

青海祁曼塔格山一带的 *Kepingophyllum* 珊瑚动物群

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内 容 提 要

青海祁曼塔格山一带打柴沟组的珊瑚化石是近岸底栖、浅海相的块状复体四射珊瑚, 属于晚石炭世至早二叠世过渡性质的 *Kepingophyllum* 珊瑚动物群, 共 7 属 19 种, 其中 1 新属和 14 新种。这些珊瑚的个体外壁由泡沫板和隔壁分化演变而成, 它们与华南及西南地区相应时代中的珊瑚关系密切。

关键词 *Kepingophyllum* 珊瑚动物群 形态特征 古生态 打柴沟组 青海

一、前 言

青海祁曼塔格山一带的晚古生代地层中有一套厚约 131—195m 的由生物碎屑灰岩组成的碳酸盐相沉积, 产丰富的筴类和珊瑚化石。这套地层的岩性已由本文作者之一(周光第, 1987)作过描述并命名为打柴沟组, 作为石炭-二叠系过渡层。本文仅报道珊瑚化石。根据珊瑚化石的性质, 笔者拟将其称为 *Kepingophyllum* 珊瑚动物群。它主要由个体外壁为泡沫板和隔壁分化演变而成的块状复体四射珊瑚组成。在描述 7 属 19 种(含 1 新属和 14 新种)的同时, 对该珊瑚动物群的性质、形态特征及其与生活环境的关系进行了叙述。

二、*Kepingophyllum* 珊瑚动物群的性质

青海祁曼塔格山一带的 *Kepingophyllum* 珊瑚动物群由下列分子组成: *Antheria polygonalis* Wu et Zhao, *A. naotica* sp. nov., *A. rara* sp. nov., *Nephelephyllum antheriaoides* sp. nov., *Kepingophyllum curvatum* sp. nov., *K. proliferum* sp. nov., *Anfractophyllum facetum* Wu et Zhou, *A. facetum minor* Wu et Zhou, *A. dupliforme* Wu et Zhou, *A. lytintortum* sp. nov., *A. perfectum* sp. nov., *A. grossum* sp. nov., *Eokepingophyllum simplex* X. Yu, *E. difforme* sp. nov., *E. delicalum* sp. nov., *Prokepingophyllum typicum* gen. et sp. nov., *P. minor* gen. et sp. nov., *P. multiforme* gen. et sp. nov., *Yokoyamaella multiseptata* sp. nov.。其中 *Nephelephyllum* 最早见于贵州西部威宁头坡上石炭统马平组(吴望始等, 1974), 后来在四川江油的马平组(范影年, 1978)、青海杂多县扎青乡扎西拉武寺陶奇涌的上石炭统(李璋荣等, 1979)及贵州盘县达拉的马平组(吴望始等, 1988)陆续被发现, 值得注意的是在云南

沾益炎方下二叠统下部也有见及(吴望始等, 1982, 1988); 由此看来, *Nephelophyllum* 的地质时代为晚石炭世晚期至早二叠世早期; 当前 *N. antheriaodea* 与产自云南广南小独山下二叠统下部的 *N. yunnanense* Wu et Kong 较为相近。 *Antheria* 最早也见于贵州西部威宁头坡上石炭统马平组(吴望始等, 1974), 后来在四川松潘上石炭统威宁组(范影年, 1978)、广西大新县新民屯上石炭统下部(贾慧贞等, 1978)和隆林隆或马平组(郑春子, 1986)、云南册亨马平组(吴望始等, 1982)及内蒙古巴彦宝力格公社下勒哈达上石炭统金河组(郭胜哲, 1983)见及。值得注意的是, 此属在云南沾益炎方下二叠统下部也有发现(吴望始等, 1988), 这说明 *Antheria* 的时代是从晚石炭世早期至早二叠世早期。 *Nephelophyllum* 和 *Antheria* 共生于青海祁曼塔格山一带的打柴沟组, 且层位也比较低。这两个属至今尚未在世界其他地区见及。 *Kepingophyllum* 最早见于新疆柯坪地区上石炭统康克林组(吴望始等, 1982), 根据现有的资料, 它分布在贵州西部、江苏南部、广西南宁和宜山以及新疆拜城等晚石炭世地层中(吴望始等, 1978, 1979; 俞学光, 1980; 郑春子, 1986), 但近年来在云南沾益、贵州盘县达拉和威宁赵家山等下二叠统下部也有发现, 这也说明 *Kepingophyllum* 的地质时代并不局限于晚石炭世, 也可到达早二叠世早期。在当前这个珊瑚动物群中较繁盛的 *Anfractophyllum* 最早也是见于新疆柯坪地区的康克林组, 同时在云南广南册亨的 *Robustoschwagerina* 带(吴望始等, 1982)和贵州龙吟马平组(吴望始等, 1988)也都见及, 除此之外, *Anfractophyllum* 在云南沾益炎方的下二叠统下部也有发现, 笔者之一(赵嘉明)在研究广西来宾地区下二叠统的珊瑚时发现栖霞组的 *Anfractophyllum* 与 *Polythecalis* 共生。所以 *Anfractophyllum* 的地质时代与 *Kepingophyllum* 是相同的。在当前打柴沟组中 *Anfractophyllum* 与 *Kepingophyllum* 也常共生。 *Eokepingophyllum* 最早见于江苏宜兴青龙山船山组(俞学光, 1980), 近年来在新疆拜城康克林组(蔡土赐, 1986)和江西船山组也见有这个属的分子(朱正刚等, 1992)。当前出现的 *Eokepingophyllum*, 它与 *Kepingophyllum* 和 *Anfractophyllum* 都共生。 *Prokepingophyllum* 是个新属, 它与 *Eokepingophyllum* 比较相似, 分布的层位比 *Nephelophyllum* 和 *Antheria* 高, 与 *Kepingophyllum*、*Anfractophyllum* 和 *Eokepingophyllum* 共生。 *Yokoyamella* 最早见于日本本州下二叠统 *Pseudofusulina* 带, 据资料得知, 这个属还分布在阿尔卑斯山的 *Pseudoschwagerina* 带(Heritsch, 1936), 在我国四川巴塘下二叠统上部冰峰组(吴望始等, 1979)、广西隆林隆或的马平组上段(郑春子, 1986)及贵州威宁马平组(吴望始等, 1988)也有发现, 由此看来, *Yokoyamaella* 的地质时代也是从晚石炭世晚期至早二叠世早期。

从上述珊瑚性质的分析来看, 当前青海祁曼塔格山一带打柴沟组的珊瑚是一类从晚石炭世晚期至早二叠世早期的珊瑚群。这个珊瑚群与新疆柯坪地区康克林组的珊瑚群相比, 不同的是康克林组的珊瑚出现属种较多的单体珊瑚, 但未见 *Nephelophyllum* 或 *Antheria*; 这两地的珊瑚群尽管属的分异度有差别, 但都存在 *Kepingophyllum* 和 *Anfractophyllum*, 说明这两个珊瑚群之间还是有一定的联系。黔西和桂北地区马平组有 *Nephelophyllum*、*Antheria* 和 *Kepingophyllum*(郑春子, 1986), 与本区也有联系, 不同的是黔西和桂北除了上述块状复体珊瑚以外, 还存在不少单体珊瑚。江苏南部地区船山组的珊瑚(俞学光, 1980), 除了存在单体珊瑚以外, 块状复体珊瑚也不少, 其中 *Kepingophyllum* 和 *Eokepingophyllum* 与本地区的可以互比, 但缺少原始分子 *Antheria* 和 *Nephelophyllum*。

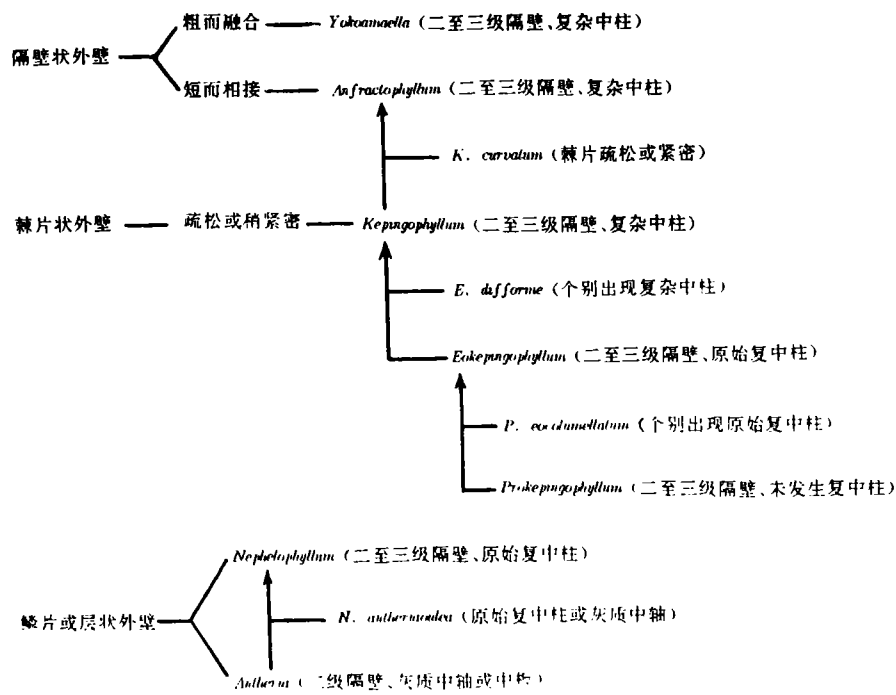
与当前珊瑚动物群共生的筴类有 *Pseudoschwagerina*, *Zellia*, *Pseudofusulina*, *Eopara-*

fusulina, *Schwagerina*, *Sphaeroschwagerin*, *Quasifusulina*, *Boultonia*, *Schubertella*, *Paraschwagerina*, *Rugosofusulina*, *Staffella* 及 *Triticites* 等, 其中的 *Sphaeroschwagerina glomerose* 这些属属于 *Sphaeroschwagerina glomerose* 亚带, 时代为晚石炭世晚期(据张遵信面告)。从当前 *Kepingophyllum* 珊瑚动物群的性质来看, 它的时代可从晚石炭世晚期至早二叠世早期。据 Fontaine(1986)报道, 在苏门答腊岛 Mesumai 河上游区的 *Pseudoschwagerina* 带(中—上 Asselian 阶)也有 *Kepingophyllum* 珊瑚出现。

三、Kepingophyllum 珊瑚动物群的形态特征与 其生活环境的关系

青海祁曼塔格山一带的 *Kepingophyllum* 珊瑚动物群主要以块状复体珊瑚组成。根据它们个体外壁的演变。可分为 3 种类型(表 1)。

表 1 *Kepingophyllum* 珊瑚动物群中属的特征及它们之间的关系
The characteristics and mutual relations of genera in *Kepingophyllum* fauna



1. 鳞片或层片外壁型(squamo-theca or strato-theca)

这类外壁主要是由泡沫板加厚成鳞片或层片, 并以叠层排列, 常与一些不规则的钩片穿夹而成, 以 *Antheria* 和 *Nephelophyllum* 为代表。由于种不同, 组成外壁的成分在程度上也不同, 有的以鳞片为主, 有的是鳞片和少量钩片。由于珊瑚体轴部构造形态的差异, 仅发育灰质中轴或中板的以 *Antheria* 为代表; 以发育原始复中柱, 即中板、斜板和轴板均不稳定的以 *Nephelophyllum* 为代表。在隔壁的发生上, 这两个属也不同, *Antheria* 仅发生二级隔壁, 而 *Nephelophyllum* 有时发生三级隔壁, 当然这些三级隔壁并不很稳定, 但比仅有二级隔壁的

Antheria 似乎要进化些。珊瑚体的发生有突变也有渐变,从当前这两个属的分子来看,其中就有渐变的过渡类型,如 *Nephelophyllum antheriaoides*,这个种的轴部既有灰质中轴,也有原始的复中柱。

2. 棘片外壁型(brambly-theca)

