

## Analysis of vicarious species *Folsomia kuznetsovae* sp.n. and *F. bisetosa* Gisin (Collembola: Isotomidae)

### Анализ викарирующих видов *Folsomia kuznetsovae* sp.n. и *F. bisetosa* Gisin (Collembola: Isotomidae)

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KEY WORDS: Collembola, Isotomidae, *Folsomia*, new species, vicarious species.

КЛЮЧЕВЫЕ СЛОВА: ногохвостки, Isotomidae, *Folsomia*, новый вид, викарирующие виды.

ABSTRACT. *Folsomia kuznetsovae* sp.n. is described from forest zone of European part of Russia, Ukraine and Scandinavia. It is closely related to *F. bisetosa* Gisin, 1953 and differs by presence of m1 setae on manubrium, fewer setae on body tergites and foil setae missing on last abdominal segment. The distribution map of two species in Palearctic is given. In Asia *F. bisetosa* is distributed in Arctic and boreal regions but is limited to the Arctic in Europe; *F. kuznetsovae* sp.n. takes the corresponding biotopes of the former species (damp and oligotrophic sites) in forest zones of Europe.

РЕЗЮМЕ. Описывается *Folsomia kuznetsovae* sp.n., распространённая в лесной зоне Европейской части России, Украины и Скандинавии. Новый вид близок к *F. bisetosa* Gisin, 1953 и отличается наличием m1 хет на манубрии, меньшим числом хет на тергитах тела и отсутствием хет-ножей на последнем сегменте брюшка. Дана карта распространения этих двух видов в Палеарктике. В Азии *F. bisetosa* встречается в Арктике и бореальных областях, в Европе — в Арктике, тогда как в лесной зоне Европы влажные и олиготрофные местообитания занимает замещающая её *F. kuznetsovae* sp.n.

### Introduction

Since its first description *F. bisetosa* Gisin, 1953 was defined as a blind species of *Folsomia* Willem, 1902 with two pairs of setae on anterior side of manubrium and middle-sized dens. Such a general understanding led the species being accepted widely distributed. In literature, *F. bisetosa* is characterized as having mostly northern distribution with the records scattered almost all over Holarctic [Bellinger et al., 1996–2008; Baben-

ko, 2005; Babenko & Fjellberg, 2006; Fjellberg, 2007; Potapov, 2001]. Two recently described closely related species, *F. cryptophila* Potapov et Babenko, 2000 and *F. bisetosella* Fjellberg, 2005, made its distribution area and ecological preferences more restricted but many southern records of the species have been left unverified, e.g. those from Romania [Fiera, 2007] and South Siberia [Stebaeva, 1976]. In the present paper, we redefine the distribution area of *F. bisetosa* and describe a new species having more southern records.

### ABBREVIATIONS:

Ant.1–4 — antennal segments 1–4

Abd.I–VI — abdominal segments I — VI

bms — basal microsensillum on antennal segments

f, fa, fp — foil setae

ms — microsensillum

PAO, ПАО — postantennal organ

s — sensillum

Th.II–III — thoracic segments II and III

### *Folsomia kuznetsovae* Potapov, sp.n.

Figs 1–5, 8–10

TYPE MATERIAL. Holotype: adult ♀, Russia, Komi Republic, Vylgort Distr., Elya-Ty, floodplain soil birch-aspen forest, central part of floodplain terrace of Sysola river, 19.IX.2003, A.Taskaeva leg.; 20 paratypes (subadult and adult ♀♀): the same place as holotype; 6 paratypes (subadult and adult ♀♀): Russia, Vologda Area, Darvinsky Nature Reserve, nearby Borok, fir forest with *Sphagnum*, 25–27.VI.1982 N.Kuznetsova leg. Type specimens are deposited in Moscow State Pedagogical University, Moscow.

