THE ALL TAXA BIOLOGICAL INVENTORY OF THE GREAT SMOKY MOUNTAINS NATIONAL PARK

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SYNOPSIS

The history, organizational structure, and purpose of the all taxa biodiversity inventory (ATBI) of the Great Smoky Mountains National Park are detailed. The benefits of the ATBI to the areas of Conservation, Education, and Science are explained.

In December of 1997 scientists, educators, and administrators gathered in Gatlinburg, Tennessee to discuss the idea of an all taxa biodiversity inventory (ATBI) of The Great Smoky Mountains National Park and, after three days of exchanging ideas and opinions, the ATBI was born. An inventory of this magnitude was attempted only once before, by D. Janzen in Guanacaste State in Costa Rica. For a number of reasons (financial and political) this endeavor changed into a survey of selected taxa over the whole of Costa Rica. Thus, the Great Smoky Mountains endeavor might be considered the sole extant ATBI.

In this paper I want to briefly discuss what we are trying to achieve and why such a herculean task is important to society.

Purpose

For every species of life in the Park we want to answer three questions: 1. What is it? 2. Where is it? 3. What does it do? And, we want to make this information easily accessible to a wide range of users.

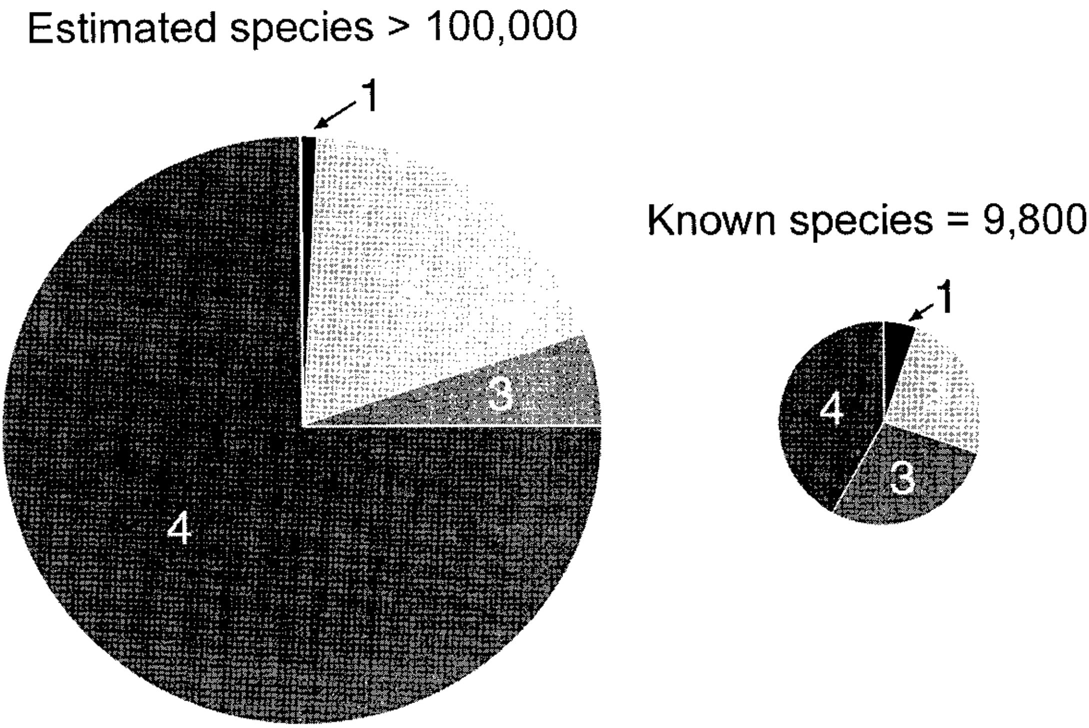
Most readers will recognize that two of these questions are potentially endless pursuits to which more and more detail could be added. We are looking for only the most basic answers. Our quest can best be explained with a simple example. If someone in the Great Smokies were to find an organism eating another organism, we would like to have the tools and information assembled to allow that person to identify the organisms to species. We would like to have a database that would allow her/him to find out where and when they occur in the Park (and perhaps elsewhere). Finally, we would like to have a homepage for the two species so that the user could access biological information, view images, and link to relevant web sites and published articles.