这类外壁主要由隔壁外端演变成棘片或钩片而组成,以 *Kepingophyllum*, *Eokepingophyllum* 和 *Prokepingophyllum* 为代表。由于隔壁外端演变程度不同,有些外壁全部以分散的棘片为主,有些则以疏松的钩片和棘片混合构成。也由于珊瑚体的轴部构造形态不同,分为三类:发生复杂复中柱或稍简单复中柱的以 *Kepingophyllum* 为代表,发生原始复中柱的以 *Eokepingophyllum* 为代表,轴部构造缺乏的以 *Prokepingophyllum* 为代表。上述 3 属,虽然在轴部构造上有差异,但它们之间还是存在过渡类型的分子,如在 *Kepingophyllum* 与 *Eokepingophyllum* 之间有原始复中柱和完整复中柱的分子,如 *Eokepingophyllum difforme*。同样情况,在 *Eokepingophyllum* 和 *Prokepingophyllum* 之间大部分缺乏轴部构造,少数出现原始的复中柱,如 *Prokepingophyllum eocolumellatum*。从隔壁发生看,上述 3 属基本都有三级隔壁,只不过是发育程度上不同或不甚稳定。

3. 隔壁外壁型(septal-theca)

这类外壁由隔壁外端分化演变成直立的棘片或直接由隔壁伸向外端剧烈加厚互相融合而成,前者以 *Anfractophyllum* 为代表,后者以 *Yokoyamaella* 为代表。它们之间的差别还表现在复中柱结构上,其中 *Yokoyamaella* 的复中柱比 *Anfractophyllum* 复杂,表现为致密、加厚且常具围壁;另一区别是 *Yokoyamaella* 个体边缘泡沫板发育程度比 *Anfractophyllum* 差。

上述三种不同外壁类型的属中,鳞片或层片外壁型者(*Antheria*, *Nephelophyllum*)占全属数的 28.6%,棘片外壁型者(*Kepingophyllum*, *Eokepingophyllum*, *Prokepingophyllum*)占 42.8%,隔壁外壁型者(*Anfractophyllum*, *Yokoyamaella*)占 28.6%,其中占优势的是棘片外壁型者(插图 1)。

在种的发生率方面,*Antheria* 占珊瑚动物群种数的 16%,*Nephelophyllum* 为 4.5%,*Kepingophyllum* 为 11%,*Eokepingophyllum* 和 *Prokepingophyllum* 各为 16%,*Anfractophyllum* 为 32%,*Yokoyamaella* 为 4.5%。明显看出,其中 *Anfractophyllum* 占优势(插图 2)。

当前 *Kepingophyllum* 珊瑚动物群的成员虽然在外壁结构上有一定差别,但还有共同之处,即珊瑚体内缘或多或少发育泡沫板,个别的从成体的轴部生长,如当前 *Yokoyamaella multiseptata* 的个别个体就具 2 个复中柱,它们在边缘泡沫带内生长(图版 VI, 图 4a)。块状体珊瑚繁殖后代有两种方式,一种就如上所述的从泡沫带出芽繁殖,称为无性繁殖;另一种是雌雄同体而产生浮浪幼虫,经过流水而迁移至别处发育生长,称之为有性繁殖,块状复体珊瑚的横向分布如此广泛,这与浮浪幼虫的迁移有很大关系。*Kepingophyllum* 珊瑚动物群中丰富的块状珊瑚可能也是由这种生殖方式所产生。同时,它们的骨片结构十分复杂,这是抵御动荡海水的一种生物结构。由此可见,青海祁曼塔格山一带在晚石炭世晚期至早二叠世早期,海水的能量较高,较动荡,食料来源也较丰富,是处在亚动荡带(suburbulent zone)中(Hill, 1985)。

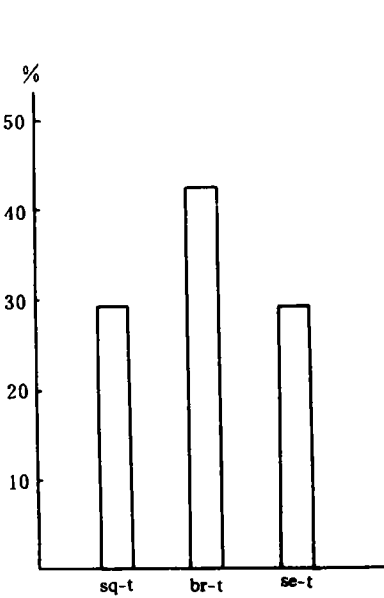


插图 1 不同外壁属的发生率
(occurring rate of variable thecal genera)
sq-t(squamo-theca):鳞片或层片外壁;
br-t(brambly-theca):棘片外壁;
se-t(septal-theca):隔壁外壁

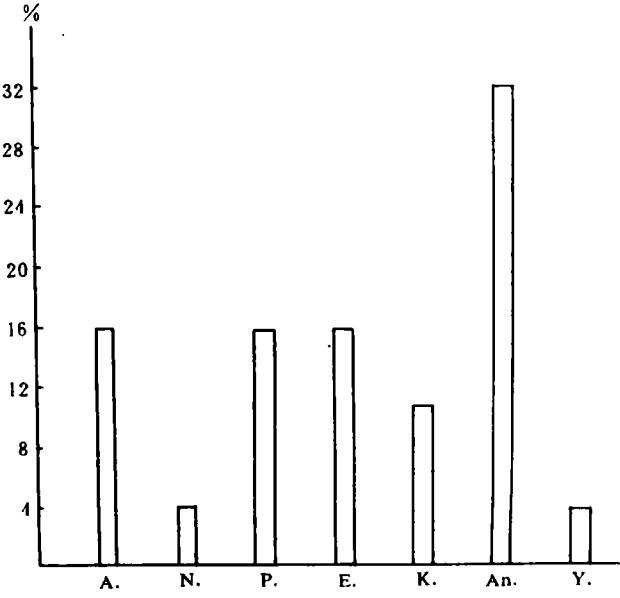


插图 2 种的发生率(occurring rate of species)
A. *Antheria*; N. *Nephelophyllum*; P. *Prokepingophyllum*;
E. *Eokepingophyllum*; K. *Kepingophyllum*; An. *Anfractophyllum*;
Y. *Yokoyamaella*

四、属种描述

柯坪珊瑚科 *Kepingophyllidae* Wu et Zhou, 1982

花珊瑚属 *Genus Antheria* Wu et Zhao, 1974

模式种 *Antheria polygonalis* Wu et Zhao, 1974

块状复体珊瑚。个体外壁完整或稍消失,外壁由鳞片小板聚集而成,有时夹小钩片,排列紧松不一。隔壁二级。泡沫带发育,宽窄不一。中轴呈纺锤形或条板状。床板平缓,或向中轴缓倾。

讨论 该属建立于 1974 年,当时缺乏比较。迄今为止,归于 *Antheria* 的有 15 种,它们的外壁有的全由鳞片相叠而成,有的在鳞片中央夹有小而分散的钩片,另外有的发育边缘泡沫板。以上特征也正是本文加以补充的。这个属的外壁性质、隔壁形态等与 *Nephelophyllum* 十分相近,但不同的是后者轴部为复中柱类型或与具中轴型的相同,并发生不稳定的锥形三级隔壁。从演化关系上来看, *Nephelophyllum* 可能由 *Antheria* 演化而来。

时代分布 晚石炭世晚期至早二叠世初期;中国。

多角花珊瑚 *Antheria polygonalis* Wu et Zhao

(图版 I, 图 2a—c)

1974 *Antheria polygonalis* Wu et Zhao, 吴望始等, 273 页, 图版 138, 图 2, 3; 图版 139, 图 3, 4.1983 *Antheria polygonalis* Wu and Kong, p. 375—376, pl. 1, fig. 3; pl. 2, fig. 3.**比较** 当前标本除了二级隔壁稍长及床板密度小些外, 其余特征与正模标本相同。**产地层位** 青海格尔木市乌图美仁乡四角羊沟; 打柴沟组(上石炭统至下二叠统)。**庙宇花珊瑚(新种) *Antheria naotica* sp. nov.**

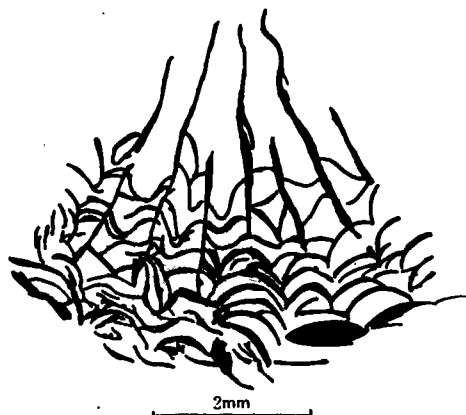
(图版 I, 图 3a, b; 插图 3)

特征 隔壁外端呈庙宇式构造。

描述 块状复体。个体横面呈四—五边形, 体径 6—8mm。外壁由许多排列疏松、稍加厚的小鳞片组成, 有时夹着倾斜的小钩片, 厚度不一, 形似串珠状。边缘泡沫带宽度不定, 泡沫板大小不一。鳞板呈角状或同心状。隔壁二级, 数目为 $(15-18) + (15-18)$, 加厚, 外端常分叉, 有的呈庙宇式构造, 末端除有 1 条一级隔壁与轴部相连外, 其余均不相连; 二级隔壁长度约为一级隔壁的 $1/3-1/2$ 。中轴常呈纺锤形或呈条状, 前者长宽为 $1.0\text{mm} \times 0.4\text{mm}$, $1.2\text{mm} \times 0.5\text{mm}$, $1.3\text{mm} \times 0.4\text{mm}$, 后者为 $1.0\text{mm} \times 0.2\text{mm}$, $2.0\text{mm} \times 0.2\text{mm}$ 。

纵面上, 外壁的小鳞片呈陡倾加厚的小型泡沫板; 两侧泡沫板大小不一, 凸面向内偏上; 床板向轴部倾斜, 3mm 内有 5—7 条。

比较 新种的外壁构造形态与产自贵州册亨的 *Antheria magna* Wu et Kong 十分相像, 不同的是后者个体大, 鳞板多及隔壁外端缺乏庙宇式构造。

产地层位 同前种。插图 3 *Antheria naotica* sp. nov. 示隔壁外端的庙宇构造 (showing septal naotic structure)**稀花珊瑚(新种) *Antheria rara* sp. nov.**

(图版 I, 图 2a, b; 插图 4)

特征 外壁和中轴欠发育。

描述 块状复体。个体横面无一定形状, 体径大致为 8—10mm。外壁部分由少数薄的鳞片组成, 部分由泡沫板代替而成。隔壁二级, 为数 $(13-16) + (13-16)$, 微加厚、稍弯曲; 一级隔壁末端伸达轴部区, 其中有 1 条伸入轴心成为十分细的中板; 二级隔壁长度约为一级隔壁的 $1/3-1/2$ 。泡沫带甚窄, 泡沫板弯曲, 无脊峰。鳞板带宽度与二级隔壁长度相当, 鳞板呈同心状和角状, 排列疏松。轴部有的由 1 条一级隔壁伸入轴心成薄的中板, 有的缺乏。

纵面上的外壁呈不规则的马蹄形泡沫板;两侧的泡沫板陡倾;床板完整时向轴部倾斜,不完整时呈交错状,总的呈盆状,在3mm内有6—7条。

比较 新种的外壁构造欠发育,中轴发育甚弱,这些特征在 *Antheria* 的现有种中尚未见及。

产地层位 青海格尔木市乌图美仁乡牛克特;层位同前种。



插图4 *Antheria rara* sp. nov.

示稀少的外壁和轴部(showing rare squamo-theca and axes)

云珊瑚属 Genus *Nephelophyllum* Wu et Zhao, 1974

花珊瑚型云珊瑚(新种) *Nephelophyllum antheriaioidea* sp. nov.

