科学通报 2017 年 第 62 卷 第 23 期: 2660 ~ 2665
快 讯
《中国科学》杂志社
SCIENCE CHINA PRESS

皖南晚白垩世恐龙蛋新类型

黄建东[1], 王强[2*], 胡远超[1], 任鑫鑫[1], 汪筱林[2,3]

1. 安徽省地质博物馆, 合肥 230031;
2. 中国科学院脊椎动物演化与人类起源重点实验室, 中国科学院古脊椎动物与古人类研究所, 北京 100044;
3. 中国科学院大学地球科学学院, 北京 100049

* 联系人, E-mail: wangqiang@ivpp.ac.cn

2016-12-30 收稿, 2017-05-22 修回, 2017-05-24 接受, 2017-07-03 网络版发表
国土资源部公益性行业科研专项(201511054)、国家自然科学基金(41672012, 41688103)和安徽省公益性地质工作项目(2011-g-32)资助

摘要 安徽黄山地区上白垩统徽州组中发现了恐龙蛋一新类型. 根据蛋化石呈椭圆形, 在蛋窝中沿长轴定向排列, 不在同一层面, 长径平均为 13.86 cm, 赤道直径平均为 10.43 cm, 形状指数为 75.25; 蛋壳外表面无纹饰, 厚度平均为 0.75 mm; 壳单元整体呈降落伞形、三角形或锥形, 排列疏密不均, 锥体呈半球形, 锥体层非常薄, 平均厚度为 0.12 mm, 约为蛋壳厚度的 1/6, 柱状层近内表面和近外表面分别发育伞形结构; 气孔道不规则等特征, 区别于已发现的其他恐龙蛋类型, 建立一新蛋属新蛋种——休宁伞形蛋(新蛋属, 新蛋种)*Umbellaoolithus xiuningensis* oogen. et oosp. nov.; 并建立一新蛋科——伞形蛋科(新蛋科)Umbellaoolithidae oofam. nov. 这一发现不仅丰富了恐龙蛋类型的多样性, 同时也为皖南地区晚白垩世红层的划分与对比提供了新的古生物证据.

关键词 恐龙蛋, 徽州组, 晚白垩世, 休宁

2011年4月, 安徽省休宁县齐云山镇一建筑工地施工过程中于徽州组地层中发现蛋化石, 后经抢救性发掘共采集蛋化石两窝, 现场施工人员将发掘的蛋化石交由休宁县齐云山管委会博物馆, 其中一窝后交由休宁县文物管理所, 并经协调转交至安徽省地质博物馆收藏, 本文是对这一窝恐龙蛋的详细记述.

安徽黄山地区中生代地层发育, 产出有大量的恐龙骨骼、恐龙蛋、恐龙足迹等[1](图1). 皖南地区恐龙蛋最早发现于1995年, 最初在休宁太平湖大桥接线公路黄土岭路段工地发现恐龙蛋, 同年3月, 安徽省地质矿产勘查局332地质队区调分队王德恩等人[2]在休宁渭桥乡上暨村发现恐龙蛋. 余心起[1]记述了这两个地点的2蛋属3蛋种, 分别命名为: 太平湖长形蛋(*Elongatoolithus taipinghuensis*)、渭桥椭圆形蛋(*Ovaloolithus weiqiaoensis*)和黄土岭椭圆形蛋(*O. huangtulingensis*). 赵资奎等人[3]在完成《中国古脊椎动物志》的过程中, 对恐龙蛋分类进行清理, 认为以上三类恐龙蛋都为存疑蛋种[3].

皖南地区大地构造位置属于扬子地块东南缘的江南造山带东段[4]. 休宁盆地位于皖南腹地, 为中生代发育的小型山间盆地, 盆地内红层出露完整, 在中国东部中(新)生代盆地中具有一定的代表性[5]. 区内中生代地层发育, 三叠纪地层分布较零星, 侏罗纪和白垩纪地层出露完整, 其中, 侏罗纪地层包括下侏罗统月潭组、中侏罗统洪琴组, 白垩纪地层包括下白垩统炳丘组、石岭组和岩塘组, 上白垩统徽州组、齐云山组和小岩组[6].

