced courses and courselets, average of three per year, $30,000/course	$900,000
4. Fund to facilitate visits by taxonomists and parataxonomists among Biodiversity Offices, $20,000/yr	$200,000
5. NOTE: no special training costs are associated with the higher level members of this program because they have been trained by the national university system and themselves; this is reflected in their higher salaries and is a free good to INBio (but generates an INBio obligation)	

C. Equipment and supplies

a. Transport

1. Motorcycles and Suzukis for the Biodiversity Offices, assuming 30 offices and 2 motos and 1 Suzuki per office, ($2,000 and $8,000 respectively)	$360,000
2. Replacement of motor pool after five years of work, 20% price rise	$432,000
3. Annual insurance and maintenance and fuel for vehicles, $50,000/yr	$500,000
4. Five liason vehicles, Toyota Safari, $25,000 each	$125,000
5. Annual insurance and maintenance and fuel for liason vehicles, $25,000 yr	$250,000

b. Equipment

1. Small equipment for 30 Biodiversity Offices (binoculars, binocular microscopes, tools, furniture, field generators, books, ovens, etc.), $30,000/office/10 years	$900,000

C. Supplies

1. Operating supplies for 30 Biodiversity Offices (plastic bags, alcohol, vials, bottles, pins, insect boxes, nets, batteries, lights, flashlights, rope, newspapers, notebooks, etc.), $5,000/yr/office — $1,500,000

D. Establishment of Biodiversity Offices

1. Remodeling or minor construction for each office, average of $5,000 each initially, with another $5,000 for major improvements during the ten years, 30 offices — $300,000

E. Total direct costs — **$19,067,000**

F. Overhead (15% of direct) — **$2,860,050**

G. Grand total — **$21,927,050**

Table 3. Estimated numbers of species of organisms in Costa Rica (source: conversations with many specialists in the respective groups).

Arthropods	365,000
Other invertebrates	85,000
Bacteria, viruses, etc.	35,000
Plants	10,000
Fungi	2,500
Vertebrates	1,500
	500,000

Table 4. Budget with footnotes for the first parataxonomist course. This budget is presented here in its original form, and the footnotes reflect what was anticipated (see text of report for actual structure of course). Shortly after the 1988 submission of the budget, the legal management of this course was passed from the Fundación Neotrópica to the Fundación de Parques Nacionales (and see footnote 11). However, US-AID continued to view the Fundación Neotrópica as responsible for the fiscal accounts until the final reimbursement in February 1992.

Budget[11]

A. Personnel.

Costa Rican course assistant, 4 months (122 days)	$2,000
8 months after the course[1]	$4,000
D. Janzen, half-time consultant, 4 months[2]	$10,480

B. Living costs.

Room and board and station use fees for 1230 person-days during the course in GNPP ($10/per diem, $1 station use fee)[3]	$13,530
Per diem ($10) for course assistant, 8 months after the course while monitoring students	$2,440

C. Travel during the 4 month course and 8 months after.

One long-body 4-wheel drive Toyota, diesel, tax free[10]	$16,000
Diesel, insurance, maintenance for one year[4]	$5,500
Miscellanea for movements of interns within and among parks, movements of visiting faculty to course	$2,000

D. Equipment and supplies for the 4 month course.

Minor equipment[5, 14]	$7,432
Expendable supplies[6, 14]	$7,568
Office supplies such as xeroxing, mail, phone, computer discs, printing paper, computer software	$3,000

E. Set up materials for each intern in his/her home park.

Minimum equipment and supplies to set up each intern and allow him or her to function normally for 8 months[7]	$40,000

F. **Total direct costs**	$113,950
H. **10% overhead for Fundacion Neotropica**	$11,395
I. **Total request to US AID**	$125,345[8]
J. **Matching funds from private sources for construction of a biological station in the GNPP**[9]	$104,000
K. **Contribution from Costa Rican government in participant salaries and facilities, as matching funds**[12]	$21,000
L. **Total proposal**	**$250,345**

Footnotes:

1. The course assistant will be selected through discussion with SPN. There are several persons within SPN who would be excellent for this position (e.g., Sr. Joaquin Gamboa) but there is also a large pool of university graduates who would be very good. He or she will work throughout the year, first during the 4 month course, and then for 8 months as general coordinator, trouble-shooter, contact, inspector and facilitator for the interns in their home parks. The course assistant will have formal or extensive informal biological training at the university level.

