On a new species of *Shergoldia* Zhang & Jell, 1987 (Trilobita), the family Tsinaniidae and the order Asaphida

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The discovery of a large number of articulated specimens of *Shergoldia laevigata* sp. nov. from the late Furongian of the Guole Section, Jingxi County, southwestern Guangxi Province, China, reveals the ventral morphology of *Shergoldia* in detail for the first time. Two specimens of *Shergoldia laevigata* sp. nov. show a triangular rostral plate that bordered the wide hypostome, expanded posteriorly, and tapered acutely anteriorly. In one other specimen, a median suture lay anterior to a triangular rostelloid-like plate. The form of the rostral plate and rostelloid-like plate in *Shergoldia laevigata* sp. nov. support the idea that the median suture of asaphid trilobites originated via progressive reduction of the width of the rostral plate. However, where known or inferred in other taxa, the rostelloid is situated toward the anterior margin of the cephalic doublure. In contrast, the rostral plate and rostelloid-like plate of *Shergoldia laevigata* sp. nov. widened posteriorly. *Shergoldia laevigata* sp. nov. possesses at least six characters putatively synapomorphic for a derived asaphid clade including Asaphidae, Taihungshaniidae, Nileidae, Cyclopygidae and possibly Ceratopygidae, and appears to be allied to the family Asaphidae. The rostral morphology may represent either significant character reversal or the independent origin of the median suture in two or more lineages of Asaphida.

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THE SANDU FORMATION, consisting mainly of mudstone and marl, crops out sparsely in Guole Township, Jingxi County, southwestern Guangxi Province, China (Fig. 1). It yields a rich fauna of trilobite fossils, including species belonging to *Shergoldia, Tamdaspis* and *Sinosauckia*, which together indicate a late Furongian (latest Cambrian) age. These fossils are both abundant and well preserved. A large proportion of the material comprises articulated specimens, and a variety of ontogenetic stages are represented. The new material of *Shergoldia laevigata* sp. nov. is the first record of completely articulated exoskeletons belonging to the genus.

THE MEDIAN SUTURE AND THE ORDER ASAPHIDA

The trilobite order Asaphida (*sensu* Fortey 1990) comprises a group of trilobites which bear the median suture, a sagittal joint connecting the doublure of the left and right fixigenae. Two models for the origin of the median suture have been invoked (Fortey & Chatterton 1988, p. 180). The first is that it arose suddenly as a novel feature within the basal asaphid (i.e., it should only have arisen in one species if monophyletic). The fact that a rostral plate was not known during the ontogeny of any trilobite with an asaphoid protaspis was considered by Fortey & Chatterton (1988, p. 180) to support a sudden origin of the median suture (but see Chatterton et al. 1994). However, it could rather be taken to indicate that the median suture is a more basal asaphid synapomorphy than the asaphoid protaspis, a suggestion also consistent with the analyses of Fortey & Chatterton (1988, text-figs 1-3). The co-occurrence of specimens of *Dikeocephalus minnesotensis* Owen, some of which show yoked librigenae and others a median suture, indicates that the suture was likely lost in some forms.
without a fatal fitness cost (see Hughes 1994), but does not throw light on the origin of the structure.

An alternative explanation is that the median suture resulted from progressive reduction of the width of the rostral plate, with the result that the two connective sutures defining the lateral margins of the rostral plate finally merged to form a single, sagittal, median suture (Öpik 1967, p. 214). It is generally agreed that the phylogenetically basal sister taxon of all forms bearing the median suture had a rostral plate (Fortey 1990). The origin of the median suture via progressive reduction of the width of the rostral plate is supported in those trilobites in which the rostral plate was reduced to an extremely narrow strip, or even isolated from the posterior margin of the doublure, in which case it was called the rostellum (Öpik 1967, p. 60). The rostellum is currently defined as a "small subtriangular plate enclosed between rostral suture and connective sutures, the latter joining as median suture posterior to rostellum" (Whittington & Kelly 1997, p. 327). Thus, in all cases in which it is known or inferred, the rostellum occurred near the anterior margin of the doublure and lay anterior to the median suture.