一窝保存不完整, 最少由9枚蛋化石组成的蛋窝. 在其中一枚恐龙蛋上取两片蛋壳, 进行蛋壳显微结构镜检薄片的制作与观察, 同时有一片蛋壳制作成薄片后用5%醋酸蚀刻60 s用于扫描电子显微镜(Scanning Electron Microscope, SEM)观察.

伞形蛋科(新蛋科) Umbellaoolithidae oofam. nov.

词源 见蛋属.

科征 见蛋属.

伞形蛋属(新蛋属) *Umbellaoolithus* oogen. nov.

引用格式: 黄建东, 王强, 胡远超, 等. 皖南晚白垩世恐龙蛋新类型. 科学通报, 2017, 62: 2660–2665
Huang J D, Wang Q, Hu Y C, et al. New oospecies of dinosaur eggs from the Upper Cretaceous of South Anhui (in Chinese). Chin Sci Bull, 2017, 62: 2660–2665, doi: 10.1360/N972016-01479

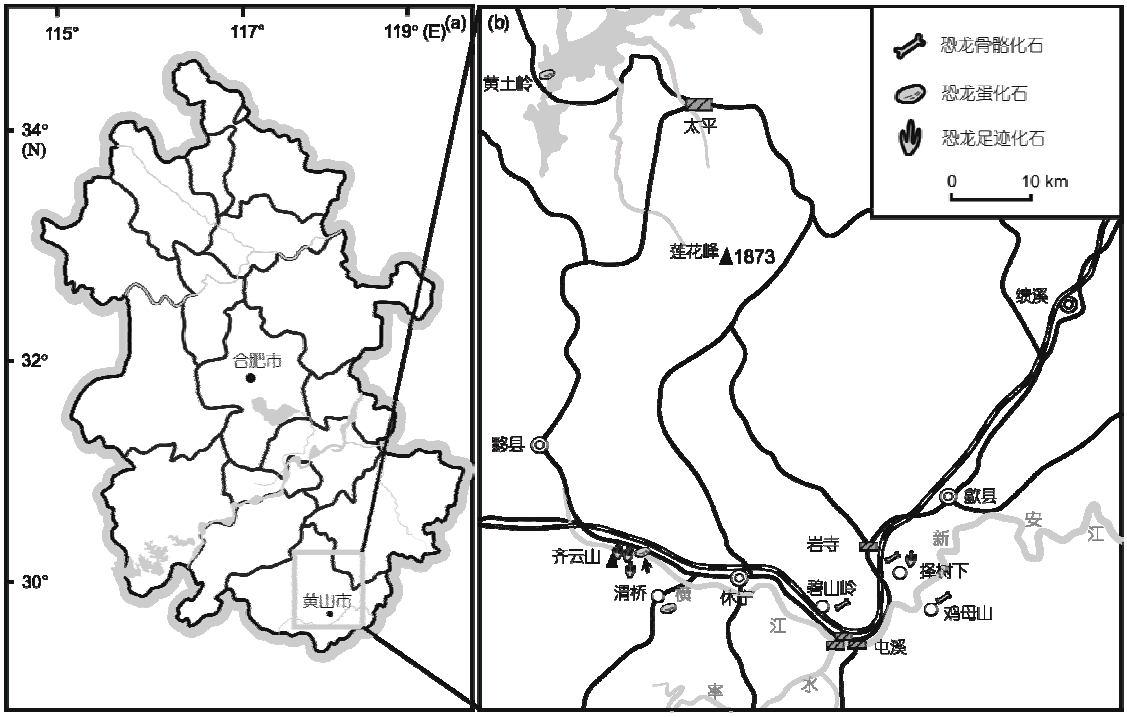

图 1 皖南地区恐龙、恐龙蛋、恐龙足迹分布示意图(据余心起[1]修改). (b)中箭头所指为本文研究恐龙蛋的产出地点

Figure 1 Distribution map of dinosaur bones, dinosaur eggs, dinosaur footprints in South of Anhui (modified from Yu[1]). The arrow shows the locality of dinosaur eggs in this paper in (b)

词源 伞形取之于拉丁词*Umbella-*, 意为壳单元径向呈降落伞型, *-oolithus* 为蛋属的后缀.

