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New Bivalved Arthropods from the Cambrian (Series 3, Drumian Stage) of Western Hunan, South China

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Abstract: We report two new three-dimensionally phosphatized microfossils, *Cambrolongispina reticulata* gen. et sp. nov. and *Cambrolongispina glabra* gen. et sp. nov., from the middle Cambrian (Series 3, Drumian Stage) at Wangcun, Yongshun County, western Hunan, South China. They are bivalved arthropods, with thin, pliable, originally chitinous or chitin-calcareous shields (c. 350–517 μm long). The shields are equipped with a pair of antero-dorsal spines. The spines are internally hollow, varying in length from 1/2 of to as long as the shield length in *C. reticulata*, and uniformly longer than the shield length in *C. glabra*. The spines of *C. reticulata* are ornamented with a longitudinal row of conical or blade-shaped denticles along the posterior edge. *Cambrolongispina* lacks marginal rims, valve lobation and sulci which are diagnostic of the Bradoriida sensu stricto. It also lacks a doublure/duplicature characteristic of phosphatocopids and some bradoriids. It could be related to the Monasteriidae (which may belong to Bradoriida sensu lato), both characterized by a pair of antero-dorsal spines. *Cambrolongispina* may have been meiofaunal detritus feeders that lived on or within sediments. The antero-dorsal spines may have been sensory organs to detect nearby predators. The posterior denticles on these spines might have facilitated the sensory function of the spines.

Key words: bivalved arthropods, Cambrian, Wangcun, western Hunan, South China

1 Introduction

The Arthropoda is the most abundant and diverse phylum among extant animal phyla, and its origination can be traced back to the Cambrian Stage 3 based on the fossil record (Waloszek et al., 2005). Arthropods were ecologically dominant in many Cambrian faunas, including the Burgess Shale and Chengjiang biotas, and played an important role in the Cambrian ecosystem (Conway Morris, 1986; Caron and Jackson, 2008; Zhao et al., 2010; Mao et al., 2013). In this study, we describe two new bivalved arthropods, *Cambrolongispina reticulata* gen. et sp. nov. and *C. glabra* gen. et sp. nov., from the Drumian Stage (Cambrian Series 3) at Wangcun, Yongshun County, western Hunan, South China. The Wangcun section has yielded a great number of three-dimensionally phosphatized microfossils with exceptionally preserved soft-part anatomies. Among them are the scalidophoran *Markuelia* that is preserved only as embryonic stages (Dong et al., 2004a; Dong, 2007, 2009; Cheng et al., 2011), cuticle fragments of palaeoscolecids (Duan et al., 2012), and Orsten-type microfossils such as phosphatocopids (Dong et al., 2005; Liu and Dong, 2009, 2010; Zhang and Dong, 2009; Zhang et al., 2011a, b, 2012) and skaracarids (Liu and Dong, 2007). Like many Orsten-type microfossils, the *Cambrolongispina* specimens described here are also microscopic, and like the phosphatocopids that are preserved as a series of larval stages (e.g., Zhang et al., 2011b), they likely also represent early larval stages. Prominent antero-dorsal spines are developed at the "eye lobe" positions of the shields, and these spines are sometimes decorated with a longitudinal row of denticles along the posterior edge.

The aims of this paper are to (1) provide a systematic description of the new fossils, (2) discuss their possible systematic position, and (3) analyze the functional and ecological importance of the antero-dorsal spines.

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2 Geological Setting, Material and Methods

Specimens were extracted from the limestone of Huaqiao Formation (Cambrian Series 3) at the Wangcun section in Yongshun County, western Hunan, South China (Fig. 1). The geological background, litho- and biostratigraphy of the Wangcun section were described in Dong et al. (2004b). Our samples were collected from a horizon that is biostratigraphically dated to the conodont *Gapparodus bisulcatus–Westergaardodina brevidens* Zone and trilobite *Ptychagnosyus atavus* Zone (Dong et al., 2004b, table 2) of the Drumian Stage (Peng et al., 2012). Samples were processed following acetic acid digestion methods described in Müller (1985). Residues from acid digestion were sorted manually under an optical microscope. *Cambrolongispina* specimens were picked and placed on aluminum stubs for scanning electron microscopy analysis.

3 Systematic Description

Specimens illustrated in this paper are deposited at the Geological Museum of Peking University, specimen number with prefix GMPKU.

Phylum Arthropoda Siebold and Stannius, 1845

Class, Order and Family uncertain

Genus *Cambrolongispina* gen. nov.

Etymology: With reference to the Cambrian age and the long antero-dorsal spines of the new genus.

