

豆海百合及其在中國的發現*

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一般說來，海百合的地質歷程比較長，地理分佈常常集中，地層的價值不大。但是，也有地質歷程較短，地理分佈很廣的，豆海百合 (*Pisocrinus*) 便是其中最顯著的一屬。

豆海百合是比較原始的海百合，屬於單環游移目 (*Monocyclica Inadunata*) 的豆海百合科 (*Pisocrinidae*)。萼 (calyx) 的體積大小如豆，因而得名。通常保存為化石的，也以萼部 (dorsal cup) 為主，具有冠莖的完整標本，甚為少見。萼部為 5 個底板 (basals)，五個輻板 (radials) 和一個輻肛板 (radial) 所組成。各個底板的體積大小不等，形狀不同；各個輻板的體積也不相等，形狀也不相同；此乃豆海百合的特徵。與豆海百合最相接近的是三海百合 (*Triacrinus*)。三海百合僅有 3 個底板，其他性質和豆海百合相似。豆海百合是志留紀的產物，而三海百合則限於泥盆紀。三海百合顯然是從豆海百合由於底板的膠結演變而成的。

自從 1858 年 De Koninck 創立豆海百合一屬名以來，據筆者所知，此屬已有 18 個種族分佈在世界各洲，而且都是產在中志留紀的地層裏。因此，豆海百合遂成為中志留紀的標準化石之一。

在歐洲，英國的 Wenlock 石灰岩中產有兩種豆海百合，即 *Pisocrinus pilula* De Koninck 及 *P. ornatus* De Koninck，此外，Bather 還提到尚有未經描述的一種。在瑞典的哥德蘭 (Gotland)，相當於 Wenlock 的地層裏產有三種豆海百合，經 Angelin 描寫，定名為 *Pisocrinus flagellifer* Angelin、*P. ollula* Angelin 及 *P. pocillum* Angelin。1893 年 Bather 描述哥德蘭的海百合化石時，對豆海百合一屬曾經詳細討論，確定了豆海百合肛板的位置，因而矯正了豆海百合的前後方位。Bather 重新描述 *Pisocrinus pilula*、*P. ollula* 及 *P. pocillum* 3 種，並將當時所知的種族予以論述。Bather^[3] 認為 *Pisocrinus flagellifer* Angelin 和

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P. pilula De Koninck 是同物異名；同時認為有些豆海百合的體板所以粗糙，並非原來的性質，乃是後來經受風化的結果，於是將 *P. ornatus* 也當作 *P. pilula* 的同義名稱 (synonym)。後來 Etheridge (1904)^[5] 和 Springer (1926)^[6] 都曾注意到豆海百合體板表面的性質，認為此種粗糙的表面是原來的性質，並非由於風化所致。筆者意 *Pisocrinus ornatus* 的這種性質為 *P. pilula* 所無，二者並不完全相同，前者應當是後者的變種。仔細比較起來，*Pisocrinus flagellifer* 和 *P. pilula* 不僅莖部的形狀有些差別，底板的性質也不相同，因此，*Pisocrinus flagellifer* 也可以當作 *P. pilula* 的變種。

在澳洲新南威爾斯的 Yass 地方，*Barrandella* 頁岩裏也曾發見豆海百合，據 Etheridge (1904) 的研究，命名為 *Pisocrinus yassensis* Etheridge 及 *P. yassensis* var. *lobata* Etheridge。澳洲的標本底板合成一個小的圓形，和 *Pisocrinus ollula* 相近。因為底板很小而且凹陷，未能辨別底板的性質，Etheridge 於描寫該項標本時於屬名之後附一問號，但他相信是五個底板，應當是豆海百合。*Pisocrinus yassensis* var. *lobata* 的莖部作五角形，和 *P. yassensis* 莖部形狀差別很大，應當是獨立的一種。

