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中国上白垩紀沉积中首次发現的一种被子植物——*Trapa? microphylla* Lesq.

李星学
(中国科学院古生物研究所)

当我們研究中生代地层的时候,总不免要为一种事实所惊奇,就是許許多多在世界各地、特别是亚洲东北部,分布很广的上白垩紀被子植物,从来沒有在中国同期的沉积中发現过,虽然在微体植物方面,徐仁先生等[1]最近曾經报道过甘肃酒泉下惠回堡系上部的木兰属和胡桃属的花粉各一种。因此,当前这种特殊的似菱类植物在我国东北松花江統的发現是值得特别注意的,因为它不只标誌着此一植物在地理上更为广泛的分布,同时还給我們以希望:不久的将来,在我国上白垩紀沉积中一定可以发現更多的重要植物化石。此外,松花江統的地質时代还是东亚地質古生物学界[2-12]一个爭論未定的問題。当前这种重要化石的发現,自然有助于其地質时代的进一步的确定。

本文描述的材料是石油工业部松辽石油普查大队陈本善同志等于1957年夏在黑龙江、哈尔滨庙台子从事地質鉆探时,自一个鉆井的岩芯中采集的。这些岩芯主要为綠灰色的細粒泥質砂岩所組成,在含这种植物化石的岩芯的上面或下面的具有同样岩性的岩芯中,常常具有大量的动物化石,如介壳类、介形虫、叶肢介及魚骨等。此区松花江統的地层及其动物羣已被許多古生物学家[7-11]研究过。有人曾經报道其中部含有极少的、零星的裸子植物化石[2,7],但是既无描述,也沒有图片,无法知道这些植物的眞实面貌。松花江統曾被小林及鈴木(1942,88頁)划分为三部分:下部名泉头层,中部名嫩江层,上部名伏龙泉层*。小林等的这种划分是否完全与实际相符,自然值得怀疑,因为他們所划分的这三层并不是見于一个完整的連續剖面。当前植物化石所在的层位,根据采集者提供的鉆井地层記录,和古生物研究所顧知微同志等于1957年秋到哈尔滨一带松花江統发育最好区域实地观察的結果,这种植物化石都是产自松花江統上部,大致和小林等的伏龙泉层相当的沉积中。至于含有这一植物化石的地层与松花江統各动物化石层的确切关系,将由顧知微同志在另一論文中加以敍述。

这些岩芯上只有这一种植物印痕的保存,沒有发現其他可資鑑定的共生植物。和其他許多产地已知标本的情况相似,产自伏龙泉层的这一化石也只是一些脫落的、不完整的叶或小叶的印痕标本,它們无一定方向地散布在岩面上,其叶脉的細微部分常常是模糊不清的。但是,在当前的标本中有两块碎片的叶脉却保存得相当完美(图版1图5—8)。

就这些小叶的形状、大小、特别是略带小齿的叶边和叶脉的类型看来,当前的材料和

* 小林等原名为伏龙层;但伏龙泉为一地名,和松花江、嫩江等名称一样,应以其全称作为命名。

勒士奎尔格（Lesquereux，1878，頁295，图版61图16—17）[13]所描述产自北美早期第三紀的 *Trapa* ? *microphylla* 的各种主要特征都相同。勒士奎尔格当年所記本种的特征，特重述如下：

"叶小，圓形或广卵形，向叶柄的部分鈍圓；自中綫之下向上的叶边具細齿；叶脉自叶柄的頂端向上作三出式（ternate），或成不規則的羽状脉；側脉分出的角度很小，15—20°，略略弯曲，具等分的支肢，都直接奔向叶边；空格明显，多边形，很小，是由許多直角状分裂的細脉所組成的細微部分"。

上述特征，似乎同样可以应用于当前的标本，不过，在我們的标本上，粗脉間的这些細微的空格，不如勒士奎尔格图17的規則。但是，这种区别并不妨碍于将当前标本和勒士奎尔格的定为同一种，因为勒士奎尔格图 16 所表示的粗脉中的小空格，就頗不同于他的图 17，17*a*。总的来看，我們这些标本的定为 *Trapa* ? *microphylla* 是完全沒有疑問。

