**Supplementary material**

**Character List.** See Fig. 2 for Pteraspidiformes anatomy and Fig. 3 for some characters explanations. Characters 1-65 are discrete characters, 66-112 are quantitative characters, in the form of ratio data. Characters 66-87 are those used in the continuous character analysis with the characters remaining after removal of correlated characters denoted by an asterisk. Characters 88-100 are the discretized characters with the psammosteid values left as missing (i.e. non-homologous) whereas 101-112 are the discretized characters where the psammosteids are coded as homologous. The discretized characters have not been checked for correlation as is standard with normal phylogenetic analysis. If discretization has resulted in a non-informative character, it was not included within the list or analysis.

**Discrete Characters.** 1. *Pineal plate (separate plate): (0) absent, (1) present*

2. *Pineal opening (macula): (0) uncovered, (1) covered.* Adapted from character 4 of Donoghue et al. (2000) character states refer to the dentine covering.

3. *Pineal plate enclosed by dorsal plate: (0) absent, (1) present*. Pineal plate enclosed by dorsal plate is condition seen in Anchipteraspididae (Elliott 1984), see Fig. 3.

4. *Pineal plate morphology: (0) triangular, (1) quadrangular, (2) circular/ovate, (3) flat topped ovate* (as seen in *Doryaspis*), see Fig. 3.

5. *Quadrangular pineal plate morphology, (0) rectangular, (1) anterior and posterior edge convex, (2) anterior edge concave, posterior edge convex, (3) posterior edge convex*. See Fig. 3.

6. *Pineal-orbital belt: (0) absent, (1) present.* Present when the orbital and pineal plates are in contact with each other separating the dorsal and rostral plates. Character (ch.) 25 of Pernègre (2002) and ch.12 Pernègre & Goujet (2007), see Fig. 3.

7. *Pineal-orbital plate contact:* (0) *point contact* (very small contact, just point to point), (1) *side contact* (contact majority of pineal width)*.* Ch.4 of Ilyes & Elliott (1994) and ch.26 of Pernègre & Elliott (2008).

8. *Rostral plate (separate plate): (0) absent, (1) present.*

9. *Pre-oral surface (ornamented medial area on the ventral side of rostral plate): (0) absent, (1) present.*

10. *Pre-oral field (unornamented area on the ventral side of rostral plate prior to the ascending lamella): (0) absent, (1) present.*

11. *Ornamentation of pre-oral surface: (0) transverse (1) variable orientation of ridges*.

12. *Anterior shape of rostral plate: (0) rounded, (1) rounded to a point, (2) truncated/ concave, (3) triangular*. Adapted from ch.35 of Pernègre & Goujet (2007) and ch.30 of Pernègre & Elliott (2008).

13. *Orbital notch in rostral plate: (0) absent, (1) present*. Adapted from ch.24 of Pernègre (2002), ch.11 of Pernègre & Goujet (2007) and ch.19 of Pernègre & Elliott (2008).

14. *Orbital notch in the rostral plate: (0) rounded, (1) angular.*

15. *Rostral plate pineal plate contact: (0) concave contact, (1) no notch, (2) convex notch.* Adapted from ch.14 of Pernègre & Goujet (2007) and ch.28 of Pernègre & Elliott (2008).

16*. Pair of orbital plates (separate plates): (0) absent, (1) present.*

17. *Possession of fused orbito-cornual plate:* *(0) absent, (1) present*. Fused orbit-cornual condition seen in the Anchipteraspididae (Elliott 1984), ch.15 of Pernègre & Elliott (2008).

18. *Dorsal position of the orbits:* *(0) absent, (1) present*. Coded as present if the entire orbital opening is seen in dorsal view.

19. *Delimitation of the branchial opening: (0) branchial plate & dorsal plate, (1) branchial plate & cornual plate, (2) branchial plate, dorsal plate & cornual plate, (3) branchial plate & fused orbito-cornual plate.* Adapted from ch.36 of Pernègre & Goujet (2007) and ch.2 of Pernègre & Elliott (2008).

20. *Branchial opening position on the dorsal plate: (0) posterior end of dorsal plate, (1) lateral side of dorsal plate.* Ch.1 of Ilyes & Elliott (1994), ch.5 of Pernègre & Goujet (2007) and ch.1 of Pernègre & Elliott (2008).

21. *Pair of cornual plates (separate plates): (0) absent, (1) present.* Adapted from ch.9 of Pernègre & Goujet (2007) and ch.12 of Pernègre & Elliott (2008).

22. *General Cornual plate morphology: (0) lateral (external) and posterior sides convex, (1) lateral (external) side concave and posterior side convex* (*Doryaspis*)*, (2) lateral (external) side convex and posterior side concave,* *(3) all sides rounded/convex so appears triangular* (see *Drepanaspis*). See Fig. 3.