北美洲的尼加拉 (Niagara) 石灰岩及其相當的地層裏產豆海百合化石很多，經過許多人的研究，計有 11 個種。1926 年 Springer 曾經詳細地討論過豆海百合，並描述了此屬在北美洲的種族如下：(1) *Pisocrinus baccula* Miller et Gurley, (2) *P. benedicti* Miller, (3) *P. camparia*, Miller, (4) *P. gemmiformis* Miller, (5) *P. gorbyi* Miller, (6) *P. globosus* (Ringueberg), (7) *P. pyriformis* (Ringueberg), (8) *P. granulatus* Rowley, (9) *P. sphericus* Rowley, (10) *P. quinquelobus* Bather, (11) *P. tennesseensis* (Roëmer). Springer 認為上述 11 種中至少有一種是其他種的同義名稱。Bather (1893) 亦曾指出，*Pisocrinus globosus* 不過是 *P. gemmiformis* 的變種。筆者贊同 Bather 的意見，將 *Pisocrinus globosus* 當作 *P. gemmiformis* 的變種。至於 *P. pyriformis* 和 *P. flagellifer* 相同，為 *P. pilula* 的錐形變種，將 *P. pyriformis* 當作 *P. pilula* var. *flagellifer* 的同義名稱比較合適。

1946 年夏，筆者隨同尹贊勳教授到四川北部調查地質時，於廣元縣中子舖的東面，在志留紀羅惹坪統中獲得一個豆海百合化石標本，此為豆海百合化石在中國甚至在亞洲的初次出現^[9]。此種豆海百合很像“屬型” (genotype) *Pisocrinus*

pilula De Koninck, 僅底板較大, 萼的背部形狀稍異, 代表一個新的變種, 茲以尹贊勳教授之姓名之, 叫做 *Pisocrinus pilula* var. *yini* Mu (n. var.)

上述十數種豆海百合化石, 可以依照底板性質的不同分作兩組: 在一組裏, 其底板較大, 合成三角形, 在萼的側面可以看到底板的一部分。在另一組裏, 其底板較小, 合成很小的圓形, 全部被莖的最上一個莖板所掩蓋, 在外面看不到底板。這種底板性質的差別非常顯著, 此種性質至少應當是亞屬 (subgenus) 的性質, 這兩組應當代表兩個亞屬。如此, 豆海百合一屬可作如下的分類:

豆海百合屬 (Genus *Pisocrinus* DeKoninck)

單環海百合。萼部很小, 由 5 個底板、5 個輻板及一個輻肛板所組成。這些體板的體積不等, 形狀不一。每個輻板上端具有兩個脊狀突起即輻板脊 (radial process)。兩脊之間即為輻板節面 (radial facet)。僅有兩個大的輻板與底板相接觸, 這兩個大的輻板和輻肛板三者組成萼部的大部分。一個小的肛板 (anal) 位於輻板之上。肛管 (anal tube) 細長和腕相似。五個腕, 單列 (uniserial), 腕板細長, 無羽肢 (pinnules)。莖細, 莖板圓而光滑, 少有支莖或蔓肢 (cirri) (參看圖版 I, 圖 10)。

屬型: *Pisocrinus pilula* DeKoninck

(一) 豆海百合亞屬 (Subgenus *Pisocrinus* DeKoninck, 狹義的)

豆海百合, 其底板較大, 合成三角形或近於三角形。底板並不全被莖板所掩蓋, 在萼的側面可以看到一部分 (插圖 1; 並參看圖版 I, 圖 6 及 7)。

亞屬型: *Pisocrinus pilula* DeKoninck (Bather,

1893, 圖版 I, 圖 4 及 5)。

- 種族: 1. *Pisocrinus (Pisocrinus) pilula* DeKoninck
2. *P. (Pisoc.) pilula* var. *flagellifer* Angelin
3. *P. (Pisoc.) pilula* var. *ornatus* De Koninck
4. *P. (Pisoc.) pilula* var. *yini* Mu (新變種)
5. *P. (Pisoc.) pocillum* Angelin
6. *P. (Pisoc.) baccula* Miller et Gurley
7. *P. (Pisoc.) benedicti* Miller
8. *P. (Pisoc.) campana* Miller
9. *P. (Pisoc.) gemmiformis* Miller
10. *P. (Pisoc.) gemmiformis* var. *globosus* (Ringueberg)
11. *P. (Pisoc.) gorbyi* Miller
12. *P. (Pisoc.) granulosus* Rowley

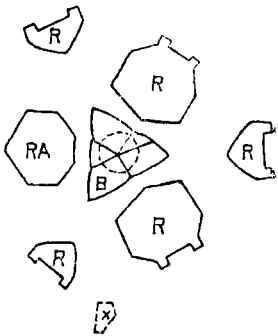


圖 1 *Pisocrinus* (s. str.) 萼部體板的分析
B. 底板; R. 輻板;
RA. 輻肛板; X. 肛板。

(二) 副豆海百合亞屬 (Subgenus *Parapisocrinus* Mu, 新亞屬)

