The PALEONICHES-TCN

B.S. Lieberman, J.R. Hendricks, A.L. Stigall, U.C. Farrell, D. Briggs, A. Molineux, J.H. Beach, R. Portell, B. Hunda, K. Hauer

U. of Kansas, San José State U., Ohio U., U. of Texas, Yale U., Cincinnati Museum, Miami University, Florida Museum

PALEONICHES – TCN : Data and Research

- ~ 700,000 specimens databased
- > 9,000 fossil localities georeferenced
- > 1,000 images of fossil species
- *All data shared via iDigBio and institutional websites*

Journal of Biogeography (J. Biogeogr.) (2014) **41**, 1352–13

Journal of Biogeography

ORIGINAL ARTICLE

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INTRODUCTION

Predicting the impacts of future climate change on biodiversity is critical to preserving biological resour

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doi:10.1111/jbi.12289

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Research

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Cite this article: Saupe EE, Hendricks JR, Portell RW, Dowsett HJ, Haywood A, Hunter SJ, Lieberman BS. 2014 Macroevolutionary consequences of profound climate change on niche evolution in marine molluscs over the past three million years. *Proc. R. Soc. B* **281**: 20141995.
http://dx.doi.org/10.1098/rspb.2014.1995

Received: 12 August 2014
Accepted: 8 September 2014

Subject Areas:
palaeontology, evolution, environmental science

Keywords:
Atlantic coastal plain, conservation palaeobiology, fundamental niche, macroevolution, mid-Pliocene warm period, Mollusca

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Electronic supplementary material is available at http://dx.doi.org/10.1098/rspb.2014.1995 or via http://rspb.royalsocietypublishing.org.

Royal Society Publishing

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2015)

A Journal of Macroecology

Global Ecology and Biogeography

RESEARCH PAPERS

Niche breadth and geographic range size as determinants of species survival on geological time scales

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ABSTRACT

Aim Determining which species are more prone to extinction is vital for conserving Earth's biodiversity and for providing insight into macroevolutionary processes. This paper utilizes the Pliocene to Recent fossil record of mollusks to identify determinants of species' extinction over the past three million years of Earth history.

Location Western Atlantic.

Methods We focus on 92 bivalve and gastropod species that lived during the mid-Pliocene Warm Period (mPWP; ~3.264–3.025 Ma) and have either since gone extinct or are still extant. We used ecological niche modeling (ENM) to assess the vulnerability of these species to extinction as a function of both fundamental (FN) and realized (RN) niche breadth proxies, geographic range size, and amount of suitable area available to them during the Last Glacial Maximum (LGM; ~21 Ka).

Results Geographic range size emerged as a key predictor of extinction for the studied mollusk species, with RN breadth and amount of suitable area available during the LGM as secondary predictors. By contrast, FN breadth was not a significant predictor of extinction risk.

Main conclusions The failure to recover FN breadth as a predictor of extinction may suggest that extinction resistance is achieved when species are more successful in filling the geographic extent of their fundamental tolerances. That is, when it comes to species' survival, being a generalist or specialist *sensu stricto* may be secondary to the unique historical, dispersal, and biotic constraints that dictate a species' occupation of suitable environments, and consequently of geographic space, at a particular time. Identifying the factors that promote extinction is important because of the time-intensive nature of estimating extinction risk for individual species and populations, and because of the rising concerns about the future of marine ecosystems and biodiversity.

Keywords
ecological niche modeling, extinction selectivity, fossils, fundamental niche, last glacial maximum, macroecology, macroevolution, niche volume, realized niche.

INTRODUCTION

Determining which species are more prone to extinction is vital for conserving Earth's biodiversity (McKinney, 1997; Schwartz *et al.*, 2006; Lee & Jetz, 2011) and for providing insight into macroevolutionary processes over geological time scales (Kiessling & Aberhan, 2007; Payne & Finnegan, 2007; Meseguer *et al.*, 2014). Although several traits have been identified as correlating with extinction risk (e.g. McKinney, 1997; Mace *et al.*, 2008), one of the more robust is geographic range size. Both neontological (e.g. Thomas *et al.*, 2004; Schwartz *et al.*, 2006; Harris & Pimm, 2008) and paleontological (e.g. Kiessling & Aberhan, 2007; Payne & Finnegan, 2007; Harnik *et al.*, 2012) studies have found that large geographic range sizes enhance