ADDITIONAL MATERIAL. Russia, Komi Republic, Pechora River, upstream Pechora City, Kedrovi Shor, floodplain meadow moor birch-aspen forest, 64°50' N, 57°40' E, damp site, 05.X.2008, 3 ex. A.Taskaeva leg.; Russia, Vologda Area, Darvinsky Nature Reserve, near Mshichino, sedge turf in damp meadow, 18.VII.1982, 30 ex. N.Kuznetsova leg. (this locality was listed by Potapov & Babenko [2000] among the records of *F. bisetosa*); ibidem, oligotrophic pine-wood with *Sphagnum*, 27.VI.1982 N.Kuznetsova leg.; Russia, Leningrad Area, S.-Petersburg–Vyborg railroad, Beloostrov station, peat bog with *Pinus*, *Sphagnum*, *Ledum*, *Eriophorum*,

24.VIII.2002, 15 ex. M.Potapov leg.; Russia, Penza Area, between Penza and Leonidovka, boggy mixed forest with *Betula*, *Pinus*, *Calamagrostis*, *Carex*, *Vaccinium myrtillus*, *Polytrichum*, 21.VII.2006, 20 ex. Yu.Shveenkov leg..

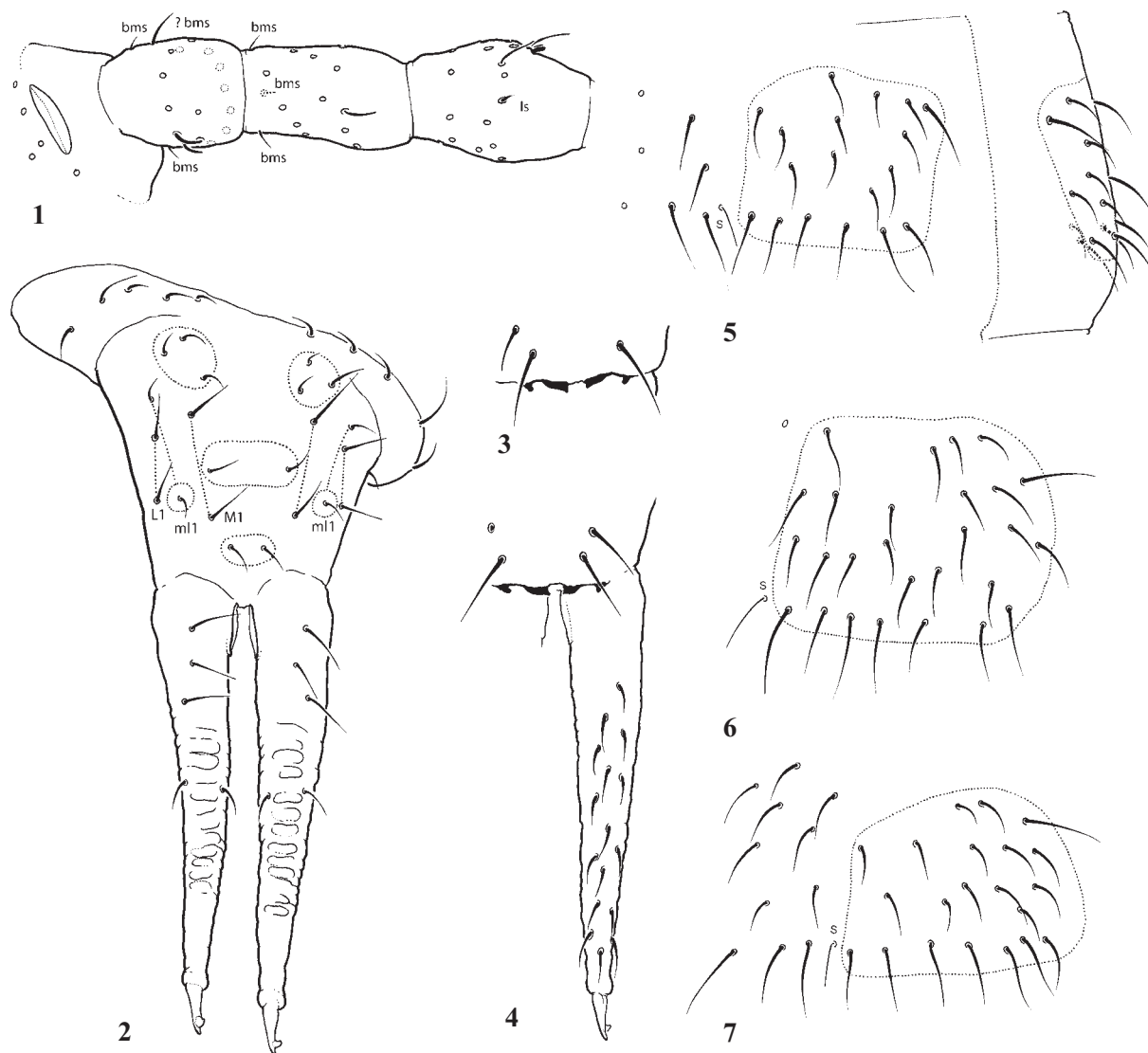
Additional material which have not seen by us but was determined by others: Ukraine, Lvivska Region, Yavorovski Distr., Rostoch'ye Nature Reserve, Zalivki, boggy meadow, 25.X.2004, 1 ex. I.Kaprus' leg.; Norway, Tjome, Vestfold County, coniferous forest, 28.IX.1998 A.Fjellberg leg.; Sweden, Fiby Urskog, Uppland, litter at forest stream, 26.IX.1995. A.Fjellberg leg.; Sweden, Johansholm, Dalarna. 03.X.1995, debris, lake shore A.Fjellberg leg. With few specimens from each of three last localities.