本种的分类地位还未确定。正如其属名后加一問号所示，它和現代的菱类似有某种亲緣关系，虽說这种关系一直未加肯定。对于这种植物的属名和种名的采用，也还存在着相当的分歧的意見[14]。茲将这一植物的簡史及其重要的爭执点略加論述如下。

这一植物很早以前就曾发現于北美的下白堊紀及古新世的地层中，紐伯利(Newberry)可能是最先注意这种叶部化石的人。当时他把它当作一种蕨类的小羽片，将它暫归于形态属 *Neuropteris* 而名为 *Neuropteris*? *angulata*。但是，直到 1874 年才由勒士奎尔格将这种植物加以仔細的描述。勒士奎尔格当年給这种植物所写的，如上所述的特征，也是根据一些脫落的小叶而已。后来，許多完整得多的标本曾陆續发現于北半球的各地，許多古植物学家[14—19]曾对这些标本加以詳細的描述和发表其图影，其中的一部分曾轉載于某些古植物学教科书上[20—22]是为大家所熟知的，另一块很重要的、但是不大为人所知的标本是布朗(Brown)等[17]发現于北美加拿大的，具有两个果实，其中的一个还直接着生于莖上，特附印本文的图版上（图版 1 图 1），以作討論时的参考。这些完好的标本給我們增加了許多有关这一植物的知識。很显然，这是一种水生被子植物，具有四分的蓮座状的复叶，其每一个小叶的形状，甚至于叶脉，都可以按其着生地位的不同而有某些变化。这种植物的果实为卵圓形，約 1 厘米长，具有一个稍稍伸长而微微缺裂的頂端，以一短粗的梗着生于其蓮座状飄浮叶丛之下的莖上，和現代菱类果实着生的情况或多或少的相似。然而，这种植物的果实，如布朗等最标准的标本所示，是沒有現代菱类果实所特有的那种角的；同时它的叶是复叶，也和現代菱类的单叶不同。因此，这些叶部化石和果实，以往曾被描述于各种不同的属名之下，例如，用于叶部化石的属名，有 *Nymphaeites*, *Dicotylophyllum*, *Macclintockia*, *Protorrihipis* 等；其果实的属名則有 *Carpolithes*, *Viburnum*, *Nyssa*, *Quereuxia* 等（参閱克里斯托佛維契，1953，第 23 頁的同物异名表及第 26 頁等）。值得注意的是，大多数的古植物学家，仍然是跟随勒士奎尔格的意見将这种植物定作 *Trapa* ? *microphylla*。因为布朗等（1939，第37頁）已經指出过，存在于这一化石和現代菱类在叶子和果实方面的这种差异，"并不足以妨碍其与現代菱类可能有的、并不很远的亲緣关系，因为在果实和叶部存在着一些这样大的差异是可以同样地发生于显花植物的其他許多科中的"。不久以前，克里斯托佛維契对于这一化石植物的淵源及其相关的知識作一彻底的研究时，除了特别着重如上所述的这一植物和現代菱类在叶部和果实方面的差异外，他更进一步地提出了

