

松辽盆地早白垩世淡水沟鞭藻类

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内 容 摘 要

本文描述了松辽盆地早白垩世沙河子组—登娄库组(别里亚士期—阿普第早期)淡水角藻类沟鞭藻囊泡4属、5新种和2个未定种,并对拟蝙蝠藻属(*Vesperopsis* Bint, 1986)进行了修订。

关键词 松辽盆地 别里亚士—阿普第早期 角藻类沟鞭藻囊泡 淡水

松辽盆地早白垩世沙河子组,营城组和登娄库组(Berriasian—Early Aptian)发现丰富的沟鞭藻化石,保存尚好,但种类单调,壁单层,极薄,表面纹饰简单。除角藻型沟鞭藻化石外,未见到其它类型的囊泡。在沙河子组以光面拟蝙蝠藻(*Vesperopsis glabra*)占优势,粒面拟蝙蝠藻(*V. granulata*)少量,偶见十字南球藻(*Australisphaera cruciata*);在营城组以粒皱巴尔姆藻(*Balmula granorugosa*)为主;偶见假角藻(未定种)(*Pseudoceratium* sp.);在登娄库组四段以肇东拟蝙蝠藻(*Vesperopsis zhaodongensis*)为主。此化石群与我国辽宁阜新盆地的阜新组和内蒙古海拉尔盆地的大磨拐河组的沟鞭藻组合较相似,可能属于潮湿气候条件下的内陆淡水湖泊沟鞭藻生物。

本文描述了上述3组地层发现的沟鞭藻类4属、5新种和2个未定种。

化 石 描 述

甲藻门 *Pyrrhophyta* Pascher, 1914

甲藻纲 *Dinophyceae* Fritsch, 1929

多甲藻目 *Peridiniales* Haeckel, 1894

角藻科 *Family Ceratiaceae* Lindemann, 1928

南球藻属 *Genus Australisphaera* Davey, 1978

模式种 *A. verrucosa* Davey, 1978

属征 囊泡贴近式,本体透镜形或亚多角形,具一个居中的(偶尔2个)尾角及两侧凸或角,次一级的凸起或角也可能存在。原壁表面具低的雕纹。古口顶式,很可能(tA)型。口盖游离,纵沟凹口模糊显示。

比较 本属以壁单层区别于 *Muderongia* Cookson et Eisenack, 1958; 以口盖游离和通常具一居中的尾角(凸)不同于 *Vesperopsis* Bint, 1986。

分布及时代 中国松辽盆地,南非西南海外和英格兰;白垩纪。

十字南球藻(新种) *Australisphaera cruciata* sp. nov.

(图版 I, 图 13—15)

描述 囊泡贴近式, 腹背扁平, 菱形或十字形, 具一顶、两侧和一尾角。顶角胖圆锥形, 比其它的角都宽大, 顶端圆滑; 两侧角分别为圆锥形和亚圆锥形, 不等长和大, 以右侧角较大, 左侧角短而较小; 一尾角位于尾缘中部, 和顶角在一条直线上, 亚圆锥形, 末端圆滑。壁单层, 极薄, 表面平滑, 具一些次生的线状褶。反映腰带缺乏, 很可能位于两侧角之间。反映板式仅以古口所指示。古口顶式, 在背面主古口缝 Z 字形; 口盖原位, 在腹面可能连生。

度量 (μm): 囊泡长 75—90, 宽 65—71.3, 顶角长 34.5—36.8, 右侧角长 20.7—22.0, 左侧角长 11—11.5, 尾角长 11.1—13.8; 正模标本长 75, 宽 70, 顶角长 36.8, 右侧角长 22.0, 左侧角长 11.0, 尾角长 11.1。