The rostellum has been illustrated in a small number of species. It appears to have been an ontogenetically transient structure, occurring in small, but not large, holaspides of *Pterocephalia norfordi*, in which the median suture itself was rather irregular in form (e.g., Chatterton & Ludvigsen 1998, pl. 28, fig. 5). The presence of the rostellum in *Auritama aurita* was reported by Öpik (1967), but not documented in detail. The presence of a small, triangular, posteriorly narrowing rostral plate of the second protaspid instar of *Lonchodomas chaziensis* has also been used to support the idea of the origin of the median suture by reduction of the width of the rostral plate (Chatterton *et al.* 1994, fig. 14). However, the presence of a rostral plate in some larval *L. chaziensis* is difficult to interpret in terms of asaphid in-group relationships, because the mature characteristics of Trinucleoidea suggest a relationship with derived asaphids (Fortey & Chatterton 1988), which apparently lacked a rostral plate at any point in their ontogeny. Description of the ontogeny of more species and more ventral surfaces may clarify these issues.

Because the median suture is a key synapomorphy of the Asaphida (Fortey &
Chatterton 1988; Fortey 1990, 1997), the monophyly of its origin is of considerable significance. This has been questioned on the grounds that the median suture may have evolved independently in more than a single lineage of asaphid-like trilobites (Ludvigsen 1991), based on the surmise that the rostellum evolved independently in the Pterocephaliinae and Auritamidae. However, such an argument requires that the Pterocephaliinae and Auritamidae are themselves monophyletic groups, an as yet untested assertion (Chatterton et al. 1994, p. 537).

The rostral plate of Shergoldia laevigata sp. nov. is important to the question of the monophyletic origin of the median suture because it is an asaphid-like trilobite with a novel rostral morphology. Herein we reject a corynexochid affinity, invoked by some authors, for this and other tsinaniids for reasons given below. In our new species, the rostral plate is also broadly triangular but, unlike that of Lonchodoma chaziensis, it is sharply constricted in its anterior portion and widens posteriorly. The constricted form suggests adaxial migration of the connective sutures, but in a manner different from that seen in those trilobites bearing a rostellum (sensu Whittington & Kelly 1997). In some specimens of our new species it appears that adaxial migration of the anterior branches of the rostral sutures led to a median suture positioned anterior to the rostellum-like triangular plate that widened towards the posterior margin. Hence, in Shergoldia laevigata sp. nov., there was considerable intraspecific variation in the degree to which the connective sutures merged to produce a single median suture.

The phylogenetic significance of the rostral structure of Shergoldia laevigata sp. nov. depends on the status of its other characters, discussed below. Regardless of its phylogenetic placement, it suggests an alternative pattern by which the median suture might have evolved: anterior-first closure of the connective sutures, as opposed to the posterior-first closure inferred in those forms with a “true” rostellum.

SYSTEMATIC AFFINITIES OF SHERGOLDIA LAEVIGATA SP. NOV. AND OTHER TSINANIIDS

We do not attempt a comprehensive review of the systematic position of Shergoldia and the Tsinaniidae within Asaphida, but make the following comments. Shergoldia laevigata sp. nov. and other Tsinaniidae resemble Asaphida in characters commonly associated with a transversely expanded body form. These include the expanded librigenal and pygidial doublure, the quadrate hypostome with a relatively wide border, the lack of ornament on the dorsal surface and the overall effacement. It is also isopygous, with the holaspid pygidial axis comprising a large number of segments that progressively diminish in size toward the posterior. It may also have been able to enrol in a spherical manner, as did several derived asaphids. Although these features were characteristic of derived asaphids belonging to the Asaphidae, they are also known in several more basal Asaphida and non-asaphid libristomates placed in the “Ptychopariida”. The hypostome of Shergoldia laevigata sp. nov. lacks posterior marginal spines typical of many asaphids, but is reminiscent of that in Dikelocephalus minnemontesissis Owen (see Hughes 1994), Niobella aurora Westergård (Westergård 1939, pl. 2, fig. 2) and Megistaspidella extenuata (Wahlenberg) (see Jaanusson, 1956, pl. 1, fig. 5), although the hypostome of Shergoldia laevigata sp. nov. lacks maculae, and the border is more narrow in some cases.

