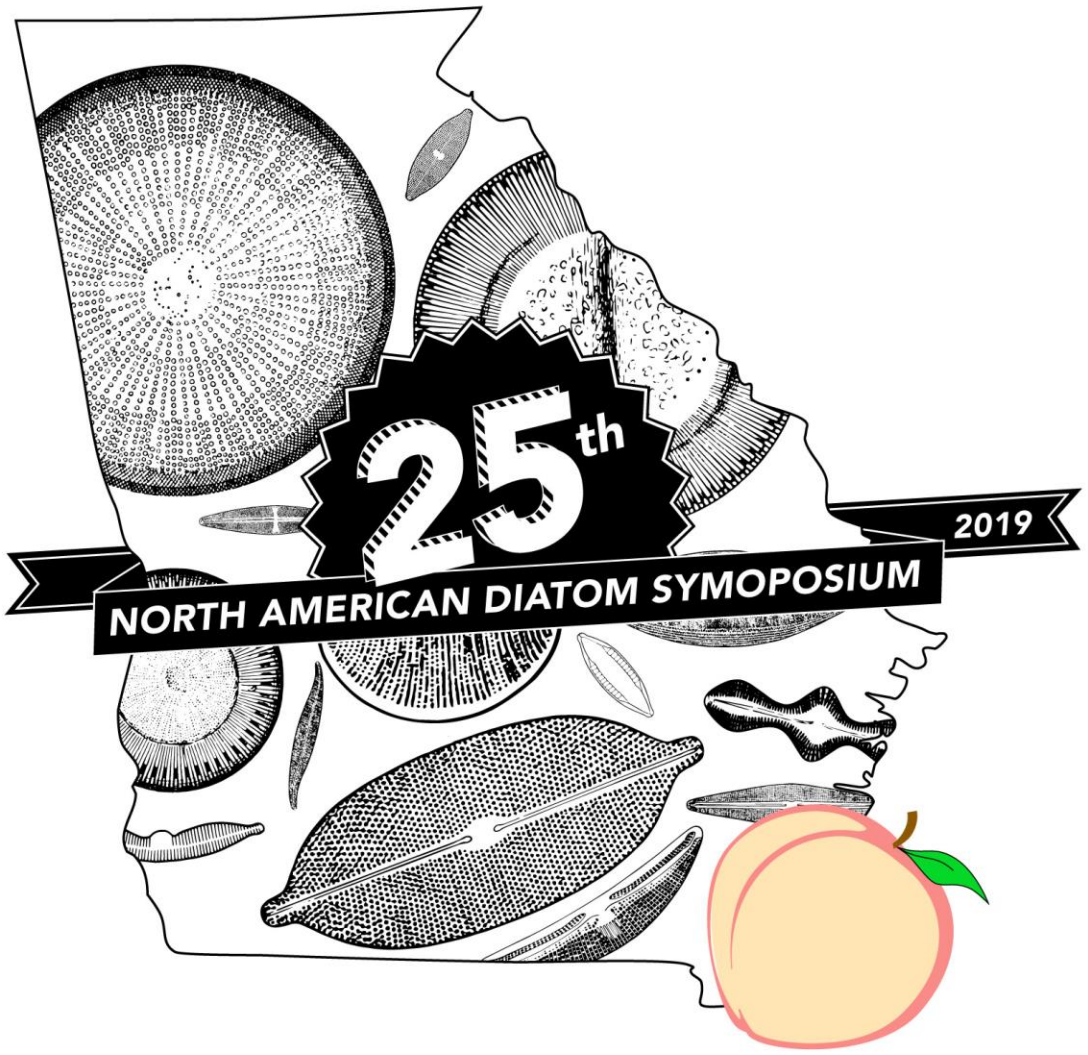

25th
2019
NORTH AMERICAN DIATOM SYMOPOSIUM

The North American Diatom Symposium: A Little History

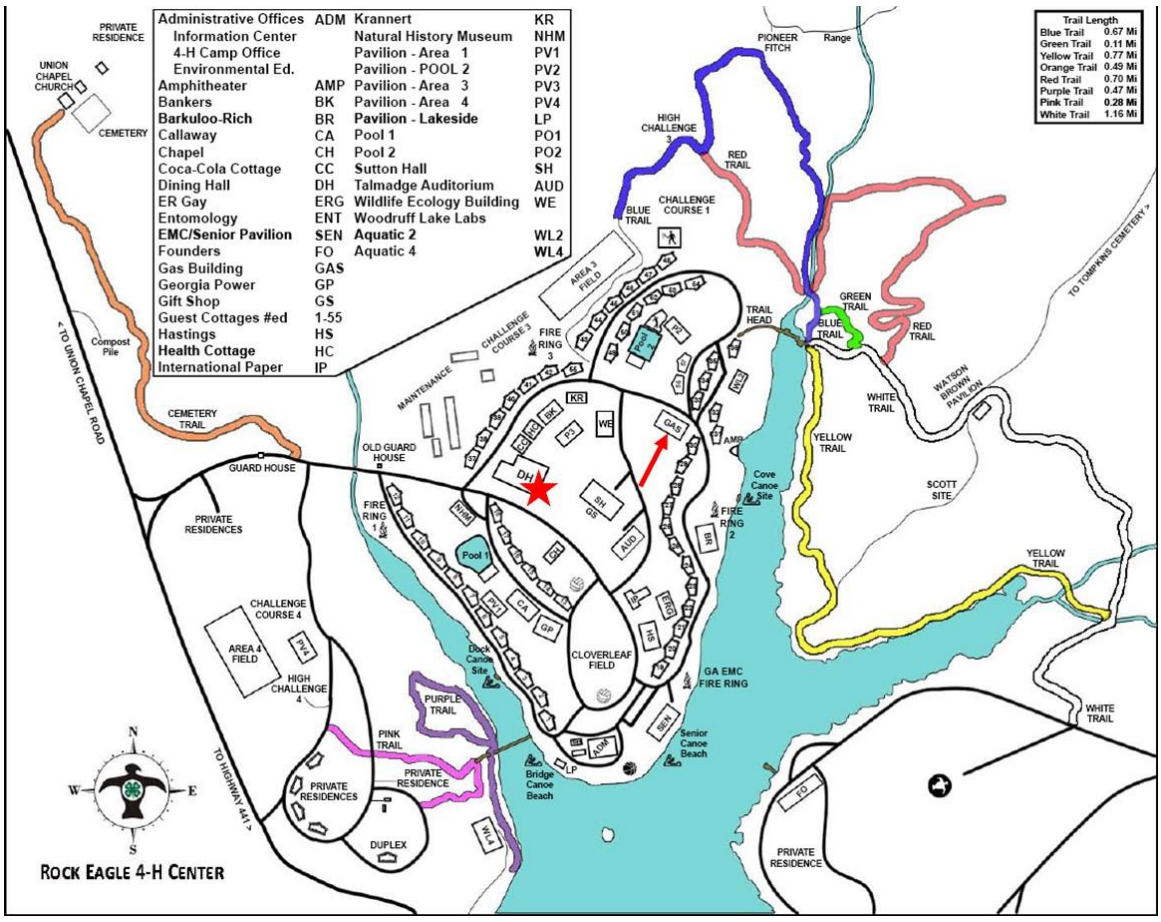
The North American Diatom Symposium (NADS) is a biennial meeting normally held at field stations throughout the United States and Canada. The meeting was first held in 1970 at Cedar Creek in Minnesota. Since that date, the gathering has been hosted at field stations in Florida, Colorado, Manitoba, Kentucky, Alabama, Ohio, Minnesota, Iowa, Wisconsin, and Michigan. NADS usually attracts 70-100 diatomists from North America and around the world. The meeting provides a student friendly atmosphere, ample opportunities to network and socialize, the ever-popular scum run, local field collecting trips, and lively auction of diatom related valuables. NADS is an informal society, that is, there are no formal officers or structure.

J. Platt Bradbury and Rick Drum organized the first NADS meeting. It was held in October 1970 at Cedar Bog Lake in central Minnesota (now the University of Minnesota's Cedar Creek Ecosystem Science Reserve). The site is notable for being the location of study for R. L. Lindeman's classic paper "The trophic-dynamic aspect of ecology. Ecology 23:399-418". The meeting was attended by 23 diatomists. After several days of discussion with no formal papers the group sat in a circle and talked about diatom ecology. This resulted in a paper (Bradbury, J. P. 1973. Ecology of freshwater diatoms. Nova Hedwigia. 24:145-168.), that was essentially a verbatim record of that conversation.

This meeting provides the opportunity to catch up with colleagues and talk to some of the foremost diatom researchers in a beautiful, natural setting, offered by the field station atmosphere that has become a tradition at the symposium.

About Our 2019 Venues:
University of Georgia Rock Eagle 4H and Georgia College and State University

Rock Eagle 4-H Center Is the largest of the five centers operated by the University of Georgia, is located in Eatonton, Georgia, adjacent to the Oconee National Forest. With nearly 1,500 acres of forested land, a 110 acre lake, and state-of-the art cabins and conference facilities, Rock Eagle provides a unique and natural setting. Thousands of young people annually participate in the Georgia 4-H Environmental Education and Summer Camp Programs. 4-H'ers from around the state attend competitive events, leadership conferences and rallies at Rock Eagle and civic, religious and business groups utilize the center for conferences and meetings. https://georgia4h.org/4-h-centers/rock-eagle-4-h-centers/



For the 25th NADS

Registration: proceed to the GAS building (long red arrow); Note: all presentations, posters, coffee breaks, book displays, microscopes and mixers will be in the GAS building

Breakfast, Lunch and Dinner will be in the Dining Hall (DH, red star)

Accommodation: room assignment for buildings 49 to 53 will be provided at registration

About Georgia College and State University (Georgia College, GCSU)
From its founding as a women's educational center in 1889, GCSU has consistently been a destination for students looking to make a difference in the world. This is Georgia's designated public liberal arts university. More importantly, GCSU teaches every student how to learn; and strives to instill a lifelong passion for learning that serves students well. Georgia College is nationally preeminent public liberal arts university where a practical education meets life-altering, real-world experiences.
https://www.gcsu.edu/about

Georgia College is located in **Milledgeville, Ga** (#5 Coolest Small Town in America 2019
https://www.budgettravel.com/video/coolest-small-towns-america-2019?fbclid=IwAR0BhCqwrLPB5TU6BYUmqQG6Sx7VEYzPE-CwXawyQ5XUsIMPUREUDK4bVHg) Conveniently situated between Atlanta and Savannah, Milledgeville is the former Georgia state capital and a charming southern town that seamlessly balances historical pre-Civil War roots and the modern role of hosting the state's only designated public liberal arts university. Literary enthusiasts will enjoy a visit to Andalusia Farm, the home of Flannery O'Connor. Outdoor enthusiasts will enjoy kayaking the Oconee River, pontooning on Lake Sinclair, or bicycling and walking along the many greenway paths that run beside the river.

Georgia's Old Governor's Mansion
Milledgeville, Ga was the capitol city with the seat of government for the State of Georgia from 1807 to 1868. **Georgia's Old Governor's Mansion** was completed in 1839, Georgia's Old Governor's Mansion is one of the finest examples of High Greek Revival architecture in the nation. During the Civil War, the Mansion was claimed as a "prize" in the "March to the Sea," when General William T. Sherman headquartered in the building on November 23, 1864. Following the war, Georgia's capitol was relocated to Atlanta, and the Mansion was abandoned. Given over to Georgia Normal & Industrial College (currently known as Georgia College) in 1889, the Mansion served as the founding building of the institution and is the campus's most treasured structure. Georgia's Old Governor's Mansion was designated a National Historic Landmark in 1973 and is an accredited museum of the American Alliance of Museums. In 2015, the Mansion was named an affiliate of the Smithsonian Institution.
https://www.gcsu.edu/mansion

The NADS Organizing Committee for 2019:
University of Georgia Rock Eagle 4H, and Georgia College and State University

Kalina Manoylov
Georgia College and State University
Co-Organizer for NADS 2019

James Nienow
Valdosta State University
Co-Organizer for NADS 2019

Paula Furey
Saint Catherine University

Jeffrey Johansen (treasurer)
John Carroll University

Organizing committee members for NADS 2019

Rebecca Bixby
University of New Mexico

Mark Edlund
St Croix Watershed Res. Sta.
Science Museum of Minnesota

Julie Wolin
Cleveland State University

Scum-Run and NADS Auction Organizers for NADS 2019

Sarah Hamsher
Grand Valley State University
NADS Webmistress

Student Organizers:
Katie Johnson (Georgia College and State University)
Maggie Blackledge (Georgia College and State University)
Kelsey J. Solomon (The University of Georgia)

Logo and t-shirt design is a collaborative between Maggie Blackledge (Georgia College and State University), Meredith Emery (Florida International University) and Alex Braidwood (Iowa Lakeside Lab and Iowa State University).

The NADS Sponsors for 2019:
University of Georgia Rock Eagle 4H, and Georgia College and State University

GCSU Office of the Provost
GCSU MURACE Office
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Individual sponsors:

Dr. Rex Lowe
Dr. Andy Bramburger
Dr. Robert Pillsbury
Dr. Richard Gordon
Michael K. Hein

Auction, Auction - Don't forget NADS Auction Friday night - bring your items to help raise money for our students.
Proceeds help out with student travel, and everyone has something they can donate! Diatom and algae memorabilia, that extra copy of P&R'75, a bottle of wine or six pack from your local microbrew/vineyard, your best homebrew, art and handmade crafts, t-shirts, books and reprints. We think we've seen it all, but I bet you can bring something different that someone will take home. Bid early, bid often, and please bring cash or check

The NADS Program for 2019: University of Georgia Rock Eagle 4H, and Georgia College and State University

7/31/2019 Wednesday -- Arrival, registration at the GAS building 14:00 to 20:00; there will be refreshments and light finger foods; mixer at 20:00 GAS building

8/1/2019 Thursday

7:30–8:30 ***Breakfast at Dining Hall***

8:30 Manoylov/Nienow Welcome

Session 1 Taxonomy and uses of diatoms for bioassessment

Moderators Katie Johnson and Kristin Briggs

8:40–9:00 Hixson, J. et al. HOW TO TRAIN YOUR DIATOM: INDUCING A DIATOM BLOOM TO DISPLACE HARMFUL ALGAL BLOOMS

9:00–9:20 Massa, E.M. & E. Gaiser EFFECTS OF PHOSPHORUS ON BENTHIC DIATOM ASSEMBLAGE NETWORK STRUCTURE

9:20–9:40 Kristan, N.V. et al. DIATOM GENUS *PLANOTHIDIUM* FROM STREAMS AND RIVERS IN CALIFORNIA (USA): DIVERSITY, DISTRIBUTION AND AUTECOLOGY

9:40–10:00 Solomon, et al. EFFECTS OF RIPARIAN RHODODENDRON REMOVAL AND TOP-DOWN CONTROL BY CRAYFISH ON DIATOM COMMUNITY STRUCTURE IN SOUTHERN APPALACHIAN STREAMS

10:00–10:20 Foster, H. &. Chraibi, V. THE DEVELOPMENT OF A DIATOM-BASED INDEX OF BIOTIC INTEGRITY TO ASSESS WATER QUALITY OF TEXAS STREAMS IN COMPLIANCE WITH THE NATIONAL RIVER AND STREAMS ASSESSMENT

10:20–10:30 ***Coffee break***

10:30–11:30 **PLENARY Cantonati, M.**
MULTIPLICITY, CHARACTERISTICS, MAIN IMPACTS, AND STEWARDSHIP OF NATURAL AND ARTIFICIAL FRESHWATER ENVIRONMENTS: THE BENTHIC DIATOM PERSPECTIVE

11:30–12:30 ***Lunch***

Session 2 Ecology, paleoecology and taxonomy

Moderators Eric Massa and Jase Hixon

12:40–13:00 Lee, et al. LITERATURE-BASED SYNTHESIS OF NUTRIENT STRESSOR-RESPONSE RELATIONSHIPS TO INFORM ASSESSMENT, MONITORING, AND CRITERIA DEVELOPMENT IN RIVERS AND STREAMS

