Personal Statement
Kyle T. David

Personal Background. For a kid passionate about biodiversity, Chicago was a good place to grow up. I spent more weekends than I can count at either the Shedd Aquarium or the Field Museum of Natural History, located ~500ft from one another on Chicago's Museum Campus. Even then I found visits more rewarding with an audience. I spent almost every birthday of my childhood at either the aquarium or museum, rattling off fun facts and natural history tidbits as I played tour guide for my friends. It wasn't long before I moved to the other side of the glass, spending summers and weekends as a guest engagement volunteer at both institutions. I was also fortunate enough to work behind the scenes at the Field Museum, identifying and preparing samples in both the mammal and marine invertebrate collections. In the summer of 2011, I was accepted into the Shedd Aquarium's High School Marine Biology program that gave me my first field experience in the form of a week-long research cruise on the R/V Coral Reef II. Together these two institutions provided me with a robust scientific toolkit as well as a vehicle for sharing my passion with others. More than anything these early opportunities gave me an appreciation for the **immense amount of animal biodiversity on earth.**

Intellectual Merit. My research interests are best characterized by a desire to understand relationships across animals and the evolutionary processes that produced them. To me, this means working with marine invertebrates because of the 35 commonly recognized animal phyla all but 2 exist in the marine environment and over half reside there exclusively. In addition, many invertebrate groups are also severely understudied relative to their diversity. Surprisingly, vertebrates represent 55% of animal species with sequenced genomes despite representing just 4% of animal species total[1]. I was able to take advantage of multiple opportunities working with marine invertebrates early in my career at the University of Miami, which I attended as a marine science & biology double major on a Presidential scholarship. I participated in several projects at the University of Miami Experimental Hatchery, where I was introduced to the recent and ongoing debate over our most distantly related animal relative: sponges or ctenophores? I was excited and challenged to learn just how much is left to discover about even **the biggest questions in animal evolution**. I also gained an appreciation for the relationship between biodiversity and evolution, how increased sampling across species provides resolution to our understanding of evolutionary relationships and processes.

Upon returning from study abroad in the Galápagos in the spring of 2016, my professor, Dr. Lynne Fieber, said that while she didn't have the time to mentor another student directly, she would allow me to use some of her experimental animals (the sea slug *Aplysia californica*) and resources for an independent research project. I spent several days reviewing literature, developing a question and an experimental method to explore it. I designed sets of behavioral trials to observe mating strategies within a cohort of *A. californica* while altering food availability in order to study mating role choice. I discovered that animals were more likely to act as males when paired with a partner who was better fed. I presented my findings at the RSMAS Undergraduate Research, Creativity, and Innovation Forum and was also featured in a science radio segment at Northwestern University. **I was able to publish this work as first author in the *Biological Bulletin***[2]. This experience was crucial in developing my independent thinking skills and learning the ropes of the scientific method firsthand.

Not until near the end of my undergraduate career did I realize the importance of molecular data in resolving some of the oldest and most controversial animal relationships that I was interested in studying. Coming from a more organismal background, I did not feel I had the appropriate skills and knowledge to excel in a phylogenetics graduate program. I decided to take a gap year to return to the Field Museum to work in the Pritzker DNA Lab where I developed molecular

skills with Sanger as well as massively parallel (Illumina) sequencing platforms. **I was able to apply my new molecular skills to a biogeographical analysis of a South American cichlid resulting in my second publication**[3].

After my gap year, I joined the Halanych Lab at Auburn University with a **Peak of Excellence Graduate Fellowship** for my first year. Within my first year, **I published a short first author paper**[4] on the mitochondrial genome of a marine worm, *Dinophilus gyrociliatus*, and have two additional first author manuscripts in preparation. The first (*Molecular Biology and Evolution*, in prep) is a gene evolution study comparing differences in selection pressure between genes following duplication vs. speciation events. I presented this work at the 2018 Society of Systematic Biologists standalone meeting and will present at the Society for Integrative and Comparative Biology meeting in 2019. For the second paper[5] (currently under consideration at Nature), I was interested in species representation in high-throughput sequencing experiments. Surprisingly, I found **that species evenness has been decreasing steadily over time, with more experiments focusing on relatively fewer species**. This highlights the need to increase sequencing efforts on understudied groups to improve our understanding of animal diversity and evolution. This past summer, I was selected to participate in the Workshop on Molecular Evolution at the Marine Biological Laboratory. There I received intensive training in the latest phylogenomic methods and was able to discuss my research with many pioneers in computational molecular evolution. I am eager to take what I have learned about species and gene tree inference and apply it to large unresolved questions in animal evolution. Each of these projects and experiences have helped lay the groundwork to my proposed research exploring phylogenomic relationships and gene duplications in an enigmatic and understudied group of marine worms (see **Research Statement**).

