Zootaxa 4555 (3): 346–358
https://www.mapress.com/j/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4555.3.4
http://zoobank.org/urn:lsid:zoobank.org:pub:1C9B95B7-EF91-4908-AF4A-22DA515E0F85

A new brachymetopid trilobite from the Early Permian Shakhtau reef complex of the southwestern Urals, Bashkortostan, Russia

EDUARD V. MYCHKO[1,2,3,5] & OLES V. SAVCHUK[4]

[1]*Shirshov Institute of Oceanology, Russian Academy of Sciences, Moscow, Russia. E-mail: eduard.mychko@gmail.com*
[2]*Museum of the World Ocean, Kaliningrad, Russia*
[3]*Borissiak Paleontological Institute, Russian Academy of Sciences, Moscow, Russia*
[4]*ALS Scandinavia AB, Danderyd, Sweden*
[5]*Corresponding author*

Abstract

New specimens of trilobites from the Lower Permian limestone reef Shakhtau (Sterlitamak, Bashkortostan, Russia) are described as *Brachymetopus* (*Conimetopus*) *alekseevi* Mychko, **sp. nov.** Although represented by a limited number of specimens, the new species is significant in extending the stratigraphic distribution of the subgenus *Brachymetopus* (*Conimetopus*) Hahn and Hahn, 1985, whose members were previously known exclusively from Carboniferous deposits. Material described previously from the Early Permian (Asselian) of the Chelyabinsk Region is also assigned to the new species.

Key words: trilobites, Aulacopleurida, *Brachymetopus* (*Conimetopus*), Permian, Asselian, Sakmarian, Shakhtau

Introduction

Permian trilobites are rare, with fewer than 200 species formally described. The goal of this work is to supplement this record by description of a new Early Permian member of the Family Brachymetopidae Prantl and Přibyl, 1950, along with assessment of the phylogenetic structure of the subgenus *Brachymetopus (Conimetopus)* Hahn and Hahn, 1985.

The Order Aulacopleurida Adrain, 2011, includes 15 families (Adrain, 2011). Only two families, Brachymetopidae and Aulacopleuridae Angelin, 1854, are known from the Carboniferous and Permian. Seventeen genera are included in Brachymetopidae, three of which (*Brachymetopus* M'Coy, 1847; *Cheiropyge* Diener, 1897; *Loeipyge* Kobayashi and Hamada, 1979) are known from the Permian (Hahn and Hahn, 1996, Fig. 1; Owens, 2003). *Loeipyge* is monotypic, and the type species is based upon one incomplete pygidium (Kobayashi and Hamada, 1979, Pl 1, figs 1a–d). Kobayashi and Hamada (1979) did not use family headings in their work, but all of their comparisons of *Loeipyge* were with Proetid genera. Owens (1983, p. 35) assigned it to Brachymetopidae. Owens (2003, p. 384) regarded *Loeipyge* as a junior subjective synonym of *Brachymetopus* M'Coy, 1847. According to Owens (personal communication, 2018), the single known pygidium shares characters of the axis and pleural ribs with those of species assigned to *B*. (*Conimetopus*), of which *Loeipyge* is possibly a senior subjective synonym.

Brachymetopus has a range from the Late Devonian to Late Permian and has been divided into six subgenera (Hahn and Hahn, 1996, p. 36). One of them, *B*. (*Iriania*) Archbold, 1981, is monotypic, found only in the Middle Permian of Indonesia (Hahn and Hahn, 1996; Jell and Adrain, 2003). The remaining five are *B*. (*Brachymetopus*) M'Coy, 1847 (45 named species), *B*. (*Acutimetopus*) Hahn and Hahn, 1985 (17 named species), *B*. (*Conimetopus*) Hahn and Hahn, 1985 (13 previously named species), *B*. (*Spinimetopus*) Hahn and Hahn, 1985 (two named species), and *Hahnus* Özdikmen, 2009 (pro *B*. (*Eometopus*) Hahn and Hahn, 1996, preoccupied; three named species).

 Accepted by J. Adrain: 4 Dec. 2018; published: 14 Feb. 2019

Brachymetopus in the Permian of Russia

Permian brachymetopids are rare compared with proetoideans, and are known from only eight Russian localities (including that described in this paper).

A cephalon of a species of *Brachymetopus* from near the village of Zlatoust (now the village of Klyuchi, Suksun Region, Perm Krai, Russia) was described by Möller (1867, pp. 184–187, Pl. 2, figs. 32–35; 1868, p. 57, Pl. 1, figs 32–35; Fig. 1a herein). The stratigraphic unit in which the cephalon was found belongs to the Sarginian horizon of the Early Permian (Artinskian; Mychko and Alekseev, 2017, p. 58). Hahn and Hahn (1996) assigned this specimen to the Asselian *Brachymetopus* (*Acutimetopus*) *moelleri* Weber, 1932.

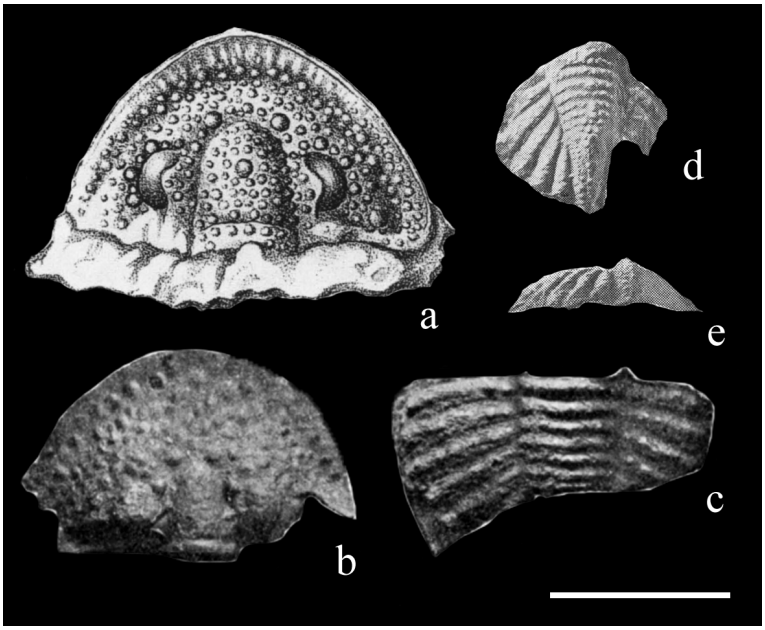

FIGURE 1. Some members of the genus *Brachymetopus* from the Permian of Russia. a—*B*. (*Acutimetopus*) *moelleri* (Weber, 1932); reconstruction of cephalon; presumably kept (possibly lost) in the collections of the St. Petersburg Mining University museum, St. Petersburg; Lower Permian, Artinskian, Sarginian (reproduced from Möller [1868, Pl. 1, Fig. 32]). b, c—*B.* (*Conimetopus*) *alekseevi* Mychko, **sp. nov.**; b—cephalon, spec. TsNIGR no. 5107/2063; c—pygidium, spec. TsNIGR no. 5107/2064; Chelyabinsk Region, Ashinsky District, right bank of the Sim River, the town of Asha, "Kazarmenny Kamen" locality; Lower Permian, Asselian; (reproduced from Weber [1937, Pl. 10, figs 10–11]). d, e—*B*. (*Acutimetopus*) *caucasicus* Likharev, 1944; spec. TsNIGR no. 5217/86, holotype, pygidium; Krasnodar Region, Mostovsky District, the Malaya Laba River basin, "Nikitinskaya Balka" locality; Upper Permian, Dzhulfian (~Wuchiapingian), Urushten or Nikitin Formations; d—view from the dorsal side, e—view from the end of the posterior margin (reproduced from Weber [1944, Pl 2, Fig. 15]). The scale bar is 1 cm.