一些新意見：他認为在已知的許多毫无疑問的菱类果实化石的記录中，除了极少的情况外，一般都沒有发現有其叶部化石的共生。值得提及的是道森（Dawson）于 1886 年所发表的一个产自加拿大 Laramie 层中属于本种的典型的小叶化石和一些菱类果实共生，这些果实曾被道森定为 *Trapa borealis* Heer。但是，这一发現并不足以証明当前这种植物的叶部化石就是菱类的叶子，因为那一小叶和那些果实并不是直接着生在一起的。同时，还可进一步地怀疑，道森对于这些果实的鑑定是否完全正确无誤。眞正的 *Trapa borealis* 总是发現于較 Laramie 层的地質时代为新的（漸新世至中新世）沉积中，而在这些較新的地层中还沒有当前这种植物化石的发現。很清楚，这种化石植物和其他属植物之間的亲緣关系这一問題，在目前只有让其悬而不决。克里斯托佛維契于是正式提出，最好是将这种化石另名为 *Quereuxia angulata* (Newb.)。这一属名是他自己从前用于一种脫落的果实化石，这种果实現在看来和当前这种植物的果实大致是相同的。至于紐伯利最早用于代表这种叶部化石的种名，伯尔（Bell）在 1949 年就曾将它复活地用过一次了（参閱克里斯托佛維契，1953，23、25、26 頁等）。

有許多理由表明，当前这一植物确实如克里斯托佛維契所建議的那样，应該另給以一个較为适当的名称。笔者对于当前材料的处理，沒有依从克里斯托佛維契的意見，而仍然采用了 *Trapa* ? *microphylla* 这一名称，仅仅是由于这一植物的分类地位还很模糊，而勒士奎尔格的著述是早已公認为使这一植物得以建立的基础工作。还有 *Trapa*? *microphylla* 这一名称早为大家所熟悉，并已广泛地应用于地質及古生物学的文献中，虽然它并不是一个最老的、很合适的名称。

当前这种植物主要是晚期白垩紀北大陆最标准分子之一，但是許多完好的标本也常見于北美早期第三紀的沉积中。在亚洲东北部它常大量出現于庫頁島的 Giliakian 統；同时，也是西伯利亚北部 Kolyma 植物羣中最常見分子之一。被远藤（1925，图版 17，图16、18、19）[23]誤定为 *Glossozamites*? *imaii*（新种），产于日本北海道 *Nilssonia* 层或 Urakawa 統[24] 的三块破碎标本，如克里斯托佛契（1953，第 25、28 頁）所指出，也应該和本种相同。这一植物在亚洲东北部的地質历程通常是限于中至上白垩紀，即从賽諾曼、士仑期（Cenomanian-Turonian）至塞諾期（Senonian），唯一例外的情况是瓦赫拉米耶弗（Vachrameev）曾在 Угольнои 海湾的下部第三紀［可能是白垩紀頂部的达宁期（Danian）］沉积中找到过这种化石（参閱 Baikoviskaya，1956，127、156 頁等）。

产自松花江統上部伏龙泉层的标本是比較破碎的，但是它們无疑地是和这一晚期白垩紀最常見的 *Trapa* ? *microphylla* 相同的。松花江統的地层及其某些淡水动物化石，前已提及，已經許多人研究过。关于松花江統的时代，小林及鈴木（1942，90 頁）曾說过，"假如松花江統是为現在一般所設想的为中生代的沉积，伏龙层就必須是上白垩紀……，古动物上的許多証据都指出松花江統中淡水动物羣的时代是中至上白垩紀"。当前这一重要的独具特征的植物在松花江統上部伏龙泉层中的发現，更从古植物方面也提供了一个充足的証据，以支持松花江統的上部或伏龙泉层的时代为上白垩紀，更确切一点的說，其时代是从賽諾曼、士仑期到塞諾期。

但是，必須指出，这并不証明松花江統中、下部的嫩江层和泉头层也必須归为上白垩紀，虽然有些人[7-11]是傾向于将它們都划入上白垩紀的。根据顧知微同志最近对于嫩江

层中許多瓣鰓类化石的初步研究，他相信嫩江层的时代可能是下白堊紀。当然，有关这些地层的时代的决定性的意見，还必須有待于古生物研究所近年来从其中收集的大量动物化石的全部鑑定及其相关的地层資料完全整理出来以后，才能提出来的。

本文承石油工业部松辽石油普查大队陈本善同志等供給标本，顧知微同志在地层、动物化石方面提供了一些宝貴意見，刘雪篤、庞茂芳同志代为摄制图影，謹此致謝。笔者还要特别感謝的是苏联科学院植物研究所的华伊柯斯卡娅教授，如果不是她給我寄来克里斯托佛維契教授 1953 年那篇重要的論文，本文是难以完成的。