MATERIAL of *F. bisetosa* (all from Russia). Arkhangel'sk Area, Pinega State Reserve, Sotka River (64°37' N, 43°02' E), at the foot of cold cliffs of river gap, under *Petasites*, 6.IX.2006, 5 ex. O.Makarova leg.; Arkhangel'sk Area, Kanin Peninsula, Nes', floodplain meadow, 23.VIII.2002, 1 ex. B.Filippov leg.; Arkhangel'sk Area, Kolokolkova Bay, Tobseda, moisture moss-willow tundra, 2003, 1 ex. G.Nakul leg., A.Taskaeva coll.; Komi Republic, Pechora River, upstream Pechora City, Kedrovi Shor, floodplain meadow birch-aspen forest,

64°51' N, 57°38' E, 5.X.2007, 1 ex. A.Taskaeva leg.; NE Yakutia (East Siberia), road Yakutsk — Magadan, Suntar-Khayata Range, upper flow of Kyubyume River (63°13' N, 139°32' E), different sites at 1400–1900 m alt., 10 ex. O.Makarova leg.; Tuva Republic (South Siberia), Sangilen, 5 km from mouth Ular River, left bank of Erzin River, second above-floodplain terrace meadow, 2.VIII.1995, 5 ex., S.Stebaeva leg.; Buryatia Republic (East Siberia), Vitim Highland, Konda Basin, near Telemba, mixed forest with *Larix gmelini* and *Betula pendula*, ca 930 m alt., 18.VII.2007, 2 ex., A.Chimitova leg.

We also verified the records of *F. bisetosa* listed by Potapov & Babenko [2000]. They are from Spitsbergen, Novaya Zemlya, Wrangel Island, Devon Island, Kolguev Island, Pechora Bay, Vaigach Island, Yamal, W Taimyr, C Taimyr, Plateau Putorana, Delta of Olenek River, Delta of Yana River, Delta of Kolyma River, Magadan Area (Aborigen), Central Yakutia (Tabaga), NE Yakutia (Ust'-Nera). For more details see the paper mentioned above.

DESCRIPTION. Body size from 0.5 to 1.3 mm (see the affinities below). Pigment absent. Body of typical habitus for '*fimetaria*' group, head relatively large. Cuticle with thin