23. *Lateral projection of cornual plates:* *(0)* *lateral projection or cornual plate less than brachial plate, (1) lateral projection the same as brachial plates, (2) lateral projection of cornual just up to greater than double that of the branchial plates* *(3)* *lateral projection vastly greater than brachial plate (4) cornual plates placed on dorsal shield*. See Fig. 3.

24. *Posterior extension of cornual plates: (0) less than posterior margin of dorsal plate, (1) equal to posterior margin of dorsal plate, (2) greater than posterior margin of dorsal plate.*

25*. Ornamentation of cornual plates: (0) scale like ornamentation, (1) long ridges parallel to the lateral (external) edge.*

26. *Dorsal plate (separate): (0) absent, (1) present.*

27*. Dorsal shield: (0) absent, (1) present. Dorsal shield composed or the equivalent to the dorsal plate, orbital plates, pineal plates and rostral plate.* Present condition seen in cyathaspids.

28. *Dorsal plate surrounded by ‘fields of tesserae’:* *(0) absent, (1) present*.

29. *Posterior margin of dorsal* *plate: (0) sinuous medial peak, (1) medial peak, (2) straight, (3) sinuous, (4) rounded*. Adapted ch.27 of Pernègre & Goujet (2007) and ch.35 of Pernègre & Elliott (2008). See Fig. 3.

30. *Brachial notch in dorsal plate: (0) absent, (1) present*. Notch in the dorsal shield for brachial opening.

31. *Embayment in dorsal plate to accommodate the cornual plates: (0) absent, (1) present* (dorsal flexture of Voichyshyn 2011).

32. *Medial posterior process (posteriorly directed medial peak/extension of the dorsal plate): (0) absent, (1) present* (present condition seen in *Doryaspis*).

33. *Notch at posterior end of the dorsal plate: (to house the dorsal spine or dorsal fulcral scale, can be enclosed), (0) absent, (1) present.*

34. *Dorsal spine: (0) absent, (1) present.* Adapted from ch.2 of Pernègre (2002) and ch.10 of Pernègre & Elliott (2008).

35. *Separate dorsal spine: (0) absent, (1) present.* Dorsal spine is its own separate plate not fused to the dorsal shield as in some Cyathaspididae.

36. *Dorsal spine base enclosed by dorsal plate: (0) absent, (1) present.*

37. *Ornamentation of dorsal spine: (0) scale like, (1) longitudinal ridges.*

38. *Orientation of the mouth: (0) ventral position, (1) dorsal position.* Ch.1 of Pernègre (2002)

39. *Number of pairs of lateral postoral (orogonal) plates: (0) 1 pair, (2) 2 pairs*. Ch.8 of Pernègre (2002) and ch.53 of Pernègre & Elliott (2008).

40. *Accessory plates along dorsal plate margin: (0) absent, (1) present.* Ch.6 of Ilyes & Elliott (1994), ch.27 of Pernègre (2002) and ch.5 of Pernègre & Elliott (2008).

41. *Internal organ impression:* *(0) absent, (1) present.* Ch.38 of Pernègre & Goujet (2007) and ch.36 of Pernègre & Elliott (2008).

42. *Continuous tubercle bands (ornamentation) pattern on dorsal shield: (0) absent, (1) present*. Condition for Pteraspidiformes and some Cyathaspididae, but not *Drepanaspis*.

43. *Arrangement of dentine tubercle ridges on dorsal plate: (0) lateral addition of dentine ridges, (1) concentric circles from a primordium.* Adapted fromch.10 of Pernègre (2002) and ch.6 of Pernègre & Elliott (2008). See Fig. 3.

44. *Position of primordium for concentric growth on dorsal plate*: *(0) primordium in the anterior half of the dorsal plate, (1) primordium in the centre of dorsal plate, (2) primordium in the posterior half of the dorsal plate.* Contingent on character 65, state (1)*.* Adapted fromch.11 of Pernègre (2002), ch.7 of Pernègre & Goujet (2007) and ch.8 of Pernègre & Elliott (2008). See Fig. 3.

45. *Dentine tubercle edge ornamentation: (0) smooth, (1) crenulate, (2) serrated*. Adapted from ch.21 of Pernègre & Goujet (2007) and ch.9 of Pernègre & Elliott (2008). See Fig. 3.

46*. Tops of dentine ridges: (0) smooth, (1) crested.* See Fig. 3.

47. *Ornamentation configuration within the banding: (0) uniform (continuous ridges), (1) undulating ridges (tuberculated ridges), (2) rows of tubercles, (3) tubercles not in rows.* Adapted from ch.2 of Ilyes & Elliott (1994). See Fig. 3.

48. *Anterior end of supra-orbital canal (SOC), (0) convergent, (1) parallel, (2) divergent.* See Fig. 2C.

