

IMPORTANCE OF FOSSIL AND ARCHAEOLOGICAL OCCURRENCE DATA FOR UNDERSTANDING THE EVOLUTION AND DISTRIBUTION OF THE FRESHWATER DRUM (*A. GRUNNIENS*)



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ABSTRACT

The Freshwater Drum (*Aplodinotus grunniens*) represents one of the most unique freshwater fish in North America given its niche and occupancy of one of the largest modern geographic ranges of any freshwater fish. Understanding the evolutionary history of any taxon is challenging however as the paleontological and archaeological published record is notoriously poor for the majority of North American freshwater fish. Moreover, as these records are developed through museum holdings or faunal descriptions few studies assemble these records into a useable review format for better understanding the divergence and biogeography of extant taxa. Therefore, the objective of this study was to concatenate the entire fossil history of the genus *Aplodinotus* in one work to better understand the evolutionary history of the genus and how it may have led to the last surviving *Aplodinotus*. Through a series of literature reviews, herein we document 50 paleontological and archaeological sites containing *A. grunniens* remains dating from Holocene to early Miocene as well as 11 paleontological sites containing remains from 5 other extinct members of the *Aplodinotus* genus. Based on these depositional dates and geographic localities, we support the hypothesis that *A. grunniens* has an origin in the Gulf of Mexico but it is not yet clear whether it evolved from one of the brackish/marine ancestors already known or a transitional taxa or lineage yet to be documented.

PROJECT METHODOLOGY & RESULTS

- A series of literature reviews were conducted using search terms of “fossil, fish, freshwater, osteology, otoliths, *Aplodinotus*, North America, South America” in Google Scholar which recovered well over a hundred documented fossil sites of freshwater fish across North America, including 50 specific to *A. grunniens* and 11 sites specific to other (extinct) *Aplodinotus* from North and South America (Table 1).
- All *A. grunniens* sites (Fig. 1) were from freshwater deposits ranging from Holocene to late Miocene and included a variety of preserved elements including osteological remains (pharyngeals, pharyngeal teeth, vertebrae, premaxilla, pterygiophores, rays, misc. spines, angulars, dentary, and cranial fragments) and remains of the acoustic-lateralis system (otoliths).
- All other *Aplodinotus* sites (Fig. 1) from the 5 currently recognized extinct taxa were from marine deposits ranging in age from early Oligocene to their disappearance from the fossil record in the early Miocene and were described only from otolith remains.

Table 1. Selected *Aplodinotus* fossil & archaeological sites. Note that not all *A. grunniens* sites are depicted here to conserve space. See appendix for full list.

