This is provided as an example proposal.
It is important that you follow the current guidelines.
The mentor letter has been removed.

PURF COVER PAGE

TITLE OF PROJECT: New Jurassic fossils from Utah: testing species identity, reproduction strategy, and paleoenvironment

NAME OF APPLICANT: Kelly O'Meara
CAMPUS/LOCAL ADDRESS: 35 N McKinley Avenue, Athens Ohio
E-MAIL ADDRESS: Km537616@ohio.edu
DEPARTMENT: Geological Sciences

BUDGET: Total Request $1,462.43
(May not exceed $1,500)

CLASS RANK: ◯ Freshman ◯ Sophomore ◯ Junior ◉ Senior
GPA: 3.0
EXPECTED DATE OF GRADUATION: May 2021 *

* Note: Students must be enrolled and maintain undergraduate student status during the proposed project period.

FACULTY MENTOR INFORMATION:
NAME: Alycia Stigall
E-MAIL ADDRESS: Stigall@ohio.edu
CAMPUS ADDRESS: 316 Clippinger Labs
DEPARTMENT: Geological Sciences
DEPARTMENT ADMIN/E-MAIL: cas-central@ohio.edu

We the undersigned have read the PURF Guidelines and understand the responsibilities we undertake should funding be granted.
We certify that the application has been conceived, written and completed by the student.

Student signature: Kelly O'Meara Date: 9/28/20
Faculty signature: Alycia L Stigall Date: 9/28/20
Faculty Advisor's Dept. Chair signature: Alycia L Stigall Date: 9/28/20

IRB AND IACUC APPROVAL:
To ensure that the University is in compliance with all federal regulations, complete the checklist below. *Note: your proposal can be approved prior to IRB or IACUC approval (put "pending" or "to be submitted" instead of approval number), but funding will be withheld until notification of approval or exemption.*

Yes	*No*	*Office of Research Compliance*	*Policy #*
☐	☑	Human Subjects in Research (including surveys, interviews, educational interventions): Institutional Review Board (IRB) Approval #: Expiration Date:	19.052
☐	☑	Animal Species: Institutional Animal Care & Use Committee (IACUC) Approval #: Expiration Date:	19.049

☑ **Optional:**
If selected for funding, I give permission to the Research Division to use my proposal as an example during training and workshop exercises. (Sign below)
Signature: Kelly O'Meara Date: 9/28/20

Abstract

In this project, I will identify and analyze a set of newly collected fossil crustaceans from the Jurassic Moenave Formation in Southwestern Utah. These crustaceans belong to the Order Spinicaudata. Spinicaudatan fossils from North America are poorly known, and these fossils likely represent new species. Scanning electron microscopy (SEM) imaging will be used to analyze and classify these spinicaudatan specimens. Spinicaudatans live exclusively in temporary pond environments, and are key environmental indicators that can be used to help reconstruct the Mesozoic environment in North America. This work is important in expanding our understanding of this important order of freshwater crustaceans.

Goals and Scope

The goal of this project is to describe a new collection of fossil spinicaudatans found in the Moenave Formation of Southwest Utah. Spinicaudatans have an incomplete fossil record and this new data that I will collect describing the morphology, ontogenetic history and carapace composition will allow for reconstruction of Mesozoic environments in North America. This data will also be used to identify mating strategies. Reconstructing the Mesozoic environment can reveal important information about climate and environment which can help understand other important animals that lived during this Era like dinosaurs and early mammals. Filling in the gaps of spinicaudatan data will help in understanding evolution of these organisms and the ecosystems they lived in.

Context

The Order Spinicaudata is a group of branchiopod crustaceans that is defined anatomically by a translucent body enclosed by a bivalved carapace, compound eyes and two pairs of antennae (Fig 1). They use trunk legs to swim and feed on algae, detritus, and bacteria (Carpenter, 1969). Spinicaudatans inhabit ephemeral pools of freshwater. This habit is indicative of a seasonal climate, where water availability fluctuates. Spinicaudatan fossils have been found transcontintenally making them great paleoindicators.

Figure 1. Image of a live spinicaudatan

The carapace, or external shell that covers the central body, is the only preserved part of most spinicaudatan specimens fossils. However, the carapace is rich in biological information that can be collected from it. For example, the ontogenetic (growth) history of each animal is preserved as discrete layers in their carapace due to incomplete ecdysis during each molt cycle (Stigall and Hartman, 2008). Spinicaudatans exhibit multiple mating strategies that are linked to the environment (Hurst and Peck, 1996). Carapace morphology varies between genders and can be

used to identify the mating strategy of a species [ex. dioecious (separate males and females) vs. hermaphroditic (female only)] (Stigall et al., 2013). Population distribution of spinicautans will be analyzed by variance in carapace shape between males and females. The number of growth lines present on a carapace can also be used to identify the age of a spinicaudatan.