DOI: 10.1111/geb.12333
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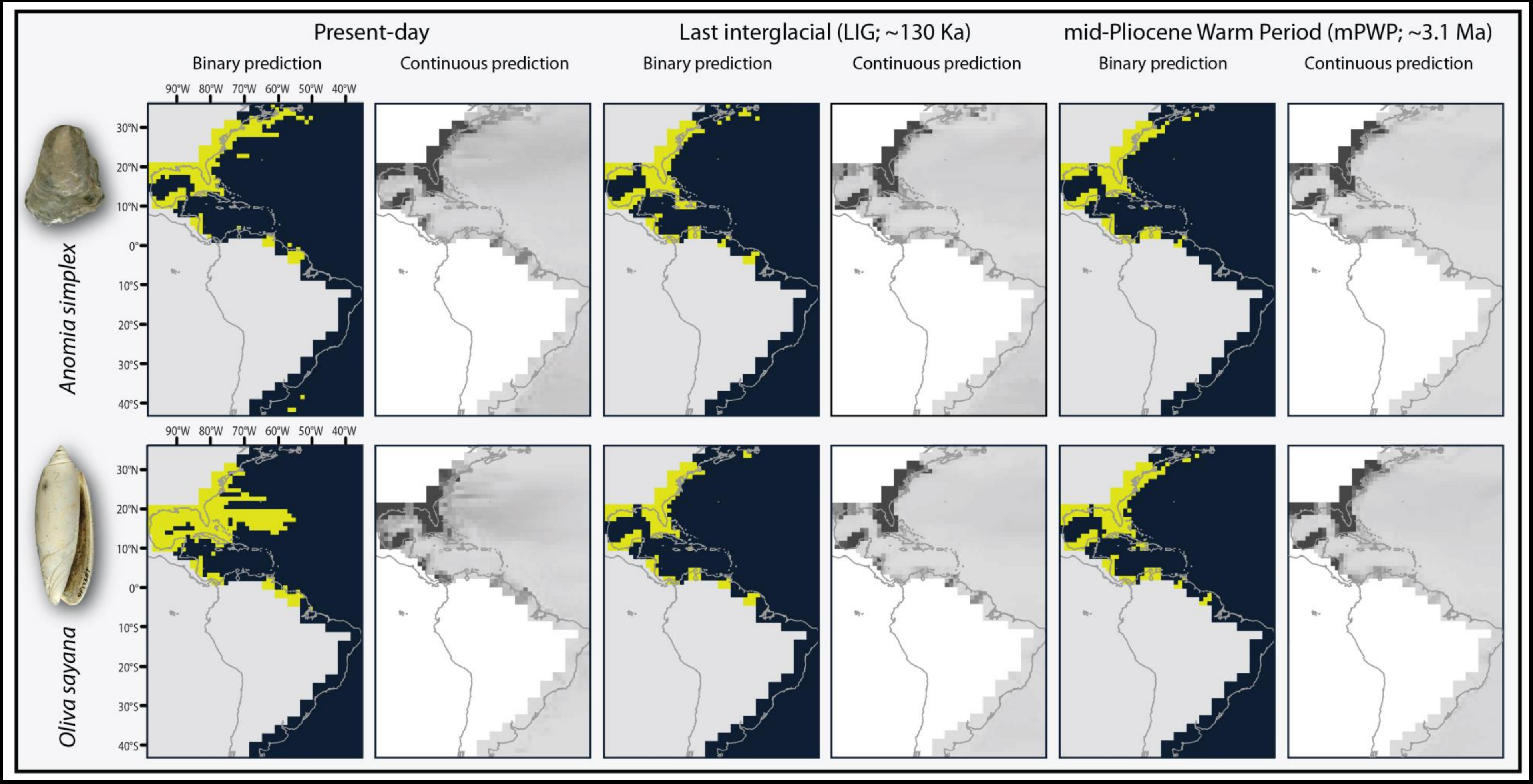