13:00–13:20 Tang & Stevenson REVISITING THE RELATIVE IMPORTANCE OF NATURAL AND ANTHROPOGENIC FACTORS AFFECTING DIATOM SPECIES COMPOSITION IN STREAMS: NATURAL FACTORS ARE REALLY IMPORTANT

13:20–13:40 Alexson, et al. LAURENTIAN GREAT LAKES DIATOM TAXONOMY CHALLENGES

13:40–14:00 Reavie, E & M. Cai DO INDIVIDUAL DIATOM SPECIES REFLECT SPECIFIC STRESSORS**?**

14:00–14:20 Edlund, et al. A PALEOLIMNOLOGICAL PERSPECTIVE ON LAKE RECOVERY: FORTY YEARS AND COUNTING

14:20–14:40 Gordon, R., Merz, C. et al. BUBBLE FARMING: SCALABLE MICROCOSMS FOR DIATOM BIOFUEL PRODUCTION

14:40–15:00 Charles & Roman THE NEOTOMA PALEOECOLOGICAL DATABASE AS A RESOURCE FOR ADDRESSING LARGE SCALE ECOLOGICAL CHANGE ISSUES

15:00–15:20 Stone, J.R. et al. A HOLOCENE RECORD OF EVOLUTION IN DIATOM MORPHOLOGY FROM CUMBRES BOG (COLORADO, USA)

15:20–15:40 Wolin, et al. DIATOM RESPONSE TO PALEOCLIMATE DRIVEN DUNE ACTIVITY ALONG THE LAKE MICHIGAN SHORELINE

15:40-16:00 Coffee break

16:00–17:30 **POSTERS**- presenters of posters with **odd numbers** should be at poster between 16:00 to 16:40; **even numbers** 16:40 to 17:20; poster numbers shown on page 50 in program

17:30–18:30 ***Dinner***

18:40–21:00 **Diatom certification committee:** Lee, Edlund, Stevenson *et al*. Diatom taxonomic exam certification preparation; other discussions

21:00 Discussions and Mixer GAS building

8/2/2019 Friday

7:30–8:30 ***Breakfast***

8:40 **Session 3 Molecules and novelty ideas**
Moderators: Breena Riley and Kala Downey

8:40–9:00 Allen and Chraibi BIODIVERSITY OF THE BACK FORTY

9:00–9:20 Spanbauer, T. et al. CHLOROPLAST GENOMES OF CLOSELY RELATED *STEPHANODISCUS* SPECIES AND POPULATIONS: TOWARDS A PHYLOGEOGRAPHY

9:20–9:40 Card, V.M. DOES BREAKING STRENGTH CONSTRAIN VARIATION IN VALVE MICROMORPHOLOGY AMONG COSCINODISCOIDS?

9:40–10:00 Sethna, et al. EXPLORING SILICA LIMITATION OF DIATOMS WITH A NUTRIENT DIFFUSING EXPERIMENT IN A HEADWATER STREAM IN INDIANA

10:00–10:20 Roberts and Alverson WHOLE GENOME SHOTGUN PHYLOGENOMICS IN THE THALASSIOSIRALES

10:20–10:30 ***Coffee break***

10:30–1130 **PLENARY Alverson, A.**
DIATOM EVOLUTION THROUGH THE LENS OF LARGE TRANSCRIPTOME, TRAIT, AND TAXONOMIC DATA SETS

11:30–12:30 ***Lunch***

12:40- 14:00 Individual preparation for Taxonomy examination

14:00–16:00 **Taxonomy certification exam** (you will need a laptop)

16:00–16:20 ***Coffee break***

16:30 Get on busses and leave for GCSU Governor's mansion, Milledgeville GA
17:00 Mansion guided tours (2 groups (last name starting with *A to M at 17:00*, and *N to Z* at 17:30)
18:00 **Old Fashioned Barbecue *Dinner (sponsored by GCSU Provost Office)***
19:00 ****NADS Auction****
21:00 Buses depart back to UGA rock Eagle campus
21:30 Discussions and mixer GAS building

8/3/2019 Saturday

7:30–8:30 ***Breakfast***

8:40 **Session 4 Evolution, Physiology and development**
Moderators: Wade Roberts and Meredith Emery

8:40–9:00 Riley, B. et al. PHOTOSYNTHESIS TO RESPIRATION RATIOS AND DIATOM ASSEMBLAGES ALONG STREAM LENGTHS IN NORTHERN SWEDEN

9:00–9:20 Gillard, J. et al. THE IMPACT OF DISSOLVED AMINO ACIDS ON THE PHYSIOLOGY AND ECOLOGY OF THE MODEL DIATOM *PHAEODACTYLUM TRICORNUTUM*

9:20–9:40 Woolam, L. et al. A DIATOM-BASED WATER QUALITY METRIC FOR TEXAS STATE-THREATENED MUSSELS: MESOCOSM EXPERIMENTS AND FIELD APPLICATIONS

9:40–10:00 Outridge, Stern, Hamilton, P. & Sanei ALGAL SCAVENGING OF MERCURY IN PREINDUSTRIAL ARCTIC LAKES

10:00–10:20 Ashworth, M. et al. ON THE SHOULDERS OF GIANTS: WHAT EPIZOIC DIATOMS ARE TEACHING US ABOUT DIATOM EVOLUTION

10:20–10:30 ***Coffee break***

10:30–11:30 **PLENARY Schoefs,** B.
REGULATION OF THE METABOLIC SHIFT TOWARD LIPID ACCUMULATION IN THE DIATOM *PHAEODACTYLUM TRICORNUTUM*

11:30–12:30 ***Lunch***

12:40 **Session 5 Taxonomy and ecosystem ecology**
Moderators: Kristy Sullivan and Lienne Sethna

12:40–13:00 Mazzei, V. et al. COMMUNITY-LEVEL MODELING OF PERIPHYTIC DIATOMS IN RESPONSE TO SEA LEVEL RISE USING THE EVERGLADES LANDSCAPE MODEL

13:00–13:20 Davis, C. & Sullivan, S. EMERGING RECOGNITION OF *NITZCHIA SORATENSIS* (MORALES AND VIS 2007) IN WATERS OF THE USA

13:20–13:40 Gaiser, E. et al. COMPARING THREE METHODS FOR DETERMINING PHOSPHORUS THRESHOLDS FOR EVERGLADES DIATOMS

13:40–14:00 Hains, J. COMPARISON OF DIATOMS OF TWO MONTANE LAKES IN THE COMMONWEALTH OF DOMINICA, WEST INDIES, AND STATUS FOLLOWING HURRICANE MARIA

14:00–14:20 Frankovich, T. et al. THE EPIZOIC GENUS *TURSIOCOLA* ON SEA TURTLES AND CETACEANS

14:20–14:40 Genter, B. DIATOM COMMUITY COMPOSITION CHANGES AS COPPER CONCENTRATION INCREASES AMONG FRESHWATER STREAMS IN THE METAL-RICH BASIN OF THE ELIZABETH MINE, VERMONT, USA.

14:40–15:00 Van De Vijver**,** B. et al. PRONOUNCED GEOGRAPHIC STRUCTURING AND ENDEMISM IN FRESHWATER DIATOMS OF THE ANTARCTIC REALM

15:00–15:20 Furey, P.C. MOTILITY IN *EUNOTIA*: WHAT CAN A REDUCED RAPHE DO FOR YOU?

15:20–16:00 ***Coffee break*** (remove posters)

16:00-17:20 Scum run

17:30–18:30 ***Dinner***
18:40–19:40 Taxonomic certification committee brief and feedback
20:00 Discussion Mixer Reception GAS building

8/4/2019 Sunday

7:30–8:30 Continental breakfast
8:30-10:00 Departures and shuttle to airport (checkout is at 10:00 AM)

ORAL PRESENTATIONS WILL BE 15 MINUTES PLUS 5 MINUTES QUESTIONS AND ANSWERS; PLENARY TALKS ARE 45 MINUTES WITH 15 MIN DISCUSSION AND QUESTIONS AFTER

LAURENTIAN GREAT LAKES DIATOM TAXONOMY CHALLENGES

Elizabeth E. Alexson, Holly A. Wellard Kelly, Meagan N. Aliff, Euan D. Reavie, Lisa R. Estepp
Natural Resources Research Institute, University of Minnesota Duluth

Diatoms have played an important role in the management of the world's largest freshwater lake resource. Most of the early work on Laurentian Great Lakes diatoms was initiated by Gene Stoermer, Julie Wolin, and Claire Schelske as part of paleolimnology programs and other collections. The USEPA's Great Lakes National Program Office (GLNPO) pelagic long-term monitoring program has been observing diatom populations in the Laurentian Great Lakes since 1983 as part of a larger effort to better understand the lower food web. Despite previous work, diatom taxonomy in the Great Lakes remains challenging. Since 2007, we have been trying to sort out taxonomic problems and align our taxonomy with past analysts to allow for a continuous record of diatoms and other phytoplankton in the Great Lakes. Unfortunately, analyst artifacts and confusion around the taxonomy of cosmopolitan species (e.g. *Cyclotella sensu lato*, *Synedra sensu lato*, *Stephanodiscus* spp.) remain prevalent. We are now attempting to address these issues by re-analyzing archived samples from earlier GLNPO cruises and closely examining species complexes and other enigmatic taxa using microscopic imagery and morphometric analysis. Recently, we examined a group of small cyclotelloids and confirmed an undescribed species, *Pantocsekiella laurentiana* sp. nov., that is prolific in summer assemblages, especially in warmer, stratified surface waters that have been responding to recent atmospheric warming. Now, we are investigating several common species of *Synedra*: *Synedra radians*, *Synedra ostenfeldii*, and *Synedra filiformis* and its questionable variety *exilis*. SEM and LM imaging along with a morphometric analysis were conducted on samples collected aboard the EPA's R/V *Lake Guardian* from all Great Lakes. Analyses reveal differences in valve morphology that allow us to distinguish the species and provide documentation of these difficult, yet abundant, species.

BIODIVERSITY OF THE BACK FORTY

Lane J. Allen, Victoria L.S. Chraibi
Department of Biological Sciences, Tarleton State University, Stephenville, TX 76402, USA

The freshwater algae present in the southern U.S. are understudied. This project is a flora voucher documenting the algae found in a small farm pond in Bowie County, Texas. The diatom assemblage is currently in the process of being identified. A species of *Stauroneis* closely resembling *S. baconia* has been identified, however the specimens display several features that suggest it may be an undescribed species. If it is *S. baconia,* it will extend the described range of this species by approximately two thousand miles. There are also several genera with a notably large diversity of species of *Eunotia*, *Cymbella,* and *Pinnularia*. The diatoms are part of a diverse algal community: several species of desmid in the genera *Micrasterias*, *Staurastrum,* and *Closterium* have been identified. In addition, the rare freshwater genera *Glaucocystis* and *Parallela* have been identified. Other heterokonts in the phylum Ochrophyta are present, including *Rhipidodendron splendidum, Mallomonas* and two species in the genus *Synura*. A species of dinoflagellate in the genus *Peridinium* is also present. In addition to a wide variety of phytoplankton there is also an interesting collection of fauna including *Stentor,* copepods, *Daphnia, Hydra, Vorticella, Amoeba,* and tardigrades. Vertebrates present in the pond include several species of *Lepomis* as well as the aquatic salamander *Siren intermedia*. This project is largely a labor of love but documenting the microflora of these systems has significance for understanding the ranges and preferred conditions of aquatic flora and fauna. Flora vouchers are crucial for the conservation of rare and endangered species. There is as much wonder in a drop of pond water as any grassland or forest.

PLENARY: DIATOM EVOLUTION THROUGH THE LENS OF LARGE TRANSCRIPTOME, TRAIT, AND TAXONOMIC DATA SETS

Teofil Nakov, Elizabeth C. Ruck, Jeremy M. Beaulieu, **Andrew J. Alverson**
Department of Biological Sciences, University of Arkansas, Fayetteville, AR USA

Despite their species richness and global importance as primary producers and anchors of aquatic food webs, the primary evolutionary drivers of diatom diversification remain poorly known. We are undertaking two parallel efforts to better understand the phylogeny, diversification, and ecological history of diatoms. The first effort builds upon a growing genomic and transcriptomic dataset for diatoms. We used hundreds of molecular markers to resolve parts of the diatom tree that have presented a challenge for analyses based on fewer markers. Similarities in clade age, species richness, and primary production motivate comparisons between diatoms and flowering plants, whose genomes have been inordinately shaped by recurrent whole genome duplications (WGDs). We used a broadly sampled genomic and transcriptomic dataset to show that WGD may have played a similarly important role in the evolution of diatom genomes. A second, complementary effort compiled all publicly available DNA sequence data for 11 genes and >1100 diatom taxa. We used this densely sampled phylogeny to better understand patterns of character evolution, habitat shifts, and species diversification. Results from this project are providing new insights into the historical importance of transitions between the plankton and benthos and marine and freshwaters. They further highlight that shifts in the mode of sexual reproduction and the evolution of active motility set in motion a species radiation that produced the majority of present-day diatom diversity.

ON THE SHOULDERS OF GIANTS: WHAT EPIZOIC DIATOMS ARE TEACHING US ABOUT DIATOM EVOLUTION

Matt P. Ashworth[1], Thomas A Frankovich[2], Michael J. Sullivan[3], Roksana Majewska [4,5], Sunčica Bosak[6], Bart Van de Vijver[7,8], Mike Arendt[9], Jeff Schwenter[9], Nicole I Stacy[10], Schonna R Manning[1]

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[2] *Florida Bay Interagency Science Center, Florida International University, Key Largo, Florida, USA*
[3] *Madison, Mississippi, USA*
[4] *School of Biological Sciences, North-West University, Potchefstroom, South Africa*
[5] *South African Institute for Aquatic Biodiversity (SAIAB), Grahamstown, South Africa*
[6] *Department of Biology, University of Zagreb, Zagreb, Croatia*
[7] *Department of Bryophyta and Thallophyta, Botanic Garden Meise, Meise, Belgium*
[8] *Department of Biology, University of Antwerp, Wilrijk, Belgium*
[9] *Department of Natural Resources, South Carolina, USA*
[10] *Large Animal Clinical Sciences, University of Florida, Gainesville, Florida, USA*

Our knowledge and understanding of diatom diversity, diversification and evolution increases with every collection made from benthic marine habitats. In recent years, one such habitat has been the body surfaces of sea turtles and manatees. This habitat has yielded much new data, particularly on taxa historically associated with the Rhoicospheniaceae. For example, we have found both photosynthetic and non-photosynthetic species of the genus *Tursiocola* Holmes, Nagasawa & Takano. This is the first reported non-photosynthetic diatom which does not appear to be associated with the order Bacillariales. The morphology of *Tursiocola* suggests no affinity to the Bacillariales, and DNA evidence, collected by single-cell DNA amplification techniques, confirmed that the loss of photosynthesis in *Tursiocola* was novel and unrelated to losses in the Bacillariales. The DNA sequence data also question the placement of *Tursiocola* and the epizoic diatoms *Poulinea* Majewska *et al.* and *Chelonicola* Majewska *et al.* in the Rhoicospheniaceae, suggesting that these genera are quite distant genetically from other marine "gomphonemoid" (transapically asymmetrical) raphid diatoms. We are also exploring the potential of the epizoic habitat as a model system for benthic diatom diversification. Thus far, the ease and ubiquity of obtaining cultures of the monoraphid diatom genus *Achnanthes* Bory from manatees and multiple sea turtle species in the southeastern US suggests that this genus may be an ideal model to study not only the diversification of diatoms in the epizoic habit, but also across hosts.