The Moenave Formation, where the spinicaudatan specimens were collected is located in Southwestern Utah (Fig. 2). The Moenave Formation is composed of red to brown in color sandstones, siltstone and mudstone deposited by rivers and lakes (Kirkland et al 2014). The presence of ephemeral lakes and streams along with burrowing activity of organism and lack of evaporites indicates a seasonally arid climate when these sediments were deposited (Tanner and Lucas, 2007). These rocks were formed during the Jurassic Period between 190 and 200 Mya (Million years ago). The oldest bed in the Moenave Formation is the Dinosaur Canyon Member which is known for its preservation of dinosaur tracks within floodplain deposits. The study specimens were collected from the Whitmore Point member, which includes mostly lake deposits.

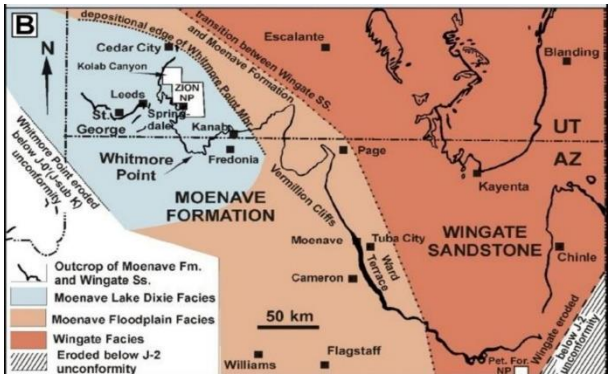

Figure 2. Map of Moenave Formation located in Northwestern AZ and Southwestern UT. Modified from Kirkland et al. (2014)

Methods

Within this project, I will employ the new collections of spinicaudatan fossils to test three hypotheses.

1. The spinicaudatan specimens belong to a previously identified family, genus, and species. The alternate hypothesis is that these specimens represent a species new to science. Detailed morphological comparisons will be used to test this hypothesis.

2. The spinicaduatan species in this collection exhibited a dioecious mating style, in which male and females are morphologically distinctive. The alternate hypothesis is that discrete gender

morphologies are not present in the population. Carapace shape analysis will be used to test this hypothesis.

3. These spinicaudatans lived in ephemeral pond environments with seasonal climates. This hypothesis will be tested by examining the sediment in which the spinicaudatans were preserved for sedimentary characteristics and any other fossils that may inform on depositional environment.

The spinicaudatan fossils that will be the primary focus of this project were previously collected from the Moenave Formation and are available to study in Clippinger Lab. Approximately 40-50 fossils comprise the collection available for analysis.

For the first part of my study, I will use digital calipers to measure each of my specimens to determine standard carapace lengths, width, and ratio measurements. After preliminary data collection, I will choose the best-preserved specimens for Scanning Electron Microscope imaging. I will use SEM imaging to identify morphological features such as growth lines and ornamentation and to determine the chemical composition of the carapace. The SEM is capable of magnification up to x300,000 and will allow for creating 3D surfaces of the carapaces (Fig. 4). This magnification ability is critical to visualize and document the fine microstructure that is present along growth bands, which is a key morphological detail needed for accurate classification. SEM analysis also contains the necessary EDS equipment to characterize the chemical composition of the spinicaudatan carapaces, which provides data for environmental interpretations.

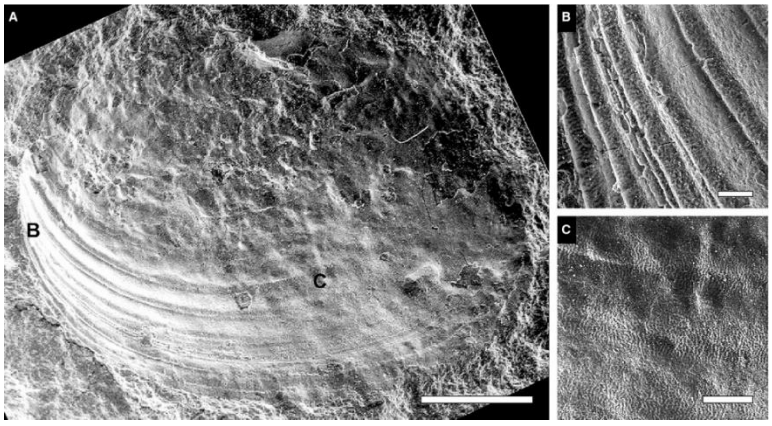

Figure 3. Figure 3: SEM image of Hardapestheria maxwelli carapace (Stigall et al., 2013)

SEM imaging will allow me to classify the fossils correct family, genus, and species (test hypothesis 1) based on the main types of ornamentation, appearance of grooves, appearance of spots, change of grooves from radial to dendritic and change of pattern (Carpenter, 1969). Distance between and number of growth line will be measured to determine the developmental stage of these spinicaudatans.