豆海百合，其底板較小，合成圓形。底板全部被莖板所掩蓋，在外面看不到底板（插圖 2；並參看圖版 I, 圖 8 及 9）。

亞屬型: *Pisocrinus ollula* Angelin (Bather, 1893, 圖版 I, 圖 19)。

種族: 1. *Pisocrinus* (*Parapisocrinus*) *ollula* Angelin

2. *P.* (*Parapisoc.*) *quintelobus* Bather

3. *P.* (*Parapisoc.*) *sphericus* Rowley

4. *P.* (*Parapisoc.*) *tennesseensis* (Roemer)

5. *P.* (*Parapisoc.*) *lobata* Etheridge

6. *P.* (*Parapisoc.*) *gassensis* Etheridge

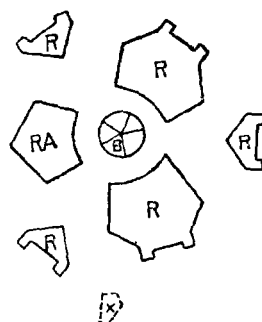


圖 2 *Parapisocrinus* (subgen. nov.) 蓐部體板的分析。
B, 底板; R, 輻板
RA, 輻肛板; X, 肛板。

中國發現的豆海百合描述

Pisocrinus (*Pisocrinus*) *pilula* var. *yini* Mu (新變種)。

(圖版 I, 圖 1—5)

僅有一個完整的蓐部標本。蓐部高 4.5 毫米 (輻板脊的高度不計在內)，寬 6 毫米。5 個輻板，兩大三小。左前輻板、右前輻板及右後輻板較小，體積相差不多，作盾形，或為五角形。左後輻板及前輻板很大，作七邊形。輻肛板亦作七邊形，其體積的大小介乎二者之間，比大的輻板略小。

此一輻肛板和兩個大的輻板構成蓐部的主要部分。5 個底板都比較小，合成一個三角形 (插圖 3)。蓐的背部凹入，底板露出，並未全被莖板所掩蓋，在蓐的側面可以看見底板的一部分。腹部的構造不清楚。肛板和口板 (oral) 均未保存。各個輻板的節面大致相等，寬 1.5—2 毫米。輻板脊高

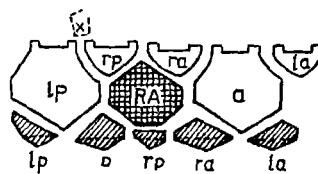


圖 3 *Pisocrinus pilula* var. *yini* (var. nov.) 蓐部體板的分析。
斜綫，底板；方格，輻肛板；
空白，輻板；×，肛板。

0.7 毫米左右，寬約 1 毫米 (相臨兩脊合計)。其寬度向內漸增。輻板與輻板之間的縫合線較深，輻板及輻肛板與底板之間的縫合線比較平整。莖及腕均未見。

比較: 此一標本與豆海百合的屬型 *Pisocrinus pilula* De Koninck^[3] 非常接

近，同時也很像北美洲的 *Pisocrinus* (*Pisoc.*) *campana* Miller 及 *P. (Pisoc.) benedicti* Miller^[6]。*P. (Pisoc.) campana* 的萼部長，爲鈴形，底板造成相當大的三角形；而 *P. (Pisoc.) benedicti* 的萼部較短，近於球形，同時底板相當小。*P. (Pisoc.) pilula* 的萼部形狀介乎二者之間。中國的標本，萼部形狀像碗，比 *P. (Pisoc.) campana* 的萼部短，其底板又比 *P. (Pisoc.) benedicti* 的底板大。因和 *P. (Pisoc.) pilula* 最爲接近，故鑑定爲該種的變種。*P. (Pisoc.) pilula* 的萼部略呈圓錐形，而我們的變種則爲碗形，兩側近於平行。由萼部形狀看起來，*Pisocrinus* (*Pisoc.*) *pilula* var. *yini* 到像 *P. (Parapisoc.) ollula*，但底板性質的差別極爲顯著。二者分別屬於兩個亞屬。前者的底板大，合成三角形；而後者的底板小，合成圓形。前者屬於豆海百合亞屬，而後者則屬於副豆海百合亞屬。

