

# 叙述龍潭船山石灰岩中的 一种 *Girvanella* 化石并討論“球狀結構”\*

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船山石灰岩中的 *Girvanella* 化石,曾被德國 Paul (1938) 研究公布于世。本文將對我們最近在船山石灰岩中所采集的一些 *Girvanella* 标本作一簡短的叙述和討論。這些标本是筆者和几位同志1955年在南京东南龍潭鎮實習時採到的。當前的 *Girvanella* 化石產于船山石灰岩下部、人所熟知的“球狀結構”(globular-texture or globulites)中。在野外觀察,“球狀結構”是一種滿布在石灰岩風化面上的、不很規則的、常呈橢圓形、蛋形或紡錘形的結構,其長徑常在3—10毫米之間。在風化的岩石表面上常呈同心狀圈紋。此種同心圈紋并不隆起。經切片觀察,我們發現這種“球狀結構”是由一叢 *Girvanella* 細管(*Girvanella-tubules*)圍繞着一個核心(nuclei)組成的。這種核心有時是一塊或几塊方解石的結晶體,有時是一個蠟類的殼。*Girvanella* 細管盤繞、堆疊成幾個或多或少平行的圈,包裹着這種核心。詳細地進行觀察以後,發現當前的 *Girvanella* 細管的直徑變異頗巨。最小的是17微米,最大的可到46微米。其中最常見的类型,直徑約在23—32微米之間。這一系列從17—46微米的細管是很难被分成兩個或兩個以上彼此絕然分開的类型,因為在薄片中我們常會看到許多或大或小、直徑介于17微米和46微米之間的細管,而這種細管又常常混雜在一個“球狀結構”或一個薄片。這些或大或小的細管的一般形态都是完全相同的。

當前的 *Girvanella* 和 Paul 1938年在浙江長興,江苏龍潭鎮和栖霞山鎮船山石灰岩中所發現的 *Girvanella grabaui* 極為相似,只是我們的 *Girvanella* 比 *Girvanella grabaui* 更不規則些,直徑更大些。至于當前的種究竟是一個新種還是代表着 *Girvanella grabaui* 的一種變异的类型,現在很难決定。Paul所給的 *G. grabaui* 的圖影只有一個,而且是很不清楚的,因此我們也無法根據他的圖影來和當前的 *Girvanella* 相互比較。根據 Paul 所給的描述(1938,第212頁),我們的種是和 *Girvanella grabaui* 不

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完全一致的。*G. grabau* Paul 的直徑是很規則的 16 微米,只偶有直徑較大的类型出現。因此筆者願意將当前的标本暫定為 *Girvanella* sp., 以待更多証据的發現。和当前的 *Girvanella* 同样具有着極大變异的种是 *Girvanella pernica* (Steinmann ms.) (Pia, 1937 第 820 頁)。这一种化石是產于意大利 Karnische Alpen 地方 Trogkoflkalk 的上部(中二疊紀)的地層中。它的直徑是 0.015—0.04 毫米。当前的标本和这一种化石的區別,是在于其管壁較薄,僅 0.004 毫米。*Girvanella pernica* 的管壁的厚度是 0.01—0.02 毫米。

茲將此次所采的 *Girvanella* sp. 的特征描述如下:

### Agathidia

#### *Girvanella* sp.

細管,纏繞、聚集成几个或多或少平行的条帶,包裹着一个核心而成蛋形、橢圓形或紡錘形的“集合体”(Colony)。管橫切面呈圓形,直徑自 23—32 微米,有时可大至 46 微米,偶而有 17 微米,平均为 27.5 微米,簡單而不分叉。管壁厚約 4 微米。