Type-species: *Cambrolongispina reticulata* gen. et sp. nov.

Diagnosis: A bivalved arthropod with a single dorsal furrow demarcating the left and right valves; shield with slight forward and retral swings; valve surface without depressions, lobes, nodes, sulci or marginal rims; a pair of long antero-dorsal spines inserted at the “eye lobe” positions; antero-dorsal spines directed postero-dorsally; postero-dorsal spikes and a doublure absent.

Occurrence: *Gapparodus bisulcatus–Westergaardodina brevidens* conodont Zone, Huaqiao Formaion, Drumian Stage, Cambrian Series 3; Wangcun section, Yongshun County, western Hunan, South China.

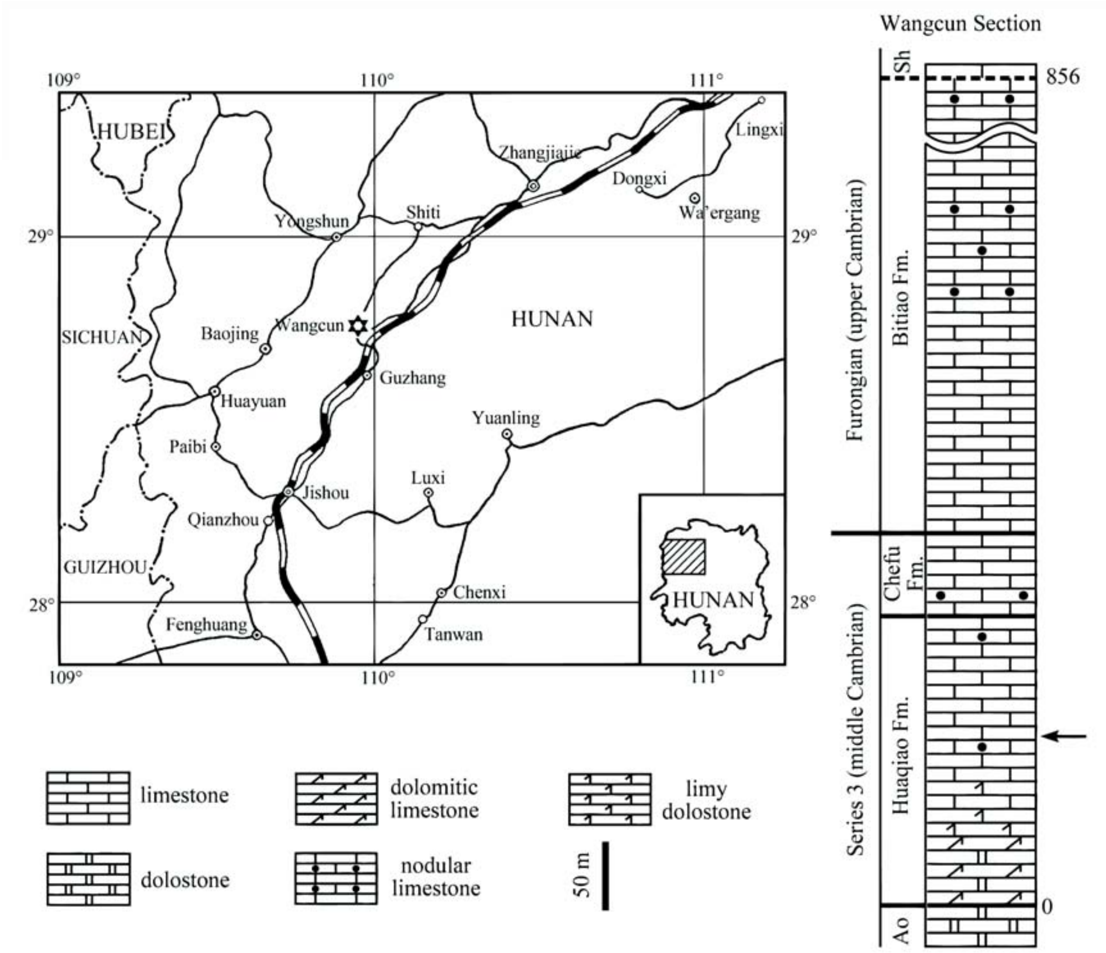

Fig. 1. Location map and stratocolumn of Wangcun section in western Hunan, South China.
The arrow indicates the stratigraphic horizon (112 m above the base of Huaqiao Formation) yielding the figured specimens in the present paper. Sh, abbreviation of the overlying Shenjiawan Formation; Ao, abbreviation of the underlying Aoxi Formation (modified after Dong et al., 2005).