属征 见属形蛋种征.

休宁伞形蛋(新蛋属, 新蛋种) *Umbellaoolithus xiuningensis* oogen. et oosp. nov.

词源 xiuning-取自恐龙蛋产地休宁的拼音.

产地 安徽省黄山市休宁县齐云山镇.

地层及时代 徽州组, 晚白垩世.

特征 蛋化石呈椭圆形, 在蛋窝中沿长轴定向排列, 蛋与蛋之间间隔一定距离, 不在同一层面, 可测得的长径平均为13.86 cm, 赤道直径平均为10.43 cm, 形状指数为75.25. 蛋壳外表面无纹饰, 较薄, 厚度平均为0.75 mm. 壳单元呈降落伞形、三角形或锥形, 排列疏密不均, 锥体呈半球形, 锥体层非常薄, 平均厚度为0.12 mm, 约为蛋壳厚度的1/6, 柱状层近内表面和近外表面分别发育伞形结构. 气孔道不规则.

至少由9枚蛋化石组成的不完整蛋窝(标本编号AGB6267, 标本保存在安徽省地质博物馆), 其中5枚稍微破损, 轮廓清晰, 另外4枚保存有部分蛋壳的蛋化石印痕(图2). 蛋化石在蛋窝中沿蛋的长轴定向排列, 相互之间疏密不均, 不在同一层面(图2). 蛋化石呈椭圆形, 其中较为完整恐龙蛋测得长径平均为13.86 cm, 赤道直径平均为10.43 cm, 形状指数平均为75.25 (表1).

蛋壳外表面光滑, 无纹饰. 蛋壳较薄, 厚度平均为0.75 mm.

蛋壳由排列疏密不均的壳单元组成, 壳单元呈降落伞形、锥形或三角形, 壳单元有时三两聚合在一起, 壳单元之间分布有不规则的气孔道(图3(a)). 在蛋壳近内表面, 壳单元间隔较明显, 为气孔道分隔开(图3(a), (b)), 近蛋壳外表面壳单元排列紧密(图3(a), (b)).

锥体呈半球形(图3(b), 4(a), (b)), 由晶核中心向外呈放射状生长(图4(b)), 直径平均为0.12 mm. 锥体层非常薄, 厚度约占蛋壳厚度的1/6. 锥体分布不均(图4(g)), 单位面积内的锥体数量平均为65个/mm^2.

锥体层与柱状层界线不明显(图

表 1 蛋化石形态数据测量值

Table 1 Measurements of eggs

标本编号	长径(cm)	赤道直径(cm)	形状指数
1	13.72	10.64	77.55
2	13.74	10.41	75.76
3	14.11	10.60	75.12
5	13.86	10.06	72.58
平均值	13.86	10.43	75.25

图 2 休宁伞形蛋(新蛋属, 新蛋种)蛋窝形态. 显示 9 枚完整程度不同的恐龙蛋(标本编号 AGB6267), 其中编号 1~5 的恐龙蛋保存较为完整, 编号 7~9 的恐龙蛋保存了大部分蛋的痕迹, 编号 6 的恐龙蛋仅保留少量的痕迹且叠压在 5 上面, 可见这些恐龙蛋沿蛋化石的长轴定向排列, 相互间隔不等, 不在同一水平面

Figure 2 The nest of the *Umbellaoolithus xiuningensis* oogen. et oosp. nov.. Nine dinosaur eggs in different complete levels, orientation along the long axis of fossil eggs, not on the same plane; No. 1–5 more complete, No. 7–9 preserve some eggshells and outline of eggs, No. 6 only a little eggshell, and stack on the No.5

