

广西六景和刘家早泥盆世介形类中华豆石介族^{*}

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内 容 提 要

报道广西六景和隆安刘家早泥盆世中华豆石介族 1 属、1 亚属和 20 种, 其中包括 9 新种和 7 未定种。根据统计, 莲花山组的中华豆石介族下垂“V”字型肌痕与闭壳肌痕的垂直高度之比值约为 0.70, 而那高岭组的中华豆石介族下垂“V”字型肌痕与闭壳肌痕的垂直高度之比值约为 0.74。通过对中华豆石介族, 特别是肌痕的研究认为, 莲花山组可与云南曲靖西屯组对比, 归晚洛霍柯夫期。

关键词 中华豆石介族 早泥盆世 广西

1 前言

介形类中华豆石介族(*Sinoleperditini*)的系统发育和肌痕的演变, 通过近来的研究已初步揭示(王尚启, 1994), 但仍缺少布拉格期(Pragian)的中华豆石介族及其肌痕资料。为了弄清此时代的面貌特征, 特别是肌痕的演变, 1994年11月, 笔者与广西壮族自治区地质研究所吴诒和邝国敦一起考察了3条剖面, 其中在六景剖面的莲花山组、那高岭组和莫丁组以及隆安县刘家上巴剖面那高岭组采到了不少中华豆石介族的标本。这些标本均为内核且不同程度地受到挤压变形或破损。经研究, 初步划分出1属、1亚属和20种, 包括9新种和7未定种。其中7种产自莲花山组, 12种产自那高岭组, 1种产自莫丁组。除莫丁组的未见到肌痕外, 其余均保存有闭壳肌痕和下垂“V”字型肌痕。此前, 孙全英(关绍曾等, 1978)虽也曾报道过那高岭组的2种中华豆石介族类, 但无肌痕描述。本文对华南泥盆纪布拉格期中华豆石介族及其肌痕的研究, 为本族的系统发育和演化, 特别是下垂“V”字型肌痕的演变提供了重要的线索, 也为华南泥盆纪滨海相地层的划分、对比提供了可靠的生物依据。文中还就莲花山组的对比及地质时代进行了探讨。

文中图影由宋之耀摄制, 图件由任玉皋清绘, 在此一并致谢。

2 地层简介及中华豆石介族动物群分析

广西六景莲花山组总厚约 334m, 不整合于寒武系砂页岩之上(插图 1)。邝国敦等(1984)和钟铿等(1992)根据岩性将本组划分成 3 段或 3 部分, 即下段由灰、灰白色中厚层石

英砂岩组成;中段为紫红色页岩、泥质粉砂岩夹薄层细砂岩及泥晶灰岩、白云质灰岩;上段以紫红色泥质粉砂岩夹具交错层的灰绿色薄层细砂岩为特征。属潮间带沉积(统称滨海相)。中华豆石介族自下段第 4 层开始出现直到上段的顶部均有发现。第 4 层样品采集较多。虽标本全为内核且受挤压变形或破损,但肌痕常保存较佳。其余层位样品采集量不足,肌痕保存较差。经鉴定,第 4 层产中华豆石介族 6 种: *Sinoleperditia* (*Sinoleperditia*) cf. *subbrevis* Wang, *S.* (*S.*) *yulinensis* Wang, *S.* (*S.*) *subelliptica* sp. nov., *S.* (*S.*) *liujingensis* sp. nov., *S.* (*S.*) cf. *brevis* Wang et Liu, *S.* (*S.*) sp. 3; 第 9 层产 *S.* (*S.*) sp. 8 和 *S.* (*S.*) spp.; 第 11 层产 *S.* (*S.*) spp.。

那高岭组,在六景剖面上厚约 147m,与下伏莲花山组呈整合接触。邝国敦等(1989)根据岩性将它划为 2 段(插图 1),下段,即高岭段,主要由含磷灰绿色泥质粉砂岩和深灰色生物灰岩组成;上段,即蚂蟥岭段,主要为灰黄、灰绿色泥岩、粉砂质泥岩和泥质粉砂岩。属浅海潮下泥坪(统称滨海碎屑岩相)。在此剖面的那高岭组中,中华豆石介族十分贫乏,只在第 14 层发现个别标本。

在隆安县刘家上巴剖面上(插图 2),那高岭组未作底界追索。根据岩性,也可大致划分为 2 段,下段主要为黄绿色、砖红色、紫红色钙质泥岩夹泥质粉砂岩和浅灰色泥灰岩;上段则主要为浅灰绿色、浅黄绿色、浅红色泥质粉砂岩、粉砂质泥岩,顶部出现黄白色石英细砂岩及粉砂岩。此处的那高岭组与六景的那高岭组一样,同属潮下(近滨)沉积。中华豆石介族标本主要产自第 2 层紫红色泥岩,标本保存为内核,个体相当丰富。经鉴定,初步划分出 12 种: *Sinoleperditia* (*Sinoleperditia*) *anteracuta* sp. nov., *S.* (*S.*) *lata* sp. nov., *S.* (*S.*) *lemboda* sp. nov., *S.* (*S.*) *liujiensis* sp. nov., *S.* (*S.*) sp. 5, *S.* (*S.*) sp. 4, *S.* (*S.*) *posteroconvexa* sp. nov., *S.* (*S.*) cf. *longanensis* (Sun), *S.* (*S.*) *angustata* sp. nov., *S.* (*S.*) sp. 6, *S.* (*S.*) *brachyovata* sp. nov., *S.* (*S.*) sp. 7。

在六景剖面上,莫丁组(又称未命名组)厚约 15m,整合于郁江组之上,主要由深灰色白云质灰岩和灰、深灰色硅质条带白云岩组成,属下斜坡与盆地过渡区沉积。中华豆石介族标本主要产于本组上部硅质条带白云岩,大多已风化且常为残缺不全的内核,未发现可资鉴定的肌痕构造。标本个体比莲花山组和那高岭组的要大,最大可达 2cm。

产自莲花山组和那高岭组的中华豆石介族动物群,基本上均可视作原地埋藏,因为潮间带和近滨地带是它们繁衍生息的主要环境。唯莫丁组的,像钟铿等(1992)指出的那样,底栖生物(包括中华豆石介族)均可能来自碳酸盐台地(异地埋藏)。