注释 这类标本较少, 古口口盖原位保存, 暗示在腹面可能连生, 暂时归于此属。

产地层位 黑龙江省泰康县, 沙河子组。

巴尔姆藻属 Genus *Balmula* Bint, 1986

模式种 *Balmula tripenta* Bint, 1986

属征 囊泡大, 腹背压扁, 其全部角包括一顶、两侧和两尾角, 但两侧角可以缺乏。所有的角都长, 两尾角近等大, 两侧角当存在时亦近等大。壁两层, 均很薄。内外壁紧贴或在囊泡的大部分表面上彼此分离。内壁形成圆滑的角的远极, 而在各角的远极缺失外壁; 外壁表面光滑, 颗粒状或短刺状。无反映板式显示, 反映腰带或由横向细脊指示。反映纵沟缺乏。古口顶式, 口盖通常原位和很可能连生。

比较 本属以内壁形成很长的角, 而外壁在角的远极消失, 以及连生口盖等区别于 *Mu-derongia* Cookson et Eisenack, 1958 和 *Nyktericysta* Bint, 1986 等属。

分布及时代 美国内地西部和加拿大亚伯达省, 晚阿尔必期—早赛诺曼期; 中国松辽盆地, 早白垩世。

粒皱巴尔姆藻(新种) *Balmula granorugosa* sp. nov.

(图版 II, 图 10)

描述 囊泡贴近式, 伸长角藻形, 本体腹背轮廓椭圆形, 侧视近圆形, 具一发达的顶角和两尾角, 圆锥形, 角端坚实或棒状。顶角通常强烈伸长, 比尾角长和大; 两尾角近等大。侧角缺乏。壁较薄, 由紧贴的两层组成, 仅在各角的远极彼此分开, 每个角的远极仅由内壁构成, 而外壁在角的远极缺乏。外壁表面具较稀的短皱夹少许颗粒; 内壁表面平滑。反映腰带在有的标本上模糊可见或缺乏。古口顶式, 由顶区开裂而成; 口盖原位和可能在腹面连生。

度量 (μm): 囊泡长 84—105.8, 宽 42—55.2, 顶角长 20.7—41, 尾角长 18.4—34.5; 正模标本长 95.8, 宽 42, 顶角长 33, 尾角长 26。

比较 当前新种以个体较小和外壁表面粒皱状等特征不同于 *Balmula tripenta* Bint 1986, 后者表面平滑。

产地层位 吉林省农安县, 营城组。

巴尔姆藻(未定种) *Balmula* sp.

(图版 II, 图 8)

描述 囊孢伸长角藻形,腹背较扁平;本体较小,近圆形,具一顶角和两尾角。顶角强烈伸长,窄圆锥形,其基部微收缩,顶端钝。两尾角强烈叉开,不等长,圆锥形,末端钝尖。侧角缺乏。壁薄,由紧贴的两层组成,彼此仅在角的远极分开,每个角的远极仅由内壁形成,而外壁在角的远极缺失;外壁表面具稀的短皱夹少许颗粒,内壁平滑。反映腰带缺乏。古口顶式,口盖原位和很可能在腹面连生。

度量 (μm): 囊孢长 91.4, 宽 34.5, 顶角长 41.4, 尾角长 16—27.6。

比较 这个未定种的标本以本体较小和顶角基部较窄等不同于 *Balmula granorugosa* sp. nov.。

产地层位 吉林省农安县,营城组。

假角藻属 Genus *Pseudoceratium* Gocht, 1957 emend. Bint, 1986

模式种 *Pseudoceratium pelliferum* Gocht, 1957

属征 囊孢贴近式,腹背扁平,轮廓角藻形,具一顶、一尾和一右侧角。此 3 个角可长,可短或退化成低圆凸形。右侧角为后腰区的延伸但也可包括腰带的一部分。通常比其它两个角小。囊孢壁单层或由原壁和被层组成;原壁平滑,颗粒状或具密而短的突起,有时突起的远极以被层相连。反映板式仅由古口指示;有时也由突起的行线不完全表示,其公式为 $4', 6'', xc, ?6''', 1p, 1'''$ 。反映腰带缺乏或由突起的排列所表示,反映纵沟通常缺乏。古口顶式, (tA) 型,口盖通常游离。

比较 当前属与 *Odontochitina* Deflandre 1935 和 *Endoceratium* Vozzhennikova 1965 的区别主要是非腔式囊孢。

分布及时代 澳大利亚、欧洲、北美及亚洲等地,晚侏罗世—早白垩世。

假角藻(未定种) *Pseudoceratium* sp.

