ATBI QUARTERLY
Autumn Newsletter 2001 (Volume 2, Number 4)
Great Smoky Mountains National Park, The Natural History Assoc., Discover Life in America, and Friends of the Smokies

Rebecca Shiflett

Keith Langdon (NPS) and Upward Bound students

Rebecca Shiflett

Tom Rogers and Ed Riley examining a collection

Contents

In our winter issue: explore microbial diversity with Steve Wilhelm and learn about aquatic oligochaetes from Mark Wetzel

Beetle Blitz: Scientists and Volunteers Converge on the Smokies in Quest for Coleoptera

Tom Rogers

The Beetle Blitz, held from Thursday, 28 June through Sunday, 1 July, was a resounding success! Specimens representing 62 beetle families were collected. Researchers working at the blitz included Coleoptera TWIG leader Chris Carlton and Victoria Moseley, both from Louisiana State University, and Alexander Konstantinov from the USDA. Mike Thomas of the University of Florida worked on the Cerambycidae and Cucujidae, while Ed Riley of Texas A & M and Shawn Clark of the West Virginia Department of Agriculture worked on the Chrysomelidae. Alexey Tischechkin of Louisiana State University worked on the Histeridae. Roger Dajoz and wife Aline from France searched the unique and often challenging habitats of Great Smoky Mountains National Park. Even lepidopterists joined in! Dave Wagner, University of Connecticut and Brian Scholtens, College of Charleston, made light traps available to the coleopterists and assisted with guiding students in the field. Some of our work was supported by Discover Life in America (DLIA) grants—monies contributed by the Great Smoky Mountains Natural History Association and Friends of the Smokies.

Training for this event began March 10, with the DLIA spring volunteer weekend where new volunteers were presented with an overview of the ATBI program and the various volunteer opportunities available, including a discussion of the Beetle Blitz. In June we met again to learn the actual collecting methods to be used during the blitz and we prepared to go into the field with the various researchers and contribute to the process. After an initial orientation and safety meeting the first morning of the event, people divided into groups and scattered throughout the Park to collect. Each afternoon we met to sort the day's collections and to organize for the next day or for collecting that evening.

Over 70 DLIA volunteers participated, including 50 high school students from various parts of the Southeast in the Upward Bound program for math and science held at the University of Tennessee. Volunteer photographers documented the event, National Park staff assisted with the effort, and local and national media conveyed the excitement of the project to the public. The program culminated in a refreshing Smoky Mountain downpour, followed by a barbecue dinner for about 100 people, which was generously provided by Orkin Company.

Researchers also took time to work on the Park's specimen collection. The collection work has pointed the way for future efforts. If the volunteer groups prepare material in advance of a researcher's visit to the Park, then they can quickly work through the specimens to make identifications. This will be an efficient alternative to a researcher receiving specimens in alcohol and spending their valuable time mounting and labeling each specimen. Sorting workshops planned for this fall and winter will be the next steps in training volunteers to address this need. Other such collecting ventures are in the works for the coming years, including another Lepidoptera Blitz in June of 2002.

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Letter from DLIA President Frank Harris

Events of September 11 have left us all in a state of shock and disbelief that something so horrible could happen in a civilized world. Our thoughts, prayers and compassion go out to all who have been touched by this tragedy. We don't realize how small our world has become until some event of such huge, horrific proportions makes us realize that we are but one or two steps removed from one another despite the physical distance that might seem to matter. Let us each take the time to reflect on this event and from it determine how we might change to make the world a better place.
Peace be with you,

Frank Harris
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Annual Discover Life in America Conference

The 2001 All Taxa Biodiversity Inventory - Discover Life in America Annual Conference will take place at the Glenstone Lodge in Gatlinburg, Tennessee from November 28-December 1. The meeting is being held earlier this year to allow for semester exams, and potentially bad weather. There have been many accomplishments over the past year, such as new species discoveries, increased financial support, volunteer action, exciting prospects for science education, and plans for a new NPS Science Center to mention a few! Don't miss this opportunity to join together to share knowledge, ideas, and visions for the future.

Note that our volunteer photographers are hosting a Photo Workshop on Wednesday, November 28, with classes, guest presenters, and field trips into the Park. Contact Kevin Fitz Patrick at 828-526-0272 or media3@gte.net to register. All other ATBI sessions will be held on Thursday, Nov. 29 and Friday, Nov. 30.

VENUE: The meeting will be held at the newly refurbished Glenstone Lodge, Historic Nature Trail (formerly Airport Road), P.O. Box 330, Gatlinburg, TN 37738. Please make your own reservations by calling the Glenstone at 1-800-362-9522 or 865-436-9361. We have reserved a block of rooms at a discounted rate of $60.00 per night. Please tell them that you are with Discover Life in America for the ATBI Conference. The Glenstone Lodge has again graciously provided us with meeting rooms at no charge. We are looking forward to your participation.

Fundraising and Development

Discover Life in America has accomplished so much in three short years with the help of a small army of volunteers. I have two more volunteer teams that I would like to add to the volunteer plan written by Jeanie Hilten; a Development Team and a Community Relations & Publicity Team.