Cambrolongispina reticulata gen. et sp. nov. (Fig. 2)

Etymology: Latin, *reticulatus*, with reference to the reticulated sculpture on the shield surface.

Holotype: GMPKU 3091 (Fig. 2a).

Material: Three specimens.

Measurements: c. 350–470 μm in shield length.

Occurrence: Cambrian Series 3 *Gapparodus bisulcatus–Westergaardodina brevidens* conodont Zone; Huaqiao Formation, Wangcun section, Yongshun County, western Hunan, South China.

Diagnosis: Antero-dorsal spines half of to as long as the shield length; spines ornamented with a row of conical or blade-shaped denticles along the posterior edge; shield surface with reticulated sculpture.

Description: The shields are bivalved and range in length from 350 μm (Fig. 2a) to 470 μm (Fig. 2j). The bivalved shield is am-plete in shape, i.e., the maximum height at the midline of the anterior-posterior axis. The shield has slight forward and retral swings, i.e., the anterior-most and posterior-most points of the shields are located a little ventral to dorsal rim, so the maximum shield length is slightly ventral to dorsal rim. The shield is longer than high, with a length/height ratio of about 1.45. The left and right valves are demarcated dorsally by a single dorsal furrow, and the dorsal rim is straight, without any associated structures or ornaments (Fig. 2c, h). The valves are relatively thin and pliable. The shield surface is devoid of structures such as lobes, nodes, sulci or ridges, but is ornamented with reticulated sculpture (Fig. 2b, h). The pustular ornaments on valve surface in one specimen (Fig. 2g, h) are probably secondarily formed phosphatic structures. A pair of antero-dorsal spines occurs on the dorsal margin, at about 1/7 of the shield length from the anterior end and close to the dorsal rim (Fig. 2a). The spines are inserted bilaterally on both valves and are directed postero-dorsally. The spines are about 1/2 of the shield length among smaller individuals (Fig. 2a, g), and during ontogeny they grow to nearly as long as the shield length (Fig. 2j). They taper distally to a pointed tip (Fig. 2e, m), bent ventrally or ventro-laterally. Some spines are internally solid (Fig. 2f) but this appears a preservational artifact (see discussion below). The spine is ornamented with a longitudinal row of denticles along the posterior edge. The denticles are conical (Fig. 2e, i) or blade-shaped (Fig. 2n, o), and are posteriorly directed. The blade-shaped denticles are more densely arranged than the conical ones, and their blade plane is parallel to the spine length. They decrease gradually in size from spine base to tip. They are absent from the most distal portion of the spines. On the right spine of one specimen (Fig. 2l), there are some small papillate to hemispherical structures on right lateral surface (Fig. 2m, n). On the distal part of the spine, there is a longitudinal row of eight papillate structures on the right lateral surface (Fig. 2m, black arrows). The papillate structures are different in shape and position from the denticles. A doublure and a postero-dorsal spike are not observed, and soft parts are not preserved.

Cambrolongispina glabra gen. et sp. nov. (Fig. 3)

Etymology: Latin, *glaber*, with reference to the smooth shield and smooth antero-dorsal spines.

Holotype: GMPKU3094 (Fig. 3a).

Material: Five specimens.

Measurements: c. 360–517 μm in shield length.

Occurrence: Cambrian Series 3 *Gapparodus bisulcatus–Westergaardodina brevidens* conodont Zone; Huaqiao Formation, Wangcun section, Yongshun County, western Hunan, South China.

Diagnosis: Antero-dorsal spines 1.2–1.5 times longer than the shield length; spine surface smooth; shield surface smooth.

Description: The shield is bivalved, with symmetrical right and left valves. The shield is am-plete in outline and has slight forward and retral swings, thus the maximum length is slightly ventral to dorsal rim. It is slightly longer than high and the length/height ratio is about 1.4. The shield surface is smooth without any sculpture. A pair of spines are inserted antero-dorsally at a position about 1/7 of the shield length from the anterior end of the shield. The spines are smooth, internally hollow (Fig. 3c, i), and directed slightly postero-dorsally. They taper gradually towards a pointed and sometimes hooked tip (Fig. 3e, g). They are about 1.2–1.5 times as long as the shield length. A doublure and a postero-dorsal spike are not observed, and the soft-part anatomy is not preserved.

Remarks: The orientation of the shields is inferred from the direction of the antero-dorsal spines. The spines are posteriorly directed so that they would not obstruct the forward movement of the animal. This orientation is also consistent with the inferred insertion of the antero-dorsal spine at the "eye lobe" position.