層位及產地：*Pisocrinus* (*Pisoc.*) *pilula* var. *yini* (新變種) 產於四川省廣元縣中子舖中志留紀羅惹坪統中，共生化石有 *Orbignyella mui* Yang, *O. globata* Yang,^[8] *Coronocephalus*, *Spirifer* 及 *Petalocrinus* 等。登記號碼：6630 (正型標本)。

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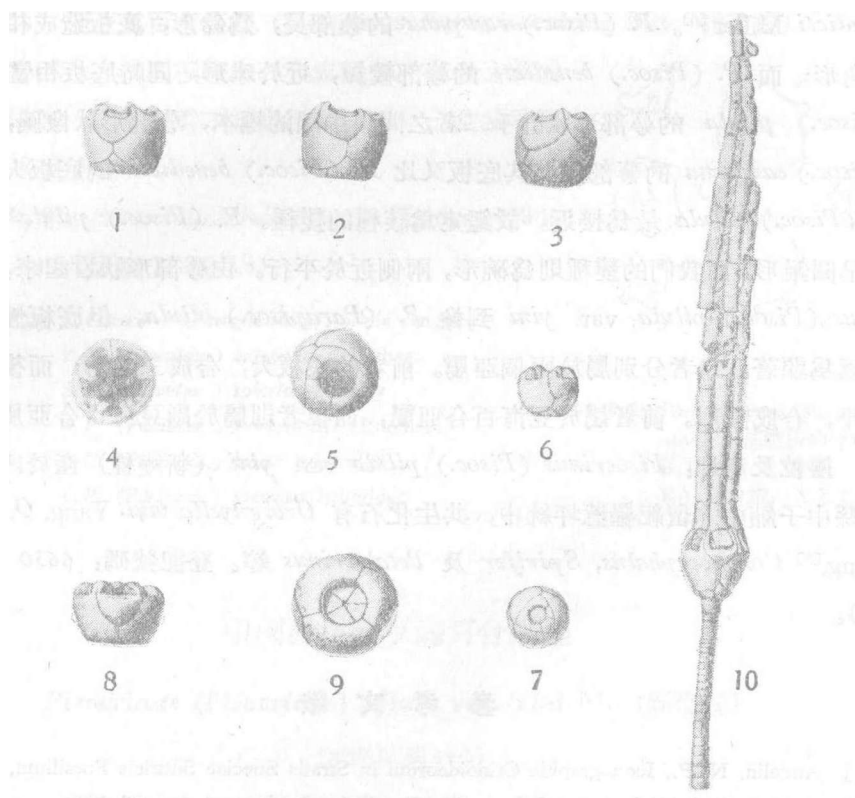


圖 版 說 明

圖 1—5. *Pisocrinus (Pisocrinus) pilula* var. *yini* Mu (var. nov.) 放大×2。

1—3. 蓐部的側視，示蓐部的形狀及各個體板的性質。

4. 蓐部的腹視，示輻板脊的形狀。5. 蓐部的背視，示底板的性質。

圖 6—7. *Pisocrinus (Pisocrinus) pilula* Angelin, 放大×2, 根據 Bather, 1893, Pl. I, fig. 4, 5, 用作比較。

6. 蓐部的側視，示蓐部的形狀。7. 蓐部的背視，示底板的性質。

圖 8—9. *Pisocrinus (Parapisocrinus) ollula* Angelin, 放大×2, 根據 Bather, 1893, Pl. I, figs. 9, 12, 用作比較。

8. 蓐部的側視，示蓐部的形狀。9. 蓐部的背視，示底板的性質。

圖 10. *Pisocrinus (Pisocrinus) pilula* var. *flagellifer* Angelin, 放大×2, 根據 Bather, 1893 Pl. I, fig. 1, 示豆海百合完整標本的情形。

ON THE OCCURRENCE OF *PISOCRINUS* IN CHINA

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The genus *Pisocrinus* De Koninck is a rather primitive crinoid, belonging to the family Pisocrinidae Angelin of the Order Monocyclica Inadunata Bather. The characteristic feature of this genus is that all the plates of the dorsal cup, such as the five basals, five radials, and one radianal, are unequal in size, variable in shape and unsymmetrical in position. In the form of the cup, this genus stands nearest to *Triacrinus* Münster; however, it can be readily distinguished from the latter by the number of basals, by five basals in *Pisocrinus* and three in *Triacrinus*. Most probably, *Triacrinus* is derived from *Pisocrinus* due to the fusion of the basal plates.