The Magnitude of the Task (Fig. 1)

At one of the annual meetings of the ATBI we asked the participating biologists to estimate the number of species that occur in the Park for their particular taxon of expertise. The tabulated result was 100,000 species. We know the number of species that have been recorded from the Park to be about 9,800. Of this number, many are simply published records of species occurrences and therefore there is much to do before these species can be considered "inventoried" for the Park. As Fig. 1 illustrates, some taxa such as mammals and vascular plants are well known but the megadiverse groups like fungi and arthropods are barely known. Indeed, less than 6% of the invertebrates are recorded!

Our first mission is to collect all species. Of course it will not be necessary to collect black bears or red oak trees, but collections will be necessary for the vast majority of taxa. These then have to be named. Willing systematists must be recruited, who, in many cases, will have to describe new species. Once there are names applied to organisms, the collection data must be incorporated into a central database. Further, we want to construct illustrated, interactive, identification keys for all taxa, including all species. Finally, we intend to construct species homepages that provide images and a synopsis of basic information about each species, as well as links to other more comprehensive sources of information.

One of the most prolific systematists in history was C. P. Alexander; a dipterist who described over 10,000 species in his lifetime. However, the average number of species "treated" by systematists today is far less than this. Even those who research diverse arthropod groups usually describe less than a few hundred species in a lifetime. Naturally, alpha taxonomy is not the sole task of most systematists; all of us are involved in higher classification, teaching, biodiversity studies and other research and duties. Nonetheless, imagine that the average taxonomist involved in the project could treat 40 species each year. This would include the major components of the inventory: naming (describing) the species, recording the data in the database, constructing interactive keys, and producing species' homepages. Some groups of organisms like the vertebrates and vascular plants could be dealt with at a much greater annual rate, but 40 seems a reasonable average since most of the biodiversity is composed of relatively poorly studied taxa. At this pace it would take 2,250 person-



	Estimated total in Park	Number currently known
1 Vertebrates	450	450
Fungi	20,000	2,250
3 Plants	5,400	2,816
4 Invertebrates	76,000	4,280

Fig. 1. Pie charts illustrating the relative abundance of organisms in the Park and the relative abundance of what is known.

years to deal with 90,000 species; it would take 100 systematists 22.5 years, and it would take 200 systematists 11.25 years to complete. I do not wish to discuss in detail the real monetary cost of this endeavor; but if all equipment, overhead, and personnel costs were calculated, the budget would be hundreds of millions of dollars. I hope that I have impressed upon the reader that this is no trivial task; rather it is one of the grandest scientific endeavors ever to be attempted. It is comparable to the moon-shot or the human genome project. What are the benefits to justify such a large expenditure of time and money? Is it worth doing? Can it be done?

Benefits

Conservation

According the book of Genesis (4:14), God gave Man his/her first task, which was to name all the beasts of the land, all the fish of the sea, and all of the birds in the sky over the Garden of Eden. Contrary to popular belief, this makes taxonomy the oldest profession in the world. This original task is repeated in the mythologies of most cultures, and with good reason. We can only benefit from natural resources if they are known, protect ourselves from natural hazards if nature is known, and, most immediately, we can conserve and protect only those natural resources that we are aware of.

It is inconceivable for any successful economic enterprise not to have an inventory of their products and raw materials. Maintaining a ledger that lists inventory is a basic responsibility that companies owe to their shareholders . . . not to mention the IRS. In the same way, is not the scientific community, including you and me, not responsible for providing an inventory of the natural resources in the way of an all-species inventory? This was recognized by the federal government on August 25, 1916, when President Woodrow Wilson signed an act creating the National Park Service, a new federal bureau in the Department of the Interior responsible for protecting the 40 national parks and monuments then in existence and those yet to be established. One of the original justifications for the great expense of the park system was to ". . . to promote and regulate the use of the . . . national parks . . . which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." (National Park Service Organic Act, 16 U.S.C.1). How can we conserve and protect "the wildlife therein" if we don't know what they are?

There are many threats to the environment in the United States and around the world. In the Great Smoky Mountain National Park (GSMNP) these environmental threats include the following: global warming, acid precipitation, ground-level ozone, and deleterious non-native organisms. Just what effect these perturbations are having on the Park's ecosystem we don't know in much detail. Acid precipitation levels in the Park are amongst the highest in the nation and threaten a great deal of life forms. In the short run, those in freshwater systems where acidity can fluctuate rapidly are especially vulnerable. We know that acid rain is having an impact on the biodiversity of the Smokies, but are species being threatened with extinction? We have little idea because we don't have a comprehensive idea of what is/was there. How threatening is acid rain to soil invertebrates? The soil in most of the Park is not well buffered and the effects are likely dramatic.

