Additional observations of *Spiniferites alaskensis* from topotype material

Fabienne Marret[1]*, Kenneth Mertens[2]

[1]Department of Geography and Planning, School of Environmental Sciences, University of Liverpool, Liverpool, L69 7ZT, UK
[2]Ifremer, LER BO, Station de Biologie Marine, Place de la Croix, BP40537, F-29185 Concarneau Cedex, France

Here we present new observations of *Spiniferites alaskensis*, a relatively rare species described from the Eemian of the Gulf of Alaska. We show that the species shows a gonyaulacacean tabulation: Po, 4´, 6´´, 6c, ?s, 6´´´, 1p, 1´´´´. The surface is finely granulate to scabrate. The species bears characteristic processes: these are exclusively gonal, membranous, perforated and end distally in platforms with stumpy ends. We provide more detail as how this species compares to closely related species belonging to the genus *Spiniferites.*

Keywords: Gulf of Alaska, chorate, *Spiniferites*, processes, Eemian, ODP

1. Introduction

Spiniferites alaskensis Marret et al. 2001 ex Marret in Fensome and Williams 2004 was first identified in the North East Pacific Ocean, in the Eemian interval that was recovered during the ODP Leg 145, site 887B (54°21' N – 148°23' W, 3647 m water depth) (Marret et al. 2001). The name was validated by Fensome & Williams (2004) because Marret et al. (2001) did not indicate which of the illustrations represented the holotype. The original description of this taxon mentioned a chorate cyst of ovoid shape with an apical boss, thin cyst wall, a finely granulate surface, gonal and broad terminally trifurcate processes, low sutural septa between the processes and a gonyaulacacean tabulation. This taxon was described as differing from other known *Spiniferites* only by the shape of the processes and their pointed-end termination.

New observations have been carried out, using a combination of light-transmitted and scanning electron microscopy, enabling to fully characterise the morphology of this relatively unknown species.

2. Material and methods

Permanent slides made from residues prepared by Marret et al. (2001) from the type locality (ODP Leg 145 core 887B, section 2H5 at 65 cm in section, Gulf of Alaska) were examined using a light microscope at Geotop, Montreal, Canada (Leica DMR equipped with an Leica DFC490 digital camera). Single specimens were picked under an inverted microscope with a micropipette and observed using a scanning electron microscope (Hitachi S-3400N SEM) at Geotop, Montreal, Canada. Kofoid's nomenclature is used to designate the plates.

3. Results

Division DINOFLAGELLATA (Bütschli 1885) Fensome et al. 1993, emend. Adl et al. 2005
Class DINOPHYCEAE Pascher 1914
Subclass PERIDINIPHYCIDAE Fensome et al. 1993
Order GONYAULACALES Taylor 1980

[1] Corresponding author. Email: f.marret@liverpool.ac.uk

Suborder Gonyaulacineae autonym
Family Gonyaulacaceae Lindemann 1928
Subfamily Gonyaulacoideae autonym
Genus *Spiniferites* Mantell 1850, emend. Sarjeant 1970
Spiniferites alaskensis Marret et al. 2001 ex Marret in Fensome and Williams 2004
Plate 1, Figures 1–10; Plate 2, Figures 1–6.

Synonymy. None.

Holotype. Marret et al. 2001, their Plate 1, Figures 7–9.

Locus typicus. ODP core 887B, section 2H5 at 65 cm in section, Gulf of Alaska.

Stratum typicum. Sediments deposited during isotope stage 5e in the Gulf of Alaska (ODP Leg 145, site 887) northeastern North Pacific.

Etymology. Named *alaskensis* from its type locality in the Gulf of Alaska, NE Pacific (Marret et al. 2001).