(图版1,图1a—c;插图5)

特征 轴部构造差异大。

描述 块状复体。个体横面呈不规则的四—五边形,体径为6—9mm。外壁完整,厚度最大为1.5mm,由许多紧密排列的小鳞片组成。隔壁二级,弯曲微加厚,外端常分叉与泡沫板相混合,或被泡沫板所阻,数目为 $(14-18) + (14-18)$,细构造为羽针垂直型;一级隔壁末端伸入轴部区,有的与轴部相接;二级隔壁长度为一级隔壁的 $1/2 - 2/3$;三级的锥形隔壁有时出现。泡沫带甚窄,不完整,泡沫板形状和大小不规则,无脊峰。鳞板呈不规则倾斜条状或呈角状。轴部有的为一条加厚的中板,呈直扁形,或呈纺锤形,长宽为 $1.3\text{mm} \times 0.6\text{mm}$ 、 $1.5\text{mm} \times 0.6\text{mm}$ 、 $1.7\text{mm} \times 0.2\text{mm}$ 、 $1.7\text{mm} \times 0.6\text{mm}$ 、 $2\text{mm} \times 0.2\text{mm}$,一端有时与1条一级隔壁的末端相连。

纵面上,外壁呈小型泡沫交织形。两侧的泡沫板大小不甚一致,向内倾斜,最多为7列。床板完整或交错,均向轴部倾斜,3mm内有4—5条。

比较 如果按照中轴型的轴部形态,此标本可归入 *Antheria*,但由于有不甚稳定的锥形三级隔壁,这却是 *Nephelophyllum* 的特征之一,为此本文把此标本归入 *Nephelophyllum*,并



插图5 *Nephelophyllum antheriaioidea* sp. nov. 示外壁的鳞片构造(showing the structures of the squamo-theca)

认为这个种是 *Nephelophyllum* 和 *Antheria* 之间的过渡类型。

从外壁由小鳞片重叠而成层状及轴部形态看,当前新种与 *Nephelophyllum simplex* Wu et Zhao 有些相似,不同的是后者外壁缺失多些、隔壁数最多为 14+14 以及二级隔壁微弱且泡沫板较规则。

产地层位 青海格尔木市乌图美仁乡打柴沟;层位同前种。

柯坪珊瑚属 Genus *Kepingophyllum* Wu et Zhou, 1982

弯曲柯坪珊瑚(新种) *Kepingophyllum curvatum* sp. nov.

(图版 V, 图 2a, b)

特征 复中柱的中板、辐板及斜板均弯曲。

描述 块状复体。个体横面呈不规则多边形,体径为 8—10mm,最大为 12mm。外壁由粗细不均的棘片组成,粗者长宽为 $(0.3-0.4\text{mm}) \times (0.6-1.0\text{mm})$,细者呈不规则的鱼钩片,当外壁缺失时,由泡沫板相连。隔壁一般二级,局部三级;一级隔壁数目为 16—20,厚薄不均,厚者最宽为 0.3mm,外端变薄或直接与棘片外壁相连或断续伸于泡沫带;薄者弯曲,一般不达外壁;一级隔壁末端止于复中柱外;二级隔壁长度约为一级隔壁的 $2/3$;三级隔壁最长约为一级隔壁的 $1/4$ 。泡沫带发育,宽度不一,泡沫板呈不规则、不完整的圆形,板面上具有脊峰。鳞板呈同心状。复中柱的中板、辐板及斜板均为弯曲状,形成不规则的椭圆脑纹状,周围由弯曲的斜板围着,长宽为 $(1-1.5\text{mm}) \times (2-2.5\text{mm})$ 。

纵面上的泡沫板一般平列状或微向内倾斜,脊峰粗细不均,呈层状排列,粗者两侧具侧斜板。斜床板发育,陡倾;横床板带甚窄,床板平缓,3mm 内有 8—9 条。

比较 新种在复中柱具围壁、隔壁数目及局部发生三级隔壁的特征上,与 *Kepingophyllum polythecaloides* Wu(吴望始等,1979)较为相似,不同的是后者的外壁、隔壁和泡沫带的泡沫板粗细较为均匀,并且复中柱的中板、辐板和斜板不如前者弯曲。

产地层位 同前种。

多育柯坪珊瑚(新种) *Kepingophyllum proliferum* sp. nov.

(图版 V, 图 1a—c)

特征 一些幼体同时出现在泡沫带中。个体外壁的棘片有时排列紧密。

描述 块状复体。个体横面呈多边形或不完整的环形,体径一般为 8—9mm;幼体较多,同时出现在泡沫带中,体径为 3—4mm,外壁的棘片排列松紧不均,局部缺失。幼体之间大部由泡沫板相连;隔壁带与泡沫带之间的界限较清晰,隔壁带直径为 2—2.5mm,隔壁数为 $(10-12) + (10-12)$,一级隔壁短些,二级隔壁长度不定,一般为一级隔壁的 $1/2$;泡沫带甚为发育,脊峰少;鳞板甚少;轴部甚为简单,由完整或不完整的中板和一系列环弧形斜板组成,有的仅为一条加厚的中板,其大小占隔壁带的 $1/5$ 。

成年期个体,隔壁带与泡沫带之间的界限尚为清晰,隔壁带直径约 3—4mm,隔壁主要为一至二级,局部具锥形三级隔壁,微加厚、稍直,外端有时与棘片相连,有时止于泡沫带或断续的消失在泡沫带内,一、二级隔壁数目为 $(16-18) + (16-18)$,末端与轴部不相连,二级隔壁长度约为一级隔壁的 $1/2-2/3$ 。泡沫带的宽度不定,一般占个体半径的 $1/3$,泡沫板形状、大小不规则,板面上具少量脊峰。鳞板带的宽度约与二级隔壁长度相当,呈同心状。复中

柱微加厚、呈椭圆形,具围壁;中板稍弯曲;辐板少数呈断续状;斜板环形,约2—3列,长宽为 $(1-1.5\text{mm}) \times (0.8-1\text{mm})$ 。

纵面上床板平缓,微向内倾斜,3mm内有9条。

比较 在个体外壁形态、直径大小、隔壁数目及复中柱构造形态上,新种与 *Kepingophyllum proectum* X. Yu(俞学光,1980)十分相似,不同的是前者泡沫带内局部发生一些幼体,成年体中的复中柱比较小。

产地层位 青海格尔木市乌图美仁乡四角羊沟、打柴沟、牛克特;层位同前种。

弯曲珊瑚属 Genus *Anfractophyllum* Wu et Zhou, 1982

精美弯曲珊瑚 *Anfractophyllum facetum* Wu et Zhou

(图版 V, 图 3a, b)

1982 *Anfractophyllum facetum* Wu et Zhou, 吴望始等, 230 页, 图版 V, 图 1—8。

比较 当前标本除了床板生长的密度稍大外,其他特征与新疆的正模标本一致。

产地层位 青海格尔木市乌图美仁乡四角羊沟;层位同前种。

完美弯曲珊瑚(新种) *Anfractophyllum perfectum* sp. nov.

(图版 N, 图 3a, b)

特征 个体较完整。

描述 块状复体。个体横面呈规则的五—六边形,个体直径6.5—10mm。外壁大部分完整,由紧密排列的直立棘片组成,厚度尚均匀。隔壁带与泡沫板之间的界限不甚清晰;隔壁带直径3—5mm,隔壁三级,一、二级隔壁数目为 $(17-18) + (17-18)$,微加厚,直,外端大部断续伸入泡沫带,少数与棘片相连;一级隔壁长,伸至轴部边缘,有时由1条一级隔壁与轴部相连;二级隔壁长度约为一级隔壁的 $1/2-2/3$;三级隔壁不稳定,长度不一,在个体伸长部位尤为显著。复中柱发育,呈纺锤状,加厚,中板直或弯曲,辐板少数断续状,斜板1—4列,环弧形,直径为 $1.5\text{mm} \times 0.7\text{mm}$, $1.5\text{mm} \times 0.8\text{mm}$, $1.8\text{mm} \times 1.8\text{mm}$, $1.8\text{mm} \times 1.2\text{mm}$ 。泡沫带发育,由小至中等型泡沫板所组成,具脊峰。鳞板同心状,排列较密。

纵面上的泡沫板大小不一,向上偏内。斜床板发育不多,横床板完整,向轴部倾斜呈盆形或交错状,3mm内有10—12条。

比较 从完整的个体看,新种与 *Anfractophyllum regulare* Wu et Zhou(吴望始等,1982)有些相似,不同的是后者个体出现三种类型:一类全部完整,隔壁外端与棘片相连;第二类边缘发生泡沫带;第三类外壁部分缺失或全部缺失。

产地层位 同前种。

松扭弯弯曲珊瑚(新种) *Anfractophyllum lytintortum* sp. nov.

(图版 N, 图 2a, b)

特征 泡沫板大。

描述 块状复体。个体横面呈不完整多边形,体径10—12mm。外壁由加厚、直列的棘片相连而成,局部呈小钩片,有时与隔壁相连,局部外壁缺失。隔壁带与泡沫带之间的界限尚清

晰,隔壁带直径 4mm,隔壁三级,一级隔壁数目 18—20,外端与棘片相连或止于泡沫带或断续进入泡沫带;一级隔壁伸入轴部边缘,与复中柱不相连,一般较薄,局部加厚;二级隔壁长度为一级隔壁的 $1/2-2/3$;三级隔壁局部发育,长度约为二级隔壁的 $2/3$ 。泡沫带发育,宽度不一,泡沫板中等大小,个别较大,具脊峰。复中柱呈椭圆形,由稍直或弯曲的中板、少许断续的辐板及 2—3 列环形或泡弧形的斜板组成,长宽 $1.2\text{mm} \times 0.8\text{mm}$, $1.3\text{mm} \times 0.5\text{mm}$, $1.3\text{mm} \times 0.6\text{mm}$, $1.3\text{mm} \times 0.8\text{mm}$ 。

纵面上的斜床板少。横床板完整或交错,平缓状或微向轴部倾斜,3mm 内有 9—10 条。

比较 在个体大小、隔壁数目及复中柱特征方面,新种与 *Anfractophyllum intortum* Wu et Zhou(吴望始等,1982)有些相似,不同的是后者外壁缺失较多及床板排列密度大。

产地层位 青海格尔木市乌图美仁乡打柴沟;层位同前种。

厚弯曲珊瑚(新种) *Anfractophyllum grossum* sp. nov.

(图版 V, 图 1a, b; 插图 6)

特征 外壁的棘片甚厚。

描述 块状复体。个体横面呈不规则角圆形,四—五边形,直径 7—9mm。外壁由两端浑圆的加厚棘片组成,排列紧密,偶缺失。隔壁二级,数目为 $(14-15) + (14-15)$,加厚,外端与棘片相连或被泡沫带所阻;一级隔壁较长,末端几乎与复中柱相接;二级隔壁长度约为一级隔壁的 $1/2-2/3$ 。泡沫带宽度不定,泡沫板大而不规则,呈拱圆形,凸面上常有脊峰。鳞板同心状或不规则倾斜。复中柱小而简单,结构疏松,由少数辐板和斜板及中板所组成,有的仅为一条加厚的中板,复中柱最大直径为 1mm。

纵面上的斜床板呈泡沫状,横床板平列状,少数交错状,3mm 内有 9—10 条。

比较 按简单的复中柱特征,新种似可归入 *Eokepingophyllum*,但新种外壁的棘片排列紧密,归入 *Anfractophyllum*。新种个体的规则形态与 *Anfractophyllum regulare* Wu et Zhou(吴望始等,1982)相似,不同的是后者的骨片加厚程度低,复中柱小而简单。

产地层位 同前种。

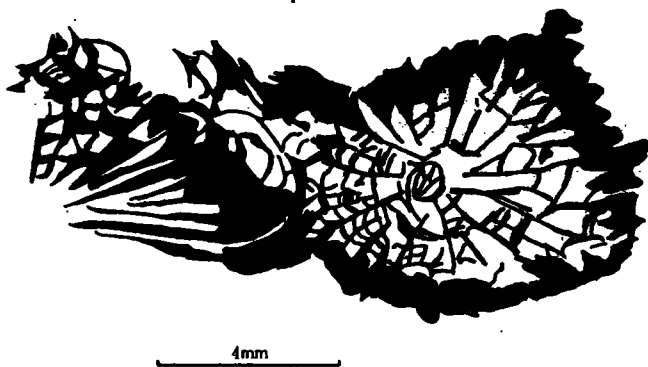


插图 6 *Anfractophyllum grossum* sp. nov. 示加厚的棘片外壁
(showing the thick brambly-theca)

始柯坪珊瑚属 Genus *Eokepingophyllum* X. Yu, 1980

不均始柯坪珊瑚(新种) *Eokepingophyllum difforme* sp. nov.