THE RECENT HISTORY OF LAKE MICHIGAN, ACCORDING TO THE DIATOMS:

Andrew J. Bramburger and Euan D. Reavie
Natural Resources Research Institute, University of Minnesota Duluth. 1049 University Dr., Duluth MN 55812, USA

Among the Laurentian Great Lakes (LGL), Lake Michigan is the second largest by volume, and supports the highest human population (>12 million) within its drainage basin. The lake has been subjected to a wide variety of natural and anthropogenic stressors since European colonization, including expanding populations within the basin and associated land use change, eutrophication, industrial pollution, and more recently, a rapid expansion of invasive dreissinid mussels. Paleolimnological investigations of L. Michigan document the effects of these stressors on historical diatom communities. Metrics consistent with high productivity, including frustule accumulation rates and total biomass, as well as indicators of cultural eutrophication (e.g. *Tabellaria flocculosa*, *Synedra* spp.) peaked during the mid-20th century prior to implementation of mitigation measures associated with the Great Lakes Water Quality Agreement, and show evidence of recovery in recent decades. However, this mitigation signal is confounded by the effects of invasive dreissinids, which have caused a marked increase in diatom standing crops since the early 2000s. In recent decades, we have also observed the rise of taxa within the genus *Cyclotella sensu lato*, consistent with observations from other LGL and indicative of warming water temperatures and stronger stratification in the pelagic zone.

PLENARY: MULTIPLICITY, CHARACTERISTICS, MAIN IMPACTS, AND STEWARDSHIP OF NATURAL AND ARTIFICIAL FRESHWATER ENVIRONMENTS: THE BENTHIC DIATOM PERSPECTIVE

Marco Cantonati
MUSE—Museo delle Scienze, Limnology and Phycology Section, Corso del Lavoro e della Scienza 3, 38123 Trento, Italy; marco.cantonati@muse.it

The rationale of this talk is to briefly examine the ecological characteristics, conservation status, and main impacts suffered by the diverse types of freshwater habitats, and then illustrate these using selected benthic-diatom examples/case studies from my own research. Among the habitats that will be considered are: springs, glacial streams, high-mountain lakes and reservoirs, mires, large lakes, lowland ditches and modified springs, saline and desert springs, tropical running waters, streams in geographic areas with Mediterranean climate. The examples/case studies will include: a diatom species indicating spring (crenal) conditions in carbonate headwaters, macroscopic growth of a hard-water diatom species in a limestone-precipitating spring (LPS), high-mountain mires as habitats exceptionally rich in diatom species included in threat categories of the Red List, the proportion of aerial diatom species as an indicator of environmental instability or of an extended land-water ecotone in springs, Swiss springs as refugia for sensitive and endangered species and the LIHRe (Least-Impaired Habitat Relicts) concept, the effects of nitrate deposition on spring diatom assemblages in different part of the Alps and in the Alps as compared to the Himalaya, diatom assemblages of springs recovering from past acidification as compared to those of extremely-low alkalinity but non-acidified springs, diatom indicators of water-level and discharge fluctuations in lakes (reservoirs) and springs, numerous putative invasive diatom species in anthropogenically modified lowland streams and springs and in fish-stocked oasis springs, salinization indicators in a shallow oasis lake, diatom species with a strict relationship to specific lithological/ hydrochemical types in springs and lakes, looking for the biogeography-effect by comparing diatoms from streams with the same environmental conditions but of geographically distant areas with the same climate, species replacement due to moderate nutrient enrichment in tropical streams. A closing discussion will briefly address benthic-diatom based assessments and biodiversity-inventorying in the multiplicity of inland-water habitats, and propose reflections on the risk of separating the two. It will be underpinned that species matter, and that only accurate, updated, and high-resolution species identification allows us to fully exploit the body of knowledge built up by environmental biologists in the last decades, and to meaningfully (and correctly) address ecological problems.

DOES BREAKING STRENGTH CONSTRAIN VARIATION IN VALVE MICROMORPHOLOGY AMONG COSCINODISCOIDS?

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The morphology of diatom valves varies distinctly among taxa in overall shape and size as well as in the internal structure of the siliceous cell wall. The high breaking strength of diatom valves may benefit cells by increasing their resistance to predation. If so, then maintenance of valve strength may act as a constraint on the variation of valve structure among taxa. To provide the same resistance to breakage, the valves of a larger cell of the same shape must be made of stronger cell wall. This study focused on members of the Coscinodiscales, which have an interesting 3-layered cell wall composed of a relatively thick central honeycomb core layer with large chambers (areolae) and two relatively thin face layers of porous solid (cribrum and basal layer). The mechanical properties of such sandwich panel structures vary based on the geometry of the layers. The hypothesis was tested through measurement of scanning electron micrographs (SEMS) of valves and valve fragments from several coscinodiscoid taxa from the UTEX Culture Collection of Algae. Valves ranged in diameter from small (18-22μm) to large (220-270μm), and core layers varied from 51% to 72% of the total wall thickness in the smallest cells to the largest cells (respectively) and basal face layers varied from 30% to 14%, in concordance with the hypothesis; however, the total thickness of the cell walls and the porosity of the core and basal layers did not vary consistently with cell diameter. These results suggest that valve strength alone is not the dominant factor affecting differences in valve structure among these taxa. It is also possible that the mechanical properties of the constituent composite material biosilica are different among the different taxa. Other factors that may be of even greater importance in determining valve structures for this group include the role of porosity and valve thickness in determining nutrient uptake rates and the role of pore size in protecting cells from attack by parasites such as watermolds and viruses.

THE NEOTOMA PALEOECOLOGICAL DATABASE AS A RESOURCE FOR ADDRESSING LARGE SCALE ECOLOGICAL CHANGE ISSUES

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Many ecological issues have been addressed using paleoecological approaches. Most focus on individual sites or smaller regions. Broader scale issues (e.g., climate change) can be addressed by combining paleoecological data for large geographic regions, but it is difficult to create combined datasets for this purpose. The Neotoma Paleoecology Database (www.neotomadb.org), a community-curated data resource supporting global change research, provides access to existing diatom paleoecological data for over 2000 sites. This presentation will summarize data currently available and show examples of how data can be acquired and used. Neotoma contains diatom counts, chronology, and water chemistry data for stratigraphic cores, surface sample calibration sets and top-bottom studies from sites in North and South America. Data can be found and downloaded using the Explorer application on the Neotoma website and the Neotoma R application. Neotoma can be used to explore and map distributions of individual or groups of taxa (e.g., complexes, ecological categories) representing current and past time intervals; it can generate stratigraphic diagrams that can be used to compare change in relative abundance of taxa at multiple sites over time and space (e.g., latitude and elevation). These tools and others can be used to address many questions, e.g., changes in cell size as a function of warming, change in wind-mixing / stratification patterns, change in nutrient concentrations, recovery from acidification and others. Another use of Neotoma is the ongoing effort to create a comprehensive dataset for the Northeast US for use by agency biologists in New England and nearby states to develop and test diatom metrics useful for lake management.

EMERGING RECOGNITION OF *NITZCHIA SORATENSIS* (MORALES AND VIS 2007) IN WATERS OF THE USA

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Nitzschia soratensis (Morale and Vis 2007) was first described from alpine streams in Bolivia, South America 12 years ago, then became widely recognized in central Europe in 2011, and reports appear to have emerged within the USA in 2015. Prior to recognition, specimens were likely reported as *Nitzschia inconspicua*. European field and lab studies of these two morphologically similar taxa have revealed important autecological similarities (e.g. indifference to phosphorus) as well as key differences (strictly freshwater vs wide salt tolerance). A preliminary review of multiple datasets indicates a very high occurrence (>14,000 records) of this complex in USA waters. In fact, this complex is the 3rd most commonly occurring taxon in samples we have analyzed from waters in Montana and Washington. Given the prevalence of this complex it seemed pertinent to consider the potential ramifications for past analysis (pre-2015) using the complex as well as moving forward with separating these two similar species. A preliminary analysis of our most recent western USA dataset shows a general prevalence of *N. soratensis* in waters of the Western Mountain ecoregions (EPA/NRSA), while *N. inconspicua* is prevalent in waters of the Northern Plains (EPA/NRSA). These results support the previous published suggestions that water conductivity/alkalinity, driven by watershed geology, is the primary environmental variable determining the distribution of these two taxa.

A PALEOLIMNOLOGICAL PERSPECTIVE ON LAKE RECOVERY: FORTY YEARS AND COUNTING

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Waters in the United States that are deemed impaired require plans for remediation; however, bringing lakes back from impairment is rarely straightforward. We used multiproxy paleolimnological analysis (dating, geochemistry, diatoms, fossil pigments) of sediment cores recovered from Bartlett Lake in northern Minnesota to determine the lake's environmental history of degradation and recovery. Bartlett Lake has a long history of degradation–logging, shoreline sawmills, and discharges directly to the lake by a creamer, primary treated sewage, and storm sewers–whose impacts caused Bartlett Lake to become hypereutrophic by the 1970s. In the late 1970s, most of the point source loadings were curtailed and the lake began the slow process of recovery. Our multiproxy analysis showed the lake underwent 70 years of degradation following Euroamerican settlement with dramatic restructuring of its diatom and cyanobacterial community, has continued to suffer from internal loading of legacy phosphorus (P), but that burial of P is slowly removing the legacy P in a process that has led to over 40 years of incremental lake recovery. Our estimates suggest that the lake will require between 10 and 20 more years to fully recover enough to meet current lake standards. Equally important in this study has been our efforts to communicate our findings to agency and local groups most affected and concerned by the lake's health and allowing them use fact-based results to weigh their options for remediating Bartlett Lake.

THE DEVELOPMENT OF A DIATOM-BASED INDEX OF BIOTIC INTEGRITY TO ASSESS WATER QUALITY OF TEXAS STREAMS IN COMPLIANCE WITH THE NATIONAL RIVER AND STREAMS ASSESSMENT

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Water pollution is increasing as water availability is decreasing in Texas, causing an immediate need for more and multi-pronged approaches to water quality monitoring. IBIs (Indices of Biotic Integrity) are a promising rapid method to assess water pollution levels, and some have been previously produced for urban streams in Texas, though small rural streams remain largely understudied. Diatoms are excellent candidates for an IBI due to their abundance, ubiquity, species-specific environmental optima, hardy silica-based frustule, and rapid generational turnover. These characteristics of diatoms allow for a more indicative process of detecting the long-term effects of environmental pollutants on a stream community. In Texas, prior National Stream and Rivers Assessment (NRSA) surveys have indicated potentially endemic species in the streams that were sampled; this suggests that creating voucher floras and an IBI of diatoms in more streams, particularly in rural areas, will strengthen the meaningfulness of NRSA assessments in the state. This study aims to develop an IBI for eighteen rural streams in north-central Texas. Rock and water samples were collected in spring and summer of 2018 to account for seasonal variability in the diatom assemblage. Water chemistry measurements for pH, DO, temperature, conductivity, and stream velocity were taken during sample collection and TN and TP were analyzed in lab settings. Diatoms were chemically digested and at least 300 diatom valves were counted on each slide and identified with the use of published literature. Community assemblage data will be calculated as percent abundance. A CCA (canonical correspondence analysis) will be used to visually represent the relationship between assemblage data and water chemistry data. The IBI will be constructed with the use of sensitivity values, indicator values, Trophic Diatom Index (TDI), Percentage Pollution Tolerant Value (%PTV), and Generic Diatom Index (GDI). An IBI for rural Texas streams would be beneficial because there is no routine monitoring of these streams and other established IBIs may be unable to accurately determine pollution values for these streams because of differing diatom assemblages or environmental stressors.

THE EPIZOIC GENUS *TURSIOCOLA* ON SEA TURTLES AND CETACEANS

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The epizoic diatom genus *Tursiocola* is rarely studied and for nearly two decades since its establishment in 1993 was known to consist of only 3 species, all exclusively occurring on cetaceans and therefore became referred to as members of the unique group of "whale diatoms" by diatomists. Since 2012, new species have been discovered and described from a freshwater turtle, manatees, and sea turtles, expanding the genus to 13 species. In order to better understand the distribution of these diatoms and evaluate the host-specificity of *Tursiocola* species, epizoic diatoms were sampled from the skin and carapace of six sea turtle species (loggerhead, green, leatherback, Kemp's ridley, olive ridley, and hawksbill), the skin of live bottlenose dolphins and from a stranded false killer whale. Detailed SEM observations and preliminary phylogenetic analyses indicate host specificity between larger vertebrate host animal groups (i.e., cetaceans, sea turtles, and manatees) and a shared distribution of *Tursiocola* species on various sea turtle hosts.

ASSESSMENT OF DIATOM POPULATIONS AS REPRESENTED IN THE SEDIMENTS OF AN ULTRA-OLIGOTROPHIC RESERVOIR

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This survey of sediment diatoms was performed for ultra-oligotrophic North Saluda Reservoir in the Blue Ridge Mountain Province of South Carolina, headwaters of the Santee River Basin. North Saluda Reservoir has an area of 17,000 acres and is characteristically low in conductivity, alkalinity and nutrients. Its waters are pristine – prior to July 2000, filtration of this source water was not required for drinking water treatment, reflected in its turbidity of an average of 1.2 NTU. The lake is in a protected watershed with no public access and no contaminant sources. I collected sediment samples from the lake near its maximum depth of 93 feet. Specimens were cleaned and mounts were prepared by me using conventional techniques. I identified more than 4000 valves with their taxonomic characteristics entered into a comprehensive database. The dominant genera observed were Aulacoseira, Cyclotella, Cymbella, Eunotia, Gomphonema, Navicula and Tabellaria. Most of these typify lakes with low alkalinity, but surprisingly, some of the taxa normally found in lakes and rivers in our region were absent. Missing, for example, were Eunotia zasuminensis, (Cabejszekowna) Korner, and Aulacoseira herzogii, (Lemmerman) Simonsen. This study was the first such sediment diatom assessment performed for this lake and lakes in the region and it will serve as a baseline for future assessments as the lake ages and the environment changes.

MOTILITY IN *EUNOTIA*: WHAT CAN A REDUCED RAPHE DO FOR YOU?

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Research on motility in diatoms often centers on motile groups with complex raphe systems, like those present in naviculoid or nitzschioid forms, whereas diatom taxa with reduced raphe systems, like those in the genus *Eunotia* Ehrenb., remain understudied. I review the current state of knowledge around movement in this weakly or slightly motile genus. Coverage of historical and current accounts of motility in a handful of *Eunotia* species reveals a variety of movement types that allow cells to move forward, pivot, and reorient to ventral-girdle view where raphe ends can connect with the substratum. The wide variation in growth form, overall valve morphology, location and shape of the raphe, and the number and location of rimoportulae likely drive patterns of movement across different species. The ability to move and to carry out different types of movements may influence resource interactions and habitat preferences. Examination of motility in *Eunotia* may provide unique insight into motility in diatoms overall, especially for raphid diatoms. Consideration of motility in *Eunotia* in the context of diatom evolution also reinforces the need for the inclusion of eunotioid taxa in studies on diatom motility. I pose directions for future study to increase knowledge around motility in *Eunotia* to help enrich understanding and provide novel insight into motility in diatoms as a whole.