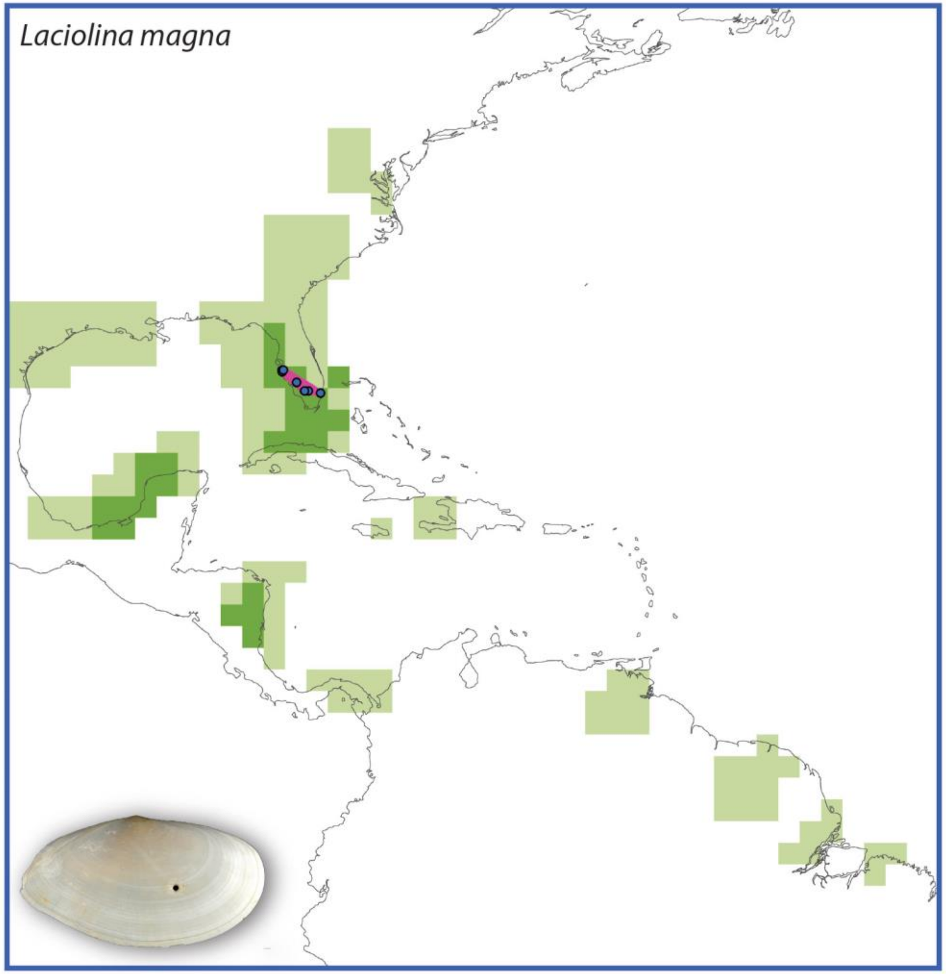
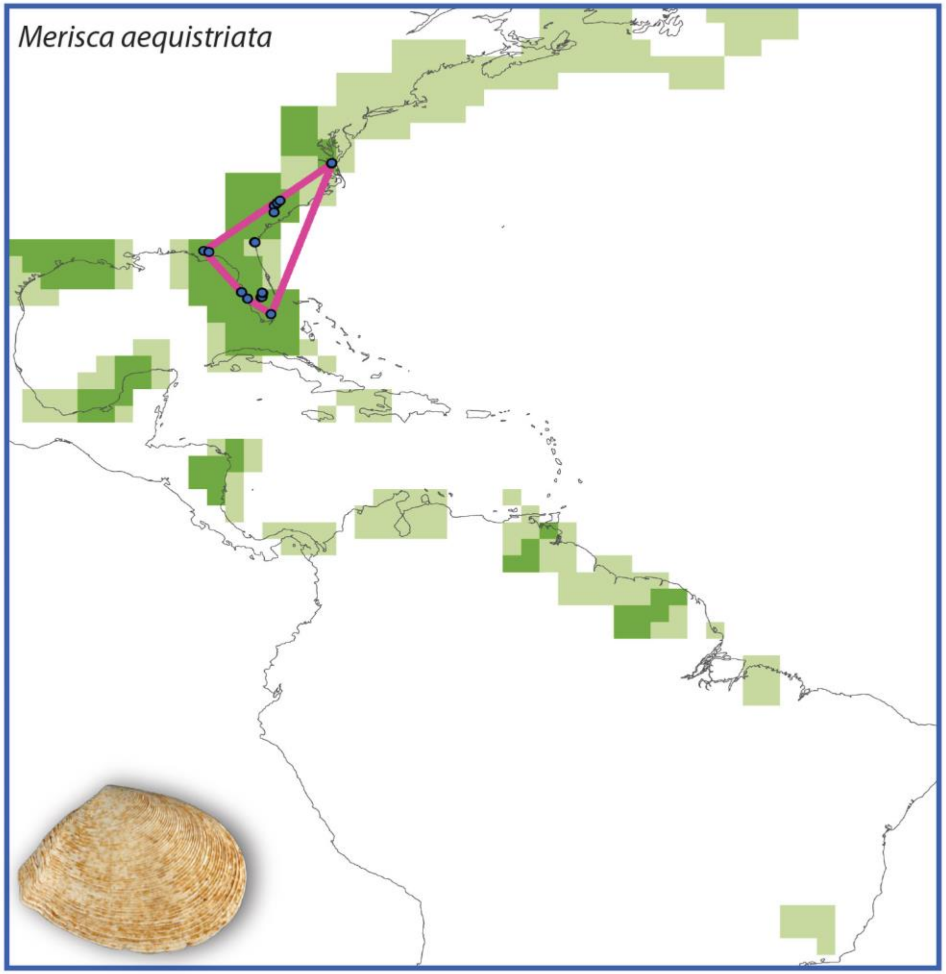