Krasnopolsky (1887, p. 295) reported a trilobite specimen identified as "*Brachymetopus uralicus* Vern.," from near the village Kyn on the Talca River, Perm Region, Russia. The age of this specimen is unknown and could potentially range from Middle Carboniferous to Early Permian (Mychko and Alekseev, 2017, p. 56). Subsequently, from the rocky outcrop of the Upper Carboniferous—Lower Permian limestone reef "Kamen Plakun" on the Chusovaya River, Krasnopolsky (1889, p. 221) reported a specimen also identified as "*Brachymetopus uralicus* Vern." No images of these specimens were published and their precise age is unknown. According to Hahn and Hahn's (1996, p. 114) revision, the species *B*. (*Conimetopus*) *ouralicus* (de Verneuil, 1845) is known from the Early and Middle Carboniferous (Fig. 4). Krasnopolsky's (1887, 1889) specimens are unlikely to belong to *B*. (*Conimetopus*) *ouralicus*. Weber (1937, p. 84) assigned a trilobite cephalon and pygidium (Fig. 1b, c) from the locality "Kazarmenny Kamen" in the Southern Urals (now "Kazarmenny Greben", Chelyabinsk Region, Ashinsky District, the right bank of the Sim River near the Asha town) to the species now classified as *Brachymetopus* (*Acutimetopus*) *moelleri* Weber, 1932. Weber (1937) considered this locality Late Carboniferous. However, the age of "Kazarmenny Greben," which is a large Bryozoan-Tubiphytes boundstone (Tolstikhina, 1941, p. 73; Miloradovich and Ilina 1951, pp. 17–20), was revised as Asselian by Mychko and Alekseev (2017, p. 60) based on the occurrence of the Early Permian foraminiferan *Sphaeroschwagerina moelleri* (Rauzer-Chernousova, 1936).

Hahn and Hahn (1996, p. 137) assigned these specimens to the Carboniferous subspecies *B*. (*Conimetopus*) *ouralicus ouralicus* (de Verneuil, 1845). Here they are reassigned to *B*. (*Conimetopus*) *alekseevi* Mychko, **sp. nov.**

Weber (in Chernov and Chernov [1940]) identified a trilobite fragment from the Terravean-Kozhim Formation (Early Permian; Asselian; Mychko and Alekseev, 2017, p. 54) of the Kozhim River in Komi, *Brachymetopus* sp. ind. This specimen has never been illustrated.

Brachymetopus (*Acutimetopus*) *caucasicus* Licharev (in Weber, 1944, Pl. 2, Fig. 15; Fig. 1d, e herein) is known from a single pygidium from the Northern Caucasus, near the "Nikitinskaya Balka" locality (Krasnodar Krai, Mostovsky District, the Malaya Laba River basin). In this locality, there are deposits of the Nikitin and Urushten Formations that belong to the Dzhulfian (~Wuchiapingian) of the Upper Permian (Kotlyar *et al.,* 1983). These are the youngest known members of the genus *Brachymetopus* in Russia.

Locality

Shikhan (Russian for an isolated cone-shaped landscape elevation) Shakhtau (Fig. 2) was a complex reef structure and a part of a large reef complex along with Shikhans of Tratau, Juraktau, and Kushtau (Kulagina *et al*., 2015). These giant reefs were formed in the Ural paleo-ocean during the Early Permian and have been exposed by means of neotectonic uplift of the edge of the Cisuralian trough during the Neogene (Puchkov, 2010). The reef system extended along the eastern frame of the Russian platform and had a complex structure and geological history. Today, Shikhan Shakhtau is no longer a mountain, which it was until the 1960s, and is a quarry about 20 meters deep and 1.5 km by 0.8 km long, stretching in the north-west direction. During the development of the quarry it was studied by many researchers (Rauzer-Chernousova, 1950; Kulik, 1978; Korolyuk 1985; Rauser-Chernousova and Korolyuk, 1991; Shamov, 1957, 1984; Chuvashov, 1983).

The age boundaries (horizons and zones of the upper parts of the Asselian and Sakmarian) in the reef body are difficult to identify (Rauzer-Chernousova *et al.*, 1977), thus, the exact age of the horizons in which the trilobite specimens occur is a complex question.

In a limestone sample which yielded pygidium PIN no. 5610/5 (Pl. 1, Fig. 5), A.S. Alekseev discovered one specimen of the conodont *Mesogondolella obliquimarginata* (Chernykh in Chuvashov *et al.,* 1991). According to Chernykh (2006, pp. 40–41), this species is widespread in the Southern Urals in the conodont zones of *postfusus* (terminal part of the Asselian) and *merrilli* (basal part of the Sakmarian).

The first finds of trilobites at Shakhtau were mentioned by Murchison *et al.* (1845) and identified as *Phillipsia Eichwaldi*. Eichwald (1861, p. 1441) described a pygidium from "Sterlitamak" assigned to "*Griffithides truncatulus* Phill.," but the specimen was not illustrated and the exact location is unknown (Mychko and Alekseev 2017, p. 60). Gerasimov (1934, p. 6) noted the presence of trilobites only in the C3a series of the Schwagerin Horizon (i.e. Asselian) (Mychko and Alekseev, 2017, p. 61). A trilobite pygidium of the genus *Brachymetopus* was also found by Y.A. Gatowski in a limestone in Tratau, a neighboring to Shakhtau reef (Mychko and Alekseev, 2017, p. 61).

The most common trilobite in the Lower Permian limestones of Shakhtau is *Triproetus gruenewaldti* (Möller, 1867). In the collection titled "Shakhtau" and stored at PIN (no. 5610), 26 out of 32 specimens belong to *T. gruenewaldti*, and the remaining 6 to *B*. (*Conimetopus*) *alekseevi*. Interestingly, these two species have not been found together. Possibly there are blocks of different age, among which the limestones with *K. gruenewaldti* may be younger, since this species occurs mainly in the Sakmarian and Artinskian of the Urals (Möller, 1867; Möller 1868; Weber, 1937; Mychko, 2012; Mychko and Alekseev, 2017).

Systematic palaeontology

Repositories. Figured specimens are stored at the Paleontological Institute, Russian Academy of Sciences, Moscow, Russia; collection no. 5610; specimen number prefix PIN RAS) and the A.P. Karpinsky Russian Geological Research Institute, St. Petersburg, Russia; collection no. 5217; specimen number prefix TsNIGR).

Order Aulacopleurida Adrain, 2011

Family Brachymetopidae Prantl and Přibyl, 1950

***Brachymetopus* M'Coy, 1847**

Type species: *Phillipsia Maccoyi* Portlock 1843, from the Courceyan or Chadian (Tournaisian or Visean; Early Carboniferous) of County Kildare, Ireland.

***Brachymetopus* (*Conimetopus*) Hahn and Hahn, 1985**

Type species: *Phillipsia ouralica* de Verneuil 1845, from the Bashkirian (Late Carboniferous), Shartimka River, Southern Urals, Russia.

Other species: *B*. (*C*.) *alekseevi* Mychko **sp. nov.**, the upper part of Asselian or the Lower Sakmarian, Lower Permian, Shakhtau locality, Sterlitamak town, Bashkortostan, Russia; *B*. (*C*.) *arcticus* Hahn et Hahn, 1992, Middle Morrowan to Middle Atokan (~Bashkirian), Pennsylvanian, Mariana Islands, Alexander Archipelago, Southeast Alaska; *B*. (*C*.) *conifrons* Gandl, 1987, Namurian C (~Upper Part of the Bashkirian), Pennsylvanian, Province of León, Cantabrian Mountains, Spain; *B*. (*C*.) *esus* Hahn et Hahn, 1982, Lower Warnantium (~Upper Visean), Mississippian, Vise and Richelle, Belgium; *B*. (*C*.) *inflatus* Weber, 1937; Upper Visean–Serpukhovian, Mississippian, Kizil Formation, Horizon D, Kargaly River, Southern Urals, Russia; *B*. (*C*.) *ingridae* Gandl, 2011, Westfalium D (~Moskovian), Pennsylvanian, near Palencia, Cantabrian Mountains, Spain; *B*. (*C*.) *latorensis* Gandl, 1987, upper part of the Bashkirian, Pennsylvanian, Spain, the quarry near Oviedo, Cantabrian Mountains, Spain; *B*. (*C*.) *ornatus* (Woodward 1884), Upper Asbian (~Middle-Upper Visean), Mississippian, Scaleber Knoll reef limestones, Settle, North Yorkshire, England; *B*. (*C*.) *sagittifer* Weber, 1937; Upper Visean–Serpukhovian, Mississippian, Kizil Formation, Horizon D, outcrop no. 494, eastern slopes of the Southern Urals, Russia; *B*. (*C*.) *ultimus* Hahn, Hahn et Yuan, 1989, Kasimovian, Pennsylvanian, Nandan County, Province Guangxi, Southern China; *B*. (*C*.) *zhenanensis* Zhou, 1983, probably Serpukhovian or Bashkirian, Zhenan District, Shanxi Province, China.

