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New Trematothoracinae (Hymenoptera: Sepulcidae) from the Lower Cretaceous of Transbaikalia

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Новые трематоторацины (Hymenoptera: Sepulcidae: Trematothoracinae) из нижнего мела Забайкалья

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Abstract. Two species of Trematothoracinae, *Trematothorax kasparyani* **sp. n.** and *T. demeter* **sp. n.**, are described from the Lower Cretaceous of Transbaikalia. The morphological features of Trematothoracinae, namely structure of mesonotum, size of metanotum, and "double" costal vein, are discussed.

Key words. Hymenoptera, Symphyta, Cephoidea, Sepulcidae, Trematothoracinae, *Trematothorax*, Lower Cretaceous, Transbaikalia, new taxa, fossil insects.

Резюме. Из нижнего мела Забайкалья описаны два новый вида сепулек из подсемейства Trematothoracinae – *Trematothorax kasparyani* **sp. n.** и *T. demeter* **sp. n.** Обсуждаются морфологические особенности, характерные для данного подсемейства: строение мезонотума, размеры метанотума и «двойная» костальная жилка.

Ключевые слова. Hymenoptera, Symphyta, Cephoidea, Sepulcidae, Trematothoracinae, *Trematothorax*, сепульки, нижний мел, Забайкалье, новые таксоны, ископаемые насекомые.

Introduction

Sepulcidae is a large family of sawflies, which lived from the Early Jurassic to Late Cretaceous. The first four genera of sepulcids (*Sepulca* Rasnitsyn, 1968, *Sepulenia* Rasnitsyn, 1968, *Parapamphilius* Rasnitsyn, 1968 and *Shurabisca* Rasnitsyn, 1968) were described by Rasnitsyn (1968) from the Jurassic of Central Asia (Karatau in Kazakhstan and Shurab III in Kyrgyzstan) as representatives of different Symphyta families or as genera of uncertain systematic position. Later Rasnitsyn (1988) revised these fossils and grouped them together with three other genera, *Ghilarella* Rasnitsyn, 1988, *Trematothorax* Rasnitsyn, 1988 and *Thoracotrema* Rasnitsyn, 1988, from the Cretaceous of Mongolia (Bon-Tsagaan), Transbaikalia (Baissa) and Magadan Province (Obeshchayushchiy Creek) in the family Sepulcidae. A suggestion about the origin of Cephidae from sepulcid-like ancestors has also been proposed. Nowadays the family Sepulcidae includes 17 genera and more than 40 species grouped into five subfamilies: Sepulcinae Rasnitsyn, 1968, Parapamphiliinae Rasnitsyn, 1968, Trematothoracinae Rasnitsyn, 1988, Ghilarellinae Rasnitsyn, 1988 and Xyelulinae Rasnitsyn, 1993 (Rasnitsyn, 1993). Sepulcids are known from Ka-

zakhstan (Rasnitsyn, 1968), Kyrgyzstan (Rasnitsyn, 1968, 1993), Mongolia (Rasnitsyn, 1988, 1993), Transbaikalia and the Russian Far East (Rasnitsyn, 1988, 1990, 1993), China (Ren *at al.*, 1995; Zhang *et al*., 2007), India (Rasnitsyn, 2008), Britain (Rasnitsyn *et al*., 1998), Spain (Rasnitsyn, Martinez-Delclos, 2000; Rasnitsyn, Ansorge, 2000), Germany (Rasnitsyn *et al*., 2003) and Brazil (Darling, Sharkey, 1990; Martins-Neto *et al*., 2007).

In 2004 and 2009, expeditions of the Borissiak Palaeontological Institute RAS (PIN), have collected extensive material on the Lower Cretaceous fossil insects, crustaceans and plants of the recently discovered locality Khasurty in southwestern Transbaikalia. The insect assemblage of Khasurty is very rich in hymenopterans, including eight representatives of Sepulcidae: two in *Trematothorax* Rasnitsyn, 1988, *Ghilarella* Rasnitsyn, 1988, and *Onokhoius* Rasnitsyn, 1990, one in Parapamphiliinae (new genus) and Sepulcidae (undetermined subfamily). It is noteworthy that such modest collection from one site includes all four subfamilies known from the Cretaceous. This paper deals with the most notable sawflies of that assemblage, the subfamily Trematothoracinae.