Distinguishing characters. Ovoid to pear shaped cysts with an apical boss (Plate 1, Figures 4–6) that touches all the apical plates (Plate 1, Figure 1). The cyst wall is thin (less than 1 µm) and has a finely granulate to scabrate wall surface, which is confirmed by SEM observation (Plate 2, Figures 1–4). This surface texture continues on the bases of processes and the bases of the connecting crests of the processes (Plate 2, Figure 2), but not on the more distal part, which is smooth to shagreenate (Plate 2, Figures 5–6). Processes are exclusively gonal, stout, membranous, with perforated polygonal platforms with stumpy distal ends (Plate 2, Figures 5–6). Processes at the junctions of the apical plates are shorter compared to others, and those along 1´´´´ are the longest. The processes do not bear granules, as opposed to the sutural septa connecting the processes. These sutural septa define a gonyaulacacean tabulation: Po, 4´, 6´´, 6c, ?s, 6´´´, 1p, 1´´´´ (Plate 1, Figures 1, 3). The tabulation is expressed with a generally low sutural arrangement, with slightly undulating sutures (Plate 1, Figure 7), except being high where they connect cingular processes (arrow "a"), between 1´, 4´ and as (arrow "b"), between 6´´´ and 1´´´´ (arrow "c"), and between 1p and 1´´´´ (arrow "d") (Plate 1, Figure 10). Observation of the epicyst shows an arrangement of four apical and six precingular plates (Plate 1, Figure 1), and for the hypocyst, six postcingular plates although 1´´´ is not well expressed, 1p, and an asymmetrical 1´´´´. The cingular arrangement shows six plates, with a typical displacement of one cingular width, without overhang. In the sulcal area, a pronounced suture is observed above ps and below as. The other sulcal plates are not well reflected. The archeopyle has a pentagonal shape, corresponding to the third precingular plate (3´´), with rounded angles, and is reduced and free (Plate 1, Figure 8).

Dimensions. Central body diameter length 26.3 (31.4) 36.8 µm and width 23.6 (29.3) 31.5 µm with length of processes 7.5 (10.1) 12.5 µm (Marret et al. 2001). Number of specimen measured: 11

Biological affiliation. Unknown.

Comparison to other taxa. *Spiniferites alaskensis* shows some similarities to a number of *Spiniferites* species, such as *Spiniferites ludhamensis* Head 1996 which has a similar shape and stout processes, but *Spiniferites ludhamensis* has hollow processes, and the cyst has a thicker wall and no apical boss (Head 1996). *Spiniferites ristingensis* Head 2007 and *Spiniferites delicatus* Reid 1974 also have membranous processes with petaloid distal ends. However, *Spiniferites ristingensis* has small, densely distributed blisters and hollow undulations over the surface (comparable to "bubble–wrap") (Head 2007). *Spiniferites delicatus* has a granular surface, with high sutural crests (Reid 1974). *Spiniferites bentorii* (Rossignol 1964) Wall & Dale 1970 also has a pear shaped body, with an apical boss, but has processes often with claustra at their base and these processes are not membranous. *Spiniferites belerius* Reid 1974 can also have an oval to pear shaped body, but has a shorter apical boss, its wall surface is not as granular and there is a larger cingulum displacement,

and has box-like processes (Reid 1974). *Spiniferites alaskensis* also differs from *Spiniferites falcipedius* Warny & Wrenn 1997, as the latter has hollow processes, no apical boss and high crests between the antapical processes (Warny & Wrenn 1997). Lastly, *S. alaskensis* is distinguished from *Spiniferites lazus* Reid 1974 as the latter has a clearly elongated ovoidal shape and claustra at the base of the processes (Reid 1974).

Acknowledgements

We like to thank Anne de Vernal for use of microscope facilities at GEOTOP. Maryse Henry and Raynald Lapointe are acknowledged for help with SEM preparations at GEOTOP. We also are very grateful for the constructive comments from reviewers Laurent Londeix and André Rochon that helped to improve the manuscript.

References

Adl SM, Simpson AGB, Farmer MA, Andersen RA, Anderson OR, Barta JR, Bowser SS, Brugerolle G, Fensome RA, Fredericq S, James TY, Karpov S, Kugrens P, Krug J, Lane CE, Lewis LA, Lodge J, Lynn DH, Mann DG, McCourt RM, Mendoza L, Moestrup Ø, Mozley-Standridge SE, Nerad TA, Shearer CA, Smirnov AV, Spiegel FW, Taylor M.F.J.R. 2005. The new higher level classification of Eukaryotes with emphasis on the taxonomy of Protists. J Eukaryot Microbiol. 52:399–451.

