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## *Belinurus* Bronn, 1839 (Chelicerata, Xiphosura) has priority over *Bellinurus* Pictet, 1846

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In the first half of the nineteenth century, a marked shift occurred in our understanding and treatment of the chelicerate fossil record, with the differentiation and recognition of entirely extinct genera for the first time. At the heart of this taxonomic revolution were the Eurypterida (sea scorpions) and Xiphosura (horseshoe crabs), although both groups were in fact considered crustaceans until Lankester's (1881) seminal comparative anatomical study of the extant xiphosuran *Limulus* Müller, 1785 and modern scorpions. The oldest available eurypterid genus is *Eurypterus* deKay, 1825; the oldest available fossil arachnid genus name is that of the scorpion *Cyclophthalmus* Corda, 1835. However, there has been considerable historical confusion over the oldest available fossil xiphosuran genus name, which has been recognized alternately as *Belinurus* König (with a publication date of either 1820 or 1851) or the synonymous *Bellinurus* Pictet, 1846. Most recent treatments (e.g., Selden and Siveter, 1987; Anderson and Selden, 1997; Anderson et al., 1997; Lamsdell, 2016, 2021; Bicknell and Pates, 2020) have favored *Bellinurus* Pictet, 1846 as the available name; however, Haug and Haug (2020) recently argued that *Belinurus* König, 1820 is valid and has priority, a position then followed by Lamsdell (2020), prompting a reinvestigation of the taxonomic history of the genus. Upon review, it is clear that neither of the previously recognized authorities for *Belinurus* are accurate and that the two candidate type species for each genus are, in fact, synonyms. Given the convoluted and at times almost illogical history of the competing names, along with the most recent controversy as to which has priority, we present a complete history of the treatment of the genus to resolve the issue.

The issue arises from the partial publication of König's (1825) *Icones Fossilium Sectiles*. This volume (Centuria Prima) was bound and published, comprising one hundred figures across eight plates with associated descriptions. Planned further volumes of *Icones Fossilium Sectiles* beyond the first were never published (Urban, 1851); however, it is apparent that a limited number of lithographs for the plates for the second and third volumes were produced and shared by König among interested parties (Woodward, 1830). Among these plates (figure 230, on plate 18) was a single specimen of a small horseshoe crab labeled simply *Belinurus bellulus*.

The informal proliferation of these plates created a scenario in which the proposed name was widely known among researchers but explicitly recognized as unpublished (see Woodward, 1830) and presumably therefore unavailable. Buckland (1837), in his contribution to the Bridgewater Treatise series, figured

and described a new horseshoe crab species as *Limulus trilobitoides*, explicitly stating that this new species was the same as König's unpublished *Belinurus bellulus* and Martin's (1809) *Entomolithus Monoculites? Lunatus* (a non-binomial name that has been suppressed by the International Commission on Zoological Nomenclature along with all other names within *Petrificata Derbiensia*). Subsequently, Louis Agassiz, in his German translation of Buckland's (1839) *Bridgewater Treatise*, followed Buckland's description of *Limulus trilobitoides* with a note that the genus *Bellinurus* König [sic] is deserving of recognition as a distinct genus from *Limulus* (pl. 46; it is worth noting that this is the first recorded occurrence of the alternative *Bellinurus* spelling and that it follows an accurate transcription of the spelling of *Belinurus* from Buckland's text on the same page). In the same year, a summary list of fossil horseshoe crabs appeared in the *Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, which was edited by Karl von Leonhard and Heinrich Bronn. The summary itself is not attributed to either editor; however, the article stated that it was done at the request of van der Hoeven. In turn, van der Hoeven (1838) stated that he had been in contact with Bronn regarding the status of the fossil xiphosuran species, and so Bronn (1839) can be reliably ascribed as the author of the article. In it, Bronn directly assigned the species *Entomolithus Monoculites? Lunatus* Martin, 1809 (as "*Entomolites monoculites*") and *Limulus trilobitoides* Buckland to the genus *Belinurus* König, with no reference to *B. bellulus* König. However, the species reappeared in Morris's (1843) *A Catalogue of British Fossils*, where it was listed as a synonym of *Limulus trilobitoides* Buckland.