The genus *Pisocrinus* is of world-wide distribution, being formerly known from the Middle Silurian of Europe, N. America and Australia. Nearly twenty species of *Pisocrinus* had been described from the different continents, as far as the writer's knowledge goes. In Europe, L. De Koninck, N. P. Angelin and F. A. Bather described five species of *Pisocrinus* from the Wenlock limestone of England and its equivalent beds of Sweden. They are (1) *Pisocrinus pilula* De Koninck, (2) *P. ornatus* De Koninck, (3) *P. flagellifer* Angelin (4) *P. ollula* Angelin, and (5) *P. pocillum* Angelin. Besides these, Bather had noted an undescribed species of almost hemispherical shape from the Wenlock shale of Dudley.

According to Bather's opinion, *Pisocrinus ornatus* and *P. flagellifer* are synonyms of *P. pilula*^[3]. It seems to the writer that the former two species may be regarded as the varieties of *P. pilula*, in as much as the ornate surface of *P. ornatus* and the shape of the basals of *P. flagellifer* are different from those of *P. pilula*.

In 1904, R. J. Etheridge^[5] reported the occurrence of *Pisocrinus* in Australia and described two new forms from the *Barrandella* shale of the Yass district, New South Wales, namely (1) *Pisocrinus yassensis* Etheridge and (2) *P. yassensis* var. *lobata* Etheridge. The variety *lobata* is better to be regarded as a distinct species, according to the peculiar form of its dorsal cup.

In 1926, F. Springer^[6] discussed at greater length on the genus *Pisocrinus* and described all species of this genus in North America known to him. The Niagara limestone and its equivalent beds afford the following species: (1) *Pisocrinus baccula* Miller, (2) *P. benedicti* Miller, (3) *P. campana* Miller, (4) *P. genuiformis* Miller, (5) *P. globosus* (Ringueberg), (6) *P. gorbyi* Miller, (7) *P. granulatus* Rowley, (8) *P. pyriformis* (Ringueberg), (9) *P. quinquelobus* Bather, (10) *P. sphericus* Rowley and (11) *P. tennesseensis* (Roemer). It has been stated by Springer that among the American species, at least one of them is a synonym of the other.

The writer agrees with the view of Bather that *Pisocrinus globosus* is merely a variety or even a synonym of *P. genuiformis* and that *P. pyriformis* is a variety of *P. pilula*. It is better to consider *P. pyriformis* as a synonym of *P. pilula* var. *flagellifer* Angelin.

During a geological trip to northern Szechuan in the summer, 1946 Dr. T. H. Yin and the writer were able to secure a well preserved specimen of *Pisocrinus* from the Lojopingian Series at Chungtzepu, Kuangyuan district^[9]. This is the only specimen of *Pisocrinus* hitherto known from China and even from Eastern Asia. This specimen is determined by the writer as a new variety of the genotype of this genus, *Pisocrinus pilula* Angelin.

As mention above, we can make a summary from our findings, thus: there are 15 species and 3 varieties up to the present time excluding the undescribed species of Dudley. Comparing with the mode of connection of the basal plates, the writer noticed that these species and varieties fall within two distinct groups. In one group, the basals form a triangle which may be partly seen from the lateral side of the dorsal cup, whereas in the other group the basals form a small round area which is entirely covered by the top joint of the stem. The writer is of the opinion that the two groups represent two subgenera of *Pisocrinus* based upon the different characters of the basals. Thus, the genus *Pisocrinus* may be classified as follow:

Genus *Pisocrinus* De Koninck- Very small monocyclic crinoid. Basals five, radials five, all unequal in size and different in shape. Radial large, situated between the bassals and radials. This plate and the two large radials constitute the greater part of the dorsal cup. The three small radials do not touch the basals. Arms simple and uniserial. Stem rounded, usually smooth.

Genotype: *Pisocrinus pilula* De Koninck.**I. Subgenus** *Pisocrinus* De Koninck emend.

Basals large, usually forming a triangle which is visible in the lateral view (text fig. 1).

Subgenotype: *Pisocrinus pilula* De Koninck (Bather, 1893, pl. I, figs 4,5.)