Bütschli O. 1885. II. Abtheilung: Mastigophora. In: Dr. H.G. Bronn's Klassen und Ordnungen des Thier-Reichs, wissenschaftlich dargestellt in Wort und Bild. Ester Band Protozoa. Leipzig & Heidelberg: C.F. Winter'sche Verlagsbuchhandlung; p. 865–1088.

Fensome RA, Taylor FJR, Norris G, Sarjeant WAS, Wharton DI, Williams GL. 1993. A classification of fossil and living dinoflagellates. Micropaleontology Special Publication 7:1–245.

Fensome RA, Williams GL. 2004. The Lentin and Williams Index of fossil dinoflagellates 2004 Edition. American Association of Stratigraphic Palynologists, Contributions Series 42.

Head MJ. 1996. Late Cenozoic dinoflagellates from the Royal Society borehole at Ludham, Norfolk, eastern England. J Paleo. 70: 543–570.

Head MJ. 2007. Last Interglacial (Eemian) hydrographic conditions in the southwestern Baltic Sea based on dinoflagellate cysts from Ristinge Klint, Denmark. Geological Magazine 144:987–1013.

Lindemann E. 1928. Abteilung Peridineae (Dinoflagellatae). *In* Engler A & Prantl K [Eds.] Die Naturlichen Pflanzenfamilien nebst ihren Gattungen und wichtigeren Arten insbesondere den Nutz-pflanzen. Zweite stark vermehrte und verbesserte Auflage herausgegeben von A. Engler. 2 Band. Wilhelm Engelmann, Leipzig; pp. 3–104.

Mantell, GA. 1850: A Pictorial Atlas of Fossil Remains Consisting of Coloured Illustrations Selected from Parkinson's "Organic Remains of a Former World", and Artis's "Antediluvian Phytology". xii+207 p., 74 pl.; Henry G. Bohn, London, U.K.

Marret F, de Vernal A, Pedersen TF, McDonald D. 2001. Middle Pleistocene to Holocene palynostratigraphy of Ocean Drilling Program Site 887 in the Gulf of Alaska, northeastern North Pacific. Can J Earth Sci. 38:373–386.

Pascher A. 1914. Über Flagellaten und Algen. Berichte der Deutschen Botanischen Gesellschaft 32: 136–160.

Reid PC. 1974. Gonyaulacacean dinoflagellate cysts from the British Isles. Nova Hedwigia 25:579–637.

Rossignol M. 1964. Hystrichosphères du Quaternaire en Méditerranée orientale, dans les sédiments Pléistocènes et les boues marines actuelles. Revue de micropaléontologie 7:83–99.

Sarjeant WAS. 1970. The genus *Spiniferites* Mantell, 1850 (Dinophyceae). Grana 10:74–78.

Taylor F. 1980. On dinoflagellate evolution. BioSystems 13: 65–108.