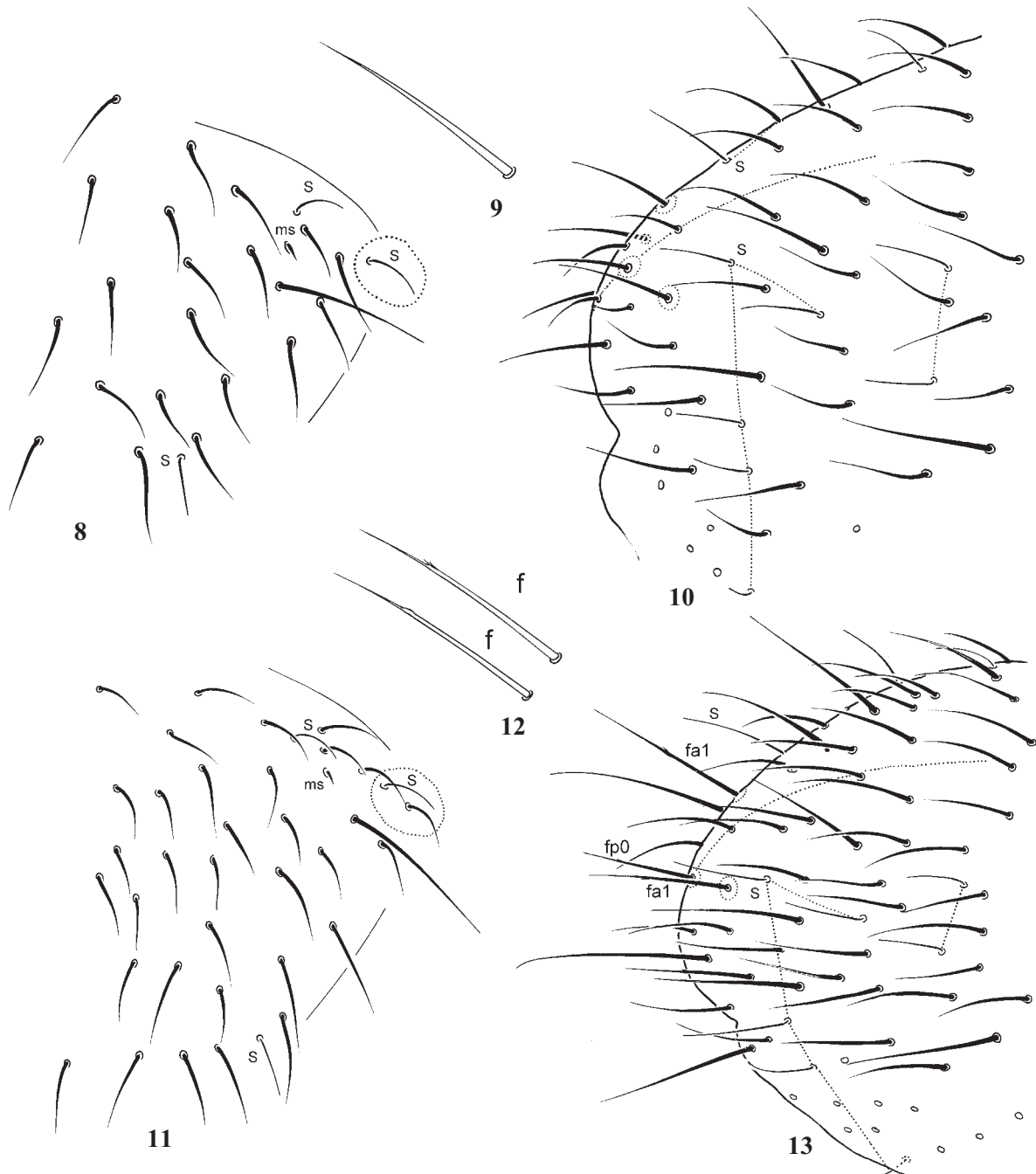
Figs 1–7. *Folsomia* spp.: 1 — PAO and three antennal segments; 2–4 — chaetotaxy of furca, posterior (2) and anterior (3–4) sides; 5–7 — ventromedial setae on Abd.II; 1–5 — *F. kuznetsovae* sp.n.; 6–7 — *F. bisetosa*; bms — basal microsensillum.