Species niches are conserved over millions of years and major climate changes

Saupe et al. 2015. Proceedings of the Royal Society

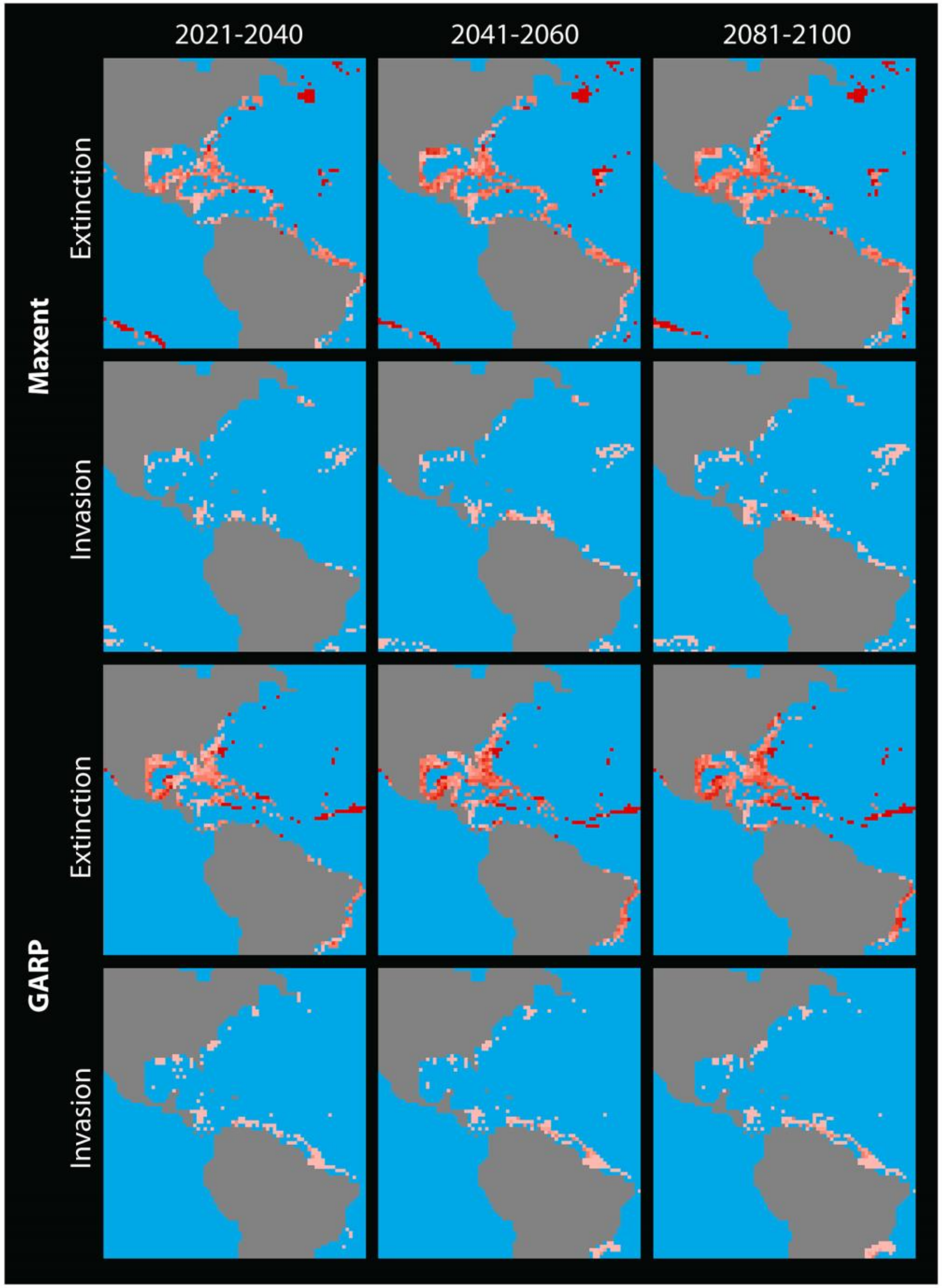




The major factor that determines where species occur is climate, with biotic factors playing a much more limited role.

Saupe et al. 2015. Global Ecology & Biogeography

Many modern marine mollusks will go extinct by 2100 due to climate change because niches can't change, modern climate change is rapid, and the marine biota is stressed by human activities.



Saupe et al. 2014. Journal of Biogeography

PALEONICHES – TCN: Training

- 9 graduate students (7 female)
- 10 undergraduate students (8 female)
- 1 female post-doctoral fellow
- 2 high school students (EVO interns)

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NO
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PALEONICHES – TCN: Outreach

Digital Atlas of Ancient Life

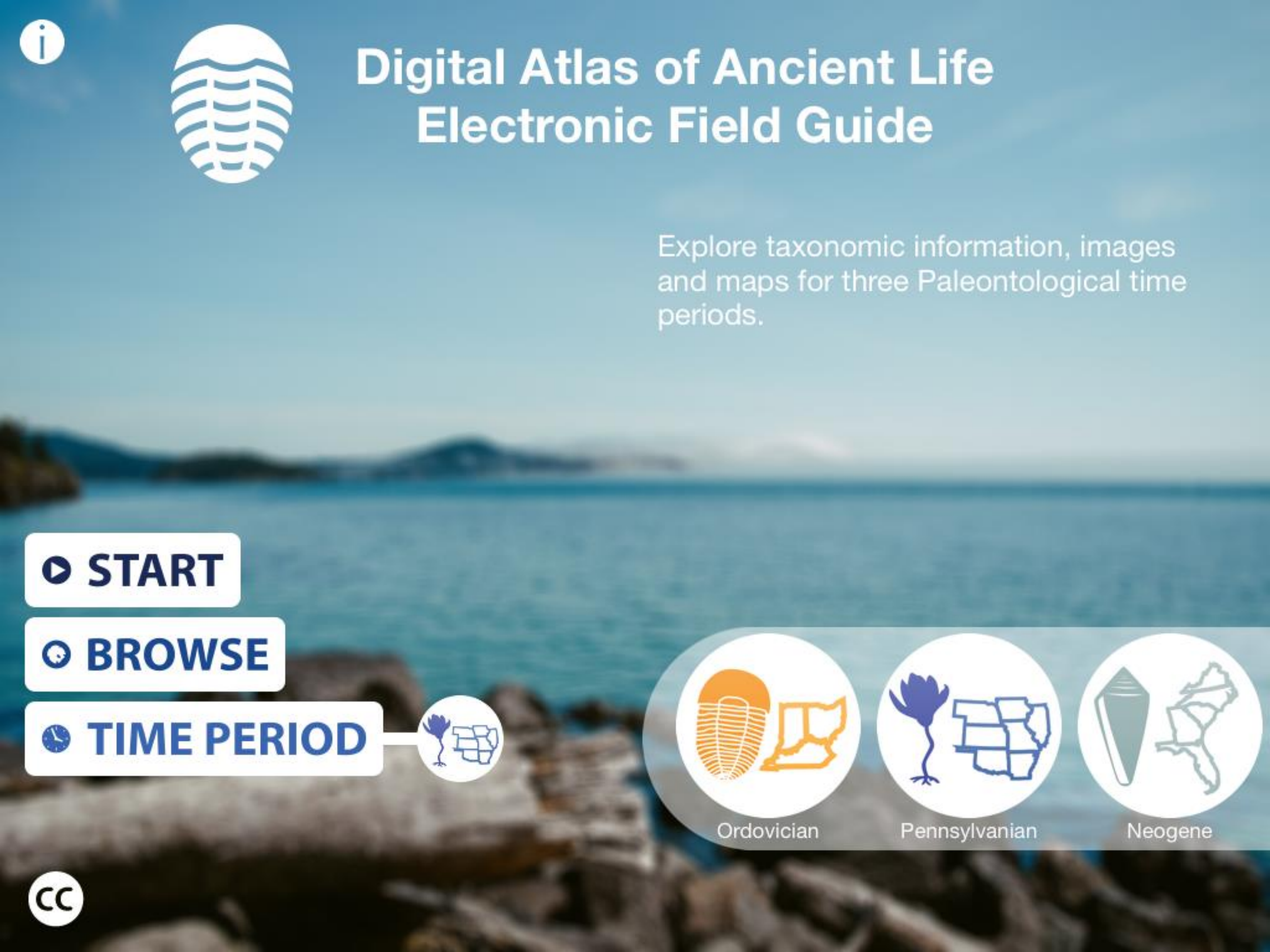
Guide to Ordovician, Pennsylvanian, and Neogene fossils

www.digitalatlasofancientlife.org

@PaleoDigAtlas

Digital Atlas App

Free for iPhone/iPad


Digital Atlas of Ancient Life
Electronic Field Guide
Explore taxonomic information, images and maps for three Paleontological time periods.
START
BROWSE
TIME PERIOD
Ordovician
Pennsylvanian
Neogene
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Information