49. *Middle/Posterior end of SOC, (0) convergent, (1) parallel, (2) divergent.* Adapted from ch.33/34 of Pernègre & Goujet (2007) and ch.49/50 of Pernègre & Elliott (2008). See Fig. 2C.

50. *Posterior prolongation of SOC, (0) between orbital and pineal plate/areas, (1) onto the pineal plate/area, (2) onto orbital plate/area*. Adapted from ch.20 of Pernègre & Goujet (2007) and ch.48 of Pernègre & Elliott (2008). See Fig. 2C.

51. *Position of SOC, (0) medial, (1) lateral*. See Fig. 2C.

52. *Anterior extension of Median dorsal canal (MDC) when meeting the pineal canal, (0) pineal plate, (1) orbital plate, (2) meets pineal canal on the dorsal plate, (3) between orbital and pineal plates.* Adapted from ch.19 of Pernègre & Goujet (2007) and ch.45 of Pernègre & Elliott (2008). See Fig. 2C.

53. *Anterior end of MDC, (0) convergent, (1) parallel, (2) divergent.* Ch.15 of Pernègre (2002), ch.4 of Pernègre & Goujet (2007) and ch.44 of Pernègre & Elliott (2008). See Fig. 2C.

54. Anterior *MDC begins on the dorsal disc without connection to any other canals,* *(0) absence, (1) presence.* See Fig. 2C.

55. *Pineal canal, (0) absence, (1) presence.* Adapted from ch.13 of Pernègre (2002) and ch.51 of Pernègre & Elliott (2008). See Fig. 2C.

56. *Pineal canal, (0) loops around pineal plate, (1) loops through pineal plate*. Adapted ch.5 of Ilyes & Elliott (1994), ch.13 of Pernègre (2002), ch.2 of Pernègre & Goujet (2007) and ch.52 of Pernègre & Elliott (2008). See Fig. 2C.

57. *Number of transverse commissures (TC) on the dorsal plate* *(0) 3 (1) 4*. Adapted ch.3 of Pernègre (2002). See Fig. 2C.

58. *TC pattern, (0) radial, (1) parallel, (2) anterior set parallel, posterior 2 sets radial, (3) anterior 2 sets parallel, posterior radial*. Adapted from ch.39 of Pernègre & Elliott (2008). See Fig. 2C.

59. *Pattern of first pair (anterior) of TC, (0) straight, (1) concave*. Contingent on ch.58(0). Adapted from ch.29 of Pernègre & Goujet (2007) and ch.40 of Pernègre & Elliott (2008). See Fig. 2C.

60. *Pattern of second pair (middle) of TC, (0) straight, (1) concave, (2) convex*. Contingent on ch.58(0). Adapted from ch.30 of Pernègre & Goujet (2007) and ch.41 of Pernègre & Elliott (2008). See Fig. 2C.

61. *Pattern of third pair of TC (posterior), (0) straight, (1) concave, (2) convex*. Contingent on ch.58(0). Adapted from ch.31 of Pernègre & Goujet (2007) and ch.42 of Pernègre & Elliott (2008). See Fig. 2C.

62. *2 pairs of continuous median transverse commissures (MTC), (0) absence, (1) presence.* Adapted from ch.43 of Pernègre & Elliott (2008). See Fig. 2C.

63*. First pair of MTC (0) continuous from TC, (1) anterior to TC*. See Fig. 2C.

64. *Second pair* (*middle) of* *TC contact with lateral dorsal canal (LDC) in relation to contact with MDC in radial canal forms, (0) anterior, (1) parallel, (2) posterior.* Contingent on ch.58(0). See Fig. 2C.

65. *First pair* *(anterior) TC contact with LDC (0) anterior third or LDC, (1) median third of LDC*. Contingent on ch.58(0). Adapted from ch.22 of Pernègre & Goujet (2007) and ch.46 of Pernègre & Elliott (2008). See Fig. 2C.

**Continuous characters**. 66. \**Ratio of pineal plate width to pineal plate length.*

67. *Ratio of pineal plate width to orbital plate median lamellae length.*

68. \**Ratio of rostral plate width to rostral plate length.*

69. *Ratio of rostral plate length to dorsal plate length.*

70. \**Ratio of the median process of the orbital plate length to distance from orbital opening to orbital opening.*

71. *Ratio of posterior process of orbital plate length to orbital plate length.*

72. \**Ratio of anterior process of orbital plates length to orbital plate length.*

73. *Ratio of orbital plate median lamellae length to orbital plate length.*

74. *Ratio of orbital plate length to dorsal plate length.*

75. *Ratio of the distance of the branchial opening from the anterior end of the dorsal plate to dorsal plate length.*

76. *Ratio of brachial plate length to dorsal plate length.*

77. \**Ratio of cornual plate length to dorsal plate length.*

78. *Ratio of dorsal plate width to dorsal plate length.* Ch.16 of Pernègre & Goujet (2007) and ch.32 Pernègre & Elliott (2008).