Some specimens in our collection are crumpled or distorted (Figs. 2a, j, 3a, b, d, h), indicating that the shields were somewhat flexible and pliable. We hypothesize that the shields were originally chitinous or chitin-calcareous rather than biomineralized (e.g., phosphatic). The shields were secondarily phosphatized through mineral encrustation and impregnation processes (Xiao and Knoll, 1999). As a result, some specimens are additionally coated with a thin layer of calcium phosphate (Figs. 2b, 3c, i). Viewed through a taphonomic lens, it is clear that the

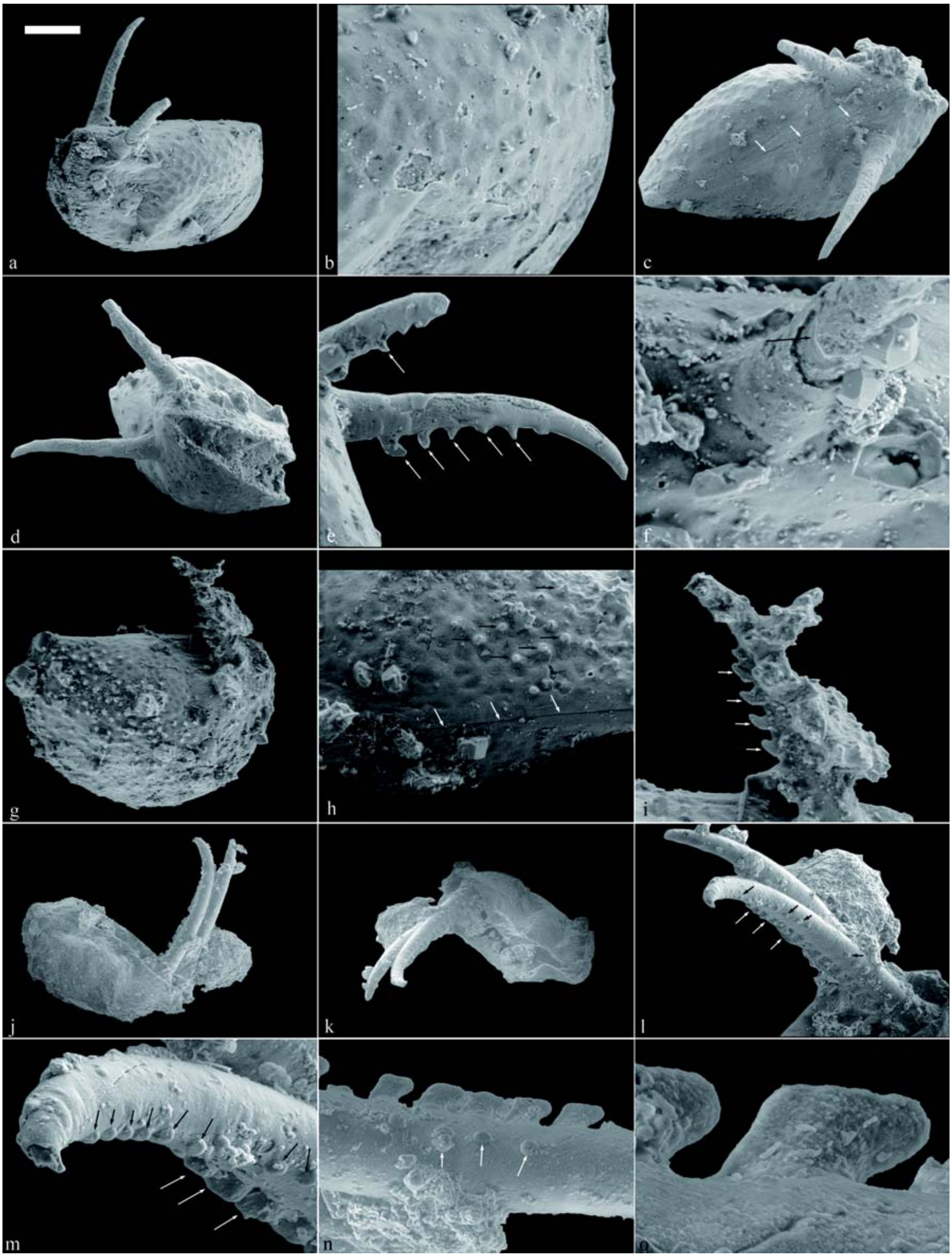

Fig. 2. *Cambrolongispina reticulata* gen. et sp. nov. from Cambrian Series 3 in Yongshun, western Hunan.
a–f, GMPKU3091, holotype, 350 μm in shield length; a, antero-lateral view; b, close-up of valve surface, showing reticulate sculpture; c, dorsal view, white arrows denoting the single dorsal furrow; d, anterior view; e, close-up of antero-dorsal spines, white arrows indicating conical denticles along posterior edge; f, close-up of spine base, black arrow indicating secondary infilling of hollow spine; g–i, GMPKU3092, 440 μm in shield length; g, lateral view; h, close-up of dorsal rim, white arrows indicating the dorsal furrow, black arrows pointing to secondarily formed small phosphatic pustulae; i, close-up of antero-dorsal spines, white arrows indicating conical denticles; j–o, GMPKU3093, 470 μm in shield length; j, antero-lateral view; k, dorso-lateral view; l, lateral view of antero-dorsal spines, white arrows indicating blade-shaped denticles, black arrows indicating papillate phosphatic structures; m, close-up of the distal portion of the right spine, white arrows indicating the blade-shaped denticles, black arrows indicating papillate phosphatic structures; n, close-up of the right spine to show blade-shaped denticles, white arrows indicating papillate phosphatic structures; o, close-up of denticles. Scale bars: a, 95 μm; b, 29 μm; c, 67 μm; d, 79 μm; e, 37 μm; f, 18 μm; g, 95 μm; h, 40 μm; i, 41 μm; j, 139 μm; k, 142 μm; l, 71 μm; m, 17 μm; n, 22 μm; o, 5 μm.