The Digital Atlas of Ancient Life Electronic Field Guide App is supported by a grant from the National Science Foundation to principal investigators Dr. Bruce Lieberman (University of Kansas), Dr. Alycia Stigall (Ohio University), and Dr. Jonathan Hendricks (San Jose State University). The grant is titled, "Digitizing Fossils to Enable New Syntheses in Biogeography - Creating a PALEONICHES-TCN" (TCN stands for Thematic Collections Network).

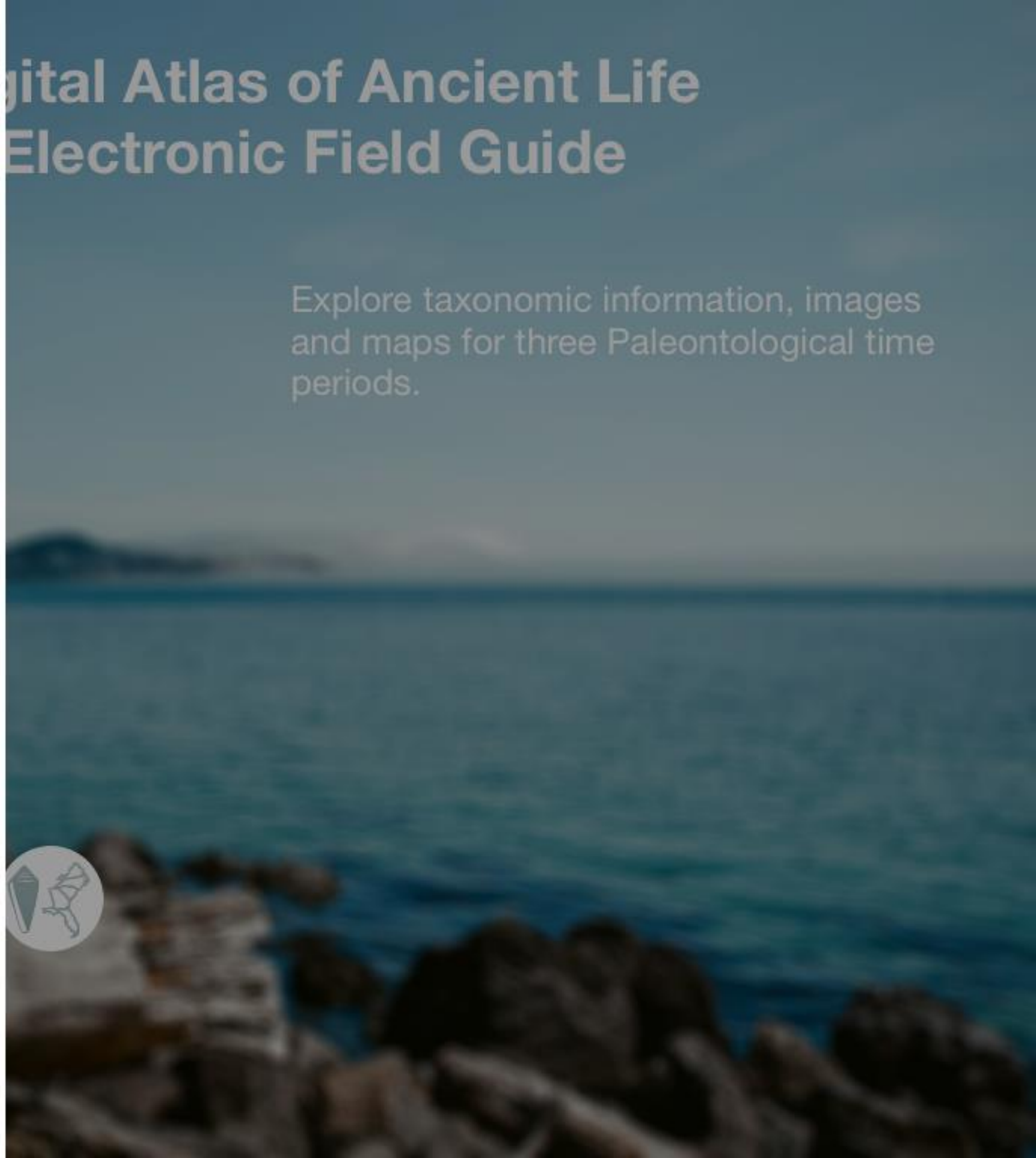
This project is related to a broader natural history specimen digitization effort supported by the National Resource for Advancing Digitization of Biodiversity Collections (ADBC) called Integrated Digitized Biocollections, or iDigBio.

The main portal page for the Digital Atlas of Ancient Life project can be accessed at www.digitalatlasofancientlife.org. For additional information about the project, please see the recently published open-access paper by Hendricks, Stigall, and Lieberman (2015) in Palaeontologia Electronica. The individual websites can be accessed at: Ordovician Atlas, Pennsylvanian Atlas, and Neogene Atlas.

