

SUPPLEMENTARY ONLINE MATERIAL FOR

**New cranial material of the acanthothoracid placoderm *Palaeacanthaspis vasta* from  
the Lower Devonian of Podolia—  
phylogenetic and taxonomic significance**

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**Supplementary Online Material**

**SOM 1.** Phylogenetic analysis for *Palaeacanthaspis vasta*.

**References**

**SOM Fig. 1.** Strict consensus tree of gnathostomes.

Matrix file (in Mesquite format) available at

[http://app.pan.pl/SOM/app66-Dupret\\_etal\\_SOM/for\\_palaeacanthaspis\\_20201113\(Romu\\_corrected\)](http://app.pan.pl/SOM/app66-Dupret_etal_SOM/for_palaeacanthaspis_20201113(Romu_corrected))

TNT-2020.11.13-Run.10 files available at

[http://app.pan.pl/SOM/app66-Dupret\\_etal\\_SOM/data.ss](http://app.pan.pl/SOM/app66-Dupret_etal_SOM/data.ss)

[http://app.pan.pl/SOM/app66-Dupret\\_etal\\_SOM/log.out](http://app.pan.pl/SOM/app66-Dupret_etal_SOM/log.out)

[http://app.pan.pl/SOM/app66-Dupret\\_etal\\_SOM/runInformation.txt](http://app.pan.pl/SOM/app66-Dupret_etal_SOM/runInformation.txt)

[http://app.pan.pl/SOM/app66-Dupret\\_etal\\_SOM/Script.bat](http://app.pan.pl/SOM/app66-Dupret_etal_SOM/Script.bat)

[http://app.pan.pl/SOM/app66-Dupret\\_etal\\_SOM/taxonNamesTranslationTable.txt](http://app.pan.pl/SOM/app66-Dupret_etal_SOM/taxonNamesTranslationTable.txt)

[http://app.pan.pl/SOM/app66-Dupret\\_etal\\_SOM/TNT\\_Trees.txt](http://app.pan.pl/SOM/app66-Dupret_etal_SOM/TNT_Trees.txt)

[http://app.pan.pl/SOM/app66-Dupret\\_etal\\_SOM/TNTCommands.txt](http://app.pan.pl/SOM/app66-Dupret_etal_SOM/TNTCommands.txt)

## SOM 1. Phylogenetic analysis for *Palaeacanthaspis vasta*.

### **Reminder (from main text):**

The Taxon/character matrix was built in Mesquite (Maddison and Maddison, 2019) from the one built by Vařkaninová et al. (2020; itself updated from Qiao et al., 2016), with the addition of *Palaeacanthaspis vasta*, leading to a matrix of 108 taxa and 335 characters. Galeaspida and Osteostraci are the outgroup. All characters are unordered and unpolarised, and of equal weights. The data were analysed in TNT (Goloboff and Catalano, 2016) using the Zephyr module (Maddison and Maddison, 2020; Maddison and Will, 2020) in Mesquite 3.61 interface (Maddison and Maddison, 2019). A New Technology search was performed (using the default sectorial search, ratchet, drift and tree fusing options, 1000 random addition sequences, random seed 1), with the most parsimonious trees found (26, of 961 steps) then used for a Traditional Search (tree bisection–reconnection (TBR) algorithm), from which a strict consensus tree was calculated (Fig. 3). The strict consensus tree is 1053 steps long, has a CI of 0.330, and a RI of 0.774; it was built from 18600 trees of 961 steps each. No robustness analysis (Bremer nor Bootstrap) was made.

### **Further remarks on character coding for *Palaeacanthaspis*:**

Information missing from ZPAL Ag. V/1 was taken from other material published in Stensiö, 1944. The following non exhaustive list refers to the latter, as well as on the coding of “unknown/missing data” vs. “not applicable”, which are both considered as “missing data” by the phylogenetic research algorithms, and are optimised to retain the most parsimonious phylogenetic hypothesis.

- **Character 22:** series of paired median skull roofing bones meeting in the midline: coded “0” (absent) in *Palaeacanthaspis* because only the preorbital plates meet in the midline, and do not constitute a series.
- **Character 24:** Pineal opening perforation in dermal skull roof, coded “1” (absent, as evidenced in Stensiö, 1944:pl. 1-2).
- **Character 25:** Enlarged postorbital tessera separate from orbital series; coded “–” (not applicable).
- **Character 54:** median dermal bone of palate (parasphenoid), coded “?” (unknown).
- **Character 55:** Nasal opening(s) coded “0” (dorsal placed between orbits).