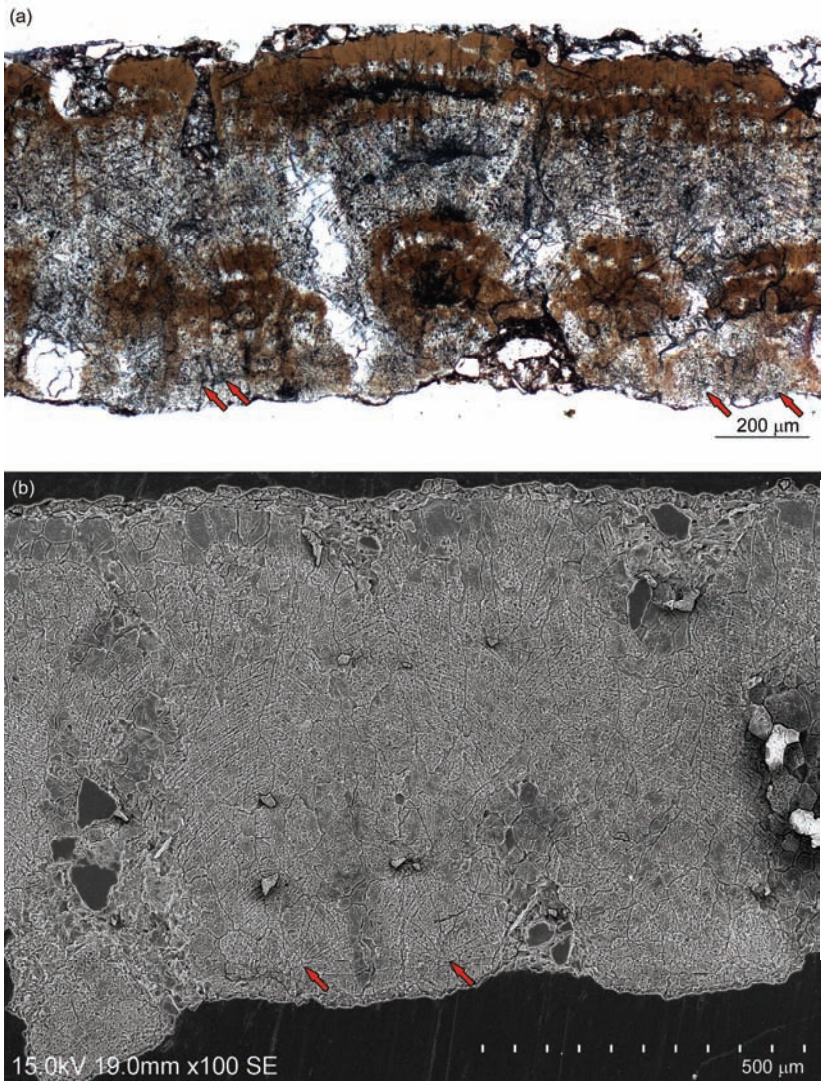

图 3 休宁伞形蛋(新蛋属, 新蛋种)蛋壳径切面. (a) 蛋壳径切面偏光显微镜, 示伞形、锥形和三角形的壳单元结构, 壳单元排列疏密不均, 有的三两聚集在一起, 相互间为气孔所分割, 红色箭头所指为半球形锥体的晶核中心; (b) 蛋壳径切面扫描电子显微镜(SEM)观察示紧密排列的壳单元, 红色箭头所指为锥体的晶核中心

Figure 3 Microstructure of the *Umbellaoolithus xiuningensis* oogen. et oosp. nov. in radial sections. (a) Microstructure of eggshell in Polarizing microscope, showing umbrella, cone and triangle eggshell units, eggshell units not uniform, and some of the units three or two gathered together, separated by the pores, the red arrow showing the nucleation center of the hemispherical cone; (b) microstructure of eggshell units in SEM, showing Calcite crystal structure of the eggshell units, showing the nucleation center of the hemispherical cone (red arrow)

3(a), (b); 4(a), (f)). 壳单元中有两层呈降落伞型的结构, 一层位于近锥体层与柱状层的过渡层, 另一层位于近蛋壳外表面(图3(a); 4(c)~(f)). 这些伞型的结构由排列较为紧密的大块方解石晶体组成, 而位于这两层之间的方解石较为细密.