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TRAPA ? *MICROPHYLLA* LESQ., THE FIRST OCCURRENCE FROM THE UPPER CRETACEOUS FORMATION OF CHINA

H. H. Lee

(*Institute of Palaeontology, Academia Sinica*)

(With 1 Plate)

In studying the Mesozoic stratigraphy, one is always struck by the fact that no determinable angiospermous leaves have so far been found in any of the supposed late Cretaceous strata of China, though a few remains of microflora were recently recorded by Hsü and Chow[1] from the uppermost part of the Lower Huihuipou formation of Western Kansu. The discovery of the present characteristic plant from the Sungari Series in Northeastern China is therefore of special interest, for it shows not only a wider geographical distribution of the species, but also throws light for future discoveries of many more important fossil plants from the late Cretaceous deposits in China. The present discovery is further more of some importance in view of the fact that opinions differ so much as to the age of the Sungari Series[2—12].

The material briefly described here was obtained by Mr. P. S. Chen in 1957 from some core-slabs of a boring made by the geological party belonging to the Ministry of Petroleum Industry, People's Republic of China, in the vicinity of Harbin, Heilungkiang Province, Northeastern China. The rock slabs consist chiefly of greenish grey argillaceous and sandy rock, while other slabs of the same lithological characters found immediately below or above them, generally contain numerous organic remains of shells, estherids, ostracods and fish-bones, etc. The general stratigraphy and the fauna assemblages of the Sungari Series in this region have already been studied by many palaeontologists[7—11]. The occurrence of very fragmentary gymnospermous remains from the middle portion of the series has been reported by several authors accompanied by neither description nor figures (Tan and Wang, 1929, p. 38, 41; Chang, 1957, p. 479, 490). Kobayashi and Suzuki[12] have divided the Sungari Series (1942, p. 38) into three parts: the Chuantou formation in the lower, the Nengkiang in the middle and the Fulungchuan[1] in the upper. The age of the Sungari Series as a whole is considered by them to be in the range from Middle to Upper Cretaceous. According to the stratigraphical data of the boring supplied by the collector and a field investigation of the type-locality of the Sungari Series recently made by Mr. C. W. Ku, one of the chief members of our Institute, in the autumn of 1957, the plant fossils at hand might be all from the Fulungchuan formation. The stratigraphical relation of the plant-bearing beds to those of the fauna assemblages of the Sungari Series in this region will be dealt with by Ku in a separate paper.

The plant is singly preserved in the core-slabs. No other determinable plant remains have been found in association with it. Like many specimens[14—19] of the species occurring in other localities, the plant is represented by numerous impressions of incomplete detached leaves or leaflets, which are scattered in all directions and usually fail to reveal the details of their nervations. How-

1) Fulungchuan formation was originally printed as Fulun formation in Kobayashi's paper; it seems to be desirable to write it as Fulungchuan formation, for the complete name of the locality from which the formation designation is derived is Fulungchuan.

ever, two fragments of our specimens have the nervation beautifully preserved (Pl. 1 figs. 5—8).

In regard to the general form and size, especially the slightly dentate margin and the pattern nervation of the leaves, our material agrees in all essential respects with specimens described and figured by Lesquereux (1878, p. 295, pl. 61, figs. 16—17a) as *Trapa? microphylla* (=*Quereuxia angulata* Krysht.) from the Early Tertiary of North America. The original diagnosis given by Lesquereux for the species may be reprinted below:

> "Leaves small, round or broadly oval and obtuse, rounded to the petiole; borders denticulate from below the middle upward; nervation ternate from the top of the petiole, or irregularly pinnate; lateral veins at an acute angle of divergence, 15° to 20°, flexuous, with dichotomous branches, all craspedodrome; areolation distinct, polygonal, minute by subdivisions of the veinlets at right angle."