- **Character 56:** olfactory tracts, coded “0” (short) because of similarities between *Palaeacanthaspis* and *Romundina* in the orbital and ethmoid areas of the neurocranium (on current specimen ZPAL Ag. V/1 and P5003 in Stensiö, 1944:pl. 1-2): it is extremely unlikely that the olfactory tracts were long.
- **Character 63:** subpituitary fenestra, coded “1” (present).
- **Character 68:** main trunk of facial nerve (N. VII), coded 1 (“is stout and divides within otic capsule at the level of the postorbital process”); although its length is unknown, its path was not identified on the orbital floor.
- **Character 74:** Ascending basisphenoid pillar pierced by common internal carotid, coded “0” (absent) (N.B. coded “0” in forms lacking basisphenoid, but “?” when forms are not complete [e.g. CPW9]).
- **Character 76:** position on hyomandibular articulation: states corrected into actual value position (rather than “absent/present”) in data matrix file.
- **Character 81:** labyrinth cavity, coded “0” (separated from the main neurocranial cavity by a cartilaginous or ossified capsular wall”, as visible in Fig. 2B).
- **Character 84:** pituitary vein canal coded “-” (not applicable), because basiptyergoid unknown.
- **Character 87:** trigeminofacial recess coded “0” (absent) as evidenced in Fig. 2B, although a ventral view.
- **Character 103:** Pectoral fenestra completely encircled by dermal shoulder armour coded as unknown (could be “0” present according to Stensiö, 1944:, although some forms like *Romundina* are coded “1” present...)
- **Character 120:** Pectoral fins covered in macromeric dermal armour, coded as “unknown” although very unlikely that the condition was similar to antiarchs (NB: *Romundina* is also coded “unknown”).
- **Character 159:** Large unpaired median skull roofing bone anterior to the level of nasal capsules: we consider that such element (i.e. premedian plate) is present in *Palaeacanthaspis*, based on the specimen NRM.P.5003 (Stensiö, 1944:fig. 1, pl.1), although Stensiö attributed it to the “ethmoidal dermal capsule”; we reinterpret this element as a premedian plate, and locate the rostromedionasal capsule just posteriorly to it, but anteriorly to the preorbital plate, the presence of which is emphasized by their midline junction.
- **Character 171:** number of paranuchal plates, coded “1” (two pairs); although three pairs of paranuchal plates may be present in *Palaeacanthaspis*, the “two pairs” coding is considered as “more than one pair”.

It is also noteworthy that there is still no consensus on whether which term should be used between “second / posterior central plate” or “median paranuchal plate”, nor whether the two structures are different homologous or not among the different and diverse taxa in which they are observed, although the two plates can also be present in some taxa (for example *Arabosteus* but see discussion in Olive et al., 2011). This is an interesting problem, which cannot be addressed, in the present article.

- **Character 190:** Anteroposterior position of middle and posterior pit-lines on postparietal, coded “?” (unknown), as mpl and ppl not visible on postparietals (=centrals) of *Palaeacanthaspis*.
- **Character 191:** Mediolateral position of middle and posterior pit lines on postparietal, coded “?” (unknown), as mpl and ppl not visible on postparietals (=centrals) of *Palaeacanthaspis*.
- **Character 275:** Medial processes of paranuchal wrapping posterolateral corners of nuchal plate, coded “0” (absent) for *Palaeacanthaspis* and corrected from “2” (paranuchals precluded from nuchal by centrals) to “0” for *Romundina* (because we consider the homology as a median paranuchal plate, not a posterior central).
- **Character 295:** postorbital process coded present (both anterior and posterior postorbital processes), also corrected from “0” (absent) to “1” for *Romundina*.

### **Critical analysis of the differences in matrix between *Palaeacanthaspis* and *Romundina***

Here are only described the differences which do not involve “missing or not applicable data” in the coding.