We tend to see the effects of man's perturbations on large species. For example, the balsam woolly adelgid is an insect that was accidentally introduced to North America and it is well on its way to destroying the high altitude forests in the Park. These are dominated by Fraser fir trees, which are killed after the insects block the xylem transport system after feeding on the trees. We see the steady disappearance of the fir trees but we have little idea of the cascade effect that results when fir forests disappear. I would guess that there are many species of life that are dependent on the Fraser fir for their existence, either by maintaining some necessary environmental parameter or directly through the food chain. Most of these species will be lost long before the last Fraser fir succumbs to disease. A survey conducted by Fred Coyle (1997) on the spruce-fir moss spider (*Microhexura montivaga*) concludes that the decline in the high elevation Fraser fir canopy has caused extensive damage to the forest floor community, and has disturbed the fragile ecosystem that depends on protection afforded by Fraser firs. How many, if any, species have been, or will be, lost? How many of these were/are endemic to the Park? To determine what is being lost we must have some idea of what is there . . . and we just do not. The first benefit of an all species inventory is that it will allow us to monitor the effects of environmental pollution and other disturbances to the environment, including our most recent great concern, global warming.

Education

The educational benefits of the ATBI are enormous and they are already being realized. The curved line in Fig. 2 represents our present state of knowledge about the Park biota. Thanks to the efforts of D. K. Smith at the University of Tennessee and many other botanists we have a lot of information on the vascular plants of the Great Smokies. We have much less information on the species of fungi in the Park and still less on the insects. It is the goal of the ATBI to move this curve of knowledge up and to the right until the area of darkness becomes a small semicircle in the far upper right corner.

The educational benefits are represented in Fig. 3. The products of the ATBI will enlighten all sectors of society. Professional biologists (specialists) will be able to identify a diversity of organisms and to access the wealth of information that these names provide.

To give you an example of our current state of knowledge on a very diverse and relatively poorly known group, I will use the Braconidae. My systematic research centers on this family of parasitoid wasps and I estimate that there are about 2,000 species of braconids in the Great Smoky Mountains National Park, about one-half to two-thirds of which are described. Adult females of braconid wasps lay their eggs in or on other insects and their progeny consume and eventually kill their hosts. Braconids and other parasitoid wasps are very abundant and they are important in the natural balance of life. I will explain the process of trying to identify braconids from the Park using a simple, though somewhat hopeful example. Because I spent more than 13 years at the Canadian National Collection, where I was responsible for building the braconid collection

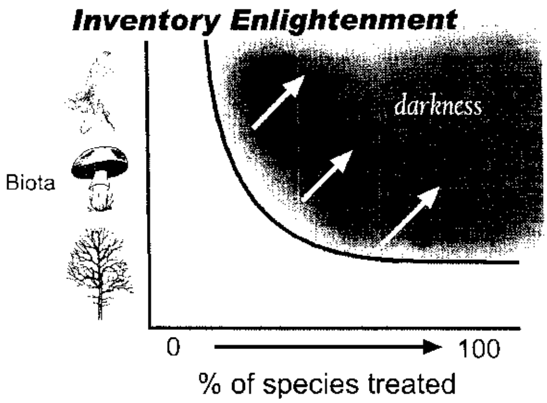


Fig. 2. The y axis refers to the physical size of an organism and the x axis refers to the percentage of species that have been recorded in the park. See text for explanation.

and identifying these wasps to species, I am one of the most qualified people in the world to do this and I have in hand all of the literature and identification keys for the North American species of the Braconidae.

Imagine that ten species of braconids are collected in the Park and luckily all of them are described. Because I recognize most of the 300 or so genera of braconids but a very small fraction of the species, I would go directly to species-level keys. I would plow through these keys and descriptions to obtain temporary identifications and then check these against my collection at the University of Kentucky. This would yield about five satisfactory identifications. For the remaining five specimens I would have several options: ask for type specimens from the museum curators where they are deposited, send the specimens to colleagues who happen to know more than I do about the particular subfamily, or travel to the Smithsonian Institution and/or other major collections to make comparisons with types or reliably determined material. The point that I am trying to make is that even the 'world experts' have great difficulty identifying the vast majority of the described species that are in the Park. The described species present another set of problems.