*Girvanella* sp. 產于船山石灰岩下部,常和 *Triticites* 相伴而生。

除了極少的情況以外,*Girvanella* 是密切和“球狀結構”共生的。这种所謂“球狀結構”顯然是由于藻类的活动生成的,而不可能是由于化学作用生成的。关于 *Girvanella* 这种藻类是“造岩者”抑为“破坏者”(rock builder or destroyer) 这一問題曾有过不少爭論。Wethered 顯然相信 *Girvanella* 是“造岩者”。他(Wethered, 1890, 第 281 頁)詳細地研究了英國石炭紀及侏羅紀的石灰岩中的“鮎狀岩”及 *Girvanella* 以后,甚至認為所有的鮎狀結構都是由于生物的作用生成的。Cayeux (1916) 在研究了 La-Ferriere-aux-Etangs 地方志留紀地層中的鮎狀岩(鮎狀赤鐵礦)以后,得出和 Wethered 相反的結論。他認為 *Girvanella* 是鑽孔破坏着鮎狀結構的同心層的。Cayeux 推論(參看 Garwood, 1931, 第 xciii 頁),这种由 *Girvanella* 鑽孔破坏同心層的現象也可能在鈣質的鮎狀岩中存在。后来不断的被事实証明,这二位学者的結論都并不完全正确。*Girvanella* 确实常和鮎狀岩(尤其是鈣質的鮎狀岩)伴生,但这可能由于形成鮎狀岩的环境也適宜于 *Girvanella* 的生長。因为,事实上有大部分的鮎狀岩中沒有絲毫 *Girvanella* 的痕迹。值得注意的是,那些凡是由 *Girvanella* 組成的所謂魚卵石或豆石是很不規則的,并不像一般由化学作用沉淀而成的魚卵石或豆石一样。它們大小不一,常随着核心(nuclei)的形狀而變异。真正的魚卵石都是比較規則的,有極明顯的同心層,或有放射狀構造(radiate structure)。关于其成因亦已被近代的观察和实验所証实,是由于化学作用而

生成的。Eardley(1938) 观察証明美國 Utah 州大鹽湖 (Great Salt Lake) 現代正在不断生成着的鮠狀岩是由于鈣質在不大深的、动蕩的、温和的水中圍繞着一个核心而沉淀的。在这种环境下碳酸鈣特別容易饱和。同样的事实也曾在許多室內实验中和在紅海沿岸、北美佛罗里达沿岸等地的观察中獲得。由是可知 *Girvanella* 虽然常常和鮠狀岩共生, 虽然常常造成一些貌似魚卵石的集合体 (Colonies), 这些都不足以解釋現在正在不断進行着的鮠狀岩的生成。这种由 *Girvanella* 或其他藻类圍繞着一个核心而生的“集合体”是應該归入另一范疇中的, 不能和化学沉淀的魚卵石或豆石混为一談。在近代有很多低等藍綠藻是寄生的 (parasitic), 例如一种鑿孔的藍綠藻 *Hyella* 屬, 就能溶解軟体动物的鈣質壳, 并能鑽入其壳內。在近代珊瑚的骨骼中甚至在古代珊瑚(如 *Calceola*, *Goniophyllum* 等) 及魚骨中都會找到过这类極低等的生物痕迹(見 Seward, 1878, 第 127 頁)。这种細管狀的寄生生物很可能是藍綠藻或是菌絲 (fungus)。至于 *Girvanella* 却很可能是一种石灰質的藻类, 它常常群集而成或大或小的“集合体”。并不曾見過 *Girvanella* 穿鑿到其他生物体内, 虽然它是常常包圍着其他生物殘骸而生長的。

前面已經指出, 船山石灰岩中的“球狀結構”是由藻类的活动生成的。这种“結構”其实是一种藻类的“集合体”。这种集合体, 現在的藻类化石研究者往往根据內部結構或外形給以各种“屬”名。当前的“球狀結構”的形态和大小酷似 Twenhofel (1919, 第 315 頁) 所定的新屬 *Osagia*。茲將該屬特征簡述于下: “集合体 (Coenoplases) 的大小 (7×4 毫米) 和形狀似 *Fusulina*, 但常常比 *Fusulina* 更大些更粗些。每一个集合体中間是一个由石塊或介壳組成的核心。內部構造不詳, 因为所有的标本都为褐鉄礦 (limonite) 所充填而变色 (discolored)。”在 Johnson 1946 年 (第 1103 頁) 对北美康薩斯州的 Pennsylvanian 和二叠紀地層中的 *Osagia* 研究中發現了其內部構造是由各种不同的管狀或絲狀的藻类組成的。在 Middle Pennsylvanian 下部地層中, *Osagia* 式的集合体是大部或全部由 *Girvanella* 細管組成的; 在二叠紀地層中的 *Osagia* colonies 是由 “*Nubecularia*” 和細絲狀藻类組成的。就如 Johnson (1946, 第 1104 頁) 所指出說: “这种化石 (*Osagia*) 不是一个真正的生物学上的‘种’, 而僅是一种 (藻类的) 生長型式 (growth form)。”船山石灰岩中的“球狀結構”和 *Osagia* 式的集合体, 实是完全一致的, 虽然“球狀結構”有时可大至 1 厘米。这种被称为 *Osagia* 式的集合体, 本來也沒有一个絕對的大小标准, 因此我們也可以把船山石灰岩中的“球狀結構”称为 *Osagia* 的。