Рис. 1–7. *Folsomia* spp.: 1 — ПАО и три антеннальных сегмента; 2–4 — хетотаксия фурки, задняя (2) и передняя (3–4) стороны.; 5–7 — вентромедиальные хеты на Abd.II; 1–5 — *F. kuznetsovae* sp.n.; 6–7 — *F. bisetosa*; bms — базальная микросенсилла.

hexagonal primary granulation ("smooth"). Ocelli lacking. PAO narrowly elliptical, constricted, 0.6–0.8 as long as Ant.1 width and 1.0–1.3 as inner unguis length. Maxillary outer lobe with 4 sublobal hairs, maxillary palp bifurcate. Labral formula as 3–4/5,5,4. Labium with 5 usual papillae (A-E), full set of guard setae (*e*7 present), 3 proximal and 4 basomedian chaetae. Ventral side of a head with 4+4, rarely 3+3 postlabial chaetae. Ant.1 with 2 small basal microsensilla (bms), dorsal and ventral, and 2 ventral sensilla (s), Ant.2 with 3 bms and 1 latero-distal s, Ant.3 with 1 bms and 5 distal

s (including 1 lateral) (Fig.1). Sensilla on Ant.4 weakly differentiated.

Sensillary formula as 4,3/2,2,2,3,5 (s), 1,0/1,0,0 (ms). Tergal sensilla as long as common setae and hardly distinguishable in some specimens (Figs 8, 10). Medial sensilla on all tergites situated in p-row, on Abd.1–III between Mac1 and Mac2. On Abd.V 3 dorsal sensilla nearly equal to sensilla on Abd.IV. Lateral sensilla a little shorter than dorsal ones (Fig. 10). Macrochaetae smooth and short, 1,1/3,3,3 in number, medial ones on Abd.V 2.1–2.5 times shorter than dens and



Figs 8–13. *Folsomia* spp.: 8, 11 — lateral part of Th.II; 9, 12 — large setae on dorsum of Abd.VI; 10, 13 — chaetotaxy of posterior part of abdomen; 8–10 — *F. kuznetsovae* sp.n.; 11–13 — *F. bisetosa*; s — sensillum; ms — microsensillum; f, fâ, fp — foil setae.

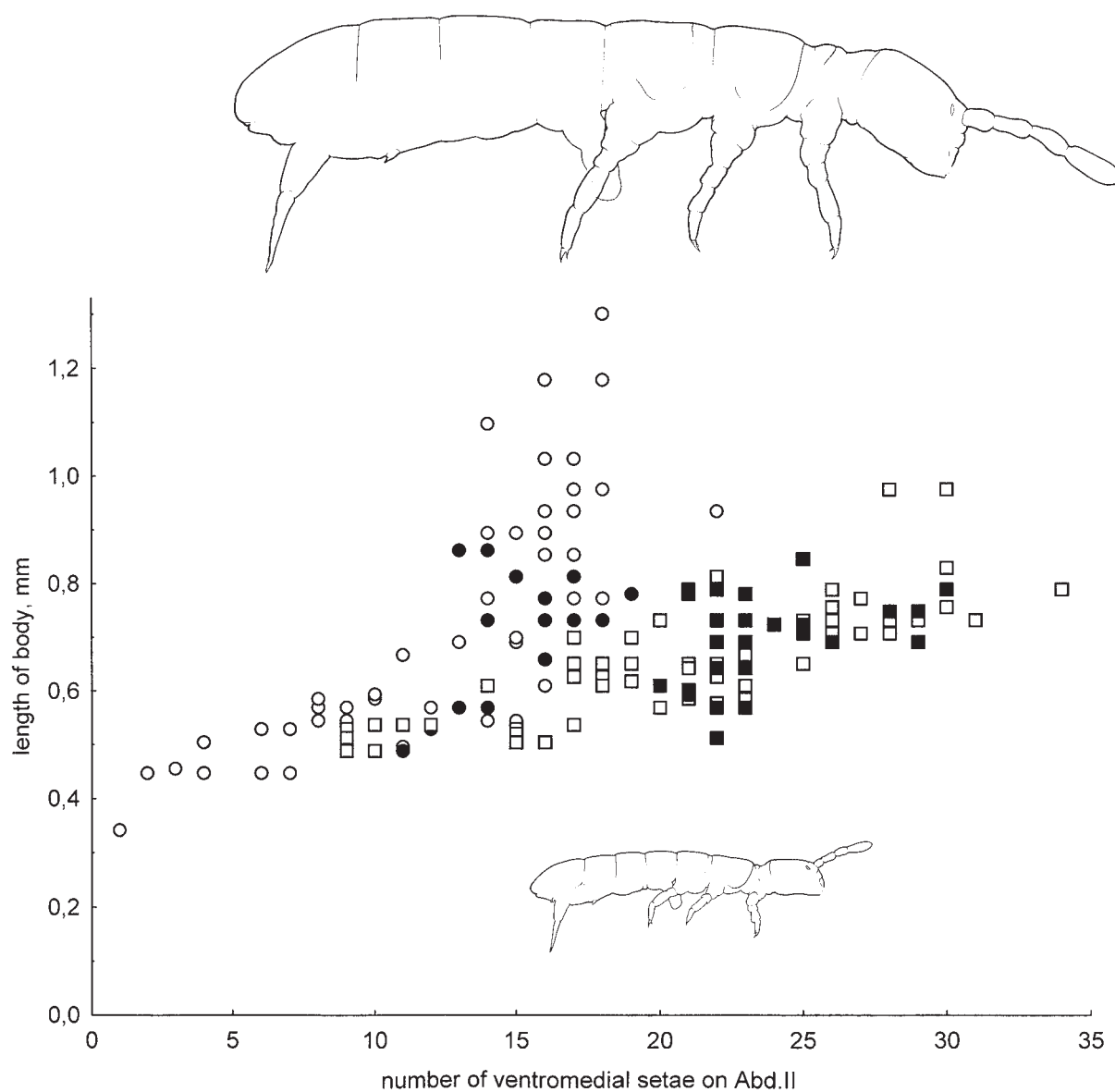
Рис. 8–13. *Folsomia* spp.: 8, 11 — латеральная часть Th.II; 9, 12 — крупные хеты на дорсальной поверхности Abd.VI; 10, 13 — хетотаксия задней части брюшка; 8–10 — *F. kuznetsovae* sp.n.; 11–13 — *F. bisetosa*; s — сенсилла; ms — микросенсилла; f, fa, fp — хета-нож.