(图版 II, 图 9)

描述 囊孢角藻形,腹背扁平,侧边微凹,腰区向外凸,尾边近平直;具一顶角,一后腰角和一尾角,圆柱形,角端圆滑,其中以顶角最大。壁单层,较薄,表面短皱状。反映腰带可能位于囊孢最宽处,轮廓模糊,以侧边浅凹所表示。反映纵沟不明。古口顶式,由顶区开裂而成,口盖原位和可能连生。

度量 (μm): 囊孢长 80.5, 宽 57.5, 顶角长 23, 尾角长 13.8。

产地层位 吉林省农安县,营城组。

拟蝙蝠藻属 Genus *Vesperopsis* Bint, 1986 emend.

模式种 *Vesperopsis mayi* Bint, 1986

修订属征 囊孢中等到大,非腔式,腹背扁平,具一顶、两侧和两尾角。两侧角大小相当可变,从近等的宽大角到右侧角缺乏;当两侧角发育时,每个侧角具或不具一前腰区 and 一后腰区延伸的突起或角。两尾角近等大或右尾角减小。原壁极薄,表面平滑。反映板式以古口和(或)

反映腰带所表示。反映腰带可由侧角的凹入,偶尔由横向线脊所指示,或缺乏。古口顶式,口盖连生和通常原位保存或被破坏掉。主古口缝轻微角状—Z字形。

讨论 当前的修订是为了包括缺乏一侧角的类型。*Vesperopsis* 以原壁不同于 *Muderongia* Cookson et Eisenack, 1958 和 *Nyktericysta* Bint 1986, 同时 *Muderongia* 具游离或粘附口盖。*Australisphaera* Davey 1978 具游离口盖和原壁上具纹饰。*Pseudoceratium* Gocht 1957 仅具一侧角和一尾角。当前的修订指出 *Vesperopsis* 的囊泡的侧角是一个相当不稳定的构造特征,使 *Contrangularia* Wan et Zhang 1990 可能成为 *Vesperopsis* 的晚出同义名。

分布及时代 北美、英格兰和中国东北等地,早白垩世。

光面拟蝙蝠藻(新种) *Vesperopsis glabra* sp. nov.

(图版 I, 图 1—9; 图版 III, 图 1—12)

描述 囊泡贴近式,腹背扁平,本体横椭圆形,具一顶、一侧和两尾角,均为圆锥形。顶角总比其它角宽大得多,由上囊延伸而成,与本体之间无明显界线(过渡的),顶端圆滑。一左侧角较发达,向上伸或平伸,主要从前腰区延伸出来,大体上可称之左前腰角,其大小可变,通常和两尾角差不多大,末端钝或尖;右侧角缺乏或仅以腰区肿胀所表示。两尾角较发达,近等大,彼此强烈叉开,通常基部毗连,少数相距较远,角端一般钝尖或圆滑。原壁薄膜状,表面平滑或近平滑,可褶皱,淡色。反映腰带缺乏或偶尔仅能模糊地确定。反映板式仅以古口所指示。古口顶式,通常较明显,由顶区开裂而成,主古口缝在背面微角状。口盖在腹面连生,通常原位保存。

度量 (μm): 囊泡长 74—87.5, 宽(不包括侧角) 40—52.5, 顶角长 22—38.7, 尾角长 20—27.5, 侧角长 10—21.5; 正模标本长 81.3, 宽(不含侧角) 50, 顶角长 27, 尾角长 25, 侧角长 21.5。

比较 本新种以表面平滑和仅具一个左前腰角区别于本属中已描述的各种。

产地层位 黑龙江省泰康县,沙河子组。

粒面拟蝙蝠藻(新种) *Vesperopsis granulata* sp. nov.