如前所述,莲花山组第 4 层产中华豆石介族 6 种。从横向分布来看,其中 *S.* (*S.*) *subbrevis* 和 *S.* (*S.*) *yulinensis* 已知产自云南曲靖西屯组的中部; *S.* (*S.*) *subelliptica* (或相似标本)在西屯组中部亦见有产出。从产自第 4 层中华豆石介族的下垂“V”字型肌痕与闭壳肌痕垂直高度之比(插图 3)来看,其比值变化范围在 0.69—0.72 之间,平均比值大约为 0.7,比下西山村组的(大约 0.65)大,与产自西屯组中部的比值变化范围及平均比值(约 0.705)一致或接近。综上分析,笔者认为莲花山组大致可与西屯组对比。*S.* (*S.*) *yulinensis* Wang, 1994 (= *Sinoleperditia guangxiensis* Wang, 1989) 原先发现于广西玉林樟木北均塘剖面 *Neomonograptus hercynicus* 笔石带,后在西屯组中部发现的同种标本,不仅在外形特征上与前者一致,而且在下垂“V”字型肌痕与闭壳肌痕垂直高度的比值(约 0.7)上也十分接

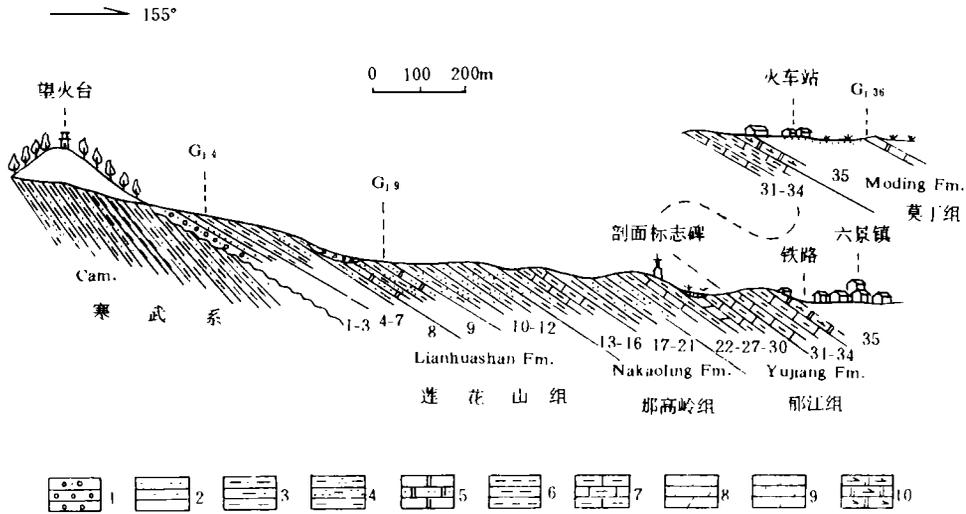


插图 1 广西横县六景下泥盆统剖面(据卞国敦等,1989)

Lower Devonian section at Liujing of Hengxian, Guangxi

- 1. 砾岩 (conglomerate); 2. 砂岩 (sandstone); 3. 泥质砂岩 (pelitic sandstone); 4. 泥质粉砂岩 (pelitic siltstone);
- 5. 粉砂质白云岩 (silt dolomite); 6. 泥岩 (mudstone); 7. 泥质灰岩 (argillaceous limestone); 8. 泥灰岩 (marl);
- 9. 灰岩 (limestone); 10. 硅质白云岩 (siliceous dolomite)

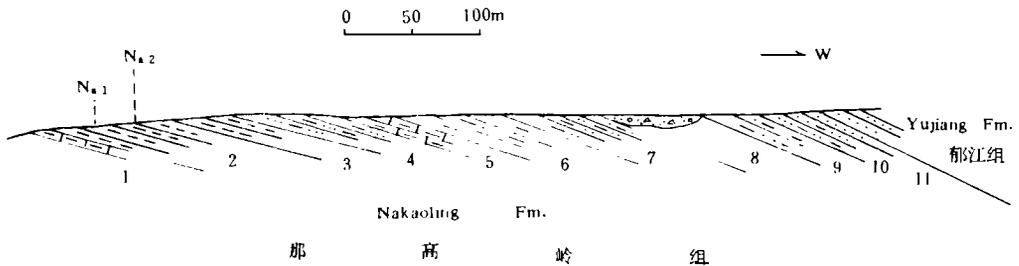


插图 2 广西隆安刘家上下泥盆统剖面示意图

Lower Devonian section at Shangba of Liujia of Long'an, Guangxi

近,进而推测西屯组的地质时代可能为晚洛赫霍柯夫期(late Lochkovian) (王尚启, 1994)。另外,莲花山组第 9 层的 *S. (S.)* sp. 8, 其下垂“V”字型肌痕与闭壳肌痕垂直高度之比值约为 0.74; 在西屯组上部同时也发现具有肌痕比值约为 0.76 的中华豆石介族分子。这两个比值都与布拉格期那高岭组的平均比值(大约 0.74)接近。但遗憾的是前者闭壳肌痕的底缘界线不甚清晰, 后者下垂“V”字型肌痕的下端也保存欠佳, 两者均为参考值; 另一方面, 不同个体的肌痕比值也常有一定变化。总之, 根据个别标本, 特别是保存欠佳的肌痕比值, 还不能确定莲花山组和西屯组的上部是否属布拉格期, 还需进一步采集标本研究解决。

刘家上巴剖面那高岭组第 2 层所产中华豆石介族 12 种, 几乎均为新种和未定种, 它们是一个既不同于莲花山组或西屯组又不同于埃姆斯期(Emsian) 的新的中华豆石介族组合。

从插图 3 看, 它们的下垂“V”字型肌痕与闭壳肌痕垂直高度的比值分布共有 2 组, 一组变化范围在 0.69-0.74 之间; 另一组则在 0.74-0.8 之间。前一组与莲花山组或西屯组接近, 后一组则显著大于莲花山组或西屯组的变化范围。根据统计, 产自本层的中华豆石介族, 其下垂“V”字型肌痕与闭壳肌痕垂直高度之比值的平均值大约是 0.74, 比莲花山组或西屯组的平均比值(约 0.7) 约大 0.04, 但显著小于埃姆斯期的平均比值(大于 0.9) (王尚启, 1994; 插图 5)。在六景剖面上, 那高岭组高岭段的上部已知产牙形刺 *Eognathodus sulcatus* 等, 根据王成源的意见, 此种是布拉格期的标志化石, 且更可能代表中布拉格期(根据共生的其它牙形刺种)。根据岩性和古生物面貌, 刘家上巴剖面第 2 层与上述六景剖面产牙形刺的层位接近或稍低, 归布拉格期当属无疑。