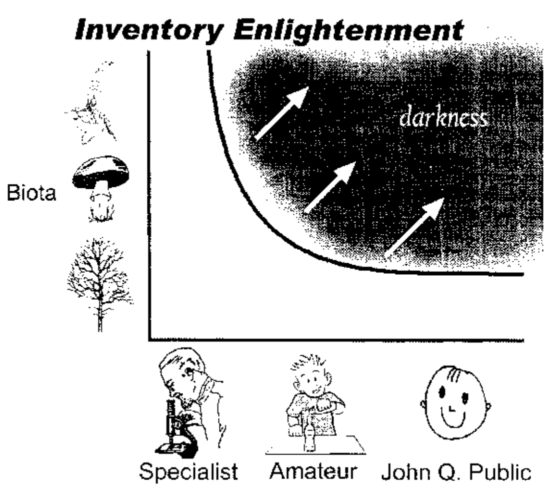


Fig. 3. The y axis refers to the physical size of a species, and the x axis refers to the state of knowledge of various segments of the population. It is our goal to move the curve to the upper right. See text for explanation.

After the completion of the ATBI the task of identifying the braconids will be greatly facilitated. The illustrated interactive keys would permit reliable identifications; the color images on the species homepages would verify most identifications, and in a worst case there would be access to reliably identified specimens of all of the species in one museum. (It is our intention to have representative specimens of each species deposited in the Park collection, and the Park is in the process of building a multimillion dollar science center to house the biological collections emanating from ATBI activities).

People with amateur interests in biodiversity will also benefit greatly from the products of the ATBI. I have an amateur interest in the Ichneumonidae (These are parasitic wasps closely related to the Braconidae and there are about 3,000 species estimated in the Park). If I were asked today to identify a handful of species of ichneumonids from the Park, I would be able to identify the beasts to the subfamily or maybe the generic level but further identification would be unlikely for all but the most well-known taxa. I would have to rely on the aid of one of the few world experts in the group who, in turn, would have to go through the process described above. With the aid of the tools supplied by the ATBI, especially the interactive keys and images, I could obtain reasonably accurate species identifications for this diverse family. I have some confidence in these claims because I have developed many interactive keys using the software DELTA (Dallowitz 1994) and INTKEY (Dallowitz et al. 2000), and I have asked amateurs, including my 15-year-old daughter, to test them. Many of these are on my website (www.uky.edu/~mjshar0). Although printed dichotomous keys are all but impossible for amateurs, illustrated interactive keys make identifi-cations quick and easy.

With easy access to electronic identification tools for rather esoteric groups of organisms we can expect greater interest in their natural histories. Most readers know of published works that have accomplished this to some degree for a particular taxon. In my own experience I have seen a greatly increased interest in braconids since the publication of a manual for the identification of the 404 genera of Braconidae that are known to occur in the New World (Wharton et al. 1997). One of the expected results of the ATBI will be that many of the taxa that are in the inaccessible "darkness" region of Fig. 3 will become popularized.

What about the average person (J. Q. Public, in Fig. 3)? Our experience tells us that this is the segment of the population that is most likely to benefit from the ATBI. Most readers of this article are biologists and will appreciate that with an increased knowledge of the natural world comes an increased appreciation and fondness for nature. We all know that an educated community will enjoy and use the Park far more than an uneducated one.

In one of our outreach events for the ATBI, the public was invited to the Park to experience the ATBI. A laptop computer with an illustrated interactive key to the 30 species of salamanders that occur in the Park was taken into the field with a large group of people ranging in age from five to 75. They were so excited about catching salamanders and identifying them with the picture keys that it was the most successful event of the day. Incidentally, the participants were carefully instructed on how to handle salamanders so as not to injure them. We envision interactive keys for the more conspicuous fauna and flora in the Park, such as vertebrates, wild flowers, mushrooms, etc., to be available to Park visitors on handheld devices that can be carried into the Park. Campbell Webb of Yale University has already developed interactive key software (PalmKey) that operates on handheld PalmPilots.