Shergoldia laevigata sp. nov. also shows a number of characters that may, in combination, be considered diagnostic of the family Asaphidae. These include the conterminant hypostomal condition, the presence of eight homonomous thoracic segments in the holaspid phase, the isolated form of the S1 furrows, the presence of baculae and of an eye socle, and the absence of the circumocular suture. These characters are apparently synapomorphic for a derived group of asaphids including Asaphidae, Taihungshaniidae, Nileidae and Cyclopigidae (Fortey & Chatterton 1988). The anterior branches of the dorsal facial suture of Shergoldia laevigata sp. nov. (as in other tsinaniids) run supramarginally which, within this clade of derived asaphids, is a character considered synapomorphic for Asaphidae (Fortey & Chatterton 1988). Other tsinaniids also bore such features (e.g., the eye socle of Shergoldia antidictys; see Shergold 1975, pl. 49, figs 3, 6).

A remarkable feature of Shergoldia laevigata sp. nov. is the presence of a segment with markedly elongated pleural spines at the anterior of the early holaspid pygidium (Figs 2A-B, 3J). These spines became entirely obsolete in later holaspides (Figs 2F-G, 3A-B, E, H), in which all thoracic segments were homonomous and the pygidial margin smooth. Transient spines evident at the anterior of the pygidium in other tsinaniids resemble those present in the holaspid pygidia of Ceratopygidae, which is classified as a sister taxon of the Asaphidae under the Asaphoidea (Fortey & Chatterton 1988, text-fig. 1; Fortey 1997). In ceratopygids, as in Shergoldia laevigata sp. nov., such spines are evidently associated with a single segment, in contrast to the marginal
pygidial spines of some other derived asaphids, which may have been associated with several segments (Fortey & Chatterton 1988). A similar “single segment spine” condition also pertains in Promegalaspides, an early member of the Asaphidae, in which the eighth thoracic segment is macropleural (Westergård 1939). While it might be tempting to interpret ontogenetic loss of the spine in Shergoldia laevigata sp. nov. as an intermediate state between the macropleural condition in some ceratopygids and the spineless condition in most Asaphidae, both the presence and position of macropleural spines was variable among these asaphid groups and establishing specific homologies may be challenging. For example, the macropleural spine occurs on the ninth trunk segment, which is the anterior pygidial segment, in holaspid Shergoldia laevigata sp. nov., on the eighth trunk segment, which is the last thoracic segment, in holaspid Promegalaspides kinnekullensis Westergård, 1939, and on the tenth trunk segment, which is the anterior pygidial segment, in holaspid Proceratopyge (Proceratopyge) truncata Yang (see Peng et al. 2004, pl. 54, fig. 6).

Despite this combination of overall and specific similarities to several members of the derived Asaphida, Shergoldia laevigata sp. nov. differs from such taxa in some features considered of key importance in assessing asaphid systematics. In addition to the remarkable presence of a rostral and rostellum-like plate, it and other tsinaniids lack a median pre-occipital tubercle, which is seen in most derived asaphids. An occipital tubercle is evident in the holotype of the type species of the genus Shergoldia, S. nomas (Shergold 1975, pl. 47, fig. 1) and this suggests that the absence of the pre-occipital tubercle in tsinaniids is not simply due to effacement. The condition of other potentially important features in assessing asaphid systematics, such as the presence of the asaphoid protaspid and the petaloid facet (which is also known in dikelocephalids [Hughes 1993] and therefore not restricted to a derived asaphid clade containing Asaphidae, Taihungshaniidae, Nileidae and Ceratopygidae) is presently unknown in S. laevigata sp. nov. Overall, the evidence at hand places Shergoldia laevigata sp. nov. and other tsinaniids within a derived clade containing the Asaphidae, Taihungshaniidae, Nileidae and Ceratopygidae, with location among basal Asaphidae being the best supported hypothesis.