气孔道不规则, 在蛋壳中分布不均匀(图3(a); 4(g), (h)).

本文研究的恐龙蛋呈椭圆形, 在蛋窝中沿蛋的长轴定向排列, 不在同一层面等特征明显不同于蛋化石呈长形, 在蛋窝中两枚一组, 围绕蛋窝呈放射状规则排列的长形蛋类[3,7]和巨型长形蛋类[3,8], 也不同于垂直或近垂直排列的棱柱形蛋类[3]; 伞形、锥形或三角形的壳单元特征不同于圆形蛋类[3,9]、石笋蛋类[3,10]和椭圆形蛋类[3]的壳单元结构特征, 更不同于壳单元排列呈网形的网形蛋类[3,11]、柱状分散排列的蜂窝蛋类[3,12]、树枝状的树枝蛋类[3]等, 其锥体呈半球形, 柱状层发育两层伞形结构等特征明显区别于以上各种恐龙蛋类型, 据此可建立新蛋属, 新蛋种——休宁伞形蛋*Umbellaoolithus xiuningensis* oogen. et oosp. nov., 并建立新蛋科——伞形蛋科Umbellaoolithidae.

皖南发现了大量的恐龙足迹、恐龙骨骼和恐龙蛋, 此次新发现的恐龙蛋类型增加了恐龙蛋类型的多样性, 同时也为皖南红层的进一步划分与对比提供了新的古生物证据.

皖南成窝恐龙蛋的发现, 将为进一步研究皖南地区早白垩世晚期-晚白垩世早期恐龙生存的古环境、古地理提供更加丰富的材料.