(图版 N, 图 1a—c)

特征 轴部构造不稳定。

描述 块状复体。个体横面呈不规则多边形,直径 2.7—3.5mm。外壁由粗直排列紧密

或细短排列疏松的棘片组成,粗直的棘片常与隔壁外端相连接。隔壁三级,微加厚,外端有时被泡沫板所阻或断续的进入泡沫带中;一级隔壁数目为 16—18,末端伸入轴区,与复中柱不相接;二级隔壁长度约为一级隔壁的 $1/2-2/3$;三级隔壁长短不一,断续出现。泡沫带发育不均匀、宽度不一,局部不发育,泡沫板不甚规则,具少许脊峰。鳞板呈同心状或不规则倾斜。轴部构造不甚稳定,有时由不明显的中板、极少数的辐板和不规则环形或泡沫状的斜板组成十分简单的复中柱,大小不及 1mm;有时由 1 条一级隔壁伸入中心形成条状中轴;也有缺乏任何构造的空轴,这类个体的一级隔壁较长,几乎伸入轴心。

纵面上的斜床板发育,横床板向轴部倾斜。3mm 内有 4—5 条。

比较 按外壁的棘片粗细排列,当前标本与 *Anfractophyllum* 十分类似,不同的是后者的外壁棘片紧密排列,复中柱发育相对稳定。该标本与 *Kepingophyllum* 相比,后者的外壁棘片排列疏松,复中柱发育比较稳定且较为复杂。

根据当前新种复中柱不稳定的特征,它与 *Eokepingophyllum simplex* X. Yu (俞学光, 1980) 比较接近,不同的是后者棘片排列疏松而不规则,轴部构造虽简单,但比较稳定。

产地层位 青海格尔木市乌图美仁乡打柴沟和四角羊沟;层位同前种。

细密始柯坪珊瑚(新种) *Eokepingophyllum delicalum* sp. nov.

(图版 II, 图 3a,b)

特征 外壁由较细的棘片和钩片组成。

描述 块状复体。个体横面呈规则的四—五边形,大小较接近,体径 5—7mm。外壁由较细的棘片和钩片所组成,排列规则,常与隔壁外端相连接。隔壁一般二级,局部出现不稳定的雏形三级隔壁;一级隔壁数目为 14—16,微加厚,末端进入轴区或未入轴区;二级隔壁长度为一级隔壁的 $1/2-2/3$ 。泡沫带窄,泡沫板大小不一,多为拱圆形,大小相间排列,具少许脊峰。鳞板同心状或不规则倾斜。复中柱小而简单,由中板、辐板和 2—3 列斜板组成,直径最大为 0.7mm;有的仅发育中板或不发育。

纵面上斜床板发育,横床板完整或交错,均向轴部倾斜而呈盆状。3mm 内有 8—9 条。

比较 从轴部构造不稳定的特征看。新种与 *Eokepingophyllum difforme* sp. nov. 十分相似,不同的是后者个体大,体径大小悬殊,外壁棘片和隔壁稍厚,泡沫带较宽。

产地层位 青海格尔木市乌图美仁乡牛克特及四角羊沟;层位同前种。

简单始柯坪珊瑚 *Eokepingophyllum simplex* X. Yu

(图版 II, 图 4)

1980 *Kepingophyllum simplex* X. Yu, 俞学光, 79 页, 图版 25, 图 2。

比较 当前标本缺纵面,但从横面构造特征看与江苏宜兴的正模标本极为相似。

产地层位 青海格尔木市乌图美仁乡四角羊沟;层位同前种。

前柯坪珊瑚属(新属) Genus *Prokepingophyllum* gen. nov.

模式种 *Prokepingophyllum typicum* gen. et sp. nov.

特征 块状复体珊瑚。个体呈多边形。外壁由钩片或棘片组成,排列疏松。隔壁二—三

级。泡沫带发育。轴部构造绝大部分缺失,或极少个体出现一条伸入轴心成“中板”的一级隔壁。床板向轴部倾,呈盆形。

讨论 从外壁由棘片或钩片构成的特征看,当前新属与 *Kepingophyllum* 较为相近,不同的是前者轴部构造大多缺失。新属与 *Eokepingophyllum* 相比,不同的是后者轴部常发育小而简单的复中柱或中板。

根据轴部的发育情况来看,*Kepingophyllum* 具比较完整的复中柱,*Eokepingophyllum* 为比较原始、不甚完整的简单复中柱,甚至有的仅为条状中板。新属的轴部构造绝大部分缺失,仅个别的出现由 1 条一级隔壁延伸入轴区而成的“中板”。由此推测,这 3 属可能存在 *Prokepingophyllum*→*Eokepingophyllum*→*Kepingophyllum* 这样一个演化关系。

时代分布 晚石炭世晚期至早二叠世早期;中国青海。

典型前柯坪珊瑚(新属、新种) *Prokepingophyllum typicum* gen. et sp. nov.

(图版 I, 图 3a-c; 插图 7)

特征 外壁棘片疏松,轴部构造均缺乏。

描述 块状复体。个体横面为多边形,两相邻个体中心之间的距离为 5—7mm。外壁由排列疏松、有时加厚的钩片组成,常与隔壁外端相连。隔壁二—三级,外端有时断续伸入泡沫带中,隔壁加厚,向内变薄,一级隔壁数目为 12—15,长度约为个体半径的 2/3,个别较长;二级隔壁长度约为一级隔壁的 1/2—2/3;三级隔壁仅在局部发生,长度不定。隔壁细构造为分羽楣

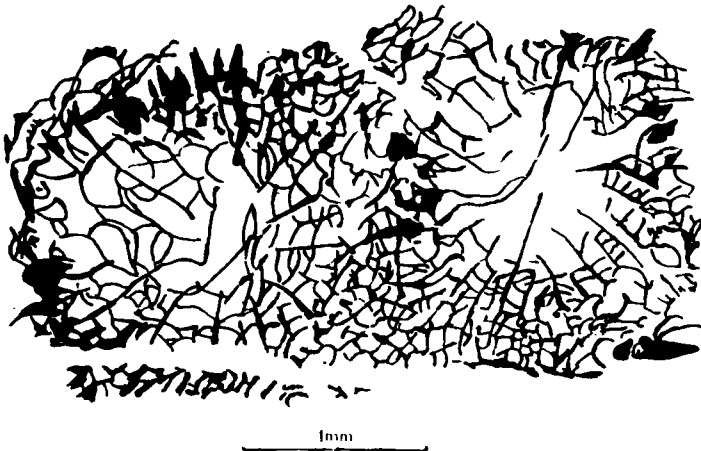


插图 7 *Prokepingophyllum typicum* gen. et sp. nov.

示局部个体的横面形态 (showing part transverse section)

型。泡沫带窄,泡沫板大小、形状不一,具脊峰。鳞板不规则。轴部构造均缺乏。

纵面上斜床板发育甚少,横床板发育完整或交错,向轴部倾,呈盆形,3mm 内有 5—6 条。

产地层位 青海茫崖镇双石峡南;层位同前种。

轴芽前柯坪珊瑚(新属、新种) *Prokepingophyllum eocolumellatum* gen. et sp. nov.

(图版 II, 图 2a-c; 插图 8)

特征 个别个体出现轴芽构造。

描述 块状复状。个体横面呈四—六边形,两相邻个体中心之间距为 4.5—6.5mm。外壁由棘片或钩片组成,似网状排列,棘片厚,钩片薄,厚者常与隔壁的外端直接相连。隔壁带

与泡沫带之间的界限尚明显,隔壁一般二级,极少个体局部出现不稳定的锥形三级隔壁;一级隔壁数目为13—16,伸达轴区,未达轴心,末端一般呈浑圆,极少个体中有1条一级隔壁伸入轴心成“中板”;二级隔壁短,为一级隔壁的 $1/3-1/2$ 。泡沫带宽度约为个体半径的 $1/3$,泡沫板大小不一,脊峰甚少。鳞板甚少,呈同心状。轴部大多无构造,极个别个体出现十分简单的中板或由一列泡弧形斜板组成的中柱。

纵面上的泡沫鳞板带由2—5列陡倾的泡沫板组成,排列紧密。床板完整或交错,均向轴部倾斜,呈盆形,3mm内有19—20条。局部出现陡倾泡弧形的斜板。

比较 当前新种与模式种 *Prokepingophyllum typicum* 相比,不同的是后者均缺乏轴部构造,棘片和钩片均加厚,隔壁较厚,床板生长密度小。

产地层位 青海格尔木市乌图美仁乡牛克特;层位同前种。

小型前柯坪珊瑚(新属、新种) *Prokepingophyllum minor* gen. et sp. nov.

(图版Ⅱ,图1a,b)

特征 个体小,两相邻个体中心之间距为3.5—4.5mm。

描述 块状复体。个体横面呈不规则的多边形,两相邻个体中心之间距为3.5—4.5mm。外壁由微加厚的排列疏松的钩片组成,少数与隔壁外端相连接。隔壁带与泡沫带界线不明显,隔壁二级,薄而弯曲,数目为 $(12-14)+(12-14)$;一级隔壁长达轴区,但未达中心,二级隔壁长度为一级隔壁的 $1/2-2/3$ 。泡沫带甚窄,泡沫板不规则,具少许脊峰。鳞板同心状或斜列状。轴部无构造。

纵面上的泡沫带由1—3列陡倾的泡沫板组成。斜床板少数,横床板下凹状,3mm内有9—10条。

比较 这个种与模式种 *Prokepingophyllum typicum* gen. et sp. nov. 相比,不同的是后者个体大及隔壁厚。当前新种与 *Prokepingophyllum ecolumellatum* gen. et sp. nov. 相比,不同的是后者极少个体中出现原始性的复中柱。

产地层位 青海格尔木市乌图美仁乡打柴沟;层位同前种。

横山珊瑚属 Genus *Yokoyamaella* Minato et Kato, 1965

模式种 *Lonsdaleia*(? *Waagenophyllum*) *yokoyami* Ozawa, 1925

特征 块状复体珊瑚。个体多边形,外壁由隔壁外端高度加厚并相互融合而成隔壁壁。边缘泡沫带发育不稳定。隔壁一般二级,局部三级。鳞板存在。复中柱构造为中板、辐板及斜板所组成的复杂型,常具围壁。斜床板和横床板均发育,横床板向轴部倾斜。

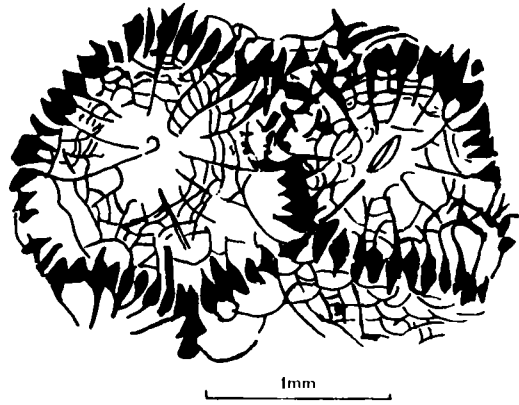


插图8 *Prokepingophyllum ecolumellatum* gen. et sp. nov.
示局部个体横面形态(showing part transverse section)

讨论 *Yokoyamaella* 属的外壁是由隔壁外端强烈加厚并相互融合而成的隔壁壁,与一般由珊瑚软体的外胚层分泌而成的外壁性质不同,所以笔者认为 *Yokoyamaella* 归入 *Kepingophyllidae* 科较宜。它与 *Anfractophyllum* 较为相似,不同的是后者外壁的棘片加厚程度及相互融合程度远不及 *Yokoyamaella*,另外,复中柱构造的复杂程度也远不及 *Yokoyamaella*。

时代分布 晚石炭世至早二叠世;日本、阿尔卑斯山区及中国。

多隔壁横山珊瑚(新种) *Yokoyamaella multiseptata* sp. nov.