莫丁组产菊石、牙形刺、竹节石等, 如 *Erbeneras elegantulum*, *Polygnathus perbonus*, *Nowakia* (*N.*) *barrandei*, *N.* (*N.*) *elegans*, 时代为早埃姆斯期晚期。此组虽产中华豆石介族, 但尚未发现肌痕特征, 还有待采集更好的标本进一步研究。

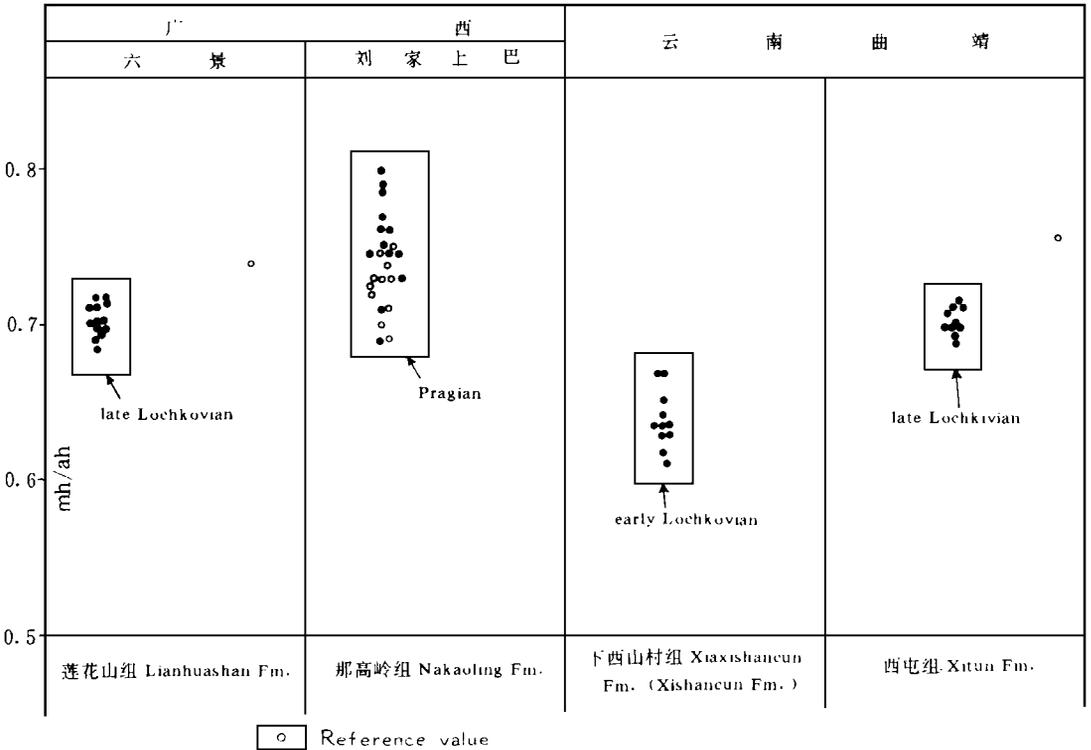


插图 3 早泥盆世早、中期中华豆石介族类 mh/ah 值的分布范围

Range of mh/ah value of Sinoleperditini from Lochkovian and Pragian

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LEPERDITIID SINOLEPERDITIINI (OSTRACODA) FROM EARLY DEVONIAN OF LIUJING AND LIUJIA, GUANGXI, CHINA

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Key words Sinoleperditini, Early Devonian, Guangxi**Summary**

This paper describes and illustrates ²⁰ taxa which are assigned to ¹ genus and ¹ sub-genus of *Sinoleperditini*, including ⁹ new taxa, namely, *Sinoleperditia* (*Sinoleperditia*) *subelliptica*, *S.* (*S.*) *liujingensis*, *S.* (*S.*) *anteracuta*, *S.* (*S.*) *lata*, *S.* (*S.*) *lemboda*, *S.* (*S.*) *liujiaensis*, *S.* (*S.*) *posteroconvexa*, *S.* (*S.*) *angustata* and *S.* (*S.*) *brachyovata*. Among the ²⁰ species, ⁷ are obtained from the Lianhuashan Formation and ¹ from the Moding Formation at the Liujing section of Hengxian and ¹² from the Nakaoling Formation at the Shangba section of Liujia in Long'an, Guangxi, China. The specific assemblage of *Sinoleperditini* and the mean mh/ah value of about ^{0.7} (mh: vertical height of trailing chevron muscle scar below a parallel line through the top of adductor muscle scar to dorsal margin; ah: vertical height of adductor muscle scar) strongly suggest that the Lianhuashan Formation is correlative with the Xitun Formation of Qujing, Yunnan which may be dated the late Lochkovian. The Pragian Nakaoling Formation is different from the Lianhuashan and Xitun Formations in the composition of species and the mean mh/ah value of about ^{0.74} which is larger than those of the Lianhuashan and Xitun Formations but much smaller than those (^{> 0.9}) known from the Emsian. Both the specific assemblage of

Sinoleperditini from the Nakaoling Formation and, especially, the mean mh/ah value could be regarded as the important bases for stratigraphical correlation and age-dating of the Pragian littoral strata.

The family Leperditidae Jones, 1856, as we know, originated from the Ordovician and became extinct in the Late Devonian as in North America, Europe and Siberia. There is, however, an exception that this family is only known from the Devonian in South China. A group of leperditids, which was proposed by the writer in 1994 as the tribe Sinoleperditini of Leperditidae occurring in this area, is very special in the development of trailing chevron muscle scar uninterruptedly extending downward with the passing time in contrast to those bearing hardly varied chevron muscle scar from the contemporary of North America, Europe and Siberia. The phylogeny of Sinoleperditini and especially evolutionary trends mainly shown by the trailing chevron muscle scar in the tribe, which were preliminarily reported by the author in 1994, will play important roles in correlating and dating the Devonian marine strata, particularly those of littoral facies. In addition, they also may be considered as marking the Devonian biogeographical province of South China. Unfortunately, the Pragian Sinoleperditini was almost unknown before. This paper is to deal with the Sinoleperditini collected in November 1994 from the Pragian Nakaoling Formation at the Shangba section of Liujia, Long'an and from the Lianhuashan and Moding (= Unnamed) Formations at the Liujiing section of Hengxian, with a preliminary discussion on the correlation of the Lianhuashan Formation with the Xitun Formation of Qujing, Yunnan.