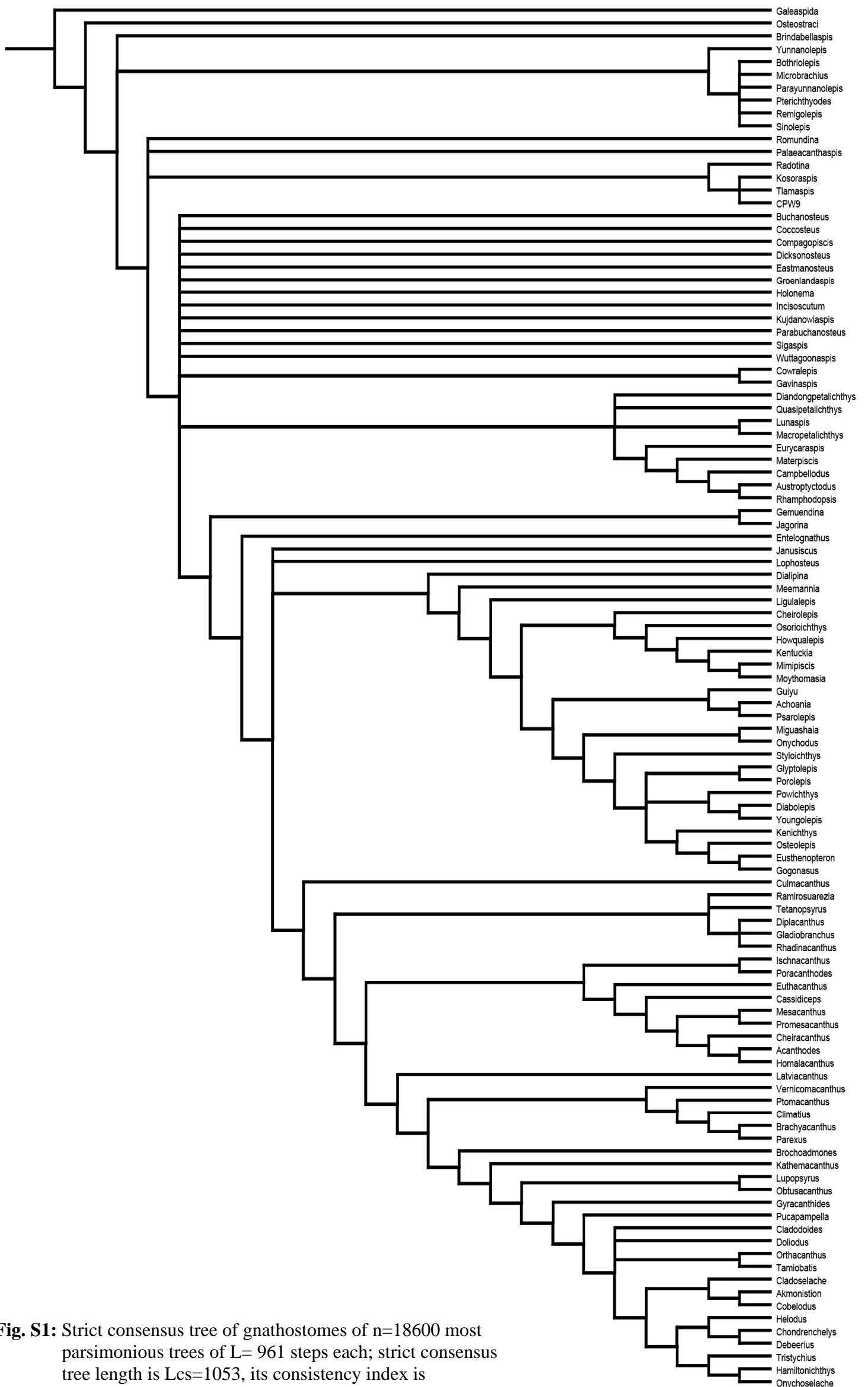
- **Character 24:** opening of a pineal foramen in the dermal skull roof, coded present in *Romundina* but absent in *Palaeacanthaspis*. No foramen is observable in the only rostrompineal capsule known in *Palaeacanthaspis*, which is also poorly preserved. The preservation may thus be misleading, and led to a discrepancy in the coding.
- **Character 194:** posterior extension of supraorbital canal on postpineal for *Romundina* (the groove is observed only this plate; in other words, its anterior extension is also on the postpineal plate) and on the preorbital plate (i.e. parietal plate). The occurrence of the supraorbital sensory line groove on the

preorbital rather than the postpineal plate should be regarded carefully because it may not represent a very strong phylogenetic signal. The postpineal plate is usually a “filling” plate.

- **Character 272:** Median commissure between supraorbital sensory lines is coded as absent in *Palaeacanthaspis* and either present or absent in *Romundina*. This is related to both the plasticity of the character (individual variation) and the sample size (limited to one specimen in *Palaeacanthaspis*).

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**Fig. S1:** Strict consensus tree of gnathostomes of n=18600 most parsimonious trees of L= 961 steps each; strict consensus tree length is Lcs=1053, its consistency index is CIs=0.330 and its retention index is RIs=0.774.s.