

Supplementary Information

Title: **Articulated *Wiwaxia* from the Cambrian Stage 3
Xiaoshiha Lagerstätte**

Authors: Jie Yang¹, Martin R. Smith², Tian Lan¹, Jin-bo Hou¹, and Xi-guang Zhang^{1*}

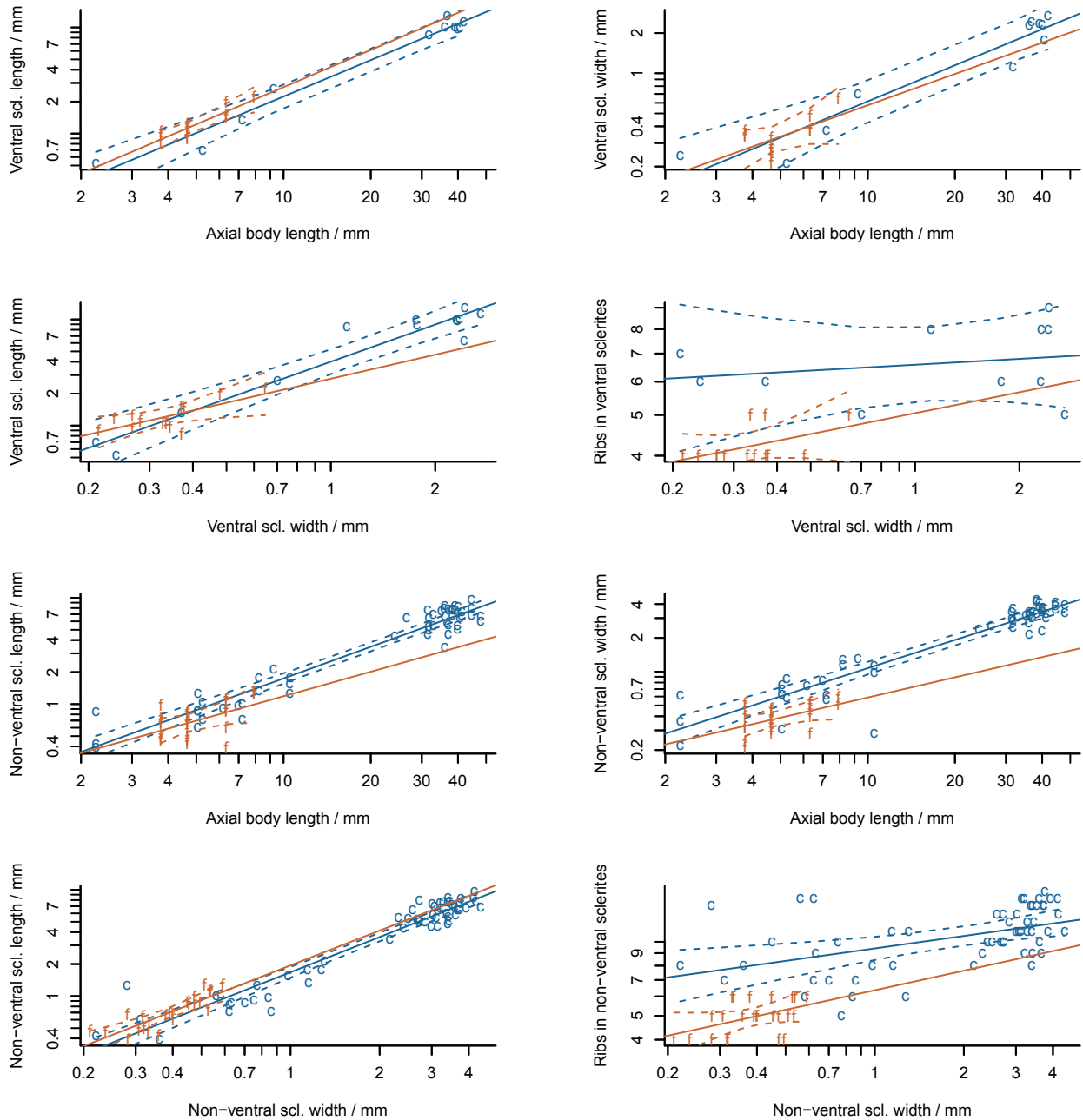
¹ Key Laboratory for Palaeobiology, Yunnan University, Kunming 650091, China.

² Department of Earth Sciences, University of Cambridge, Downing Street,
Cambridge, CB2 3EQ, UK.

* Correspondence and requests for materials to Xi-guang Zhang
(xgzhang@ynu.edu.cn).

Supplementary Figure 1 | Sclerite metrics

Variation in sclerite proportions with size in *Wiwaxia corrugata* (c, blue) and *W. foliosa* (f, orange).
Solid line: linear model of relationship; dotted lines: 99% confidence intervals. Axes logarithmic.



Supplementary Table 1 | Sclerite metrics

Measurements from digital images were log-transformed and analysed in R using linear regression models. Method and *W. corrugata* data from ref. 15.