1 SINOLEPERDITIINI: STRATIGRAPHY AND FAUNAL ANALYSIS

The Lianhuashan Formation (Text-fig. 1) mainly consists of clastic rocks deposited in the littoral zone, yielding ostracodes, bivalves, fish fragments, brachiopods (*Lingula*), etc. Specimens of Sinoleperditini found from Beds 4-12, especially Bed 4, are preserved as steinkerns and often deformed, damaged and exfoliated, with seven species preliminarily recognized as follows:

Bed 4: *Sinoleperditia* (*Sinoleperditia*) cf. *subbrevis* Wang, *S.* (*S.*) *yulinensis* Wang, *S.* (*S.*) *subelliptica* sp. nov., *S.* (*S.*) *liujingensis* sp. nov., *S.* (*S.*) cf. *brevis* Wang et Liu and *S.* (*S.*) sp. 3; Bed 9: *S.* (*S.*) sp. 8.

The Nakaoling Formation (Text-fig. 1) is mainly composed of clastic rocks with marl and limestone intercalations, representing a sediment of subtidal (mud-flat) zone (Zhong *et al.*, 1992). This formation yields abundant brachiopods, bivalves, ostracodes and a few conodonts, tentaculites, corals, etc., with only a few specimens of Sinoleperditini preserved as steinkerns without muscle scars.

The Moding Formation (Text-fig. 1) is characterized by dolomite with banded silicite and dolomitic limestone, representing the slope facies (Zhong *et al.*, 1992), and

yielding pelagic and benthic faunas. The specimens of *Sinoleperditia*, which might be allochthonous like other benthos, were obtained from the upper part of this formation and also preserved as steinkerns without any muscle scars, with only one taxon, *S. (S.)* sp. 9, recognized so far.

The Nakaoling Formation at the Shangba section of Liujia (Text-fig. 2) is similar to that at the Liujing section (Text-fig. 1) in lithological character and faunas, but differs from the latter in containing less marl and limestone intercalations and probably less faunas. All specimens of *Sinoleperditia* preserved as steinkerns were discovered from Bed 2 in the lower part of this formation, with 12 species recognized as follows:

Sinoleperditia (Sinoleperditia) cf. longanensis (Sun), *S. (S.) anteracuta* sp. nov., *S. (S.) lata* sp. nov., *S. (S.) lemboda* sp. nov., *S. (S.) liujiaensis* sp. nov., *S. (S.) posteroconvexa* sp. nov., *S. (S.) angustata* sp. nov., *S. (S.) brachyovata* sp. nov., *S. (S.)* sp. 4, *S. (S.)* sp. 5, *S. (S.)* sp. 6 and *S. (S.)* sp. 7.

The Nakaoling Formation mentioned above was known as almost absent in the material of *Sinoleperditia* before. These species, proposed here as an assemblage, are mainly new and indeterminate, with the exception of *S. (S.) longanensis*, which was reported by Sun in 1978 from the same formation in this area. Text-fig. 3 shows two groups of mh/ah values, with one group ranging from 0.9 to less than 0.74 and the other from 0.74 to 0.8, both bearing a mean mh/ah value of about 0.74 which is larger than that from the late Lochkovian Lianhuashan or Xitun Formation (about 0.7; see below) but much smaller than that from the Emsian (larger than 0.9; see Wang, 1994, Text-fig. 5). The Nakaoling Formation at the Liujing section has been dated as the Pragian, probably the middle Pragian based on such conodonts as *Eognathodus sulcatus*, *E. linearis*, from Bed 16 (Text-fig. 1) (Wang Chengyuan, oral account). At the Shangba section, Bed 2 bearing 12 species of *Sinoleperditia* (Text-fig. 2) may be close to or slightly lower than Bed 16 bearing conodonts of the Nakaoling Formation at the Liujing section (Text-fig. 1) based on lithological character and faunas. Thus, it is also possibly placed in the Pragian or middle Pragian. The specific assemblage of *Sinoleperditia* and especially the mean mh/ah value stated above, would serve as important evidences for correlating and dating the Pragian strata, especially those of littoral facies (so-called nonmarine facies).

The Lianhuashan Formation has been disputed for a long time concerning geological age and correlation due to poorly preserved fossils. In the light of the specific assemblage of *Sinoleperditia* and the mean mh/ah value, a preliminary discussion is made on these problems.

The specific assemblage of *Sinoleperditia* from Bed 4 of the Lianhuashan Formation, as aforementioned, comprises 6 species, of which *S. (S.) subbrevis*, *S. (S.) yulinensis* and conspecific specimens of *S. (S.) subelliptica* also have been discovered from the specific assemblage of *Sinoleperditia* yielded from the middle part of the Xitun Formation of Qu-

qing, Yunnan (so far as we know, the latter assemblage only comprises these ³ species). Furthermore, the mean mh/ah value (about ^{0.7}) of the specific assemblage of *Sinoleperditia* from Bed ⁴ is almost equal to that (about ^{0.705}) of the assemblage from the middle part of the Xitun Formation (Text-fig. 3). Consequently, the Lianhuashan Formation may be roughly correlated with the Xitun Formation. They may be placed in the late Lochkovian based on the presence of *S. (S.) yulinensis* (= *Sinoleperditia guangxiensis* Wang, 1989) earlier recorded from the beds bearing the graptolite *Neomonograptus hercynicus* zone at the Beijuntang section of Zhangmu, Yulin, Guangxi (Wang, 1989). In addition, it is also pointed out that *S. (S.)* sp. ⁸ from Bed ⁹ of the Lianhuashan Formation (Text-fig. 1) has an mh/ah value of about ^{0.74}, and a specimen from the upper part of the Xitun Formation bears an mh/ah value of about ^{0.76}, both being roughly approximate to the mh/ah value (about ^{0.74}) of the specific assemblage of *Sinoleperditia* from the Nakaoling Formation. But these two values are separately obtained from one specimen with poorly preserved muscle scars. It is still uncertain whether the upper part of the Lianhuashan and Xitun Formations is Pragian in age and therefore further collection will be necessary for age determination.

The Moding Formation is generally placed in the late early Emsian based on the presence of *Nowakia barrandei*, *N. elegans*, and *Polygnathus perbonus*. More specimens of *Sinoleperditia* with well-preserved muscle scars still remain to be collected from the formation.

2 SYSTEMATIC PALAEOLOGY

Family Leperditidae Jones, 1856

Tribe *Sinoleperditia* Wang, 1994

Genus *Sinoleperditia* Wang, 1989

Subgenus *Sinoleperditia* (*Sinoleperditia*) Wang, 1989

Sinoleperditia (*Sinoleperditia*) cf. *subbrevis* Wang

(Pl. 1, figs. 1-3)

1994 *Sinoleperditia* (*Sinoleperditia*) *subbrevis* Wang, p. 701, pl. 1, figs. 6, 7.