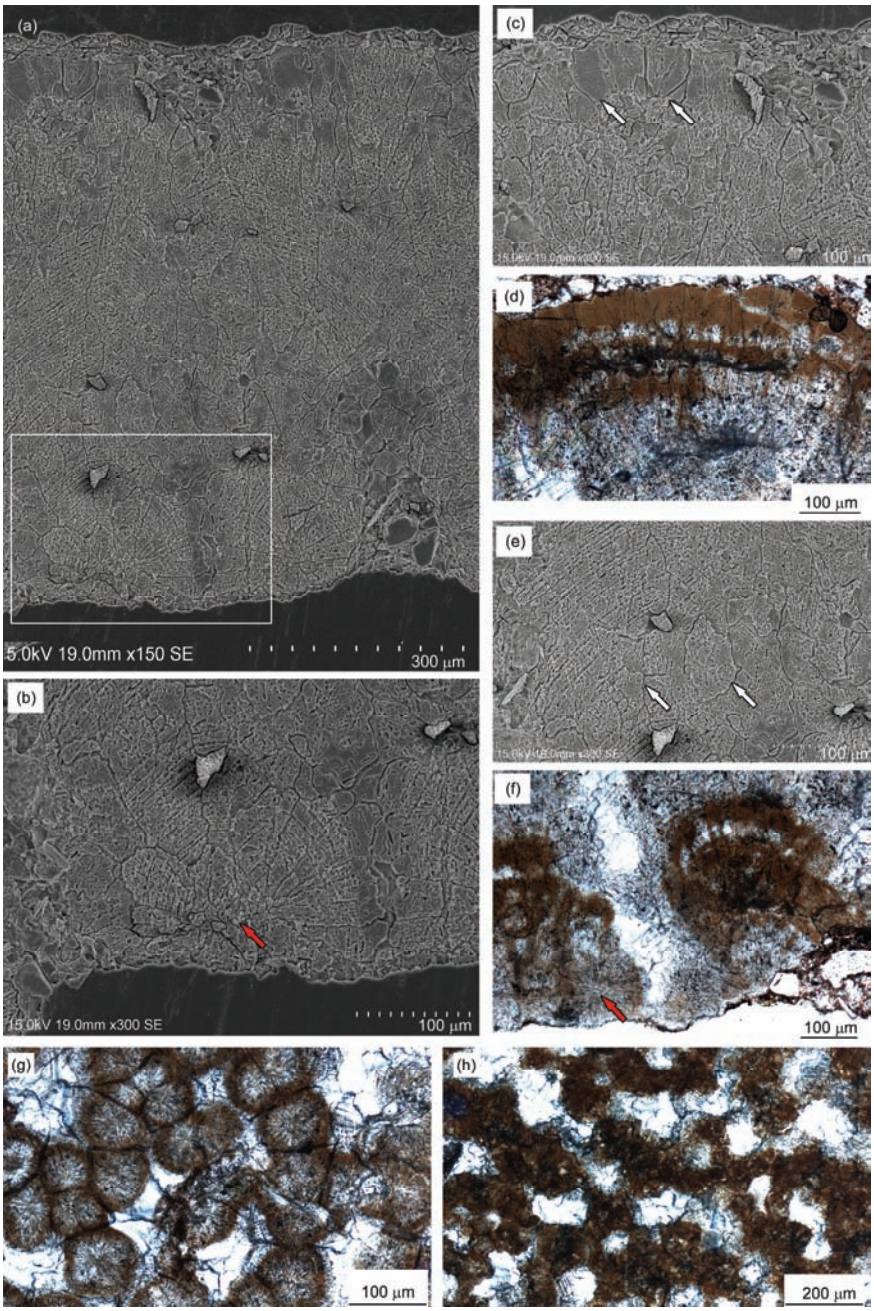

图 4 休宁伞形蛋(新蛋属, 新蛋种)蛋壳显微结构. (a) 蛋壳径切面扫描电子显微镜(SEM)观察; (b) 单个半球形的锥体扫描电子显微镜观察((a)中方框部分)及其晶核中心(红色箭头所指); (c), (d) 柱状层近外表面处壳单元的伞形结构((c)为扫描电子显微镜(SEM)观察, (d)为组织学切片的普通光观察), 伞形结构由大块的方解石晶体组成((c)中白色箭头所指); (e), (f) 锥体层与柱状层过渡处壳单元的伞形结构((e)为扫描电子显微镜(SEM)观察, (f)为组织学切片的普通光观察), 伞形结构由大块的方解石晶体((e)中白色箭头所指), (f)中红色箭头所指为锥体的晶核中心; (g) 蛋壳锥体层弦切面, 示排列疏密不均的锥体, 锥体呈半球形沿晶核中心向外呈放射状生长, 部分锥体紧密相连; (h) 蛋壳柱状层中上部弦切面, 示间隔明显的壳单元和不规则气孔

Figure 4 Microstructure of the *Umbellaoolithus xiuningensis* oogen. et oosp. nov.. (a) Microstructure of eggshell units in SEM; (b) a single hemispherical cone in SEM (enlarge of the block in (a)), showing the nucleation center of the hemispherical cone (the red arrow); (c), (d) umbrella structure of the eggshell units near outsurface of the eggshell ((c) in SEM, (d) in Polarizing microscope), the umbrella structure of eggshell composed of large calcite crystals (white arrow in (c)); (e), (f) umbrella structure of the eggshell units near the boundary of the cone layer and the columnar layer ((e) in SEM, (f) in Polarizing microscope), the umbrella structure of eggshell also composed of large calcite crystals (white arrow in (e)), and showing the nucleation center of the round cone (red arrow in (f)); (g) uneven arrangement cones in tangential section through the cone layer, and nucleation center of the hemispherical cone; (h) distinct interval eggshell units and irregular pores in tangential section through the columnar layer

致谢 在项目完成过程中，安徽省地质矿产勘查局 327 地质队毕治国、齐敦伦，安徽省地质博物馆宫维莉等参加了野外调查与标本采集工作，中国科学院古脊椎动物与古人类研究所张文定协助完成了蛋壳显微结构扫描电子显微镜的观察，周红娇修复了标本，高伟拍摄蛋窝照片，赵资奎研究员审阅了文章初稿，Corwin Sullivan 审阅了英文摘要，两位审稿人提出了宝贵的修改意见，在此一并表示感谢.