79. *Ratio of dorsal shield width to dorsal shield length (excluding cornual plates)*.

80. \**Ratio of distance to widest part of the dorsal plate from the anterior end of dorsal plate to dorsal plate length.*

81. *Ratio of distance to beginning of embayment (in dorsal plate) area from anterior end of dorsal plate to length of dorsal plate.*

82. \**Ratio of distance to narrowest part of embayment (in dorsal plate) from the anterior end of the dorsal plate to dorsal plate length.*

83. *Ratio of narrowest part of embayment (in dorsal plate) width to dorsal plate width*.

84. *Ratio of pineal notch depth in dorsal plate to dorsal plate length.*

85. *Ratio of dorsal spine base width to dorsal spine base length.*

86*. \*Ratio of dorsal spine base length to dorsal plate length*.

87. *Density of ornamentation ridges per mm in medial area of dorsal plate.*

**Discretized characters (psammosteid coded as missing).** 88. *Ratio of pineal plate width to orbital plate median lamellae length* (discretized character 68), *(0) 0.29-1.55, (1) 2.33-2.40*.

89. *Ratio of anterior process of orbital plates length to orbital plate length* (discretized character 73), *(0) 0.09-0.32, (1) 0.33-0.52*.

90. *Ratio of orbital plate median lamellae length to orbital plate length* (discretized character 74), *(0) 0.23-1.03, (1) 1.26-1.36, (2) 1.63.*

91. *Ratio of orbital plate length to dorsal plate length* (discretized character 75), *(0) 0.13-0.49, (1) 0.58-0.62.*

92. *Ratio of the distance of the branchial opening from the anterior end of the dorsal plate to dorsal plate length* (discretized character 76), *(0) 0.29, (1) 0.41-0.65, (2) 0.78, (3) 0.9-0.91.*

93. *Ratio of brachial plate length to dorsal plate length* (discretized character 77), *(0) 0.1, (1) 0.2-0.21, (2) 0.28-0.61, (3) 0.71-0.77, (4) 0.83.*

94. *Ratio of cornual plate length to dorsal plate length* (discretized character 78), *(0) 0.15, (1) 0.24-0.44, (2) 0.52-0.56.*

95. *Ratio of dorsal plate width to dorsal plate length* (discretized character 79), *(0) 0.45-0.62, (1) 0.68-0.8, (2) 0.85- 0.96, (3) 1.05, (4) 1.112, (5) 1.23.*

96. *Ratio of dorsal shield width to dorsal shield length (excluding cornual plates)* (discretized character 80), *(0) 0.27, (1) 0.35, (2) 0.42-0.84, (3) 0.93, (4) 1.04-1.06.*

97. *Ratio of distance to beginning of embayment (in dorsal plate) area from anterior end of dorsal plate to length of dorsal plate (*discretized character 82), (*0) 0.51-0.59, (1) 0.63-0.65, (2) 0.71-0.73.*

98. *Ratio of distance to narrowest part of embayment (in dorsal plate) from the anterior end of the dorsal plate to dorsal plate length (*discretized character 83), *(0) 0.52, (1) 0.64-0.77, (2) 0.93-0.97.*

99. *Ratio of dorsal spine base length to dorsal plate length* (discretized character 87), *(0) 0.08-0.09, (1) 0.11, (2) 0.14- 0.25, (3) 0.28-0.3, (4) 0.32-0.34, (5) 0.36-0.37, (6) 0.4.*

100. *Density of ornamentation ridges per mm in medial area of dorsal plate* (character 88), *(0) 1.5, (1) 3-10, (2) 12-15.*

**Discretized character (psammosteid data included***)*. 101. *Ratio of pineal plate width to orbital plate median lamellae length* (discretized character 68), *(0) 0.29-1.55, (1) 2.33-2.40.*

102. *Ratio of posterior process of orbital plate length to orbital plate length* (discretized character 72), *(0) 0.25, (1) 0.41-0.82, (2) 0.87-0.91.*

103. *Ratio of orbital plate median lamellae length to orbital plate length* (discretized character 74), *(0) 0.23-1.03, (1) 1.26-1.36, (2) 1.63.*

104. *Ratio of the distance of the branchial opening from the anterior end of the dorsal plate to dorsal plate length* (discretized character 76), *(0) 0.29, (1) 0.41-0.65, (2) 0.76-0.78, (3) 0.9-0.91, (4) 1.04.*

105. *Ratio of brachial plate length to dorsal plate length* (discretized character 77), *(0) 0.1, (1) 0.17-0.21, (2) 0.28- 0.57, (3) 0.61, (4) 0.71-077, (5) 0.83-0.85.*