Science

The benefits to taxonomy and systematics are myriad. Many of our most species-diverse taxa are not investigated and remain almost completely unknown because investigating them on a cosmopolitan basis is an undertaking that is simply too large. This is especially true for those taxa that do not have an obvious influence on our economic activities. In the systematic studies of most organisms it is now normal procedure to "revise" monophyletic taxa. (Monophyletic taxa are groups of organisms that exclusively share a common ancestor, i.e., an ancestral species and all of its descendants.). This practice allows the researcher to construct cladograms, with which hypotheses of phylogenetic relationship can be posed and tested. In biodiversity studies, such as the ATBI, this is difficult because usually we are not dealing with monophyletic taxa but with subsets of monophyletic taxa. Nonetheless, a great amount of information on character state distributions is obtained, and preliminary hypotheses of monophyly can be postulated and tested with more extensive collections. The ATBI of the Great Smokies will deal with many megadiverse taxa for the first time in the modern era of systematics. The results of these studies will provide a stepping-stone for studies of some of these taxa on a larger geographic scale, perhaps the Nearctic region or perhaps the world. In many cases, the number of species found in the Smokies for any monophyletic group will allow us to have an educated guess at the number of species found in the United States, or even worldwide.

The identification tools generated by the ATBI will directly service the entire eastern United States north of Florida and much of southeastern Canada. Only a small percentage of the species that occur in this vast area do not also occur in the Park. We expect that the database and identification keys will be augmented to offer biotic information to a much larger geographical area that will have an even greater audience than that of the ATBI. Though the inventory is restricted to the Park, the products will have far reaching utility for a much greater geographic area.

Any biologist conducting whole organism research can imagine that having available any biodiverse area of the world where all of the species are named and all are relatively easy to identify would be a great bonus to their research. It would be the ideal place to study natural biological interactions, an unprecedented living laboratory.

There is a comprehensive Geographical Information System (GIS) in the Park with which all of our sampling and locality data will be associated. This facilitates community structure studies and those on species distributions and interactions. The information will be available for extrapolation far beyond the Park boundaries.

Economic and other Societal Benefits

In their draft report to NSF on the feasibility of an ATBI in the tropics, Janzen and Hallwachs (1994) listed numerous benefits. Since the societal benefits are made succinctly in their text I have selected a few and present them here almost verbatim.

- Enormous opportunity to gather biodiversity samples, as an add-on process, for biodiversity prospecting of genes, chemicals, structures, and behavior.
- Enormous opportunity to gather living samples with which to stock seed banks, gene banks, tissue banks, sperm banks, culture collections, botanical gardens, zoos, etc.
- A major injection of actual wildland specimens and genes into the national and global pool from which all sectors of society can draw for their needs.
- A major step forward in the evolution of scientific and computer technology that can accept, manage, manipulate, and package large masses of highly particulate and diverse biological information.
- A major step forward in the evolution of the administration of a highly interdisciplinary, cross-society project.
- A major injection of funds, motivation and experience into the Taxasphere (Taxa-

sphere refers to all of those people involved in taxonomic study and industry).
- A major increase in appreciation of the Taxasphere as a crucial social element.
- A major social event for the region in terms of employment, local opportunities for learning and training, commercial enterprise, and income generation through development of the information that will be forthcoming.
- A high profile biological effort that will generate considerable positive press, educate the public about diversity, and stimulate greater interest in and support of taxonomy and systematics.
- A world-class project for the processes that generate all of these products.

HOW TO DO IT

Administration: Discover Life in America (DLIA)

Shortly after our meeting in December of 1997, where we first discussed the idea of the ATBI, a group of us established Discover Life in America, a not for profit, public benefit organization, under the auspices of which the ATBI would be administered. This organization allows us to accept tax-exempt donations and interact in a coordinated manner with the Park administration. Our current president is Frank Harris of the University of Tennessee. A blue-ribbon Science Advisory Panel to DLIA has been organized to provide advice on the conduct of the ATBI. The panel consists of Daniel Janzen (University of Pennsylvania), Thomas Lovejoy (The World Bank), Ronald Pulliam (University of Georgia), Peter Raven (Missouri Botanical Garden), and Edward O. Wilson (Harvard University).

One of the committees appointed by the board of directors of DLIA was the Science Committee co-chaired by Peter White of The University of North Carolina and John Morse of Clemson University. Their most important task, to date, was to compile a science plan (White et al. 2000, available at http://atbi.biosci.ohio-state.edu:898/atbi/sciplan2000.pdf.). The interested reader can refer to that document for details. We wish to complete the inventory in 10-15 years, understanding that we will never find every species in the Park, even with enormous resources. Biodiversity is a dynamic process and what is found in one year will not be the same as the next.