参考文献

1 Yu X Q. Characteristics of dinosaur fossils from southern Anhui and their significance for stratigraphic division (in Chinese). Reg Geol China, 1998, 17: 278–284 [余心起. 皖南恐龙类化石特征及其地层划分意义. 中国区域地质, 1998, 17: 278–284]

2 Wang D E, Yu X Q, Jiang G B. Dinosaur eggs from Xiuning County of South Anhui (in Chinese). Geol Anhui, 1995, 5: 60 [王德恩, 余心起, 江功炳. 皖南休宁县发现恐龙蛋化石. 安徽地质, 1995, 5: 60]

3 Zhao Z K, Wang Q, Zhang S K. Dinosaur eggs (in Chinese). In: Palaeovertebrata Sinica. Vol II, Fascicle 7. Beijing: Science Press, 2015. 1–168 [赵资奎, 王强, 张蜀康. 恐龙蛋类. 见: 中国古脊椎动物志. 第 2 卷, 第 7 册. 北京: 科学出版社, 2015. 1–168]

4 Zhu G, Liu G S. Basic characteristics and Mesozoic orogenic process of the Jiangnan intracontinental orogenic belt in Southern Anhui (in Chinese). Geotect Metall, 2000, 24: 103–111 [朱光, 刘国生. 皖南江南陆内造山带的基本特征与中生代造山过程. 大地构造与成矿学, 2000, 24: 103–111]

5 Yu X Q, Wang D E. Jurassic-Cretaceous sequence stratigraphy of Huangshan area in South Anhui (in Chinese). Geoscience, 2001, 15: 27–34 [余心起, 王德恩. 安徽黄山地区侏罗纪-白垩纪层序地层学特征. 现代地质, 2001, 15: 27–34]

6 Huang J D, You H L, Yang J T, et al. A new sauropod dinosaur from the Middle Jurassic of Huangshan, Anhui Province (in Chinese). Vert PalAsiat, 2014, 52: 390–400 [黄建东, 尤海鲁, 杨精涛, 等. 安徽黄山中侏罗世蜥脚类恐龙一新属种. 古脊椎动物学报, 2014, 52: 390–400]

7 Wang Q, Wang X L, Zhao Z K, et al. A new oogenus of elongatoolithidae from the Upper Cretaceous Chichengshan Formation of Tiantai Basin, Zhejiang Province (in Chinese). Vert PalAsiat, 2010, 48: 111–118 [王强, 汪筱林, 赵资奎, 等. 浙江天台盆地上白垩统赤城山组长形蛋科一新蛋属. 古脊椎动物学报, 2010, 48: 111–118]

8 Wang Q, Zhao Z K, Wang X L, et al. A new oogenus of macroelongatoolithid eggs from the Upper Cretaceous Chichengshan Formation of the Tiantai Basin, Zhejiang Province and a revision of the macroelongatoolithids (in Chinese). Acta Palaeontol Sin, 2010, 49: 73–86 [王强, 赵资奎, 汪筱林, 等. 浙江天台晚白垩世巨型长形蛋科一新属及巨型长形蛋科的分类订正. 古生物学报, 2010, 49: 73–86]

9 Liu J Y, Wang Q, Zhao Z K, et al. A parataxonomic revision of spheroolithid eggs from the Upper Cretaceous Quantou Formation in Changtu, Liaoning (in Chinese). Vert PalAsiat, 2013, 51: 278–288 [刘金远, 王强, 赵资奎, 等. 辽宁昌图上白垩统泉头组恐龙蛋化石的分类订正. 古脊椎动物学报, 2013, 51: 278–288]

10 Wang Q, Wang X L, Zhao Z K. A new oofamily of dinosaur egg from the Upper Cretaceous of Tiantai Basin, Zhejiang Province, and its mechanism of eggshell formation. Chin Sci Bull, 2012, 57: 3740–3747 [王强, 汪筱林, 赵资奎, 等. 浙江天台盆地上白垩统恐龙蛋一新蛋科及其蛋壳形成机理. 科学通报, 2012, 57: 2899–2908]