Species	Epoch	Environment	Location	Age Range Estimates
<i>A. grunniens</i>	Miocene	Freshwater	Kansas, USA	11–9 Ma
<i>A. grunniens</i>	Miocene	Freshwater	Alabama, USA	7.3–6.8 Ma
<i>A. grunniens</i>	Pliocene	Freshwater	Nebraska, USA	4.75–2.58 Ma
<i>A. grunniens</i>	Pleistocene	Freshwater	Texas, USA	0.1–0.05 Ma
<i>A. grunniens</i>	Pleistocene	Freshwater	Mississippi, USA	0.115–0.011 Ma
<i>A. grunniens</i>	Pleistocene	Freshwater	Texas, USA	0.05–0.037 Ma
<i>A. grunniens</i>	Pleistocene	Freshwater	Michigan, USA	0.050 Ma
<i>A. grunniens</i>	Pleistocene	Freshwater	Texas, USA	0.04–0.02 Ma
<i>A. grunniens</i>	Pleistocene	Freshwater	Oklahoma, USA	0.034 Ma
<i>A. grunniens</i>	Pleistocene	Freshwater	Alabama, USA	0.0265–0.0118 Ma
<i>A. grunniens</i>	Holocene	Freshwater	Ontario, Canada	0.0101–0.008 Ma
<i>A. grunniens</i>	Holocene	Freshwater	Illinois, USA	0.0091–0.0057 Ma
<i>A. grunniens</i>	Holocene	Freshwater	Louisiana, USA	0.0082–0.0074 Ma
<i>A. grunniens</i>	Holocene	Freshwater	Alabama, USA	0.008–0.0035 Ma
<i>A. grunniens</i>	Holocene	Freshwater	Alabama, USA	0.008–0.0035 Ma
<i>A. grunniens</i>	Holocene	Freshwater	Michigan, USA	0.006–0.004 Ma
<i>A. grunniens</i>	Holocene	Freshwater	Louisiana, USA	0.006–0.005 Ma
<i>A. grunniens</i>	Holocene	Freshwater	Louisiana, USA	0.006 Ma
<i>A. distortus</i>	Early Oligocene	Marine	Mississippi, USA	33.9–27.8 Ma
<i>A. distortus</i>	Early Oligocene	Marine	Louisiana, USA	28.4–23.0 Ma
<i>A. gemma</i>	Early Oligocene	Marine	Mississippi, USA	33.9–28.1 Ma
<i>A. gemma</i>	Early Oligocene	Marine	Mississippi, USA	33.9–27.8 Ma
<i>A. gemma</i>	Early Oligocene	Marine	Louisiana, USA	28.4–23.0 Ma
<i>A. gemma</i>	Early Oligocene	Marine	Louisiana, USA	28.4–23.0 Ma
<i>A. gemma</i>	Early Oligocene	Marine	Alabama, USA	28.4–23.0 Ma
<i>A. hoffmani</i>	Early Miocene	Marine	Falcón, Venezuela	20.4–16 Ma
<i>A. ventriosus</i>	Early Miocene	Marine	North Carolina, USA	23–20.4 Ma
<i>A. santosi</i>	Early Miocene	Marine	Pará, Brazil	23–20.4 Ma