Remarks. The subgenus *B*. (*Conimetopus*) Hahn and Hahn, 1985, to which the new species described undoubtedly belongs, is comparatively diverse (12 species) and occurs exclusively in Carboniferous deposits of Asia, Europe and North America (Hahn and Hahn, 1996, p. 120).

There are several main morphological features that are characteristic of *B*. (*Conimetopus*). The following can be distinguished: the presence of genal spines, a carapace usually decorated with tubercles, large eyes, the presence of basal glabellar lobes, a smooth edge of the pygidium, ca. 20 rachial rings and 9–11 pairs of pleural ribs on the pygidium. Species assigned to the subgenus are very similar to one another, and the number of diagnostic features of each is comparatively small.

The oldest members of *B*. (*Conimetopus*) are known from Middle Visean (Fig. 4). There are two very closely related species, *B*. (*C*.) *ornatus* (Woodward, 1884) and *B*. (*C*.) *esus* Hahn and Hahn, 1982. *Brachymetopus* (*C*.) *ornatus* occurs in the Middle Visean of Europe and has been considered to include three subspecies: *B*. (*C*.) *ornatus esus* Hahn and Hahn, 1982; *B*. (*C*.) *ornatus ornatus* (Woodward, 1884) and *B*. (*C*.) *ornatus sanctacrucensis* Osmólska, 1968 (Hanh and Hahn 1996, pp. 125–126). In this work *B*. (*C*.) *esus*, described from the Lower Warnantium (~Upper Visean) of Belgium (Hahn and Hahn 1982, p. 93), is considered an independent species. *Brachymetopus* (*C*.) *ornatus sanctacrucensis* from Visean (Substages D_2) of Poland (Holy Cross Mountains) was synonymised with *B*. (*C*.) *ornatus* by Owens (1986, p. 22). Specimens of *B*. (*C*.) *ornatus* and *B*. (*C*.) *esus* have a unique feature for the entire subgenus—a subtriangular shape of the cephalon, which makes them somewhat similar to species of *Brachymetopus* (*Acutimetopus*) Hahn and Hahn, 1985.

Two Mississippian species, *B*. (*C*.) *inflatus* Weber, 1937, and *B*. (*C*.) *sagittifer* Weber, 1937, were described only with pygidia, which were discovered in Horizon D of the Kizil Formation (Upper Visean–Serpukhovian) in eastern slopes of the Southern Urals (Kargaly River).

The species *B*. (*C*.) *conifrons* was described from the Upper Part of the Bashkirian (Namurian C) of the Cantabrian Mountains in Spain (Gandl, 1987, p.52) and is similar to *B*. (*C*.) *ornatus* in the indented marginal rim, whereas all other species of the subgenus species have a flat rim.

Brachymetopus (*C*.) *zhenanensis* Zhou, 1983, was described based on a pygidium from the Late Mississippian or Early Pennsylvanian (probably Serpukhovian or Bashkirian) of the Zhenan District, Shaanxi, China.

The type species, *B*. (*Conimetopus*) *ouralicus* (de Verneuil 1845) was described (de Verneuil, 1845, p. 378, Pl. 28, Fig. 16) from a pygidium discovered in Carboniferous deposits on the Shartimka River in the Southern Urals in Russia. The neotype of *B*. (*C*.) *ouralicus* (de Verneuil 1845) was designated by Osmólska (1968, p. 363) from another pygidium from the same locality. According to the recent data (Mychko and Alekseev, 2017, p. 63), trilobites in this section occur in are of Bashkirian age, and not Visean as previously thought.

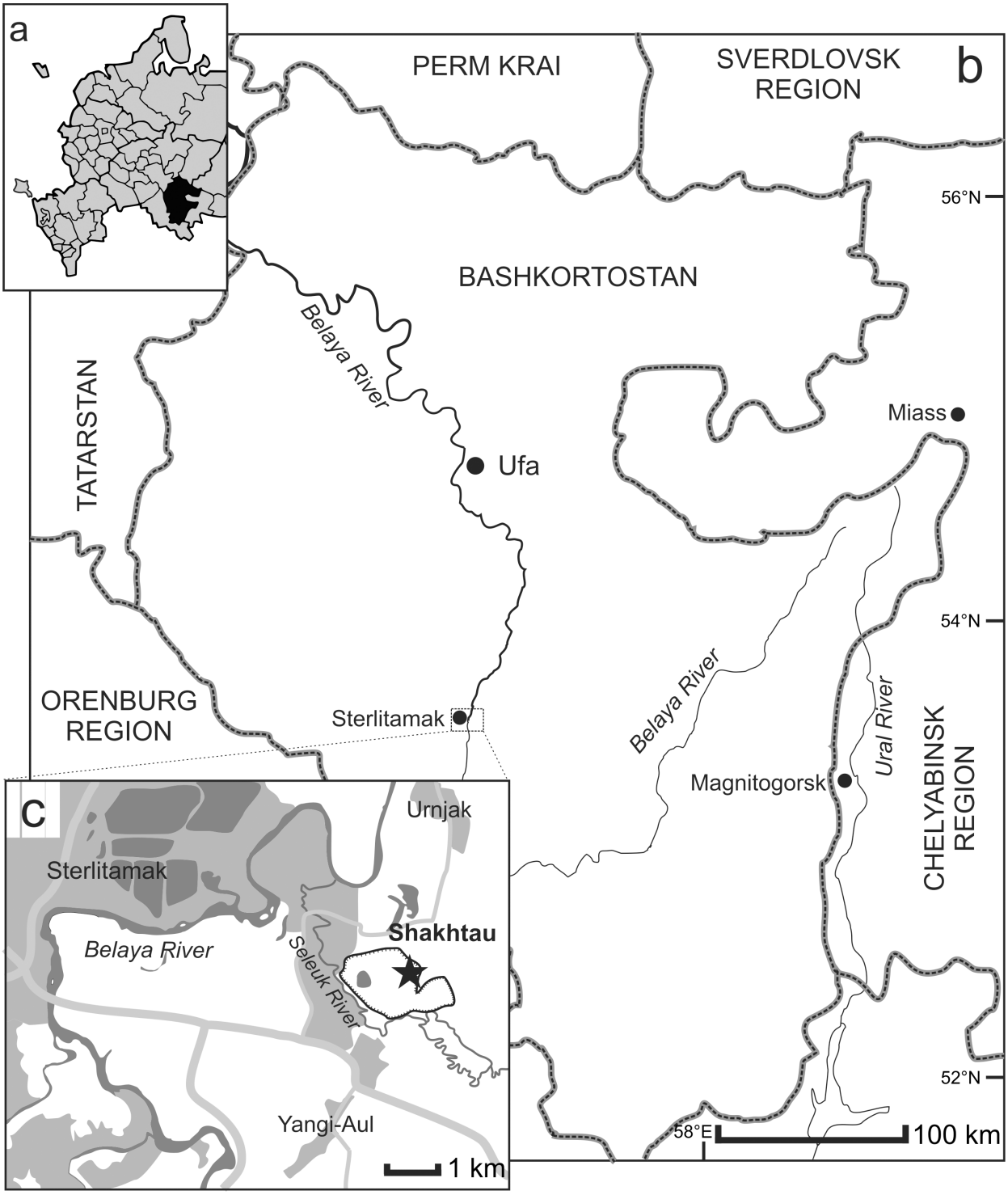

FIGURE 2. Locality map. A—the European part of Russia with administrative division; B—the Republic of Bashkortostan and adjacent regions; C—the area around the Shakhtau locality.