Trematothoracines are the sepulcids with a unique structure of mesonotum. It consists of two coarsely sculptured lateral lobes divided by a large non-sclerotised "hole" in the centre of the mesonotum (the structure of the mesonotum and other Trematothoracinae features are discussed below). Trematothoracinae is the largest subfamily of Sepulcidae. It includes 19 species grouped into four genera: *Trematothorax* Rasnitsyn, *Prosyntexis* Sharkey, 1990, *Thoracotrema* Rasnitsyn, and *Trematothoracoides* H. Zhang *et al*., 2001. The genus *Sinosepulca* Ren *et al*., 1995 described as member of Trematothoracinae (Ren *et al*., 1995) was also included in this subfamily, but it should be correctly placed in Praesiricidae (Blank *et al*., 2009). The genus *Trematothorax* includes six species: *T. baissensis* Rasnitsyn, 1988 (Baissa, Lower Cretaceous of Transbaikalia; Fig. 11), *T. ingodensis* Rasnitsyn, 1993 (Semen, Lower Cretaceous of Transbaikalia; Figs 12 and 13), *T. clementsi* Rasnitsyn et Jarzembowski, 1998 (Purbeck, Lower Cretaceous of Britain), *T. valdensis* Rasnitsyn et Jarzembowski, 1998 (Wealden, Lower Cretaceous of Great Britain), and two new species from two well-preserved imprints of Khasurty locality described below. Two more species previously placed in *Trematothorax, T. gobiensis* Rasnitsyn, 1993 and *T. okhotensis* Rasnitsyn, 1993, are transferred into the genus *Prosyntexis* (Rasnitsyn *et al*., 1998). Two new species described here are remarkable in their fore wing length over 13 mm, the largest in known Trematothoracinae.

Material and methods

The studied material was collected in Khasurty locality situated in a roadway excavation near Khasurta farm, 25 km E Zakamensk, Zakamensk District, Republic of Buryatia, Russia (N 50°21', E 103°37'). The age is dated to lowermost Lower Cretaceous (Kopylov, 2011, 2012; Sinitshenkova, 2011). The fossils were collected by two palaeoentomological expeditions of PIN headed by D.E. Shcherbakov in 2004 and D.S. Kopylov in 2009.

The specimens were collected, prepared and studied using standard palaeoentomological methods. The photographs were made with a Leica MZ 9.5 microscope and Leica DFC 420 camera. The line drawings were made using CorelDraw X5 software.