2.1–2.7 times longer than mucro. Thorax without ventral setae. No foil setae at the tip of abdomen.

Unguis normal, without lateral and inner teeth. Empodial appendage 0.55–0.70 as long as unguis. Tibiotarsi 1–2 with or without some additional chaetae, i.e. from 21 to 23 on each. Tibiotarsal tenent chaetae pointed. Ventral tube with 5+5 laterodistal and 5–6 posterior setae, anteriorly without setae. Tenaculum with 4+4 teeth and 1 seta. Anterior furcal subcoxae with 8–11, posterior one with 5–6 setae. Anterior side of manubrium normally with 2+2 setae, more rarely with 2+1 or 1+1 setae in adult individuals (Figs 3–4). Posterior side of manubrium with 5+5 laterobasal, 2 apical setae (ap), 3+3 setae in distal transversal row (M1, ml1, L1), a pair of l2 setae. The most common variant of chaetotaxy shown on Fig. 2, ml2 often absent. Dens usually with 14–16 anterior chaetae with

the whole variation range of 12–18 (see the remarks). Posterior side of dens crenulated and with 5 chaetae (3 basal and 2 at the middle) (Fig. 2). Mucro bidentate. Ratio of manubrium : dens : mucro = 4.2–6.0 : 4.7–6.9 : 1. No males found.

VARIABILITY. The species shows remarkable variation of length of adult. In type population the adult individuals ranged from 0.7 to 1.0 mm. Adults came from Penza don't exceed 0.6 mm. In Kedrovi Shor (Komi) all subadult females were longer than 1.1 mm (Fig. 14). In all features these populations are according to the diagnosis of *F. kuznetsovae* sp.n. The individuals with 3 (instead 4) prelabral setae often occur in all populations studied by us. Two big-sized subadult females with 2 prelabral setae were also seen. This character is also unstable in Siberian (Yakutia, Magadan, Tuva) populations of *F. bisetosa* where 3 prelabral setae



*F. kuznetsovae*: ○ – juvenile and subadults ● – adults *F. bisetosa*: □ – juvenile and subadults ■ – adults

Fig. 14. Length of body and number of ventromedial setae on Abd.II in *F. kuznetsovae* sp.n. (on 5 localities) and *F. bisetosa* (on 13 localities). Habituses of the smallest adult and the largest subadult females of *F. kuznetsovae* sp.n. are shown.