The Development Team will work on special events and fundraisers for DLIA. The first event on our schedule is the Biodiversity Auction to be held on Thursday, Nov 29, during the Annual Conference reception. Volunteers are needed to help obtain auction items and organize the event. It would be great to have a volunteer auctioneer in our midst. The Development Team also will help with house parties, receptions, and other fundraising activities.

The Community Relations & Publicity Team will help get out the word about DLIA. Volunteers can help the ATBI by tending booths or tables at community events like Earth Day and professional and public meetings. This team may help with press conferences to bring attention to publications and media opportunities. We would like a volunteer roving reporter to interview ATBI scientists and educators for newsletter and video presentations. We could also use some help in preparing an ATBI-DLIA video or multimedia presentation. If you would like to work on these activities, please call Emily Jones at 865-453-2428 or send an e-mail to fotsej@icx.net.

Mining Beetle Diversity in the Smokies

Chris Carlton

During June, a team of specialists from the Louisiana State Arthropod Museum (LSAM) participated in the Beetle Blitz (see front page) along with a large contingent of other scientists, volunteers, and Upward Bound students. This was a wonderful event and a great way to jump-start the beetle diversity project. We and other ATBI specialists are now sorting and identifying.

How many beetle species are there in the Smokies? When asked this question at the media event during the blitz I confidently said 6000, a figure that was picked up by the Associated Press and quoted enough times in newspapers around the country to make it sound plausible, and make me feel compelled to defend it. Less commonly quoted was my statement to the effect that I was curious to discover how wrong I would be when the results were final. In their 1998 checklist, S. Peck and M. Thomas recorded 4675 beetle species from Florida, but emphasized that their list was only the beginning of understanding beetle diversity in the state. In eastern Oklahoma, coleopterist Karl Stephan collected over 3500 species from Latimer County (189,540 hectares) during approximately 20 years of effort. At 221,000 hectares, the Park is comparable in area, but has dramatically greater topographic relief, habitat diversity and a moister climate, all of which promote high levels of diversity and local endemism (species restricted to a small area). Given these conditions for maximizing species diversity and our current incomplete state of knowledge of many beetle groups, I felt that a figure of 6000 was a reasonable upper limit.

How many beetle species are there in the Smokies?

So which habitats will yield the most beetle species?

Our LSAM team will concentrate survey efforts on one of the least understood habitats in the Park, forest litter. This stratified forest floor habitat has a top layer of freshly fallen leaves and woody debris and extends through a series of zones of finer organic matter to a basement of subsoil and bedrock. Beetles are one of the most diverse insect Orders in this habitat niche and exhibit an amazing array of life history strategies and body forms, mostly in lilliputian sizes (as small as 0.5 mm). Many subsist on the abundant and diverse fungal decomposers of plant debris. Families of beetles such as hairy fungus beetles (Mycetophagidae), handsome fungus beetles (Endomychidae), pleasing fungus beetles (Erotylidae) and feather-winged beetles (Ptiliidae) all graze on mycelia and spores in the moldy litter, or feed on fruiting bodies (e.g., mushrooms) that emerge from it. Other litter beetles are predatory, while a few feed directly on dead plant material or spend time in the litter only during their larval stages. The subjects of my own research are the predatory short-winged mold beetles (Pselaphinae, one of several large subfamilies of staphylinid, or rove beetles). Some, such as the bizarre-shaped *Adranes lecontei*, pictured, live in intimate association with ants. Their complete integration into the social order of ant colonies is associated with the evolution of specialized glands that produce secretions that the ants find irresistible. They are in turn fed by the ants through a specialized kind of regurgitation called trophallaxis, and are generally cared for by the ants and treated somewhat like pets. Though considered to be rare, we collected a nice series of them in litter samples during the Beetle Blitz, an example of what can be accomplished using specialized techniques. Many other species of short-winged mold beetles are restricted to GRSM and adjacent mountains. Some species are known only from single localities and some from only a single individual!

Adranes lecontei, illustration by Nancy Lowe

These are the kinds of arcane coleopteran jewels that will send beetle diversity in the Smokies to my now famous (or infamous) 6000 species estimate. Give us 10 years and we'll prove it! You can track progress on the beetle species count by logging onto the Smokies Coleoptera TWIG website at www. agctr. lsu.edu/arthropodmuseum/smokybeetles.htm.

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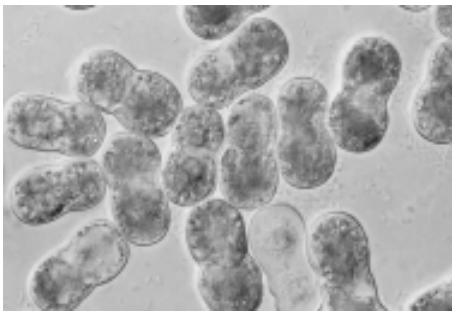
Rebecca Shiflett

Victoria Mosely and Chris Carlton search along the Indian Gap Trail

Latest Adventures of the Algal TWIG

Shannon Gomez and Jeff Johansen



Shannon Gomez

Actinotaenium cucurbita, new species for the Park

The algae of Great Smoky Mountains National Park are less well studied than many of the other pPhyla. Two previous diatom studies have given us a relatively large number of diatom records, but the soft algae have received only limited attention. Jeff Johansen and Shannon Gomez (of John Carroll University in Cleveland, Ohio) recently received a grant from Discover Life in America to study the non-diatom algae of subaerophytic habitats in the Park. These habitats include springs and seeps on rock surfaces, as well as the moist splash zones of waterfalls.

