

Fuxianhuiids are mandibulates and share affinities with total-group Myriapoda

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SUPPLEMENTARY NOTES

Terminological note. We mostly reuse the terms applied before (Hou 1987a; Chen *et al.* 1995; Yang *et al.* 2013) to fuxianhuiid morphology, although we replace cephalic (Hou 1987a) or head (Chen *et al.* 1995) shield by carapace, as we follow (Aria and Caron 2017) in the distinction between shield (cephalon with posterior articulation and limited free movement) and carapace (moveable sclerite with anterior attachment). We also adopt the term ‘ocular sclerite’ to replace “eye-bearing sclerite” (Chen *et al.* 1995) or “anterior sclerite” (Yang *et al.* 2013). The former is misleading, since the sclerite does not in fact connect to the eyes, but is placed in-between them on a protrusion of the body, while the latter is imprecise, since there are three sclerites that are effectively “anterior.”

Carapace. There has been debate about whether the fuxianhuiid carapace in general should be considered bivalved (Waloszek *et al.* 2005). Considering the lack of evidence for a bivalved carapace in either *Chengjiangocaris* (Hou and Bergström 1997; Yang *et al.* 2013), *Alacaris* (Yang *et al.* 2018) or *Shankouia* (Waloszek *et al.* 2005), this condition may be autapomorphic for *Fuxianhuia*.

Eye stalks. The eye stalks are conspicuously bulbous (Figs. 1A, C, D, 2D, 3B, D), possibly containing protocerebral ganglia such as nested optic neuropils documented by previous authors (Ma *et al.* 2012). In early interpretations of the protocerebrum of *Fuxianhuia* (Hou 1987b; Chen *et al.* 1995), however, the shape of these “protrusions” were not explicitly associated with the accommodation of specific internal tissues—as indeed the fossil specimens do not show neuropils large enough to need such an expanded internal space. Alternatively, Bergström *et al.* (2008) had proposed that these lobes could be secondary (we may say “median”) eyes. Their argument that the lobes contained the same carbonaceous traces (of nerve tissues) as the lateral eyes in their specimens was opposed by Ma *et al.* (2012), arguing, based on the absence of “corneal facets” in their own material, that these lobes had no optic function. It is noteworthy that both groups included the same specimen YKLP 15006 as a central piece of evidence in their studies, given the exceptional preservation of brain tissues in this specimen. YKLP 15006 itself does not seem to show any remains of the eye facets, but also lacks indication of internal tissues within the lobes. Our material, by contrast, does show that darker traces can also be preserved in these small structures, as well as carbonaceous margins that may delimit the frontal portion of the lobe from the stalk (Fig. 2C).

Modified and new morphological characters. The following characters were modified or newly implemented in the matrix since Aria (2020). [ACX] refer to the character number in Aria and Caron (2017):

- [21] Multiple median eyes pedunculate, large relatively to head size and forming cluster
0. Absent
1. Present

Remark: Opabiniid apomorphy also present in *Kylinxia* (Zeng *et al.* 2020). The smaller size and lack of pedunculation (or at least “protrusion” in the case of *Kylinxia*) makes this character absent in spiders and pancrustaceans. Only applicable for taxa with more than 2 median eyes.

- [37] Tergite of the ocular (protocerebral) somite, type [AC128]
0. Small, rounded
1. Small, sub-triangular
2. Large, elliptical to sub-triangular

- [38] P-Element
0. Absent
1. Present

Remark: Coding based notably on observations in Moysiuk and Caron (2019).

- [78] Disposition of contiguous hypostome and labrum plates
0. Appressed flat on ventral side of head
1. Articulating fronto-ventrally

Remark: Fuxianhuiids and euthycarcinoids both have hypostome and labral plates occupying the ventral cephalic area, by contrast to extant myriapods having these sclerites expressed fronto-ventrally, because posterior cephalic space is occupied by differentiations of cephalic appendages.

- [153] Hypopharyngeal sensilla concentrated near the mouth
0. Absent
1. Present

Remark: Shared by *Heterocrania* and myriapods, see Edgecombe *et al.* (2020). Inapplicable in taxa without hypopharynx.

- [154] Anterior tentorial apodemes
0. Absent
1. Present

Remark: Shared by *Heterocrania*, myriapods and hexapods, see Edgecombe *et al.* (2020).

- [155] Superlinguae / paragnaths
0. Absent
1. Present

- [217] Rod-like apodemes connecting to limb insertion

- 0. Absent
- 1. Present

[267] Telson type [AC202]

- 0. Spine
- 1. Plate / Spatula
- 2. Flexible extension (*Fortiforceps* and *Kylinxia*)

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