106. *Ratio of cornual plate length to dorsal plate length* (discretized character 78), *(0) 0.15-0.18, (1) 0.24-0.44, (2) 0.52-0.56.*

107. *Ratio of dorsal plate width to dorsal plate length* (discretized character 79), *(0) 0.45-0.62, (1) 0.68-0.8, (2) 0.85- 0.96, (3) 1.05, (4) 1.112, (5) 1.23.*

108. *Ratio of dorsal shield width to dorsal shield length (excluding cornual plates)* (discretized character 80), *(0) 0.27, (1) 0.35, (2) 0.42-0.62, (3) 0.67-0.84, (4) 0.93-0.97, (5) 1.04-1.06.*

109. *Ratio of distance to beginning of embayment (in dorsal plate) area from anterior end of dorsal plate to length of dorsal plate (*discretized character 82), *(0) 0.51-0.59, (1) 0.63-0.65, (2) 0.71-0.73.*

110. *Ratio of distance to narrowest part of embayment (in dorsal plate) from the anterior end of the dorsal plate to dorsal plate length (*discretized character 83), *(0) 0.52, (1) 0.64-0.77, (2) 0.93-0.97.*

111. *Ratio of dorsal spine base length to dorsal plate length* (discretized character 87), *(0) 0.08-0.09, (1) 0.11, (2) 0.14- 0.25, (3) 0.28-0.3, (4) 0.32-0.34, (5) 0.36-0.37, (6) 0.4.*

112. *Density of ornamentation ridges per mm in medial area of dorsal plate* (discretized character 88), *(0) 1.5, (1) 3-10, (2) 12-15.*