Funding for development and construction of this webpage was provided by the National Science Foundation (EF-1206757, EF-1206769, and EF-1206750)

Version: 1.0 (26)

Created by Rod Spears
Designed by Zach Spears

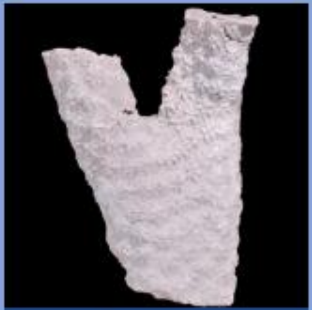


Tap on a fossil to dig deeper into the taxonomic information.

Phylum

Arthropoda

Brachiopoda



Bryozoa

Cnidaria

Echinodermata

Hemichordata

Mollusca

Porifera

Trace Fossils

Back

Class Trilobita

Phylum
Arthropoda

Class
Trilobita

Asaphida

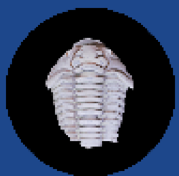
Lichida

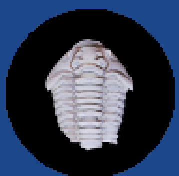
Phacopida

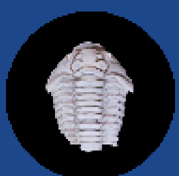
Ptychopariida


Class
Trilobita


Order
Phacopida


Family
Calymenidae


Genus
Flexicalymene


Species
Flexicalymene me...

< Back

Flexicalymene meeki

(Foerste, 1910)

Geological Range

Maysvillian to Richmondian Age, C2 to C6 sequences

Paleogeographical Distribution

Ohio, Indiana, Kentucky, Virginia, New York, and Minnesota

Remarks

The most commonly found trilobite in Cincinnatian strata. Characterized by 13 (rarely 12) segments, sub triangular glabella, three glabellar furrows, and blunt, rounded genal spines.

Stratigraphic Occurrences

Richmondian C6
- Bull Fork Formation
- Dillsboro Formation
- Elkhorn Formation
- Upper Whitewater Formation

Richmondian C5
- Bull Fork Formation
- Dillsboro Formation
- Liberty Formation
- Waynesville Formation
- Whitewater Formation

Richmondian C4
- Arnheim Formation

Maysvillian C3
- Corryville Formation
- Dillsboro Formation
- Gilbert Formation
- Grant Lake Formation
- Mount Auburn Formation

Maysvillian C2
- Bellevue Formation
- Calloway Creek Formation
- Fairmount Formation
- Fairview Formation
- Mount Hope Formation

Chatfieldian	Edenian	Maysvillian		Richmondian		
	C1	C2	C3	C4	C5	C6

Class
Trilobita

Order
Phacopida

Family
Calymenidae

Genus
Flexicalymene

Species
Flexicalymene me...

< Back

Flexicalymene meeki

(Foerste, 1910)

Class
Trilobita

Order
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Family
Calymenidae

Genus
Flexicalymene

Species
Flexicalymene me...

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Flexicalymene meeki

(Foerste, 1910)


Class
Trilobita


Order
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Genus
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Species
Flexicalymene me...

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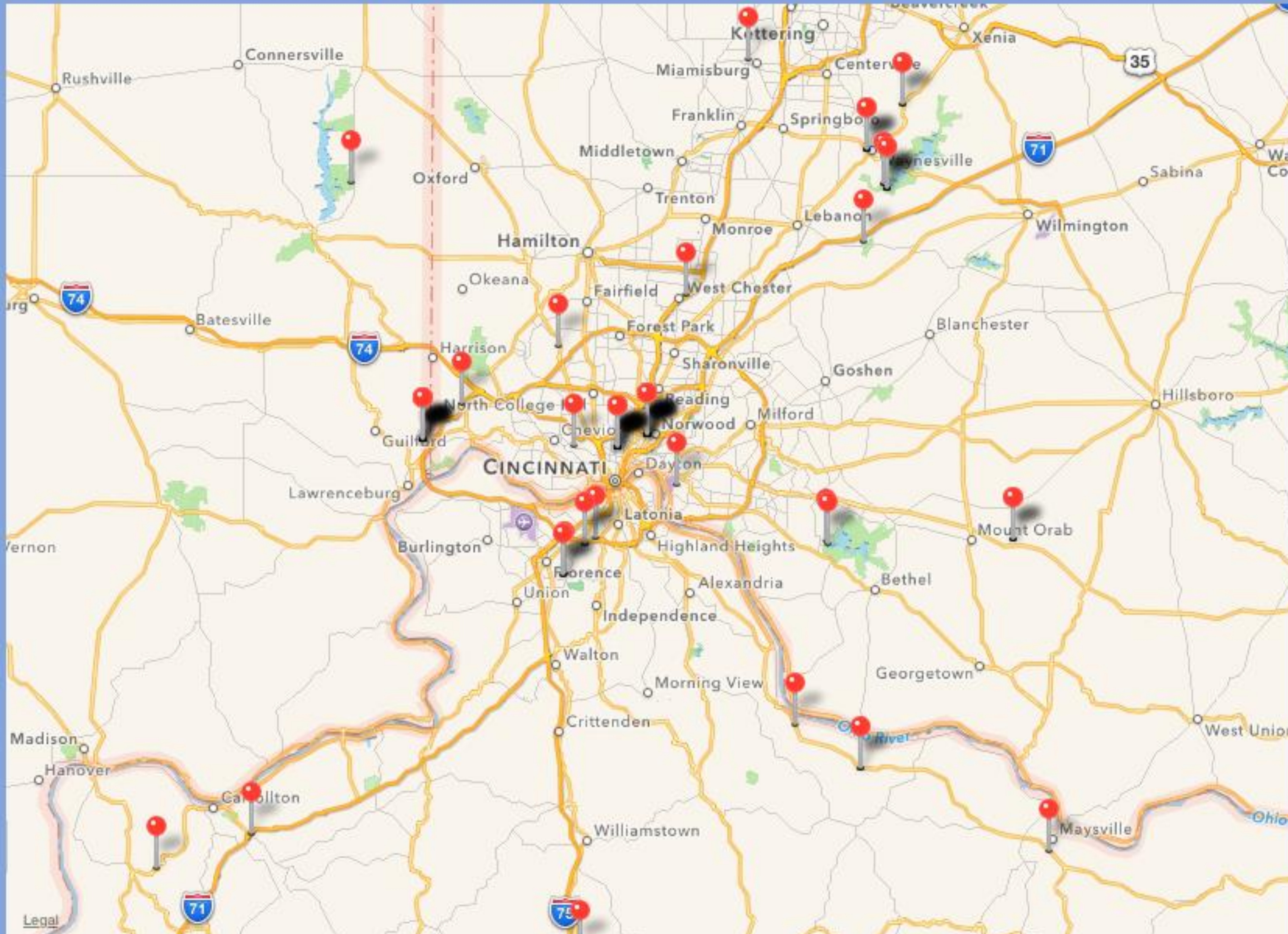
Flexicalymene meeki