Taxonomic part

Order Hymenoptera

Family Sepulcidae Rasnitsyn, 1968

Subfamily Trematothoracinae Rasnitsyn, 1988

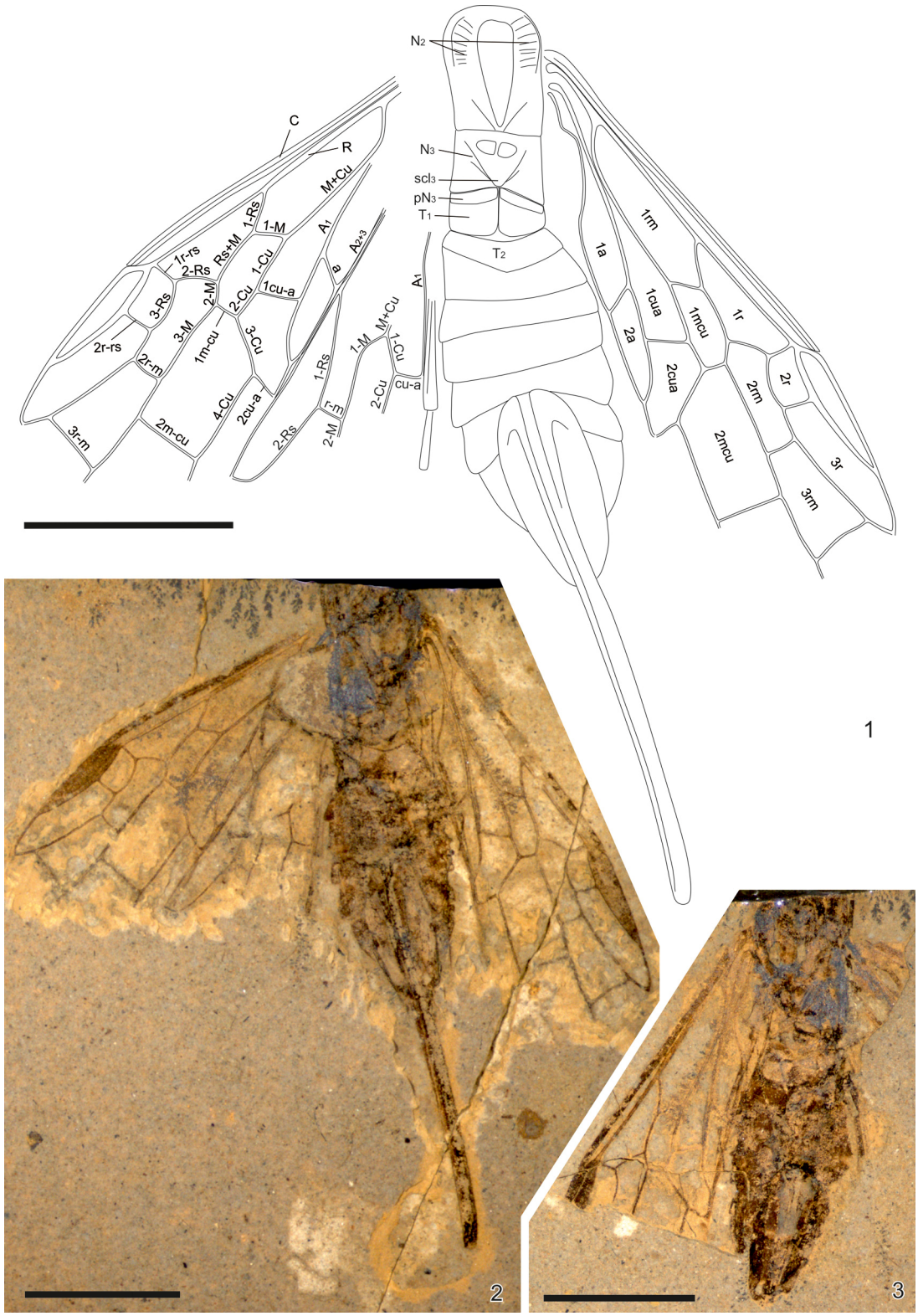
Genus *Trematothorax* Rasnitsyn, 1988

***Trematothorax kasparyani* Rasnitsyn et Kopylov, sp. n.**

(Figs 1–3, 6, 7, 10)

Etymology. The species is named in honour of Dr Dmitri R. Kasparyan.

Type material. Holotype: female, PIN, no. 5026/676, part and counterpart; head, anterior part of thorax and legs absent, wings and ovipositor well preserved. Russia, Buryatia, Khasurty; Lower Cretaceous.

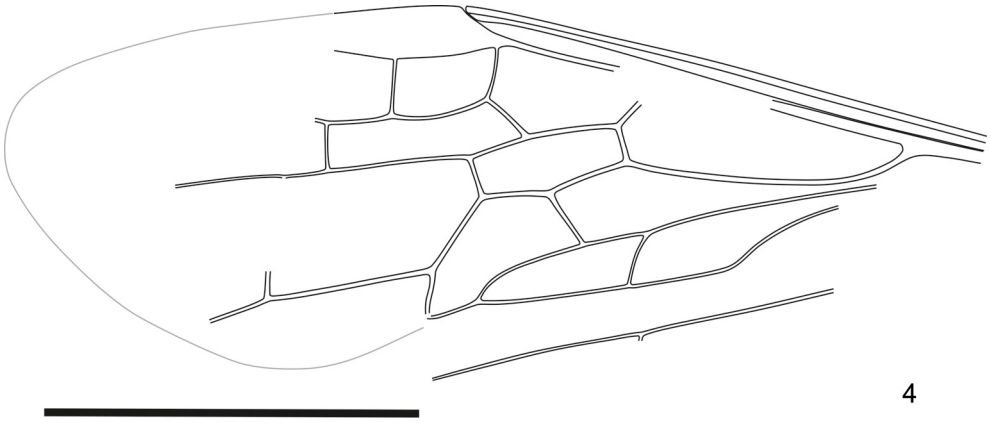


Figures 1–3. *Trematothorax kasparyani* **sp. n.** (holotype, no. 5026/676, Lower Cretaceous, Khasurty). 1 – habitus drawing (N_2 – mesonotum, N_3 – metanotum, scl_3 – metascutellum, pN_3 – metapostnotum, T_1, T_2 – first and second abdominal terga, cell and vein names are given as in text); 2, 3 – part and counterpart, photographs. Scale bar – 5.0 mm.