(图版 VI, 图 4a, b)

特征 外壁由隔壁外端强烈膨胀成纺锤形的隔壁壁,隔壁数目为 $(24-26) + (24-26)$, 复中柱呈复杂的蛛网状。

描述 块状复体。个体横面呈四—五边形,体径一般为 7—8mm,个别为 10mm。外壁由隔壁外端强烈膨胀成纺锤形的棘片组成,加厚,在 1mm 左右。隔壁二级,数目为 $(24-26) + (24-26)$,外端常被泡沫板所阻;一级隔壁末端伸至复中柱外围;二级隔壁长度约为一级隔壁的 $2/3$;局部出现三级隔壁。泡沫带不稳定,泡沫板大小不匀。鳞板同心状。复中柱呈椭圆形,直径 1.5—2.0mm,由细长中板、6—8 条辐板及 2—3 列斜板组成蛛网状,具围壁,常加厚。

纵面上斜床板发育甚少,横床板交错状或向轴部倾斜,呈盆形,3mm 内有 9—10 条。

比较 新种在外壁形态结构上与日本的模式种 *Yokoyamaella yokoyamai* (Ozawa) 比较相似,不同的是后者的隔壁数少且较薄,未发生三级隔壁。它与 *Yokoyamaella dulanense* (Li et Liao) (李璋荣等, 1979) 也较相似,不同的是后者外壁棘片薄,个体大小相差悬殊。

产地层位 青海格尔木市乌图美仁乡四角羊沟;层位同前种。

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[1993年8月10日收到]

RECORDS OF THE *KEPINGOPHYLLUM* CORAL FAUNA FROM MT. QIMANTAGE OF QINGHAI

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Key words *Kepingophyllum* fauna, morphological property, environment, Dachaigou Formation, Qinghai Province

Summary

The *Kepingophyllum* coral fauna under study was collected from the Upper Carboniferous—Lower Permian Dachaigou Formation in the Qimantage mountains district, Qinghai. This formation, about 131—195m in thickness, yields the fusulinids *Sphaeroschwagerina*, *Pseudoschwagerina*, *Zellia*, *Pseudofusulina*, *Eoparafusulina*, *Schwagerina*, *Quasifusulina*, *Boultonia*, *Schubertella*, *Paraschwagerina*, *Rugosofusulina*, *Staffella*, etc. Based on these symbiotic fusulinids, the *Kepingophyllum* coral fauna is attributed to late Late Carboniferous in age. This coral fauna is composed of 7 genera and 21 species in total (including 1 new genus and 16 new species), namely, *Antheria polygonalis* Wu et Zhao, *A. naotica* sp. nov., *A. rara* sp. nov., *Nephelophyllum antheiroidea* sp. nov., *Kepingophyllum curvatum* sp. nov., *K. proliferum* sp. nov., *Anfractophyllum facetum* Wu et Zhou, *A. facetum minor* Wu et Zhou, *A. dupliforme* Wu et Zhou, Wu et Zhou, *A. lyntintontum* sp.

nov. , *A. perfectum* sp. nov. , *A. grossum* sp. nov. , *Eokepingophyllum simplex* X. Yu, *E. difforme* sp. nov. , *E. delicalum* sp. nov. , *Prokepingophyllum typicum* gen. et sp. nov. , *P. minor* gen. et sp. nov. , *P. multiforme* gen. et sp. nov. and *Yokoyamaella multiseptata* sp. nov. Among them, *Nephelophyllum* has been found from the Maping Formation in western Guizhou (Wu Wang-shi et al. , 1974), and Jiangyou, Sichuan (Fan Ying-nian, 1978), and the Upper Carboniferous in Zadoi, Qinghai (Li Zhang-rong et al. , 1979), but it also has been found in the lower part of the Lower Permian in Zhanyi, Yunnan (Wu Wang-shi et al. , 1982), while *N. antheriaoides* is similar to *N. yunnanense* Wu et Kong, 1982 from the fusulinid *Robustos chwagerina* Zone of Guangnan, Yunnan. *Antheria* is distributed in the Maping Formation of western Guizhou (Wu Wang-shi et al. , 1974), Longlin, Guanxi (Zheng Chun-zi, 1986), Ceheng, Guizhou (Wu Wang-shi et al. , 1982), and Daxin, Guangxi (Jia Hui-zhen and Xu Shou-yong, 1978), and the Jinhe Formation of Inner Mongolia (Guo Sheng-zhe, 1983), but it also has been found in the lower part of the Lower Permian (Wu Wang-shi et al. , 1988). *Kepingophyllum* is known to occur in the Kangkelin Formation of Kalpin and Baicheng, Xinjiang (Wu Wang-shi et al. , 1982; Cai Tu-ci, 1986), the Maping Formation of western Guizhou (Wu Wang-shi et al. , 1979), and Nanning, Yishan of Guangxi (Zheng Chun-zi, 1986), and the Chuanshan Formation of southern Jiangsu (Yu Xue-guang, 1980); in recent years, this genus also has been found from the lower part of the Lower Permian in Zhanyi, Yunnan, Panxian and Weining, Guizhou (Wu Wang-shi et al. , 1988), and from the fusulinid *Pseudoschwagerina* zone (Lower Permian) in Sumatra according to Fontaine's (1986) report. *Anfractophyllum* is known to occur in the Kangkelin Formation of Kalpin, Xinjiang (Wu Wang-shi et al. , 1982), the fusulinid *Robustochwagerina* zone of Guangnan, Yunnan (Wu Wang-shi et al. , 1982) and the Maping Formation of Longjin, Guizhou (Wu Wang-shi et al. , 1988), but also has been found from the lower part of the lower Permian in Zhanyi, Yunnan (Wu Wang-shi et al. , 1988), and is in coexistence with *Polythecalis* of early Early Permian in Laibin, Guangxi. *Eodepingophyllum* is known to occur in the Chuanshan Formation of Jiangsu (Yu Xue-guang, 1980) and the Kangkelin Formation of Baicheng, Xinjiang (Cai Tu-ci, 1986); recently, it also has been found from the Chuanshan Formation of Jiangxi. *Yokoyamaella* was first known to occur in the Lower Permian of Japan, and also has been found from the fusulinid *Pseudoschwagerina* zone of Alps (Heritsch, 1936), the Lower Permian Bingfeng Formation of Batang, Sichuan (Wu Wang-shi et al. , 1979), the Maping Formation of Longlin, Guangxi (Zheng Chun-zi, 1986) and Weining, Guizhou (Wu Wang-shi et al. , 1988). The present horizons containing *Antheria* and *Nephelophyllum* are lower than, while the horizon containing *Yokoyamaella* is higher than those containing other corals in this region.

The characteristics of the *Kepingophyllum* fauna indicate an age probably from late Late Carboniferous to early Early Permian.

The present coral fauna is composed of massive corals, and may be divided into three

types based on the structures of outer wall.

1) Squamo-theca or strata-theca type, such as *Antheria* and *Nephelophyllum*. Their outer walls are composed of some thickened structures to form lamellar cysts, sometimes with irregular hooks. Among them, *Antheria* developed stereocolumella or median plate and septa of two orders, while *Nephelophyllum* developed elementary complex columns and septa of two or three orders (but the tertiary septa are unsteady). The intermediate element between *Antheria* and *Nephelophyllum* is *N. antheriaoides* which developed stereocolumella and elementary complex columns. Both genera account for 28.6% of the total genera in this coral fauna; among them, *Antheria* accounts for 16% of the total species, while *Nephelophyllum* for 4.5%.

2) Brambly-theca type, such as *Kepingophyllum*, *Eokepingophyllum* and *Prokepingophyllum*. Their outer walls are composed of brambly or hooked thecae which had evolved from the outer part of septa. In axial structures, *Kepingophyllum* developed complex columns, while *Eokepingophyllum* developed elementary complex columns and *Prokepingophyllum* usually developed no columns, but they all developed more or less tertiary septa. The intermediate element between *Prokepingophyllum* and *Eokepingophyllum* is *P. eocolumellatum* which developed elementary complex columns in some corallites; the intermediate element between *Kepingophyllum* and *Eokepingophyllum* is *E. difforme* which developed elementary and complex columns in some corallites. These three genera account for 42.8% of the total genera in this coral fauna. Among them, *Prokepingophyllum* and *Eokepingophyllum* each account for 16% of the total species, while *Kepingophyllum* for 11%. Based on axial development, *Eokepingophyllum* might have evolved from *Prokepingophyllum*, and *Kepingophyllum* from *eokepingophyllum*, their evolutionary relationship may be indicated as *Prokepingophyllum* → *Eokepingophyllum* → *Kepingophyllum*.

All these massive corals developed more or less peripheral cysts zones as breeding places for buds; sometimes produced in the hermaphroditism were larvae which grew and bred alone after leaving the adult corallites.

Based on the complex structures of the densely interjoint skeleton in morphology it can be seen that the *Kepingophyllum* coral fauna inhabited in an ecological environment of slightly shallow water with high energy.

Family Kepingophyllidea Wu et Zhou, 1982

Genus *Antheria* Wu et Zhou, 1974

Type species *Antheria polygonalis* Wu et Zhou, 1982

Diagnosis Corallum compound and massive. Outer wall composed of squamous lamellae sometimes with some brambles. Septa of two orders. Cystosepimentarium developed. Stereocolumella fusiform or lamellar in shape. Tabulae slightly horizontal or inclining toward the axle.

Remarks In the structures of outer walls of corallites, this genus is very similar to *Nephelophyllum*, but the latter bears syncolumella or stereocolumella and has developed some embryonic form tertiary septa.

Distribution and geological range Guizhou, Sichuan, Guangxi, Yunnan and Nei Monggol; Late Carboniferous to Early Permian.

***Antheria naotica* sp. nov.**

(Pl. I, figs. 3a, b; Text-fig. 3)

Diagnosis Naotic septa slightly developed.

Description Corallum compound and massive, composed of numerous tetragonal to pentagonal corallites measuring 6—8 mm in diameter. Outer walls composed of numerous slightly thickened and loosely arranged squamous lamellae with some oblique brambles to form beads in shape. Cystosepimentarium composed of cysts unequal in size and width. Dissepiments in herringbone or concentricity. Septa of two orders, (15—18) + (15—18) in number, thickened, sometimes forming naotic septa in shape; major septa longer, with one of them extending to the stereocolumella; minor septa about $1/3 - 1/2$ as long as major ones. Stereocolumella in the shape of spindle or twig, measuring (1—2 mm) \times (0.2—0.5 mm) in longitudinal and transverse diameters.

In longitudinal section, squamous lamellae thickened to form smaller cysts. Tabulae inclining toward the stereocolumella, with 5—7 of them occupying a space of 3 mm.

Remarks In the structures of outer walls, the present form is closely similar to *Antheria magna* Wu et Kong, 1982, but in the latter, the corallites are larger, the dissepiments are numerous and the naotic septa are less developed.

Horizon and locality *Sphaeroschwagerina glomerose* subzone, Dachaigou Formation; Sijiaoyanggou of Wuertumeiren township, Golmud city, Qinghai province.

***Antheria rara* sp. nov.**

(Pl. I, figs. 2a, b; Text-fig. 4)

Diagnosis Outer walls and stereocolumella less developed.

Description Corallum compound and massive, composed of corallites unequal in shape and measuring 8—10 mm in diameter. Outer walls composed of some thinner squamous lamellae or absent. Septa of two orders, about (13—16) + (13—16) in number, slightly thickened and flexuous with one of the major septa extending to the center; minor septa about $1/3 - 1/2$ as long as major ones. Cystosepimentarium very narrow, composed of flexuous cysts. Dissepimentariums subequally as long as minor ones, composed of loosely arranged concentric or herringbone dissepiments. Axle composed of a thinned plate or absent.

In longitudinal section, squamous lamellae of outer walls forming irregular horseshoe-

shaped cysts. Tabulae complete and inclining toward the axle, or incomplete and alternating to form a tub-shape with 6—7 of them in a space of 3 mm.

Remarks This species is characterized by the rare outer walls and stereocolumella. These features serve to distinguish it from any other species of the same genus as mentioned above.

Horizon and locality From the same horizon as the preceding species; Niukete of Wuertumeiren township, Golmud city, Qinghai Province.

***Nephelophyllum antheriaoides* sp. nov.**

(Pl. I, figs. 1a—c; Text-fig. 5)

Description Axes variable. Corallum compound and massive, composed of irregularly tetragonal-pentagonal corallites measuring 6—9 mm in diameter. Outer walls complete, measuring 1.5 mm in thickness, composed of numerous smaller and denser squamous lamellae. Septa of two or three orders, flexuous and slightly thickened, sometimes split in cystosepimentarium, (14—18) + (14—18) in number, fibronormal in fine skeletal structure; major septa extending to or connected with the axes; minor septa about $1/2$ — $2/3$ as long as the major ones; embryo tertiary ones sometimes developed. Cystosepimentarium narrow, incomplete, composed of cysts irregular in shape and in size. Dissepiments irregularly inclining or in herringbone. Axes composed of a flat or spindle median plate, measuring $(1.3\text{--}2\text{ mm}) \times (0.2\text{--}0.6\text{ mm})$ in longitudinal and transverse diameters.

In longitudinal section, outer walls composed of smaller interwoven vesicles. Cystosepimentarium composed of 4—7 rows of unequal cysts inclining inwards. Tabulae complete or incomplete, inclining toward the axes, with 4—5 of them in 3 mm.