IMPLICATIONS OF THE ROSTRAL STRUCTURE OF SHERGOLDIA LAEVIGATA SP. NOV.

Three hypotheses could explain the curious rostral structure of Shergoldia laevigata sp. nov. The first is that the rostral plate and rostellum-like plate plus median suture are taphonomic artifacts related to movement of the hypostome into the glabellar cavity during compaction, following soft part decay. Fractures in the doublure mimicking rostral sutures might have occurred if the hypostome was rigidly attached to the doublure. Arguments in favour of this explanation include the variable appearance of the rostral plate and rostellum-like plate/median suture, and the fact that simple simulations of this kind of compaction using a seed case in one attempt and an egg shell in another produced cracks that mimicked the inverted “V” shaped form of the rostral plate.

Arguments against this explanation include: 1) Shergoldia laevigata sp. nov. possessed a hypostomal suture that functioned to permit separation of the hypostome and doublure in at least one specimen (Fig. 3C-D) – that structure would be expected to accommodate most of the displacement during compaction and evidently did so in one case; 2) although variable, the rostral sutures in Shergoldia laevigata sp. nov. are consistently bilaterally symmetrical and more regular than cracks evident elsewhere on the exoskeleton (Fig. 3F, H); 3) the variability seen in Shergoldia laevigata sp. nov. is consistent with that in the presence and form of the median suture known among other trilobites (Hughes 1993, 1994; Chatterton & Ludvigsen 1998); and 4) sutures indicate the presence of the posteriorly widening rostral plate in disarticulated librigenae that may never have belonged to compacted carcasses (Fig. 2E). These arguments provide a powerful case against the compaction-related explanation for these structures.

A second possibility is that the occurrence of the rostral plate and rostellum-like plate in Shergoldia laevigata sp. nov. is an evolutionary reversal. The rostral condition of other tsinaniids is unknown, but no other cases of reversal to a rostral plate are known within Asaphida, although loss of the median suture was quite common. In this case, reversal would not simply involve atavistic resurrection of a former structure, but would also require the formation of a novel structure, the posterior rostellum-like plate.

The third possibility is that intraspecific variation in the rostral condition of Shergoldia laevigata sp. nov. chronicles origin of the median suture. If so, and the monophyly of the Asaphida is to be maintained, considerable revision of concepts of character polarity within the order will be required. However, the presence of the rostellum and median suture in natant trilobites such as Pterocephalia norfordi, is considered by Fortey & Chatterton (1988) to represent the basal stages of the evolution of the median
suture. Such trilobites are strikingly different from *Shergoldia laevigata* sp. nov. in many aspects of their morphology. Hence it is possible that there was a diphyletic origin of the median suture. In one lineage, reduction of the width of the rostral plate led to formation of the anteriorly situated rostellum with a median suture behind it, as in *Pterocephalia*, and in the other, to the formation of the posteriorly situated rostellum-like plate, as seen in *Shergoldia laevigata* sp. nov. This explanation implies separate origins for major clades of asaphid trilobites and challenges the current concept of the order Asaphida. It would also require a diphyletic origin for the asaphoid protaspis. This seems rather unlikely, although similarly inflated protaspides do occur convergently among non-asaphid trilobites (Lerosey-Aubril & Feist 2005), perhaps in relation to a planktic life mode (Speyer & Chatterton 1989) or lecithotrophy.