有趣的事实是: 在北美 Pennsylvanian 及二叠紀的地層中的 *Girvanella* 經常和一种管狀有孔虫 “*Nubecularia*” 共生 (見 Johnson, 1946, 1950 等)。在我們所观察的标本中也發現 *Girvanella* 細管常和一些粗管共生的情形 (圖版 I, 圖 6)。这些粗管的大

小和形态和 Johnson 所谓的“*Nubecularia*”极为相像。虽然这种粗管和 DeFrance 当时所定的 *Nubecularia* 的属型化石是并不十分相像的(比较 Galloway, 1933, 第 115 页, 图版 9, 图 15)。

在船山石灰岩下部最丰富的是蓝绿藻和蛭科化石。蛭科的大部分的种都是底栖生活并且是生长在浅海的, 而蓝绿藻类也只能生长在极浅的水中(大约 40—60 米), 因此我们可以推测在石炭纪后期的时候, 这一地区的海水是相当浅的, 沉积作用大约是在相当于陆棚上部的地方进行的。*Girvanella* 围绕着一个核心而形成 *Osagia* 式的集合体, 说明了那时可能是一个海水动荡的环境。*Girvanella* 附着在蛭壳或石屑、矿物的结晶体上, 随着核心的不断滚动而逐渐形成蛋形、椭圆形或纺锤形的“集合体”。

本文是在斯行健教授指导之下完成的, 斯教授并特抽暇修改本文稿件, 笔者谨在此表示深切的感谢。卢衍豪、王钰、李星学三位先生审阅手稿, 并提出很多宝贵指示, 何炎同志赠予部分的薄片, 并供给有关有孔虫方面的参考资料, 均于此深表谢意。

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## NOTES ON GIRVANELLA-REMAINS FROM CHUANSHAN LIMESTONE OF LUNGTAN DISTRICT, WITH REMARKS ON THE GLOBULITES

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Remains of blue green algae of the *Girvanella*-type from the Chuanshan Limestone of E. China, was made known by Herny Paul in a paper published in 1938. In this paper, a new species of *Girvanella*, *G. grabau* was described. His specimens were collected by T. K. Huang, from the Chekiang and Kiangsu provinces. During a field trip to Lungtan, S. E. of Nanking in the summer of 1955, the writer in accompanying with several comrades of our Institute collected many small calcareous knobs known as globulites from the lower part of the Chuanshan Limestone. The Chuanshan Limestone has been commonly known as a light gray or pinkish grey rather pure limestone marked by the presence of abundant globulites in the lower part. The globulites are more or less oval, elliptical or circular in contour, varying from 3-10 mm., they do not show any relief on the weathered rock surface. Viewed in a thin section of globulites, these are seen to be masses of *Girvanella*-tubules forming a crust around a nuclei. The nuclei usually consists of crystals of calcite or a test of Fusulinids. The tubules are flexous and are aggregated in somewhat parallel rows surrounding the nuclei; occasionally, they are interweaved orderlessly and are scattered here and there in groundmass. A critical examination of the sections shows that there is a considerable variation in regarding to the diameter of tubules. The smallest tubules have a diameter only about  $17\mu$ , while the largest may attend to  $46\mu$ . Most common forms are of  $23-32\mu$  in diameter. No sharp line can be drawn between these tubules. The two extremes are connected with many intermediate forms. The general appearances of all these types are similar.

The present form of *Girvanella* differs in no essential respect from *Girvanella grabau* described by Paul (1938, p. 212) from the same horizon, except that most tubules of the present species are less uniform and much larger. It is very difficult to decide whether the present form may represent a separate species or may fall within the specific limitation of *Girvanella grabau*. The writer would prefer to follow the safer course and describes the specimens as *Girvanella* sp. for the present, though he thinks it is highly probable that the two forms may be found to be iden-

tical. The present species resembles *Girvanella permica* (Steinmann ms.) (Pia, 1937, p. 820) of the Upper Trogkoflkalk of Middle Permian Age in Carnic Alps in having the great variation in diameter of tubules, but the wall of *Girvanella permica* is much thicker than the present species.

