

Supplementary Information

Complexity and diversity of eyes in Early Cambrian ecosystems

Fangchen Zhao^{1,2}, David J. Bottjer², Shixue Hu³, Zongjun Yin¹ & Maoyan Zhu¹

¹State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, China,

²Department of Earth Sciences, University of Southern California, Los Angeles, California 90089, USA,

³Chengdu Institute of Geology and Mineral Resources, Chengdu Center of China Geological Survey, Chengdu 610081, China

Supplementary Table 1 | Occurrence of eyes in species from Mafang quarry.

TAXA	Phylum	Count	%	Life habits	Feeding types	Eyes
1 <i>Kunmingella douvillei</i>	Arthropoda	1962	19.74	EV	HS	Yes
2 <i>Cricocosmia jinningensis</i>	Priapulida	1958	19.70	IV	HS	No
3 <i>Diandongia pista</i>	Brachiopoda	1883	18.94	ES	SU	No
4 <i>Leanchoilia illecebrosa</i>	Arthropoda	832	8.37	EV	HS	Yes
5 <i>Mafangsclex sinensis</i>	Priapulida	674	6.78	IV	HS	No
6 <i>Naraoia spinosa</i>	Arthropoda	436	4.39	EV	HS	No
7 <i>Naraoia longicaudata</i>	Arthropoda	391	3.93	EV	HS	No
8 <i>Heliomedusa orientia</i>	Brachiopoda	282	2.84	ES	SU	No
9 <i>Lingulella chengjiangensis</i>	Brachiopoda	230	2.31	IV	SU	No
10 <i>Eoredlichia intermedia</i>	Arthropoda	178	1.79	EV	HS	Yes
11 <i>Isoxys auritus</i>	Arthropoda	130	1.31	PE	HS	Yes
12 <i>Stelostomites eumorpha</i>	Unknown	127	1.28	PE	HS	No
13 <i>Burithes yunnanensis</i>	Mollusca	89	0.90	EV	DE	No
14 <i>Waptia ovata</i>	Arthropoda	85	0.86	NK	DE	Yes
15 <i>Naraoia sp.</i>	Arthropoda	49	0.49	EV	HS	No
16 <i>Wangyuia yunnanensis</i>	Brachiopoda	43	0.43	IV	SU	No
17 <i>Branchiocaris? Yunnanensis</i>	Arthropoda	42	0.42	NK	HS	Yes
18 <i>Hazelia sp.nov</i>	Porifera	42	0.42	ES	SU	No
19 <i>Amplectobelua symbrachiata</i>	Arthropoda	41	0.41	NK	HS	Yes
20 <i>Primicaris lavaformis</i>	Arthropoda	39	0.39	EV	SU	No
21 <i>Fuxianhua protensa</i>	Arthropoda	27	0.27	EV	HS	Yes
22 <i>Canadaspis laevigata</i>	Arthropoda	22	0.22	EV	HS	Yes
23 <i>Ercaicunia multinodosa</i>	Arthropoda	21	0.21	EV	DE	Yes
24 <i>Leptomitius teretiusculus</i>	Porifera	21	0.21	ES	SU	No
25 <i>Archotuba conoidalis</i>	Cnidaria	19	0.19	ES	SU	No
26 <i>Yunnanocephalus yunnanensis</i>	Arthropoda	18	0.18	EV	HS	Yes
27 <i>Anomalocaris saron</i>	Arthropoda	17	0.17	NK	HS	Yes
28 <i>Saetaspongia densa</i>	Porifera	16	0.16	ES	SU	No
29 <i>Paraleptomitella dictyodroma</i>	Porifera	15	0.15	ES	SU	No
30 <i>Archisaccophyllia kunmingensis</i>	Cnidaria	14	0.14	ES	SU	No
31 <i>Sicyphorus rara</i>	Priapulida	13	0.13	IV	DE	No
32 <i>Paraselkirkia jinningensis</i>	Priapulida	13	0.13	IV	HS	No
33 <i>Lingulellotreta malongensis</i>	Brachiopoda	12	0.12	IV	SU	No
34 <i>Onychodictyon ferox</i>	Lobopodia	11	0.11	EV	HS	No
35 <i>Isoxys paradoxus</i>	Arthropoda	10	0.10	PE	HS	Yes
36 <i>Xiangguangia sinica</i>	Cnidaria	10	0.10	ES	HS	No
37 <i>Luolishania longicuris</i>	Lobopodia	10	0.10	EV	HS	Yes
38 <i>Isoxys curvirostratus</i>	Arthropoda	9	0.09	PE	HS	Yes
39 <i>Allonina phrixothrix</i>	Chancelloriids	9	0.09	ES	SU	No
40 <i>Palaeopriapulites parvus</i>	Priapulida	8	0.08	IV	HS	No
41 <i>Vetulicola cuneata</i>	Vetulicolia	8	0.08	NK	SU	No
42 <i>Urokodia aequalis</i>	Arthropoda	7	0.07	EV	UN	?
43 <i>Cindarella eucalla</i>	Arthropoda	7	0.07	EV	HS	Yes
44 <i>Combinivalvula chengjiangensis</i>	Arthropoda	7	0.07	EV	UN	Yes
45 <i>Longtancunella chengjiangensis</i>	Brachiopoda	7	0.07	ES	SU	No
46 <i>Leptomitella conica</i>	Porifera	7	0.07	ES	SU	No
47 <i>Retifacies abnormalis</i>	Arthropoda	6	0.06	EV	HS	Yes
48 <i>Xandarella spectaculum</i>	Arthropoda	6	0.06	EV	HS	Yes
49 <i>Haikoucaris ercaiensis</i>	Arthropoda	6	0.06	EV	HS	Yes
50 <i>Paucipodia haikouensis</i>	Lobopodia	6	0.06	EV	HS	No