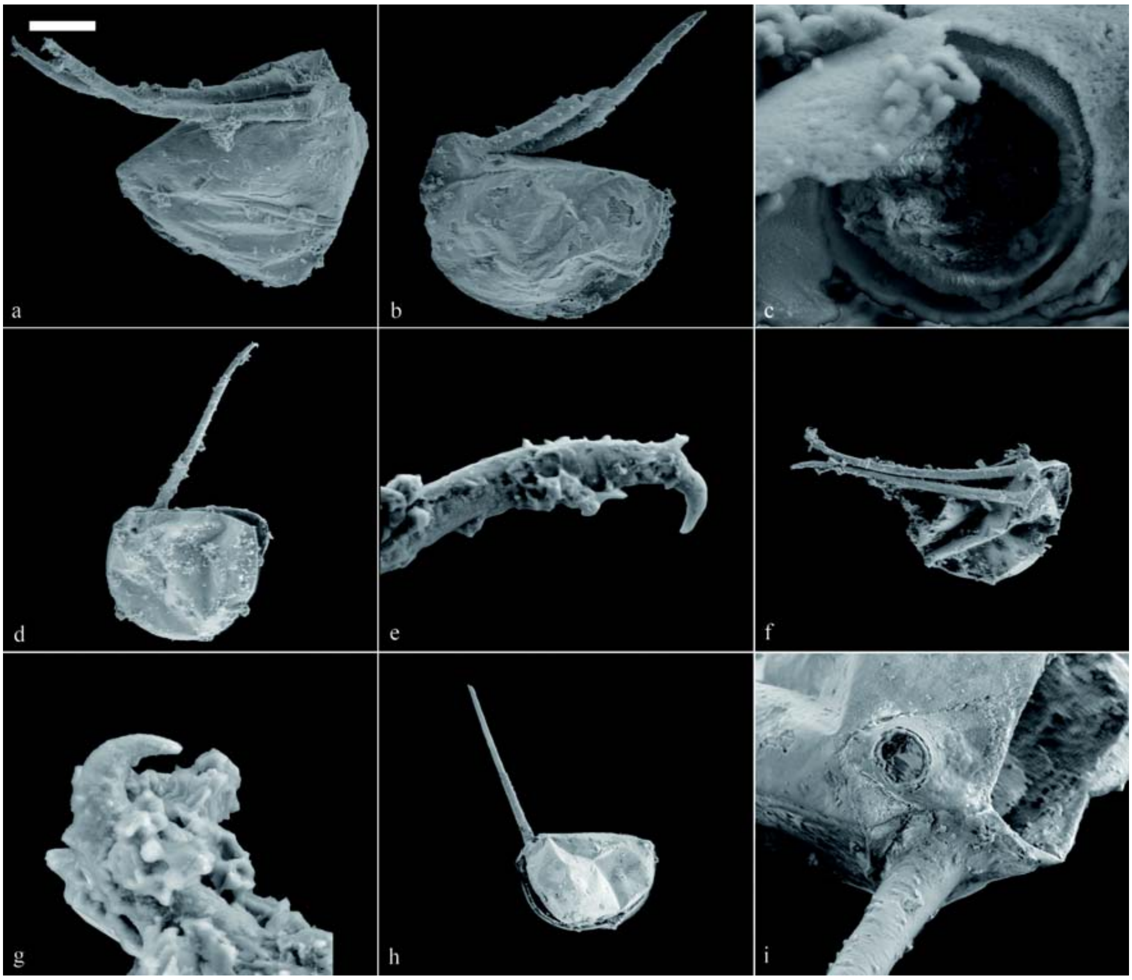

Fig. 3. *Cambrolongispina glabra* gen. et sp. nov. from Cambrian Series 3 in Yongshun, western Hunan.
a, GMPKU3094, holotype, 360 μm in shield length, lateral view; b, c, GMPKU3095, 370 μm in shield length, with a broken left spine; b, lateral view; c, close-up of distal end of broken spine, showing internally hollow nature of the spine; d, e, GMPKU3096, 377 μm in shield length, with left spine missing; d, lateral view, showing the extremely long antero-dorsal spine; e, close-up of spine, showing distally tapering and curved tip; f, g, GMPKU3097, 510 μm in shield length; f, latero-dorsal view; g, close-up of left spine, showing distally tapering tip; h, i, GMPKU3098, 517 μm in shield length, left spine missing; h, lateral view, showing the extremely long spine; i, close-up of antero-dorsal region, showing broken base of left spine. Scale bars: a, 96 μm; b, 100 μm; c, 6 μm; d, 160 μm; e, 24 μm; f, 192 μm; g, 15 μm; h, 240 μm; i, 48 μm.

antero-dorsal spines were internally hollow and the spine wall was an extension of the shield wall; the apparently solid spines (Fig. 2f) were formed secondarily through taphonomic infilling with calcium phosphate. An inner lamella, if present as in phosphatocopids (Müller, 1982; Liu and Dong, 2010), would also extend smoothly into the inner surface of the spines.

4 Comparison

The two species of *Cambrolongispina* are similar in gross shield shape, the presence of two antero-dorsal spines, the lack of a postero-dorsal spike and a doublure, and a shield devoid of structures as lobes, nodes, sulci, or depressions. They differ from each other mainly in shield ornamentation and details of antero-dorsal spines. The shield surface of *Cambrolongispina reticulata* is ornamented with reticulated sculpture whereas that of *Cambrolongispina glabra* is smooth without any ornaments. The antero-dorsal spines of *C. reticulata* are short relative to the shield length and are ornamented with denticles, whereas those of *C. glabra* are long relative to the shield length and are smooth without any ornaments. These differences support the distinction of two taxa at the species level, rather than sexual dimorphism or ontogenetic difference between instars.