Remarks In the character of axes and outer walls, the present form is similar to *Nephelophyllum simplex* Wu et Zhao 1974, but the latter has mostly vanished outer walls, less numerous septa (with minor ones less developed) and regular cysts.

Horizon and locality From the same horizon as the preceding species; Dachaigou of Wuertumeiren township, Golmud city, Qinghai province.

***Kepingophyllum curvatum* sp. nov.**

(Pl. V, figs. 2a, b)

Diagnosis Median plate, radial lamellae and tabellae all curved.

Description Corallum compound and massive, composed of irregularly polygonal corallites measuring 8—12 mm in diameter. Outer walls composed of thickened or thinned brambly lamellae; thickened lamellae measuring $(0.3\text{--}0.4) \times (0.6\text{--}1)$ in longitudinal and transverse diameters, while thinned ones forming irregularly hook-shaped structure. Septa of two or three orders, thickened or thinned, with their outer part connecting brambly lamellae or merging into cystosepimentarium; major septa 16—20 in number, with their

ends not connecting axial structure; minor and tertiary septa about $2/3$ and $1/5 - 1/4$ as long as major ones. Cystosepimentarium developed, unequal in width, composed of irregular and incomplete cysts with septal crests. Dissepiments in concentricity. Axle composed of all flexuous median plates, radial lamellae and tabellae to form meandrine syncolumella with enclosing wall, measuring $(1 - 1.5\text{mm}) \times (2 - 2.5\text{mm})$ in longitudinal and transverse diameters.

In longitudinal section, cystosepimentarium composed of cysts which are horizontal or slightly inclining inwards with thickened or thinned septal crests to form stratiform. Clino-tabulae developed and steeply inclined; transverse tabulae narrow and slightly horizontal, with 8—9 of them in 3mm.

Remarks In the number of septa, the development of tertiary septa and the character of enclosing wall, the species is similar to *Kepingophyllum polythecaloides* Wu, 1979, but the latter is characterized by all the equally thickened outer walls, septa and cysts and by the slightly straight median plate, radial lamellae and tabellae.

Horizon and locality Same as the preceding species.

***Kepingophyllum proliferum* sp. nov.**

(Pl. V, figs. 1a—c)

Diagnosis Some larvas developed simultaneously in cystosepimentarium of corallites, while some brambly-thecae loosely arranged.

Description Corallites compound and massive, composed of polygonal or incomplete annular corallites measuring 8—9 mm in diameter. In some larvas measuring 3—4 mm in diameter, brambly-thecae loosely or densely arranged, sometimes absent; boundary between septal zone and cystosepimentarium distinct. Septal zone measuring 2—2.5 mm in diameter, with septa $(10 - 12) + (10 - 12)$ in number; major septa slightly shorter while minor septa about $1/2$ as long as major ones. Cystosepimentarium developed, composed of a few cysts with a few septal crests; dissepiments very few; axle composed of very simplex, complete or incomplete median plates and slightly ringlike tabellae, sometimes with only one thickened median plate, measuring $1/5$ as wide as the septal zone.

In adult corallites, boundary between septal zone and cystosepimentarium slightly distinct; septal zone measuring 3—4 mm in diameter. Septa of two or three orders, slightly thickened and straight, with outer ends sometimes connecting brambles or merging into cystosepimentarium; major septa 16—18 in number, disconnected with axle at inner ends; minor septa about $1/2 - 2/3$ as long as major ones. Cystosepimentarium with a width of $1/3$ the radius of corallites, composed of cysts in about unequal shape and size, and bearing a few septal crests; dissepimentariums subequally as long as minor ones, composed of concentric dissepiments; syncolumella composed of slightly flexuous median plates, a few radial lamellae and 2—3 rows of ringlike tabellae, forming an elliptical outline and measur-

ing $(1-1.5\text{mm}) \times (0.8-1\text{mm})$ in longitudinal and transverse diameters.

In longitudinal section, tabulae horizontal and slightly inclining inwards, with about 9 of them occupying a space of 3 mm.

Remarks In the feature of outer walls, size of corallites, number of septa and character of syncolumella, the new species is very similar to *Kepingophyllum provectum* X. Yu, 1980, but in the former the several larvae are developed simultaneously in the cystosepimentarium of corallites, and the syncolumellae of adult corallites are smaller.

Horizon and locality From the same horizon as the preceding species; Sijiaoyanggou. Dachaigou and Niukete of Wuertumeiren township, Golmud city, Qinghai Province.

Anfractophyllum perfectum sp. nov.

(Pl. IV, figs. 3a, b)

Diagnosis Description Corallum compound and massive, composed of pentagonal to hexagonal corallites measuring 6.5—10 mm in diameter. Outer walls mostly complete, composed of straight, dense and thickened brambles. Boundary between septal zone and cystosepimentarium indistinct. Septal zone measuring 3—5 mm in diameter. Septa of three orders, slightly thickened, straight; outer ends mostly merging into cystosepimentarium, with some connecting brambles; major septa longer, extending to the peripheral of axle, sometimes with one of them conjoining the axle; minor septa unequal in length, or unsteady in development. Syncolumella fusiform, thickened, composed of straight or flexuous median plates, a few radial lamellae and 1—4 rows of ringlike tabellae, measuring $(1.5-1.8\text{mm}) \times (0.7-1.2\text{mm})$ in longitudinal and transverse diameters. Cystosepimentarium composed of smaller and medium-sized cysts with septal crests. Dissepimentarium in concentricity, densely arranged.

In longitudinal section, clinotabulae less numerous; tabulae complete and inclining inwards or anastomosed, forming a tub-like shape, with 10—12 of them occupying a space of 3 mm.

Remarks In the complete corallites, this species is similar to *Anfractophyllum regulare* Wu et Zhou, 1982, but the latter has three types of corallites: 1) complete corallites with outer ends of septa connecting brambles; 2) those with developed peripheral cysts and 3) those with outer walls partly or wholly absent.

Horizon and locality From the same horizon as the preceding species; Niukete of Wuertumeiren township, Golmud city, Qinghai Province.

Anfractophyllum lytintortum sp. nov.

(Pl. IV, figs. 2a, b)

Diagnosis Cysts larger.

Description Corallum compound and massive, composed of incomplete polygonal

corallites measuring 10—12 mm in diameter. Outer walls composed of thickened, straight brambles with smaller pricks. Boundary between septal zone and cystosepimentarium distinct. Septal zone measuring 4 mm in diameter. Septa of three orders, with outer ends connecting brambles or discontinuously extending to cystosepimentarium; major septa extending to peripheral part of axle, usually thinned, partly thickened; minor septa about $1/2-2/3$ as long as major ones; tertiary septa partly developed, about $2/3$ as long as minor ones. Cystosepimentarium composed of medium-sized cysts, a few larger cysts, with septal crests. Syncolumella elliptical, composed of slightly straight or flexuous median plates, a few radial lamellae and 2—3 rows of ringlike or arched tabellae, measuring $(1.2-1.3\text{ mm}) \times (0.5-0.8\text{ mm})$ in longitudinal and transverse diameters.

In longitudinal section, clinotabulae rarely developed; tabulae complete, horizontal or incomplete, anastomosed or slightly inclining toward axle, with 9—10 of them occupying a space of 3 mm.

Remarks In size of corallites, number of septa and character of syncolumella, this species is similar to *Anfractophyllum intortum* Wu et Zhou, but in the latter, the outer walls are mostly absent and the tabulae are densely arranged.

Horizon and locality From the same horizon as the preceding species; Dachaigou of Wuertumeiren township, Golmud city, Qinghai province.

***Anfractophyllum grossum* sp. nov.**

(Pl. VI, figs. 1a, b; Text-fig. 6)

Diagnosis Brambles thickened.

Description Corallum compound and massive, composed of irregularly angular, rounded, or tetragonal-pentagonal corallites measuring 7—9 mm in diameter. Outer walls composed of thickened brambles with perfectly rounded ends and densely arranged, sometimes absent. Septa of two orders, $(14-15) + (14-15)$ in number, thickened, with outer part connecting brambles or obstructed by cysts; major septa longer, almost connected with syncolumella, while minor septa about $1/2-2/3$ as long as major ones. Cystosepimentarium composed of larger, irregular arched cysts with septal crests. Dissepimentarium composed of concentric or irregular inclining dissepiments. Syncolumella smaller and simplex, composed of a few radial lamellae, tabellae and median plates, measuring not more than 1 mm in diameter.

In longitudinal section, clinotabulae vesicle-like; tabulae horizontal (a few anastomosed), with 9—10 of them occupying a space of 3 mm.

Remarks In the character of syncolumella, this species may be assigned to *Eokepinophyllum*, but in the latter, the brambles or pricks are loosely arranged. In the regular corallites, this species may be compared with *Anfractophyllum regulare* Wu et Zhou, 1982, but in the latter, the skeletons are less thickened and the syncolumellae are smaller.

Horizon and Locality Same as the preceding species.

***Eokepingophyllum difforme* sp. nov.**

(Pl. IV, figs. 1a—c)

Diagnosis Syncolumellae developed unsteadily.

Description Corallum compound and massive, composed of irregularly polygonal corallites measuring 2.7—3.5 mm in diameter. Outer walls composed of brambles which are thickened, straight and densely arranged or thinned and loosely arranged. Septa of three orders, slightly thickened, outer part sometimes obstructed by cysts, interrupted, extending to cystosepimentarium; major septa 16—18 in number, extending to , but not connected with the axle; minor septa about $1\frac{1}{2}$ — $2\frac{2}{3}$ as long as major ones; tertiary septa unequal in length. Cystosepimentarium unequal in width; cysts irregular with a few septal crests. Dissepimentarium composed of concentric or irregular inclining dissepiments. Axle including three type , with Type 1 composed of indistinct median plates, very few radial lamellae and irregular ringlike or vesicle-like tabellae to form very simplex syncolumella measuring less than 1 mm in diameter; Type 2 composed of a major septum extending to the center to form lamellar stereocolumella and Type 3, in which no central column was developed.

In longitudinal section, clinotabulae developed, tabulae inclining inwards, with 4—5 of them occupying a space of 3 mm.

Remarks In the thickening and arrangement of brambles, this species may be assigned to *Anfractophyllum*, but in the latter, the brambles are densely arranged and the axle is developed steadily. It may be compared with *Kepingophyllum*, but in the latter, the brambles are loosely arranged and the syncolumellae are well developed.

In the unsteadily developed central column, it may be compared with *Eokepingophyllum simplex* X. Yu, 1980, but in the latter, the brambles are irregular, loose and the central column is developed and slightly steadfast.

Horizon and locality From the same horizon as the preceding species; Dachaigou and Sijiaoyanggou of Wuerumeiren township, Golmud city, Qinghai Province.

***Eokepingophyllum delicalum* sp. nov.**

(Pl. II, figs. 3a, b)

Diagnosis Brambles and pricks thinned.

Description Corallum compound and massive, composed of tetragonal to pentagonal corallites measuring 5—7 mm in diameter. Outer walls composed of thinned brambles and pricks in regular arrangement. Septa of two or three orders, slightly thickened; major septa 14—16 in number, extending to the axial area or not; minor septa about $1\frac{1}{2}$ — $2\frac{2}{3}$ as long as major ones. Cystosepimentarium composed of cysts unequal in size with a few septa crests. Dissepimentarium composed of concentric or irregular inclining dissepiments. Syn-

columella composed of median plate, radial lamellae and 2—3 rows of tabellae, or with only a median plate, measuring not more than 0.7 mm in diameter.

In longitudinal section, clinotabulae developed; tabulae complete, anastomosed and inclining inwards to form a tub-shape with 8—9 of them occupying a space of 3 mm.

Remarks In the development of central column, this species is very similar to *Eokepingophyllum* sp. nov., but in the latter, the corallites are larger, and irregular in diameter, the brambles and septa are thickened, and the cystosepimentarium is wider.

Horizon and Locality from the same horizon as the preceding species; Niukete and Sijaoyanggou of Wuertumeiren township, Golmud city, Qinghai province.

Genus *Prokepingophyllum* gen. nov.

Type species *Prokepingophyllum typicum* gen. et sp. nov.

Diagnosis Corallum compound and massive, composed of polygonal corallites. Outer walls composed of brambles or pricks, usually loosely arranged. Septa of two or three orders. Cystosepimentarium developed. Central column usually absent or occasionally appearing as a median plate connected with a major septum. Tabulae inclining toward axle to form a tub-shape.