Morphological data about carapace shape will allow me to test hypothesis 2 and determine if sexual dimorphism occurs in this species of Spinicaudata. This will be done by plotting the carapace shape data using correspondence analysis to identify whether two discrete morphological clusters occur using the methods of Astrop et al. (2012).

Environmental reconstruction (hypothesis 3) will be tested by examining the chemical composition of the spinicaudatan carapaces compared to the sedimentary matrix to determine how the fossils were altered. If specimens were replaced with minerals different than the carapace mineralogy of living spinicaudatans, this will indicate specific environmental conditions. Similarly, if other fossils of organisms such as ostracods are present on the rocks, that will provide additional information to better interpret the climate and environment in which the spinicaudatans lived, specifically water availability and seasonality of the climate.

Significance

As very little systematic research has been done in North America, this research will likely result in the description of a genus or species of spinicaudatan that is new to science. Most prior work on fossil Spinicaudata of North America lacked SEM imaging, and key indicators could not be identified. This study will allow the full biological information preserved in these fossils to be utilized to describe the entire life history of these organisms. Spinicaudata are useful environmental indicators. Therefore, analyzing these spinicaudatans will provide key data to better reconstruct the

environment of western North America during the Jurassic Period. In particular, these fossils will provide constraints on the amount of water and seasonality present in southwestern Utah around 190-200 million years ago.

Timeline

- September: Preparing grant applications and writing senior thesis proposal for the department.
- October: Developing initial identification of specimens to the family level; conducting preliminary/ background research and assemble key literature for the identified family.
- November-early January: Imaging specimens with SEM; developing genus and species level identification; comparing EDS data with environmental parameters.
- Late January: Developing final species identification and environmental interpretations.
- February-March: Writing and revising thesis.
- March 14-16: Present results at Northeastern Regional GSA meeting.
- April: Defense thesis and prepare submission to the *Journal of Paleontology* to disseminate results.

Students Role

Dr. Stigall is a leading expert in fossil spinicaudatans, and the fossils that will be examined in this project were collected by Dr. Stigall's colleagues. Dr. Stigall notified me that these specimens were available to study, but the research on these specimens is an independent project that I am undertaking. Dr. Stigall is training me in the appropriate methods, but developing the species images, identifications, and interpretations will be work conducted independently by myself. This project is separate from any other projects ongoing within the Stigall Lab.

Bibliography

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Biographical Information

As an undergraduate senior in Ohio University's Geological Sciences department I feel equipped with the knowledge and experience to take on this research project. My relevant course work includes GEOL 3400: Introduction to Paleontology, GEOL3400: Sedimentology and Stratigraphy, GEOL 2550: Historical Geology and GEOG 3600: Cartography I. My hands on experience with identifying numerous well-preserved fossils in my previous Paleontology class will be useful in identifying spinicaudatan carapace morphology. I have learned ArcGIS Pro and Adobe Illustrator software in previous GIS courses which I will use to create maps and images that aide in the understanding of the fossil specimens.

I am passionate about the Geological Sciences, and I incorporate that into my everyday life by collecting Cincinnatian fossils at parks, traveling and hiking. I have been to Zion, Grand Canyon and Bryce Canyon National Parks and studied the sedimentary rocks that are extremely similar to the rocks that have fossilized my spinicaudatan specimens. Hiking trips to the Western United States have familiarized me with identifying sedimentary structures.

Budget

Item	Amount	Source	Justification
Scanning Electron Microscope	$40 per hour for 15 hours= $600	PURF	SEM imagery is essential for analysis of specimens
GSA Registration fee for 2021 Northeastern section meeting in Hartford, CT	$75	PURF	Dissemination of research
Transportation to GSA meeting via personal car	.575¢ x 639 miles= $367.43	PURF	Dissemination of research
Hotel costs	$100 x 3 nights= $300	PURF	Dissemination of research
Per diem	$40 x 3 days= $120	PURF	Dissemination of research
TOTAL REQUESTED	$1,462.43		

Budget justification:

SEM analysis: Funds are requested to for 15 hours of time on the Scanning Electron Microscope located in the Ohio University Institute for Corrasion and Multiphase Technology: http://www.icmt.ohio.edu/technology/sem.asp. This machine operates in the necessary low vacuum mode for fossil imaging and also includes EDS equipment to identify elemental composition of the fossil material that is required for fully characterizing the sedimentary setting.

Travel Funds: Funds are requested to attend and present results of this research at the Northeastern Section meeting of the Geological Society of America in Hartford, CT from March 15-16, 2021: https://www.geosociety.org/GSA/Events/Section_Meetings/GSA/Sections/ne/2021mtg/home.aspx. Funding is requested for both registration and travel expenses. Should the meeting transition to a virtual format, only registration costs will be required and other funds would be returned to the PURF program.