Description. Body (at least thorax and abdomen), veins of wings and ovipositor dark. Fore wing with *C* appearing as double vein, with longitudinal groove almost over its entire length; pterostigma sclerotised, with distinct traces of bordering veins, long and narrow, 4.5 times as long as wide and slightly narrower than cell 2*r*; 1-*Rs* 1.4 times as long as 1-*M*; 1-*M* oblique, not parallel to 1*m-cu*; cell 1*mcu* 2.5 times as long as wide, with 2-*Rs* and 1*cu-a* strongly shifted apically, *Rs+M* 2.8 times as long as 2-*M*, 1-*Cu* 2.1 times as long as 2-*Cu*; 2-*Rs* 1.7 times as long as 1*r-rs*; 1*r-rs* well before pterostigmal midlength; 2*r-rs* 1.1 times longer than 1*r-rs*. Thorax short, fusiform in dorsal view; ovipositor almost as long as fore wing.

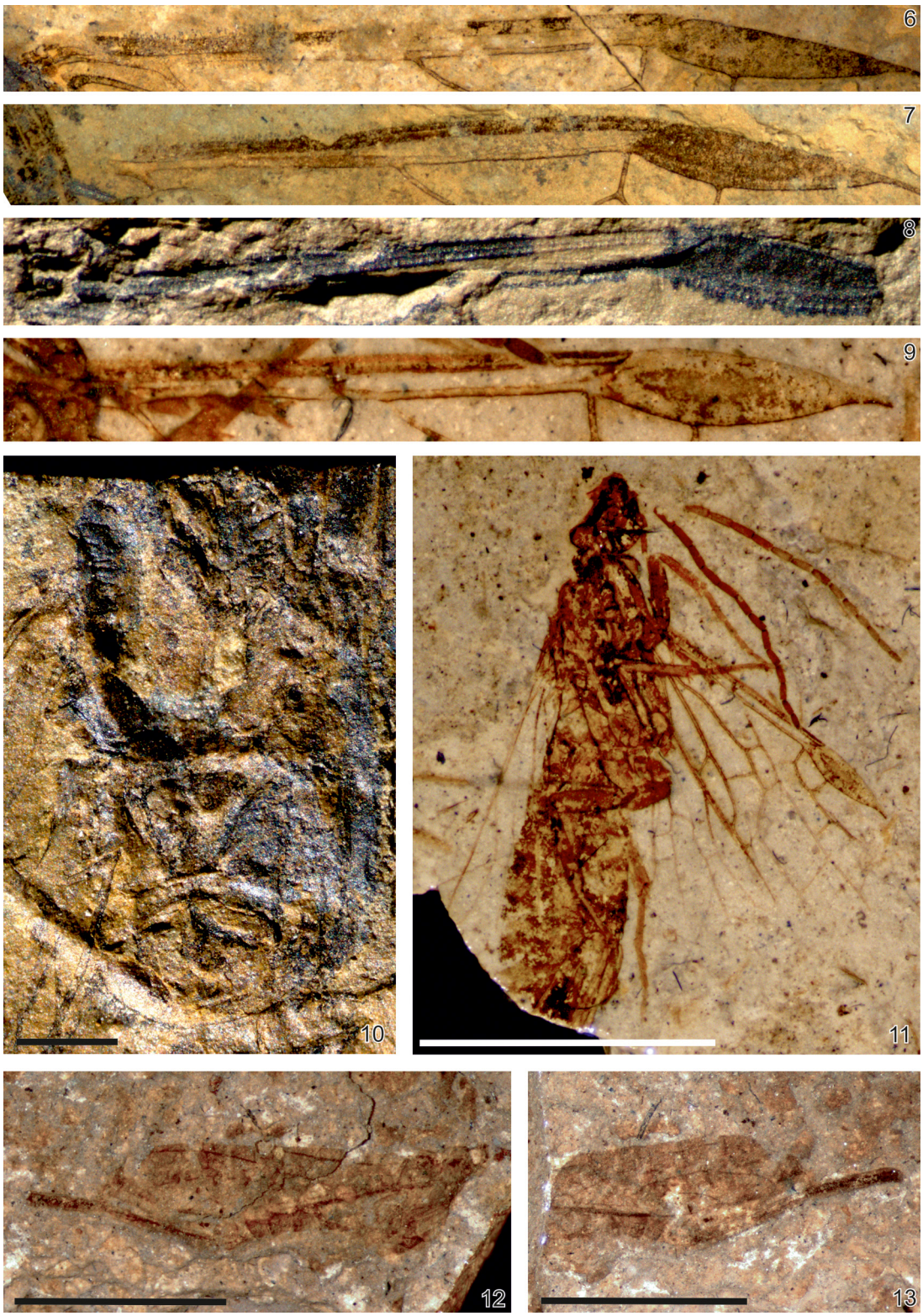
Size. Fore wing length 13.3 mm, width 4.7 mm; abdomen length 8.8 mm; ovipositor length 12.7 mm.