Johansen and Gomez initiated their study of the non-diatom algae this summer. They were joined by Rex Lowe and Amy Kireta (Bowling Green State University) and Klára Kubecková (South Bohemia University) in May when they spent one week in the Park collecting subaerophytic algae. Eighty separate samples were collected at that time. Samples were taken from wet rock faces representing nine different geological formations. These formations included: Anakeesta, Thunderhead Sandstone, Basement Complex, Pigeon Siltstone, Longarm Quartzite, Roaring Fork Sandstone, Metcalf Phyllite, Rich Butt Sandstone, and Cades Sandstone. Shannon and Klára returned in August and sampled the Great Smoky Group, Wilhite Formation and Elkmont Sandstone, and also re-sampled some of the other formations. Sixty-two samples were collected in August. The samples collected represent a pH range of 3.8 to 7.4, and combined with the mineral differences in the different formations, these samples represent an enormous diversity of algal habitat.

Klara Kubeckova, Jeff Johansen, and Shannon Gomez collecting algae along a rock outcrop

Direct examination of living material was made while the researchers were in the Smokies and upon returning to John Carroll University. Selected samples were cultured on Bold's basal medium, and a portion of every sample was preserved in 3% formalin for later identification. Some algal taxa can be correctly identified only by examining uni-algal cultures, as details of their life history are needed for proper identification. Although much of the analysis remains ahead, already many interesting new records have been seen.

Prior to this study, there were 408 algal species reported from the Park, of which 299 were diatoms. So far, Gomez and Johansen have found 27 new species records for the Park, of which 12 are Cyanophyta, 14 are Chlorophyta, and 1 is in the Tribonemophyceae (Heterokontophyta). Of these, there are 8 new generic records for the Park. In addition, they have found a large number of taxa which are distinctive and unlike previously described species (and also representing more new generic records). At least some of these difficult taxa represent new species, and will be the subject of further study this year. Although there is much work to do to catalog all algal species, this study will certainly yield many more new records to the inventory of species in the Park.

Shannon Gomez

Xanthonema bristolianumand, new species for the Park

Shannon Gomez and Jeff Johansen
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Dictyostelids are Slime Molds Too

John Landolt

Steve Stephenson

J. Landolt collecting litter samples near the mouth of Gregory's Cave

Dictyostelid cellular slime molds, like their bigger, flashier myxomycete slime mold cousins, play a role in influencing the size of decomposer bacteria populations living in soil and decaying leaf litter. In turn, cellular slime molds are utilized as food by protozoa, nematodes, small arthropods and other small creatures.

As individual amoebae, cellular slime molds may engulf and digest bacteria at such a rate that a small, local population of bacteria within a cubic centimeter may be decimated. When this obliteration of the bacterial food supply occurs, a truly amazing transformation of the slime mold takes place. Thousands of cellular slime mold amoebae that had been operating as independent single-celled organisms, begin to stream together to form aggregations from which arise larger, multicellular entities. Each multicellular pseudoplasmodium, behaving now as a single creature, moves in response to light and chemical stimuli, eventually develops different, specialized cell types, and rearranges itself to form a stalked structure bearing one or more packets of dispersible spore cells.

Spores may remain dormant for months or germinate in a short time to liberate more amoeboid cells to feed on replenished bacteria. The spores may be ingested inadvertently by birds, rodents, or amphibians foraging for food on the ground. After passing unharmed through the animals' digestive system, these spores can be redeposited in a different locale to germinate and devour fresh supplies of bacteria. Viable cellular slime mold spores have been recovered from the wings of moths that have emerged from cocoons in the ground. Spores also have been found in the droppings of bats that feed on these moths. **Evidence exists that migratory songbirds regularly may ingest and transport spores for hundreds, or even thousands of miles between the tropics and higher latitudes.**

There are almost 100 described species of cellular slime molds in the world. The tropical zone of the western hemisphere is home to the largest variety of forms, but it is likely that up to 25-30 % of these cellular slime mold species have distributions that overlap the borders of Great Smoky Mountains National Park. However, since all of the life stages of cellular slime molds are essentially microscopic, it is almost impossible to observe them in the field. Laboratory culturing from field collected soil and litter material is required.

Prior to the ATBI initiative, about 10 species of this group had been recorded from the Park. In just the last three years, the number of species on this list has more than doubled. Survey work for discovering cellular slime mold distributions has been conducted in only a few sites so far, with many areas in the Park yet to be examined.

The cellular slime mold ATBI project has become an example of a collaboration not only among the individuals of the Slime Mold TWIG, but also with many others, including members of other ATBI groups. Others who have become involved in the cellular slime mold component of the ATBI are undergraduate students Melissa Bolt of Northern Virginia Community College (field collections) and Nancy Critzer from Shepherd College (laboratory processing and analysis). DLIA Volunteers David Stairs and Nancy Lowe have participated in making field collections. Park personnel Chuck Parker and Ian Stocks have made field collections of soil and litter material to be examined for cellular slime molds. Will Reeves (Clemson University), in the course of his ATBI entomology work has collected soil samples from caves within the Park which have yielded interesting cellular slime mold records. The Tree Canopy Biodiversity group headed by Harold Keller (Central Missouri State U.) provided sample litter material from the forest canopy that contained a cellular slime mold record.