Chatterton (1980, fig. 3) showed that the librigenae of a late protaspid of *Isotelus parvirusgosus* Chatterton & Ludvigsen, 1976 are separated by a median suture, but that this suture divides into two branches at the anterior of the hypostome. It might be argued that the area of the hypostome indented into the doublure is a small rostral remnant fused to the anterior of the hypostome and, if so, this might resemble structures seen in *Shergoldia laevigata* sp. nov. However, such an interpretation of the rostral structure of *I. parvirusgosus* is speculative.

The assignment of Tsinaniidae has long been debated because of their effaced morphology, incomplete knowledge of ventral surfaces, and their curious combination of characters. Members of the family are commonly assigned to Ptychoparioidea (Shaw 1952; Kobayashi 1962), Asaphoidea (Hupé 1955; Lochman-Balk 1959; Chernysheva 1960; Lu et al. 1965), Leiostegioidea (Shergold 1975, 1991) or Illaenoidea (Fortey 1990, 1997). The Illaenoidea/corynexochid affinity links the bacculae of tsinaniids and some leiosestegids to the lunettes of illaenids. We do not see diagnostic features that link tsinaniid bacculae to illaenid lunettes, as tsinaniid bacculae also can be compared to the bacculae of Asaphida. Shergold’s (1975, p. 197) argument for leiosestegid links is based primarily on: 1) the similarity of some leiosestegid pygidia with those of tsinaniids; and 2) the short and sharply upturned anterior border of a meraspid cranidium of *Shergoldia necopina* that was suggested to resemble the form of the leiosestegid anterior border. With regard to the first point, although we acknowledge the specific similarity to which Shergold alluded, we consider the pygidial condition reported in *Lloydia (Leiosestgium) douglasi* (see Harrington & Leanza 1957, fig. 24.3a, c) to be derived and convergent with a condition common throughout Asaphida. Similar marked convergence in pygidial form is well known among lower Palaeozoic trilobites (Rushton & Hughes 1996), and we see no compelling reason for preferring a specific link between tsinaniid and leiosestegid pygidia. Macropleural spines such as those seen in *Shergoldia laevigata* sp. nov. are also known within derived Asaphida (see above). With regard to the second character, we note the corollary of Shergold’s argument: holaspid tsinaniid cranidia are distinguished from leiosestegiid cranidia by the marked frontal area, a character shared between tsinaniids and Asaphida (among other trilobites). Furthermore, asaphid juveniles also commonly had short frontal areas. In summary, we do not consider that the few characters purported to link tsinaniids to leiosestegiids or corynexochids are likely to be of phylogenetic importance. Rather, we consider that the multiple characters shared with members of Asaphida justify our exclusive comparison of *Shergoldia laevigata* sp. nov. with members of that group.

As mentioned above, *Shergoldia laevigata* sp. nov. had a pair of anterolateral marginal pygidial spines which disappeared in later holaspides. *Tsinania canens* (Walcott, 1905), the type species of *Tsinania* (Zhang & Jell 1987), *Shergoldia necopina* (Shergold, 1975) and *Lonchopygella mansuyi* (Sun & Xiang, 1979) also have a pair of anterolateral marginal pygidial spines which disappeared in later holaspid instars. Trunk development in tsinaniids was apparently protarthrous (Hughes et al. 2006) in that additional pygidial segments appeared during holaspid ontogeny (Figs 2F, 3J).

**SYSTEMATIC PALAEONTOLOGY**

The morphological terms used in this study are defined by Whittington & Kelly (1997). All of the specimens from the Sandu Formation described herein are deposited in the collections of the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences (NIG143429-143438).