Remarks In the character of outer walls, this genus is similar to *Kepingophyllum*, but the latter has developed a complex central column. It is also similar to *Eokepingophyllum*, but the latter has developed a simplex central column or with only a median plate.

Occurrence Late Late Carboniferous to early Early Permian; Qinghai, China.

***Prokepingophyllum typicum* gen. et sp. nov.**

(Pl. I, figs. 3a—c; Text-fig. 7)

Diagnosis Brambles loosely arranged; central column absent.

Description Corallum compound and massive, composed of polygonal corallites. Distance between centers of two adjacent corallites about 5—7 mm. Outer walls composed of looser brambles with thickened pricks. Septa of two and three orders, thickened, tapering gradually toward center, fibronormal in fine skeletal structure, with outer parts connecting brambles or extending interruptedly to cystosepimentarium; major septa 12—15 in number, with a length of about $\frac{2}{3}$ the radius of corallites; minor septa about $\frac{1}{2}$ — $\frac{2}{3}$ as long as major ones; tertiary septa partly developed and unequal in length. Cystosepimentarium narrow, composed of cysts unequal in size and shape with septal crests. Dissepimentarium composed of irregular dissepiments. Central column all absent.

In longitudinal section, clinotabulae less developed; tabulae developed, complete, anastomosed and inclining toward axle to form a tub-shape, with 5—6 of them occupying a space of 3 mm.

Horizon and locality From the same horizon as the preceding species; southern Shuangshi Gorge of Mangya town, Qinghai Province.

***Prokepingophyllum eocolumellatum* gen. et sp. nov.**

(Pl. I, figs. 2a—c; Text-fig. 8)

Diagnosis Central column less developed.

Description Corallum compound and massive, composed of tetragonal to hexagonal corallites. Distance between centers of two adjacent corallites about 4.5—6.5 mm. Outer walls composed of thickened brambles and thinned pricks to form a network. Boundary between septal zone and cystosepimentarium slightly distinct. Septa of two or three orders; majou septa 13—16 in number, with their ends perfectly round, usually not or rarely extending to the central area to form a median plate; minor septa about $1/3$ — $1/2$ as long as major ones. Cystosepimentarium with a width of about $1/2$ the radius of corallites, composed of cysts unequal in size and shape with a few septal crests. Dissepimentarium composed of a few concentric dissepiments. Central column usually absent but sometimes developed with very simplex median plate and a row of tabellae in a few corallites.

In longitudinal section, cystosepimentarium composed of 2—5 rows of inclining cysts closely arranged. Tabulae complete and anastomosed, inclining toward the axle to form a tub-shape, with 19—20 of them occupying a space of 3 mm. Tabellae arched.

Remarks This species may be compared with *Prokepingophyllum typicum*, but in the latter, the central column is absent, the brambles, pricks and septa are all thickened, and the tabulae are less numerous.

Horizon and locality From the same horizon as the preceding species; Niukete of Wuertumeiren township, Golmud city, Qinghai province.

***Prokepingophyllum minor* gen. et sp. nov.**

(Pl. I, figs. 1a, b)

Diagnosis Corallites smaller. Distance between centers of two adjacent corallites about 3.5—4.5 mm.

Description Corallum compound and massive, composed of irregularly tetragonal-pentagonal corallites. Distance between centers of two adjacent corallites about 3.5—4.5 mm. Outer walls composed of slightly thickened pricks loosely arranged. Boundary between septal zone and cystosepimentarium indistinct. Septa of two orders, thinned and flexuous, (12—14) + (12—14) in number; major septa extending to the axial area but not to the center; minor septa about $1/2$ — $2/3$ as long as major ones. Cystosepimentarium narrow, composed of irregular cysts with a few septal crests. Dissepimentarium composed of concentric and inclining dissepiments. Central column absent.

In longitudinal section, cystosepimentarium composed of 1—3 rows of inclining cysts.

Clinotabulae less developed. Tabulae sagging, with 9—10 of them occupying a space of 3 mm.

Remarks This species may be compared with *Prokepingophyllum typicum*, but in the latter, the corallites are larger and the septa thickened. It may be compared with *Prokepingophyllum eocolumellatum*, but in the latter, the elementary complex column is less developed.

Horizon and locality From the same horizon as the preceding species; Dachaigou of Wuertumeiren township, Golmud city, Qinghai Province.

***Yokoyamaella multiseptata* sp. nov.**

(Pl. VI, figs. 4a, b)

Diagnosis Outer walls composed of septa which are strongly dilated, forming fusiform septal-thecae in outer parts.

Description Corallum compound and massive, composed of tetragonal to pentagonal corallites measuring 7—10 mm in diameter. Outer walls composed of septa which are strongly dilated, forming fusiform septal-thecae in outer parts, measuring 1 mm in thickness, with their ends connecting septal-thecae or obstructed by cysts; major septa extending to the peripheral part of syncolumella; minor septa about 2/3 as long as major ones; tertiary septa partly developed. Cystosepimentarium developed unsteadily, composed of cysts unequal in size. Dissepiments in concentricity. Syncolumella elliptical, thickened, measuring 1.5—2 mm in diameter, composed of fine, longer median plate, 6—8 rows of radial lamellae and 2—3 rows of tabellae, forming a cobweb-shape with enclosing walls.

In longitudinal section, clinotabulae less developed. Tabulae anastomosed and inclining toward axle to form a tub-shape, with 9—10 of them occupying a space of 3 mm.

Remarks In the character of outer walls, this species is similar to *Yokoyamaella yokoyamai* (Ozawa), 1925, but in the latter, the septa are less numerous, less thinned and the tertiary septa not developed. It is also similar to *Yokoyamaella dulanense* (Li et Liao, 1979), but in the latter, the septal-thecae are thinned and the corallites are unequal in diameter.

Horizon and locality From the same horizon as the preceding species; Sijiaoyanggou of Wuertumeiren township, Golmud city, Qinghai Province.

图 版 说 明

薄片保存在中国科学院南京地质古生物研究所,层位为打柴沟组 *Sphaeroschwagerina glomerose* 亚带。说明中斜线上方为标本采集号,下方为登记号。

图 版 I

1a—c. *Nephelophyllum antheriaoides* sp. nov.

1a, c. 横切面; 1b. 纵切面, $\times 2.5$, holotype. 81QP-VF-25-8/105693, 105694. 青海格尔木市乌图美仁乡打柴沟。

2a, b. *Antheria rara* sp. nov.

2a. 横切面; 2b. 纵切面, $\times 3$, holotype. 81QP-1-F-21-3/105695, 105696. 青海格尔木市乌图美仁乡牛克特。

3a, b. *Antheria naotica* sp. nov.

3a. 横切面; 3b. 纵切面; $\times 3$, holotype. 81QP-V-F-25-8/105697, 105698. 青海格尔木市乌图美仁乡四角羊沟。

图版 I

1a, b. *Antheria naotica* sp. nov.

1a. 横切面; 1b. 纵切面, paratype. 81-QP-V-F-25-9/105699, 105700. 青海格尔木市乌图美仁乡四角羊沟。

2a-c. *Antheria polygonalis* Wu et Zhao

2a, b. 横切面; 2c. 纵切面; $\times 2.5$. 81QP-N-F-3-2/105701, 105702. 产地同前种。

3a-c. *Prokepingophyllum typicum* gen. et sp. nov.

3a. 横切面; 3b. 纵切面; $\times 3$; 3c. 外壁局部放大, $\times 20$; holotype. 80-QP-X-K-F-2/105703, 105704. 青海茫崖镇双石峡南。

图版 II

1a, b. *Prokepingophyllum minor* gen. et sp. nov.

1a. 横切面; 1b. 纵切面; $\times 3$, holotype. 80-QP-V-F-36-2/105705, 105706. 青海格尔木市乌图美仁乡打柴沟。

2a-c. *Prokepingophyllum eocolumellatum* gen. et sp. nov.

2a, b. 横切面; 2c. 纵切面; $\times 3$, holotype. 81-QP-N-F-5-5/105707, 105708. 青海格尔木市乌图美仁乡牛克特。

3a, b. *Eokepingophyllum delicatum* sp. nov.

3a. 横切面; 3b. 纵切面; $\times 2.5$, holotype. 80-QP-I-F-4-3/105709, 105710. 青海格尔木市乌图美仁乡四角羊沟。

4. *Eokepingophyllum simplex* X. Yu

横切面, $\times 3$, 81-QP-N-F-2-2/105711. 产地同前种。

图版 III

1a-c. *Eokepingophyllum difforme* sp. nov.

1a, c. 横切面; 1b. 纵切面; $\times 3$, holotype. 81-QP-N-F-6-2/105712, 105713. 青海格尔木市乌图美仁乡四角羊沟。

2a, b. *Anfractophyllum lyntortum* sp. nov.

2a. 横切面; 2b. 纵切面; $\times 3$, holotype. 81-QP-V-F-36-1/105714, 105715. 青海格尔木市乌图美仁乡打柴沟。

3a, b. *Anfractophyllum perfectum* sp. nov.

3a. 横切面; 3b. 纵切面; $\times 3$, holotype. 81-QP-I-F-23-2/105716, 105717. 青海格尔木市乌图美仁乡牛克特。

图版 IV

1a-c. *Kepingophyllum proliferum* sp. nov.

1a. 横切面; 1b, c. 纵切面; $\times 3$, holotype. 81-QP-N-F-5-5/105718, 105719. 青海格尔木市乌图美仁乡四角羊沟、打柴沟、牛克特。

2a, b. *Kepingophyllum curvatum* sp. nov.

2a. 横切面; 2b. 纵切面; $\times 3$, holotype. 81-QP-V-F-30-3/105720, 105721. 青海格尔木市乌图美仁乡打柴沟。

3a, b. *Anfractophyllum facetum minor* Wu et Zhou

3a. 横切面; 3b. 纵切面; $\times 3$. 81-QP-V-F-36-1/105722, 105723. 产地同前种。

图版 V

1a, b. *Anfractophyllum grossum* sp. nov.

1a. 横切面; 1b. 纵切面; $\times 3$, holotype. 81-QP-V-F-30-3/105724, 105725. 青海格尔木市乌图美仁乡打柴沟。

2a, b. *Anfractophyllum dupliforme* Wu et Zhou

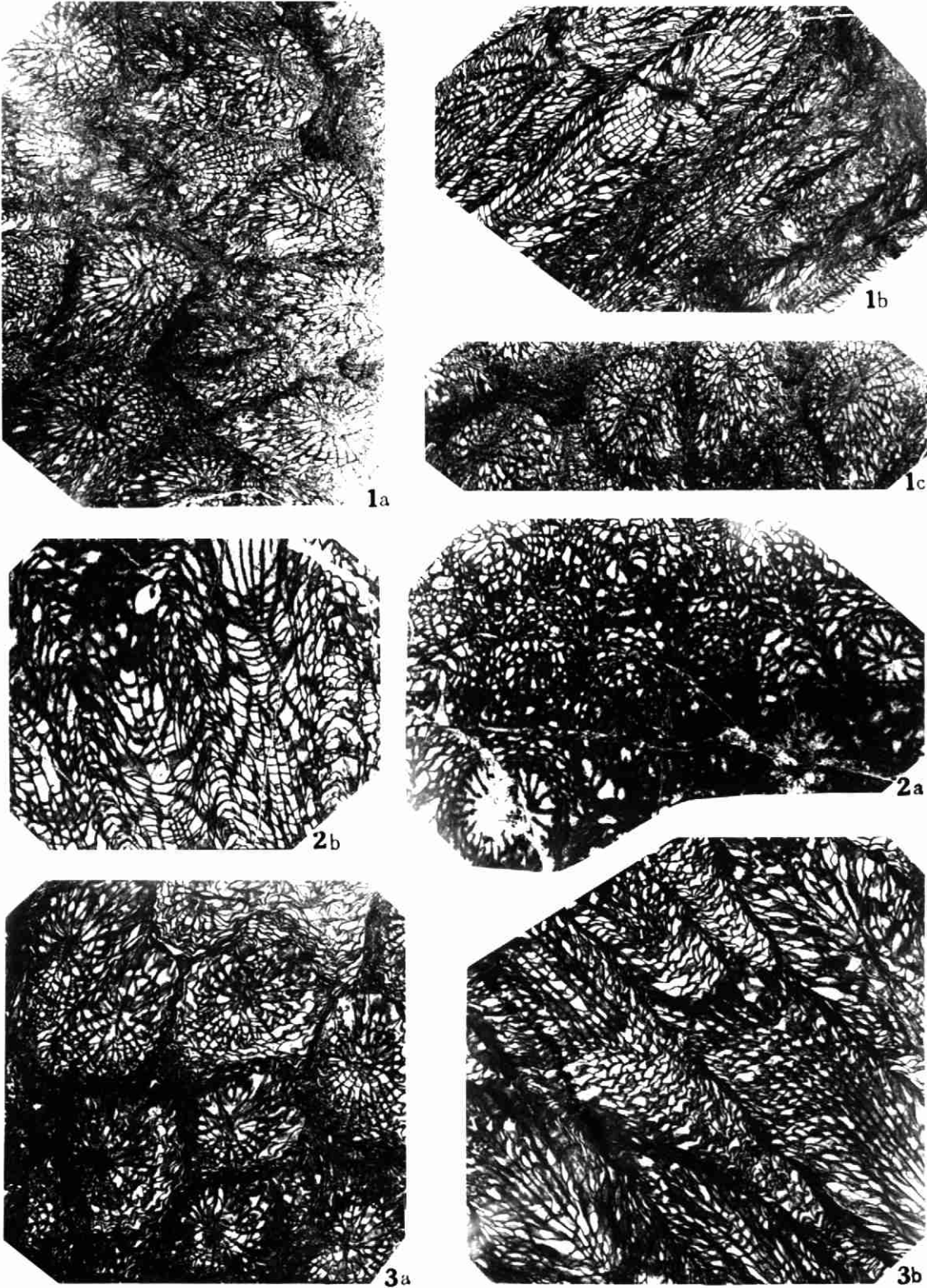
2a. 横切面; 2b. 纵切面; $\times 3$. 81-QP-I-F-22-6/105726, 105727. 青海格尔木市乌图美仁乡牛克特。