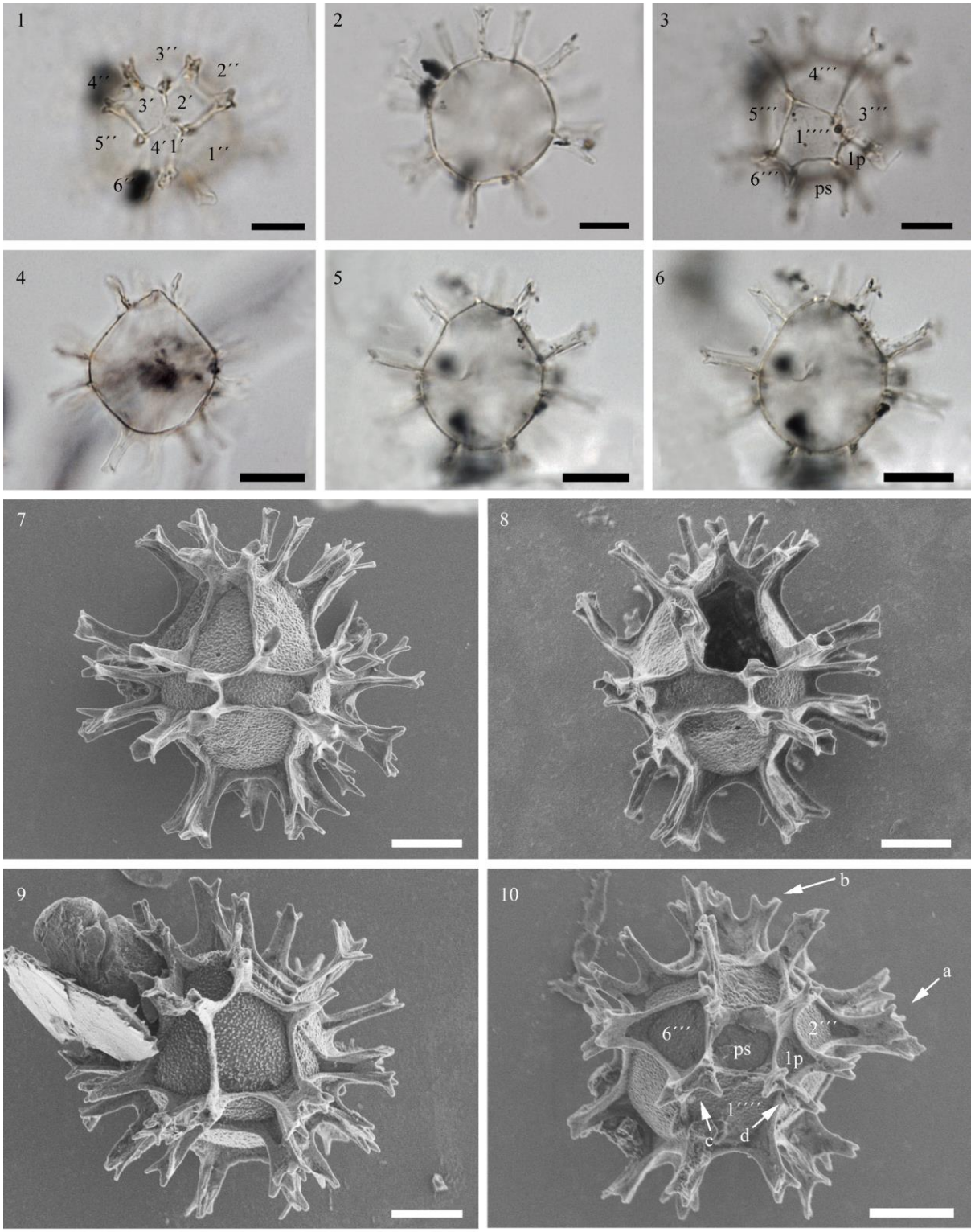
Wall D**,** Dale B. 1970. Living Hystrichosphaerid Dinoflagellate Spores from Bermuda and Puerto Rico. Micropaleontology 16:47–58.