Cellular slime molds are likely to occur in almost any setting. Interesting species, including new and different forms, may occur in any number of microhabitat types that exist in the Park where aerobic decomposition of litter by bacteria takes place. If there are any other ATBI investigators or volunteers working in situations of this sort and who would like to collect sample material to process for the recovery of cellular slime molds, please contact me.

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Melissa Bolt

From L. to R., John Landolt, Steve Stephenson and Jim Cavender at Clingman's Dome

Smoky Mountain Reptiles

Ben Cash, Joshua Ennen, and James Webb

Ben Cash

"Two in the hand..."
Fence lizards at Scott Mountain

Ben Cash

Copperhead at Meadow Creek

The reptile inventory of Great Smoky Mountains National Park is in full swing. Ben Cash, assistant professor of biology at Maryville College, and two junior Maryville College biology majors, Joshua Ennen and James Webb, spent the summer months intensively sampling localities throughout the Park.

There are 38 reptile species recorded from Great Smoky Mountains National Park. However, many of these records are based on a few individuals (or sometimes just one), leaving little knowledge of the distribution of most species. Montane habitats of the Southeast are not generally known for their reptile diversity. Add to that, the very cryptic nature of most reptile species and 221,000 hectares to cover, and this in large part explains why there is so little information on occurrence and distribution of reptiles in the Park.

A variety of methods are being used to shed light on the species richness and distribution of reptiles in the Park, starting with simply putting a lot of hiking miles under our belts. Turning rocks and logs, the tried and true method of ground-pounding herpetology, is being applied. This method is typically fruitful and large geographic areas can be covered. In an effort to diversify our sampling techniques, we are also placing temporary drift fences with screen funnel traps at selected areas in an effort to catch individuals on the move, particularly snakes. Roofing tin has been spread at various sites and has proven to be very successful. Animals found dead on the road are being collected (we owe a debt of gratitude to Park Rangers for their assistance), and turtle trapping is being conducted in streams, rivers and impoundments. Also, historic records from museum data are being collected to provide more distributional information.

Currently, no species new to the Park have been recorded, but much new information has been gathered to better understand the distribution of reptile species. For instance, the milk snake, historically known from only the Cataloochee region in North Carolina, was found this summer in Cades Cove on the Tennessee side. Thanks to efforts by Ken Dodd and his amphibian crew, and to our trapping efforts this summer, we have reconfirmed the common map turtle in Abrams Creek (previously based on one anecdotal account), and have a better picture of its occurrence along the creek.

Our ATBI activities have also provided us with outstanding educational opportunities. Drift fences (and soon tin) have been placed at the Tremont Institute (thanks to Paul Super) and at Purchase Knob (thanks to Susan Sachs). Our endeavors also are providing valuable experience to students from Maryville College and other institutions in all aspects of the project, from web page design and content, to various aspects of biological fieldwork.

In short, a lot of ground has been covered to this point, but much work is ahead. Thanks to Janice Pelton and all the Park staff at Twin Creeks, and to Jeanie Hilten for her excellent assistance. Anyone interested in contributing to the reptile inventory please contact me.

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ATBI Needs List

If you can donate any of these items or know of someone who can, please call Emily Jones at 865-453-2428 or Jeanie Hilten at 865-430-4752.

- Motel rooms and cabins (available on weekdays) for scientists conducting field research in the Park
- Bottled water, snacks and refreshments for scientist and student hospitality and special events
- Clothes washer and dryer for ATBI housing in the Park
- As always, financial contributions are gratefully accepted

Your financial contributions to Discover Life in America will:

- Provide graduate student stipends in the ATBI Sorting Center
- Underwrite costs of the ATBI Quarterly newsletter
- Help us host the ATBI-DLIA annual conference
- Purchase necessary scientific equipment for use in Bio-Blitzes and collecting, sorting, and cataloging activities
- Purchase film for volunteer photographers to document new species found in the Park

USDA

Acleris variana, one of about 125 species of leafrollers (family Tortricidae) recorded from the Park

Lepidoptera TWIG Branches Out

John W. Brown

With funds from Discover Life in America and the Smithsonian Biodiversity Program, equipped with ultraviolet lights, traps, sheets, and batteries, and spearheaded by the unflagging enthusiasm of David Wagner (University of Connecticut), the Lepidoptera TWIG is making considerable progress on its inventory of the butterflies and moths of Great Smoky Mountains National Park. Although the Lepidoptera TWIG was rather "slow out of the blocks," the Bio-Blitz in July 2000, with approximately 30 participants from across the United States, stimulated much interest and enthusiasm for this project within the community of professional lepidopterists. Since then, sampling has been conducted regularly from August through October 2000 and from May through September 2001. With over 150 blacklight trap samples collected, we likely have examined over 30,000 specimens of Lepidoptera. Vouchers of nearly all species are accumulating in the collection of the National Museum of Natural History in Washington D.C., with a synoptic set gradually returning to the Park collection at Sugarlands Visitor Center. Examples of certain target taxa have been preserved in 100% alcohol for future DNA studies examining relationships among groups at various taxonomic levels.