51	<i>Cardiodictyon catenulum</i>	Lobopodia	6	0.06	EV	HS	No
52	<i>Halichondrites elissa</i>	Porifera	6	0.06	ES	SU	No
53	<i>Kuamaia lata</i>	Arthropoda	5	0.05	EV	HS	Yes
54	<i>Choiarella radiata</i>	Porifera	5	0.05	ES	SU	No
55	<i>Microdictyon sinicum</i>	Lobopodia	4	0.04	EV	HS	No
56	<i>Pseudoiulia cambriensis</i>	Arthropoda	3	0.03	EV	UN	?
57	<i>Beidazoon venustum</i>	Vetulicolia	3	0.03	NK	SU	No
58	<i>Fortiforceps foliosa</i>	Arthropoda	2	0.02	EV	HS	Yes
59	<i>Conicula striata</i>	Cnidaria	2	0.02	ES	UN	No
60	<i>Ambrolinevitus platypluteus</i>	Mollusca	2	0.02	EV	DE	No
61	<i>Ambrolinevitus ventricosus</i>	Mollusca	2	0.02	EV	DE	No
62	<i>Pomatrum ventralis</i>	Vetulicolia	2	0.02	NK	SU	No
63	<i>Malongella bituberculata</i>	Arthropoda	1	0.01	EV	DE	?
64	<i>Acanthomeridion serratum</i>	Arthropoda	1	0.01	EV	UN	?
65	<i>Dongshanocaris foliiformis</i>	Arthropoda	1	0.01	EV	UN	?
66	<i>Parapaleomerus sinensis</i>	Arthropoda	1	0.01	EV	UN	?
67	<i>Squamacula clypeata</i>	Arthropoda	1	0.01	EV	HS	No
68	<i>Chengjiangocaris longiformis</i>	Arthropoda	1	0.01	EV	HS	Yes
69	<i>Jianfengia multisegmentalis</i>	Arthropoda	1	0.01	EV	HS	Yes
70	<i>Saperion glumaceum</i>	Arthropoda	1	0.01	EV	HS	Yes
71	<i>Shankouia zhenghei</i>	Arthropoda	1	0.01	EV	HS	Yes
72	<i>Kuanyangia pustulosa</i>	Arthropoda	1	0.01	EV	HS	Yes
73	<i>Parapeytoia yunnanensis</i>	Arthropoda	1	0.01	NK	HS	Yes
74	<i>Pectocaris spatiosa</i>	Arthropoda	1	0.01	EV	UN	Yes
75	<i>Hallucigenia fortis</i>	Lobopodia	1	0.01	EV	HS	Yes
76	<i>Facivermis yunnanicus</i>	Lobopodia	1	0.01	IV	HS	No
77	<i>Diania cactiformis</i>	Lobopodia	1	0.01	EV	UN	No
78	<i>Petalilium latum</i>	Mollusca	1	0.01	NK	HS	Yes
79	<i>Paraleptomitella globula</i>	Porifera	1	0.01	ES	SU	No
80	<i>Corynetis brevis</i>	Priapulida	1	0.01	IV	HS	No
81	<i>Xiaoheiqingella peculiaris</i>	Priapulida	1	0.01	IV	HS	No
82	<i>Yunnanpriapulid halteriformis</i>	Priapulida	1	0.01	IV	HS	No
83	<i>Cotyledion tylodes</i>	Unknown	1	0.01	ES	SU	No
84	<i>Dinomischus isolatus</i>	Unknown	1	0.01	ES	SU	No
85	<i>Phlogites longus</i>	Unknown	1	0.01	ES	SU	No
86	<i>Heteromorphus confusa</i>	Vetulicolia	1	0.01	NK	SU	No