The diagnosis suits equally well the present specimens except that the finely meshed areolation between the larger nerves in our specimens is not so regularly disposed as the illustrations given by Lesqueruex, but this difference does not appear to be of specific importance. The fine meshes in fig. 16 of Lesquereux is also somewhat distinguishable from those in his figs. 17, 17a. On the whole, our specimens can with tolerable safety be referred to *Trapa? microphylla* Lesq.

The systematic position of the species is as yet uncertain. As implied by the generic name with a query, it suggests a certain affinity with the recent water chestnut or the genus *Trapa*, which has not yet actually been established. There is still a divergence of opinion in adopting the generic and specific name for it (see Kryshtofovich, 1953, p. 23).

The plant has long been known from the late Cretaceous and Paleocene strata of North America. Newberry, who was apparently the first one to note leaflets of this plant, considered them to represent fern pinnules and referred them to the form genus *Neuropteris* with a mark of interrogation. However, it has never been carefully described except by Lesquereux in 1874, and his diagnosis reprinted above is also based merely on detached leaflets. Later, a great number of much more complete specimens from various localities of the North Hemisphere were described and figured[14—19]. Some of the illustrations commonly reproduced in some textbooks of Palaeobotany[20—22] are more familiar; another excellent specimen of Brown (1939, p. 39, fig. 1) with two fruits, one of which is still attached to the stem, is refigured in the present paper (Pl. 1, fig. 1) for reference. These valuable specimens add greatly to our knowledge of the whole habit of this plant. It is evidently a floating plant, with four-parted rosette of compound leaves. The individual leaflet may vary in some extent both in shape, size and even in nervation according to the position. The fruits of the species, ovate in shape, measuring about 1 cm. in length with a slightly elongate and emarginate apex, appear to be attached by short, stout peduncles to the stem beneath the rosette of floating leaves, somewhat in the same manner as the nuts of living species of water chestnut, *Trapa*. Inasmuch as the fruits of this species, as shown in the most typical specimens of Brown, have no characteristic horns of the living species of *Trapa*, and the leaves are compound, not simple as in living *Trapa*, the fossil leaves and fruits have thus been described by authors under considerably different generic names——the leaves described as *Nymphaeites*, *Dicotylophyllum*, *Macclintockia*, *Protorrhipis*, etc., and the fruits as *Carpolithes*, *Vibuprnum*, *Nyssa*, *Quereuxia*, etc. (see Kryshtofovich, 1953, p. 23, 25). However, most authors have followed Lesquereux in retaining this species as *Trapa? microphylla*, for Brown (1939, p. 37) has pointed out, the divergences between the fossil form and living species of *Trapa* in the foliage as well as in the fruit "do not necessarily preclude a possible relationship, not too distant, with living *Trapa*, for diversities of foliage and fruit just as great can be matched in many other families of flowering plants.". Recently, Kryshtofovich[14] laid great stress on the distinctions between the present form and living species of *Trapa* in the leaves and the fruits, and expressed further the opinion that among

the many fossil records of undoubted *Trapa* fruits, they are, with exceptionally rare cases, not found associated with the foliage. It may be noted that Dawson (1886) figured a typical leaflet of this species associated with fruits from the Laramie formation of Canada, which he referred to *Trapa borealis* Heer, but this is by no means proof that the leaflets are those of *Trapa*. And it might still be questioned whether the determination of Dawson's fruits is entirely free from doubt, since *Trapa borealis* is always found in a geologically younger strata (Oligocene-Miocene), where the present species has not yet been recorded. The plant has obviously no actual relations to the existing species of *trapa*, nor it shows any possibility of affinity with those of *Nymphaea*. The question of the generic relation of this species with any recent genera must be left open at present. Kryshtofovich is thus justified in concluding that the plant should be placed in a different designation, namely *Quereuxia angulata* (Newb.). The generic name *Quereuxia* was previously used by Kryshtofovich for the detached fruits and the specific name created by Newberry in 1861 was vivified by Bell in 1949 (see Kryshtofovich 1953, p. 23, 25, 26).