COMPARING THREE METHODS FOR DETERMINING PHOSPHORUS THRESHOLDS FOR EVERGLADES DIATOMS

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Diatom-based detection of phosphorus enrichment in aquatic ecosystems has received decades of scientific attention, generating dependable methodologies for applying diatom-based tools in adaptive water quality management. In highly oligotrophic ecosystems, detecting low-level phosphorus exposure with high accuracy is essential to preventing undesirable, and in some cases, irreversible changes. Here we compare the accuracy of three diatom-based methodologies for detecting above-ambient phosphorus exposure in diverse wetlands of the Florida Everglades. These wetlands are no stranger to diatom-based assessment due to their highly oligotrophic nature, ubiquitous presence of diverse benthic diatoms, and decades of exposure to and remediation of phosphorus enriched inflows. These diatom-based assessments of the oligotrophic status of the Everglades are so useful that they are reported, together with 8 other organism-based indicators, directly to the U.S. Congress on a biennial basis. Now that engineering projects to restore freshwater flow to Everglades wetlands are occurring in earnest, attention to ensuring these projects maintain the distinctive oligotrophic status of these ecosystems has redoubled. Here we compare the diatom-based phosphorus detection probabilities of three different methodologies. The first ("experimental approach") uses a combination of experimental and natural enrichment gradients to establish cautionary and impacted thresholds based on deviation from measured baselines. The second ("survey approach") utilizes 12 years of data from a synoptic survey of 150 sites representing all condition states and establishes thresholds based on diatom-inferred phosphorus distribution data and Threshold Indicator Taxa ANalysis. The third ("network approach") utilizes 10 years of synoptic survey data to build diatom species association networks and determines thresholds based on change-points of key network properties. All three approaches identified a significant low and high phosphorus threshold. The experimental approach had high detection accuracy limited to regions of study. The survey approach improved the accuracy of detection for these underrepresented regions. The network approach incorporated species inter-dependencies into thresholds but does not account for sensitive changes in relative abundances. Recommendations are made for applications based on adaptive management goals and spatial scales.

DIATOM COMMUITY COMPOSITION CHANGES AS COPPER CONCENTRATION INCREASES AMONG FRESHWATER STREAMS IN THE METAL-RICH BASIN OF THE ELIZABETH MINE, VERMONT, USA.

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Diatom communities in small to moderately-sized rivers near the Elizabeth Mine, South Strafford, VT, were surveyed to assess the impacts of metal stress from an abandoned copper mine on microbial communities. Species composition was a more sensitive indicator of metal concentrations than was the total number of species (richness). As bioaccumulated copper concentrations in periphyton increased, richness varied but did not differ with respect to the amount of copper until richness decreased dramatically at the two highest copper concentrations. The species composition changed dramatically at the lowest copper concentrations from dominance of *Achnanthidium pyrenaicum* to *Cocconeis placentula* becoming an important component of the flora. Then at moderately-high Cu *Fragilaria capucina gracilis* and *Brachysira microcephala* were relatively important. At the highest Cu concentrations, *Achnanthidium minutissimum* was the overwhelming dominant species. *Achnanthidium minutissimum* comprised a relatively important component of the flora at all Cu concentrations but generally increased in relative abundance as Cu increased. Diatom communities may be useful for assessing metal stress to aquatic systems.

THE IMPACT OF DISSOLVED AMINO ACIDS ON THE PHYSIOLOGY AND ECOLOGY OF THE MODEL DIATOM *PHAEODACTYLUM TRICORNUTUM*

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Marine diatom population dynamics is primarily controlled by processes that regulate ambient concentrations of dissolved nitrogen. While coastal upwelling events increase dissolved inorganic nitrogen (DIN) levels, phytoplankton grazing, viral lysis or terrestrial run-off increases levels of dissolved organic nitrogen (DON). Although diatoms mainly rely on nitrate for growth, it has long been known that various species can also assimilate organic nitrogen compounds. However, the role these substances play in diatom ecology has not been thoroughly explored and the metabolic features enabling this mixotrophic capacity are largely unknown. Using the marine species *Phaeodactylum tricornutum,* we explored the possibility that DON compounds influence normal diatom nitrate metabolism, cell growth and population dynamics. To address this hypothesis, we monitored nitrate-fueled growth of *P. tricornutum* when supplemented with various nitrogenous amino acids. We then administered their spent media to fresh nitrate-grown cultures and monitored culture dynamics in response to these media. We found that while most amino acids could supplement photosynthetic growth, the amino acid L-Asparagine (L-Asn) triggered culture collapse at the onset of stationary phase. Furthermore, the spent medium from L-Asn grown cultures was found to inhibit cell division of *P. tricornutum* fusiform cells, while promoting the proliferation of benthic oval morphotypes. Given these significant responses, we are attempting the identification of the responsible L-Asn-derived metabolites through cell-based assays with candidate molecules, and by using enzyme inhibitors to reveal the involved metabolic pathways. In conclusion, because climate change will likely affect the composition and quantity of the DON pool in coastal environments, our results provide evidence that diatom mixotrophy needs to be fully considered if one aims to understand the environmental controls on diatom population dynamics.

COMPARISON OF DIATOMS OF TWO MONTANE LAKES IN THE COMMONWEALTH OF DOMINICA, WEST INDIES, AND STATUS FOLLOWING HURRICANE MARIA

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The freshwater algal flora of the Lesser Antilles and Windward Islands in the Caribbean has received scant attention. The island of Dominica, known by its native name of Waitukubuli, has never been surveyed for its algal flora despite the presence of ecological zones ranging from dry forest to geothermal zones to high-altitude elfin forest. Dominic is the most 'intact' of all the islands in this part of the Caribbean and it has numerous aquatic habitats, from hundreds of streams to lakes and wetlands. Its algal flora is likely to be similar to that of neighboring Guadeloupe which was surveyed by Bourelly and Manguin (1952) as well as other investigations that were more specific to certain taxa. The diatom flora of these islands remains largely uninvestigated. During a comprehensive collecting effort throughout Dominica, I noticed that two high-altitude lakes, located in the same geological formation, contained vastly different algal flora, both dominated by diatoms. Boeri Lake was dominated by *Rhizosolenia* species similar to that described by Tremarin in Brazil lakes. The other lake, Freshwater Lake, was dominated by *Ulnaria (Synedra) acus* in great abundance. These lakes are close to each other and at approximately the same altitude. Observations over a period of 5 years confirmed that these dominant forms remain consistently dominant. The difference must be related to chemical nutrition. Boeri Lake receives no inputs other than rainfall. In addition to precipitation, Freshwater Lake also is affected by inflows from a geothermal area. Here I discuss the ramifications of this difference. Hurricane Maria devastated this island. Nearly the entire island was defoliated by the storm and in the subsequent two years, regrowth indicates that approximately 1/3 of the original forest remained alive. Streams received massive inputs of organic material along with the devastating flood. Here I also summarize the effect on freshwater habitats as well as other aspects of island life.

ALGAL SCAVENGING OF MERCURY IN PREINDUSTRIAL ARCTIC LAKES

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The geochemical speciation of total mercury (THg) was examined in pre-1800 Arctic lake sediments to improve understanding of the natural factors controlling "baseline" THg concentrations and fluxes. Solid-phase binding forms of THg were determined by sequential extraction of dated cores from three lakes in different ecozones (barren tundra, grassy tundra, boreal forest). Sediment organic matter (OM) was mostly of algal origin. Mercury was highly concentrated in the OM fraction of sediment (OM-Hg), comprising 60 – 87% of THg, while OM constituted only 0.6 – 13% (as total organic carbon) of sediment dry wt (DW). OM-Hg concentrations were equivalent to 159±13 to 776±215 ng Hg/g DW in algal OM, and were enriched 2–39 times compared to sediment THg, indicating that even small changes in algal OM inputs could significantly alter THg. OM-Hg explained 76 – 96% of the variation in THg concentrations over many centuries. Concentrations of S2 carbon (an algal productivity proxy) and OM-Hg were significantly correlated in two lakes, but not in the boreal forest lake possibly because of algal OM remineralization in its deep water column. Fluxes of S2 carbon, OM-Hg and THg were highly correlated in the barren tundra lake, but could not be calculated for the other lakes. The results overall indicate that high algal Hg concentrations due to scavenging of available Hg controlled the OM-Hg flux to sediments, thus driving changes in the THg concentrations and fluxes. These findings are relevant for our understanding of the long-term stability of baseline THg values in northern lakes under the changing Arctic climate, including in the modern era.

HOW TO TRAIN YOUR DIATOM: INDUCING A DIATOM BLOOM TO DISPLACE HARMFUL ALGAL BLOOMS

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Anthropogenic influences have resulted in a dramatic increase in the frequency, intensity, and duration of harmful algal blooms (HABs). These blooms are the result of additional nutrient loads to lakes and river, sourced from wastewater treatment plants and agricultural landscapes. As the availability of silica (Si) decreases, relative to nitrogen (N) and phosphorus (P), diatom communities shift to species with a lower silica demand. Imbalances between N, P, and Si facilitate HABs as diatoms become unable to outcompete their non-siliceous counterparts. However, it has been theorized that the addition of Si can promote diatom growth over harmful and nuisance non-siliceous algal taxa. Wastewater treatment plants are a major source of N and P to environmental waters. Within a plant, influent phosphate and ammonia concentrations are often greater than 5 and 50 mg/L, respectively. Lagoon treatment plants often experience short diatom blooms in the early spring before rapidly transitioning to non-siliceous algae. As a result, blooms are temporally compressed, facilitating observations. Our project is designed to induce a diatom bloom in a wastewater system that is primed for non-siliceous algal growth. We plan to add biologically available Si to wastewater lagoons in order to gain insight on how to combat the occurrence of HABs. We analyzed shifts in nutrient availability and transitions in algal communities during-and-after a spring diatom bloom. We observed a decline in dissolved Si concentrations in the water column as the algal community transitioned from diatom to green algae to cyanobacteria dominance. We then introduced biologically available silica to the lagoons, monitored nutrient availability, and characterized shifts within the algal communities. Ultimately, we intend to apply these results as a method to spike natural systems or wastewater effluent with silica in order to preferentially induce diatom blooms

DIATOM GENUS *PLANOTHIDIUM* FROM STREAMS AND RIVERS IN CALIFORNIA (USA): DIVERSITY, DISTRIBUTION AND AUTECOLOGY

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Planothidium taxa are common components of the stream periphyton. This study in based on 208 algal samples containing *Planothidium*, obtained in 2015-2016 from perennial and non-perennial streams and rivers across California, using a multihabitat sampling protocol. At least 600 diatom valves were identified and quantified from each sample. Nineteen *Planothidium* taxa were recorded in total, ranging from 0.3 to 81% relative abundance per sample, including new to science *P. sheathii* Stancheva. The genus was distributed within wide range of water parameters: specific conductance (CON 13.6-10344 µS/cm), dissolved organic carbon (DOC 0-73.8 mg/L), chloride (CHL 0.09-3300 mg/L), total nitrogen (TN 0-46 mg/L) and total phosphorus (TP 0-5 mg/L). A comparison of species-weighted means of the un-transformed environmental variables, using randomization tests to obtain p-values, showed statistically significant differences in preferences of *Planothdium* taxa for CON and DOC ($p<0.05$), but not for CHL, TN, or TP. The mean and ranges of CON and DOC for the most common species were as follows: *P. frequentissimum* Lange-Bert. (n = 172, CON 1233.8 (43.8-10344), DOC 3.6 (0-15.9), *P. lanceolatum* Lange-Bert. (n = 163, CON 945.1 (27.1-6319), DOC 3.4 (0-73.8), *P. robustum* Simonsen (n = 61, CON 1421.3 (130-3619), DOC 7.8 (2.1-15.9), *P. cryptolanceolatum* Jahn & Abarca (n = 57, CON 537.6 (43.8-4014), DOC 3.1 (0-73.8), *P. victorii* Novis, Braidwood & Killroy (n = 57, CON 1231.7 (43.8-10344), DOC 5.2 (0-12.7), *P. engelbrechtii* Krammer & Lange-Bert. (n = 41, CON 896.6 (130-10344), DOC 7.7 (1.0-11.8), *P. amphibium* Wetzel, Ector & Pfister (n = 33, CON = 407.7 (43.8-1914), DOC 3.9 (0.61-11.8). Statistically significant differences in CON were detected for *P. amphibium* vs. *P. frequentissimum*, *P. amphibium* vs. *P. robustum*, *P. cryptolanceolatum* vs. *P. frequentissimum*, *P. cryptolanceolatum* vs. *P. robustum*, and in DOC for *P. amphibium* vs. *P. engelbrechtii*, *P. frequentissimum* vs. *P. engelbrechtii*, *P. frequentissimum* vs. *P. robustum.*

LITERATURE-BASED SYNTHESIS OF NUTRIENT STRESSOR-RESPONSE RELATIONSHIPS TO INFORM ASSESSMENT, MONITORING, AND CRITERIA DEVELOPMENT IN RIVERS AND STREAMS

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Eutrophication from nitrogen and phosphorus pollution is a major stressor of freshwater ecosystems globally. Despite recognition of this problem by scientists and stakeholders, synthesis of scientific evidence is still needed to inform nutrient-related management decisions and policies, especially for streams and rivers. A rigorous assessment of what is known about nutrient-stressor response relationships and modifying factors is a critical first step for identifying, managing, and restoring aquatic resources impaired by eutrophication. We conducted systematic reviews of the literature that asked: "What are the responses of chlorophyll-a, diatoms, and macroinvertebrates to TN and TP concentrations in lotic ecosystems," and "How are these relationships affected by other factors?" We describe the reviews and discuss preliminary results based on the ~300 publications documenting cause-effect relationships between relevant nutrients and endpoints that were obtained after screening >22,000 publications from academic databases, and >4000 from other sources, for relevance, duplication, and quantitative effect sizes. These reviews provide a state-of-the-science body of evidence for assessing nutrient impacts to the most widely-used indicators of biological responses to nutrients. Synthesis of the data extracted from papers on diatom responses to nutrients is a challenging step because of high variability in the types of response measures reported in the literature. We seek feedback from the diatom research community about the most effective ways to synthesize effect sizes and other measures of diatom responses to nutrients.

EFFECTS OF PHOSPHORUS ON BENTHIC DIATOM ASSEMBLAGE NETWORK STRUCTURE

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Ecological network analysis helps identify how relationships among species differ over time and across sets of species. Microbial assemblages are ideal for evaluating changes in species interactions due to environmental changes because they are speciose and respond at multiple scales. To determine how phosphorus limitation influences diatom network structure, we analyzed relationships among 257 species of diatoms from benthic microbial (periphyton) mats from 10 years of annual samples collected from 136 sites. Expected evidence of changes in network structure in response to periphyton TP were not found, likely due to species replacement with increased TP. Analysis of species connection distributions and the effects of species removal on connections found frequency changes increases along a mean TP gradient for 51 species with significant roles in network structure. Trends in species frequency were variable, with 23 species increasing in frequency along the TP gradient, 13 species decreasing, and 15 species displaying a variable pattern along the TP gradient. This study brings a new methodology of study to the field of ecosystem restoration studies.

COMMUNITY-LEVEL MODELING OF PERIPHYTIC DIATOMS IN RESPONSE TO SEA LEVEL RISE USING THE EVERGLADES LANDSCAPE MODEL

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Uncertainty about the degree to which freshwater restoration will mitigate saltwater intrusion into coastal freshwater wetlands has prompted the development of ecosystem modeling projects, such as the Everglades Landscape Model (ELM). The ELM is an ecosystem model that integrates dynamic ecological processes to simulate landscape patterns of water, nutrients, soils and vegetation under future scenarios of climate change and water management in the Florida Everglades. In this study, we add a diatom module to the ELM to simulate how periphytic diatom assemblages will respond to future alterations in salinity and phosphorus gradients caused by sea level rise. We used existing diatom community and environmental data collected from 34 sites in the southern Everglades to develop quantitative models for diatom assemblages in response to conductivity and phosphorus (P), two of the most dominant drivers of periphyton dynamics in the Everglades. Sites were classified into assemblages based on hierarchical cluster analysis and analysis of similarity; multinomial logistic regression (MLR) was then used to develop empirical functions predicting diatom assemblage as a function of conductivity and periphyton total P for the dry and wet season. The cluster analysis identified 3 significantly dissimilar diatom assemblages in the dry season and 4 in the wet season. The misclassification error for dry and wet season MLR models was under 15%; and conductivity and mat TP were significant predictors ($p < 0.1$) for dry and wet season probability equations. The MLR-derived probability equations for diatom assemblages were encoded into ELM to simulate diatom distributions over 25 years under a baseline scenario and a sea level rise (SLR) scenario of 2 cm/yr. Under both scenarios, diatom assemblage distribution fluctuated in response to hydrology, salinity, and P with significant distributional differences between dry and wet seasons. However, under the SLR scenario, brackish, eutrophic assemblages became more widespread and the spatial boundary separating the native, freshwater assemblage from brackish weedy assemblages shifted inland. This diatom module strengthens the power of ELM projections by including a microbial component - particularly diatoms which are powerful bioindicators and a key part of the ecologically important periphyton mats of the Everglades - allowing us to forecast potential ecosystem changes at all scales. Furthermore, community-level modeling provides more information than single species distribution models or bulk ecosystem properties by integrating responses by multiple species.