Рис. 14. Длина тела и число вентромедиальных хет на Abd.II у *F. kuznetsovae* sp.n. (5 локусов) и *F. bisetosa* (13 локусов). Показаны габитусы самой маленькой половозрелой и самой крупной неполовозрелой самки *F. kuznetsovae* sp.n.

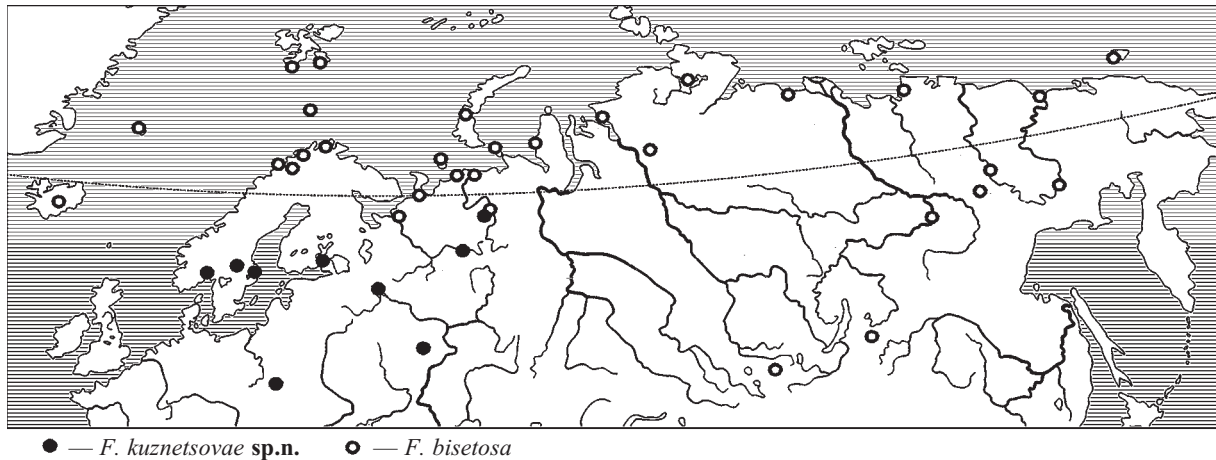


Fig. 15. Records of *F. kuznetsovae* sp.n. and *F. bisetosa* in Palearctic (those from Scandinavian countries and Iceland are taken after Fjellberg [2007]).

Рис. 15. Отметки *F. kuznetsovae* sp.n. и *F. bisetosa* в Палеарктике (по Скандинавии и Исландии взяты из Фьеллберга [Fjellberg, 2007]).

sometimes occur. *F. kuznetsovae* sp.n. often asymmetrically lacks seta on anterior side of manubrium so the variant 1+2 is common.

**AFFINITIES.** Due to the posterior position of abdominal sensilla and only one pair of macrosetae on each of Th.II and III the new species belongs to 'fimetaria' group. Two anterior setae on manubrium indicate the similarity to *F. bisetosa*, *F. cryptophila*, and *F. bisetosella*. Two last species have no microsensilla on Abd. I and have fewer prelabral setae (3 and 2, respectively).

This species was already mentioned by Fjellberg [2007] as a southern form of *F. bisetosa* differing in chaetotaxy of posterior side of manubrium. After the analysis of vast material of typical and southern forms of *F. bisetosa* we came to conclusion that the latter is a distinct species which can be distinguished by the following characters:

- seta m11 on posterior side of manubrium present (*kuznetsovae* sp.n., Fig.2) or absent (*bisetosa*). This character was proposed by Fjellberg [2007] and can be used in individuals of all ages (juveniles of first instar were not checked by us). This seta presence is shared with *F. bisetosella* which keeps this seta also in all age instars [Fjellberg, 2005].

- foil setae absent (*kuznetsovae* sp.n.) or present (*bisetosa*) on Abd.VI (Figs 9–10 and 12–13, respectively). The character is less safe since changes with age: the bundle of cilia on foil setae almost invisible in young individuals of *F. bisetosa* and is sometimes expressed as only a swelling in adult and subadult ones.