The characters of the present form are given below:

*Girvanella* sp.

Tubules entwined, aggregated in somewhat parallel rows, involved the nuclei to form an oval, more or less lozenge sharp colony, rounded in cross section, having diameters 23–32 $\mu$ , sometimes up to 46 $\mu$ , occasionally 17 $\mu$ , averaging 27.5 $\mu$ , usually simple and never branching. Walls about 4 $\mu$  thick.

The present form occurs in close association with *Triticites* in the lower part of the Chuanshan Limestone.

With a few exceptions, *Girvanella* occurs in the Chuanshan Limestone intimately in association with the "globular texture". There seems to be no doubt that the so-called globulites may be algae in origin. In regard to the shape and size, it recalls Twenhofel's genus *Osagia*. The genus was first defined (Twenhofel 1919, p. 351) as coenoplases of more or less fusiform, having a length of about 7 mm and a thickness of about 4 mm. No microstructure can be detected as the specimens are filled with limonite. Johnson (1946, p. 1103) in a recent study of this form of colonies from Pennsylvanian and Permian rocks of Kansas has found that colonies classed as *Osagia* consist of intimate intergrowth of algal filaments of several types. The colonies of *Osagia* in lower Middle Pennsylvanian rocks are built largely or entirely by algae having fine tubular filaments of type known as *Girvanella*. In Permian rocks "*Nubecularia*" and fine algal threads present invariably and form a large portion of the colonies. As has been stated by Johnson (1946, p. 1104), this fossil represents merely a growth form, instead of being a true biological species. The so-called globulites of the Chuanshan Limestone are slightly larger than the American colonies referred to *Osagia*. As there are no critical criteria in regard to the size of these small colonies, it seems reasonable to assign the globulites of the Chuanshan Limestone to the form-genus *Osagia*.

The *Girvanella* has been found very frequently consorted with tubular foraminifera "*Nubecularia*" in Pennsylvanian and Permian rocks of North America (see Johnson 1946, 1950, etc). In the present material, we found also many irregular coarser tubes (Pl. 1, fig.6) which bear a resemblance to those referred by Johnson to "*Nubecularia*", but both the Chinese and the American forms seem very unlike

the type specimen described by DeFrance (see Galloway, p. 115, Pl. 9, fig. 15).

The most abundant fossils of the present material are the fusulinids and the blue green algae. It is known that most of the species of fusulinids are of benthonic habit and are lived in shallow water, and that the blue green algae are confined to the shallow water. The occurrence of these organisms clearly indicates that the deposition of this rock in the Nanking region may be taken place in the upper part of continental shelf. Evidently, the *Osagia*-colonies were building up in an agitated circumstance.

The writers is greatly indebted to Dr. H. C. Sze who has incessantly guided him and kindly reads through the manuscript.

## 圖 版 說 明

下列各圖攝影者為劉雪筠同志。薄片皆保存在中國科學院古生物研究所。

圖 1. *Osagia* colony ×10

產地：龍潭大石山，野外編號：AV 116 登記號碼：PB 2537。

圖 2. *Giroanella* sp. ×15 表示 *Giroanella* 圍繞生長情形。

產地：龍潭大石山，野外編號：AV 117 登記號碼：PB 2536。

圖 3. *Osagia* colony ×15 表示 *Giroanella* 圍繞 *Triticites* 生長情形 (showing *Giroanella* included the test of *Triticites*).

產地：龍潭大石山，野外編號：AV 115 登記號碼：PB 2533。

圖 4. *Giroanella* sp. ×30

產地：龍潭觀山，野外編號：AV 22 登記號碼：PB 2534。

圖 5. *Giroanella* sp. ×30

產地：龍潭大石山，野外編號：AV 116 登記號碼：PB 2537。

圖 6. *Nubecularia?* sp. ×30 圖片中細管為混生的 *Giroanella* sp. (showing *Nubecularia* associated with *Giroanella*).

產地：龍潭觀山，野外編號：AV 22 登記號碼：PB 2534。

圖 7. *Giroanella* sp. ×30 表示 *Giroanella* 包裹筲壳生長情形 (showing *Giroanella* surrounding a fusulinid).

產地：龍潭大石山，野外編號：AV 116 登記號碼：PB 2535。