Broader Impacts. I have long maintained a commitment to science communication. My background in museum and aquaria outreach has shown me how biological specimens can bridge the gap between hard science and an engaged public audience. **As president of the University of Miami Aquarium Club, I learned that local organisms displayed in a natural setting can serve as ambassadors for conservation**. Many people aren't aware of the breadth of local biodiversity and are much more likely to care when introduced firsthand. Through outreach I was able to almost double the membership of the club while president. **During my semester abroad in the Galápagos Islands, I volunteered at the Tortoise Breeding Center**. In addition to helping the tortoises directly I was also able to interact with tourists and locals to raise awareness for this unique and vulnerable species. As with my work at the Shedd, Field, and Aquarium Club, I learned to use specimens as a tool to foster engagement and education with a public audience.

As a graduate student I am increasing my efforts toward science communication. For the previous two semesters, I have been an active participant in **Skype a Scientist, a program that matches researchers with K-12 classrooms all over the world**. This provides a great opportunity for science education and also gives younger students an idea of what being a scientist is like. Last spring I used specimens collected by my lab to teach basic evolutionary concepts (homology vs. analogy, extinct vs. extant, sister groups). Afterward the teacher asked if I would consider meeting with the other 3rd grade classes as well. In one class some students even decided to skip recess in order to talk with me a little longer. I currently meet with 2-4 classes a semester; however with a GRFP award I would be able to increase this number up to 8-10. Online outreach is an effective way to disseminate science education to a wide audience; however, it is no substitute for local engagement. According to a 2010 census **my county (Lee**

County, AL) is 23% African-American and 22% impoverished, two demographics that have been historically excluded from STEM higher education. According to the National Assessment of Educational Progress, Alabama ranks #46 in scientific literacy for 4th graders and #49 for 8th graders. Alabama is also part of the Established Program to Stimulate Competitive Research (EPSCoR), meaning it is targeted by the NSF in order to improve STEM capability and capacity. The lack of science education in Alabama is perhaps surprising given that Alabama is also one of the most biodiverse regions in the U.S., with more freshwater fish, mussel, snail, crayfish, and turtle species than any other state. Unfortunately, Alabama is also home to 123 endangered species according to U.S. Fish & Wildlife, the third highest in the country.

Exposure to biodiversity through both living and preserved specimens was crucial to my development as both a scientist and conservationist. In an effort to provide others with similar experiences I have worked closely with the Auburn University Museum of Natural History in open house and outreach events in an effort to educate local communities on the diverse and imperiled animal groups living in their own backyard. Last fall, I helped run the Destination STEM program, an interactive experience for Alabama middle and high school students to engage and meet with researchers. **I educated participants using specimens from the invertebrate collection, including both local freshwater species as well as deep-sea specimens they would be unlikely to see in a zoo or aquarium**.

Financial support from my degree program requires a teaching assistantship on-campus at Auburn University. A GRFP award would allow me to devote more time to education and outreach efforts directed at K-12 students locally and abroad. One program I would be able to participate in is the **Summer Science Institute (SSI), an advanced STEM program for gifted 11th and 12th grade Alabama students from underrepresented backgrounds**. Dr. Rita Graze from the Department of Biological Sciences at Auburn has received funds to expand the program as part of a new CAREER award. I will run a biodiversity and phylogenetics module as part of the SSI. Students will create their own phylogenies from morphological characters of biological specimens and compare and contrast them with trees inferred from molecular data.

Future Goals. I am motivated by a desire to understand the evolutionary patterns and relationships that contribute to the incredible amount of animal diversity we see on earth today. I believe this goal is best accomplished through broad, comprehensive sampling. However, my recent research has shown that despite having access to more genetic data than ever before, molecular research is still largely biased toward the same small minority of species[5]. Throughout my career, I aim to address this imbalance by sequencing understudied organisms in order to gain a greater understanding and appreciation of animal evolution. This goal is paired with an intense desire to share my passion with others, particularly those who have not yet had the exposure to biodiversity that I benefited from early in my career. I believe an engaged, hands-on approach is the best way to improve scientific literacy and raise awareness for conservation. My long-term goal is to become a curator of invertebrates at a natural history museum that would grant me access to a wide variety of specimens for research in addition to allowing me to focus outreach toward a public audience. A GRFP fellowship would be instrumental to helping me achieve these goals.

[1] Dunn & Ryan. (2015). *Current Opinion in Genetics & Development.* **[2] David** et al. (2016). *The Biological Bulletin.* **[3]** McMahan…**David** et al. (2017). *PloS one*. **[4] David** & Halanych. (2017). *Mitochondrial DNA Part B*. **[5] David** et al. (2018). *Sequencing Disparity in the Genomic Era*. Manuscript submitted to Nature.