Based upon collecting efforts so far, approximately 1,200 species of Lepidoptera have been recorded from the Park. It is estimated that the Park may support as many as 2,500 species, about 20% of the entire moth and butterfly fauna of America north of Mexico. Some of the more interesting finds include a new species of Geometridae (the inchworm family) in a tribe previously unrecorded from North America; several new species of fungivorous Tineidae (the clothes moth family); and two interesting southern range extensions of boreal Tortricidae (the leafroller family). While the butterflies and "macro-moths" of the Park are becoming relatively well known, there is still much to be discovered about the *microlepidoptera* fauna.

Future activities involving the Lepidoptera TWIG include continued survey work throughout 2001 (except during the winter when few species fly), development of a more rigorous database to quantify differences and similarities among sampling sites, additional preservation of specimens in alcohol for future molecular analyses, and another Bio-Blitz in June of 2002. Stay tuned for more news from the Lepidoptera TWIG.

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Independent Fern Gametophytes

Paul Davison

Fern gametophytes (plants that alternate generations; the haploid, gamete-producing phase) aren't typically thought of when considering fern diversity. Yet Great Smoky Mountains National Park is home to three of the fern gametophyte species known to science. These species were named in the early 1990's by Don Farrar of Iowa State University and his colleagues. Named from perennial gametophytic populations that have apparently lost the ability to produce sporophytes, *Vittaria appalachiana*, *Trichomanes intricatum*, and *Hymenophyllum tayloriae* are small plants only millimeters long and quite different from the typical fern gametophytes illustrated in general biology texts. These gametophytes grow in filamentous and branching, ribbon-like forms. **They are usually interpreted to be relicts from the much warmer Tertiary Period when sporophytic** (spore-producing, diploid phase in a life cyle characterized by alternation of generations) **populations of the species presumably occurred.**

With changing climatic conditions of the Pleistocene, it is postulated that the sporophytes became extinct and the gametophytes persisted in rock crevices and rock underledges where they may still be found today. The persistence of gametophytes is possible due to their production of gemmae (a small mass of vegetative tissue) from perennial gametophyte plants. Gametophytic gemmae, which are specialized means of asexual reproduction, are known only in three fern families, all tropical: Vittariaceae, Hymenophyllaceae, and Grammitidaceae. Each family is represented in the Southern Appalachians by independently reproducing gametophytic populations. Grammitidaceae is represented by *Grammitis nimbata* (known from a single locality in Macon Co., N.C. and functional sporophytes in the West Indies). Vittariaceae is represented by *Vittaria appalachiana*, the most common of all the gametophyte species and was first collected in east Tennessee by Aaron Jack Sharp in 1930. Hymenophyllaceae is represented by two gametophytic species, the widespread *Trichomanes intricatum* (Vermont to Alabama) and the much rarer *Hymenophyllum tayloriae* which was until recently, known from northwest Alabama and a few counties in the narrow region bordering North Carolina, South Carolina, and Georgia.

This summer, *Hymenophyllum tayloriae* was added to the known flora of Tennessee and Great Smoky Mountains National Park. Three populations were found in the Park during two days of field surveys sponsored by the Tennessee Natural Heritage Program and the U.S. Fish and Wildlife Service. Individual plants are nearly microscopic, typically only a few cells wide, and were found with the aid of a flashlight and close examination of rock ledges along stream ravines. To see images of *Hymenophyllum tayloriae* and the other species of independent fern gametophytes, see the web site: http://www.goldsword.com/sfarmer/ATBI/.

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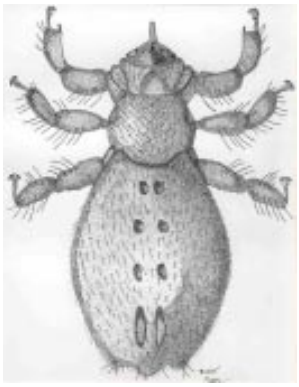
The Hidden Diversity Inside Biting Flies

Will Reeves

Of all the insects in the Park, biting flies are one of the few groups encountered by most visitors. Few people can honestly say that a mosquito has never bitten them and most visitors can identify mosquitoes, black flies, punkies, deer flies, and horse flies. Biting flies are among the best-studied groups of insects because they are the single most destructive group of animals in the world. Blood-feeding flies transmit viruses, bacteria, protozoa, and worms to their hosts. These same flies also play host to their own symbiotic organisms. In truth, insect symbionts (an organism living in association with a dissimilar organism) are among the most diverse taxa in the world.



Will Reeves

Hippoboscidae, Order Diptera

Almost every insect species has at least one species-specific symbiont and some insects can have a dozen symbiotic species. To start cataloging the diversity of symbiotic organisms in the Park we needed to focus our efforts on taxonomically well known hosts. Great Smoky Mountains National Park has over 100 species of biting flies and we expect at least 100 species of symbionts to be associated with these flies. This number could easily exceed 1000. Biting flies are the ideal group for this study, because most are identifiable to species and are easy to collect. Eleven families of biting flies might be found in the Park and that means the symbiont diversity could be enormous.