Comparison. *Trematothorax kasparyani* **sp. n.** differs from other species of this genus in having 2-*Rs* and 1*cu-a* strongly shifted apically; the larger body size and narrow pterostigma (except *T. demeter* **sp. n.**); 2*r-rs* longer than 1*r-rs* and longer cell 1*mcu* (except *T. baissensis* and *T. demeter* **sp. n.**); and 2-*Rs* much longer than 1*r-rs* (except *T. ingodensis*). The new species also differs from *T. baissensis* in having short 1-*Rs*, and from *T. ingodensis* in having longer ovipositor (not known in the other species).





Figures 4, 5. *Trematothorax demeter* **sp. n.** (holotype, no. 5026/682, Lower Cretaceous, Khasurty). 4 – fore wing drawing; 5 – fore wing photograph. Scale bar – 5.0 mm.



Figures 6–13. *Trematothorax kasparyani* **sp. n.** (6, 7, 10), *T. demeter* **sp. n.** (8), *T. baissensis* Rasnitsyn (9, 11) and *T. ingodensis* Rasnitsyn (12, 13). 6–9 – costal vein (6 and 7 – left and right wings of same specimen); 10–13 – structure of thorax (12 and 13 – part and counterpart). Scale bar: 6–9 and 11–13 – 5.0 mm; 10 – 1.0 mm.

Trematothorax demeter **Rasnitsyn et Kopylov, sp. n.**

(Figs 4, 5, 8)

Etymology. Demeter, the name of the Greek goddess of the earth and its fertility (alluding to the origin of the Russian name Dmitry). Noun in apposition.

Type material. Holotype: female, PIN, no. 5026/682, part without counterpart; body poorly preserved; head, legs, hind wings absent, fore wing incomplete, coloration not preserved, some veins secondarily coloured with manganese salt. Russia, Buryatia, Khasurty; Lower Cretaceous.

Description. Fore wing with *C* appearing as double vein; pterostigma with strong traces of bordering veins, narrow, slightly narrower than cell 2*r*; 1-*M* vertical, parallel to 1*m-cu*; cell 1*mcu* 2.5 times as long as wide, with 2-*Rs* and 1*cu-a* near its midlength (*Rs+M* 1.5 times as long as 2*M*, 1-*Cu* 1.2 times as long as 2-*Cu*); 2-*Rs* as long as 1*r-rs*; 2*r-rs* slightly longer than 1*r-rs*. Size. Fore wing length 13.2 mm, width 4.7 mm.

Comparison. *Trematothorax demeter* **sp. n.** differs from other species of this genus by the large body size and narrow pterostigma (except *T. kasparyani* **sp. n.**); and 2*r-rs* longer than 1*r-rs*, longer cell 1*mcu* and 1-*Cu* longer than 2-*Cu* (except *T. baissensis* and *T. kasparyani* **sp. n.**). It also differs from *T. kasparyani* **sp. n.** by the cell 1*mcu* with 2*Rs* and 1*cu-a* near its midlength, vertical 1-*M* and shorter 2-*Rs*.