There are certainly many reasons for the plant to have a more appropriate designation as Prof. Kryshtofovich proposed. However, the present material is here treated as generally defined only because the precisely systematic position of the plant is still obscure and the work of Lesquereux is the one that has been agreed upon as the basis of this peculiar plant. Moreover, *Trapa? microphylla* is more familiar and widely employed both in palaeontological and geological literatures, though it is neither the oldest, nor the very adequate name.

The species is chiefly characteristic of the late Cretaceous of the Northern hemisphere, though well-preserved remains have not uncommonly been found in the Early Tertiary deposits of North America. In Northeastern Asia it is represented abundantly in the Giliakian Series of Saghalien. It is also one of the commonest elements of the Kolyma flora of North Siberia. Three fragmentary specimens figured by Endo[23] (1925, pl. 17, figs. 16, 18, 19) as *Glossozamites* (?) *imaii* n. sp. from the *Nilssonia*-bed or the Urakawa Series[24] of Hokkaidô in Japan, as remarked by Kryshtofovich (1953, p. 25, 28), seem to be identical with this form, too. The stratigraphical range of the plant occurring in the localities of NE Asia is considered to be confined to the Middle and Upper Cretaceous, extending from the Cenomanian-Turonian to Senonian, with a single exception of that the species was found by Vachrameev from the Lower Tertiary (possibly Danian) deposits in the угольноц Bay (see Baikoviskaya, 1956, p. 127, 156, etc).

The specimens found in the upper part (Fulunchuan formation) of the Sungari Series are fragmentary, which, however, is unquestionably identical with the most common species *Trapa? microphylla* of the late Cretaceous. The stratigraphy and some of the non-marine animal fossils of the Sungari Series, as remarked above, have already been studied by many palaeontologists. Concerning the geological age of the Sungari Series, Kobayashi and Suzuki (1942, p. 90) have mentioned, "If the Sungari Series is a Mesozoic formation as generally believed now, the Fulung formation must be Upper Cretaceous, ..., the palaeontological evidences show that the age of the non-marine Sungari fauna is in the range from Middle to Upper Cretaceous".

The presence of this important characteristic plant from the Fulungchuan formation of the Sungari Series affords further a satisfactory palaeobotanical evidence to support the Upper Cretaceous, or more precisely the Cenomanian-Turonian and Senonian age of the plant-bearing formation. However, this cannot be applied to the middle (Nengkiang formation) and the lower (Chuantou formation) divisions of the Sungari Series, though their age has been held by many authors[7–11] as Middle and Upper Cretaceous. After a preliminary study of numerous pelecypods recently found in the Nengkiang formation, the age of the latter is believed by Mr. Ku[1] to be probably

1) An oral statement from Mr. C. W. Ku to the writer.

Lower Cretaceous; but a decisive opinion as to the age of these formations ought to be postponed until the whole faunal material accumulated in our Institute has been examined and notes of his field observations have been worked out.

The writer takes pleasure to acknowledge his great indebtedness to Prof. T. N. Baikoviskaya of the Institute of Botany, Academy of Science, U.S.S.R., in Leningrad, who kindly sent him the important paper of Prof. Kryshtofovich (1953) formely not accessible in Nanking and gave him valuable suggestions. Thanks are also due to Mr. C. W. Ku for his assistance in stratigraphical as well as palaeontological literatures. The writer also wishes to express his sincere thanks to Mr. P. S. Chen for placing who gave him the valuable specimens under his disposal.

图 版 說 明

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Trapa ? microphylla Lesq.