Database

Our first and most important charge was to develop a central database to organize all of the information that would be forthcoming. It was clear from the beginning that this was the core of the inventory and in time it would become the inventory. With the help of a NSF grant, Norman Johnson and colleagues at Ohio State University have completed the development of the database. Now all that is left is to fill it with the information that we gather for the 100,000 species of life in the Park, and this process is well underway.

Taxonomic Working Groups (TWiGS)

As an organizational tool we have adopted the Taxonomic Working Group (TWiG) structure originally developed by Daniel Janzen for his ATBI in Costa Rica. We have divided life into approximately 20 units. A systematist has been assigned to develop a team for each of these TWiGS. The TWiGS are not necessarily organized around monophyletic taxa. Rather, practical considerations like the size of the organisms and their life histories are considered. For example, we have a Hymenoptera TWiG that is investigating a monophyletic taxon and an aquatic insects TWiG that is studying fresh water insects, a non-monophyletic assemblage.

Collecting organisms for the ATBI is very taxon dependent and consists of a mixture of organized repeated sampling and ad hoc collecting. As an example of how the TWiG structure works I will use the Hymenoptera TWiG. We have identified 19 terrestrial life zones in the Park that range from lowland cove hardwood to high altitude spruce-fir forests. In each of these we have established biodiversity reference points that are one hectare in area (Fig. 4). These serve as the primary sites for structured sampling. Currently we have 11 of these sites being sampled by Chuck Parker (Biological Resources Division) and his team. Every two weeks samples from Malaise and pitfall traps and Lindgren funnels are collected and sent to a primary sorting center in the Park. The samples are processed in a sorting pool in the Park where they are divided into TWiG taxa. One of these is the Hymenoptera. The Hymenoptera samples are sent to my lab at the University of Kentucky where they are sorted to the family level and sent out to the members of the Hymenoptera TWiG.

As an example of what happens at this next level I will use the Braconidae. Most braconid specimens are mounted, labeled, and given a unique identifying code. All braconids are identified to genus. There are a number of braconid genera that have hundreds of species, the majority of which are not described, and these are not mounted now but placed in vials of alcohol and stored in a freezer. I identify to species members of those genera that are sufficiently well known taxonomically. For braconid subfamilies for which I have colleagues with more expertise, the specimens are shipped to them for identification. The identified specimens are eventually returned to me and the specimen data are then entered into the ATBI database at Ohio State University. Im-

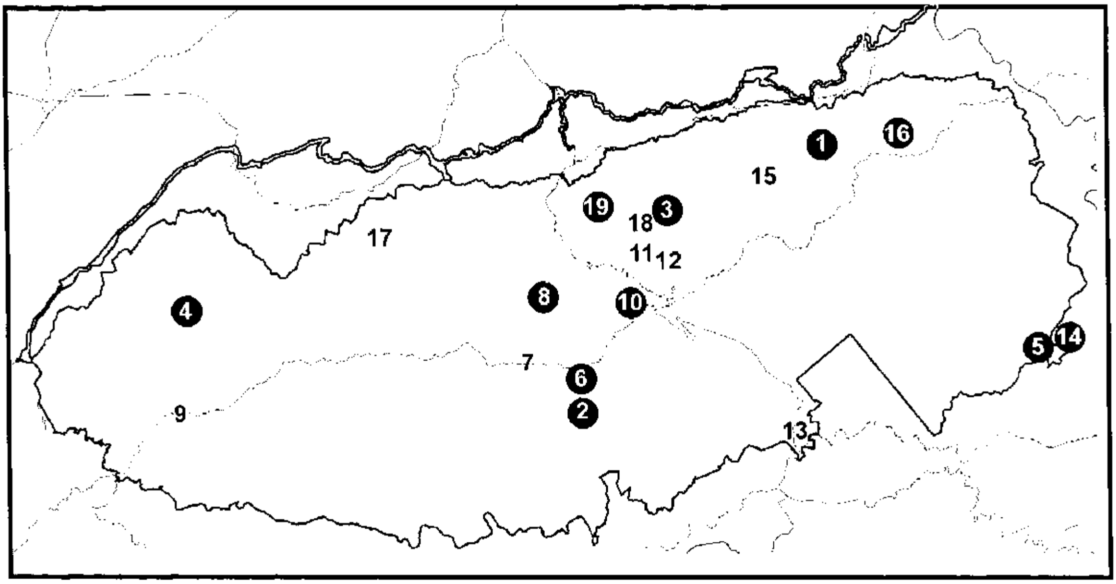


Fig. 4. The 19 localities where repeated long-term sampling will be conducted for the ATBI. The localities represented with black circles are currently being sampled with pit-fall traps, Malaise traps and other arthropod sampling methods.