My advisor Peter Adler and I received a DLIA grant for the first multi-TWIG based study focusing on biting flies and their symbionts. Biting flies fall under the Diptera TWIG, but their symbionts include other arthropods, bacteria, fungi, nematodes, nematomorphs, platyhelminths, protozoa, viruses, and even plants. **The initial results from our survey indicate that a significant amount of the diversity in the Park may be among the symbionts of insects.**

Sampling biting flies involves collecting larvae from tree holes, streams, and roadside ditches or trapping adults with nets and dry ice baits. To isolate and identify symbionts, the flies must be kept alive and examined in a laboratory under a microscope. Detection of symbiotic organisms often involves hundreds of fly dissections before the symbionts are discovered. Preservation and identification often involves hazardous chemicals, electron microscopy, or molecular techniques. Some parasitic organisms must be reared to the adult stage or cultured before they are identified. The species composition of both flies and their symbionts changes with the weather and season. Weekly collections of biting flies allow us to monitor species changes in both the symbionts and hosts during the year.

This summer we collected and identified over 30 species of biting flies from the Park. These include several new state or Park records for black flies and mosquitoes. Two undescribed black flies were collected in the Park, and we expect to find several other undescribed flies. The symbiont diversity has been exceptional. An insect virus was detected in the Park's tree hole mosquitoes. A previously unreported pathogenic bacterium was isolated and identified from black fly larvae in North Carolina. A possible new microsporidian parasite of mosquitoes was also discovered. We have identified over six species of symbiotic trichomycete fungi from black flies and mosquitoes and one of these is potentially undescribed. Trypanosomatids and a complex of parasites have been identified in mosquitoes, black flies, and deer flies from the Park, and some of these include probable new species, state, or Park records. Symbiotic ciliates have also been identified from mosquitoes in the Park, some of which are benign commensals, but others appear to be parasitic.

Great Smoky Mountains National Park has over 100 species of biting flies and we expect at least 100 species of symbionts to be associated with these flies.

The world's first record of a larval nematomorph (horsehair worm) in a larval black fly was made from a seepage on the North Carolina side of the Park. Four species of nematomorphs have been identified from the Park, and some of these use flies as intermediate hosts. On a more ominous note, a nematode resembling dog heartworm was dissected from a mosquito at the Oconaluftee Visitor Center, and a possible new species of insect pathogenic nematode was found in 25% of the larval black flies in the Mingus Mill millrace. Even other arthropods are parasitic on biting flies. Parasitic mites were discovered feeding on mosquitoes in the Park. Overall the symbiotic fauna associated with biting flies is diverse and under-reported. All of this points to the possibility for a richer fauna in the more diverse groups like Coleoptera or Hymenoptera to exist.

I urge anyone working under a valid permit in the Park who encounters biting flies to collect them. I am very interested in examining any fly that bites you or animals you are working with. We know very little about the feeding habits of biting flies on wildlife; even amphibians are preyed upon by some species of mosquitoes and screw- worms. With the growing interest in West Nile Virus and other insect-transmitted pathogens, the results of our research will be useful in understanding wildlife and human diseases in the Park.

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Leeches of Great Smoky Mountains National Park

William Moser and Donald J. Klemm

Readily recognized by their segmented bodies and suction discs, leeches are an interesting and diverse monophyletic group within the Phylum Annelida, Subphylum Clitellata. The word "leech" is derived from the Anglo-Saxon *loece*, "to heal," in reference to the early bloodletting practices of western medicine. However, the name usually brings reactions of disgust and fear, due to the voracious blood-feeding habits of a few species. In actuality, leeches exhibit a diverse range of feeding strategies. Approximately half are host-specific vertebrate blood-feeders and the other half feed on invertebrate tissue and/or body fluids. Leeches are an important component of ecosystems. They serve as indicators of water pollution and often are top predators. However, they are often ignored or identified only as "leech" in many analyses which limits their utility as indicators. Identification keys are available, and specimens are easy to identify to family, genus, and species.

Leeches are hermaphroditic (possessing both male and female sex organs), deposit eggs within a cocoon that is secreted by the clitellum, have direct development of the young (i.e. no larval stage) and a fixed number of body segments. Based upon their digestive anatomy, leeches are further divided into two Orders: leeches with a muscular pharynx with or without teeth and jaws (Arhynchobdellida); and leeches with a protrusible proboscis (Rhynchobdellida). There are approximately 600 described species world-wide inhabiting freshwater, marine and terrestrial ecosystems from the marine waters of the North Pole to the Antarctic Ocean.