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| **Taxa** |  | **Distribution** | **Specimens and References** |
| *Anglaspis macculloughi* | Woodward 1891 | Prìdoli, Welsh Borders - UK, Lochkovian, Welsh Borders - UK & Artois | BU, BIRUG.16255, NHM, P.4797, P.22062, Wills (1935), Denison (1971) |
| *Nahanniaspis mackenziei* | Dineley & Loeffler 1976 | Lochkovian, Mackenzie Mountains | NMC, NMC.13192, NMC.13212, Dineley & Loeffler (1976) |
| *Drepanaspis gemuendenensis* | Schluter 1887 | Emsian, Germany | RNM, C.1273, C.1275, C.2921, Tarlo (1964), Tarlo (1965), Blieck (1984) |
| *Psammosteus megalopteryx* | Gross 1933 | Frasnian, Scotland & Main Devonian Field | Tarlo (1961), Tarlo (1964), Tarlo (1965) |
| *Alaeckaspis verbivciensis* | Voichyshyn 1999 | Lochkovian, Podolia | Voichyshyn (2006), Voichyshyn (2011) |
| *Althaspis elongata* | Zych 1927 | Pragian, Cornwall - UK & Podolia | NRM, C.1569, C.1575, C.1576, NHM, P.18044, Blieck (1984) |
| *Anchipteraspis crenulata* | Elliott 1984 | Prìdoli, Canadian Arctic | NMC.13855, Elliott (1984) |
| *Blieckaspis priscillae* | Elliott & Ilyes 1996 | Eifelian, Western USA | FMNH, PF867, Elliott & Ilyes (1996) |
| *Brachipteraspis latissima* | Zych 1927 | Pragian, Podolia | Blieck (1984), Dumbrava & Blieck (2005), Voichyshyn (2011) |
| *Canadapteraspis alcostomata* | Dineley & Loeffler 1976 | Lochkovian, Mackenzie Mountains | NMC, NMC.19992, NMC.19993, NMC.21340, NMC.21457-8, Dineley & Loeffler (1976), Blieck (1984) |
| *Cosmaspis transversa* | Denison 1970 | Emsian, Western USA | FMNH, PF4334, PF4924, PF4926, Denison (1970), Blieck (1984) |
| *Cyrtaspidichthys ovata* | Bryant 1932 | Emsian, Western USA | RNM, C.1712, FMNH, PF1523, Denison (1970), Blieck (1984) |
| *Djurinaspis prima* | Novitskaya 1983 | Pragian, Podolia | Novitskaya (2004), Voichyshyn (2011) |
| *Dnestraspis firma* | Novitskaya 1983 | Pragian, Podolia | Novitskaya (2004), Voichyshyn (2011) |
| *Doryaspis nathorsti* | Lankester 1884 | Pragian, Spitsbergen | Blieck (1984), Pernègre (2002) |
| *Errivaspis waynensis* | White 1935 | Lochkovian, Welsh Borders - UK | NHM, P.16327, P.16783, P.16789, P.16848, P.16883, P.17477, P.17479, P.19159, White (1935), Blieck (1984) |
| *Escharaspis alata* | Elliott 1983 | Lochkovian, Canadian Arctic | NMC, NMC.13946, Elliott (1983) |
| *Eucyclaspis erroli* | Denison 1967 | Emsian, Western USA | FMNH, PF3814, Denison (1967), Denison (1970), Blieck (1984) |
| *Europrotaspis arnelli* | Brotzen 1936 | Pragian, Podolia | RNM, C.1685, C.4067, Blieck (1984), Voichyshyn (2011) |
| *Gigantaspis isachseni* | Heintz 1962 | Pragian, Spitsbergen | RNM, C.2010, C.2022, Blieck (1984), Pernègre & Goujet (2007) |
| *Helaspis finis* | Elliott 2000 | Givetian, Alberta & British Colombia | Elliott et al. (2000) |
| *Lamiaspis longiripa* | Ilyes & Elliott 1994 | Emsian, Western USA | Ilyes & Elliott (1994) |
| *Lampraspis tuberculata* | Denison 1970 | Emsian, Western USA | FMNH, PF4342, PF4374, PF4754, PF4927, Denison (1970), Blieck (1984) |
| *Larnovaspis stensioei* | White 1935 | Lochkovian, Welsh Borders - UK | NHM, P.24418, Blieck (1984), Voichyshyn (2011) |
| *Loricopteraspis dairydinglensis* | White 1961 | Lochkovian, Welsh Borders - UK | NHM, P.29918, P.29936, P.32248, P.42361, P.42366, Tarlo (1961b), Blieck (1984) |
| *Miltaspis anatirostrata* | Geny 1975 | Lochkovian, Spitsbergen | NMH, P.31103, P.31104, (Blieck 1975), Blieck (1984) |
| *Mylopteraspidella gracilis* | Stensio 1958 | Lochkovian - Pragian, Podolia | RNM, C.1547, C.2311, Tarlo (1961b), Blieck (1984), Novitskaya (2004) |
| *Mylopteraspis robusta* | Stensio 1958 | Pragian, Podolia | Blieck (1984) |
| *Oreaspis dunklei* | Denison 1970 | Pragian, Western USA | NHM, P.62719, Denison (1970), Blieck (1984) |
| *Palanasaspis chekhivensis* | Voichyshyn 2011 | Pragian, Podolia | Voichyshyn (2011) |
| *Panamintaspis snowi* | Elliott & Ilyes 1996 | Eifelian, Western USA | Elliott & Ilyes (1996) |
| *Parapteraspis plana* | Stensiö 1958 | Lochkovian, Welsh Borders - UK | NRM, C.1548, C.1558, Blieck (1984), Novitskaya (2004), Voichyshyn (2011) |
| *Pavloaspis pasternaki* | Voichyshyn 1999 | Pragian, Podolia | Voichyshyn (2011) |
| *Pirumaspis lancasteri* | Ilyes & Elliott 1994 | Emsian, Western USA | Ilyes & Elliott (1994) |
| *Podolaspis lerichei* | Zych 1927 | Lochkovian, Welsh Borders - UK & Podolia, Pragian, Podolia | NHM, P.17681, P.17740, P.17750, P.20775, P.20795, P.20760, P.31150, Tarlo (1961b), Blieck (1984), Voichyshyn (2011) |
| *Protaspis bucheri* | Bryant 1932 | Emsian, Western USA | RNM, C.1711, C.2866, FMNH, PF2157, PF2168, Denison (1970), Denison (1971), Blieck (1984) |
| *Protopteraspis gosseleti* | Leriche 1906 | Prìdoli, Welsh Borders - UK, Lochkovian, Welsh Borders - UK & Artois | NMH, P.23014, P.34077, P.34120, P.34628, Tarlo (1961b), Blieck & Tarrant (2001) |
| *Protopteraspis primaeva* | Kiaer 1928 | Lochkovian, Spitsbergen | NHM, P.31133, P.31135, RNM, C.1552, C.1555, C.1585, Tarlo (1961b), Blieck (1984) |
| *Psephaspis idahoensis* | Denison 1968 | Eifelian, Western USA | FMNH, PF5680, PF5682, Denison (1970) |
| *Pteraspis rostrata* | Agassiz 1835 | Lochkovian, Welsh Borders - UK & Artois-Ardenne | NHM, P.16831, P.20193, P.20194, P.23768, 31677, Tarlo (1961b), Blieck (1984) |
| *Rachiaspis pteriga* | Elliott 1984 | Prìdoli - Lochkovian, Canadian Arctic | NMC, NMC.13847, Elliott (1984) |
| *Rhinopteraspis dunensis* | Roemer 1855 | Lochkovian, Dour Massif | NHM, P. 16366, P.24466, P.31625, P.31629, Tarlo (1961b), Blieck (1980), Blieck (1984) |
| *Semipodolaspis slobodensis* | Voichyshyn 2011 | Lochkovian, Podolia | Voichyshyn (2011) |
| *Stegobranchiaspis baringensis* | Elliott 1983 | Lochkovian, Canadian Arctic | NMC, NMC. 13950, NMC.13962, Elliott (1983) |
| *Tuberculaspis elyensis* | Ilyes & Elliott 1994 | Emsian, Western USA | Ilyes & Elliott (1994) |
| *Ulutitaspis notidana* | Elliott 1984 | Prìdoli - Lochkovian, Canadian Arctic | NMC, NMC.13823, NMC.13830, NMC.13835, Elliott (1984) |
| *Unarkaspis schultzei* | Elliott 1983 | Lochkovian, Canadian Arctic | NMC, NMC.69382, Elliott (1983) |
| *Woodfjordaspis felixi* | Pernegre 2006 | Pragian, Spitsbergen | (Pernègre 2006) |
| *Xylaspis prima* | Pernegre 2003 | Pragian, Spitsbergen | Pernègre (2003), Pernègre (2006), Pernègre & Elliott (2008) |
| *Zascinaspis heintzi* | Brotzen 1936 | Lochkovian - Pragian, Podolia | RNM, C.1356, C.1603, C.1824, Tarlo (1961b), Blieck (1984), Voichyshyn (2011) |
| *Zascinaspis carmani* | Denison 1960 | Pragian, Western USA | FMNH, PF1870, PF2018, Denison (1960), Blieck (1984) |