(Foerste, 1910)



Acantholabia sarasotaensis

Agathotoma candidissima

Agladrillia aulakoessa

Agladrillia rabdotacona

Agnocardia acrocome

Architectonica chipolana

Architectonica nobilis

Arene agenea

Arene solariella

Arene tricarinata

Astralium phoebium

Bellaspira pentagonalis

Class
Gastropoda

Order
Heterobranchia

Family
Architectonicidae

Genus
Architectonica

Species
Architectonica no...

Architectonica nobilis

Roding, 1798

Geological Range

Late Miocene to Middle Pleistocene; Recent.

Paleogeographical Distribution

Panama to Virginia.

Remarks

For information on the modern distribution of the species, see Malacolog and WoRMS.

Stratigraphic Occurrences

Middle Pleistocene
- Bermont Formation (S. FL)

Early Pleistocene
- Caloosahatchee Formation (S. FL)
- Nashua Formation (N. FL)

Late Pliocene
- Duplin Formation (SC, NC)
- Duplin / Raysor formations (GA)
- Jackson Bluff Formation (N. FL)
- Mare Formation (Venezuela)
- Raysor Formation (SC)
- Tamiami Formation (S. FL)
- Tamiami Formation (Lower) (S. FL)
- Tamiami Formation (Ochopee Limestone) (S. FL)
- Tamiami Formation (Pinecrest Beds) (S. FL)
- Yorktown Formation (VA)

Early Pliocene
- Bowden Formation (Jamaica)
- Cayo Agua Formation (Panama)
- Playa Grande Formation (Maiquetia Member) (Venezuela)

Late Miocene
- Chagres Formation (Panama)
- Gatun Formation (Upper) (Panama)
- Gatun Formation (Middle) (Panama)
- Gatun Formation (Lower) (Panama)

Pleistocene				Pliocene		Miocene					
Late	Middle	Early		Late	Early	Late		Middle		Early	
Tarantian 0.126–0.0117	Ionian 0.781–0.126	Calabrian 1.80–0.781	Gelasian 2.58–1.80	Piacenzian 3.600-2.58	Zanclean 5.333-3.600	Messinian 7.246-5.333	Tortonian 11.62-7.246	Serravallian 13.82-11.62	Langhian 15.97-13.82	Burdigalian 20.44-15.97	Aquitanian 23.03-20.44

