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Ostracods as proxies for past seagrass: A review

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ABSTRACT

Recently, attention has been drawn to the recognition of past seagrass for which a number of proxies have been proposed. Several studies have quoted ostracods as having some value as proxies, particularly *Loxoconcha*, *Xestoleberis* and *Aurila*. Although these may be found in a variety of marine environments, they are often found with faunas containing seagrass or which can be interpreted as in proximity to seagrass. In such situations, they may be found with other possible seagrass proxies such as sirenians, lucinid bivalves, soritid and other benthic foraminiferans. The presence of *Loxoconcha*, *Xestoleberis* and *Aurila* and other ostracods may be suggestive of past seagrass environments, the interpretation of which is strengthened by the presence of other proxies in some collections.

Contents

1. Introduction

Seagrasses are halophytic members of the aquatic angiosperm group Alismatidae which may have had its origins in Eurasia during the late Cretaceous (Chen et al., 2013). They are currently found nearly worldwide, rooted in the photic zone of shallow marine environments (Short et al., 2007). The earliest fossil records of seagrass are from the late Cretaceous (Campanian–Maastrichtian) (van der Ham et al., 2007) and represent one of the last major events of the angiosperm radiation which began in the early Cretaceous. Seagrass does not preserve well and there are relatively few fossil records of seagrass and, whilst these are sufficient to provide a history of the group, their areal distribution is not well recorded. Extant seagrass, particularly in warm-water areas, is characterised by an abundant and diverse fauna. A number of seagrass proxies have been evaluated (Reich et al., 2015). Possibly the most used of these in the past has been diverse and abundant benthic foraminifera (Brasier, 1975; Brandano et al., 2009), which have been noted in extant seagrass (Mateu-Vicens et al., 2010; Frezza et al., 2011). Amongst these, soritid foraminiferans appear to have a close relationship to seagrass (Richardson, 2001) and have been recorded from the fossil record (Moissette et al., 2007). Sirenians are major herbivores on seagrass currently and fossil forms have been interpreted as indicating seagrass presence (Vélez-Juarbe, 2014). The use of gastropods has recently shown promise (Reich, 2014). Of particular note is the nerite *Smaragdia*, some species of which are found almost exclusively in seagrass (Rueda and Salas, 2007) and used here as a seagrass proxy. Lucinid bivalves common in seagrass currently (van der Heide et al., 2012) and abundant as fossils have not been widely used as past seagrass proxies and are considered of limited value by Reich et al. (2015). Stanley (2014) drew attention to the close radiation of lucinids and seagrass. Generally, proxies used for past seagrass are not exclusive to these environments and a series of fossil taxa may provide more confident interpretations.

Amongst seagrass proxies, relatively abundant and well-preserved ostracods have been suggested. Ostracods have been noted in studies of both recent (Brasier, 1975, Yassini and Jones, 1987, Cronin et al., 2005, Corlett & Jones, 2007) and fossil (Moissette et al., 2007, Reuter et al., 2011) seagrass communities. However, few studies have focused

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Table 1
The presence of *Loxoconcha* (L), *Xestoleberis* (X) and *Aurila* (A) in selected faunas together with seagrass interpretation and the presence of other potential seagrass proxies—Lucinidae (Bivalvia) and Soritidae (Foraminifera). Numbers refer to number of species. Interpretations of seagrass, unless otherwise noted, based on presence of ostracods by the author. Discussion provides additional information. PDB = PaleoDatabase collection number.