Specimens preserved as steinkerns and more or less compressed or incomplete, coincident with those of *S. (S.) subbrevis* Wang from the middle part of Xitun Formation of Qujing, Yunnan in lateral outline and mean mh/ah value (about ^{0.7}), but different in the more convex ventral margin.

Plesiotypes Lianhuashan Formation/124896/Gj-4 (Pl. 1, fig. 1), 5.4 mm in length and 3.6 mm in height; 124897/Gj-4 (Pl. 1, fig. 2), 5.2 mm in length and 3.5 mm in height; 124898/Gj-4 (Pl. 1, fig. 3), >3 mm in length and >2 mm in height.

Occurrence Lianhuashan Formation; Liujing, Guangxi.

Sinoleperditia (Sinoleperditia) yulinensis Wang

(Pl. I, figs. 4, 5)

1989 *Sinoleperditia guangxiensis* Wang, p. 252, pl. III, fig. 11.1994 *Sinoleperditia guangxiensis*, Wang and Liu, pl. 1, fig. 13.1994 *Sinoleperditia (Sinoleperditia) yulinensis* Wang, p. 701, Pl. I, figs. 4, 5.

Specimens essentially coincident with those of *S.* (*Sinoleperditia*) *yulinensis* Wang known from the late Lochkovian strata of Beijuntang section of Zhangmu, Yulin, Guangxi and the Xitun Formation of Qujing, Yunnan in shape and mean mh/ah value (about 0.7) but different in the smaller size.

Plesiotypes Lianhuashan Formation/124899/Gj-4 (Pl. I, fig. 4), 5.7mm in length and 3.25mm in height; 124900/Gj-4 (Pl. I, fig. 5), >4.5mm in length and about 2.7mm in height.

Occurrence Lianhuashan Formation; Liuqing, Guangxi.

Sinoleperditia (Sinoleperditia) subelliptica sp. nov.

(Pl. I, fig. 6)

Derivation of name Sub, Latin, approximate, referring to the shape of the species, which is approximate to that of *Leperditia elliptica* Sun.

Material Over 2 valves.

Diagnosis Carapace small to medium-sized and subelliptical in lateral view. Dorsal margin long and straight, with obtuse cardinal angles; ventral margin moderately convex, with a maximum convexity near the mid-ventral margin. Anterior end rounded and most convex near mid-height; posterior end more broadly rounded than the anterior and most convex below mid-height. Valve evenly convex in dorsal view and thickest at the center. Brims on ends present. Adductor muscle scar oval; trailing chevron muscle scar curved-conic in shape. $Mh/ah = 0.712$.

Holotype Lianhuashan Formation/124901/Gj-4 (Pl. I, fig. 6), 4.5mm in length and 2.8mm in height.

Discussion The new species appears to be similar to the species *Leperditia elliptica* Sun, from the Nakaoling Formation of Long'an, Guangxi in lateral outline, but differs in having a more anteriorly elongated upper part of anterior end and a more posteriorly elongated lower part of posterior end.

Occurrence Lianhuashan Formation; Liuqing, Guangxi.

Sinoleperditia (Sinoleperditia) liujingensis sp. nov.

(Pl. I, figs. 7-10)

Derivation of name Liuqing, the fossil locality.

Material Over 7 valves.

Diagnosis Carapace generally 6mm in length, with some attaining or over 7mm, and truncated-circular in lateral view. Dorsal margin short but straight, with a more obtuse postero-cardinal angle than anterior one; ventral margin strongly convex with a maximum convexity behind the center of ventral margin. Anterior end broadly rounded with a maximum convexity above mid-height; posterior end more broadly rounded than anterior one and extending rather strongly backward below mid-height. Maximum thickness subcentral in dorsal view. Hingement prionodont. Brims on ends unknown.

Muscle scars relatively well-preserved, with mh/ah values ranging from 0.68 to 0.717 and mean mh/ah = about 0.7.

Holotype Lianhuashan Formation/124902/Gj-4 (Pl. I, fig. 7), 6.15mm in length and 4.2mm in height.

Paratypes Lianhuashan Formation/124903/Gj-4 (Pl. I, fig. 8), 6mm in length and 4.3mm in height; 124904/Gj-4 (Pl. I, fig. 9), 7mm in length and 4.9mm in height; 124905/Gj-4 (Pl. I, fig. 10), 4.9mm in length and 3.3mm in height.

Discussion All specimens referred to the new species are preserved as steinkerns and compressed. The new species is easily distinguished from *S. (S.) brevis* Wang et Liu, 1994 known from the Xiaxishancun Formation of Qujing, Yunnan by the relatively short and broad lateral outline, especially the anterior end, and the mean mh/ah value of about 0.7 (the latter is relatively long and narrow in lateral view with a small mean mh/ah value of about 0.65).

Occurrence Lianhuashan Formation; Liuqing, Guangxi.

Sinoleperditia (Sinoleperditia) sp. 3

(Pl. I, fig. 11)

Specimen being a fragment but with well-preserved muscle scars, Adductor muscle scar oval and trailing chevron muscle scar shortly conic with mh/ah = about 0.7.

Lianhuashan Formation/124906/Hi-4 (Pl. I, fig. 11.11), >6mm in length.

Occurrence Lianhuashan Formation; Liuqing, Guangxi.

Sinoleperditia (Sinoleperditia) cf. brevis Wang et Liu

(Pl. I, fig. 12)

Specimen being a compressed steinkern, overturned dorsally along dorsal part and laterally along ventral part, similar to those of *S. (S.) brevis* in general outline but easily distinguished by the mh/ah value of 0.71 or 0.72 from the latter which is generally smaller than 0.68 in the mh/ah value (averagely about 0.65).

Plesiotype Lianhuashan Formation/124907/Gj-4 ((Pl. I, fig. 12)), 6.8mm in length and 4.5mm in height.

Occurrence Lianhuashan Formation; Liuqing, Guangxi.

Sinoleperditia (*Sinoleperditia*) *anteracuta* sp. nov.

(Pl. II, fig. 1, 2)

Derivation of name Anter, Latin, anterior, and acuta, Latin, referring to the lateral outline.

Material Over 7 valves.

Diagnosis Carapace 5–7 mm in length truncated-elliptical in lateral view. Dorsal margin straight, with a blunter postero-cardinal angle than anterior one; ventral margin relatively convex but nearly straight or slightly convex along mid-ventral margin. Anterior end high and narrowly straight or slightly convex along mid-ventral margin. Anterior end high and narrowly rounded, with a maximum extension prominently above mid-height; posterior end much more broadly rounded than anterior one and most convex below mid-height. Sides slightly convex in dorsal view and thickest near midventral part.