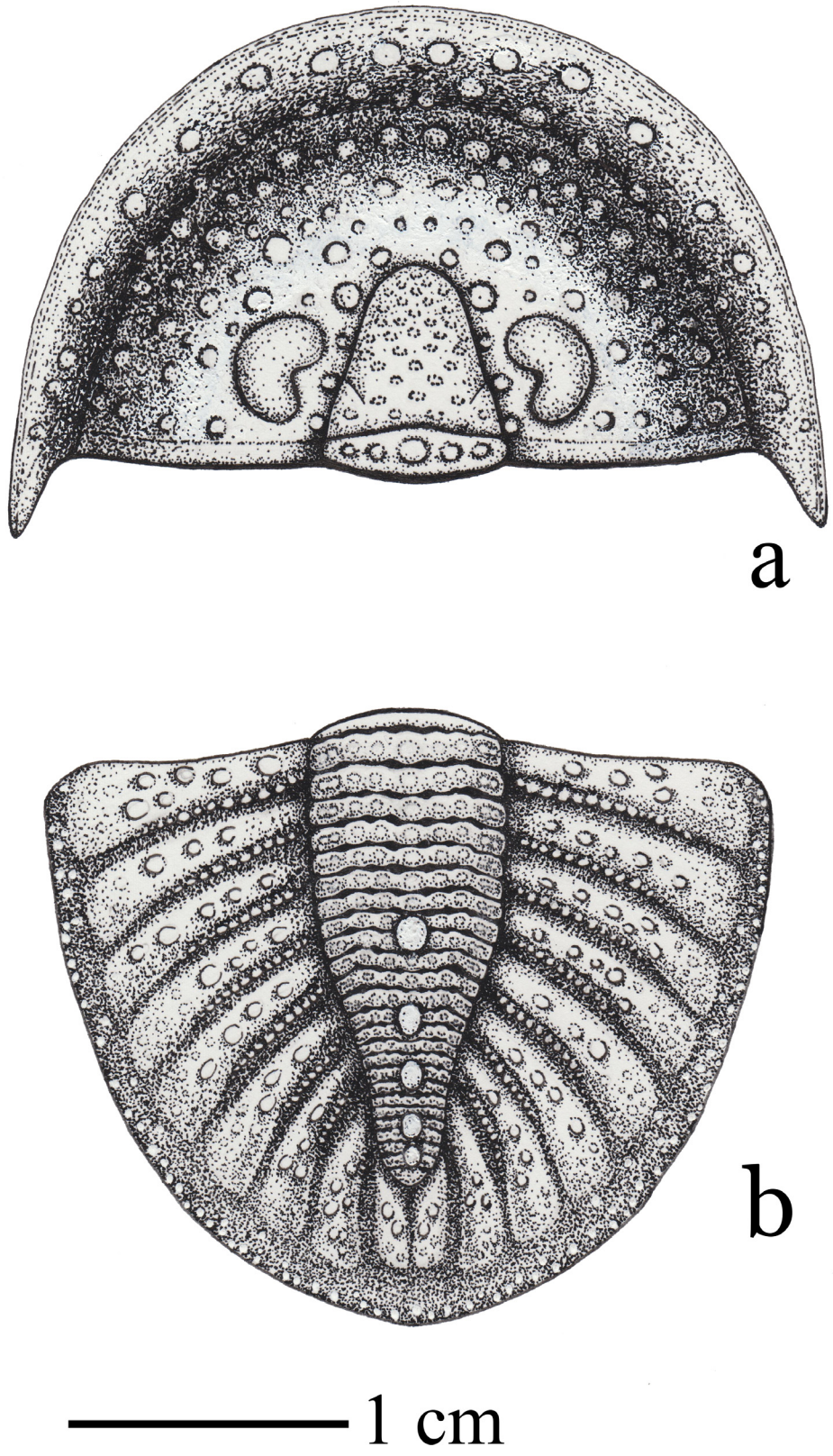

FIGURE 3. Reconstruction of the carapace of *Brachymetopus* (*Conimetopus*) *alekseevi* Mychko, **sp. nov.** a—cephalon. b—pygidium.

The species *B.* (*C*.) *arcticus* Hahn and Hahn, 1992, was described from well-preserved specimens (cephalon and pygidium) from the Carboniferous Ladrones Limestone of the Alexander Archipelago, southeast Alaska (Hahn and Hahn, 1992, p. 114; Hahn and Hahn, 1996, p. 122). According to conodonts data, these deposits are Middle Morrowan to Middle Atokan (Savage and Barkeley, 1985), which correlates with the Bashkirian.

The species *B*. (*C*.) *latorensis* Gandl, 1987, was described based on a cephalon from upper part of the Bashkirian of the Cantabrian Mountains, Spain. Hahn and Hahn (1996) considered it a subspecies of *B*. (*C*.) *ouralicus.* In the present work, it is considered an independent species.

Brachymetopus (*C*.) *ouralicus ingridae* Gandl, 2011, is based on well-preserved cephala and pygidia from the Moscovian (Westfalium D) near Palencia, Spain. This form is derived from deposits younger than that of *B*. (*C*.) *ouralicus*, and small but significant differences (*ingridae* has more rachis rings, usually around 25 and the tubercle between the upper part of the eye and glabella not pronounced; and also according to Gandl (2011) the *ingridae* has a shorter and wider cephalon) exist on the species level with *B*. (*C*.) *ouralicus*. Hence, *ingridae* is considered a separate species herein.

The species *B*. (*C*.) *ultimus* Hahn, Hahn and Yuan, 1989, was described based on cephala and a pygidium (Hahn *et al.,* 1989, p. 129) from the Kasimovian of Southern China (Guangxi Zhuang Autonomous Region, Hechi, Nandan, and Ghe-Gang). Later, a pygidium from the Kasimovian of Vaygach Island, Arctic Russia, which was identified by V.N. Weber (1937, p. 84, Fig. 68c) as *Brachymetopus* (*Brachymetopina*) *moelleri*? was assigned to this species (Hanh and Hahn, 1996, p. 142).

The species *B*. (*C*.?) *psilus* Hahn and Hahn, 1996, is represented by a single fragmentary cephalon from the Lower Carboniferous Richrather Kalk, Sonderland, Germany (Hahn and Hahn 1996, p. 141). Amler and Herbig (2006, p. 461) have assigned these strata to the Richrath-Subformation (lower part of Heiligenhaus Formation) and considered that they are of Early Visean age. The cephalon of *psilus* does not have a tuberculate sculpture, which distinguishes it from all other species *B*. (*Conimetopus*) and most members of the genus *Brachymetopus*. Its affinity is uncertain and it is provisionally excluded from *Brachymetopus* (*Conimetopus*) herein.

Thus, the species *B*. (*C*.) *alekseevi* Mychko **sp. nov.** is the youngest member of the subgenus *Brachymetopus* (*Conimetopus*) and the third species known from Carboniferous-Permian deposits in Russia.

***Brachymetopus* (*Conimetopus*) *alekseevi* Mychko sp. nov.**

Plate 1; Figure 3

urn:lsid:zoobank.org:act:E5970BCA-7D22-4DB2-B3A9-1126698C75C7

Brachymetopus (*Brachymetopina*) *moelleri* n. nom. (?): Weber, 1937, p. 84, Pl. 10, figs 10, 11; Fig. 68b.
non *Brachymetopus* (*Conimetopus*) *ouralicus ouralicus*: Hahn and Hahn, 1996, p. 136, figs 181–183.