(图版 I, 图 10—12)

描述 囊泡贴近式,腹背扁平,本体轮廓近圆形,具一顶、一侧和两尾角,除顶角外均为圆锥形。顶角胖圆锥形,比其它的角都大,顶部宽而圆滑。一左侧角颇显著,主要是从左前腰区向上斜伸而成,大小可变,大者和两尾角的大小几乎相等,角端钝尖。右侧角缺乏。两尾角近等大,强烈叉开,基部彼此毗连,末端尖。原壁极薄,淡色,表面稀的细颗粒—弱的粒皱状,具不规则褶皱。反映腰带缺乏。反映板式仅以古口所表示。古口顶式,由顶区开裂而成,在背面主古口缝微角状,口盖原位和在腹面连生。

度量 (μm): 囊泡长 58.1—75, 宽(不包括侧角) 40—41.4, 顶角长 20—26, 侧角长 11.2—25, 尾角长 13.5—25。正模标本长 75, 宽约 40, 顶角长 22, 侧角长 22, 尾角长 20—22。

比较 当前新种以本体近圆形,壁表面稀颗粒—短皱状区别于 *Vesperopsis glabra* sp. nov.。

产地层位 黑龙江省泰康县,沙河子组。

肇东拟蝙蝠藻(新种) *Vesperopsis zhaodongensis* sp. nov.

(图版 II, 图 1—7)

描述 囊孢中等到大, 非腔式, 腹背压扁, 具一顶角, 两侧角和两尾角。顶角强壮, 近圆柱形一胖圆锥形、较长, 顶端封闭而钝圆; 两尾角近等大, 末端尖, 尾边缘弧形或倒 U 字形; 两侧角较宽钝, 近等大或左侧角较大, 具前、后腰区延伸的突起, 其中后腰区延伸的突起较长而尖, 前腰区延伸的突起钝而不明显。囊孢壁薄, 单层, 壁表面具颗粒状纹饰, 局部颗粒连成短皱状。反映腰带由侧角的凹入和弱的横脊指示。反映纵沟没有标志, 或少数标本的下囊腹面在尾部有一倒 U 字形区域。反映板式由反映腰带和古口所指示。古口顶式, 口盖在腹面连生; 主古口缝 Z 字形或模糊角状。

度量 (μm): 囊孢长 76.8—84.0, 宽 62.4—69.0, 顶角长 16.8—24, 侧角长 7.4—9.6, 尾角长 19.2—21.6; 正模标本长 76.8, 宽 62.4, 顶角长 24, 侧角长 7.4, 尾角长 19.4。

比较 新种以壁单层, 表面具颗粒纹饰区别于 *Nyktericysta puyangensis* Wan et Qiao (在出版中), 后者壁表面为密的长短不一的皱纹夹少许颗粒, 以及后腰区延伸的突起一般较长些; 以具宽而钝的两侧角不同于 *Vesperopsis granulata* sp. nov.。

产地层位 黑龙江省肇东市, 登娄库组四段。

参 考 文 献

- 万传彪、张莹, 1990: 海拉尔盆地早白垩世沟鞭藻类和疑源类的发现及其意义。大庆石油地质与开发, 9(3): 1—14。
 宋之深、何承全、钱泽书、潘昭仁、郑国光、郑岳芳, 1978: 渤海沿海地区早第三纪沟鞭藻类和疑源类, 1—190 页。科学出版社。
 郑亚惠、何承全, 1984: 苏北钦 30 井晚白垩世泰州组的孢粉学。中国科学院南京地质古生物研究所丛刊, 8: 55—118, 11pls。
 茅绍智、余静贤, 1990: 陆相沟鞭藻的起源和演化及其生油意义。地球科学——中国地质大学学报, 15(3): 283—290。
 Bint, A. N., 1986: Fossil Ceratiaceae: A restudy and new taxa from the Mid-Cretaceous of the Western Interior, U. S. A. Palynology, 10: 135—180, 9pls。
 Batten, D. J. and J. K. Lister, 1988: Early Cretaceous dinoflagellate cysts and chlorococcalean algae from freshwater and low salinity palynofacies in the English Wealden. Cretaceous Research, 9: 337—367, 7figs.