Muscle scars well-preserved: Adductor muscle scar oval and trailing chevron muscle scar curved-conic in shape; mh/ah values ranging from 0.73, with a mean value of about 0.72.

Holotype Nalaoling Formation/124908 Na-(Pl. II, fig. 1), 5.6 mm in length and 3.7 mm in height.

Paratype Nakaoling Formation/124909 Na-(Pl. II, fig. 2), 6 mm in length and 3.9 mm in height.

Discussion The new species is close to *S. (S.) yulinensis* Wang in the mean mh/ah value but differs in the presence of nearly straight mid-ventral margin and relation and relatively high and narrow anterior end.

Occurrence Nakaoling Formation; Liuji of Ling'an, Guangxi.

Sinoleperditia (*Sinoleperditia*) *lata* sp. nov.

(Pl. II, fig. 3, 4)

Derivation of name Lata, Latin, broad, referring to the lateral outline.

Material Over 5 valves.

Diagnosis Carapace generally 7–7.5 mm in length and suboval or truncated-circular in lateral view. Dorsal margin straight with a more obtuse postero-cardinal angle than anterior one; ventral margin moderately convex and most convex at posterior 1/3 of valve length. Anterior end broadly rounded and most convex slightly above mid-height; posterior end more broadly rounded than the anterior with a maximum extension near mid-height. Sides weakly convex in dorsal view with a maximum thickness at center. Lower part of anterior end to lower part of posterior end broken (Pl. II, fig. 3), Brims on ends unknown.

Adductor muscle scar shortly oval and trailing chevron muscle scar curved-conic in shape; mh/ah values ranging from 0.746 to 0.76, with a mean value of about 0.75.

Holotype nakaoling Formation/124911/Na (Pl. II, fig. 4), 7.4mm in length and 4.9mm in height.

Paratype Nakaoling Formation/124910/Na (Pl. II, fig. 3), 7mm in length and >4.6mm in height.

Discussion The new species is similar in the outline of posterior end to *S. (S.) anteracuta* sp. nov., but can be distinguished from the latter by the relatively broadly rounded anterior end and most convex ventral margin at posterior $1/3$ of valve length, and the mean $mh/ah = 0.75 \pm$

Occurrence Nakaoling Formation; Liujia, Guangxi.

***Sinoleperditia (Sinoleperditia) lemboda* sp. nov.**

(Pl. II, fig. 5-7)

Derivation of name Lemboda, Latin, boat-shaped, referring to the lateral outline.

Material Over 6 valves.

Diagnosis Carapace generally 5-6mm in length and truncated-circular in lateral view. Dorsal margin substraight with a more obtuse postero-cardinal angle than anterior one; ventral margin moderately convex and most convex near the center of ventral margin. Anterior end high and narrowly rounded, with a maximum projection above mid-height; posterior end more broadly rounded than anterior one, with a maximum extension near mid-height. Brims on ends unknown. Specimen in Pl. II, fig. 5 becoming compressed and deformed from dorsal to ventral margins and broadened along posterior part; with specimen in Pl. II, fig. 6, 7 showing 2 transversal grooves parallel to anterior and posterior margins respectively, caused by compression.

Adductor muscle scar shortly oval and trailing chevron muscle scar curved-conic in shape; mh/ah values ranging from 0.75 to 0.8 with a mean value of about 0.78. Holotype Nakaoling Formation/124913/Na (Pl. II, fig. 6, 7), 5.4mm in length and 3.5mm in height.

Paratype Nakaoling Formation/124912/Na (Pl. II, fig. 5), >5.8mm in length and 3.8mm in height.

Discussion Among the described species the new species is most similar to *S. (S.) yulinensis* Wang in shape, but can be easily distinguished by the relatively very convex ventral margin and the mean mh/ah value of about 0.78 (the latter has a gently convex ventral margin and a mh/ah value of about 0.7).

Occurrence Nakaoling Formation; Liujia of Long'an, Guangxi.

***Sinoleperditia (Sinoleperditia) liujiaensis* sp. nov.**

(Pl. II, fig. 8, 9)

Derivation of name Liujia, the fossil locality.

Material Over 3 valves.

Diagnosis Carapace smaller in size and suboblong in lateral view. Dorsal margin relatively short and straight with obtuse and subequal anterocardinal and posterocardinal angles; ventral broader than anterior one. Valve longest near mid-height. Sides moderately convex in dorsal view and thickest slightly below the center. Specimen in Pl. II, fig. 9 with dorsal margin and upper part of posterior end broken.

Adductor muscle scar relatively large and curved-conic in shape; $mh/ah = 0.79$ (Pl. II, fig. 9).

Holotype Nakaoling Formation/124914/Na-(Pl. II, fig. 8), 5.1 mm in length and 3.2 mm in height.

Discussion The new species is almost identical in the mh/ah value with *S. (S.) lembo-da* sp. nov., but can be readily distinguished by the suboblong lateral outline, which is truncated-circular in the latter.

Occurrence Nakaoling Formation; Liujia of Long'an, Guangxi.

Sinoleperditia (Sinoleperditia) sp. 5

(Pl. II, fig. 10)

Specimen being a steinkern and fragment with well-preserved muscle scars. Adductor muscle scar large, shortly reniform and inclining anteriorly; trailing chevron muscle scar large and nearly vertically conic in shape, with a $mh/ah =$ about 0.75.

Nakaoling Formation/124913/Na-(Pl. II, fig. 10), > 7 mm in length and 4.9 mm in height.

Occurrence Nakaoling Formation; Liujia of Long'an, Guangxi.

Sinoleperditia (Sinoleperditia) sp. 4

(Pl. II, fig. 11)

Specimen being a steinkern, broadened along the dorsal part and overturned dorsally due to compression. Muscle scars well-preserved; Adductor muscle scar oval and inclining posteriorly; trailing chevron muscle scar curved-conic in shape, with $mh/ah =$ about 0.76.

Nakaoling Formation/124917/Na-(Pl. II, fig. 1), 5.3 mm in length and > 3.4 mm in height.

Occurrence Nakaoling Formation; Liujia of Long'an, Guangxi.

Sinoleperditia (Sinoleperditia) posteroconvexa sp. nov.

(Pl. III, fig. 1-3)

Derivation of name *Poster*, Latin, posterior, and *convexa*, Latin, convex, referring to the lateral outline.

Material Over 5 valves.

Diagnosis Carapace generally 4–6mm in length and suboblong in lateral view. Dorsal margin straight with a blunter postero-cardinal angle than anterior one; ventral margin gently convex. Anterior end rounded, with a maximum projection near mid-height. Valves moderately convex in dorsal view and thickest near mid-height. Valves moderately convex in dorsal view and thickest near midventral area. Specimen in Pl. III, fig. 3 strongly thickened along dorsal part probably due to compression. Brims on ends unknown.