Material. Holotype, PIN RAS, no. 5610/2, cephalon (Pl. 1, Fig. 1a–c), and paratypes (TsNIGR Museum, no. 5217/2063, cephalon, Fig. 1, b; PIN RAS, no. 5610/3, pygidium, Pl. 1, Fig. 4; PIN RAS, no. 5610/4, pygidium, Pl. 1, Fig. 3; PIN RAS, no. 5610/5, pygidium, Pl. 1, Fig. 5a,b; PIN RAS, no. 5610/6, pygidium, Pl. 1, Fig. 2a,b; PIN RAS, no. 5610/7, pygidium, Pl. 1, Fig. 6; TsNIGR, no. 5217/2064, pygidium, Fig. 1, c.), Lower Permian (upper Asselian or lower Sakmarian), Shakhtau quarry, Sterlitamak town, Ishimbay District, Bashkortostan, Russia (specimens from PIN RAS) and Lower Permian, Asselian, "Kazarmenny Kamen" locality, right bank of the Sim River, the town of Asha, Ashinsky District, Chelyabinsk Region (specimens from TsNIGR).

Etymology. In honor of A.S. Alekseev, paleontologist and stratigrapher, professor at the Faculty of Geology, Lomonosov Moscow State University, scientific mentor of the corresponding author of this article.

Description. The cephalon is large (more than 1 cm in width) and of semielliptical shape, stretched in width (L/W=0.6), strongly convex. It terminates with short and narrow genal spines rounded at the edges. The glabella is very convex, conical in shape, short (slightly less than 40% of the length of cephalon) and it narrows down from back end to front. The posterior part of the glabella is 2.6 times as wide as the anterior part. The basal lobes are very weakly defined. The entire surface of the glabella is covered with small round convex tubercles of different sizes, equidistant from each other and staggered. The occipital ring is long, narrow, convex. On its surface there are five or six large convex tubercles aligned in a row. The eyes are small, crescentic, and very prominent, located opposite the posterior half of the glabella. The palpebral lobes cover 1/3 of the eye. On either side of the glabella, a pair of large convex and detached tubercles is located at the top of the eyes. Posterior to them, between the

palpebral lobe and the glabella there is a row of three other smaller tubercles. A number of variably sized tubercles are located around the eyes. The preglabellar field is generally flat though close to the anterior part of the glabella it rises steeply. The entire surface of cephalon is tuberculate. The largest, flattened tubercles are located closer to the marginal rim. They are more diffuse than the tubercles on the steep, central part of the cephalon - cranidia and regions of librigenae—on which the tubercles are denser and alternate with very small tubercles. The marginal rim is flat and very narrow, with 5 thin terrace lines on it.

The thorax is not known.

The pygidium is large (up to 4 cm in length), of semielliptical shape, wider than long (L/W=0.9), flattened. The rachis is long, occupying about 80% of the length of the pygidium. It becomes narrower towards the posterior margin (the posterior margin of the rachis is 6 times narrower than the anterior margin) and has a slight lateral narrowing nearer to the posterior end. The anterior margin of the rachis is three times narrower than the overall pygidium. In profile, the rachis is convex and subtriangular. It consists of 25 rings separated by deep and wide furrows. On each ring there is a row of 10 densely distributed large tubercles. The largest tubercles are located on the dorsal part of the rachis, and the tubercles decrease in size proportionally towards the dorsal furrows of the pygidium. In the posterior half of the rachis, on the dorsal parts of its five rings, there are large spine-like tubercles (broken off on all the specimens in the collection). The distance between them from the most rear to the frontal spine-like tubercle increases exponentially. The lateral lobes of the pygidium are nearly flat, and bear nine broad and long pleural ribs that are separated by wide and deep interpleural furrows which gradually widen to the marginal rim. In the anterior part of the pygidium, pleural ribs are almost perpendicular to the dorsal furrows, but as they approach the posterior end of the pygidium, the posterior pleural ribs become parallel to the dorsal furrows. The pleural furrows are distinct, deep, dividing the pleural ribs into a wider anterior and narrower posterior half-ribs. The posterior half-rib is decorated with densely spaced, elongated tubercles aligned in a row. The anterior half is covered with chaotically located tubercles of different sizes, among which the largest tubercles are located closer to the dorsal furrows. The pleural ribs smoothly pass into a very narrow marginal rim which is devoid of terrace lines. The marginal furrow is absent. The marginal rim along its edge is densely littered with numerous small tubercles aligned in a single row.

Dimensions of the holotype and paratype specimens are given in Table 1.

TABLE 1. Dimensions (mm) of the holotype and paratype specimens of *Brachymetopus* (*Conimetopus*) *alekseevi* Mychko, **sp. nov.**

CEPHALON										
Specimen no.	CL	CW	GL	ORL	AGW	PGW	EL	MRW	L/W	CW/GW
PIN RAS, no. 5610/2, holotype	8.1	13.3	3.0	3.0	1.6	2.9	1.9	0.3	0.6	8.3
TsNIGR Museum, no. 5217/2063, paratype	7	11	2.5	2.5	~1	2.3	1.3	?	0.6	~1

PYGIDIUM						
Specimen no.	PL	PW	WR	L/W	W/WR PMR	PL
PIN RAS, no. 5610/3, paratype	27.2	~27	8.5	~1	3.2	5.27
PIN RAS, no. 5610/4, paratype	8.35	7.8	3.0	1.0	2.6	1.8
PIN RAS, no. 5610/5, paratype	17.2	18.4	6.3	0.9	2.9	2.8
PIN RAS, no. 5610/6, paratype	13.7	13.7	4.9	1	2.7	2.4
PIN RAS, no. 5610/7, paratype	~16	~20	7.7	~0.8	~2.5	3.4
TsNIGR, no. 5217/2064, paratype	?	~10	3.4	?	2.9	?
Mean value	16,6	13,3	6,0	0,96	2,9	3,1

Legend: **CL**—length of cephalon, **CW**—width of cephalon, **GL**—length of glabella, **ORL**—length of occipital ring, **AGW**—width of glabella in the anterior part, **PGW**—width of glabella in the posterior part, **EL**—length of the eye, **MRW**—width of the marginal rim, **L/W** is the ratio of the length of the cephalon to its width, **CW/GW** is the ratio of the width of the cephalon to the width of the glabella in the anterior part, **PL**—length of pygidium, **PW**—width of pygidium, **WR** is width of the rachis in the anterior part, **L/W** is the ratio of the length of the pygidium to its width, **W/WR** is the ratio of the width of the pygidium to the width of the rachis in the anterior part, **PMR** is the distance from the end of the rachis to marginal rim of pygidium.

Remarks. *B. (C.) alekseevi* is very similar to the type species, *B*. (*C*.) *ouralicus* (Hahn and Hahn, 1996, figs 181–183) but differs in having 25 versus 20 pygidial rachial rings and nine versus ten pairs of pleural ribs . From the species *B*. (*C*.) *ingridae* (see: Gandl 2011, Taf. 14, figs 205–208) it is distinguished by the presence of a pair of distinct tubercles on both sides of glabella in the anterior part of the eyes and a smaller number of pleural ribs (*B*. (*C*.) *ingridae* has 10 pairs of pleural ribs). From *B*. (*C*.) *ultimus* (see: Hahn, Hahn and Yuan, 1989, Table 2, figs 1–4; Hahn and Hahn, 1996, Abb. 159–160) it differs in the shape of the tubercles on cephalon (in *B*. (*C*.) *ultimus* they are drop-like and elongated ones), relatively large tubercles on the occipital ring (in *B*. (*C*.) *ultimus* these tubercles are small and scattered chaotically) and a larger number of the rings of the rachis (rachis of *B*. (*C*.) *ultimus* consists of 20 rings). From *B*. (*C*.) *ornatus* (see: Hahn and Hahn, 1996, Abb. 163–168) it differs in the round shape of cephalon (cephalon *B*. (*C*.) *ornatus* has a subtriangular shape), flat marginal rim of cephalon (marginal rim of *B*. (*C*.) *ornatus* is dented) and a greater number of rings of the rachis (*B*. (*C*.) ornatus has 17–20 rings on the rachis). From the species *B*. (*C*.) *conifrons* (see: Gandl, 1987, Taf. 8, Fig. 111a–c; Hahn and Hahn, 1996, Abb. 161–162) it is distinguished by a flat marginal rim of cephalon (marginal rim of *B*. (*C*.) *conifrons* is dented) and a larger number of rings of rachis (in *B*. (*C*.) *conifrons* has 17–20 rachis rings). It differs species *B*. (*C*.) *arcticus* (see: Hahn and Hahn, 1992, Abb. 13–14, Taf. 1, figs 13–15; Hahn and Hahn, 1996, Abb. 157–158) in the following: the presence of a tubercles sculpture on the surface of the entire cephalon (the tubercles of *B*. (*C*.) *arcticus* are located only on the glabella and the eyes), less apparent basal lobes, tubercles on the occipital ring, comparatively large eyes, a smaller number of pleural ribs (lateral lobes of *B*. (*C*.) *arcticus* carry 12 pairs of ribs). It is very different from *B*. (C.?) *psilus* (see: Hahn and Hahn 1970, Abb. 15, Taf. 2, Fig. 20; Hahn and Hahn, 1996, Abb. 184): the presence of a tubercles sculpture on the carapace (cephalon of *B*. (*C*.?) *psilus* is smooth and devoid of sculptural formations).