2. Actual participation will range from %200 of full time to %10, depending on the detailed circumstances. In addition, throughout the remainder of the year, Janzen will coordinate and provide quality control for the material sent to the National Insect Collection at the Museo Nacional from the five biodiversity centers.

3. This total of $11 per day for room, board and other station costs is as near as can be calculated to actual cost.

4. One full year of use is requested for this vehicle so that it can circulate on a planned schedule to facilitate the collecting activities of the park guards in their own respective parks. The course assistant will continue in this role of general contact and facilitator, normally being the person who moves the vehicle from one park to another. When the vehicle is in one of the other parks, the resident intern will take that opportunity to use it to get to inaccessible places. The course assistant will also aid the interns in obtaining and moving the equipment that they need to set up in their home parks.

5. The GNPP does not have adequate equipment and supplies to simply absorb the demands of a course such as this one. Some of these items will remain with the GNPP field stations and thereby

greatly increase their value to researchers and courses in general, but the majority of the items will move to the five other parks with the interns as they establish their offices.

6. While this may seem excessive, this project will use at least $5,000 worth of insect pins and $3,200 worth of insect shipping and storage boxes.

7. The intern must set up an office/laboratory and $5,000 is a minimum cost for minor equipment and supplies such as listed earlier in the budget for the course in the GNPP. Each park will provide a large room for this purpose, and such working facilities will increase as the biodiversity center grows over upcoming years. This cost is estimated for each of the interns, rather than for each park, because two interns working together will generate at least double if not more material and be using easily twice as much expendable material as will a single intern. Furthermore, it may well be that two different offices will have to be established in different parts of the very large parks.

8. This total does not cover intern salaries, or per diem at their home parks. If these items could be provided by AID from local currency, it would greatly increase the effectiveness of the newly trained interns. Likewise, if each of the five national parks can designate an apprentice for the intern, the impact of this course will rapidly multiply; however, the salary and living expenses of such apprentices would have to be found outside of the regular budget of the Servicio de Parques Nacionales.

9. These funds from the Stroud Foundation in Avondale, Pennsylvania, will be used to construct a dormitory, aquatic biology and other kinds of research laboratory, and caretaker complex at Estación Maritza at the western base of Volcán Orosí (550 m elevation). Construction will begin immediately on this complex when the AID proposal is funded, and it is anticipated that it will be in service by June 1988. These matching funds were provided in direct response to the matching funds demand from the AID proposal.

10. In northern Guanacaste Province, the only vehicles that can be reliably serviced and parts obtained for are Toyotas and Landrovers. Toyotas are vastly superior in all respects for heavy field use. There is no American-made vehicle that can be purchased for project such as this one, because not only are they inappropriate for the work, but with any servicing or repairs the vehicle is out of service for days to weeks while the (sometimes) futile quest for spare parts continues. The project is sufficiently remote that even minor garage time requires an additional half day of round trip to the garage, and the waste of a person's time doing it. Worse, vehicle breakdowns have a nasty habit of occurring many hours walk from anywhere. Our job is biology, not servicing vehicles.

The vehicle recommended is $16,000 tax free (through the Fundacion Neotropica) and $30,000 if taxed. The same vehicle rented for a year would be $18,000 (minimum current rates, if lucky, are $1,500/mo before insurance). If project rules prohibit purchase, then there is no option but to rent a new Toyota for $18,000 and the budget should be increased accordingly. I should point out that renting a vehicle means that the project is left without a vehicle for continuity at the end of a year, the project is forced to work with a vehicle that has already suffered the rough treatment traditional for rental vehicles (and therefore will cause us loss of more garage time), and the drivers of the vehicle are less likely to take care of it (meaning also that they will then waste more time in repairs).