BUBBLE FARMING: SCALABLE MICROCOSMS FOR DIATOM BIOFUEL PRODUCTION

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Currently there are two standard ways of growing microalgae for biofuel: open raceways and closed photobioreactors. Open raceways are a relatively inexpensive option, but are subject to airborne and exotic species contamination and evaporative losses of water, requiring large amounts of relatively flat land, and constant energy input for water circulation and stirring. Closed photobioreactors are much more expensive, can accumulate biofilms that diminish light from uniformly reaching the cells, are closed to gas exchange with the atmosphere, and require frequent maintenance. We propose that farming using bubble wrap (Bubble Farming) can solve most of these problems. The use of bubble wrap with selectively bred or genetically modified diatoms or other microalgae has the potential to make biofuels sustainable and cost competitive with fossil fuels as it will minimize water and energy use and protect from contamination, while allowing gas exchange for carbon dioxide absorption from and oxygen release to the ambient air. Diatoms could be harvested or milked or they could ideally secrete a potentially high-octane biofuel hence simplifying product (biofuel) separation. Bubble farming may also allow simultaneous cultivation of crops that thrive in hydroponic or aquaponics settings, and if so, food crops could be potentially grown via Bubble Farming, with the added benefit of protection from drought and insects.

DO INDIVIDUAL DIATOM SPECIES REFLECT SPECIFIC STRESSORS?

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Are certain diatom species indicative of stressors like agriculture, mining and deforestation? To investigate we compiled a detailed set of long-term, quantitative stressor data for 60 watersheds surrounding the Laurentian Great Lakes and related these parameters with fossil diatom relative abundances recovered from sediment cores. Stressors included population, mining, deforestation and GIS coverages for agricultural land, with records extending back as far as 1780. A distinct suite of diatom species was associated with agricultural activity which peaked in the mid-20th century. Another subset of taxa are associated with population growth, a trend that may be concurrently related to climate change. Despite the unique physico-chemical characteristics of each lake, Great Lakes basin-wide indicators of stress were detectable. This work clarifies the indicator role of several diatom species in the world's largest freshwater resource. Further, having clear, species-specific stressor information enables alternative diatom-based

PHOTOSYNTHESIS TO RESPIRATION RATIOS AND DIATOM ASSEMBLAGES ALONG STREAM LENGTHS IN NORTHERN SWEDEN

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The region around Abisko, Sweden, is located above the Arctic Circle. Due to its high latitude, it is environmentally vulnerable to the effects of climate change. Waters in northern Sweden are in relatively pristine condition, so the Swedish government does not conduct routine environmental monitoring. Thus, riverine diatom diversity is not well understood because the absence of a need to develop biotic indices. Rivers in the region are highly oligotrophic and nutrient-limited and are exposed to about 24 hours of sunlight daily during the summer season. Many river reaches are reported to be highly turbulent. Prior work with alpine and boreal lakes in Canada and Sweden suggests that lacustrine diatoms are often most strongly associated with pH. Rivers and lakes in the region range from pH ~5.5-7.5. The study sought to understand how diatom assemblages and photosynthesis-to-respiration ratios (P/R) change along the length of autotrophic streams in northern Sweden. P/R was assessed via changes in oxygen isotopes (δ^{18}O-DO) as a proxy for dissolved oxygen. The study gathered information about nutrients levels (as a measure of total Kjedahl nitrogen, total phosophorus, and total silica) at each site to form a more complete understanding of factors that affect diatom assemblages and P/R (with a special focus on carbon cycling) among sites in-stream and across different streams within the same catchment basin. Diatoms were collected from sites in the Miellajokka catchment and from sites in Abisko National Park, both of which drain into Lake Torneträsk. Diatom community structure data from the study were related to environmental and nutrient parameters taken from each site. Data were also compared to prior studies in the same catchment basins that studied carbon fluxes in Lake Torneträsk.

WHOLE GENOME SHOTGUN PHYLOGENOMICS IN THE THALASSIOSIRALES

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Understanding how species evolve and adapt to new and changing environments have been long-standing goals in evolutionary biology. The Thalassiosirales is a diverse diatom lineage containing multiple transitions between freshwater and marine environments. We plan to use this lineage to investigate the genomic mechanisms involved in these transitions. Recently, it has become feasible and inexpensive to sequence the entire genomes of numerous species in parallel using shotgun sequencing. Using both short read (Illumina) and long read (Oxford Nanopore) technologies, we will sequence, assemble, and analyze low coverage genomes of > 50 Thalassiosirales species that span both freshwater and marine environments. These data will be used to explore phylogenetic relationships and how genome size, genome complexity, and gene family evolution relate to the adaptations to these different environments. We have currently sequenced and assembled draft genomes of *Cyclotella cryptica*, *Cyclostephanos tholiformis*, and *Thalassiosira profunda* and estimated their genome sizes to be 163 Mb, 33 Mb, and 45 Mb, respectively. Long read sequencing has greatly improved the reference genome of *C. cryptica*, bringing the number of contigs down from 116k to 839 while increasing the N50 from 12 kb to 596 kb. These preliminary results demonstrate the power of long read technologies to sequence and assembly quality, low coverage genomes across entire lineages.

PLENARY: REGULATION OF THE METABOLIC SHIFT TOWARD LIPID ACCUMULATION IN THE DIATOM *PHAEODACTYLUM TRICORNUTUM*

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Diatoms constitute a major group of photosynthetic microalgae. Diatoms have a high biotechnological potential because they produce of biomolecules of high interest for industries in the sector of energy, nutrition, cosmetics, health and well-being. However, the scientific knowledge of biological processes remains too scarce to make the diatom biotechnology a viable source of biomolecules and more research must be carried on to fulfil this gap. Because biomolecules are mostly/exclusively, composed by carbon atoms, the carbon metabolism constitutes the heart of diatom metabolism. Under nonstressful condition, the carbon metabolism produces sugars that are used to sustain growth. Under difficult conditions, such as a decrease in nutrient deficiency, the carbon metabolism is reoriented towards the accumulation of molecules with a high density in energy, typically lipids. Thus, the elucidation of the mechanisms controlling the carbon metabolism is crucial for the understanding of diatom's life and also for the development of biotechnological applications. In this frame, the lecture will address the following aspects of the control of the carbon metabolism in diatoms:

- Does lipid accumulation constitute a default mechanism of the stress response in diatoms? It is usually observed that under stress, diatoms accumulate lipids. This observation is general enough to hypothesize that this reorientation of the carbon metabolism constitutes a default mechanism. Recent data in favour of this hypothesis will be presented.
- Can the regulatory elements controlling the reorientation of the carbon metabolism in diatoms be deciphered? The reorientation of the carbon metabolism must involve cellular, biochemical and molecular components. Using high-to-low carbon availability transition, some of these components have been identified among which transcription factors (TF).
- Can the regulation of the carbon metabolism reorientation controlled by transcription factors?

The change in the expression levels of TFs measured in progressive N deprivation conditions has been recorded. Physiological, biochemical and molecular analysis coupled with mRNA quantification, have been used to generate gene regulatory networks. As a consequent step, TF genes have been selected for gene editing and generation of mutant strains. The on-going screening and characterization will confirm the function of the selected TFs in the metabolic shift.

EXPLORING SILICA LIMITATION OF DIATOMS WITH A NUTRIENT DIFFUSING EXPERIMENT IN A HEADWATER STREAM IN INDIANA

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Harmful algal blooms are an increasing hazard for streams and lakes in Indiana. The Si limitation of diatoms in freshwater has been theorized to facilitate the growth of cyanobacteria and other non-siliceous algal groups, yet the timing and magnitude of this limitation is not well studied, particularly in streams. Our research seeks to characterize the relationship between essential nutrients (nitrogen [N], phosphorus [P], and silica [Si]) and algal community composition in order to better understand the stoichiometric nutrient demands of diatoms in streams of Indiana. In order to assess nutrient limitation, including the potential for dissolved silica limitation of diatoms, we are using nutrient diffusing substrata (NDS) enriched with different combinations of N, P, and Si. Nitrate, phosphate, and silicate salts are added to an agar medium and then diffuse through a porous glass disk once the NDS are placed in a stream. Algae are able to colonize the glass disks and reflect the enriched nutrient availability relative to the control and natural substrate. The study stream is located in Monroe County, Indiana and drains a predominantly forested watershed. Incubating nutrient diffusing substrata in natural waters is a well-established method used in stream ecology to identify nutrient limitation and co-limitation. We are using multiple treatments of variable N:P:Si to identify the types of diatoms that grow under enriched nutrient availability. Treatments will include additions of Si, P, N, N and Si, P and Si, and all three nutrients. The response variables include total algal biomass (as chlorophyll-a) and species-level assessment of diatom community structure. This study aims to identify the diatom species that can act as proxies for stream nutrient concentrations which facilitate siliceous algal growth over nuisance and harmful non-siliceous algae. The effects of the treatments relative to the control will be analyzed using one-way analysis of variance (ANOVA) with pairwise comparisons. Multivariate techniques may be used to explore the diatom community data. Characterizing shifts in the diatom community composition can offer insight into the variations in nutrient demands of different diatom groups as well as assessment for the potential for dissolved Si limitation of diatoms.

EFFECTS OF RIPARIAN RHODODENDRON REMOVAL AND TOP-DOWN CONTROL BY CRAYFISH ON DIATOM COMMUNITY STRUCTURE IN SOUTHERN APPALACHIAN STREAMS

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Primary producers in headwater streams are controlled by both bottom-up (e.g., light, nutrients) and top-down (e.g., stream consumers) factors. In the southern Appalachians, *Rhododendron maximum* is a pervasive evergreen shrub in headwater riparian zones that severely limits light availability to algal communities year-round. Although rhododendron is native to the southern Appalachians, the U.S. Forest Service is interested in potentially removing it along stream banks to promote the growth and regeneration of hardwoods. Previous studies indicate that increased light conditions after rhododendron removal had a positive effect on algal growth, although algal consumption by macroconsumers mediated this effect. Studies of how crayfish affect algal community composition in this region have shown mixed results, and it is unclear to what extent these top-down effects interact with increased light levels resulting from rhododendron removal. In this study, we examine how top-down control by crayfish interacts with increased light availability created by reach-scale removal of riparian rhododendron to influence diatom community structure. We experimentally excluded crayfish from localized benthic areas using electric "fences." Crayfish exclosure treatments were paired with crayfish access controls. We ran two 32-day experiments, pre-rhododendron/post-rhododendron removal, whereby diatoms at the conclusion of the experiment. Preliminary analyses indicate that pre-rhododendron removal, diatom communities were dominated by adnate forms (e.g., *Eunotia* and *Nupela* spp.) and crayfish exclusion had little effect on diatom community composition. Post rhododendron removal, crayfish exclusion shifted diatom community composition from adnate diatoms (e.g., *Eunotia* and *Achnanthidium* spp.) in access plots to upright diatoms (e.g., *Gomphonema* and *Encyonema* spp.) in exclusion plots. These results suggest that crayfish have top-down effects on diatom community composition associated with different growth forms in this region, but this linkage may only occur under increased light availability, such as higher light conditions caused by rhododendron removal.

CHLOROPLAST GENOMES OF CLOSELY RELATED *STEPHANODISCUS* SPECIES AND POPULATIONS: TOWARDS A PHYLOGEOGRAPHY

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Stephanodiscus niagarae is a cosmopolitan species with a known distribution throughout North America in temperate freshwater lakes and reservoirs. It is also found in fossil deposits in North America, Africa, Asia, and Europe. Several closely related descendant species of *S. niagarae* are endemic to one or few lakes in several locations in the United States (together forming the *S. niagarae* complex). One of these species, *Stephanodiscus yellowstonensis,* from Yellowstone Lake (Yellowstone National Park [YNP]) has a well-documented record of morphological evolution from sedimentary cores that span the Holocene. Here, we use chloroplast genomes of closely related species and populations of *S. niagarae* to look at relatedness of spatially separated strains. We collected live *S. niagarae* individuals from Lewis Lake (YNP), Hebgen Lake (Montana, USA), Buffalo Bill Reservoir (Wyoming, USA), and Boysen Reservoir (Wyoming, USA). In addition, we had archival pellets of single strains of *S. yellowstonensis* from Yellowstone Lake (YNP), and of *S. niagarae* from Jackson Lake (Grand Teton National Park) and Lake Okoboji (Iowa, USA). In total, fourteen strains of *S. niagarae* and one strain of *S. yellowstonensis* were grown in continuous clonal cultures, pelleted at stationary growth phase, and total genomic DNA extracted using DNeasy plant mini kits (Qiagen). Libraries were prepared from extracted DNA, and, using a paired end 150 bp run, DNA were sequenced on Illumina's HiSeq 4000 or NextSeq 500 platforms. Chloroplast genomes were cleaned, assembled, and circularized in the software program Novoplasty. The genetic structure of the chloroplast was conserved amongst all strains, however, we found 118 polymorphic sites. Using TNT, we built a parsimony tree and found geographic signal between our locations (i.e., strains from the same lake are generally more related to each other than strains from other lakes). This is an important finding because these polymorphisms show the first genetic evidence of differences among populations of the *S. niagarae* complex where there are many known morphological differences. Further, our findings suggest our methodology may be a relatively inexpensive way to investigate the phylogeography of diatoms.

REVISITING THE RELATIVE IMPORTANCE OF NATURAL AND ANTHROPOGENIC FACTORS AFFECTING DIATOM SPECIES COMPOSITION IN STREAMS: NATURAL FACTORS ARE REALLY IMPORTANT

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Assessments of human effects on ecological conditions should account for natural variability among ecosystems because many naturally varying watershed and site-level conditions affect both what we expect natural structure and function of the ecosystem to be and the sensitivity of ecosystems to human disturbance. Curiously, we do not find great improvements in relationships of diatom-assessed conditions and human disturbance by accounting for natural variability with advanced modeling methods. One plausible reason for this problem is covariation among natural and human factors across landscapes. We tested this hypothesis with structural equation modeling (SEM) and the diatom results of the USEPA's 2008-2009 National Rivers and Streams Assessment. First, we developed machine learning models to predict expected metric values for all assessed sites in the US if they matched reference condition. Then we assessed sites as the deviation in metric values from sample counts and from modeled expected reference condition. We constructed SEMs for each ecoregion that determined: 1) how much variation in diatom multimetric indices were explained by in-stream physical-chemical conditions (pChem) and 2) how much variation in pChem could be explained by independent and covarying effects of natural factors (geology, climate, hydrology, soils) and anthropogenic factors (agricultural and urban land use). We found that direct influences on diatom MMIs by in-stream environments were greater than natural and human factors at the national scale and in all but one ecoregion. The explained variance of in-stream environments by natural and human factors ranged from 0.30 to 0.75, for which natural factors independently accounted for the largest proportion of explained variance at the national scale and in seven ecoregions. Covariation between natural and human factors accounted for a higher proportion of explained variance of in-stream environments than unique effects of human factors in most ecoregions. Ecoregions with relatively weak effects from human factors had high levels of covariance among natural and human factors and relatively high levels of human disturbance at reference sites when compared to highly disturbed sites. We conclude that accounting for effects of natural factors and their covariation with human factors in surrounding watersheds is important for accurate ecological assessments.

