



Zootaxa 3859 (1): 001–066
www.mapress.com/zootaxa/

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Monograph

ISSN 1175-5326 (print edition)

ZOOTAXA

ISSN 1175-5334 (online edition)

<http://dx.doi.org/10.11646/zootaxa.3859.1.1>

<http://zoobank.org/urn:lsid:zoobank.org:pub:24FCAAE1-AB7C-4FAD-8698-D0C9F12400EC>

ZOOTAXA

3859

Bivalves from the latest Jurassic-earliest Cretaceous hydrocarbon seep carbonates from central Spitsbergen, Svalbard

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Magnolia Press
Auckland, New Zealand

Accepted by N. Malchus: 28 Jul. 2014; published: 2 Sept. 2014

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(*Zootaxa* 3859)

66 pp.; 30 cm.

2 Sept. 2014

ISBN 978-1-77557-483-5 (paperback)

ISBN 978-1-77557-484-2 (Online edition)

FIRST PUBLISHED IN 2014 BY

Magnolia Press

P.O. Box 41-383

Auckland 1346

New Zealand

e-mail: zootaxa@mapress.com

<http://www.mapress.com/zootaxa/>

© 2014 Magnolia Press

ISSN 1175-5326 (Print edition)

ISSN 1175-5334 (Online edition)

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Abstract

The bivalve fauna from the latest Jurassic–earliest Cretaceous hydrocarbon seep deposits from central Spitsbergen, Svalbard comprises at least 17 species, four of which belong to chemosymbiotic taxa often found at seeps. These are the solemyid *Solemya* (*Petrasma*) cf. *woodwardiana*; *Nucinella svalbardensis* **sp. nov.**, which belongs to a group of large *Nucinella* species known from seeps and deep water environments; the lucinid bivalve, *Tehamatea rasmusseni* **sp. nov.**, included in a genus widely distributed in other Jurassic–Cretaceous seeps; and *Cretaxinus hurumi* **gen. et sp. nov.**, which is the oldest known thyasirid and is discussed in relation to other large seep-restricted genera in this family. The remaining species in the fauna belong to ‘background’ genera known from coeval normal marine sediments, mostly from the Boreal area. These include the nuculid *Dacromya chetaensis*, two new malletiids (*Mesosaccella rogovi* **sp. nov.** and *M. toddi* **sp. nov.**), the oxytomiid *Oxytoma octavia*, at least three *Buchia* species, at least two pectinids, including *Camptonectes* (*Costicamptonectes*) aff. *milnelandensis* and *Camptonectes* (*Camptochlamys*) *clatrathus*, the limid *Pseudolimea arctica*, the arcticid *Pseudotrapezium* aff. *groenlandicum*, and the pholadomyid *Goniomya literata*. The large number of ‘background’ species in the bivalve fauna is probably a reflection of the shallow-water setting of the Svalbard seeps. This might also explain the lack of the seep-restricted modiomorphid bivalve *Caspiconcha* from the fauna. With solemyids, *Nucinella*, lucinids and thyasirids, the latest Jurassic–earliest Cretaceous bivalve seep fauna of Svalbard contains typical representatives of the Mesozoic bivalve seep faunas, both long established and young evolutionary colonists.

Key words: *Nucinella*, *Solemya*, lucinids, thyasirids, Jurassic, Cretaceous, background fauna, evolution, new genus, new species

Introduction

Bivalves are one of the major groups of animals found in chemosynthesis-based ecosystems in modern oceans (e.g. Van Dover 2000; Dando 2010; Taylor & Glover 2010; Watanabe *et al.* 2010) and chemosymbiotic bivalve species often represent a dominant element of such assemblages (Sibuet & Olu 1998; Van Dover *et al.* 2003; Levin 2005; Dupperon 2010). The evolutionary history of bivalves in hydrocarbon seep environments is long and can be traced back to the Devonian (Peckmann *et al.* 1999; Aitken *et al.* 2002; Campbell 2006). However, most of the well studied seep bivalve faunas are from Eocene or younger circum-Pacific settings. These are dominated by bathymodiolin and vesicomid bivalves, often associated with solemyids, lucinids and thyasirids (Squires & Goedert 1991; Squires & Gring 1996; Goedert *et al.* 2003; Amano & Kiel 2007; Saether *et al.* 2010; Amano & Ando 2011; Gill & Little 2013; Kiel & Amano 2013). Knowledge of pre-Eocene bivalve seep faunas is less complete (e.g. Amano *et al.* 2007; Kiel *et al.* 2008a; Kiel *et al.* 2010; Jenkins *et al.* 2013; Kiel 2013), which partially reflects the smaller number of Mesozoic and particularly Palaeozoic seep sites available for study. Pre-Eocene bivalve seep faunas are composed predominantly of solemyids, *Nucinella*, lucinids and thyasirids (Kiel 2010). In addition, some Late Jurassic to Late Cretaceous seep faunas contained species of the large obligate seep modiomorphid genus *Caspiconcha*, which possibly had chemosymbionts (e.g. Kelly *et al.* 2000; Kiel *et al.* 2010; Jenkins *et al.* 2013; Kiel *et al.* 2013).