11. All non-expendables in this budget will be legally the property of the Fundacion Neotropica for future use, but for practical purposes the property of the place where they were purchased to use. The vehicle, for example, will continue to be the biodiversity survey vehicle in the GNPP, for use by collectors and future biodiversity courses. Users will pay a rental fee to the

GNPP where their activities are externally funded, and those fees will contribute to the vehicle's upkeep. The collecting equipment used by each of the course participants will go with that participant to his or her home park as part of setting up the biodiversity office, except where that equipment was clearly obtained as teaching materials that will stay on at GNPP for that purpose.

12. The salaries and benefits for the 8 participants in this course will be a minimum of $28,000 for one year; all of this will be paid by the Costa Rican government. In addition, each of the national parks will provide a minimum of one room for a biodiversity office and work space; the rental cost of such a room to a researcher is normally about $2.00/day. With five offices, this means a government contribution of $3,650 in rental space. This total of $31,650 easily surpasses the $21,000 needed to make up the match.

13. Nikon cameras are used because the entire world of scientific photography operates on foreign cameras; there are no US-made scientific cameras that even begin to be equivalent to Nikon for biological field work.

14. Equipment:

5 large tables at $50 each	$250
12 chairs at $10 each	$120
5 gas ovens for drying insects, $300 each	$1,500
2 gas cylinders for each oven, $30 each	$300
100 small mammal live traps, $10 each	$1,000
5 sets of spreading boards for moths and butterflies, $100 each	$500
5 sets of blacklights and two car batteries and chargers to run each set, $280/set	$1,400
8 insect nets with replacement bags	$240
8 headlamps at $9 each	$72
2 Nikon cameras with accessories	$1,400
field guides to insect families, butterflies of Costa Rica, etc., 5 copies each	$550
miscellaneous buckets and small tools	$100
Total equipment	$7,432
Expendable supplies	
insect pins; 100,000 at $32/1000	$3,200
insect storage boxes; 250 at $12.50	$3,125
plastic bags	$500
miscellanea including such things as paper, preserving fluids, bottles, cyanide for killing bottles, light bulbs, batteries, string, cork, wire, labels, film, developing, etc.	$743
Total expendables	$7,568
Grand total	$15,000

Table 5. Budget with footnotes for the second parataxonomist course. This budget is presented here in its original form, and the footnotes reflect what was anticipated (see text of report for actual structure of course). At the time of writing this budget, the Guanacaste Conservation Area was known as the Guanacaste Regional Conservation Unit. When the proposal was actually funded, it was funded directly to the Instituto Nacional de Biodiversidad (INBio)

Budget[1]

A. Personnel.

Costa Rican course faculty/coordinator, full time, 12 months, salary and benefits[2]	$7,500
D. Janzen, half-time consultant, 4 months[3]	$11,000

B. Living costs.

Room and board and station use fees for 2,025 person-days during the course in the URC G ($7/day food, $1/day station use fee)[4]	$16,200
Per diem ($10) for course assistant, 225 days after the course while monitoring parataxonomists from both courses[5]	$2,225

C. Travel during the 4.5 month course and 7.5 months after.

One long-body 4-wheel drive Safari Toyota, diesel, tax free[6]	$16,000
Diesel, insurance, maintenance for one year for new vehicle	$6,000
Movements of parataxonomists within and among URCs, movements of visiting faculty to course	$2,500

D. Equipment and supplies for the 4 month course.

Minor equipment[7]	$7,000
Expendable supplies[7]	$7,000
Office supplies such as xeroxing, mail, phone, computer discs, printing paper, computer software	$4,000