Plot #	ATBI Plot Name	Elevation	Vegetation Type
1	Albright Cove	3,390'	Montane Cove
2	Andrews Bald	5,760'	Grassy Bald
3	Brushy Mountain	4,810'	Heath Bald
4	Cades Cove Old Field	1,710'	Treeless
5	Cataloochee	4,530'	Mesic Oak
6	Clingmans Dome	6,380'	Spruce—Fir
7	Double Springs	5,600'	Beech gap
8	Goshen Prong	2,940'	Cove Hardwood
9	Gregory Bald	4,940'	Grassy Bald
10	Indian Gap	5,490'	Beech Gap
11	Mt. LeConte Blvd.	6,010'	Spruce—Fir
12	Mt. LeConte 2	6,430'	Spruce—Fir
13	Oconaluftee	2,010'	Bottomland Hardwood
14	Purchase Knob	5,020'	Northern Hardwood
15	Ramsey Cascade	2,950'	Xeric Oak
16	Snakeden Ridge	3,260	Hemlock
17	Tremont	1,500'	Tulip Poplar
18	Trillium Gap	4,600'	Beech Gap
19	Twin Creeks	1,950'	Tulip Poplar—Hemlock

ages of each species are captured in my lab and interactive keys and species homepages are developed. Identified specimens are deposited in the Park collection, the University of Kentucky collection, and duplicate specimens are returned to collaborating braconologists. Because there are many replicates of each species, each collaborator builds a very complete collection of all common species of Braconidae. To augment the collections of Braconidae, numerous trips will be taken and different collecting methods, such as sweeping and pan traps, will be employed. Illustrated, interactive keys, to the braconid subfamilies and genera that are likely to occur in the Park are now available on my web site (www.uky.edu/~mjshar0).

At this point we still have all of those big nasty unknown taxa of braconids in the freezer. These constitute about 30% of the species of Braconidae and they represent our greatest challenge. Similar challenges will be found in most of the species-diverse taxa that inhabit the Park. Previously, I described the magnitude of our task and inferred the length of time and amount of money that it would take to complete treatments for 90,000-

100,000 species. Clearly, something has to be done to accelerate the process and reduce the cost. The taxa that are in the freezer represent the biggest bottleneck in our endeavor. There are several suggestions to describe and otherwise treat the species for these largely unknown groups. The one that I like is referred to as Accelerated Research for Taxonomic Systems (ARTS). When the state of knowledge for a group is particularly poor, for example for the stink bugs (Pentatomidae), we might refer to this process as fundamental accelerated research for taxonomic systems. Either way the process and its rationalization, described below, are much the same.

The mechanics of conducting taxonomic research have not changed appreciably over the last generation. Most taxonomists do all of the work themselves. At best, they have a technician to do some repetitive work such as taking measurements or recording locality data. Taxonomists collect specimens, prepare and label the specimens, discover useful morphological characters to group the specimens into species, write dichotomous keys to allow others to distinguish the species, check type specimens and published articles to apply names to previously undescribed species, write detailed descriptions, prepare line drawings, and take photographs, including scanning electron micrographs, to illustrate characters and species. The tasks that require a systematist's expertise are few and much of our work is repetitive and technical in nature. The systematist's skills are best employed to find distinguishing characteristics to separate species and to wade through the sometimes complex literature and collections to identify previously described species. Most of the rest of the work can be automated with tools that are available today.

The DELTA/INTKEY system is one such technology. Given a list of characters and character states for each species, this combination of applications can generate diagnoses, descriptions, dichotomous keys, and interactive keys. I do not suggest that all collaborating taxonomists learn how to use these tools. On the contrary, we will train technicians to assist taxonomists. This is far more efficient and inexpensive and it will leave the taxonomists free to treat more species. Given a little direction, technicians can also be trained to acquire most of the illustrations using digital cameras attached to stereomicroscopes. New photographic technology that captures images in multiple layers allows us to illustrate structures that previously had to be drawn by hand because of depth of field limitations. I have used DELTA and INTKEY for numerous revisionary publications (Sharkey 1996, 1997, 1998) and computerized keys (see these on my web site www.uky.edu/~mjshar0); much time is saved with these applications and data are organized in such a way that it is simple to add species to the revision as new discoveries are made.