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EARLY CRETACEOUS FRESHWATER DINOFLAGELLATES FROM SONGLIAO BASIN, NE CHINA

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Key words: Songliao Basin, Berriasian—Aptian, ceratioid dinocysts, freshwater.

Summary

The Early Cretaceous dinoflagellate cysts recovered from the Shahezi to Yingcheng Formation (Berriasian—Barremian) and the Dengloulou Formation (Aptian) in the Songliao Basin are abundant in quantity but low in diversity, containing five new species and two unnamed species referable to the genera *Australisphaera*, *Balmula*, *Pseudoceratium* and *Vesperopsis*. The dinoflagellate assemblages from the Shahezi Formation and Member 4 of the Dengloulou Formation are dominated by *Vesperopsis glabra* sp. nov. and *V. zhaodongensis* sp. nov. respectively, and that from the Yingcheng Formation is characterized by *Balmula granorugosa* sp. nov. The Present ceratioid dinocysts are somewhat similar to those of the Lower Cretaceous Fuxin and Damoguaihe Formations, EN China, and are considered as originating from a freshwater lake under the moist climatic environment. Also described are some other new species, including *Australisphaera cruciata* sp. nov. and *Vesperopsis granulata* sp. nov., with an emended diagnosis of *Vesperopsis* Bint, 1986.

Description of New Species

Australisphaera cruciata sp. nov.

(Pl. I, figs. 13—15)

Description: Cyst proximate, dorsoventrally compressed, cruciate in outline, with one apical, two lateral and one antapical horns. Apical horn broadly blunt-conical, bigger than other horns; two lateral horns of unequal size, conical to subconical, with the right one bigger than the left; antapical horn located at the center of antapical edge and on the same straight line with apical horn, subconical, terminally rounded. Wall single-layered, very thin, with surface smooth and bearing some secondary linear folds. Paracingulum absent, probably located between two lateral horns. Paratabulation indicated by archeopyle only. Archeopyle apical, with principal archeopyle suture zig-zag dorsally; operculum in place and possibly adnate ventrally.

Dimensions: Cyst 75—90 μ m long and 65—71.3 μ m wide; apical horn 34.5—36.8 μ m long; right lateral horn 20.7—22 μ m long, and left lateral horn 11—11.5 μ m long, antapical horn 11.1—13.8 μ m long. Holotype with cyst 75 μ m long and 70 μ m wide; apical horn 36.8 μ m long; right lateral horn 22 μ m long and left lateral horn 11 μ m long; antapical horn 11.1 μ m long.

Remarks: The specimens of this species are less in number, with archeopyle operculum in place and possibly adnate ventrally. They are classified into the genus until more materials are available.

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lable.

Occurrence: Shahezi Formation, Taikang, Heilongjiang, NE China.

***Balmula granorugosa* sp. nov.**

(Pl. II, fig. 10)

Description: Cyst proximate, elongate-ceratioid, elliptic dorsoventrally and subcircular laterally in body ambitus, with one developed apical horn and two antapical horns, conical, terminally solid or baculate. Apical horn usually strongly elongate, longer and bigger than antapical horns; two antapical horns of subequal size; lateral horn absent. Wall thin, consisting of two layers closely adpressed and separated from each other only at the distal portion of horns, resulting in the distal portion of each horn with only endophragm and lacking periphragm. Periphragm surface ornamented with short rugae and few grains; endophragm surface smooth. Paracingulum absent or faintly present in some specimens. Archeopyle apical, formed by the rupture of apical area; operculum in place and probably adnate ventrally.

Dimensions: Cyst 84—105.8 μ m long and 42—55.2 μ m wide; apical horn 20.7—41 μ m long; antapical horns 18.4—34.5 μ m long. Holotype with cyst 95.8 μ m long and 42 μ m wide; apical horn 33 μ m long; antapical horn 26 μ m long.

Comparison: This species differs from *Balmula tripenta* Bint, 1986, in having smaller cyst individuals and rugose and granulate periphragm surface, instead of the smooth surface in the latter.