Adductor muscle scar almost vertical and subelliptical; trailing chevron muscle scar nearly vertical and conic in shape; mh/ah values ranging from 0.73 to 0.75, with a mean value of about 0.74.

Holotype Nakaling Formation/124918/Na-(Pl. III, fig. 1, 2), 5.9mm in length and 3.5mm in height.

Paratype Nakaoling Formation/124919/Na-(Pl. III, fig. 3), 4.7mm in length and 2.8mm in height. Discussion Among the described species the new species is most similar to *S. (S.) liujiaensis* sp. nov. in lateral outline, but differs in the lower and long lateral outline and relatively strongly projection posterior end.

Occurrence Nakaoling Formation; Liujia of Long'an, Guangxi.

Sinoleperditia (Sinoleperditia) of longanensis (Sun)

(Pl. III, fig. 4)

Specimen being a strindern, strongly thickened along the dorsal part and overturned dorsally due to compression from venter to dorsum, and broken along dorsal and ventral margins. It is similar in lateral outline to *Leperditia longensis* Sun, 1978 known from the Nakaoling Formation of Long'an. It is uncertain whether both are the same species because the former is poorly preserved and the latter has no muscle scars ever recorded.

Muscle scar well-preserved; adductor muscle scar subelliptical and slightly inclining posteriorly; trailing chevron muscle scar almost vertical and conic in shape; mh/ah = about 0.74.

Plesiotype Nakaoling Formation/124913/Na-(Pl. III, fig. 4), 5mm in length and 3.1mm in height.

Occurrence Nakaoling Formation; Liujia of Long'an, Guangxi.

sinoleperditia (sinoleperditia) angustata sp. nov.

(Pl. III, fig. 5, 6)

Derivation of name *Angustata*, Latin, narrow, referring to features of the valve's anterior end.

Material Over 3 valves.

Diagnosis Carapace 5–7mm in length and truncated-elliptical in lateral outline. Dorsal margin long and straight, with a blunter postero-cardinal angle than anterior one; ventral

margin moderately convex and most convex behind the center of ventral margin. Anterior end high and narrowly rounded, with a maximum projection above mid-height; posterior end much more broadly rounded than anterior one, with a maximum extension near mid-height. Sides gently convex in dorsal view and thickest near the center. Specimen in Pl. III, fig. 5 broken along posterior end and thickened along dorsal part, overturned dorsally probably due to compression; specimen in Pl. III, fig. 6 slightly broken from mid-ventral margin to lower part of anterior end.

Adductor muscle scar large and shortly oval, slightly inclining posteriorly; trailing chevron muscle scar curved-conic in shape; $mh/ah = \text{about } 0.7$.

Holotype Nakaoling Formation /124913/Na- (Pl. III, fig. 6), 6.8 mm in length and 4 mm in height.

Paraotype Nakaoling Formation /124913/Na- (Pl. III, fig. 5) > 4.5 mm in length and > 2.5 mm in height.

Discussion The new species isn similar in mh/ah value to *S. (S.) yulinensis* Wang, 1994, but can be easily distinguished by the much narrower anterior end the lower and longer outline in lateral view.

Occurrence Nakaoling Formation; Liujia of Long'an Guangxi.

sinoleperditia (*sinoleperditia*) sp. 6

(Pl. III, fig. 7)

Specimen being a steindern, strongly thickened along ventral, especially anterior mid-ventral part, and abruptly overturned ventrally along ventral part presumably due to compression, and also anterior and posterior ends subequal in width.

Adductor muscle scar commonly vertical and oval; trailing chevron muscle scar nearly vertical-conic in shape; mh/ah value about 0.74.

Nakaoling Formation /124923/Na- (Pl. III, fig. 7), 4.5 mm in length and 2.9 mm in height.

Occurrence Nakaoling Formation; Liujia of Long'an, Guangxi.

Snoleperditia (*Snoleperditia*) *brachyovafte* sp. nov.

(Pl. III, fig. 8, 9)

Dervation of name Brachy, Latin, short; ovata, Latin, oval.

Material Over 4 valves.

Diagnosis Carpace small in size, generally 4.5–5 mm length and truncated-circular in lateral vies. Dorsal margin short and straight, with subequal anterocardinal and posterocardinal angles; vetral margin strongly convex and most convex near posterior $1/3$ of valve length. Anterior end rounded, with a maximum projuECTION above mid-height; posterior end much more broadly rounded than anterior one, with a maximum extension

near mid-height. Specimen in Pl. III, fig. 8 possessing two transversal grooves parallel to anterior and posterior ends respectively, which are caused by compression. Sides slightly convex in dorsal view.

Muscle scars not so clear; mh/ah value about 0.74.

Holotype Nakaoling Formation/124913/Na-(Pl. III, fig. 8), 4.5mm in length and 3.3mm in height.

Paratype Nakaoling Formation/124913/Na-(Pl. III, fig. 9), 4.9mm in length and 3.45mm in height.

Discussion The new species appears to be similar in shape to *S. (S.) liujingensis* sp. nov., but can be distinguished by the broadly obtuse posterior end the mh/ah value = 0.74 (the latter has a posterior end relatively strongly extending backward and a mean mh/ah value of about 0.7).

Occurrence Nakaoling Formation; Liujia of Long'an, Guangxi.

Sinoleperditia (Sinoleperditia) sp. 7

(Pl. III, fig. 10)

Diagnosis Specimen preserved as a steindern, compressed and broken along antero-cardinal angle. Carapace small in size and truncated-elliptical in lateral view. Dorsal margin short but straight, with a much obtuse postero-cardinal angle than anterior one; ventral margin moderately convex. Anterior end broadly rounded, with a maximum extension slightly above mid-height; posterior end narrowly rounded and strongly convex below mid-height. Sides weakly convex in dorsal view and thickest near the center.

Adductor muscle scar suboval and trailing chevron muscle scar curved-conic in shape, with mh/ah = about 0.74.

Nakaoling Formation/124926/Na-(Pl. III, fig. 10), 5.6mm in length and 3.7mm in height.

Occurrence Nakaoling Formation; Liujia of Long'an Guangxi.

Sinoleperditia (Sinoleperditia) sp. 8

(Pl. III, fig. 11, 12)

Specimen being a steinkern, compressed and broken along upper part of anterior and posterior ends, and overturned ventrally along ventral part. Trailing chevron muscle scar well-preserved, but adductor muscle scar (especially its lower limit) relatively obscure; mh/ah value about 0.74.