In North America, there are approximately 80 species of leeches with an estimated 37 species in the Southern Appalachians (Northern Georgia, North Carolina, South Carolina and Tennessee). **To date, we have found 8 species new to Great Smoky Mountains National Park.** In the Park, there are leeches that blood-feed on fish (uncommon), frogs, salamanders, and turtles or consume invertebrate body fluids or tissue (including the possibility of 2 terrestrial leech species that eat earthworms and can be found underneath rotten logs). Contrary to popular belief, collecting leeches is not just a passive sport. Leeches are readily collected underneath submerged substrata (e.g. logs, sticks, rocks) via dip-net, and bait traps. From May through August, Glossi-phoniidae (a family in the Order Rhynchobdellida) are readily found underneath submerged substrata. In this portion of their life history, they gather to breed and then brood their membranous cocoon full of eggs. The "parent" broods the eggs until they hatch and develop, and then takes its young to their first meal.

Contrary to popular belief, collecting leeches is not just a passive sport.

Field biologists in the Park who encounter leeches in the course of their studies are asked to collect and preserve them in 70% ethanol, taking appropriate field data. Fish leeches are especially uncommon and specimens would be significant finds.

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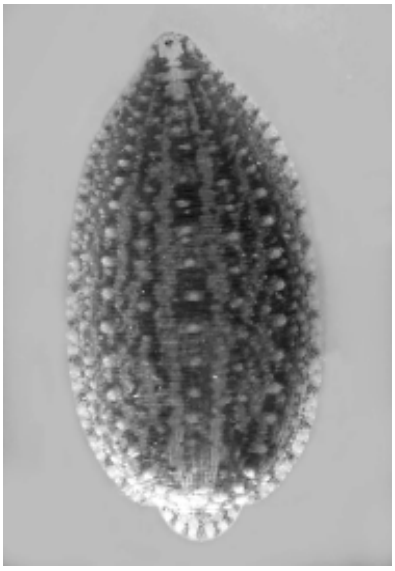
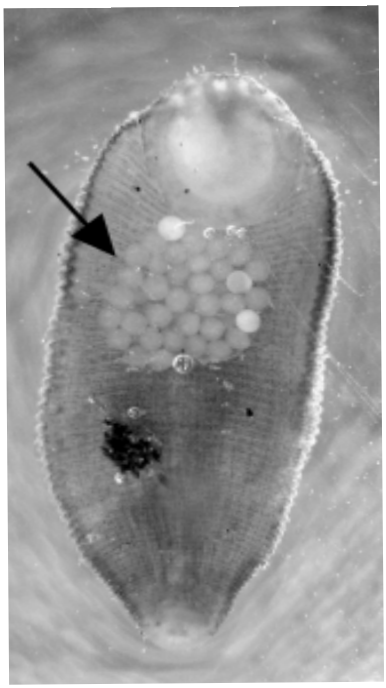


William Moser

Dorsal surface of *Placobdella papillifera* (turtle leech)



William Moser

Ventral surface of *Helobdella triserialis* (snail leech), brooding eggs

Underfoot and All Around

Ernest C. Bernard

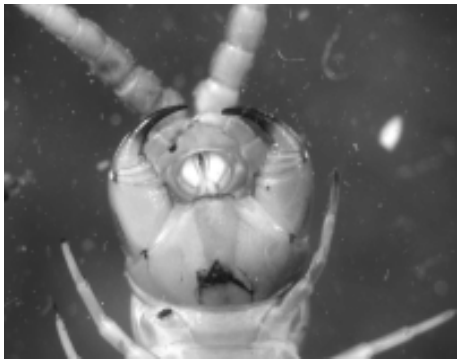


Fig. 1. Poison fangs of a 50-mm long scolopendrid centipede

Fig. 2. A japygid (*Metajapyx* sp.). Note the strong forceps-like cerci on the posterior on this 15-mm long specimen

Fig. 3. Pseudoscorpions (about 3 mm long) often move to new habitats by latching on to flies

Fig. 4. A tardigrade (1.5 mm long) consuming a soil nematode

I have been using the above phrase for a year or more to try to convey how completely surrounded we are by thousands of species, many unknown, regardless of where we are. A great mystery of the All Taxa Biodiversity Inventory in Great Smoky Mountains National Park is the actual number of arthropod species. Whereas vertebrates are well-enumerated, we have just foggy guesses on most arthropod Orders. A statement commonly heard before the ATBI really started rolling was, "We've got a good list of that Order, U. Seeum compiled it back in the 1960s." But Betty Doesnt quickly finds that the once-impressive list is missing many species because Seeum and his predecessors collected along roads during the tourist season and missed many important plant associations. So it is playing out in projects that Chuck Parker and I are now heading. For instance, Matt Petersen's ongoing study of crane flies (Tipulidae), a supposedly well-documented group in GRSM, has yielded numerous new Park records and several new species, including one more than an inch long. Since the larvae of many Tipulidae are terrestrial, they must have considerable specialization for different microhabitats, of which almost nothing is known in GRSM.

Detrital food webs in temperate mixed forests are exceedingly complex, and so we can expect to find different species arrays at each node. Each species occupies a unique multidimensional niche comprised of food source, space, soil pore size, moisture, seasonality, and so forth. Thus, in a single litter sample we will find numerous predator taxa, each specializing in prey of a certain size or type. At the top end are scolopendrid centipedes, some several inches long, which possess powerful poison fangs (FIG 1) for attacking beetles, millipedes, and spiders. All spiders and many beetles themselves are predacious, but they tend to use smaller and softer prey, such as insect larvae among the larger beetles, and springtails and diplurans among the smaller beetles. Japygids have powerful pinching cerci for manipulating any soft-bodied prey they can catch (FIG 2). Pseudoscorpions (FIG 3), less than 5 mm long, are specialists on small Collembola and other tiny arthropods. Mites, tardigrades (FIG 4), and predacious nematodes all feed on soil nematodes, the most abundant invertebrates on earth. Enumerating the biota of the Park will enable us to understand niche breadths and provide at least a qualitative understanding of species interactions.