Location	Age	Seagrass	L	X	A	Lucinidae	Soritidae	PDB	Reference
England	Cenomanian	n/a?	1	1				n/a	(Weaver, 1982)
Brazil	Turonian	n/a?	1	1				n/a	(Piovesan et al., 2015)
Arkansas (USA)	Campanian	Interpreted in this account	1	1				n/a	(Benson and Tatro, 1964)
Brazil	Lower Maastrichtian	Interpreted in this account	1	2				n/a	(Piovesan et al., 2009)
Jamaica	Maastrichtian	Interpreted in this account	1	1		1		n/a	(Puckett et al., 2012)
Trinidad and Tobago	Paleocene	Interpreted in this account	1	1				94013, 94015	(van den Bold, 1957)
Alabama (USA)	Middle Eocene	Interpreted in this account	2	1		4 (CoBabe and Allmon, 1994)		94040	(Blake, 1950)
New Zealand	Late Eocene	?	1	5				161903	(Ayress, 1995)
Antarctica	Oligocene	Interpreted in this account-	1	1				94115	(Błaszyk, 1987)
New Zealand	Late Oligocene	Interpreted by elongate limpet (Conran et al., 2014)	1	1	1	2		n/a	(Lee et al., 2014)
New Zealand	Late Oligocene	Interpreted in this account	1	3	1			n/a	(Ayress, 2006)
Antigua and Barbuda	Late Oligocene	Interpreted in this account	3	1	1			94185 and other collections	(van den Bold, 1966)
Cuba	Early Miocene	Interpreted by sirenian presence	2		1		Present	31183	(MacPhee et al., 2003)
Japan	Early Miocene	Interpreted by desmostylians presence	2	1+	2*			n/a	(Irizuki et al., 2004)
Sardinia	Early Miocene	Interpreted in this account	2	2	1			93944 and other collections	(Bossio et al., 2006)
Puerto Rico	Early Miocene	Interpreted in this account	1	1	1			94202 and other collections	(van den Bold, 1965)
India	Early Miocene	Interpreted by Reuter et al. (2011)	1	1	1	1		n/a	(Verma, 1977)
India	Early Miocene	Interpreted in this account	1		1			93899	(Bhatia and Mandwal, 1960)
South Africa	Early Miocene	Interpreted in this account	1	1				37487	(Dingle et al., 2001)
Trinidad and Tobago	Early Miocene	Interpreted in this account	1	1				93912	(van den Bold, 1958)
New Zealand	Early Miocene	Interpreted in this account	1	1				n/a	(Ayress, 2003)
Hungary	Middle Miocene	Microfauna indicates algae or seagrass (Tóth et al., 2010)	1+	1	1+			n/a	(Tóth, 2008, Tóth et al., 2010)
Hungary	Middle Miocene	Interpreted by presence of hooked *Nubecularia*	1	1	1		present	n/a	(Cornée et al., 2009)
Austria	Middle Miocene	Interpreted in this account	1	1	3	1		n/a	(Zorn, 2003)
Poland	Middle Miocene	Interpreted in this account	1	2	1			138849 and other collections	(Aiello and Szczechura, 2004)
Romania	Middle Miocene	Interpreted in this account	1	1	1	1		n/a	(Filipescu et al., 2014)
Poland	Middle Miocene	Interpreted in this account	1	1	1	2		70539	(Pisera, 1985)
Croatia	Middle Miocene	Interpreted in this account 'grasses' noted in (Vrsakjko, 1999)	1	1	2			68213	(Vrsakjko, 1999)
Austria	Middle Miocene	Interpreted in this account	1	1	1			73299	(Steininger and Thenius, 1964)
Italy	Late Miocene	Interpreted in this account	1	3	1	1		n/a	(Gennari et al., 2013)
Crete	Late Miocene	Interpreted in this account	1	3	7			138584 and other collections	(Faranda et al., 2008)
Italy	Late Miocene	Interpreted in this account	1	1	1			69899	(Bossio et al., 1996)
Morocco	Late Miocene	Interpreted in this account	1	1		1		34723 and 1 other collection	(Moissette and Saint Martin, 1995)
Algeria	Late Miocene	Interpreted in this account		1		Lucinids recorded from associated collections		70879	(Saint Martin, 1990)
Japan	Late Miocene	Interpreted in this account	4		1	Lucinids recorded in another collection		n/a	(Tanaka and Hasegawa, 2013)
Australia	Late Miocene	Interpreted in this account	1	1				166810	(Crespin, 1943)
N. Carolina – Virginia (USA)	Pliocene	Interpreted in this account	3	1	1			n/a	(Swain, 1974)
N. Carolina (USA)	Early Pliocene	Interpreted in this account	9	2	1			52582	No suitable reference
Panama	Late Pliocene	Interpreted in this account	1	1		Lucinids recorded from associated collections		91902	(Collins et al., 1999)
Rhodes, Greece	Early Pleistocene (Moissette et al., 2016)	in situ	3	1	2	3	Present	122994 and 2007 paper	(Moissette et al., 2007, 2016)

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