Cambrolongispina is similar to the Monasteriidae Jones and McKenzie, 1980 and *Gladioscutum lauriei* Hinz-Schallreuter and Jones, 1994 in having a pair of antero-dorsal spines. The antero-dorsal spines of the Monasteriidae are relatively short, especially in *Monasterium dorium* Fleming, 1973 and *Epactridion portax* Bengtson et al., 1990, where the spines are less than 1/2 of the shield length. Compared with the

Monasteriidae, *Cambrolongispina* lacks a ridge extending from the base of the spines to the postero-medial region, a depression behind the spine, and a postero-dorsal spike. The shield of *Monasterium oepiki* Fleming, 1973 is ornamented with a fine network of polygons, and that of *M. dorium* with granules, whereas the shield of *Cambrolongispina* is reticulate or smooth. *G. lauriei* is characterized by a pair of antero-dorsal spines which are much longer than its shield length, and inserted at the most anterior end of the shield, whereas in *Cambrolongispina* the paired spines are inserted at the "eye lobe" position within the valve margins. Additionally, the shield of *G. lauriei* is strongly post-plete, i.e., the maximum height posterior to the anterior-posterior midline, different from the am-plete shield of *Cambrolongispina*. *Yucola bucerus* (Zhang, 1987) has a pair of short dorsal spines but they are positioned postero-dorsally (Zhang, 2007). *Preaechmina jiangshanensis* from the Lower Ordovician also has a pair of dorsal spines (Shu, 1990), but they are symmetrically positioned at the middle point of the dorsal rim, different from the antero-dorsal positioning of spines in *Cambrolongispina* and the Monasteriidae. The antero-dorsal spines of *Cambrolongispina* are internally hollow, and hollow spines are also reported for *E. portax* and *M. oepiki* (Bengtson et al., 1990; Hinz, 1992).