Unexpected pleasures for the eye also can be found among the humble inhabitants of soil and litter. In preservative, a common Smokies springtail, *Tomocerus elongatus*, is light yellow with thin purple marginal stripes, because its dense scales are instantaneously dislodged by immersion. But if live specimens are collected and maintained in culture until they molt, a breathtakingly beautiful animal appears (FIG 5), as splendidly and intricately patterned as any butterfly, with bold stripes, checkerboard patterns, and shimmering iridescence. As much as good data, such unexpected delights make these projects worthwhile.

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Fig. 5. Newly molted *Tomocerus elongatus* (3 mm long), showing brilliantly contrasting white stripes and spots

Paul Super

GSMIT students Erin Henegar and Meredith Jagger labelling beetles

Tremont Students

Erin Henegar and Meredith Jagger

Spending one's summer in a national park sure beats flipping burgers at a fast food establishment! Although we were not quite sure what to expect from our jobs, we have certainly enjoyed our experiences made possible by a Discover Life in America grant to the Great Smoky Mountains Institute at Tremont (GSMIT). One of this summer's focuses for the ATBI was to identify as many beetles as possible living in the Smoky Mountains. The Beetle Blitz greatly aided this endeavor by bringing experts and volunteers together for a four-day intensive search. During the blitz, we had the privilege of assisting M. and Mme. Dajoz, a French ecologist and his wife, in their investigation of the old-growth forest beyond Laurel Falls. The other areas we searched included: Cove Mountain Trail, Abrams Creek, Foothills Parkway, and Roaring Fork Motor Nature Trail. We offered many explanations about our beetle collecting to curious Park visitors, many of whom voiced support of the effort.

Besides the Beetle Blitz, our ATBI duties include many activities at GSMIT. Weekly, we set out pollinator traps and collected bee specimens from different elevations. A refrigerator moth trap is also set regularly; on one occasion, we aided in identifying 45 species of moths. Paul Super, the Tremont Science Education Specialist, was instrumental in directing our efforts this summer. We would like to thank Paul Super and the DLIA organization for allowing us the opportunity to work in and learn more about the Park.

Erin Henegar and Meredith Jagger
GSMIT-ATBI Research Assistants

July 2001 Beetle Blitz Photo Album

Kevin Fitz Patrick

ATBI Beetle Blitz Volunteers

Rebecca Shiflett

Upward Bound students observing

Rebecca Shiflett

Dave Wagner and students examining specimens

Rebecca Shiflett

Mike Thomas and students sorting

ATBI-DLIA Annual Conference

November 28-December 1, 2001

The Glenstone Lodge, Gatlinburg, Tennessee

Presenting Discoveries of Life in Great Smoky Mountains National Park

The National Park Service, Great Smoky Mountains Natural History Association, Discover Life in America, and Friends of the Smokies

Conference Featured Speakers

Michael J. Donoghue - G.E. Hutchinson Professor in Yale University's Department of Ecology and Evolutionary Biology

Michael Soukup - Associate Director of Natural Resource Stewardship and Science, National Park Service

General Schedule:

Wednesday, November 28 - *Photography Workshop
1:00 pm to 10:00 pm
Thursday, November 2 - General Sessions and Guest Speakers
8:00 am to 5:00 pm
Reception, Musical Jam Session, Biodiversity Auction
6:00 pm to 10:00 pm
Friday, November 30 - General Sessions and Guest Speakers
8:00 am to 5:00 pm
Saturday, December 1 - Discover Life in America Board Meeting
9:00 am to 12:00 pm

* Please register separately to Kevin Fitz Patrick <media3@gte.net>

Registration Form (Return to Jeanie Hilten, DLIA, 1314 Cherokee Orchard Rd., Gatlinburg, TN, 37738, or e-mail to Jeanie@discoverlife.org)

Name: _____

Address: _____

City: _____State: ____Zip: _____

Phone:_____e-mail: _____

(We offer this conference at no charge,
but are glad to accept donations . Contribution enclosed: _____)

Discover Life in America, Inc. is a non-profit organization

Biodiversity Auction

To be held at the ATBI Conference Thursday evening, Nov. 29 to benefit the 2002 Grant Program

What to Bring:

An item to donate to the auction that represents the taxa you work on, the institution you work for or that is somehow related to the All Taxa Biodiversity Inventory. Use your imagination and sense of fun. It can be a dragonfly pin, an old hand lens, a stuffed animal, a gift certificate to the Trout House, a back pack, field guides, a toy salamander, your favorite critter paperweight, a framed print, a bottle of exotic wine, etc. Look for things that will appeal to your colleagues. Humor is good. If you need suggestions call Emily Jones at (865) 453-2428 or e-mail fotsej@icx.net

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