Later, in his *Traité élémentaire de paléontologie*, Pictet (1846) included the genus *Bellinurus* König—once again misspelled—to which he assigned the species *Limulus trilobitoides*, with the erroneous taxonomic authority of König (notably, there was again no reference to *B. bellulus* König), although the second edition listed *B. bellulus* König as a senior synonym of *Limulus trilobitoides* (Pictet, 1854). Matters were further complicated by Bailly (1859a–c), who in a series of papers utilized the name *Bellinurus* König, recognizing *B. bellulus* König as a synonym of *B. trilobitoides* (Buckland) and proposing the genus *Steropsis* to accommodate a variety of species, including *B. trilobitoides* (Buckland). Bailly (1863) later recognized *Steropsis* as a junior synonym of *Belinurus* König, 1820 (potentially the year that the unpublished lithographs were first made available), stating that Pictet (1846) had made the genus name

available. Baily also here treated *B. bellulus* König, 1820 as a valid and available species for the first time and considered it to have priority over *B. trilobitoides* (Buckland). Henry Woodward, in his extensive works on British fossil chelicerates, was inconsistent in his treatment of the genus, at first attributing Baily (1863) as the authority for *Belinurus* König with *B. trilobitoides* (Buckland) as the type species (Woodward, 1867) before later following Baily (1863) in recognizing *Bellinurus* König, 1820 with *B. bellulus* König, 1820 as the valid type species (Woodward, 1872, 1907).

Moving into the twentieth century, there appeared to be a consensus that *Belinurus* König, 1820 was the accurate name and authority, with *B. trilobitoides* (Buckland) being a junior synonym of the type species *B. bellulus* König (Dix and Pringle, 1929; Eller, 1938; Størmer, 1952). Uncertainties regarding the taxonomic history of the species continued, however, with Størmer (1952) erroneously listing Woodward (1866–1878) as the taxonomic authority for *B. bellulus*. Størmer (1955) later compounded this error in the *Treatise on Invertebrate Paleontology*, which continued to recognize *Belinurus* König, 1820, but incorrectly listing Meek and Worthen (1865) as the authority of the junior synonym *Bellinurus*.

This situation changed dramatically with the publication of Morris's (1980) *Catalogue of the type and figured specimens of fossil Crustacea (excl. Ostracoda), Chelicerata, Myriapoda and Pycnogonida in the British Museum (Natural History)*. In it, Morris reported that the second part of König's work had become available only after his death and that the earliest the genus and species could date to is 1851. This would render *Belinurus*, made available by Pictet in 1846, as having priority over *Belinurus* König, c. 1851. Similarly, *B. trilobitoides* (Buckland, 1837) would have priority over *B. bellulus* König, c. 1851. The next treatment of the group, by Selden and Siveter (1987), followed Morris in recognizing *Bellinurus* Pictet as having priority but considered *B. bellulus* König, c. 1851 the valid type species. Subsequent workers all recognized *Bellinurus* Pictet, 1846 as the appropriate taxon name and authority (Schultka, 1994; Anderson and Selden, 1997; Anderson et al., 1997; Lamsdell, 2016, 2021; Bicknell and Pates, 2020). Very few of these treatments considered the issue of the appropriate type species, although Bicknell and Pates (2020) listed both *B. bellulus* (ascribed to Pictet, 1846) and *B. trilobitoides* (Buckland) as distinct, valid species. Then Haug and Haug (2020) argued on the basis of an available scan of *Icones Fossilium Sectiles* from the Biodiversity Heritage Library that König's plates were published in 1820 and that *Belinurus* König had priority over *Bellinurus* Pictet, which Lamsdell (2020) then followed in a comprehensive revision of xiphosurid taxonomy.