5 Affinity of *Cambrolongispina*

In the absence of soft-part anatomy, the affinity of *Cambrolongispina* can only be inferred based on the shield composition and morphology. The two most plausible interpretations relate *Cambrolongispina* to the bradoriids or phosphatocopids. Based on our observation, the shield of *Cambrolongispina* was originally chitinous or chitin-calcareous rather than biophosphatic, generally consistent with a bradoriid affinity rather than a phosphatocopid one (Siveter and Williams 1997; Williams and Siveter, 1998; Hou et al., 2001). This inference is also consistent with the lack of a doublure in *Cambrolongispina*, considering that the Phosphatocopida typically has a doublure (Zhang et al., 2011b) whereas a duplicature/doublure has been found only for some bradoriids (Zhang, 2007). However, *Cambrolongispina* also lacks key characters of the Bradoriida sensu stricto, e.g., marginal rims, valve lobation, and sulci (Hou et al., 2001). It also lacks diagnostic features of the Monasteriidae, e.g., a ridge extending from the base of the spines to the postero-medial region and a depression behind the spines (Jones and McKenzie, 1980). On balance, we propose that *Cambrolongispina* may be a close relative of the Monasteriidae (which belongs to the Bradoriida sensu lato), emphasizing the importance of the pair of antero-dorsal spines.

Strictly speaking, the Bradoriida Raymond, 1935 may not be a monophyletic taxon. Many Cambrian ostracod-like arthropods are assigned to the Bradoriida, and some of them likely represent stem-group ostracods in the lower Palaeozoic, but this interpretation needs to be substantiated with further evidence from soft-part anatomy (Raymond, 1935; Williams et al., 2007; Siveter, 2008). Müller (1964) established the suborders Phosphatocopina and Bradoriina within the Bradoriida under the Ostracoda, based on the difference of shield composition. Subsequently, both suborders are elevated to the ordinal level (Müller, 1982). Recently, the Phosphatocopida and some bradoriids are excluded from the Ostracoda, and even from crown-group crustaceans, based on soft-part anatomical evidence (Maas et al., 2003; Hou et al., 2010). The Phosphatocopida is now accepted as a sister-group to the Eucrustacea (Maas et al., 2003; Zhang et al., 2012). As to the Bradoriida, its monophyletic status is still uncertain and at least some bradoriids may be non-crustacean euarthropods and represent evolutionary transitions towards the crustaceans (Hou et al., 1996; Shu et al., 1999; Hou et al., 2010; Zhang et al., 2012). Soft-part anatomy of several phosphatocopids has been reported from Orsten-type Lagerstätten (e.g., Siveter et al., 2003; Maas et al., 2003; Dong et al., 2005), but their ontogenetic stages are incompletely preserved and many phosphatocopid species lack soft-body preservation. Soft-body preservation in the Bradoriida is rare (Hinz-Schallreuter, 1993; Hou et al., 1996; Shu et al., 1999; Chen, 2004; Hou et al., 2010). Thus, the systematic distinction between the Phosphatocopida and Bradoriida still largely relies on shield features (Siveter and Williams 1997; Williams and Siveter, 1998; Hou et al., 2001), and it is sometimes difficult to unambiguously assign a taxon to the Brarodiida or Phosphatocopida. For example, univalved dabashanellids were proposed to belong to the Phosphatocopida (Hou et al., 2001; Maas et al., 2003), but this assignment becomes conclusive only when its soft part anatomy was discovered (Zhang and Pratt, 2012).

As another example, the Monasteriidae has been variously interpreted as phosphatocopids (Jones and McKenzie, 1980; Maas et al., 2003) or bradoriids sensu lato (Fleming, 1973; Hinz, 1992; Williams et al., 2007). The Monasteriidae is characterized by bivalved shields with a pair of long and strong antero-dorsal spines. The Monasteriidae consists of two genera, *Monasterium* Fleming, 1973 and *Epactridion* Bengtson et al., 1990. *Monasterium* was originally assigned to the Beyrichonidae (Fleming, 1973), but it is devoid of the three valve lobes typical for Beyrichonidae, and instead develops a valve ridge that does not occur in other beyrichonids (Williams et al., 2007). *Monasterium* shares an antero-dorsal depression with the Beyrichonidae, but this feature is also present in other families (Williams et al., 2007). Subsequently, Jones and McKenzie (1980) interpreted *Monasterium* as a phosphatocopid and placed it in the new family Monasteriidae. This interpretation is echoed in some recent studies (e.g., Maas et al., 2003) but others regard the Monasteriidae as bradoriids albeit outside the Bradoriida sensu stricto (Williams et al., 2007). According to the literature, a doublure is either absent (Fleming, 1973) or present (Hinz, 1992) in *M. oepiki*, casting further doubt on its affinity with the Phosphatocopida. The doublure was not described in *Epactridion portax*, and Bengtson et al. (1990) remarked that *Epactridion* and the Monasteriidae should questionably be referred to the Phosphatocopida. In our opinion, the Monasteriidae is more similar to bradoriids than it is to phosphatocopids, because it bears a suite of characters that are typical of bradoriids, such as a postero-dorsal spike, a ridge extending from the base of the spines to the postero-medial region, and a depression behind the antero-dorsal spine. The so-called doublure, if at all present in the Monasteriidae as reported by Hinz (1992), differs greatly in general morphology from the doublure of the Phosphatocopida. Therefore, we follow Williams et al. (2007) to assign the Monasteriidae to the Bradoriida sensu lato, and as *Cambrolongispina* is probably a close relative of the Monasteriidae, it may well belong to the Bradoriida sensu lato.