- lateral sensillum on Th.II free (*kuznetsovae* sp.n.) or supplied with a common seta (*bisetosa*) positioned more laterally (Figs 8 and 11).

- number of common setae situated more medially than lateral sensilla on ventrum of Abd.II: 12–18 in *kuznetsovae* sp.n. versus 20–34 in *bisetosa* (Figs 5 and 6–7, respectively).

Two last characters are also certainly age dependent so the juvenile specimens of *F. bisetosa* also have few ventromedial setae on Abd.II and no lateral setae on Th.II. Relationship between length of body and number of ventromedial setae is shown on Fig. 14. After our data all adults and big subadult individuals (> 0.6 mm) can be discriminated with this character reliably. In this couple of species the early age instars are separable due to posterior chaetotaxy of manubrium.

**DISTRIBUTION AND ECOLOGY.** Known from damp sites of several scattered localities within forest zone of European part of Russia, Ukraine, Norway and Sweden (Fig. 15).

**NAME DERIVATION.** The countenance and care by my better half, Natalia Kuznetsova, are very important in my taxonomic life.

#### Distribution of *F. bisetosa* and *F. kuznetsovae* sp.n.

The classification of ranges types of insects of tundra and forests belts of European Part of Russia by Gorodkov [1984] can be used to characterize the distribution area of this pair of species. According to this and other classifications (e.g. de Lattin [1967]) a range of taxon has at least two components, as latitudinal (or zonal) and longitudinal (or historical). In Palearctic, *F. bisetosa* sensu lato is recorded from both the Arctic and the boreal belts (Fig. 15). *F. bisetosa* sensu stricto have latitudinal range component complex as it is a typical arctic-boreal species in Asia. Its arctic distribution is beyond question since *F. bisetosa* is common in all arctic sectors of Europe, Asia and Nearctic [Babenko & Fjellberg, 2006; Fjellberg, 1994, 2007; Gisin, 1953]. According to the distribution in the latitudinal transect of Taimyr (N Siberia) this species belongs to so-called the Hypoarctic group (after Chernov & Matveyeva [2002]) as being abundant and eurytopic in southern tundra belt and continuously decreasing towards the north (typical and arctic tundra belts) and towards the south (north taiga belt) [Babenko, 2003, 2005, 2009]. In European sector of the Arctic (Spitsbergen, Novaya Zemlya Archipelago) it is also abundant and eurytopic [Fjellberg, 1994; Babenko & Bulavintsev, 1993]. The Pinega Reserve (Arkhangel'sk Area, northern taiga of Russian Plain) was the first locality for *F. bisetosa* lying outside the tundra zone [Babenko, 2008]. However, there it was recorded only in the "arctic communities" — the coldest karst habitats developing along streams running

in deep gaps. We also found few individuals of this species in floodplain meadow birch-aspen forest in Komi Republic (northern taiga). *F. bisetosa* is also recorded in N Norway and N Sweden, mostly in alpine belt [Fjellberg, 2007]. According to literature data and our materials typical *F. bisetosa* disappears in more southern forests belts starting with middle taiga zone. In Asiatic part *F. bisetosa* penetrates in more southern areas where it is not a common species. In several dozens sampling sites of low mountains of S Siberia (Tuva, Buryatia, coll. S.Stebaeva and A.Chimitova) we found one habitat in each of these two areas where this species lives. Such a distribution is probably characteristic for some other northern species of Collembola. As an example, in Asia *Morulina gigantea* (Tullberg, 1876) shows nearly the same pattern of records [Babenko & Fjellberg, 2001].

*F. kuznetsovae* **sp.n.** is distributed in boreal (taiga) and subboreal (broadleaves forests) belts and therefore belongs to temperate group (following to the range classification of Gorodkov [1984]). It at least sometimes ecologically replaces *F. bisetosa* in Europe, inhabiting damp and oligotrophic sites. Both species were recorded in floodplain birch-aspen forest of Komi Republic, occupying different microsites, damp depressions by *F. kuznetsovae* **sp.n.** and drier elevations by *F. bisetosa*.

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