Table 1. Taxa, locality, stratigraphical range and reference material used in analyses.

Supplementary phylogenies



Supplementary Figure 1. Majority rule consensus trees with bayesian analysis with **A,** discrete characters **B**, discretized (Psammosteidae continuous data not included in analysis). Psammosteidae taxa highlighted in bold font.



Supplementary Figure 2. Discrete data sets with different implied weighting values. **A**, implied weighting with a concavity value of *k*=2, strict consensus of 4 MPT, with a tee length of 26.92. **B**, implied weighting with a concavity value of *k*=1, strict consensus of 2 MPT with a tree length of 32.46. Psammosteidae taxa highlighted in bold font.

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Supplementary Figure 3. Discrete with continuous character data sets with different implied weighting values. **A**, implied weighting with a concavity value of *k*=2, 2 MPT, with a tee length of 30.97. **B**, implied weighting with a concavity value of *k*=1, 1 MPT with a tree length of 37.57. Psammosteidae taxa highlighted in bold font.

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Supplementary Figure 4. Discrete (1-65) and continuous characters (Psammosteidae continuous data coded and homologous) characters (66, 69-70, 72, 77, 80, 82, 86-87). **A,** equally weighted characters, strict consensus of 3MPT with a tree length of 367.14. **B**, analysis with implied weighting (*K*=3), 1MPT with a tree length of 27.13. Psammosteidae taxa highlighted in bold font.



Supplementary Figure 5. Discrete (1-65) and discretized continuous characters (101-112) (gap coding) including the Psammosteidae continuous measurements i.e. homologous coding. **A,** equally weighted analysis, strict consensus of 808 MPT with a tree length of 355. **B**, implied weighting (*k*=3) 1MPT with a tree length of 28.32. Psammosteidae taxa highlighted in bold font.

**References**

**Blieck, A.R.M**., 1975. Althaspis anatirostra nov. sp. Pteraspidide de Devonien inferieur de Spitsberg. *C.R. Somm. Soc. Geol. Fr.*, **3**, 74–77.

**Blieck, A.R.M**., 1980. Le genre Rhinopteraspis Jackel (Vertebres, Heterostraces) du Devonien inferieur: systematique, morphologie, repartition. *Bulletin du Muséum national d'histoire naturelle, Paris***, 2,** 25–47.

**Blieck, A.R.M**., 1984. *Les Heterostraces Pteraspidiformes: systemastique, phylogenie, biostratigraphie et biogeographie*, Cahiers de Paléontologie (section Vertébrés), éditions du CNRS.

**Blieck, A.R.M. & Tarrant, P.R**., 2001. Protopteraspis gosseleti (Vertebrata: Pteraspidimorphi: Heterostraci) from the Lower Devonian of Shropshire, England. *Palaeontology*, **44**, 95–112.

**Denison, R.H**., 1960. Fishes of the Devonian Holland Quarry Shale of Ohio. *Fieldiana: Geology*, **11**, 555–613.

**Denison, R.H.**, 1971. On the tail of Heterostraci (agnatha). *Forma et functio*, **4**, 87–99.

**Denison, R.H**., 1970. Revised classification of Pteraspididae with description of new forms from Wyoming. *Fieldiana: Geology*, **20**, 1–41.