With such a turbulent taxonomic history, the question remains: what is the correct formulation of the genus name, and what is the correct taxonomic authority? To determine this, it must first be ascertained whether the plates for König's second volume were published before 1851, or if not, which publication first made *Belinurus* available and whether it pre- or post-dated Pictet's making *Bellinurus* available in 1846. With regard to the publication of König's plates, all contemporary sources (Woodward, 1830; Urban, 1851) are clear in stating that the later volumes of *Icones Fossilium Sectiles* were not published and the plates were not publicly available. The fact that

the plates for the second and third volumes were distributed and appended to bindings of the first volume after König's death, as stated by Sherborn (1902) and Lang et al. (1940), explains the undated binding from the Natural History Museum, London, that led Haug and Haug (2020) to believe that these plates were published before 1851. The matter then becomes when *Belinurus* and *Bellinurus* each first became available. Although Buckland (1837) stated his *Limulus trilobitoides* is the same as König's *Belinurus bellulus*, he did so with reference to the unpublished plates and so did not make the genus or species available as per Article 12.3 of the *International Code of Zoological Nomenclature* (International Commission on Zoological Nomenclature, 1999). Similarly, Agassiz's note in his translation of Buckland (1839) was the first reference to *Bellinurus* in the literature but did not include an assignation of an available species name and so did not make that spelling of the genus available. However, Bronn's (1839) summary of fossil horseshoe crabs explicitly listed *Belinurus* König as a valid genus including the valid species *Limulus trilobitoides* Buckland by indication. This satisfies Article 12.2.5 of the *International Code of Zoological Nomenclature* (International Commission on Zoological Nomenclature, 1999) and is sufficient for the genus name to become available, whereby its taxonomic authority is Bronn (1839) following Article 50.1 (International Commission on Zoological Nomenclature, 1999). *Bellinurus* was first made available by Pictet, and so *Belinurus* Bronn, 1839 is the valid senior synonym of *Bellinurus* Pictet, 1846. Pictet, however, made no reference to *B. bellulus*, which Morris (1980) stated was first made available by the distribution of König's plates in or after 1851. If the plates were distributed after 1854, *B. bellulus* would be attributable to Pictet (1854), who figured a specimen alongside a diagnosis of the species. Irrespective as to whether the species was made available in 1851 or 1854, as *B. trilobitoides* (Buckland, 1839) and *B. bellulus* König, c. 1851/Pictet, 1854 are subjective synonyms, *B. trilobitoides* has seniority and is the valid name.

To clarify these issues for future paleontologists, we present a revised systematic paleontology for *Belinurus* Bronn, 1839, including all currently valid species assignable to the genus.

## Systematic paleontology

Xiphosurida Latreille, 1802

Belinurina von Zittel in von Zittel and Eastman, 1913

Family Belinuridae von Zittel in von Zittel and Eastman, 1913

(= Euproopidae Eller, 1938; = Liomesaspidae Raymond, 1944)

Genus *Belinurus* Bronn, 1839

(= *Bellinurus* Pictet, 1846; = *Steropsis* Baily, 1859a)

*Type species.*—*Belinurus trilobitoides* (Buckland, 1837) (lectotype: BNMH 34889; paralectotype: BMNH 46393) (= *Belinurus bellulus* König, c. 1851/Pictet, 1854) from the clay-ironstone of the Coalbrookdale Coal Measures, Telford, Shropshire, by subsequent designation.

*Other species.*—*Belinurus carwayensis* Dix and Pringle, 1929; *Belinurus concinnus* Dix and Pringle, 1929; *Belinurus grandaevus* Jones and Woodward, 1899; *Belinurus kiltorkensis* Baily, 1869; *Belinurus morgani* Dix and Pringle,

1930; *Belinurus pustulosus* Dix and Pringle, 1929; *Belinurus silesiacus* (Roemer, 1883); *Belinurus sustai* (Prantl and Přibyl, 1956); *Belinurus trechmanni* Woodward, 1918.

**Diagnosis.**—Belinurid with axis of first thoracetrone tergite medially inflated; thoracetrone ovoid to semicircular in outline; thoracetrone fixed tergopleural spines elongate, needle-like (after Lamsdell, 2020).

**Occurrence.**—Carboniferous: Canada, Czech Republic, Germany, and United Kingdom.

**Remarks.**—Morris (1980) listed two syntypes for *Belinurus trilobitoides*, one figured by Buckland (1837) and the other not. No lectotype has been subsequently designated, and so here we select Buckland's figured specimen, BMNH 34889, as the lectotype for the species following Article 74.1 of the *International Code of Zoological Nomenclature* (International Commission on Zoological Nomenclature, 1999). According to Morris, this is also the specimen figured by König (c. 1851). There is no indication as to the identity of the specimen figured by Pictet (1854).

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