A HOLOCENE RECORD OF EVOLUTION IN DIATOM MORPHOLOGY FROM CUMBRES BOG (COLORADO, USA)

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We used landmark shape analysis on a *Eunotia* species group from a set of fossil diatom assemblages to better understand variability in diatom valve morphology. Cumbres Bog is a deep sub-alpine bog located on a high-elevation plateau (elevation=3050 m a.s.l.) in a remote region of the San Juan Mountains. The sediment record from Cumbres Bog was radiocarbon dated and spans the entire Holocene over several meters of core. Prior analyses of the diatom assemblages indicate that the bog has a long history of water level fluctuations, causing it to repeatedly alternate between lake and peat-bog states, gradually evolving into the bog that currently occupies the modern basin. *Eunotia* taxa similar to *E. formica* dominated many of the diatom assemblages during shallower-water bog intervals, and have continuously existed in diatom assemblages throughout the sediment record from at least the last 9,500 years. Scanning electron microscope analyses of these *Eunotia* species shows that while substantial variation in valve outline occurs throughout the record, the ultrastucture and valve features remain relatively constant. Because of the high morphological variability commonly observed in this diatom group and difficulty in distinguishing simple reliable characteristics to define speciation and species boundaries, we used traditional morphometrics and landmark analyses to evaluate differences in valve size and outline from a set of representative samples collected approximately every 1,000 years throughout the Holocene. Morphometric analyses indicate that long-term patterns in valve breadth and outline, particularly valve end shape, varied substantially throughout the Holocene; this variability more or less stabilized in the mid-Holocene around features that define at least one distinct new species that appears to have evolved from the original early Holocene populations.

EVIDENCE THAT PERIPHERAL ISOLATION IS A COMMON MECHANISM FOR SPECIATION IN *STEPHANODISCUS* EHRENB.

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There is abundant evidence that diatoms and other protists have the capacity to disperse readily at least over moderate distances. If this is true and if this promotes interbreeding among different populations, then one might expect both differentiation among populations and also speciation processes to be restrained or impeded. It is certainly difficult to conceive of speciation in protists as following an allopatric dumbbell model (e.g., some vicariant event separating a single population into two equally large populations). How then do protists speciate? An extreme explanation is that reproductive isolation and speciation is local and instantaneous. There are mechanisms that could cause this to happen. This might be accomplished by a ploidy level change. An alternative is that relatively few mutations could produce instantaneous lack of recognition between cell lineages. A well-documented example of recent speciation in *Stephanodiscus* supports the idea of rapid and instantaneous reproductive isolation accompanied ecological peripheral isolation in at least three populations in the *S. niagarae* complex. But the new species remain isolated in single lakes, and so this arguably may not be generalizable. However, it offers a suggestion into how peripheral isolation as a speciation model may be inferred in more widespread species complexes. Examination of several species complexes in *Stephanodiscus* Ehrenb. have recovered complexes with widespread plesiomorphic forms, closely related to more narrowly distributed (but not endemic) and apomorphic relatives, suggesting that peripheral isolation with subsequent dispersal of the descendent species has occurred several times in *Stephanodiscus*.

PRONOUNCED GEOGRAPHIC STRUCTURING AND ENDEMISM IN FRESHWATER DIATOMS OF THE ANTARCTIC REALM

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Microorganisms are crucial players in all global biogeochemical cycles and ecosystem functioning in terrestrial and aquatic habitats. Despite this, information on their large-scale biogeographic structuring is largely lacking, mainly due to a lack of taxonomic resolution and consistency in the available datasets. Despite a growing number of morphology- and DNA-based studies on microbial biodiversity, our understanding of large-scale microbial biogeographical patterns remains a contentious issue, mainly because of the lack of taxonomic resolution and consistency in the available datasets. In this lecture, an analysis will be presented of biogeographic patterns in freshwater diatoms based on a high-resolution and internally fully consistent species-level taxonomic data set from > 400 lakes covering the entire Antarctic Realm. A strong biogeographic structuring at multiple spatial scales was observed with distinct, differently sized diatom floras characterizing Continental Antarctica, Maritime Antarctica and the Sub-Antarctic islands. Additional biogeographic provincialism emerged in all three regions. These patterns were underlain by species turnover rather than nestedness; explained predominantly by historical and spatial factors, such as distance between regions and differences in the deglaciation history. A total of 59% of the recorded species are currently only known from the Antarctic Realm. The proportion of regionally restricted species was particularly high in predominantly terrestrial genera and, in contrast to local and regional richness, significantly increased with increasing latitude. This strong biogeographical structuring suggests that effective dispersal between the biogeographical regions has been limited, fostering the evolution of highly endemic diatom floras, making a compelling case for the important role of historical events in the evolution of lacustrine diatoms, which is similar to macroscopic organisms from the Antarctic Realm based on morphological and genetic data.

DIATOM RESPONSE TO PALEOCLIMATE DRIVEN DUNE ACTIVITY ALONG THE LAKE MICHIGAN SHORELINE

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Coastal dunes along Lake Michigan are not stable over time and changes are most likely tied to climate change (lake level, wind, and storm frequency and intensity). Timing of dune migration can be determined by optically stimulated luminescence dating (OSL) of minerals or radiocarbon dating of buried organic material, but these methods are limiting due to the inherent processes of dune migration. Previous work on Gilligan Lake near Holland, MI shows the presence of periodic sand layers in lake sediments related to lake-level change in Lake Michigan. Multi-proxy data (charcoal, pollen and % sand) from Gilligan Lake sediments were used to determine climate-related dune migration activity. Diatom microfossils were analyzed from a specific sediment region of interest. The diatoms indicate a diverse community in Gilligan Lake during this time period. Taxa are consistent with flora common in lakes associated with wetland habitats and contain many acidophilic species common to lower pH environments. Two major signals are evident from the diatom data in this section of the core, a decline in open lake condition, and a decrease in acidophilic taxa associated with littoral wetland or bog systems. Diatom data were then compared with other multi-proxy data (charcoal, pollen and % sand) to better understand climate-related dune migration activity.

A DIATOM-BASED WATER QUALITY METRIC FOR TEXAS STATE-THREATENED MUSSELS: MESOCOSM EXPERIMENTS AND FIELD APPLICATIONS

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North America has the highest diversity of freshwater mussels in the world with approximately 297 species. However, they are also some of the most imperiled, with 67% of North American species considered threatened. There are 53 known species in Texas, of which 15 are listed as state threatened. An initial mussel survey identified two state-threatened species (*Cyclonaias petrina* and *Cyclonaias houstonensis*) in the Colorado River near its confluence with the San Saba. To assess the habitat quality of new sites for mussel introductions to increase the population, we are constructing a diatom-based water quality metric tailored to the Colorado River. Diatoms are golden-brown algae that are widely distributed in freshwater environments and are excellent indicators of water quality because they are sensitive to changes in the ambient environment. To do this, artificial streams were constructed to simulate the natural stream conditions of the Colorado River; a 10-week experiment cultured diatoms in conditions that introduced low-water levels to simulate drought and manipulated nutrient conditions. Water quality was monitored in terms of pH, TDS, DO, conductivity, and productivity; diatom communities were subsampled on a weekly basis and assessed for community changes. The most abundant species throughout the experiment were *Nitzschia amphibia*, *Nitzschia palea*, *Nitzschia soratensis*, *Navicula trivialis*, *Rhopalodia gibba*, and *Gomphonema johnsonii*. Two notable shift in the mesocosms were the decrease of individuals of *Cyclostephanos dubius* in Week 4 and the increase of individuals of *Rhopalodia gibba* in Week 5. Statistical analysis constructed an Index of Biotic Integrity (IBI). This summer the IBI will be applied in the field to assess habitat quality for mussels in terms of water quality and food availability.

Poster Presentation List and Abstracts
University of Georgia Rock Eagle 4H, and Georgia College and State University

POSTERS DIRECTIONS: PLEASE MAKE SURE POSTERS FIT WITHIN landscape or portrait 46" x 36" (120 x 92 cm, smaller sizes are acceptable). Place poster at the designated number on Wednesday evening and remove Friday afternoon.

LIST OF POSTERS:

1. Marshall *et al.* DEVELOPING AQUATIC MICROBIOTA AS TRACE EVIDENCE OF AQUATIC CRIME SCENES AND DROWNING

2. Alverson *et al.* MYDIATOMS: A CITIZEN-SCIENCE INITIATIVE TO RAISE PUBLIC AWARENESS OF DIATOM DIVERSITY

3. Sullivan and Gaiser SEASONAL VERTICAL DISTRIBUTION OF PHYTOPLANKTON IN A SUBTROPICAL DYSTROPHIC LAKE

4. Van de Vijver *et al.* FOUR UNKNOWN EPIZOIC DIATOM SPECIES FOUND ON LOGGERHEAD SEA TURTLES IN THE ADRIATIC SEA

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17. Downey *et al.* EVOLUTIONARY PATTERNS OF ADAPTIVE GENE EXPRESSION IN MARINE AND FRESHWATER DIATOMS

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26. Allen *et al.* PALEOLIMNOLOGICAL ASSESSMENT OF HARMFUL ALGAL BLOOM TRENDS IN TEXAS RESERVOIRS

#1. DEVELOPING AQUATIC MICROBIOTA AS TRACE EVIDENCE OF AQUATIC CRIME SCENES AND DROWNING

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Aquatic environments are common grounds for criminal activities such as drownings and body disposals. By identifying specialized aquatic biota based on trace evidence like pollen and phytoliths, one can determine the site of origin. However, forensic scientists acknowledge the limitations of using aquatic microbiota as trace evidence because of a lack of resources and training. As well, diatoms can be used as trace evidence of drowning by their presence in the lung tissue, blood stream, and bone marrow of drowning victims. However, not much is known about the pathway of diatoms into bone marrow and the limitations of using this trace evidence of drowning and body disposal. The first goal of this project is to collect high-resolution microscope images of aquatic plant pollen and phytoliths found in Texas aquatic environments to create an identification resource for trace evidence. The second half of the research will evaluate postmortem entry of aquatic microbiota into bone marrow to assess the accuracy of using diatoms as evidence of drowning as opposed to long-term submersion postmortem. We will address research questions such as: Do diatoms need to be alive in order to actively enter bone marrow, or do they enter bone marrow passively through diffusion? If diffusion is passive, can other common co-existing microbiota like pollen and phytoliths also enter bone marrow? Does frustule size limit entry of some diatoms into bone marrow? Does mobility by the raphe system influence entry into bone marrow? Pig femur bones will be submerged in suspended slurries of either live or dead diatoms along with pollen and phytoliths for different lengths of exposure time ranging from 2 days to 6 months. Diatoms, pollen, and phytoliths will be isolated from the bone marrow and enumerated. The bone marrow assemblages will be compared to the original assemblage of the slurry to determine what diffused into bone marrow, and how equally different sizes and types of trace evidence diffused into bone marrow. Having access to identification materials for aquatic pollen and phytoliths, along with knowledge of how diatoms enter bone marrow, will help forensic scientists make more accurate interpretations of trace evidence.

#2. MYDIATOMS: A CITIZEN-SCIENCE INITIATIVE TO RAISE PUBLIC AWARENESS OF DIATOM DIVERSITY

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Although microbes constitute most Earth's biodiversity, public awareness of this diversity is generally limited to pathogens and medically relevant taxa. Unlike macroorganisms, however, microbes are often trivial to collect and transport—a single soil or water sample can contain hundreds or thousands of microbial species. To increase public understanding of diatom diversity, we are launching a citizen science initiative called *myDiatoms* in which participants will be encouraged to collect samples from local water bodies and ship them to our lab at the University of Arkansas where we will process the samples and photograph diatoms in their samples. A project website will display a map of all the project samples. Users can click on their sample site to view a project-specific page that includes a photo and user-provided description of the location and its local importance, as well as a gallery of light microscope images of the diatoms in their study system. Each image will be linked to its corresponding page on the Diatoms of North America website where the citizen scientists can see additional images and learn more about each species. Participants will be able to visualize sampling sites with similar diatom floras as well as follow a project feed that highlights samples of exceptional diversity, rare taxa, and other metrics. The program is set to launch in fall of 2019.

#3. SEASONAL VERTICAL DISTRIBUTION OF PHYTOPLANKTON IN A SUBTROPICAL DYSTROPHIC LAKE

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Physical, chemical, and competitive processes can influence the vertical distribution of phytoplankton in freshwater lakes. While some phytoplankton control their buoyancy and motility with gas vesicles and flagella, others rely more heavily on the physical stratification of lake water to maintain their position in the photic zone. In DOC-rich waters, the photic zone may be limited to just a few meters, often above the thermocline where deep chlorophyll maxima typically occur. In these low-nutrient, high-OC environments, mixotrophs may be the dominant functional group. Mixotrophic algae, which combine heterotrophy and autotrophy, are able to sustain their metabolic functions under light, nutrient, or prey (bacteria, dissolved or particulate organic carbon) limitation, outcompeting strict auto- and heterotrophs in stressful conditions. In subtropical dystrophic Lake Annie, mixotrophs may be serving as organizers of phytoplankton assemblages, including diatom distribution, spatially and temporally. The proposed study aims to determine the influence of changing DOC and bacteria concentrations on phytoplankton species diversity, richness, and mixotrophy across vertical depths and seasons. Patterns of seasonal vertical phytoplankton distribution will be used alongside physiochemical measurements and long-term data to elucidate the potential driving mechanism(s) of mixotrophy in this subtropical lake. Preliminary results suggest diversity is greatest in the hypolimnion during stratification, while an opposite trend is observed during lake turnover. Preliminary results also suggest that species richness and diversity are greatest with higher DOC concentrations, likely due to increased resource availability for mixotrophic species.

#4. FOUR UNKNOWN EPIZOIC DIATOM SPECIES FOUND ON LOGGERHEAD SEA TURTLES IN THE ADRIATIC SEA

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In recent years, there is a growing scientific interest in epibiotic communities. Sea turtles host unique and diverse diatom communities composed of a large number of genera, several of which recently described as new to science such as *Chelonicola*, *Medlinella* and *Poulinea*, all known almost exclusively from the carapaces and skin of marine turtle species and other marine vertebrates (Majewska et al. 2015, Frankovich et al. 2016). During a survey of the epizoic diatom flora on carapaces of loggerhead sea turtles (*Caretta caretta*) from the Adriatic Sea, four unknown diatom taxa were discovered on the carapace of one turtle. For at least two of them, further analysis revealed that they most likely represent two new genera whereas the third and fourth taxon could be assigned to the genera *Catenula* and *Planothidium* respectively. These observations show the special nature of the epizoic diatom flora on loggerhead turtles and confirm our lack of taxonomic knowledge increasing the importance of the currently ongoing project. The first unknown taxon belongs to the monoraphid diatoms. The rapheless valve is characterized by the presence of a large silica crest surrounding the entire valve and covering part of the valve margin. The striae consist of two large areolae, separated by a broad hyaline plate and covered externally by porous hymenes. The raphe is rather simple with bent terminal fissures and simple, straight central endings. Comparison with achnanthoid genera such as *Scalariella*, *Kolbesia* and *Madinithidium* yielded both clear similarities but also distinct differences (Desrosiers et al. 2014, Riaux-Gobin et al. 2012). The second unknown taxon shows similarities to the genera *Nitzschia*, *Rhopalodia* and *Psammodictyon* based on the presence of an eccentric raphe, distinct fibulae forming a fibular plate and a dorsiventral valve outline. The third taxon is most likely a new *Catenula* species, a small amphoroid genus with only marginal striae, a very simple raphe structure and non-perforated, narrow girdle bands. Finally, the fourth taxon clearly belongs to the genus *Planothidium* showing uniseriate striae on the rapheless valve and distinct, shallow depressions in the axial area.

Desrosiers, C. et al. (2014) Phycologia 53(6): 583–592, Frankovich, T. et al. (2016) Phytotaxa 272(2): 101–114, Majewska, R. et al. (2015) Phytotaxa 233(3): 236–250, Riaux-Gobin, C. et al. (2012) Fottea 12(1): 13–25.