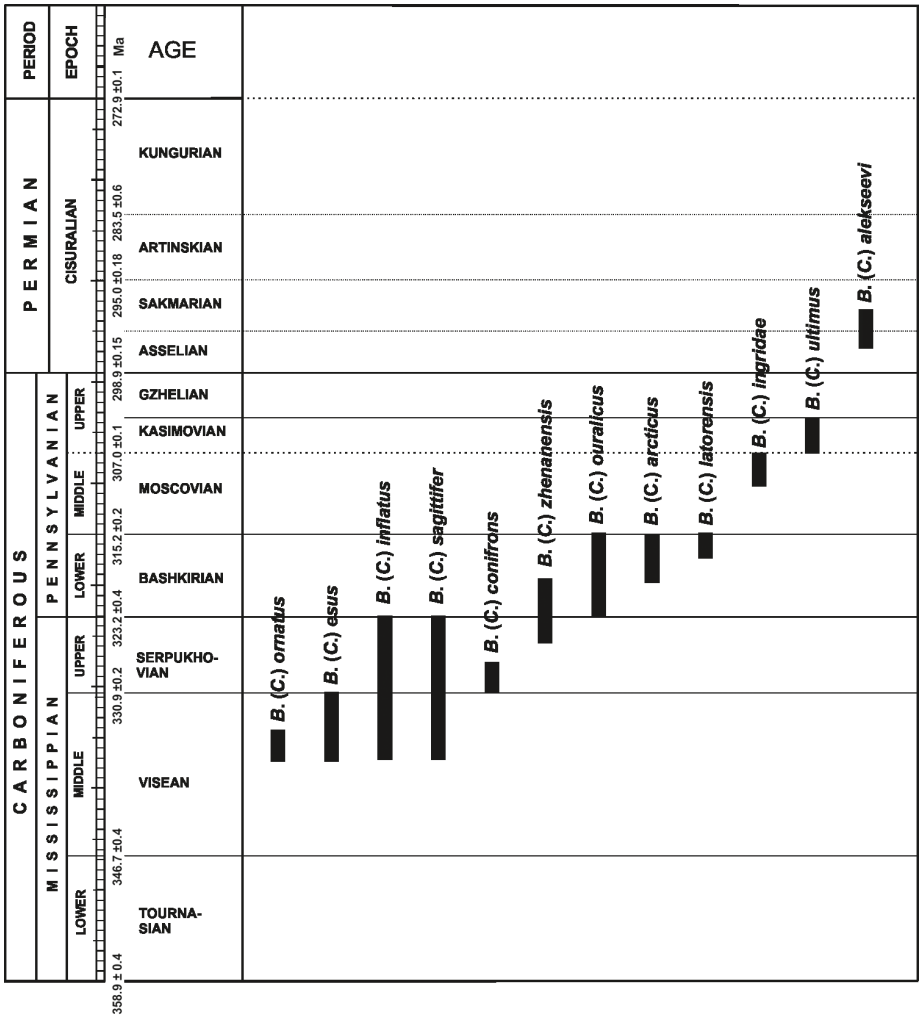

FIGURE 4. Stratigraphic distribution of species of *Brachymetopus* (*Conimetopus*).

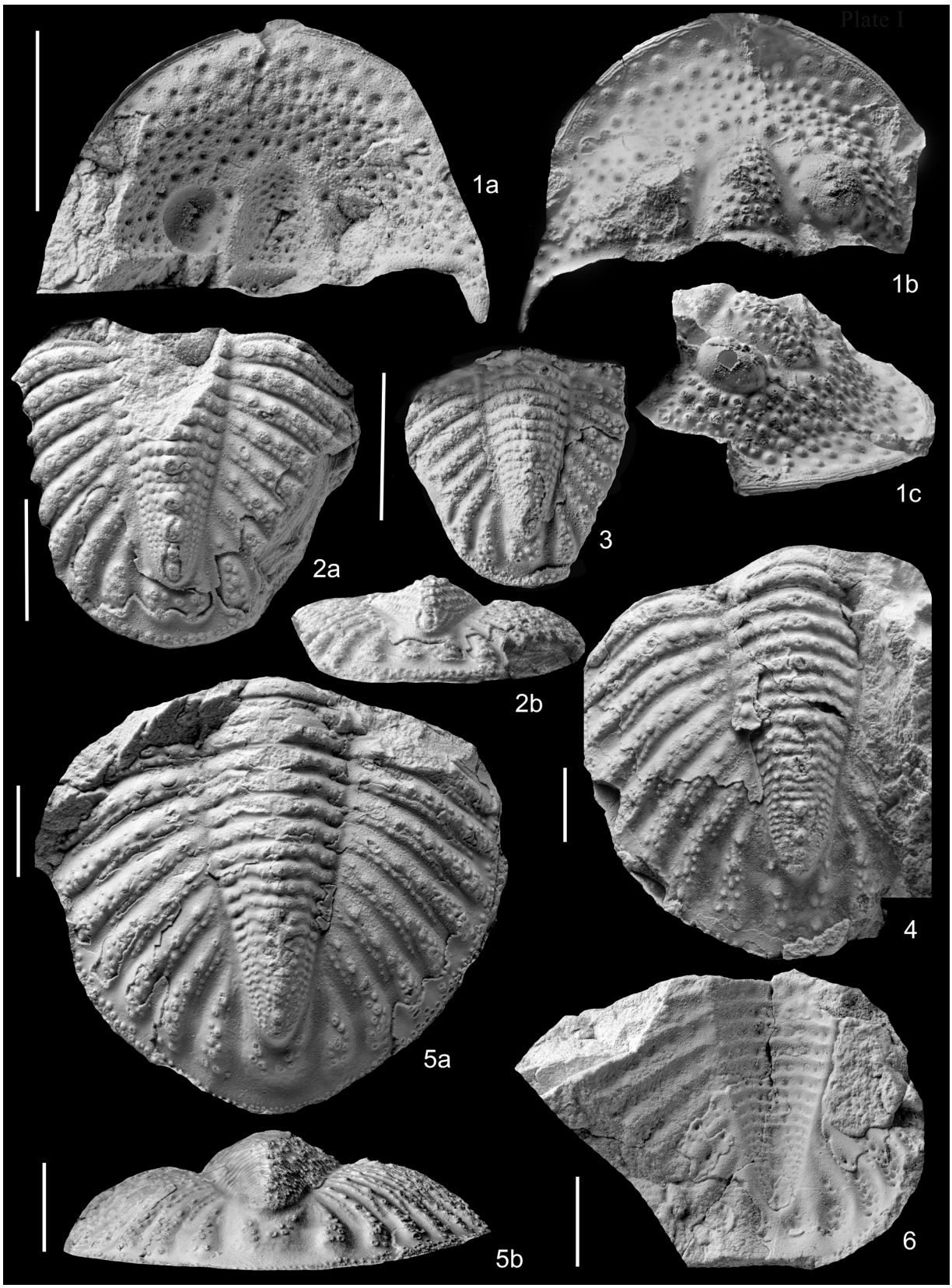

PLATE 1. *Brachymetopus* (*Conimetopus*) *alekseevi* Mychko, **sp. nov.**, Upper Asselian or Lower Sakmarian, Shakhtau quarry, Sterlitamak town, Ishimbay District, Bashkortostan, Russia. 1a—holotype, spec. PIN RAS, no. 5610/2, external mold; 1b, c—latex cast from holotype, dorsal and lateral views. 2a, b—paratype, spec. PIN RAS, no. 5610/6, pygidium, dorsal and posterior views. 3—paratype, spec. PIN RAS, no. 5610/4, pygidium, dorsal view. 4—paratype, spec. PIN RAS, no. 5610/3, pygidium, dorsal view. 5a, b—paratype, spec. PIN RAS, no. 5610/5, pygidium, dorsal and posterior views. 6—paratype, spec. PIN RAS, no. 5610/7, pygidium, external mold. The scale bar is 5 mm.