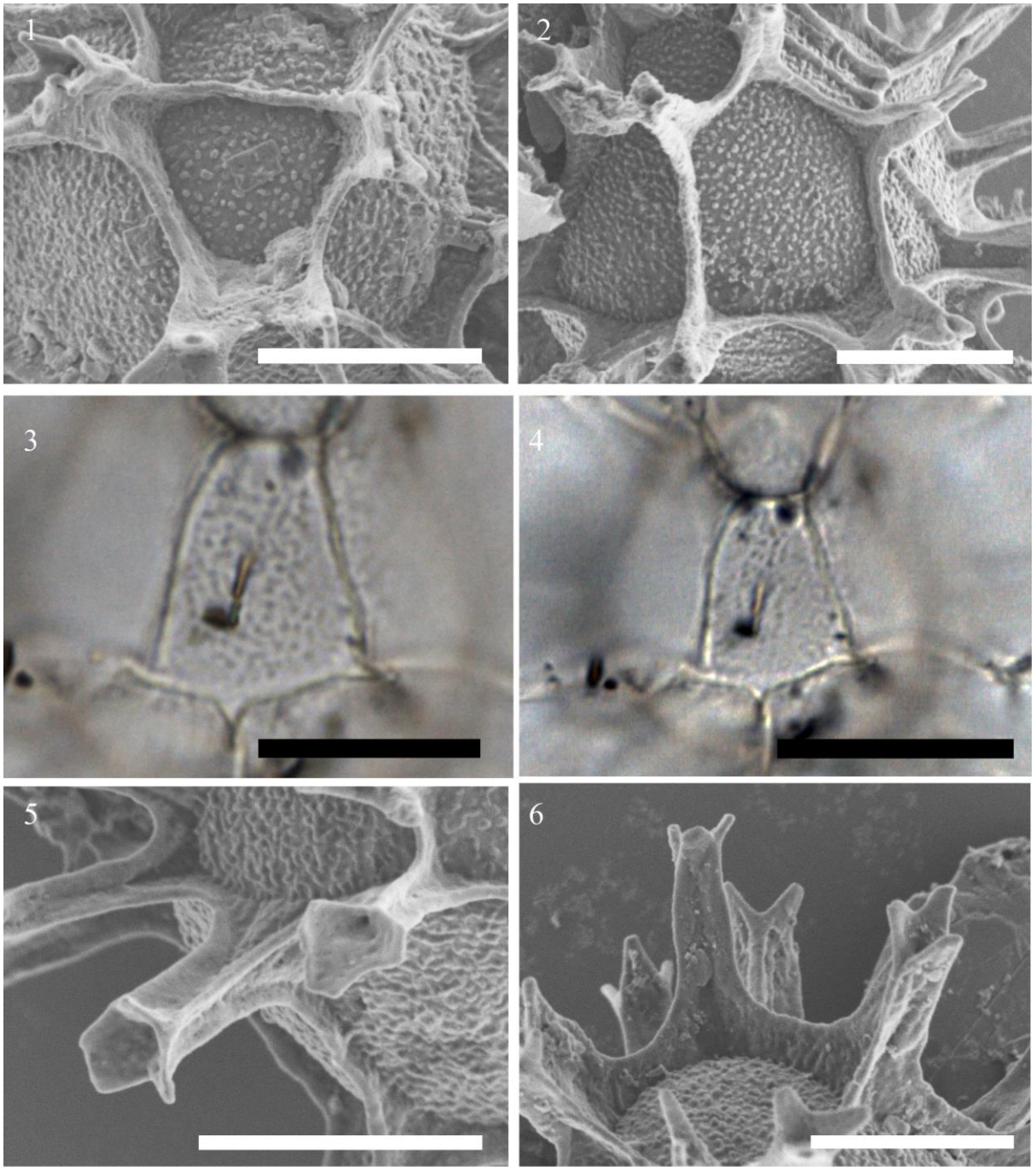
Warny SA, Wrenn JH. 1997. New species of dinoflagellate cysts from the Bou Regreg core: a Miocene-Pliocene boundary section on the Atlantic coast of Morocco. Rev Palaeobot Palynol 96:281–304.

Plate captions

Plate 1. Light microscope and SEM micrographs of topotype specimens of *Spiniferites alaskensis.* Figures 1–9. High focus to low focus of single specimen. 1. Shows epicyst with four apical plates and six precingular plates, stumpy distal ends of the processes are clearly visible; the suture between 1´ and 4´ is faintly visible under light microscope. 2. Cross-section in polar view. 3. Hypocyst showing four of the six postcingular plates, one posterior intercalary plate (1p) and one large, asymmetrical antapical plate. 4. Mid-focus of pear-shaped specimen. 5–6. Slightly higher than median focus to median focus of ovoid shaped specimen. 7. Specimen showing morphology and distribution of exclusively gonal processes with operculum still in place. 8. Specimen showing reduced archeopyle with rounded angles. 9. View of epicysta showing processes distribution and sutural crests. 10. View of hypocyst showing sulcus and high crests between some of the processes (a,b,c,d). All scale bars = 10 µm.

Plate 2. Topotype specimens of *Spiniferites alaskensis.* 1–4. SEM micrographs and light micrographs of wall texture, showing scabrate to granulate central body surface and shagreenate septa and processes. 5–6. SEM micrographs of process structure showing stumpy distal ends and low crests connecting the processes. All scale bars = 10 µm.


1
3´´
2´´
4´´
3´
2´
5´´
4´1´
1´´
6´´
2
3
4´´´
5´´´
3´´´
1´´´´´
1p
6´´´
ps
4
5
6
7
8
9
10
b
a
6´´´
ps
1p
2´´´
1´´´´´
c
d


1
2
3
4
5
6