E. **Set up materials for each of the six new offices.**	
Minimum equipment and supplies to set up each office and allow normal function for 7.5 months[8]	$36,000
F. **Apprenticeship costs for the six new offices.** $2,000/year/office to hire or subsidize local high school students as apprentices to parataxonomists[9]	$12,000
G. **Total direct costs**	$127,425
H. **10% overhead for Fundacion Neotropica**[10]	$12,743
I. **Total request to US AID**	**$140,168**[11]
J. **Matching funds from Pew Charitable Trust for establishment of the INBio parataxonomy course endowment**[12]	$500,000
K. **Contribution from Costa Rican government in participant salaries and facilities, as matching funds**[13]	$90,000
L. **Total proposal**	**$730,168**

Footnotes:

1. All non-expendables in this budget will be legally the property of the Unidad Regional de Convservacion Guanacaste, SNAC or the National Biodiversity Institute for future use, depending on their nature. For example, the minor equipment to set up the biodiversity offices will become the property of those offices. The minor equipment to teach the course becomes part of the

parataxonomy course equipment resource, except for that issued individually, which moves to the biodiversity offices. The vehicle will continue to be a biodiversity survey vehicle in the URC G, for use by parataxonomists and future biodiversity courses, as is the case with the vehicle from the 1989 course. Users will pay a rental fee to the URC G if their activities are externally funded, and those fees will contribute to vehicle upkeep.

2. The Costa Rican course faculty/coordinator will be selected through discussion with the INBio. There are recent biology graduates of the University of Costa Rica, recent employees of the INBio, and several government biologists who would be very good. He or she will work throughout the year, first during the course in the URC G, and then as general coordinator, trouble-shooter, contact, inspector and facilitator for the parataxonomists in their home URCs.

3. Actual participation will range from about 2-12 contact hours a day during the first two months of the course. In May, it will be about 4 contact hours per day. In the 1989 course, about 70% of full time was spent on the course, and there is no reason for this figure to change substantially. Janzen will also provide considerable input to the INBio in his role as member of the Board of Directors, and advisor for the Department of Arthropods. The salary figure is based on the maximum allowable, and a substantial reduction in salary from his salary for the remaining months with the University of Pennsylvania.

4. This total of $7/day for food is a $3/day reduction from the budget of the previous year, and the $1/day accomodation cost is only a token fee by the URC G, the administration of which is doing everything it can to encourage the course.

5. This figure $10/day is greater than the $8/day per student for the URC G, because many days traveling are not spent in an URC; for example, just local food in ordinary restaurants in San Jose can easily average $10/day.

6. In northern Guanacaste Province, as in the vicinity of other rural URCs, the only vehicles that can be reliably serviced and parts obtained for are Toyotas and other Japanese field vehicles. Toyotas are also vastly superior to all other makes available in all respects for heavy field use. There is no American-made vehicle that can be purchased for project such as this one, because not only are they inappropriate for the work, but with any servicing or repairs the vehicle is out of service for days to weeks while the (sometimes) futile quest for spare parts continues in San Jose. The project is sufficiently remote that even minor garage time requires an additional half day of round trip to the garage, and the waste of a person's time doing it. Worse, vehicle breakdowns have a nasty habit of occurring many hours walk from anywhere. Our job is biology, not servicing vehicles.

The vehicle recommended is $16,000 tax free (to the URC G through the Ministry of Natural Resources) and $34,000 if taxed. The same vehicle rented for a year would be $24,000 (minimum current rates, if lucky, are $2,000/mo before insurance for a good vehicle with unlimited mileage). Renting a vehicle also means that the project is left without a vehicle for continuity at the end of a year, the project is forced to work with a vehicle that has already suffered the rough treatment traditional for rental vehicles (and therefore will cause us loss of more down time), and the drivers of the vehicle are less likely to take care of it (meaning also that they will then waste more time in repairs).