#5. *PSAMMOTHIDIUM MANGUINII:* FROM ONE TO SIX…

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Psammothidium manguinii Hustedt is a common constituent of the limno-terrestrial diatom flora of the Antarctic Region with records ranging from the Maritime Antarctic region in the southern Atlantic Ocean to the belt of sub-Antarctic islands in the entire Southern Ocean. The species shows a broad variability in several morphological and morphometrical features such as valve outline, valve width, striation pattern and length/ width ratio. Hustedt originally described the species as *Achnanthes manguinii* in 1952 from several samples collected on Iles Kerguelen, the largest sub-Antarctic archipelago in the southern Indian Ocean. Two years later, Manguin (in Bourrelly & Manguin 1954) separated the more elliptical forms as *A. manguinii* var. *elliptica* Manguin. The material of the latter taxon, however, contained two morphologically distinct taxa with only one being similar to the original drawings. The present poster shows the morphological analysis of the type material of both *A. manguinii* (Hustedt material) and *A. manguinii* var. *elliptica* (Manguin material) together with an analysis of a large number of *P. manguinii* populations from the sub-Antarctic Region (with samples from all major islands in the southern Atlantic, Indian and Pacific Ocean). The results led to a clear morphological revision of the species. The original variety elliptica was split off the nominate form as *P. ellipticomanguinii* Van de Vijver. Four new species are described, *P. acutomanguinii* Van de Vijver, *P. antarcticum* Van de Vijver, *P. mannensianum* Van de Vijver and *P. hodgsonii* Van de Vijver et Verleyen. The morphology, ecology and distribution of all species are discussed. *Psammothidium antarcticum* is the most widespread of all six in the *manguinii*-group and found in both the Maritime Antarctic and sub-Antarctic region. On the other hand, *P. mannensianum* (Campbell Island) and *P. hodgsonii* (Macquarie Island) are restricted to only one island in the southern Pacific Ocean.

Bourrelly, P. & Manguin, E. (1954) Mém. Inst. Scientifique Madagascar, Séries B., Vol. V: 5–58, Hustedt, F. (1952) Bot. Notiser 1952: 366–410.

#6. THE PLANOTHIDIUM PERICAVUM/ENGELBRECHTII COMPLEX

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In 1966 John Carter described and illustrated Achnanthes pericava from the Tristan da Cunha Archipelago, a small island group located in the southern Atlantic Ocean. This species, transferred in 1999 by Lange-Bertalot to the genus Planothidium, is characterized by a rapheless valve lacking the typical spot of P. lanceolatum (sinus) or P. frequentissimum (cavum). The valves are elliptical-lanceolate with slightly protracted, broadly rounded apices.
Planothidium pericavum forms important populations on several islands in the southern hemisphere but it also seems resent in the northern hemisphere. Lange-Bertalot & Krammer (1989) illustrated the type of A. pericava and added several dubious conspecific populations from the Canary Islands, Chile and Catalonia. The ultrastructure of this species is unfortunately not known to date, which prevents to have a correct idea of the identity of Planothidium pericavum.
In order to disentangle the exact taxonomy of this species, populations of P. pericavum from Tristan da Cunha and Ile Amsterdam (southern Indian Ocean) as well as several European populations (Sicily, Flanders), identified as P. pericavum, were analyzed to determine their conspecificity with the typical population from Tristan da Cunha. As the species shows a clear resemblance to Planothidium (Achnanthes) engelbrechtii, described by Cholnoky in 1955 from South Africa, the type material of the latter was also investigated to compare it with the type of P. pericavum.
The poster presents the ultrastructure of the P. pericavum populations of the Tristan da Cunha Islands, Ile Amsterdam Island, Sicily and Flanders and the type of P. engelbrechtii. Each population is illustrated using light and detailed scanning electron microscopy. The similarities and differences between the different populations are highlighted

#7. DIATOM COMMUNITY DYNAMICS IN GEORGIA STREAMS WITH REPEATED SAMPLING

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Evaluating water quality in aquatic systems through time is important for the understanding and maintenance of healthy ecosystems. Using biota in assessment is useful as biological communities integrate the chemical and physical characteristics of environment. Diatoms are valuable indicators of ecosystem conditions and species composition and abundance in Georgia streams have been assessed. Diatom community indices are incorporated into the state of Georgia assessment of state's waters strategy. This project began in 2008 with a total of 550 samples collected. Surface waters in the State of Georgia, USA by law have to protect human health, fish conservation, wildlife, and other beneficial aquatic life. Wadable streams and rivers in the State of Georgia were sampled following standard protocols by Environmental Protection Division biologists. Diatom community composition and physicochemical characteristics at each site were assessed and compared. In this project we present 70 common diatom taxa for the streams sampled at least 3 different times. Population morphology and size descriptions through time were use stream classification and changes. Unique diatom water quality index was tested on documented community and compared to other indices in the literature. Species richness, dominance, diversity and presence of Cymbelloid vs Naviculoid/Nitzschioid diatoms suggest 70 % of the streams evaluated can be classified having good or excellent water quality. Changes in stream water quality through time are reported.

#8. CREATING DIATOM VOUCHER FLORA, INVESTIGATING SAMPLING METHODS AND POSSIBLE *GOMPHONEMA PARVULUM* MORPHOTYPES FOR SOUTHEASTERN TRIBUTARY UPPER THREE RUNS CREEK

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Water quality monitoring through biological assessments is important for collecting and analyzing data concerning nutrient enrichment. Nutrient loading has led to degradation of fresh water ecosystems and surface water resources. The mediation of impacts caused by nutrient enrichment has cost the United States billions of dollars annually. Due to the scarcity and necessity of these resources to provide potable water, productive fisheries, and safe recreational areas, it is imperative that the water quality of these systems is protected. Diatoms have been found to indicate changes in water quality better than other biota (fish and macroinvertebrates) currently used in biological assessments. Therefore, understanding diatom biodiversity would yield insight about the eutrophication of an ecosystem and consequently its protection. However, diatom biodiversity in the southeastern United States remains largely unknown. To better understand diatom communities and condition gradients, the U.S. Geological Survey and other North American institutions have created "voucher flora" consisting of light micrographs of samples with corresponding names associated with each diatom and project. The Savannah River is one of Georgia's largest rivers, which provides potable water to an estimated 1.4 million people. Upper Three Runs Creek (UTRC) is a tributary of the Savannah River, and is known as a southeastern biodiversity hotspot. This creek is designated by the Savannah River Site to receive minimal anthropogenic impacts and serve as a control site in scientific studies. The Academy of Natural Sciences of Philadelphia used diatometers in past water quality assessments of UTRC. These studies found an overwhelming dominance (75%) of *Gomphonema parvulum*, making conclusions about water quality difficult. In this study: 1) we created a voucher flora for an upstream site along UTRC, 2) compared algal biodiversity estimates from different sampling methods, and 3) assessed possible *G. parvulum* morphotypes from this study and past studies. Our methodologies consist of collecting samples from two periphytometers (deployed from both the right and left banks of the creek) and composite samples. High diatom biodiversity at our site and species richness similarities across collection methods are discussed.

#9. AN EXTINCT DIATOM SPECIES AND GENUS FROM THE LAKE MALAWI DRILLCORE?

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A fossil diatom observed from the Lake Malawi drillcore record likely represents a new species and monotypic new genus. Specimens were observed in a sample estimated to be approximately 22,000 years old. Specimens occurred very rarely - less than 0.3% relative abundance of the assemblage. Here I present images of the 'new species' as characterized using light and electron microscopic observations. The specimens observed have a bilateral (naviculoid) morphology, superficially similar to *Aneumastus* in light microscopy, but with a single central stigmoid and an undulate raphe that terminates in heteromophic ends that hook in opposite directions. In SEM, a series of marginal wavy longitudinal ribs cross the exterior of the frustule in outside of the sternum, highlighting its unique ultrastructure. The species likely is a benthic diatom, fortuitously preserved in a very deep water lake environment as a result of downslope sediment focusing from hyperpycnal flows into the basin. No specimens of the species have been observed in any of the other sediment core samples collected from Lake Malawi and no extant specimens have been observed from the lake, suggesting that it likely represents an extinct species (and genus) with a very short geological range.

#10. THE EFFECT OF WATER TRANSPARENCY FLUCTUATION ON DIATOM ASSEMBLAGES OF LAKE ANNIE, FLORIDA

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Lake Annie is a monomictic, subtropical lake in Florida that exhibits a multi-decadal oscillation in water transparency. Previous research examined a rare 35+ year limnological monitoring record to show that transparency is controlled by influx of colored dissolved organic carbon (DOC) driven by the Atlantic Multidecadal Oscillation (AMO) that controls the region's rainfall. The AMO oscillates between a cool phase, where the mean rainfall is less than the long term mean, and a warm phase, where the mean rainfall is higher than the long term mean and more variable among years. Lake Annie's water clarity is clearer in an AMO cool phase because of lower water column DOC concentrations that produce secchi depth ranges from 3-8 meters, in contrast to AMO warm phases when high DOC concentrations reduce the secchi depth range to 1-5 meters. Monthly phytoplankton samples were taken during an AMO warm phase, from 2006 to 2018, when secchi depth ranged from <1 to over 6 meters, reflecting highly variable regional rainfall. Our goal was to determine the effect of intra- and interannual fluctuations in water transparency on phytoplanktonic diatom assemblage composition. A strong relationship between diatom assemblage composition and transparency would allow us to develop a transfer function to reconstruct a longer (500 year) record of water transparency in Lake Annie to help resolve the role of the AMO in driving Florida's paleoclimate.

#11. DIATOMS OF THE INDIAN OCEAN: FINE STRUCTURE OF FOUR COSCINODISCOID DIATOMS OF SPECIAL INTEREST

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We are currently updating a checklist of Indian Ocean diatoms originally created by Professor TV Desikachary as a companion to his *Atlas of Indian Ocean Diatoms*, by updating the nomenclature, adding new records from the literature, and examining archived samples of marine diatoms from the collection of Prof. Desikachary, as well as additional materials collected by AKSKP. Here we describe the fine structure of four coscinodiscoid diatoms of special interest. *Coscinodiscus alboranii* Pavillard is noteworthy for its weakly silicified structure, two types of areolae on the valve face and a marginal ring of endochiastic areolae. Two macrolabiate processes are located ~120^{o} from each other in the ring of endochiastic areolae; a ring of microlabiate processes is located farther from the edge of the valve. *Coscinodiscus reniformis* Castracane is easily recognized by the reniform shape of the valve. In *C. reniformis* there is a ring of closely spaced microlabiate processes near the edge of the valve, connected on the exterior by narrow slits; numerous additional microlabiate processes are scattered over the valve face. Two macrolabiate processes are located away from the edge at ~180^{o} from each other along the short axis of the valve. The structure of *Coscinodiscus* sp A is more typical of the genus *Coscinodiscus*. However, in this case, instead of single macrolabiate processes in the ring of marginal processes, they occur in pairs or triplets, sometimes in conjunction with one or more microlabiate processes. All three of these taxa challenge our current understanding of the genus *Coscinodiscus*. We also examined dominant populations of what we identify as *Coscinodiscus concinnus* Wm. Smith sensu E. Cupp 1943 from net hauls collected from the adjacent waters of the Gulf of Thailand that may represent a previously unrecognized taxon in the *C. concinnus*-*C. concinnoides*-*C. concinniformis* species cluster.

#12. LIGHT AND ELECTRON MICROSCOPE OBSERVATIONS OF NITZSCHIA OSSIFORMIS IN THE NORTHEASTERN GULF OF MEXICO

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During a systematic investigation of the phytoplankton in the northeastern Gulf of Mexico in the aftermath of the Deepwater Horizon blowout we encountered a population of *Nitzschia ossiformis* (Taylor) Simonsen (=*Synedra ossiformis* Taylor) located about 75 km offshore and concentrated at a depth of 60-80 meters. The density of individuals in the population was sufficient to make detailed observations using light and electron microscopy. Cells are solitary or united into short ribbon-like colonies, although occasionally ribbon-like colonies partially separate to form zig-zag colonies. Individual cells have two plate-like plastids. The valves are linear, inflated at the center and at the poles, 60 to 100 µm long, 2.3 to 3.1 µm wide at the widest point in the center. The inflated poles have a distinct concavity, giving them an ossiform appearance. In SEM, the valves are clearly heteropolar: a transverse furrow can be seen in the exterior surface of one of the poles; the other pole lacks this furrow and instead has a small flap of silica that follows the outline of the valve end. The number of striae in 10 µm ranged from 21 to 24. Striae are formed by two rows of circular poroid areolae occluded by hymenes with a hexagonal array of small pores. An eccentric canal raphe is located along the margin, just visible in light microscopy, clearly evident in electron microscopy. The densities of fibulae and striae are approximately equal. The median fibulae are somewhat distant from each other, creating a central interspace. Internally, the two branches of the raphe meet in a small central nodule and end in small helictoglossae. No external terminal fissures were observed. In its general features, this species conforms most closely to the genus *Fragilariopsis*. However, the unique features present at the poles seem to warrant its placement in a separate genus.

#13. EXTENSIVE CHLOROPLAST GENOME REARRANGEMENT AMONGST THREE CLOSELY RELATED *HALAMPHORA* SPP. (BACILLARIOPHYCEAE), AND EVIDENCE FOR RAPID EVOLUTION AS COMPARED TO LAND PLANTS

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Diatoms are the most diverse lineage of algae, but the diversity of their chloroplast genomes, particularly within a genus, has not been well documented. Herein, we present three chloroplast genomes from the genus *Halamphora* (*H. americana*, *H. calidilacuna*, and *H. coffeaeformis*), the first pennate diatom genus to be represented by more than one species. *Halamphora* chloroplast genomes ranged in size from ~120 to 150 kb, representing a 24% size difference within the genus. Differences in genome size were due to changes in the length of the inverted repeat region, length of intergenic regions, and the variable presence of ORFs that appear to encode as-yet-undescribed proteins. All three species shared a set of 161 core features but differed in the presence of two genes, *serC* and *tyrC* of foreign and unknown origin, respectively. A comparison of these data to three previously published chloroplast genomes in the non-pennate genus *Cyclotella* (Thalassiosirales) revealed that *Halamphora* has undergone extensive chloroplast genome rearrangement compared to other genera, as well as containing variation within the genus. Finally, a comparison of *Halamphora* chloroplast genomes to those of land plants indicates diatom chloroplast genomes within this genus may be evolving at least ~4–7 times faster than those of land plants. Studies such as these provide deeper insights into diatom chloroplast evolution and important genetic resources for future analyses.

#14. CHARACTERIZATION OF THE DIATOM COMMUNITIES ON SANTA CATALINA ISLAND, CALIFORNIA

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Recently, California State University – Long Beach formed a collaboration with the Catalina Island Conservancy (CIC), who is steward to 84% of the island. Santa Catalina Island has 14 intact watersheds that are relatively unstudied and, compared to the mainland, these watersheds have experienced very little anthropomorphic disturbance and engineering. In January 2016, eight diatom samples were collected from four freshwater streams or seeps around the island. In June 2018 and April 2019, we resampled six sites, as well as two new sources. We are curious how the diatom communities on the island in 2016 will compare to those found in the same areas after drought conditions in 2018 and after above average precipitation in 2019. We also compared diatom communities collected from the same water way, but on different substrates (e.g. epiphytic, epidendric, sediment grabs, planktonic).