11 Wang Q, Zhao Z K, Wang X L, et al. New forms of dictyoolithids from the Tiantai Basin, Zhejiang Province of China and a parataxonomic revision of the dictyoolithids (in Chinese). Vert PalAsiat, 2013, 51: 43–54 [王强, 赵资奎, 汪筱林, 等. 浙江天台盆地网形蛋类新类型及网形蛋类的分类订正. 古脊椎动物学报, 2013, 51: 43–54]

12 Zhang S K. A parataxonomic revision of the Cretaceous faveoloolithid eggs of China (in Chinese). Vert PalAsiat, 2010, 48: 203–219 [张蜀康. 中国白垩纪蜂窝蛋化石的分类订正. 古脊椎动物学报, 2010, 48: 203–219]

Summary for “皖南晚白垩世恐龙蛋新类型”

New oospecies of dinosaur eggs from the Upper Cretaceous of South Anhui

HUANG JianDong[1], WANG Qiang[2*], HU YuanChao[1], REN XinXin[1] & WANG XiaoLin[2,3]

[1] *Anhui Geological Museum, Hefei 230031, China*
[2] *Key Laboratory of Vertebrate Evolution and Human Origins of Chinese Academy of Sciences, Institute of Vertebrate, Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing 100044, China;*
[3] *College of Earth Sciences, University of Chinese Academy of Sciences, Beijing 100049, China*
* Corresponding author, E-mail: wangqiang@ivpp.ac.cn

A new oogenus and oospecies, *Umbellaoolithus xiuningensis* oogen. et oosp. nov., is described on the basis of specimens from the Upper Cretaceous Huizhou Formation in the Huangshan area of Anhui Province, China. The Mesozoic strata developed in South Anhui, producing a large number of dinosaur skeletons, dinosaur eggs, dinosaur footprints and so on. The Xiuning Basin is a small intermountain basin during the Mesozoic. The Triassic strata are scattered and the Jurassic and Cretaceous strata are intact in the basin. The Jurassic strata include the lower Jurassic Yuetan Formation, and Middle Jurassic Hongqin Formation. The Cretaceous strata include the lower Cretaceous Bingqiu Formation, Shiling Formation and Yantang Formation, Upper Cretaceous Huizhou Formation, Qiyunshan Formation and Xiaoyan Formation. The materials we studied were found in the Huizhou Formation of Qiyunshan, Xiuning, in 2011. There is an incomplete egg nest consisting of at least 9 dinosaur eggs. The eggs are oval, arranged along the long axis of all the eggs parallel to each other, and not at the same horizontal level within the clutch, obviously differing from the elongated eggs, paired, regular arrangement and radial orientation seen in clutches attributable to the Elongatoolithidae and Macroelongatoolithidae. The eggs of *Umbellaoolithus xiuningensis* also differ in typical alignment from those of the Prismatoolithidae, which are vertical or near vertical. The average diameter of the eggs is 13.86 cm, the equatorial diameter is 10.43 cm, and the shape index is 75.25. In general, the eggshell units have the shape of an umbrella, triangle or cone, and are arranged irregularly, unlike in the Spheroolithidae, Stalicoolithidae and Ovaloolithidae. The cones are hemispherical in shape. The cone layer is very thin, its average thickness of 0.12 mm representing approximately 1/6 of the total eggshell thickness. Umbrella-like eggshell units are well-developed near the inner and outer surfaces of the columnar layer. The eggshells have numerous irregular pores, unlike in several oofamilies including the Dictyoolithidae and Faveoolithidae. Consequently, we established a new oofamily: Umbellaoolithidae oofam. nov.. This new specimen unambiguously represents a distinct oospecies of dinosaur eggs in southern Anhui, and provides new paleontological evidence bearing on the classification and correlation of Upper Cretaceous strata in southern Anhui.

dinosaur eggs, Huizhou Formation, Late Cretaceous, Xiuning

doi: 10.1360/N972016-01479