Order ASAPHIDA Salter, 1864

Superfamily ASAPHOIDEA Burmeister, 1843

Family TSINANIIDAE Kobayashi, 1933

**Remarks.** Since its establishment, this family has been reviewed by Lochman-Balk (1959), Shergold (1975), Zhang & Jell (1987) and Fortey (1997). We concur with nearly all previous authors in placing *Tsinania (=Dictya* Kobayashi, 1933; =*Dictyites* Kobayashi, 1936) and *Shergoldia* in Tsinaniidae. Kobayashi (1933) also assigned his
new genus *Dictyella* to this family, and this was accepted by Jell & Adrain (2003), but Han & Chen (2004) ascribed *Dictyella* to Asaphidae based on their new material that included two nearly complete exoskeletons, which were collected from the same section as ours. *Dictyella* is distinguished from *Shergoldia* by a long terminal spine on the pygidium, but most of its dorsal features are unclear, except for the wide librigenal and pygidial doublures. *Dictyella* and *Shergoldia* are closely comparable, and a comprehensive revision is required to assess whether the former is a senior synonym of the latter. Sun & Xiang (1979) ascribed their new genus *Lonchopygella* to Tsinaniidae, and that opinion has been accepted by Zhang & Jell (1987), Jell & Adrain (2003), and also by us. *Lonchopygella* is distinguished from *Shergoldia* by its nearly rectangular glabella, shorter preglabellar area, and triangular pygidium which bears a terminal spine. *Paradictyites* Liu, 1982 is very reminiscent of *Shergoldia*, and is distinguished only by the sharply forward tapering glabella, relatively longer preglabellar area (sag.) and wider pygidial border, and we concur with Liu (1982) and Jell & Adrain (2003) on assigning *Paradictyites* Liu, 1982 to Tsinaniidae. *Taipaikia* Kobayashi, 1960 was assigned to the Tsinaniidae by Kobayashi (1960) and Jell & Adrain (2003), but its facial suture cuts the frontal margin at about the mid-breadth of the fixigena, which contrasts with the condition in other taxa assigned to Tsinaniidae. Other ‘upper’ Cambrian genera such as *Esseigania* Kobayashi, 1943 and *Guluheia* Zhang & Wang, 1985, which were included in Tsinaniidae by Jell & Adrain (2003), are tentatively referred to the Tsinaniidae based on their overall resemblance to *Tsinania*, but many important features of morphology are unknown in these genera. *Esseigania* is easily differentiated from *Shergoldia* by its small, posteriorly situated palpebral lobes. *Guluheia* appears to lack a preglabellar field, which may distinguish it from *Shergoldia*. Some ‘middle’ Cambrian trilobite genera, such as *Jiwangshania* Zhang & Wang, 1985, *Leiaspis* Wu & Lin in Zhang et al., 1980, and *Zhujia* Ju in Qiu et al., 1983, are distinguished from other tsinaniids in having cranidia with strongly upturned anterior borders and/or firmly impressed anterior border furrows. These taxa and *Blandiaspis* Qian in Qiu et al., 1983, which is differentiated from *Shergoldia* by its proportionally wider cephalic and pygidial axis, relatively large palpebral lobes and short anterior border, may also lack the supramarginal condition of the anterior branches of the facial suture, which is considered diagnostic of the family Tsinaniidae. We consider it likely that the similarities of these genera with other tsinaniids are convergent. An emended diagnosis of this family, based partly on our new material, is presented below.

**Diagnosis.** Effaced opisthoparian and isopygous trilobites. Glabella low, sides subparallel or tapering forward, with or without bacculae, front rounded; frontal area present, all furrows faint or obsolete; medium-sized palpebral lobes situated slightly behind midlength of cranidium; anterior facial suture supramarginal and meeting in the sagittal point of anterior margin; hypostomal condition conterminant, hypostome quadrate, border wide; librigenae with eye socle and visual surface attached, wide doublure and long genal spines. Holaspid thorax with seven to nine segments, with deep, narrow pleural furrow and broadly falcate ends. Pygidium subtrangular to semicircular, axis low, long and narrow, comprising a large number of segments; pleural fields wider than axis, with expanded doublure, with or without a terminal spine. Surface smooth.

**Shergoldia** Zhang & Jell, 1987

1987 *Shergoldia*; Zhang & Jell, p. 196.
1991 *Shergoldia* Zhang & Jell; Shergold, p. 31.
2005 *Shergoldia* Zhang & Jell; Duan et al., p. 170.