#15. A COMPREHENSIVE ENVIRONMENTAL AND DIATOM DATABASE FOR ASSESSING EVERGLADES RESTORATION

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The Everglades is composed of a diversity of aquatic ecosystem types, each with distinct biogeochemical conditions, plant and animal communities, and benthic algal assemblages. These attributes are naturally highly spatiotemporally dynamic, but are also subject to changes in freshwater and nutrient delivery and saltwater intrusion driven by global to local anthropogenic factors, including regional hydrologic restoration. A significant body of research has detailed the composition and function of benthic algal assemblages including a diverse and unusual karstic wetland diatom flora that is highly sensitive to environmental change. For this reason, diatom assemblage assessments are incorporated into Adaptive Monitoring and Assessment for the Comprehensive Everglades Restoration Plan. This project began in 2004 with quarterly assessments at over 150 locations selected to represent the greater Everglades ecosystem in a generalized random tessellation stratified design. After 2010, sampling was reduced to annual visits, resulting in 15 years of spatially-explicit biogeochemical and plant, animal, diatom and soft algae community data. We are assembling these data into a centralized relational database that includes 107 variables, 3,691 samples, and 388 diatom taxa. Morphological measurements, high-resolution images, environmental optima and range data, and relative abundance maps are available for 121 of the most common diatom taxa. The goal is a publically-available, pictorially-guided database of Everglades diatoms linked to morphological, biogeochemical and habitat descriptors. This poster presents our study design, workflow, database structure and example taxon description to promote exchange of ideas on the utility of this platform for advancing diatom science and for evaluating its compatibility with other diatom databases.

#16. ULNARIA CF. SPATHULIFERA FROM BURNT CEDAR BEACH, LAKE TAHOE, NEVADA

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We investigated populations of *Ulnaria* species from epilithic samples from Burnt Cedar Beach located along the north shore of Lake Tahoe in Incline Village, Nevada. A dominant species of *Ulnaria* had spatulate ends, similar to *Ulnaria ulna var. spathulifera* (Grunow) Aboal in Aboal et al. 2003 (basionym: *Synedra spathulifera* Grunow in Van Heurck 1881). However, the apical expansions of our specimens were more pronounced than those found in references. According to Van Heurck 1881, *Synedra spathulifera* was observed in Van Heurck slide 25. We attempted to obtain micrographs from the material associated with Van Heurck No. 25 from the Meise Botanic Garden, but the label on the Van Heurck material states the taxon *Synedra splendens* var. *subspathulata* Grunow. We do not know if this was a mistake in labeling. Additionally, we compared our specimens to references for other long araphid taxa with similarly spatulate apices found in the Pantocsek Diatom Collection at the Hungarian Natural History Museum, including *Synedra balatonis* Pantocsek 1902, *Synedra balatonis var. staurophora* Pantocsek 1902, and *Synedra rostrata* Pantocsek 1902. We studied the morphological variation within the Burnt Cedar Beach populations. The extent of apical expansion was not associated with seasonality (spring versus summer). We also investigated potentially inconsistent attribution of the names *Ulnaria ulna* var. *spathulifera* and *Synedra ulna* var. *spathulifera* in large bioassessment surveys.

#17. EVOLUTIONARY PATTERNS OF ADAPTIVE GENE EXPRESSION IN MARINE AND FRESHWATER DIATOMS

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Understanding how species colonize and diversify in new environments, including whether independent environmental transitions require the same genetic changes, are central questions in evolutionary biology. Gene expression variation is one of the mechanisms utilized by organisms to cope with highly variable environmental factors, such as temperature or salinity. Diatoms are common in both marine and freshwater habitats, a pattern resulting from many independent transitions across the salinity barrier. A number of such transitions are found in the order Thalassiosirales, a diverse group of centric diatoms that occurs in the full range of naturally occurring salinities. We want to determine what role gene expression played in these transitions and which genes facilitated them. We will measure and compare variation of gene expression in taxa across the lineage to reconstruct ancestral patterns of gene expression. Analysis of these data will reveal whether variation in expression levels is the result of natural selection or neutral drift. A total of 40 species, sampled across Thalassiosirales, will be grown across a range of salinities in a laboratory common garden experiment to characterize reaction norms indicative of salinity generalists and specialists. Transcriptome sequencing will allow us to reconstruct patterns of natural selection on gene expression and identify candidate genes involved in adaptation to low salinity. Successful colonists of novel salinity environments must first mitigate the stressors imposed by the new environment, so another set of experiments will characterize patterns of short-term (10 minutes to 48 hours) gene expression in response to exposure to a new, non-native salinity.

#18. A MORPHOLOGICAL STUDY OF LANCEOLATE NITZSCHIA TAXA FROM A MIDWESTERN NORTH AMERICA RIVER SYSTEM

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Small to medium-sized rivers in the agricultural prairie region of Midwestern North America deposit nutrient-rich layers of silt over sand or gravel beds as discharge recedes following river basin runoff events. Increased light penetrates to more of the riverbed when nutrient-rich water clears and the water level lowers; this supports the growth of algal films dominated by diatoms while temperatures are cool. Changes in runoff composition and frequency occur as both climate and land-use respond to natural and human activities. The response of diatom communities in rivers to these new water quality conditions includes changed abundance and taxonomic composition. Lanceolate Nitzschia taxa often dominate the epipelon of these river systems, frequently spreading onto epiphytic and epilithic substrata as well. These epibenthic growths often become tychoplankton in flowing waters. Advances in microscopy and information analysis among other technologies are enabling researchers to better describe taxonomic composition and develop better estimates of abundance. Nitzschia taxa with slender lanceolate forms have often been difficult to distinguish in the past. An example included in this study is *Nitzschia palea sensu lato*. This study examined several samples rich in lanceolate Nitzschia individuals using methodology being developed in response to the regulatory need for better description of diatom community structure response to water quality. High-resolution light microscopy yielded digital images that were studied using computer technology to produce collages illustrating size and shape variations. These were sorted into identified and unidentified taxa. The samples were collected from the Cedar River watershed in north central Iowa USA as part of a long term study extending over the past 45 years. The results are compared with the growing body of literature describing diatoms in rivers elsewhere.

#19. INCORPORATING DIATOMS INTO THE CLASSROOM

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Due to their global prevalence, diversity, and ecology, diatoms provide an excellent example of various aspects of biological and environmental sciences. This presentation will describe several activities that have been created or adapted as short classroom-based experiential learning activities. This includes a matching activity for diatom ecology and morphology, an activity for community change over time in response to environmental and anthropogenic stressors, an activity for community change over time and evolution. Additionally, a brief description of inexpensive stream mesocosms that can be used for long-term manipulation of diatom communities for laboratory-based classes. These activities are appropriate for courses in limnology, marine biology, phycology, ecology and evolution.

#20. EFFECTS OF HERBICIDE EXPOSURE ON DIATOM ASSEMBLAGES IN A STREAM MESOCOSM

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Do pesticides have an effect on the diatom assemblages found in freshwater rivers that come into contact with the runoff of land purposed for agricultural use? Various pesticides are utilized year-long to combat the ever changing population of biotic organisms that jeopardize the viability of agricultural yields. Texas is currently one of the largest pesticide users and sources of agricultural non-point pollution in North America. The presence, concentration, and ecological effects of pesticides in Texas streams are not well understood. Diatoms are considered with high regard in terms of their use as bioindicators in determining the overall health of aquatic systems. Diatoms, while able to live in nearly any place with a bit of moisture and light exposure, have limitations and environmental optima that can be discerned based off of multiple factors, reasonably including tolerance towards toxic compounds. This research project utilized eight artificial streams in a paired replicate study with controls to experimentally study the potential chronic exposure effects that the common pesticides glysophate (the main ingredient of RoundUp) and Terbacil may have on the diatom assemblage of the Colorado River at the Timberlake Biological Field Station near Goldthwaite, Texas. These two herbicides are of particular interest at this site because Terbacil is a commonly used herbicide at pecan plantations just upstream of the field station, and a long-term project to remediate a field of Bermuda grass near the river at the field station is considering the use of herbicide. Epilithic and epipelic diatom communities were collected from a site within the Colorado River along with river water to ensure more accurate comparisons among stream mesocosms. The artificial streams created an environment that mimicked the actual river as closely as possible. Each treatment stream was exposed to one of the pesticides in chronic low concentrations that accumulated over time in the closed system. Diatom communities were subsampled weekly and enumerated; comparisons between the control and the treatment were assessed. While such experiments can elucidate chronic exposure effects on community assemblage, more research is needed to understand the interactions that herbicides have with the individual species of diatoms.

#21. THE RELATIVE INFLUENCES OF TURTLE ECOLOGY AND AMBIENT WATER QUALITY ON DETERMINING THE COMMUNITY COMPOSITION OF EPIZOIC DIATOMS

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Diatoms often attach themselves to the carapaces of aquatic turtles. Studies conducted in Oklahoma on museum specimens of the common snapping turtle suggest that some species of diatom specifically live on turtles; they do not live on other substrates within their environment (Wu and Bergey, 2017). However, no studies of this kind have been conducted in Texas. This study considers the relative importance of water quality, substrate availability, and aspects of turtle ecology and behavior on the diatom community assemblage. We sampled at least 10 individuals each from specimens of 5 different aquatic turtle species for the presence of epizoic diatoms. The carapace was scrubbed with a test tube brush to collect samples before releasing the turtle. Museum specimens were sampled to consider differences among different species. To consider potentially confounding influences of ambient water quality, various species of turtles were caught by live-trapping and by hand in the Trinity River Basin in Texas. In addition, turtles were trapped in nearby golf course ponds to consider potential influences of lentic versus lotic systems. Rocks were also sampled for epilithic diatoms for comparison. Water quality metrics such as TP, TN, conductivity, temperature, pH, and TDS were taken on site. Finally, diatom community composition from the same species of turtle (red-eared slider) were compared among different rivers. Preliminary results find that benthic species are dominant in all samples, including members of the genera *Luticola*, *Gyrosigma*, and *Gomphonema*. Statistical analysis considers the relative importance of water quality, substrate availability, and aspects of turtle ecology and behavior for the diatom community assemblage.

#22. TYPIFICATION OF THE PUZZLING DIATOM SPECIES *NEIDIUM IRIDIS* EHRENB. INCLUDING DNA FOR THE DIATOM LIBRARY

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Researchers have looked through the New York mica's (West Point) for *Navicula iridis* (e.g. Lange-Bertalot pers. Comm., P.B. Hamilton) but were not able to find a specimen of *N. iridis*. Katarzyna Stachura-Suchoples and Wolf-Henning Kusber were able to find two specimens from the New York (West Point) micas matching the line drawing of Ehrenberg. In addition, original material was found. The objective of this study is to circumscribe and emend the species description of *Neidium iridis* (*Navicula iridis*) using original and current samples from North America. Comparisons are also made with an unknown taxon, and two other closely related taxa *N. columnaris* (Ehrenb.) Mills and *N. maximum* (Cleve) F.Meister which have not been typified. Genetic data for *N. iridis* and other *Neidium* taxa are further used to identify a simple phylogenetic structure within the genus.

#23. MOLECULAR AND MORPHOLOGICAL DATA REVEAL HIDDEN DIVERSITY IN COMMON NORTH AMERICAN *FRUSTULIA* SPECIES (AMPHIPLEURACEAE)

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Frustulia Rabenhorst is an old established diatom genus that is common and widespread across North America. Like many diatom genera, *Frustulia* has been the subject of considerable taxonomic confusion. Although recent studies have examined taxa from Europe and New Zealand, there exists no detailed genetic data for North American individuals. Using both molecular (i.e. *rbcL* and 18S rRNA sequences) and morphological (i.e. frustule characters and shape analysis) data, we investigated common taxa from the genus *Frustulia* in North America. European and New Zealand taxa were also included in order to study how North American species were related. We recognized nine taxa in this study including three unknowns A new species, *F. gibsonea* sp. nov., is described. This species was found in previous studies and described as *F.* cf. *krammeri* based on morphology. The use of molecular characters in this study demonstrates that the group is a distinct species, not a morphotype of *F. krammeri* as was previously thought. Despite differences in phylogeny and molecular sequences, *F. gibsonea* and *F. krammeri* are quite similar morphologically, showing overlap using both traditional measurements and shape analysis. This suggests that the combination of molecular and morphological data can help in deciphering cryptic taxa. We were unable to separate *F. saxonica*, our identification of *F. crassinervia*, and *F. krammeri* based on molecular data alone, although they could be separated based on morphological characters. As evidenced by the low sequence divergence values obtained between the three taxa, they are very closely related. Future molecular research, focusing on less conserved genes, will likely be necessary to resolve the relationships of these taxonomic complexes. Alternatively, this morphological variation may be the result of phenotypic variation.

#24. DIATOMS AND ALGAE OF CANADA: A WEBSITE DOCUMENTING THE DIVERSITY OF CANADA

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The mandate of the National Museum (Canadian Museum of Nature) is to document for prosperity the diversity of life across Canada. The current collection and database includes 232,300 identifications from 50,000 collections with ca. 13,000 images. The presentation of this data and potential use to scientists and persons interested in diatom diversity and taxonomy is evident. To this end the database is linked to the globally recognized GBIF in coordination with other databases. In addition to the classical presentation of museum collections, we will be releasing (2020) new taxa identification pages to assist in the identification of Canadian diatoms and when appropriate with environmental data. The website/pages (like others) will contain simple taxonomic descriptions genera and species with the identification of key features, similar species and notes on community associations. The webpage presented here is an example of the data presentation, which will be linked to the national algae collection for Canada. Finally, we are exploring the use of a shape recognition search tool to assist in navigating and searching through the web pages.

#25. PARALLEL SEQUENCING OF DIATOM PLASTID GENOMES USING A BAIT-CAPTURE APPROACH

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The sequencing of diatom plastid genomes has revealed diverse evolutionary forces shaping these genomes. Genome architectural features like genome rearrangement, reduction and expansion have been documented, and gene content analysis has shown evidence of gene loss, duplication, pseudogenization and potential gains via horizontal transfer. Next generation sequencing has accelerated the accumulation of these data, with a total of 53 complete or nearly complete diatom plastid genomes publicly available. Still, this represents a very small sample of diatom diversity. We are using a sequence capture strategy to expedite targeted high-throughput sequencing of 200 plastid genomes from species that span the phylogenetic breadth of diatoms. We are using a biotinylated RNA probe set that was custom designed from ten previously sequenced diatom plastid genomes. These probes serve as "baits" for in-solution capture of plastid genome sequences from multiplexed Illumina DNA libraries. Both pre- and post-captured libraries are being sequenced to estimate capture efficiency and evaluate the costs and benefits of this approach in comparison to genome skimming as an alternative strategy for de novo sequencing and assembly of diatom plastid genomes.

#26. PALEOLIMNOLOGICAL ASSESSMENT OF HARMFUL ALGAL BLOOM TRENDS IN TEXAS RESERVOIRS

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Harmful Algal Blooms (HABs) caused by cyanobacteria and Prymnesium parvum are responsible for economic losses in tourism and fishing industries. The environmental factors that drive bloom formation and toxin production are not well understood. By identifying the environmental stressors that prompt HABs, lake management strategies can be improved to reduce HABs and unhealthy lake occurrences. This project investigates the dynamics of HABs in Texas reservoirs over the past ~100 years in order to identify potential trends of increasing bloom events like those occurring in northern lakes, correlating those trends with potentially important environmental stressors. Diatom subfossils were collected from sediment cores collected from three Texas reservoirs, and their relative species abundance was used to infer environmental conditions over the last 60-80 years. Sedimentary DNA from those cores indicated the occurrence of bloom events, and further HPLC analysis determined if blooms were toxin producing. The occurrence of events such as floods and drought were detected using X-ray diffraction, which assessed mineral composition and grain size. Additionally, as a supporting proxy for nutrient loading and salinity, the relative abundance of elements 1-92 was assessed using X-ray fluorescence. The cores will be dated using Cs-137, charcoal deposits, and sedimentation rate data maintained for the reservoirs. Additionally, we used sedimentary genetic markers to determine if P. parvum is a native or invasive organism in North America, the earliest reported presence of which occurred in 1980. This project serves to develop the potential to apply paleolimnological techniques to reservoirs, which are largely understudied due to their short lifespan and challenges associated with their hydrology and deposition. Nonetheless, reservoirs are commonly used sources of freshwater and often the only source of paleolimnological records in arid regions, and so contain a wealth of untapped data.