Occurrence: Yingcheng Formation, Nong'an County, Jilin, NE China.

Genus *Vesperopsis* Bint, 1986, emend.

Type species: *Vesperopsis mayi* Bint, 1986

Emended diagnosis: Cyst proximate, compressed dorsoventrally, ceratioid to pentagonal in outline, with one apical, one or two lateral and two antapical horns. Two lateral horns variable, with the left one possibly being a precingular extension and the right one possibly absent. Other features the same as those described by Bint, 1986.

Remarks: The diagnosis of genus *Vesperopsis* is here emended to include the forms lacking a lateral horn.

Geological age and geographic distribution: Late Aptian to Albian, North America and England; Early Cretaceous, Songliao Basin, NE China.

***Vesperopsis glabra* sp. nov.**

(Pl. I, figs. 1—9; Pl. III, figs. 1—12)

Description: Cyst proximate, dorsoventrally compressed; body lateral elliptical in outline, with one apical, one lateral and two antapical horns. All horns conical. Apical horn rounded, usually much larger than other horns, formed by prolongation of epicyst, indistinctly delimited from the body. Left lateral horn well-developed, extending ahead or levelly and mainly arising from precingular area, with variable and usually almost the same size as two antapical horns, terminally blunt or pointed. Right lateral horn absent or only expressed by the swelling cingular region. Two antapical horns blunt or pointed, nearly equal in size, well-developed, strongly diverged from each other, and generally connected together at the base except in a few specimens. Autophragm thin, membranous; surface smooth, with folds, light-colored. Paracingulum absent or rarely indicated weak-

ly. Paratabulation indicated by archeopyle only. Archeopyle apical, generally clearer, formed by the rupture of apical area, with principal archeopyle suture weakly angular dorsally. Operculum generally in place and adnate ventrally.

Dimensions: Cyst 74—87.5 μm long and 40—52.5 μm wide (excluding lateral horn); apical horn 22—38.7 μm long; lateral horn 10—21.5 μm long; antapical horns 20—27.5 μm long. Holotype with cyst 81.3 μm long and 50 μm wide (excluding lateral horn); apical horn 27 μm long; lateral horn 21.5 μm long; antapical horn 25 μm long.

Comparison: This species differs from other described species of the genus in the smooth surface and the only left precingular horn.

Occurrence: Shahezi Formation, Taikang County, Heilongjiang, NE China.

Vesperopsis granulata sp. nov.

(Pl. I, figs. 10—12)

Description: Cyst proximate, dorsoventrally compressed, subcircular in body ambitus, with one apical, one lateral and two antapical horns, all conical. Apical horn broadly roundly conical, larger than other horns. Left lateral horn blunt or pointed, very obvious, mainly arising obliquely upward from left precingular area, with variable size, and the larger one almost in the same size as two antapical horns; right lateral horn absent. Two antapical horns nearly equal in size, strongly diverged, and connected with each other at the base. Autophragm very thin, light-colored; surface rarely finely granulate to weakly marked by short rugae, with irregular folds. Paracingulum absent. Paratabulation indicated by archeopyle only. Archeopyle apical, formed by the rupture of apical region, with principal archeopyle suture weakly angular dorsally; operculum in place and adnate ventrally.

Dimensions: Cyst 58.1—75 μm long and 40—41.4 μm wide (excluding lateral horn); apical horn 20—26 μm long; lateral horn 11.2—25 μm long; antapical horn 13.5—25 μm long. Holotype with cyst 75 μm and 40 μm wide (excluding lateral horn); apical horn 22 μm long; lateral horn 22 μm long; antapical 20—22 μm long.

Comparison: This species differs from *Vesperopsis glabra* sp. nov. in the subcircular cyst body and the wall surface which is finely granulate to weakly marked by short rugae.

Occurrence: Shahezi Formation, Taikang County, Heilongjiang, NE China.

Vesperopsis zhaodongensis sp. nov.