图 1，4. 布朗等发現于北美加拿大的标本，原大。图 1 表示蓮座状叶丛之下有两个果实，其中的一个，还以一短粗的梗直接着生于其茎上；图 4 为两个脫落的果实。

[Brown's specimens (Ravenscrag formation, Canada), in natural size]

图 2,3,5—8. 东北、哈尔宾、庙台子松花江統上部的标本，为大小及形状都略有不同的脫落的叶部化石。其中图 6 为图 5 标本的放大，×3；图 8 为图 7 标本的放大，×5；都用以显示其叶脈的細部。

[Specimens of detached leaflets of varying size and shape from the upper part of Sungari Series in the vicinity of Harbin, North eastern China. Fig. 6, the same as 5, showing nervation, × 3; fig. 8, the same as 7, showing nervation, × 5. Otherwise in natural size.]

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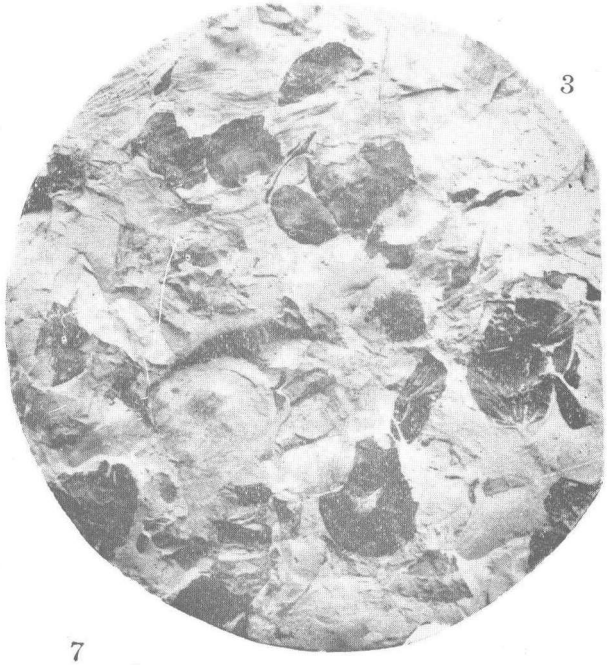
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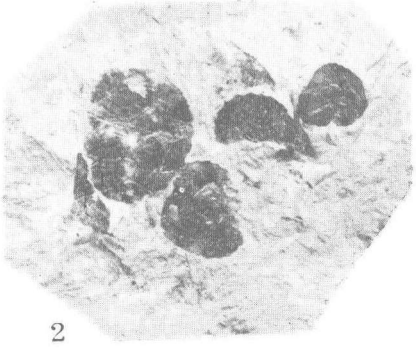
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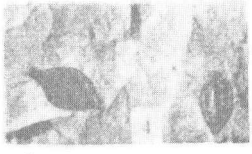
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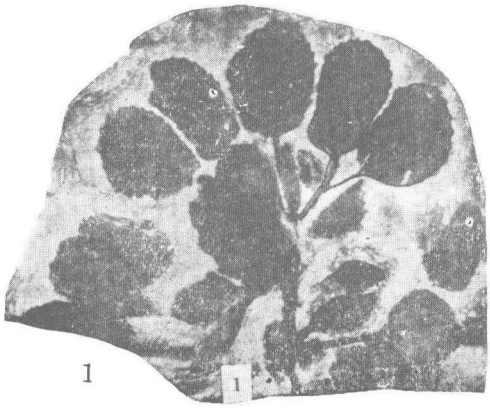
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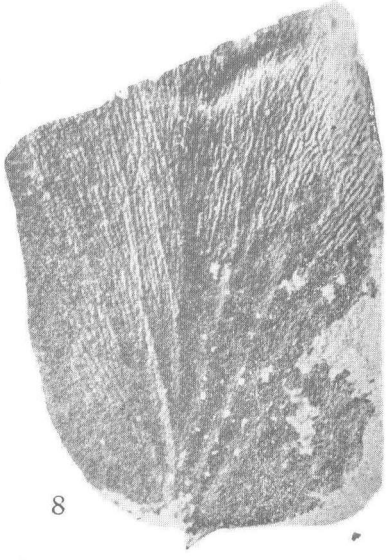
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