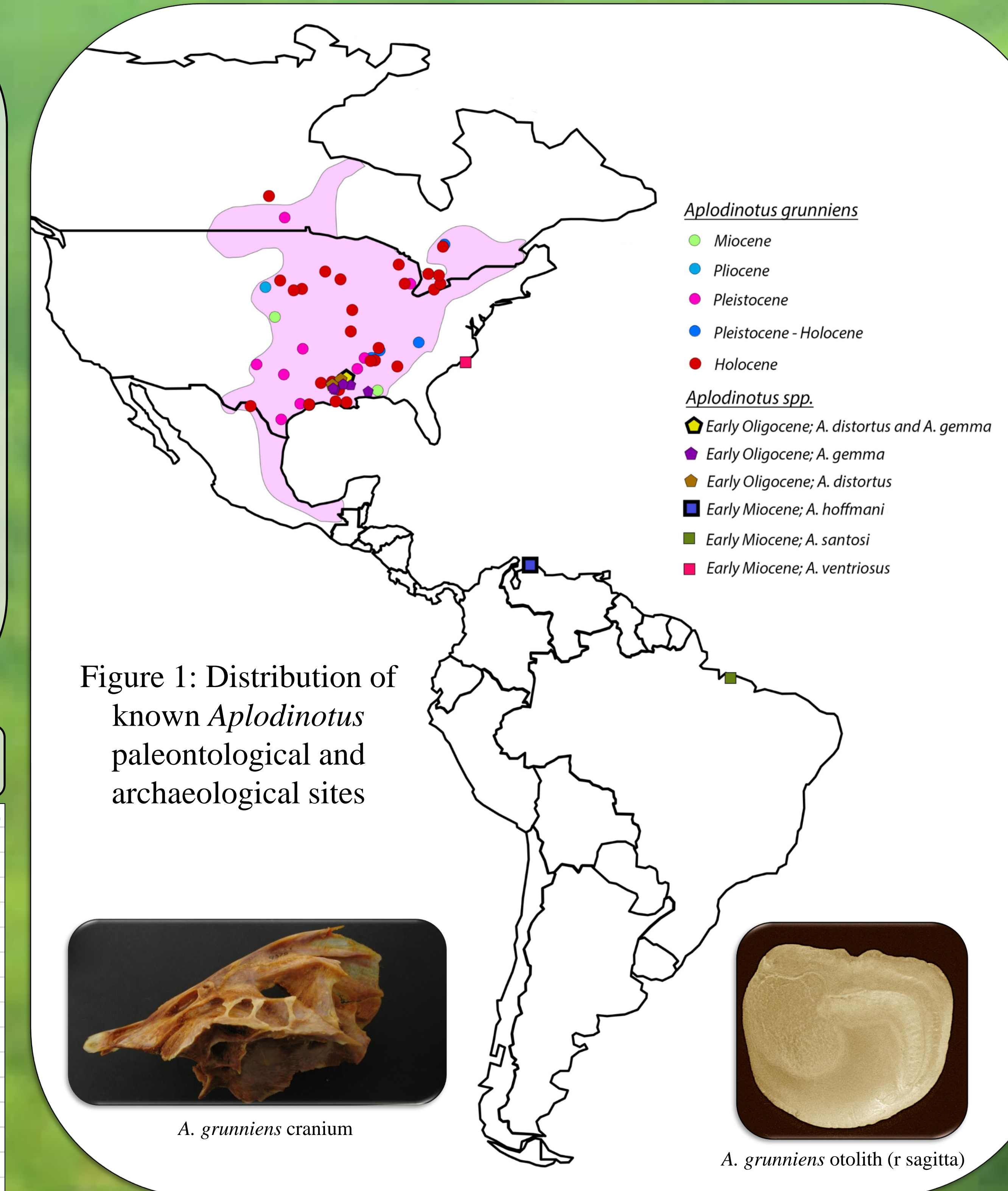


Figure 1: Distribution of known *Aplodinotus* paleontological and archaeological sites

PROJECT BACKGROUND

- The Freshwater Drum (*Aplodinotus grunniens*) exhibits the largest geographic ranges of any freshwater fish in North America as it occurs across the majority of the eastern portion of the continent (Boschung & Mayden 2004).
- Contributing to this wide range and population composition is a combination of basic evolutionary life history and niche characteristics that have facilitated dispersal and stability across many watersheds.
- The Freshwater Drum (FWD) is part of the Sciaenidae family, which contains 291+ recognized modern taxa (Lo et al. 2015, Nelson et al. 2016) and is the only living member of *Aplodinotus* genus, which also includes at least 5 other extinct taxa (Nolf and Aguilera 1998, Nolf 2003, and Aguilera et al. 2014).
- Despite a growing understanding of this taxa over the past few decades however, there has been little discussed regarding the evolutionary and biogeographical history of this genera.

PROJECT INDICATIONS

- There are no extinct *Aplodinotus* before Oligocene in marine environment.
- There are numerous occurrences of extinct *Aplodinotus* in shallow marine waters during the Oligocene and extends to the early Miocene.
- There is no evidence of *Aplodinotus* (sensu stricto) in the marine environment after the early Miocene.
- It appears that *A. grunniens* evolved from a marine/brackish ancestor in the Gulf and radiated through flooded coastal drainages in North America after the early Miocene –refuting a South American origin. Additional Miocene fossils are needed to assess whether FWD ever occurred in marine habitats.

PROJECT CONCLUSIONS

- There is a vast need for additional paleontological work in nearly every group of fishes but given the growing literature base on niche, distribution, genetic variation, etc. among North American freshwater fish, additional work to expand the current spatial and temporal coverage could have even broader benefits.
- It is unfortunate that so relatively few paleontological studies on freshwater fishes have been undertaken as these sorts of studies act as foundational pieces to disentangle evolutionary trends among some of the most species rich groups of freshwater fishes of earth.
- This work begins to disentangle the evolutionary history of *Aplodinotus* but additional work in the fossil and modern records needs to be undertaken to fill remaining gaps in our understanding of population genetics and origin.

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PROJECT OBJECTIVES

The objective of this project was to summarize the fossil history of *Aplodinotus* in an effort to contribute to our understanding of the divergence timing and origin of the genera, particularly as it relates to the modern *A. grunniens*.