**Type species.** *Tsinania nomas* Shergold, 1975, p. 202-203, pl. 47, figs 1-7, text-fig. 66; Chatsworth Limestone, western Queensland, Australia; late Upper Cambrian, early Payntonian, *Pseudagnostus quasibilobus-Shergoldia nomas* Assemblage-Zone; by original designation (Zhang & Jell 1987, p. 196).

**Other species.** Species listed by Zhang & Jell (1987) are accepted herein. In addition, Shergold et al. (1988), Shergold (1991), Peng (1992) and Duan et al. (2005) each contributed one additional species to the list. *Shergoldia* cf. *S. nomas* (Shergold et al. 1988, p. 316, fig. 4A-G) from the Tarutao Formation, Tarutao Island, Thailand; *Shergoldia* sp. undet. (Shergold 1991, p. 31, pl. 1, figs 12-17) from Assemblage 1 of the Payntonian/early Datsonian Pacoota Sandstone, Furongian (latest Cambrian), Amadeus Basin, Northern Territory, Australia; *Shergoldia australis* Peng (1992, p. 80, fig. 42C-E, L) from the *Shergoldia-Ivshinaspis quasibilobus* Subzone of the *Lotagnostus punctatus-Hedinaspis regalis* Zone, late Furongian, Shenjiawan Formation, Shenjiawan, Cili, Hunan; *Shergoldia yanshanensis* Duan (in Duan et al. 2005, p. 170-171, pl. 34, figs 12-13), from Fengshan Formation (late Furongian), Yangjiazhangzi,
Jinxi, Liaoning.

Emended diagnosis. Less effaced Tsinaniidae. Anterior facial suture divergent forward, branches beginning to curve smoothly inward opposite anterior margin of glabella to meet axially; librigenal borders wide and extending backward into genal spines. Frontal area with short preglabellar field and plectrum, weakly incised border furrow, and long border. Holaspid thorax with eight segments. Holaspid pygidium with narrow axis and broad border, having no terminal spine.
Shergoldia laevigata sp. nov. (Figs 2-3)

Etymology. From the Latin laevigatus, smooth, referring to the smooth exoskeleton.

Holotype. NIG143435, Fig. 3A-D; paratypes NIG143429-143434; 143436-143438, Figs 2A-G, 3E-J.

Diagnosis. Shergoldia with large exoskeleton, glabella tapering forward gradually with a pair of small bacculae opposite the posterior ends of palpebral lobes; occipital and glabellar furrows faint, occipital ring short (sag.); palpebral lobe small for genus, situated opposite midpoint of glabella; posterolateral projection short and wide, posterior border furrow faint; pygidial axis tapering backward strongly, pygidial border broad.

Description. Exoskeleton ovate, cephalon semicircular with low convexity, occupying one-third of exoskeletal length; glabella tapering forward gradually, broadly rounded anteriorly; occipital furrow faint; at least three pairs of faint lateral glabellar furrows which are isolated from the axial furrows; a pair of small baccalae merge with glabella; anterior of baccalae level with the posterior of the palpebral lobes; axial furrow shallow. Palpebral lobe moderately convex, up to 42% of glabellar length, midpoint opposite the midpoint of glabella, palpebral furrow evident; eye ridge moderately convex, narrowing adaxially. Anterior branches of facial suture supramarginal and divergent forward, meeting sagittally at the cephalic margin, posterior branch strongly divergent backward. Preglabellar area long (sag.), nearly half length of glabella, preglabellar field short (sag.), anterior border long (sag.), border furrow weakly incised; palpebral area nearly equal in width to glabella, posterolateral projection blade-like, width equal to that of postocular area. Librigena wide, with broad lateral border, extending backward to form stout genal spine, doublure wide with terrace ridge ornament; eye socle moderately convex, separated from fixigena by eye socle furrow, visual surface fused to eye socle. Rostral plate triangular in outline, wider posteriorly with terrace ridge ornament less dense on ventral surface than on dorsal surface, or with triangular rostelmate-like plate preceded by median suture; hypostomal condition conterminant, outline quadrate with broad border, anterior lobe of middle body elliptical, with high convexity, medial furrow wide and deep, posterior lobe of median body short and crescentic; anterior border wide, surface with fine terrace ridge ornament.