Acknowledgements

The corresponding author, Dr. Eduard V. Mychko, is deeply grateful to the senior research staff of the Paleontological Institute of Russian Academy of Sciences, namely, A.V. Mazaev and M.S. Boyko for comprehensive assistance in the search for fossils; professor of the Faculty of Geology, Lomonosov Moscow State University, A.S. Alekseev for valuable comments and recommendations; staff photographer of the Paleontological Institute of Russian Academy of Sciences S.V. Bagirov for taking professional photos of the trilobite specimens; artist Y.V. Kosheleva for the trilobite reconstruction illustrations. We are grateful to Professor Jonathan Adrain (University of Iowa, USA) for valuable comments and assistance in editing the paper, and also Dr. Robert Owens (National Museum Wales, UK) and an anonymous reviewer for constructive review of this work. The study was funded by Russian Foundation for Basic Research (RFBR) according to the research project № 18-35-00165.

Literature cited

Adrain, J.M. (2011) Class Trilobita Walch, 1771. *In*: Zhang, Z.-Q. (Ed.), Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness. *Zootaxa*, 3148, pp. 104–109.

Amler, M.R.W. & Herbig, H.-G. (2006) Ostrand der Kohlenkalk-Plattform und Übergang in das Kulm-Becken im westlichsten Deutschland zwischen Aachen und Wuppertal. *In*: Amler, M.R.W. & Stoppel, D. (Eds.), *Deutsche Stratigraphische Kommission. Stratigraphie von Deutschland 6: Unterkarbon (Mississippium). Schriftenreihe der Deutschen Gesellschaft für Geowissenschaften*, 41, pp. 441–477. [in German]

Angelin, N.P. (1854) *Palaeontologia Scandinavica Pars I, Iconographia crustaceorum formationis transitionis, Fasciculus II*. T.O. Weigel, Lund, 72 pp. [pp. 21–92]

Archbold, N.W. (1981) New Permian trilobite from Irian Jaya, Indonesia. *Geological Research and Development Centre. Paleontology Series,* 2, 35–41.

Chernov, A.A. & Chernov, G.A. (1940) *Geologicheskoye stroyeniye basseyna r. Kos'yu v Pechorskom kraye (otchet geologicheskogo otryada Pechorskoy kompleksnoy ekspeditsii SOPS Akademii nauk 1935 g.).* AS USSR, Moscow-Leningrad, 103 pp. [in Russian]

Chernykh, V.V. (2006) *Nizhnepermskie konodonty Urala*. Institut geologii i geokhimii UrO RAN, Ekaterinburg, 130 pp. [in Russian]

Chuvashov, B.I. (1983) Permian reefs of the Urals. *Facies*, 8, 191–212.

Chuvashov, B.I., Dyupina, G.V., Mizens, G.A. & Chernykh, V.V. (1991) *Opornyye razrezy karbona i nizhney permi zapadnogo sklona Urala*. UrO US USSR, Sverdlovsk, 369 pp. [in Russian]

Diener, C. (1897) Himalayan fossils. The Permocarboniferous fauna of Chitichun No.1. *Palaeontologia Indica*, 15, 1 (13), 1–105.

Eichwald, E. (1861) *Lethaea Rossica ou Paléontologie de la Russie. Ancienne Période. 3*. Librairie et imprimerie de E. Schweizerbart, Stuttgart, 1657 pp.

Gandl, J. (1987) Die Karbon-Trilobiten des Kantabrischen Gebirges (NW-Spanien) 4: Trilobiten aus dem hoheren Namur und tieferen Westfal. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 543, 1–179. [in German]

Gandl, J. (2011) The Carboniferous trilobites of the Cantabrian Mountains (NW Spain), 5: upper Westphalian trilobites. *Abhandlungen der Senckenberg Gesellschaft fuer Naturforschung*, 569, 1–143. [in German]

Gerasimov, N.P. (1934) Nekotoryye zamechaniya k stat'ye prof. M.E. Noinskogo Shvagerinovyy gorizont i artinskiye otlozheniya na Urale». *Uchenye zapiski Kazanskogo osudarstvennogo universiteta imeni V.I. Ul'yanova-Lenina*, 94 (1/3), 38–67. [in Russian]

Hahn, G. & Hahn, R. (1970) Trilobiten aus dem Kohlenkalk von Sondern (Rheinland). *Decheniana*, 122 (2), 217–250. [in German]

Hahn, G. & Hahn, R. (1982) Die Trilobiten des belgisehen Kohlenkalkes (Unter-Karbon). 2. Brachymetopus. *Geologica et Palaeontologica*, 15, 89–114. [in German]

Hahn, G. & Hahn, R. (1985) Trilobiten aus dem hohen Ober-Karbon oder Unter-Perm von Alaska. *Senckenbergiana lethaea*, 66 (6), 445–485. [in German]

Hahn, G. & Hahn, R. (1988) Seltene Trilobiten aus dem Unter-Aprathium (Unter-Karbon) von Erdbach und Herborn (Hessen). *Senckenbergiana lethaea*, 68 (5/6), 347–370. [in German]

Hahn, G. & Hahn, R. (1992) Trilobiten aus dem Karbon von SE-Alaska, Teil 2. *Geologica et Palaeontologica*, 26, 99–133. [in German]

Hahn, G. & Hahn, R. (1996) Die trilobiten-taxa des Karbons und Perms 2. Brachymetopidae. *Courier Forschungsinstitut Senckenberg*, 195, 1–242. [in German]

Hahn, G., Hahn, R. & Yuan, J.L. (1989) Trilobites from the Upper Carboniferous (Westphalian A) of S-China (N-Guangxi). *Geologica et Palaeontologica*, 23, 113–203.

Jell, P.A. & Adrain, J.M. (2003) Available generic names for trilobites. *Memoirs of the Queensland Museum*, 48 (2), 331–553.