Relationship	Species	Ventral		Non-ventral	
		Gradient	Intercept	Gradient	Intercept
Sclerite length ~ axial length	<i>corrugata</i>	1	-1.41 ± 0.25	1	-1.75 ± 0.25
	<i>foliosa</i>	1	-1.41 ± 0.14	1	-1.96 ± 0.30
Sclerite width ~ axial length	<i>corrugata</i>	1	-2.85 ± 0.31	0.84 ± 0.04	-0.71 ± 0.42
	<i>foliosa</i>	1	-2.70 ± 0.24	0.60 ± 0.21	-0.87 ± 1.75
Sclerite length ~ sclerite width	<i>corrugata</i>	1	1.41 ± 0.33	1.10 ± 0.04	-0.17 ± 0.32
	<i>foliosa</i>	1	1.29 ± 0.22	1.08 ± 0.14	0.06 ± 0.87
Ribs ~ sclerite width	<i>corrugata</i>	0	1.56 ± 0.46	0.17 ± 0.04	1.08 ± 0.30
	<i>foliosa</i>	0	0.48 ± 0.50	0.26 ± 0.11	0.02 ± 0.64

Supplementary Text | Description of fossil material

The six available specimens are fully articulated and preserved in varying states of enrolment: one specimen (YKLP 12125) is fully enrolled, four (YKLP 12120–12123) show a limited degree of anterior enrolment, and one (YKLP 12124) is entirely flat. The specimens range from 3.7 mm to 8.7 mm in length and 0.9–1.2 in length to width ratio, although in partially enrolled specimens these measurements will underestimate their full axial length.

The trunk's sclerites are arranged in four zones: sickle-shaped ventro-lateral sclerites and rounded lower-lateral, upper-lateral and dorsal sclerites. Spines are absent. An additional row of sclerites corresponds to the 'anterior zone' of Conway Morris¹²; the exact constitution of this zone is unclear due to its primarily bedding-perpendicular preservation.

Sclerites are organized in rows across the body; no specimen bears more than eight rows – the number in *W. corrugata* – and eight (plus the anterior sclerite zone) is assumed to represent the full complement of transverse rows. Size, aspect ratio and ornament each follow a consistent trajectory in sclerites from the upper three zones, and thus these zones were treated together for statistical purposes. The dimensions and aspect ratios of sclerites are not significantly different from those of *W. corrugata* (Supplementary Figure 1; Supplementary Table 1). The length and width of ventral sclerites, and the length of non-ventral sclerites, increase linearly with specimens' axial length; non-ventral sclerites' width increases less rapidly than axial length, and presumably this deficiency was overcome by adding more sclerites to bundles within the scleritome during growth. The density of ribs on ventro-lateral sclerites is constant throughout ontogeny; the mean number of ribs observed was 4.3 ± 0.5 , lower than in *W. corrugata* of similar size (6.7 ± 1.3). The number of ribs on non-ventral sclerites was also lower (four to six) in the Xiaoshiba material, although the number of specimens was inadequate to determine statistical significance.

The fossils retain a small degree of relief, and as such a correct interpretation hinges on the correct interpretation of the plane of splitting. YKLP 12125 (Fig. 1e) represents a laterally preserved specimen split close to its sagittal plane; its anterior is adjacent to its posterior end, and occurs at a slightly higher plane within the sediment. Clearly the organisms were not entirely flattened before preservation, but as with Burgess Shale specimens¹⁵ retain a reduced but positive degree of relief. In YKLP 12125, the non-ventral sclerites are obliquely inclined to the body surface in a manner reminiscent of *W. taijiangensis* (cf. ref 13). Extensive weathering poses challenges for further interpretation.

YKLP 12124 (Fig. 1f) represents a split near the dorsal surface of an unrolled specimen preserved in dorsal view. Sclerites are preserved in their erect position somewhat oblique to the plane of splitting; as such, their arrangement is somewhat obscured. Towards the posterior of the specimen are two bundles of upper-lateral sclerites arranged in fan-shaped arrays about a central anchoring point. Ventral sclerites lie above the plane of splitting and are thus obscured for much of the length of the specimen, preventing an accurate measurement of specimen width.

YKLP 12123 also represents a dorsal view; the roots of the ventral sclerites are overlain by other sclerites. The plane of splitting is medial, near the dorsal surface, and intersects sclerites near the body margins that are oblique to both the plane of splitting and the body surface.

YKLP 12120–12121 (Fig. 1a–d) both represent ventral views of specimens where the plane of splitting lies near the ventral surface; YKLP 12121 is associated with a partial counterpart. The anterior end of both specimens terminates abruptly with dorsal sclerites; in YKLP 12121 these are perpendicular to the fracture surface, whereas in YKLP 12120 they are inclined such that their roots are posterior to their tips – indicating that the very front of the organism had begun to enroll, either whilst the organism was either alive or during post-mortem decay. These two specimens provide an internal view of the scleritome; dorsal sclerites are visible only where they are not obscured by bundles of underlying upper-lateral sclerites. Upper-lateral sclerites project inwards towards the midline from a lateral attachment point and apparently represent the innermost of a bundle or ‘fan’ of sclerites as exhibited in YKLP 12124. Dorsal sclerites project posteriad from an anterior attachment point, whereas lower-lateral sclerites form fans that are approximately perpendicular to the plane of splitting. In YKLP 12120, two ventral sclerites (in two separate bundles) are substantially shorter than typical ventral sclerites; their width and shape is comparable with the distal region of co-occurring ventral sclerites (Fig. 1d). By analogy to the spines of *W. corrugata*¹⁵, these are interpreted as incipient sclerites that were incompletely formed at the time of burial.

YKLP 12122 (Fig. 1g–h) is preserved in a similar fashion, but with a greater extent of anterior enrolment. The distinctive anterior end – displaying all four sclerite types arranged centripetally about a central point – is preserved end on, occupying on a slightly higher surface than the ventral portion of the specimen (which is preserved in ventral perspective, as in YKLP 12120–12121, fig. 1a–d). This twisting is evident from the dorsal sclerites evident on the overturned margin of the specimen, which contrast with the ventral sclerites that occupy the highest level in the posterior portion.