**Dineley, D.L. & Loeffler, E.J.**, 1976. Ostracoderm Faunas of the Delorme and associated Siluro-Devonian Formations North West Territories Canada. *Special Papers in Palaeontology*, **18**, 1–214.

**Donoghue, P.C., Forey, P.L. & Aldridge,** R.J., 2000. Conodont affinity and chordate phylogeny. *Biological reviews of the Cambridge Philosophical Society*, **75**,191–251.

**Dumbrava, M. & Blieck, A.R.M**., 2005. Review of the pteraspidiform heterostreacans (Vertebrata, Agnatha) from the Devonian of Podolia, Ukraine, in the Ttheodor Vascautanu collection, Bucharest, Romania. *Acta Palaeont. Rom.*, **5**, 163–171.

**Elliott, D.K**., 1984. A new Subfamily of the Pteraspididae (agnatha, Heterostraci) from the Upper Silurian and Lower Devonian of Arctic Canada. *Palaeontology*, **27**, 169–197.

**Elliott, D.K.**, 1983. New Pteraspididae (Agnatha, Heterostraci) from the Lower Devonian of Northwest Teritories, canada. *Journal of Vertebrate Paleontology*, **2**, 389–406.

**Elliott, D.K., Dineley, D.L. & Johnson, H.G**., 2000. a Vertebrate Fauna From the Middle Devonian Yahatinda Formation of Southwestern Canada. *Journal of Paleontology*, **74**, 123–132.

**Elliott, D.K. & Ilyes, R.R.**, 1996. New Early Devonian pteraspidids (agnatha, Heterostraci) from Death Valley National Monument, southeastern California. *Journal of Paleontology*, **70**, 152–161.

**Ilyes, R.R. & Elliott**, D.K., 1994. New Early Devonian pteraspidids (agnathat, Heterostraci) from east-central Nevada. *Journal of Paleontology*, **68**, 878–892.

**Novitskaya, L.I.**, 2004. Agnathans and early fishes. In *Fossil vertebrates of Russia and adjacent countries*. Moscow: Geos, 1–540.

**Pernègre, V.N.**, 2002. The genus Doryaspis White ( Heterostraci ) from the Lower Devonian of Vestspitsbergen , Svalbard. *Journal of Vertebrate Paleontology*, , 37–41.

**Pernègre, V.N**., 2003. Un nouveau genre de Pteraspidiformes (Vertebrata, Heterostraci) de la Formation de Wood Bay (Devonien inferieurm Spitsberg). *Geodiversitas*, **25**, 261–272.

**Pernègre, V.N**., 2006. Un nouveau Pteraspidiformes (Vertebrata, Heterostraci) du Devonien inferieur du Spitsberg: nouvelles donnees paleo-ontogeniques. *Geodiversitas*, **28**, 239–248.

**Pernègre, V.N. & Elliott, D.K**., 2008. Phylogeny of the Pteraspidiformes (Heterostraci), SilurianDevonian jawless vertebrates. *Zoologica Scripta*, **37**, 391–403.

**Pernègre, V.N. & Goujet, D**., 2007. the Genus Gigantaspis Heintz, 1962 (Vertebrata, Heterostraci) From the Lower Devonian of Spitsbergen. *Palaeontology*, **50**, 323–346.

**Tarlo, L.B.**, 1964. Psammosteiformes (Agnatha) – A review with descriptions of new material from the Lower Devonian of Poland I. General part. *Palaeontological Polonica*, **13**, 1–135.

**Tarlo**, L.B., 1965. Psammosteiformes (Agnatha) – A review with descriptions of new material from the Lower Devonian of Poland II. Systematic part. *Palaeontological Polonica*, **15**, 1–168.

**Tarlo, L.B**., 1961a. Psammostieds from the Middle and Upper Devonian of Scotland. *Quarterly Journal of the Geological Society*, **117**, 193–213.

**Tarlo, L.B.**, 1961b. Rhinopteraspis cornubica (McCoy), with notes on the classification and evolution of the pteraspids. *Acta Palaeontologica Polonica*, **6**, 367–400.

**Voichyshyn, V.K**., 2006. Name-bearing types and type series of fossil agnathans (agnatha: Heterostraci, Osteostraci). In *Name-bearing Types and Type Series (1). Scientific Collections of the State Natural History Museum,* ***2***., 26–40.

**Voichyshyn, V.K.**, 2011. The Early Devonian armoured agnathans of Podolia, Ukraine. *Palaeontological Polonica*, **66**, 1–210.

**White, E.I**., 1935. The Ostracoderm Pteraspis Kner and the relationships of the agnathous vertebrates. , **225**, 381–457.

**Wills, L.J.**, 1935. Rare and new ostracoderm fishes from the Downtonian of Shropshire. *Transactions of the Royal Society of Edinburgh: Earth Sciences*, **58,** 427–447.