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A possible vicissicaudatan arthropod from the Late Carboniferous Mazon Creek Lagerstätte

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SUPPLEMENTARY INFORMATION: PHYLOGENETIC ANALYSIS

Table S1: Characters for phylogenetic analysis

CHARACTERS

1. *Nature of first appendage: raptorial appendage (0); antennae (1).*

2. *Antennal scale: absent (0); present (1).*

3. *Number of podomeres on raptorial limb: four (0); three (1); two (2).*

4. *Distal-most raptorial appendage spine bearing additional terminal claws: absent (0); present (1).*

5. *Raptorial appendages with flagellum: absent (0); present (1).*

6. *Length of distal spines on podomeres: absent or shorter than podomere (0); subequal to length of podomeres (1); longer than entire podomere series (2).*

7. *Number of post-ocular head segments: none (0); one (1); two (2); three (3); four (4); five (5); six (6); seven (7).*

8. *Nature of second appendage pair: biramous walking leg or antennae (0); uniramous walking leg (1).*

9. *Second cephalic appendage armature: as in other limbs (0); differentiated and enlarged (1).*

10. *Nature of third appendage pair: biramous walking leg (0); uniramous walking leg (1).*

11. *Cephalic endopods with chelate termination: absent (0); present (1).*

12. *Appendages under cephalo-thoracic articulation: absent (0); present (1).*

13. *Head/trunk exopods heteronomous: absent, exopods same in trunk and head (0); present, exopods in trunk different to exopods in head (1).*

14. *Trunk endopods: absent or reduced (0); present (1).*

15. *Trunk exopod structure: simple oval flap (0); exopod differentiated into proximal and distal lobes, the proximal lobe bearing lamellar setae, the distal lobe bearing short setae (1); numerous podomeres, each bearing a single seta (2); undivided lobe with lamellae (3); book gills (4).*

16. *Proximal exopod lobe: flattened lobe (0); slender shaft (1).*

17. *Distal exopod lobe: small to moderate sized flap (0); large, teardrop shaped lobe with long attachment (1).*

18. *Exopod with articulations: absent (0); present (1).*

19. *Imbricate exopod lamellae: absent (0); present (1).*

20. *Lamellae structure: thick, flat lamellae (0); delicate, comb-like lamellae (1); paddle-shaped lamellae with marginal setae (2).*

21. *Shape of undivided exopod lobe with lamellae: broad lobe (e.g.* Retifacies*,* Pygmaclypeatus*) (0); slender shaft (e.g.* Naraoiacompacta*) (1).*

22. *Non-overlapping marginal setae on distal lobe: absent (0); small setae (1); long spines or filaments (2).*

23. *Gnathobasic limbs: absent (0); present (1).*

24. *Lateral eyes: absent (0); present (1).*

25. *Nature of lateral eyes: stalked (0); sessile (1).*

26. *Stalked lateral eyes project in front of head: absent (0); present (1).*

27. *Calcified eyes: absent (0); present (1).*

28. *Dorsal exoskeletal bulge accommodating eyes: absent (0); present (1).*

29. *Eye slits: absent (0); present (1).*

30. *Dorsal median eyes: absent (0); present (1).*

31. *Dorsal eyes confined to anterior half of cephalic shield: absent (e.g. Trilobita) (0); present (e.g.   
Aglaspidida) (1).*

32. *Dorsal eye abutting glabella anteriorly: absent (e.g. Trilobita) (0); present (e.g. Aglaspidida) (1).*

33. *Dorsal eyes merge anteriorly into cephalon: absent (e.g. Trilobita) (0); present and eyes are separate   
(e.g.* Glypharthrus*) (1); present and eyes are medially fused (e.g.* Cyclopites*) (2).*

34. *Free head shield with bivalved carapace: absent (0); present (1).*

35. *Cephalic doublure: absent (0); present (1).*

36. *Width of doublure: narrow to moderately wide (0); wide (1); covers entire ventral side of cephalon (2).*

37. *Cephalon notched: absent (0); present (1).*

38. *Hypostome: median extension of the doublure, with no suture (0); natant, sclerite not in contact with   
doublure (1); with narrow overlap with pre-hypostomal sclerite (2); narrow attachment to doublure at hypostomal suture (3); absent/strongly reduced (4).*

39. *Anterior sclerite: absent (0); present (1).*

40. *Dorsal ecdysial sutures: absent (0); present (1).*

41. *Position of ecdysial sutures: preocciptal (0); postoccipital (1).*

42. *Elevated marginal rim: absent (0); present (1).*

43. *Marginal rim ornamented: absent (0); present (1).*

44. *Differentiated glabellar region: absent (0); present (1).*

45. *Head shield outline: genal spines (0); acute genal angles (1); rounded genal angles (2); lateral spine-like   
extensions of the carapace (3).*

46. *Reduced carapace: absent (0); present (1).*

47. *Anterolateral carapace spines: absent (0), present (1).*

48. *Marginal carapace spines or serration: absent (0), present (1).*

49. *Parallel transverse lineations on cephalic shield: absent (0), present (1).*