‹ Back

Architectonica nobilis

Roding, 1798

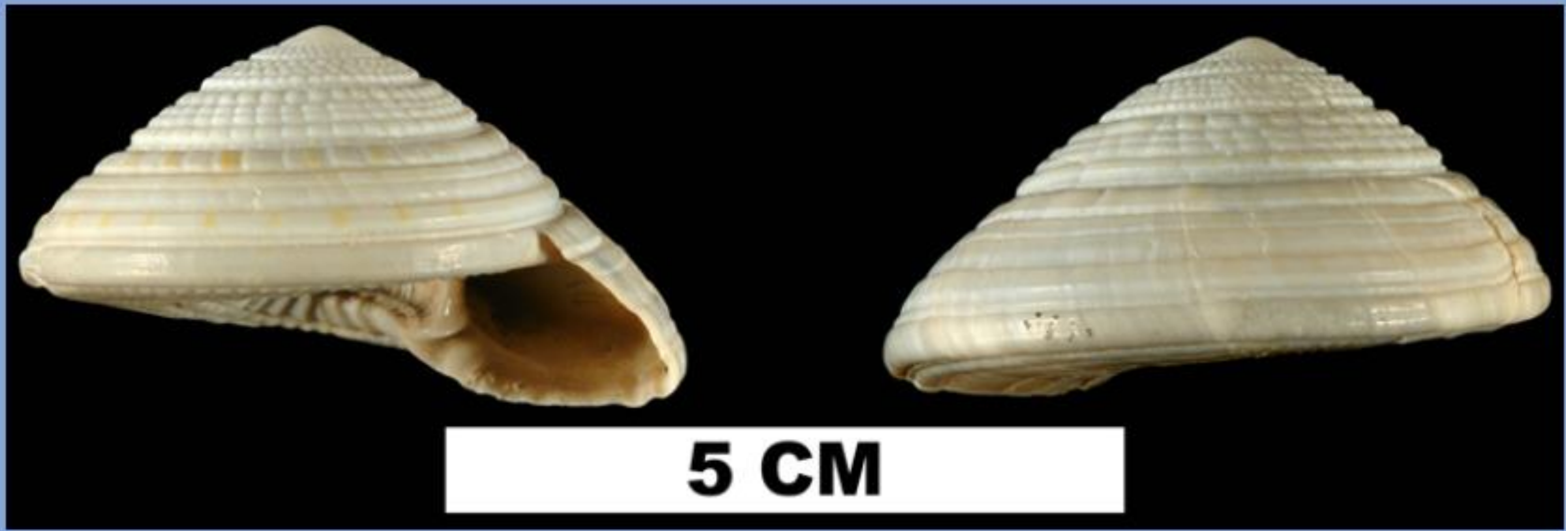
Class
Gastropoda

Order
Heterobranchia

Family
Architectonicidae

Genus
Architectonica

Species
Architectonica no...




Class
Gastropoda


Order
Heterobranchia


Family
Architectonicidae

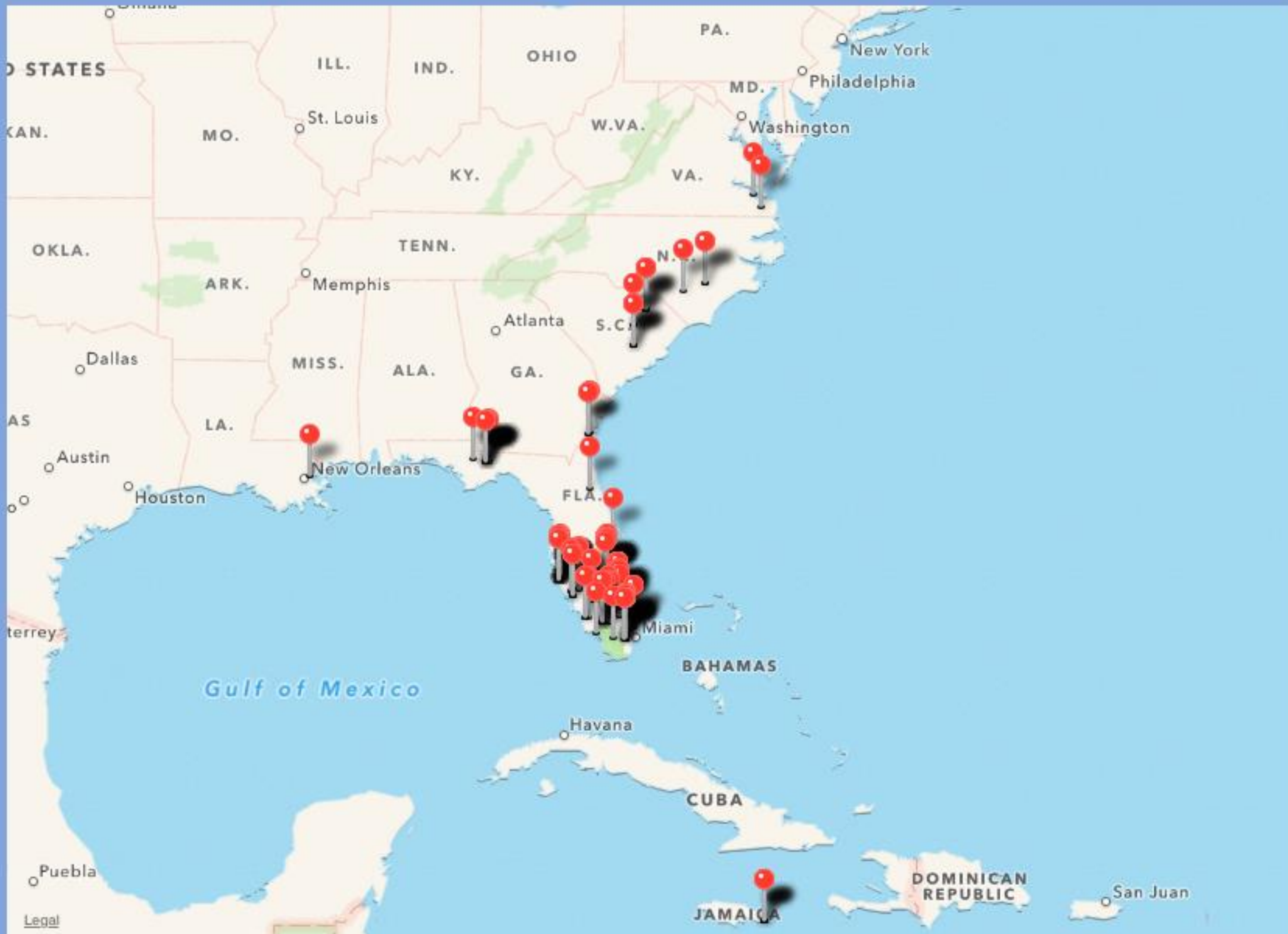

Genus
Architectonica


Species
Architectonica no...

Back

Architectonica nobilis

Roding, 1798



Thanks to:

Jonathan Hendricks (SJSU)

Alycia Stigall (Ohio U.)

Erin Saupe (Yale U.)

Una Farrell

Michelle Casey (Murray State)

Derek Briggs (Yale U.)

Susan Butts (Yale U.)

Rod and Zach Spears (KU)

<u>Funding</u>

NSF Advancing the Digitization of Biological Collections

NSF Emerging Frontiers

NSF Sedimentary Geology & Paleobiology