The Safari purchased for the first parataxonomist course is in full-time use in the URC G

biodiversity survey, but will be returned to course use in January 1990. In the 1989 course, one vehicle was immediately found to be inadequate, and the URC G had to lend a second vehicle (at no charge) to the course. Both the new Safari and the old will barely be adequate transport for the 1990 course.

7. The URC G does not have adequate equipment and supplies to simply absorb the demands of a course such as this one, but the situation is better than in 1989 because some permanent items are now available. A few of the following items will remain with the URC G field stations and thereby greatly increase their value to researchers and courses in general, but the majority of the following items will be distributed among the other biodiversity offices.

Minor equipment for the course:

5 large tables at $50 each	$250
20 chairs at $10 each	$200
1 gas oven for drying insects	$300
2 gas cylinders for the oven	$60
5 sets of spreading boards for moths and butterflies, $100 each	$500
9 sets of blacklights and two car batteries and a charger to run each set, $280/set	$2,520
16 insect nets with replacement bags	$480
16 headlamps at $20 each	$320
1 Nikon camera with accessories[14]	$700
field guides to insect families, butterflies of Costa Rica, xeroxes of lists, etc., 15 sets at $100/set	$1,500
miscellaneous buckets and small tools	$170
Total minor equipment	**$7,000**

Expendable supplies for the course:

insect pins; 100,000 at $33/1000	$3,300
insect storage boxes; 250 at $12.50	$3,125

plastic bags	$200
miscellanea including such things as paper, preserving fluids, bottles, cyanide for killing bottles, light bulbs, batteries, string, cork, wire, labels, film, developing, etc.	$375
Total expendables	**$7,000**
Grand total	**$14,000**

8. The intern must set up an office/laboratory and $6,000 is a minimum cost for minor equipment and supplies such as listed earlier in the budget for the course. While each URC will provide a large room or other quarters for this purpose, experience has shown that $1,000-$2,000 of the start-up budget needs to be spend on remodeling, repairing, building bookcases, etc. The amount budgeted here will probably not prove to be fully adequate for the supplies to a fully functional biodiversity office, but it is hoped that by 1990, the INBio will have enough of a supplies budget to be at least covering the pins, boxes, nets, etc. and other direct regular small item needs.

9. This item, not included in the 1989 budget but provided in 1989 by the US National Science Foundation, is a $2,000 fund for each of the six new biodiversity offices that is to be used at the discretion of the parataxonomists to augment their own work and to help them be masters to apprentices. It has been found that if a small fund is available to cover meals, travel, minor salary (a few dollars per day), high school students can be induced to follow their own curiosity and become involved in working in the biodiversity offices on weekends, holidays, etc. These funds also help the parataxonomists learn how to budget and handle their own funds, receipts, etc. All funds are accounted for through receipts as with all other expenses in the project.

10. The overhead will be paid to the Fundación Neotrópica or the Fundación de Parques Nacionales, or whatever other formal business administration handles the grant.

11. This total does not cover parataxonomist salaries, benefits or living costs at their home URCs. This is a major contribution to the program by MIRENEM, although it is hoped that within a few years the primary administrative costs of the URCs - including those of the Seccion Biodiversidad - will be based on endowments rather than direct government budgets.

12. These funds are being sought from the Pew Charitable Trust (Appendix 7). They are anticipated to cover the ongoing parataxonomist courses once the 1990 course is terminated; it should not be necessary to request a third year of support for this specific program from US-AID. It is clear that the first parataxonomist course was the stimulus for Pew to become interested in the program. Pew is very pleased to view the 1990 US-AID course as a form of match to their funding, and we assume that AID will view the Pew funding as an appropriate match for the US-AID course, as well as the continuation of the program initiated by US-AID.

13. The salaries and benefits for the 15 participants in this course will be a minimum of $90,000 for one year ($6,000/year in cost, which is 1.4289 the annual salary). All of this will be paid by the Costa Rican government.

14. Nikon cameras are used because the entire world of scientific photography operates on foreign cameras; there are no US-made scientific cameras that even begin to be equivalent to Nikon for biological field work.