Lianhuashan Formation/124927/Gj-(Pl. III, fig. 11, 12), 5.5mm in length and about 3.1mm in height.

Occurrence Lianhuashan Formation; Liujing, Guangxi.

Sinoleperditia (*Sinoleperditia*) sp. 9

(Pl. III, fig. 13, 14)

Diagnosis Carapace relatively larger, generally 11–16mm in length and subelliptical in lateral view. Dorsal margin substraight, with subequal and obtuse anterocardinal and posterocardinal angles; ventral margin moderately convex. Anterior end rounded and most convex above mid-height; posterior end broader than anterior one, with a maximum projection at its lower $1/3$ of carapace height. Sides moderately convex in dorsal view and thickest near the center. Specimen preserved as a steinkern with muscle scars unknown.

Moding Formation/124928/Gi-(Pl. III, fig. 13, 14), 11.5mm in length and 7mm in height.

Occurrence Moding Formation; Liujing, Guangxi.

PLATE EXPLANATION

The specimens described and illustrated in this paper are housed in Nanjing Institute of Geology and palaeontology, Academia Sinica.

Plate I

1–3. *Sinoleperditia* (*Sinoleperditia*) cf. *subbrevis* Wang

1. Right view; 2. Left view; 3. Right views of fragment. Plesiotypes (in steinkerns), $\times 10$. 124896–124898; GJ-4. All from Lianhuashan Formation at Liujing section, Guangxi.

4, 5. *Sinoleperditia* (*sinoleperditia*) *yulinensis* Wang

4. Left view; 2. Left view of fragment, plesiotypes (in steinkerns) $\times 10$. 124899, 124900; GJ-4. Both from Lianhuashan Formation at Liujing section, Guangxi.

6. *sinoleperditia* (*sinoleperditia*) *subelliptica* sp. nov.

Right view, Holotype (in steinkern), $\times 10$. 124901, GJ-4, from Lianhuashan Formation at Liujing section, Guangxi.

7–10. *Sinleperditia* (*Sinleperditia*) *liujingensis* sp. nov.

7. Holotype (in steinkern), $\times 10$. 8–10. Paratypes (in steinkerns); 8. Left view of fragment, $\times 10$; 9. Left view, $\times 10$; 10. Left view, $\times 10$. 124902, GJ-4. All from Lianhuashan Formation at Liujing section, Guangxi.

11. *Sinleperditia* (*Sinleperditia*) sp. 3

Left view of fragment (in steinkern) $\times 8$. 124906, GJ-4, from Lianhuashan Formation at Liujing section, Guangxi.

12. *Sinoleperditia* (*Sinoleperditia*) cf. *brevis* Wang et Liu

Right view. Plesiotype (in steinkern), $\times 10$. 124907, GJ-4, from Lianhuashan Formation at Liujing section, Guangxi.

Plate II

1, 2. *Sinoleperditia* (*Sinoleperditia*) *anteracuta* sp. nov.

1. Holotype (in steinkern), left view, 2. Paratype (in steinkern), right $\times 10$. 124909, Na-1, Both from Nakaoling Formation at Shangba section of Liujia, Long'an, Guangxi.

3, 4. *Sinoleperditia* (*Sinoleperditia*) *lata* sp. nov.

3. Paratype (in steinkern), right view; 4. Holotype (in steinkern), left view, $\times 10$. 124910, Na-1. Both from Nakaoling Formation at Shangba section of Liujia, Long'an, Guangxi.

5–7. *Sinoleperditia* (*Sinoleperditia*) *anteracuta* sp. nov.

5. Paratype (in steinkerns), left view of fragment; 6, 7. Holotype (in steinkern), right view of the same specimen, $\times 10$.

124912, 124913; Na⁻¹, Both from Nakaoling Formation at Shangba section of Lijjia, Long'an Guangxi.

8, 9. *Sinoleperditia (Sinoleperditia) anteracuta* sp. nov.

8. Holotype (in steinkern), left view, 9. Paratype (in steinkern), right × 10. 124914, 124915; Na⁻¹, Both from Nakaoling Formation at Shangba section of Liujia, Long'an Guangxi.

10. *Sinoleperditia (Sinoleperditia) anteracuta* sp.⁵

Right view (in steinkern), × 10, 124916, Na⁻¹. Both from Nakaoling Formation at Shangba section of Liujia, Long'an Guangxi.

11. *Sinoleperditia (Sinoleperditia) anteracuta* sp.⁴

Right view (in steinkern), × 10, 124917, Na⁻¹. Both from Nakaoling Formation at Shangba section of Liujia, Long'an Guangxi.

Plate III

1-3. *Sinoleperditia (Sinoleperditia) posteroconvexa* sp. nov.

1, 2. Holotype (in steinkern), left view of same specimen; 3. Paratype (in steinkern), right view. × 10. 124918, 124919; Na⁻¹. Both from Nakaoling Formation at Shangba section of Liujia, Long'an, Guangxi.

4. *Sinoleperditia (Sinoleperditia) cf. longanensis* (Sun)

Right view of fragment, plesiltype (in steinkern), × 10. 124920; Na⁻¹, from Nakaoling Formation at Shangba section of Liujia, Long'an, Guangxi.

5, 6. *Sinoleperditia (Sinoleperditia) posteroconvexa* sp. nov. Left view (in steinkern), × 10. 124923, Na⁻¹, from Nakaoling Formation at Shangba section of Liujia, Long'an, Guangxi.

7. *Sinoleperditia (Sinoleperditia)* sp.⁶

Left view (in steinkern) × 10. 12492, ; Na⁻¹, from Nakaoling Formation at Shangba section of Liujia, Long'an, Guangxi.

8, 9. *Sinoleperditia (Sinoleperditia) posteroconvexa* sp. nov.

8. Holotype (in steinkern), Formation at Shangba section of Liujia, Long'an, Guangxi.

10. *Sinoleperditia (Sinoleperditia)* sp.⁷

Left view (in steinkern) × 10. 124926, Na⁻¹, from Nakaoling Formation at Shangba section of Liujia, Long'an, Guangxi.

11, 12. *Sinoleperditia (Sinoleperditia)* sp.⁸

Left view (in steinkern) × 10. 124927, G_J-9, from Lianhuashan Formation at Liujing section, Guangxi.

13, 14. *Sinoleperditia (Sinoleperditia)* sp.⁹

Right and dorsal views (in steinkern), × 5. 124928, G_J-36, from Moding (Unnamed) Formation at Liujing section, Guangxi.