Given the financial resources, when a taxonomist agrees to tackle a megadiverse group for the Park, we will assist him/her by offering technical support described above. The products would complete what is needed for the ATBI but the data would be available to facilitate more extensive revisionary studies.

Another method of organized collecting and adding to the database of the ATBI is the bioblitz. In July of 2000 David Wagner and collaborating Lepidopterists visited the Park to see how many species of Lepidoptera they could find in one 24-hour period. They discovered 706 species of moths, including 301 species that had never been recorded in the Park and 25 undescribed species. The informal Park list included 800 species before the bioblitz. From these results Wagner and his group estimated that there are at least 3,000 moths and butterflies in the Park. We have also had a fly blitz and a beetle blitz.

WHY THE GREAT SMOKY MOUNTAIN NATIONAL PARK?

The Park encompasses the richest natural area in eastern North America. It is the home of more than 1,570 species of vascular plants including 130 species of native trees. It boasts a diversity of salamanders that may be unmatched anywhere else in the world. The elevational range in the rugged ancient mountains (270 m-2025 m) endows the region with an array of climates comparable to a 1,250 mile north-south transect through the eastern United States and Canada. The diversity of the region is the main reason it has been added to the list of International Biosphere Reserves and World Heritage Sites recognized by the United Nations. While biodiversity may mean wild plants and animals to much of the general public, the Great Smoky Mountains literally brings this to their backyard. Over 4.8 million people live within a radius of 500 miles of the Park (1990 census data). It is the most visited national park in the New World, and it hosted over 9 million visitors in 1999.

The Park covers approximately 2,200 square kilometers (521,621 acres) in the southern Appalachian Mountains in the states of Tennessee and North Carolina (Fig. 4). Some 95% of this area is forested, but much was subjected to a range of disturbances in the past. Nevertheless, the Park contains some of the most extensive tracts of virgin forest remaining in the eastern U.S. The bedrock is heterogeneous consisting of igneous rocks, acidic phyllites, sandstones, shales, and carbonate rocks. The carbonates have produced various karst features, including the deepest cave in Tennessee. Precipitation levels vary from 1,650 mm per year at low elevations to over 2,500 mm at the highest elevations. Fog is an additional source of precipitation and occurs about 73-100 days per year at Noland Divide. There are 3,400 km of permanent streams within the Park, and all major streams originate within its boundaries.

The choice of the GSMNP as an ATBI site is exemplary because: 1. It is the most species-diverse area in temperate North America. 2. It is federal land protected by the National Park Service. 3. It is in close proximity to millions of citizens who will benefit directly from the biodiversity research when visiting the Park and through their direct participation as volunteers. 4. The Park Service passionately supports and encourages the ATBI. 5. It is located in close proximity to one of the world's greatest concentrations of taxonomists and many important biological collections. 6. The Park is located in the United States of America, a country whose citizens have the political, economic, and intellectual will to accomplish great things.

The Future

The broad range of interest and participation in the ATBI is demonstrated by the fact that our planning meetings have included representatives from 37 colleges and universities in the United States and Canada, 17 private organizations, and officials from the National Park Service, the Smithsonian Institution, the USDA Systematic Entomology Laboratory, Biological Resources Division, USDA Natural Resource Conservation Service, USDA Forest Service, the U.S. Fish & Wildlife Service, the Environmental Protection Agency, the Oak Ridge National Laboratory, and the President's Office of Science and Technology Policy. More so than any other taxonomic endeavor, we have been widely covered by the popular press with articles in magazines such as Audubon, Science, and Newsweek.

If successful, the ATBI will require a lot of resources but, by and large, these will not be resources that would have otherwise gone towards taxonomic research. Presently, we have some funding from the National Science Foundation and other national scientific organizations but most of our support comes from private organizations such as the "Friends of the Park" which raises money for Park activities. We expect greater contributions from private sources as our products become more visible.

Due to the great public interest in the ATBI, the endeavor has become a rallying point that promotes the sciences of taxonomy and systematics. We present them to the public in such a way that they are appreciated. This sort of interest is certain to have a positive influence on the public perception of our research and therefore on the amount of money that public institutions are willing spend on taxonomy and natural history. Scientists involved in all aspects of biodiversity research, including those doing revisionary studies of monophyletic taxa, can expect to profit from the education and promotion components of the Great Smoky Mountains ATBI.

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