This paper is a systematic study of the bivalve fauna from the latest Jurassic–earliest Cretaceous hydrocarbon seep deposits from central Spitsbergen, Svalbard. It is part of a wider taxonomic treatment of macrofossils from these sites, including, so far, ammonites (Wierzbowski *et al.* 2011), cephalopod arm hooks (Hammer *et al.* 2013), lingulate brachiopod (Holmer & Nakrem 2012) and serpulids (Vinn *et al.* in press). Aside from these the Svalbard seep carbonates also contain belemnoid guards, crustaceans, echinoderms, gastropods, rhynchonellate brachiopods, scaphopods and sponges (Hammer *et al.* 2011) as well as agglutinated and calcareous foraminiferans (Hjálmaradóttir *et al.* 2012). The initial list of bivalve taxa in Hammer *et al.* (2011) comprised 14 bivalve species, all of which were left in open nomenclature. This paper extends that number to more than 17, and presents systematic descriptions for most of them; the buchiid bivalves will be dealt with in a separate paper.

Geological background. Bivalve specimens have been found in 13 out of 15 seep carbonates in the Sassenfjorden area, Central Spitsbergen, Svalbard (Fig. 1). The seeps are hosted by the Slottsmøya Member, which is composed mainly of grey to black organic-rich shales with lesser silty beds and carbonate concretions, and was deposited on the middle to outer shelf (Nagy *et al.* 1988; Dypvik *et al.* 1991; Collignon & Hammer 2012). Based on ammonite faunas, the seep deposits are of Late Volgian to latest Ryazanian age (Fig. 2; Wierzbowski *et al.* 2011). The Volgian and Ryazanian are regional stages applied around the Jurassic–Cretaceous transition in the Boreal realm, where Tithonian and Berriasian standards are not applicable, due to strong ammonite provincialism

not because of palaeobiogeography, then the absence of *Caspiconcha* in the Svalbard seeps might have been down to palaeobathymetry, as seep-restricted species are mostly found in deep-water sites (Kiel 2010). However, the Kuhnpasset seeps formed on the middle to outer shelf, like the Svalbard seeps, so the reasons for the absence of *Caspiconcha* in the latter are currently opaque, and may have had more local, ecological explanations.

The Svalbard seep bivalve fauna shares several common seep-related taxa with other Late Jurassic–Early Cretaceous seep sites, including solemyids, *Nucinella* and (as noted above) lucinids. Members of this family are known at seeps from the Oxfordian and are fairly common in seeps later on, often having a seep-restricted distribution, i.e. *Tehamatea*, which ranges from the Tithonian to the Albian in seeps world-wide (Kiel *et al.* 2010; Kiel 2013). Solemyids have been recorded in Carboniferous seeps, although they are not well enough preserved to confirm this identification (Peckmann *et al.* 2001). In the Mesozoic solemyids occur in seeps from the Tithonian (Kiel *et al.* 2008b) and were then common members of later Mesozoic seep communities, occurring in the Svalbard seeps (this study), Tithonian–Albian seeps of California (Kiel *et al.* 2008b; Kaim *et al.* in press), the Barremian Kuhnpasset seeps (Kelly *et al.* 2000), and the Albian–Campanian seeps of Hokkaido (Kiel *et al.* 2008a) and New Zealand (Kiel *et al.* 2013). *Nucinella* is known from seeps since the Triassic (Peckmann *et al.* 2011). Apart from Svalbard it then occurred in Barremian seeps of California (Kaim *et al.* in press), in Albian–Cenomanian seep sites from New Zealand (Kiel *et al.* 2013) and Cenomanian–Campanian seeps from Hokkaido (Amano *et al.* 2007; Kiel *et al.* 2008a). It does appear at seeps later on in the Oligocene as well (Amano *et al.* 2013). The latest Jurassic–earliest Cretaceous Svalbard seeps contain thyasirids, represented by *Cretaxinus hurumi*. Early Cretaceous seep thyasirids are rare, but have been reported i.e. from Valanginian–Hauterivian seeps from Carpathians (Ascher 1906; Kaim *et al.* 2013) and from Albian seeps from Japan and New Zealand (Kiel *et al.* 2010; 2013). Thyasirids are fairly common in Late Cretaceous and Cenozoic seeps (e.g. Goedert *et al.* 2003, Kiel *et al.* 2008a). The latest Jurassic–earliest Cretaceous bivalve seep fauna of Svalbard thus contains usual members of the Late Mesozoic seep faunas. These comprise either background solemyids and *Nucinella*, established at seeps since no later than Palaeozoic or the Early Mesozoic, respectively, or lucinids and thyasirids, radiating into seeps at least in the Late Jurassic and earliest Cretaceous, respectively (Fig. 20).

Acknowledgments

We would like to thank all the members of the Svalbard Jurassic Research Group (SJRG), who participated in the field work between 2007 to 2012. Special thanks go to Jørn Harald Hurum, Natural History Museum, University of Oslo, the leader of the Svalbard expeditions, for allowing us to participate in the field work. Thanks also to Øyvind Hammer, Natural History Museum, University of Oslo, for explaining how to use the PAST software; Franz-Josef Lindemann, the Natural History Museum, University of Oslo, for discussions regarding open nomenclature; Kazutaka Amano, University of Joetsu, Japan, for preparing and photographing the hinge of the arcticid bivalve; and Steffen Kiel, Georg-August-Universität Göttingen, Germany, for discussions about Mesozoic seep lucinid characters. Krzysztof Hryniewicz would also like to thank Jon Todd, Natural History Museum, London, and Jan Audun Rasmussen, Natural History Museum of Denmark, Copenhagen, for help during museum visits. Special thanks go to Robert G. Jenkins, Kanazawa University, Japan, Steffen Kiel, and Nikolaus Malchus, Institut Català de Paleontologia, Bellaterra, Spain, for careful revision and comments on the manuscript.

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