Discussion

The genus *Trematothorax* shares with other Trematothoracinae several unusual characters, which should be discussed. One of them is the unique structure of the mesonotum, which appears in fossils as a large ovate medial orifice encircled with hard, transcarinate cuticle (Fig. 11). The nature of this strange structure cannot be reliably explained until better preserved fossils become available. At present we can provisionally hypothesize that this is an original way to secure reliable eclosion of a newly hatched adult insect from the wood in which the larva fed and developed. It is well known that xylobiont hymenopterans (either feeding on hard wood themselves or parasitising xylophagous hosts) often display special morphological devices that help them to fix their thorax within a tunnel in the wood to provide sufficient support for the propleura and head while using the mandibles to clear the way out. The most widespread of such devices are transverse ridges on the mesonotum (a popular example is the extant Rhyssinae, Ichneumonidae), sometimes supplemented or replaced either with a caudal horn and femoral ridges (in Siricidae) or a trans-ridged head (as in the Lower Cretaceous *Andrenelia* Rasnitsyn et Martínez-Delclòs (Rasnitsyn, Martínez-Delclòs, 2000). Supposedly, Trematothoracinae have enhanced their mesothoracic fixating device by replacing the entire ridged plate with two more flexible and independently movable ridged stripes. This helps them to attach better to tunnel walls and thus to cling with their ridges more reliably onto the wood at higher blood pressure, which widens the thorax and pushes apart the ridged mesothoracic sclerites.

Another unusual character of many, if not all, Trematothoracinae is the structure of the costal vein (Figs. 6–9). Both new species have the costal vein with a vein-long submedian longitudinal groove, which is either distinct throughout or at least locally traceable. Some other representatives of the group display different parts of the vein coloured differently. For instance, *Thoracotrema mongolicum* Rasnitsyn, 1993 has the costa lengthwise dark internally (on the side that faces *R*) and pale (and barely visible) externally. A precise morphological interpretation of this structure also requires better preserved fossils. Provisionally it can be explained as an alternative way of costalisation of the wing, i.e., strengthening the anterior margin of the wing (its aerodynamically cutting edge), which is important for increasing flight velocity, particularly at higher wing beat frequency (Rohdendorf, 1949; Rasnitsyn, 1969). A more common way of costalisation of hymenopteran wings is direct strengthening of *R*, which can eventually result in complete loss of *C* in insects of smaller body size (Cynipoidea, Chalcidoidae and Platygastroidea; we consider large representatives of these taxa as secondarily large). Another common way to reach the same end is *C* and *R* forming a functionally single strong vein: they both become straight and tightly aligned to each other (in Ichneumonoidea and Rhopalosomatidae) or completely fused (in higher Ceraphronoidea, namely Megaspilidae, Ceraphronidae and Stigmaphronidae). Only rarely (in various Tenthredinoidea) high costalisation effect is reached by thickening of *C*. However, the latter way of costalisation is characterised by uneven (increasing towards apex) incrassation of *C*, in contrast to the more even thickening in Trematothoracinae. As far as we know, the adaptation developed by Trematothoracinae could be unique among Hymenoptera.

The third pevuliar feature of *T. kasparyani* **sp. n.**, and possibly also of some or even all Trematothoracinae, is the unusually long metanotum, which is nearly half as long as the mesonotum and only about 1.5 times as wide as long, a ratio unknown in any other Hymenoptera. Again, better preserved fossils are required to confirm the above conclusion concerning the subfamily as a whole, but at least for *T. kasparyani* **sp. n.** the uniquely hypertrophied metanotum is present beyond serious doubts, in spite of the fact that its relative size resemble rather the insects with functionally four-winged flight, such as neuropteroids or mecopterans (even though it is far from identical to their relative size). This similarity may indicate the cause of the hypertrophy. The above-described modification of the mesonotum with wide central desclerotisation inevitably weakens it as part of the flight apparatus, which, bending from constriction of the inner dorsal longitudinal thoracic muscles, causes the downstroke of the wing (as explained in more detail in any textbook of entomology). Thus, we can hypothesize that the reason for the counterbalancing hypertrophy of the trematothoracine hind wing flight motor was to secure sufficient flight capacity of the insect.

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