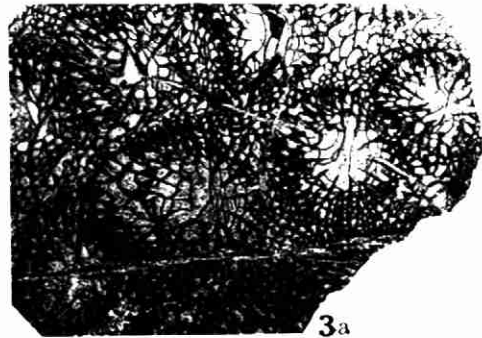
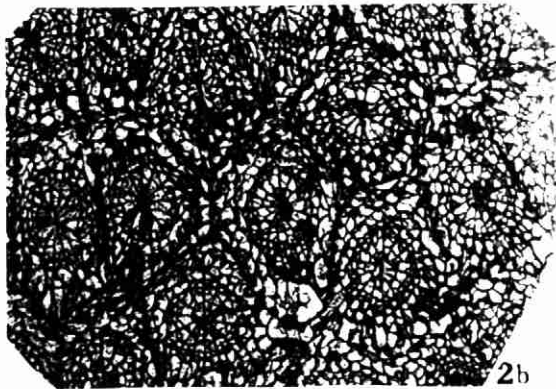
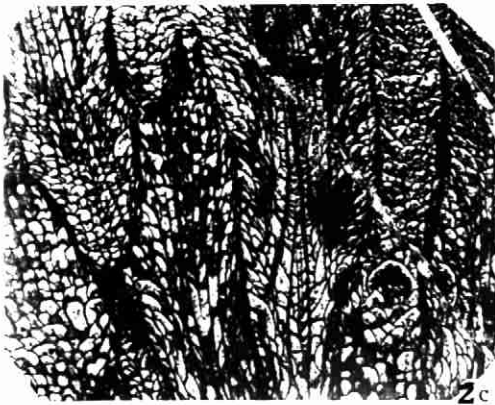
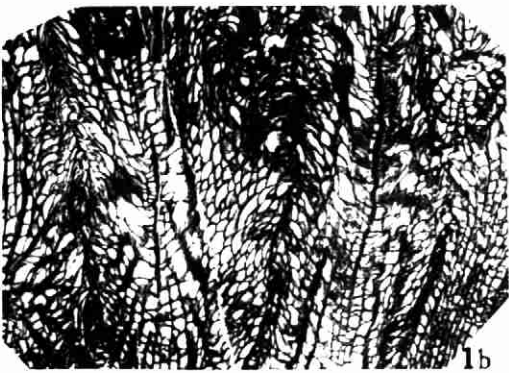
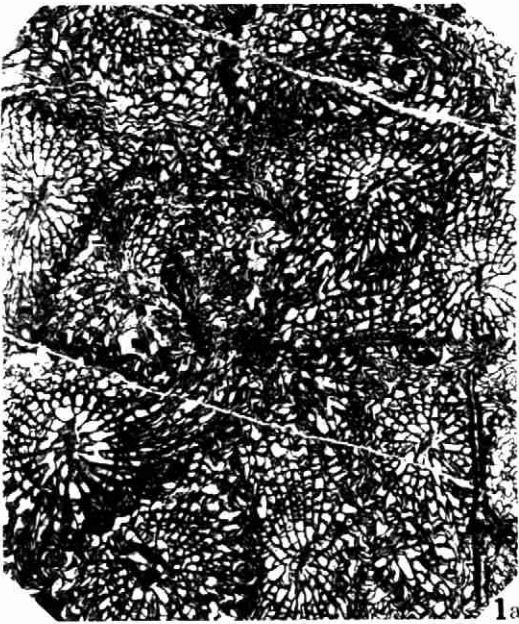
3a, b. *Anfractophyllum facetum* Wu et Zhou

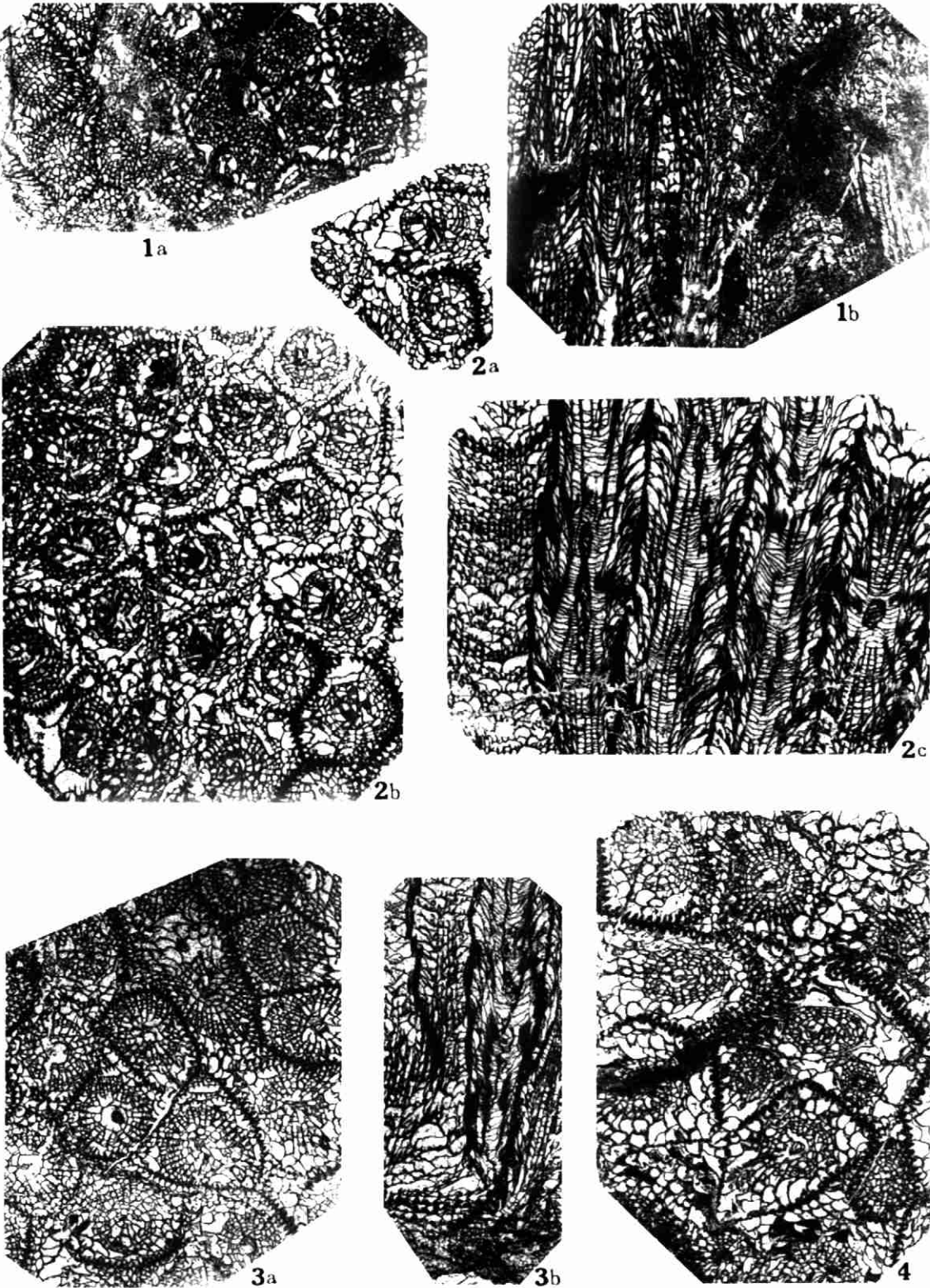
3a. 横切面; 3b. 纵切面; $\times 3$. 81-QP-M-F-6-1/105728, 105729. 青海格尔木市乌图美仁乡四角羊沟、打柴沟、牛克特。

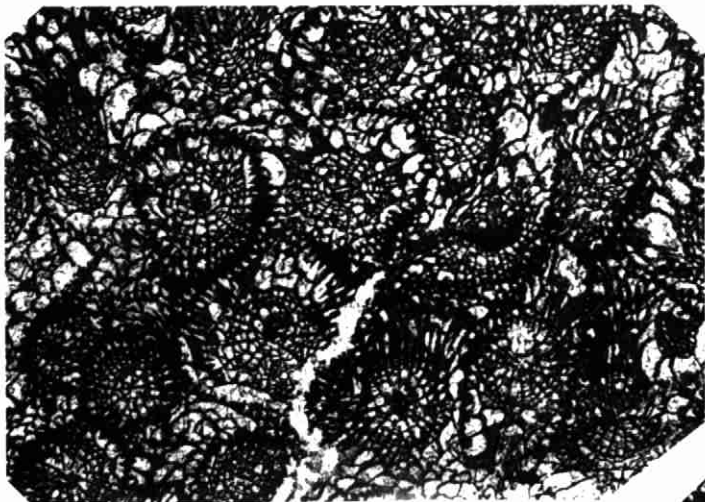
4a, b. *Yokoyamaella multiseptata* sp. nov.

4a. 横切面; 4b. 纵切面; $\times 2$, holotype. 81-QP-N-F-5-4/105730, 105731. 青海格尔木市乌图美仁乡四角羊沟。









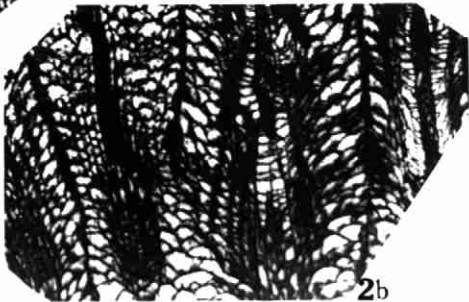
1a



1b



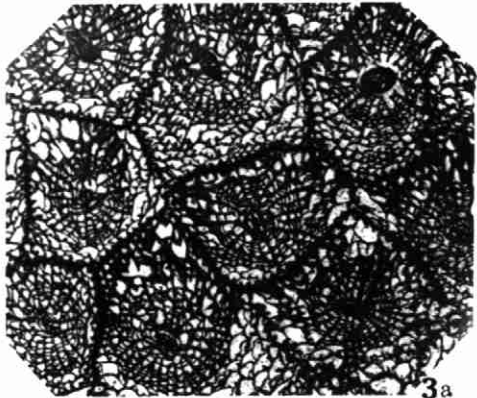
2a



2b



1c



3a



3b