Counts are actual number of specimens. Total count = 9941. Hypotheses of mode of life for these species are based on published documents, interpretations of preserved morphological and anatomical features such as the presence of preserved feeding apparatus or limbs, and the presence of gut contents. Abbreviations: Life habits: IS, Infaunal sessile; IV, Infaunal vagrant; ES, Epifaunal sessile; EV, Epifaunal vagrant; NK, Nektonic; PE, Pelagic; UN, Unknown. Feeding types: SU, Suspension; DE, Deposit; HS, Hunter/Scavenger.

Supplementary Table 2 | Percentage of species and specimens with eyes in the Mafang quarry, related to life habit, feeding types, and phylum respectively.

	Species			Individuals		
	Total	Number of species with eyes	% Eyes	Total	Number of individuals with eyes	% Eyes
	<i>Phylum</i>					
Arthropoda	39	28	71.8	4370	3440	78.7
Lobopodia	8	2	25.0	40	11	27.5
Mollusca	4	1	25.0	94	1	1.1
Priapulida	8	0	0.0	2669	0	0.0
Porifera	8	0	0.0	113	0	0.0
Brachiopoda	6	0	0.0	2457	0	0.0
Unknown	4	0	0.0	130	0	0.0
Vetulicolia	4	0	0.0	14	0	0.0
Cnidaria	4	0	0.0	45	0	0.0
Chancelloriids	1	0	0.0	9	0	0.0
	<i>Life habit</i>					
Pelagic	4	3	75.0	276	149	54.0
Nektonic	10	6	60.0	201	187	93.0
Epifaunal vagrant	41	22	53.7	4167	3116	74.8
Epifaunal sessile	19	0	0.0	2342	0	0.0
Infaunal	12	0	0.0	2955	0	0.0
	<i>Feeding types</i>					
Hunter/Scavenger	45	27	60.0	7036	3338	47.4
Deposit	7	2	28.6	213	106	49.8
Suspension	25	0	0.0	2668	0	0.0
Unknown	9	2	22.2	24	8	33.3

Supplementary Table 3 | Proportional distribution of species and individuals with eyes, related to life habit, feeding types, and phylum respectively.

	Species		Individuals	
	Count	%	Count	%
			<i>Phylum</i>	
Arthropoda	28	90.3	3440	99.7
Lobopodia	2	6.5	11	0.3
Mollusca	1	3.2	1	0.03
			<i>Life habit</i>	
Epifaunal vagrant	22	71.0	3116	90.3
Nektonic	6	19.4	187	5.4
Pelagic	3	9.7	149	4.3
			<i>Feeding types</i>	
Hunter/Scavenger	27	87.1	3338	96.7
Deposit	2	6.5	106	3.1
Unknown	2	6.5	8	0.2