(Pl. II, figs. 1—7)

Description: Cyst intermediate to large, acavate, dorsoventrally compressed, with one apical, two antapical and two lateral horns. Apical horn long and strong, subcircular to broadly conical, with closed and blunt tip. Two antapical horns approximately equal in size, distally solid and terminally pointed, with antapical margin arcuate or U-shaped. Two broad and blunt lateral horns nearly equal in size, or with the left one larger than the right, with longer and pointed postcingular extension, and blunt and less prominent precingular extension. Cyst wall thin, single-layered; surface granulate or marked by short rugae in local creas. Paracingulum indicated by indentation of the lateral horns and weakly transverse ridges. Parasulcus absent, except for U-shaped area in its corresponding position ventrally. Paratabulation indicated by paracingulum and archeopyle. Archeopyle apical, with zigzag or weakly angular principal archeopyle suture; operculum in place and adnate ventrally.

Dimensions: Cyst 76.8—84 μm long and 62.4—69 μm wide; apical horn 16.8—24 μm long, la-

teral horn 7.4—9.6 μm long; antapical horns 19.2—21.6 μm long. Holotype with cyst 76.8 μm long and 62.4 μm wide; apical horn 24 μm long; lateral horn about 7.4 μm long; antapical horn 19.4 μm long.

Comparison: This species differs from *Vesperopsis granulata* sp. nov. in having two broad and blunt lateral horns; and from *Nyktericysta puyangensis* Wan et Qiao (in press) in having single-layered wall and granulate rather than variably rugose surface.

Occurrence: Member 4 of the Dengloulou Formation, Zhaodong City, Heilongjiang, NE China.

图 版 说 明

除电子扫描照相的标本外,所有的标本均保存于大庆石油管理局勘探开发研究院地质试验室。

图 版 I

1—9. *Vesperopsis glabra* sp. nov.

1—6. 背视, 标本照相号: 477、459、464、460、482、431 (Paratype); 7—9. 腹视, 标本照相号: 466、455、522 (Holotype); $\times 600$; 样品深度: 杜 13 井 1510—1520.18m; 黑龙江省泰康县, 沙河子组。

10—12. *Vesperopsis granulata* sp. nov.

10, 11. 腹视, 标本照相号: 601、602; 12. Holotype, 背视, 标本照相号: 468; $\times 600$, 样品深度同前, 产地层位同上。

13—15. *Australisphaera cruciata* sp. nov.

13. Holotype, 顶角胖圆锥形, 一尾角较短钝和两侧角不等长, 标本照相号: 519; 14, 15. 标本照相号: 445、476; $\times 600$; 样品深度同前, 产地层位同上。

图 版 II

1—7. *Vesperopsis zhaodongensis* sp. nov.

1, 2. Holotype, 标本照相号: 708, 1. 油镜下的标本之一部分, 显示表面颗粒状纹饰, $\times 1000$; 2. $\times 800$; 3, 4, 7. 标本照相号: 727、719、705, $\times 800$; 5, 6. 标本照相号: 707, 5. 油镜下的标本之一部分, 显示表面颗粒状纹饰, $\times 1000$, 6. $\times 800$; 样品深度: 青 2 井 1954.43m, 黑龙江省肇东市, 登娄库组四段。

8. *Balmula* sp.

标本照相号: 422, $\times 600$, 样品深度: 农 101 井 2021.6m, 吉林省农安县, 营城组。

9. *Pseudoceratium* sp.

标本照相号: 408, $\times 600$, 样品深度: 农 101 井 2015.87m, 产地层位同上。

10. *Balmula granorugosa* sp. nov.

Holotype, 标本照相号: 423, $\times 800$, 样品深度: 农 101 井 2021.6m, 吉林省农安县, 营城组。

图 版 III

图 3 中的线段代表 10 μm 长, 适用于图 1—12。

1—12. *Vesperopsis glabra* sp. nov.

标本照相号: 2340、2353、2350、2386、2342、2336、2326、2382、2381、2355、2321、2383。样品深度: 杜 13 井 1510—1520.18m, 黑龙江省泰康县, 沙河子组。