Holaspis thorax of eight homonomous segments, axis weakly tapering backward, narrower than pleural region; articulating facet wider than inner pleural region in anterior segments; pleural furrow diagonal, gradually becoming wider outward, reaching the maximum width at fulcrum, then narrowing and shallowing outward, obsolete before sharp pleural tip. Pygidium wider than long, semicircular in outline and moderately convex, axis half width of pleural region, tapering strongly backward, with 11 axial rings and terminal axial piece in large holaspides, development protarthrous; border and doublure wide, fine terrace ridge ornament on doublure; pleural and interpleural furrows faint. Early holaspides with a pair of anterior pygidial spines which became obsolete in larger holaspides.

Remarks. A different density of terrace ridges on the dorsal and ventral surfaces of the rostral plate is inferred from the condition in Figure 3G, which contrasts low ridge density on the ventral surface of the doublure with the higher density on what appears to be the dorsal surface of the rostral plate. This inference is supported by the continuity of ridges seen on the doublure and rostelmate-like plate in Figure 31. From the material at hand, it is difficult to determine whether or not Shergoldia laevigata sp. nov. possessed a Panderian opening. Shergoldia laevigata sp. nov. resembles S. taianfuensis (Endo) (=Dictya dictys [Walcott] sensu Kobayashi 1933, p. 138, pl. 14, figs 7-9) in most aspects of the cranidium. These include the shape of the glabella, the proportional length of the frontal anterior area and the course of the facial suture. However, in S. taianfuensis, the anterior half of the cranidium is more effaced and the pygidial axis is relatively wider and tapers backward more gently than in the new species. Shergoldia laevigata sp. nov. is distinguished from S. dolichocephala (Kobayashi, 1933) by having more divergent anterior and posterior facial sutures. Shergoldia trigonalis (Kobayashi, 1933) is easily distinguished from the new species by having a more effaced glabella which is parallel-sided rather than forward tapering. The Australian species of Shergoldia differ from the new species in having relatively larger palpebral lobes. In addition, the glabella in S. nomas (Shergold, 1975) is more effaced and the baccalae in S. necopina (Shergold, 1975) are larger than that in the new species. The early holaspis pygidial spines of Shergoldia laevigata sp. nov. are like those of S. necopina (Shergold, 1975) and Lonchopygella mansuyi Sun & Xiang, 1979. An isolated librigena of Shergoldia cf. nomas from Thailand (Shergold et al. 1988, fig. 4D), has a
Fig. 3. *Sbergoldia laevigata* sp. nov. A-D, Holotype, NIG143435. A-B, latex cast and internal mould of nearly complete holotype exoskeleton, x3.5. C, enlarged image of latex cast of the internal mould. Note the shape of the triangular rostral plate indicated by white arrow. x21. D, partly enlarged latex cast of internal mould. Note the morphology of the hypostome and the rostral plate indicated by white arrows. x7. E-G, NIG143436. E, incomplete exoskeleton, internal mould. x1. F, same following partial excavation, x2. G, enlargement of sagittal portion of F. Note the shape of rostral plate indicated by white arrow. x2.7. H-I, NIG143437. H, incomplete exoskeleton, internal mould. x1. I, partly enlarged of H. Note the conterminant hypostomal condition, the median suture and the morphology of hypostome and rostral plate indicated by white arrows. x3. J, internal mould of an apparently early holaspid exoskeleton. Note the anterior pygidial spines that become obsolete in larger holaspides indicated by white arrow. NIG143438. x4.
similarly curved connective suture to that of the new species, suggesting the Thailand species may also possess a subtriangular rostral plate.

Occurrence. Late Furongian, Sandu Formation, Guole, Jingxi, Guangxi, China.

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