- Species: 1. *Pisocrinus (Pisocrinus) pilula* De Koninck
 2. *P. (Pisoc.) pilula* var. *flagellifer* Angelin
 3. *P. (Pisoc.) pilula* var. *ornatus* Angelin
 4. *P. (Pisoc.) pilula* var. *yini* Mu (var. nov.)
 5. *P. (Pisoc.) pocillum* Angelin
 6. *P. (Pisoc.) baccula* Miller et Gurley
 7. *P. (Pisoc.) benedicti* Miller
 8. *P. (Pisoc.) campana* Miller
 9. *P. (Pisoc.) gemmiformis* Miller
 10. *P. (Pisoc.) gemmiformis* var. *globosus* (Ringueberg)
 11. *P. (Pisoc.) gorbyi* Miller
 12. *P. (Pisoc.) granulatus* Rowley

II. Subgenus *Parapisocrinus*, Subgen. nov. - Basals small, forming a small round area which is entirely covered by the top joint of the stem (text fig. 2.)

Subgenotype: *Pisocrinus ollula* Angelin (Bather, 1893, pl. I, fig. 9).

- Species: 1. *Pisocrinus (Parapisocrinus) ollula* Angelin
 2. *P. (Parapisoc.) quinquelobus* Bather
 3. *P. (Parapisoc.) sphericus* Rowley
 4. *P. (Parapisoc.) tennesseensis* (Roemer)
 5. *P. (Parapisoc.) lobata* Etheridge
 6. *P. (Parapisoc.) yassensis* Etheridge

DESCRIPTION OF THE CHINESE REPRESENTATIVE***Pisocrinus (Pisocrinus) pilula* var. *yini* Mu (var. nov.)**

(Pl. I, figs. 1-5)

This form is represented by a specimen of a dorsal cup. The cup is bowl-shaped with an axial length of 4.5 mm (exclusive of the radial processes) and 6 mm in diameter. All the plates are smooth and slightly convex. The left anterior, the right anterior and the right posterior radials are very small, shield-shaped or pentagonal in form. The left posterior and the anterior radials are large and seven-sided. The radianal plate is situated between the radials and the basals. It is also seven-sided in form, larger than the small radials and slightly

smaller than the larger ones. This plate and the two large radials constitute the greater part of the cup. The basals are much smaller than the radials, forming a triangle which may be seen from the lateral side (text fig. 3). The dorsal side of the cup is concave and the basals is curved abruptly upward. The ventral structure is obscure. The radial facet varies from 1.5 to 2 mm in width. The processes are small, dove-tailed, widening inward. Each of them is about 0.5 mm in width and 0.7 mm in height. The anal and the oral plates are not preserved. The stem and the arms are unknown.

Remarks: In the essential characters, this form closely resembles the genotype of *Pisocrinus*, *P. (Pisoc.) pilula* De Koninck of Europe^[3]. There is also a great resemblance to *P. (Pisoc.) campana* Miller and *P. (Pisoc.) benedicti* Miller of North America^[6] in the character of the cup. The cup of *P. (Pisoc.) campana* is long and bell-shaped, and the basals form a large triangle. In *P. (Pisoc.) benedicti*, the cup is short, more or less rounded, and the basals are rather small. *Pisocrinus (Pisoc.) pilula* is an intermediate form between the two. Our form differs from *P. (Pisoc.) campana* in the shorter bowl-shaped cup, from *P. (Pisoc.) benedicti* in the larger basals, and from *P. (Pisoc.) pilula* and its variety *flagellifer*^[1] in the form of basals and in the nearly parallel sides of the cup. The cup of the Chinese form is not so conic as those of *P. (Pisoc.) pilula* and its variety *flagellifer*. From *P. (Pisoc.) pilula* var. *ornatus*, our form may be distinguished in the smooth surface of the calycal plates. In the shape of the cup, the present form bears some resemblance to *P. (Parapisoc.) ollula* Angelin, but the character of the basals is quite different.

Horizon and Locality: *Pisocrinus (Pisoc.) pilula* var. *yini* var. nov. occurs in the Middle Silurian Lojopingian Series at Chungtzepu of Kuangyuan district, North Szechuan in association with *Orbignyella mui* Yang, *O. globata* Yang^[8], *Coronocephalus*, *Spirifer*, and *Petalocrinus*.

Cat. No. 6630 (holotype).