Kobayashi, T. & Hamada, T. (1979) Permo-Carboniferous trilobites from Thailand and Malaysia. *Geology and Palaeontology of Southeast Asia*, 20, 1–21.
Korolyuk, I.K. (1985) *Metody i rezultaty izucheniya permskogo rifogennogo massiva Shakhtau (Bashkirskoye Priuralye)*. Nauka, Moscow, 120 pp. [in Russian]
Kotlyar, G.V., Zakharov, Y.D., Kochirkevich, B.V., Kropacheva, G.S., Rostovcev, K.O., Chedia, I.O., Vuks, G.P. & Guseva, E.A. (1983) *Pozdnepermskiy etap evolyutsii organicheskogo mira (Dzhul'finskiy i dorashamskiy yarusy SSSR).* Nauka, Leningrad, 200 pp. [in Russian]
Krasnopolsky, A.A. (1887) Kratkiy ocherk geologicheskogo stroyeniya Kynovskoy dachi na Urale. *Izvestia Geologicheskogo kommiteta*, 6, 267–303. [in Russian]
Krasnopolsky, A.A. (1891) Obshchaya geologicheskaya karta Rossii. List 126-y. Perm–Solikamsk. *Trudy Geologicheskogo kommiteta*, 11 (2), 30. [in Russian]
Kulagina, E.I., Skuin, I.A. & Kossovaya, O.L. (2015) *Permskiy rif Shakhtau*. Belaya reka, Ufa, 72 pp. [in Russian]
Kulik, E.A. (1978) Izvestkovyye zelenyye (sifonovyye) vodorosli assel'skogo i sakmarskogo vozrasta massiva Shakhtau (Bashkiriya). *Voprosy mikropaleontologii*, 21, 182–214. [in Russian]
McCoy, F. (1847) On the fossil botany and zoology of the rocks associated with the coal of Australia. *Annals and Magazine of Natural History*, Series 1, 20, 226–236.
https://doi.org/10.1080/037454809496037
Miloradovich, B.V. & Ilina, N.S. (1951) *Litolgo-paleontologicheskaya kharakteristika kamennougol'nykh i nizhnepermskikh otlozheniy Priural'ya*. Gostoptekhizdat, Moscow-Leningrad, 106 pp. [in Russian]
Murchison, R.I., de Verneuil, E. & von Keyserling, A. (1845) *The Geology of Russia in Europe and the Ural Mountains*. *Vol. 1. Geology.* Murray, London, 700 pp.
https://doi.org/10.5962/bhl.title.121912
Mychko, E.V. (2012) A New Species of Trilobites from Sakmarian Reefs of Bashkortostan. *Paleontological Journal*, 46 (1), 44–48.
https://doi.org/10.1134/S0031030112010108
Mychko, E.V. (2016) *Trilobity srednego-verkhnego karbona i permi Severnoy Yevrazii. Dissertation of the candidate of geologo-mineralogical sciences*. Lomonosov Moscow State University, Moscow, 393 pp. [in Russian]
Mychko, E.V. & Alekseev, A.S. (2017) Localities of middle Carboniferous—Permian trilobites in Russia and surrounding countries. *Bulletin of Moscow Society of Naturalists. Geological Series*, 92 (3), 40–83. [in Russian]
Möller, V. von (1867) Über die Trilobiten der Steinkohlenformation des Urals, nebst einer Uebersicht und einigen Ergänzungen der bisherigen Beobachtungen uber Kohlen Trilobiten im Allgemeinen. *Bulletin of the Imperial Society of Naturalists of Moscow*, 1, 1–81. [in German]
Möller, V.I. von (1868) O trilobitakh kamennougol'noy formatsii Urala, s obzorom i nekotorymi dopolneniyami predshestvuyushchikh nablyudeniy nad kamennougol'nymi trilobitami voobshche. *Zapiski Imperatorskogo S.-Peterburgskogo mineralogicheskogo obschestva*, 2, 3 (7), 5–72. [in Russian]
Osmólska, H. (1968) Brachymetopus McCoy (Trilobita) in the Carboniferous of Poland and U.S.S.R. *Acta Palaeontologica Polonica*, 13 (3), 359–374.
Owens, R.M. (1983) A review of Permian trilobite genera. *Special Papers in Palaeontology*, 30, 15–41.
Owens, R.M. (1986) The Carboniferous trilobites of Britain. Part 1. *Monograph of the Palaeontographical Society*, 138, 1–26.
Owens, R.M. (2003) The stratigraphical distribution and extinctions of Permian trilobites. *Special Papers in Palaeontology*, 70, 377–397.
Özdikmen, H. (2009) Nomenclatural changes for twenty trilobites genera. *Munis Entomology and Zoology*, 4 (1), 155–171.
Puchkov, V.N. (2010) *Geologiya Urala i Priuralya (aktualnye voprosy stratigrafii, tektoniki, geodinamiki i metallogenii)*. DizaynPoligrafServis, Ufa, 280 pp. [in Russian]
Prantl, F. & Pribyl, A. (1950) Revise čeledi Otarionidae R. a E. Richter z českého siluru a devonu (Trilobitae). *Sborník Státního Geologického Ústavu Čeckoslovenské*, 17, 1–83. [in Czech]
Rauzer-Chernousova, D.M., Beljaev, G. & Reitlinger, E. (1936) Upper Paleozoic foraminifera of the Pechora region. *Proceedings of the Polar Commission AS SSSR*, 28, 159–232. [in Russian]
Rauzer-Chernousova, D.M. (1950) Fatsii verkhnekamennougolnykh i artinskikh otlozheniy Sterlitamaksko-Ishimbayskogo Priuralya (na osnove izucheniya fuzulinid). *Trudy Instituta geologii AN SSSR*, 119 (43), 1–109. [in Russian]
Rauzer-Chernousova, D.M., Ivanova, E.A. & Korolyuk, I.K. (1977) K kharakteristike stratotipa sterlitamakskogo gorizonta (nizhnyaya perm, massiv Shakhtau, Bashkiriya). *Byulluten MOIP. Otdelenie geologii*, 52 (6), 24–37. [in Russian]
Rauzer-Chernousova, D.M. & Korolyuk, I.K. (1991) *Sterlitamakskie shikhany—rannepermskie rify. In*: *Mezhdunarodnyy kongress «Permskaya sistema Zemnogo shara». Putevoditel geologicheskikh ekskursiy. Chast II. Yuzhnouralskaya ekskursiya*. Sverdlovsk, pp. 47–71. [in Russian]
Savage, N.M. & Barkeley, S.J. (1985) Early to Middle Pennsylvanian conodonts from the Klawak Formation and the Ladrones Limestone, Southeastern Alaska. *Journal of Paleontology*, 59 (6), 1451–1475.
Shamov, D.F. (1957) Fatsii sakmaro-artinskikh otlozheniy Ishimbaevskogo Priuralya. *Trudy Ufimskogo neftyanogo nauchno issledovatelskogo instituta*, 2, 3–77. [in Russian]
Shamov, D.F. (1984) Vtoroy den. Razrez permi gor-odinochek Shakhtau i Tratau. *In*: Einor, O.L. (Ed.), *27 Mezhdunarodnyy geologicheskiy kongress. Yuzhnyy Ural. Putevoditel ekskursii 047*. Nauka, Moscow, pp. 22–25. [in Russian]

Tolstikhina, M.M. (1941) Karbon i nizhnyaya perm' vostoka Russkoy platformy i zapadnogo sklona Urala. *In*: *Trudy Bashkirskogo geologicheskogo upravleniya. Vol. 11.* Gosgeolizdat Moscow-Leningrad, pp. 1–177. [in Russian]

Verneuil, E. de (1845) Terrain Paléozoique. Animaux. *In*: Murchison, R.I., de Verneuil E. & Keyserling, A. (Eds.), G*éologie de la Russie d'Europe et des montagnes de l'Oural*. *Vol. II. Troisème partie. Paléontologie*. J. Murray, London, Bertrand, Paris, pp. 15–396.
https://doi.org/10.5962/bhl.title.121912

Weber, V.N. (1932) Trilobity Turkestana. *Trudy Vsesoyuznogo Geologo-Razvedochnogo Ob'edineniya N.K.T.P—S.S.S.R*, 178, 1–157. [in Russian]

Weber, V.N. (1937) Trilobity kamennougolnych i permskich otlozenij SSSR. Vypusk 1. Kamennougolnye trilobity. *Monografii popaleontologii SSSR*, 71, 1–104. [in Russian]

Weber, V.N. (1944) Trilobity kamennougol'nykh i permskikh otlozheniy SSSR. Vypusk 2. Permskiye trilobity. *Monografii popaleontologii SSSR*, 1944, 1–30. [in Russian]

Woodward, H. (1884) The Carboniferous Trilobites, Part 2. *Monograph of the Palaeontographical Society, London*, 182, 39–86.

Zhou, Z.-Q. (1983) Trilobita. *In*: Shengyang institute of geology and mineral resources (Ed.), *Paleontological Atlas of Northeast China*. Geological Publishing House, Beijing, pp. 475–477. [in Chinese]