6 Function of Antero-dorsal Spines

A pair of antero-dorsal spines are present in many bradoriid taxa but their function is still mysterious. The antero-dorsal lobes of most bradoriids are called "eye lobes", and the spines at a similar position are regarded as a transformation of the "eye lobes", implying a functional connection with the compound eyes beneath the shield (Hou et al., 2001; Zhang, 2007). However, compound eyes may be missing in the lobe-bearing phosphatocopids, for example *Falites fala* Müller, 1964 (Maas et al., 2003). Thus, it is possible that the antero-dorsal spines might be sensory organs, but their direct functional relationship with the compound eyes has not been universally established.

The long and slender antero-dorsal spines of *Cambrolongispina* are located at positions similar to those of the so-called "eye lobes" of bradoriids, and are directed postero-dorsally. There is no lobation around the bases of these spines, indicating an absence of the so-called "eye lobes" hence no direct relationship with the "eyes lobes". Both spines are long, slender, and easy to be broken especially towards the distal portions, thus a defense function is not favored. Their base is rigidly attached to the shield, lacking any maneuverability, thus they do not seem to have been morphologically adapted for feeding or swimming. They are internally hollow, and their internal space is confluent with the ventral space, without a "switch" to regulate the amount of water or possible air in the spine, thus a flotation function as in *Monasterium oepiki* is not supported (Hinz, 1992). The spines are basally attached to the shield, without a joint in between, indicating that they could not have been bent downwards and forwards to reach the sediments and mouth. Thus, they are unlikely to have functioned as feeding structures. This interpretation is also consistent with the lack of setae or branches characteristic of feeding appendages in some basal crustaceans such as *Oelandocaris oelandica* (Stein et al., 2008). Instead, we favor the interpretation that the antero-dorsal spines, with their thin and sensitive distal tips, may have functioned as sensory organs. The very delicate denticles suggest that they were adapted to detect sound or other wave actions generated by water currents or slight vibration produced by nearby predators. Therefore, we speculate that the antero-dorsal spines of *Cambrolongispina* were likely sensory organs for detection of predators.

7 Life Style

Cambrolongispina was probably a meiofaunal animal living on or within sediments. It does not seem to be particularly adapted to be a strong predator. Instead, it may have been the preys of other larger carnivorous animals. As discussed above, *Cambrolongispina* does not appear to have been a good swimmer because its long antero-dorsal spines lack maneuverability. It is possible that *Cambrolongispina* was detritus feeders (or filter feeders if they had any filtering apparatuses), cruising on sediment surface or in sediment interstitial space. Its long antero-dorsal spines extended above the sediment-water interface and served as a sensory organ to detect potential predators in the immediate environment.

8 Conclusions

Cambrolongispina gen. nov. is a new bivalved arthropod from Cambrian Series 3, Drumian Stage at Wangcun, Yongshun County, western Hunan, South China. It is characterized by a pair of long antero-dorsal spines at positions similar to those of the bradoriid "eye lobes". The spines are sometimes ornamented with a longitudinal row of conical or blade-shaped denticles along the posterior edge. The spines may have functioned as a sensory organ to detect the activities of nearby predators. The shield is thin, pliable, and probably chitinous or chitin-calcareous in original composition.

Cambrolongispina lacks the apomorphic features that define the Bradoriida sensu stricto. It also lacks a ventral doublure, excluding a close affinity with the Phosphatocopida. It is here interpreted as a new arthropod with uncertain but possible affinity with the Monasteriidae which may belong to the Bradoriida sensu lato.

Cambrolongispina was likely a meiobenthic animal living on sediment surface or in sediment interstitial space, with its antero-dorsal spines elevating above the sediment-water surface to detect nearby predators.

Two new species are recognized, *Cambrolongispina reticulata* gen. et sp. nov. and *Cambrolongispina glabra* gen. et sp. nov. They differ in the presence/absence of shield surface ornaments, denticles on the antero-dorsal spines, and spine length.

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