50. *Head shield with lateral notches: absent (0); present (1).*

51. *Posterior cephalic band: absent (0); present (1).*

52. *Pleural cephalic furrows: absent (0); present (1).*

53. *Cephalic articulation fused: absent (0); present (1).*

54. *Head shield extends over anterior tergites: overlap absent or identical to overlap between thoracic   
segments (0); head shield covers first thoracic tergite only (1); head shield covers multiple anterior trunk tergites (2).*

55. *Cephalic articulation with reduced tergite: absent (0); present (1).*

56. *Cuticle sculpture: absent (0); present (1).*

57. *Mineralized cuticle: absent (0); calcium phosphate (1); calcium carbonate (2).*

58. *Expanded lateral pleurae: absent (0); present (1).*

59. *Free thoracic tergites: absent (0); present (1).*

60. *Decoupling of tergites and limb pairs: absent (0); present (1).*

61. *Tergite articulations: tergites non-overlapping (0); extensive overlap of tergites (1); edge to edge pleural   
articulations (2).*

62. *Articulating half rings: absent (0); present (1).*

63. *Dorsal trunk effacement: trunk with defined (separate or fused) tergite boundaries (0); trunk tergite   
boundaries effaced laterally (1); trunk tergite boundaries completely effaced (2).*

64. *Trunk narrowed anteriorly: absent (0); present (1).*

65. *Trunk tergites reflexed anteriorly: absent, boundaries transverse or reflexed posterolaterally (0); present   
(1).*

66. *Joints between posterior tergites functional: present (0); absent (1).*

67. *Posterior tergite with single axial spine: absent (0); present (1).*

68. *Radial pleurae: absent (0); present (1).*

69. *Raised axial region: absent or weakly defined (0); present and well defined (1).*

70. *Axial furrows on trunk: absent (0); present (1).*

71. *Anterior tergal processes: absent (0); present (1).*

72. *Tuberculation of posterior tergite margin: absent (0); present (1).*

73. *Lateral axial trunk depressions of the trunk: (0) absent, (1) present.*

74. *Medial axial keel: (0) absent, (1) present.*

75. *Two parallel rows of axial carinae (spines): (0) absent, (1) present.*

76. *Two parallel rows of lateral intratergal nodes: (0) absent, (1) present.*

77. *Axial spines or nodes: absent (0); present (1).*

78. *Length of postabdomen: one segment (0); two segments (1); three segments (2); five segments (3); four   
segments (4).*

79. *Postabdomen region defined by a lack of walking legs: absent (0); present (1).*

80. *Postabdomen as differentiated tergites: absent (0); present - tergite free (e.g. some aglaspidids,   
cheloniellids,* Emeraldella*,* Sidneyia*) (1); present - preterminal tergite fused with telson (most aglaspidids) (2).*

81. *Posterior tergites strongly curved: absent (0); present (1).*

82. *Fusion of posterior trunk tergites (pygidium): absent (0), present (1).*

83. *Length of thorax relative to pygidium: longer than pygidium (0); shorter than pygidium (1).*

84. *Pygidium with median keel: absent (0); present (1).*

85. *Pygidium with broad median spine: absent (0); present (1).*

86. *Pygidium with lateral spines: absent (0); present (1).*

87. *Segmentation of raised axial region of pygidium: absent (0), present (1).*

88. *Position of anus: terminal, within telson (0); at base of telson (1).*

89. *Tailspine: absent (0); present (1).*

90. *Tailspine shape: spinose (0); paddle shaped (1); cap-like (2).*

91. *Length of tailspine: shorter than half the length of the trunk (0); longer than half the length of the trunk   
(1).*

92. *Marginal spines on tailspine: absent (0); present (1).*

93. *Tailspine with medial cleft or keel: absent (0); present (1).*

94. *Paddle with projections: absent (0); present (1).*

95. *Tailspine with multiple articulations: absent (0); present (1).*

96. *Nature of telson segmentation: single joint (telson bipartite) (0), multiannulated (1).*

97. *Telson fringed with setae: absent (0), present (1).*

98. *Lateral ridges on telson: absent (0), present (1).*

99. *Ventral sclerite covering anal region: absent (0); present (e.g. aglaspidids,* Sidneyia*) (1).*

100. *Nature of anal sclerite: anal plate (e.g.* Sidneyia*) (0); postventral plate (e.g. Aglaspidida) (1).*

101. *Postventral plate medial attachment: narrow attachment by central portion (0); wide longitudinal   
attachment (1).*

102. *Paired modified appendages: absent (0); present (1).*

103. *Nature of preterminal appendages: uropods (0); furca (1).*

104. *Nature of differentiated preterminal tergite: tergite with reduced pleurae (e.g.* Weinbergina*) (0);   
cylindrical tergite without pleurae (e.g. Aglaspidida, Cheloniellida,* Emeraldella *(1).*

**Fig. S1.** Strict consensus of 26 most parsimonious trees retrieved from the phylogenetic analysis. Support values are shown beneath each node.

