

## Comments on the chaetotaxy of the genus *Orchesella* (Collembola, Entomobryomorpha) with a redefinition of the '*spectabilis*' group and description of a new species of *Orchesella* from the Caucasus

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### Abstract

Based on the study of the chaetotaxy of 16 European species of *Orchesella* a system of notation of groups of macrosetae on head and body is proposed. It mostly corresponds to the system of notation by Jordana & Baquero (2005) for *Entomobrya*. Some groups of the latter system are not used and several new groups of setae are defined. The '*spectabilis*' group is redefined, divided into two subgroups, and taxonomical remarks are given for *O. bulgarica*, *O. croatica*, *O. flavescens*, *O. kervillei*, *O. pannonica*, *O. pontica*, *O. pulchra*, *O. spectabilis*, *O. sphagneticola* and *O. xerothermica*. *O. subnigra* is synonymised with *O. pulchra*. The distribution and ecology of species of the '*sphagneticola*' subgroup are presented. *O. stebaevae* sp. nov. is described from the Caucasus

Keywords: chaetotaxy notation system, *Orchesella stebaevae* n.sp.

### Zusammenfassung

Basierend auf dem Studium der Chaetotaxie von 16 europäischen Arten von *Orchesella* wird ein Bezeichnungssystem von Makroseten auf Kopf und Körper vorgeschlagen. Es entspricht größtenteils dem System von Jordana & Baquero (2005) für *Entomobrya*. Einige Gruppen des letzteren Systems werden nicht benutzt und mehrere neue Gruppen von Seten werden definiert. Die '*spectabilis*' Gruppe wird neu festgelegt und in zwei Untergruppen geteilt. Taxonomische Anmerkungen werden vorgenommen zu *O. bulgarica*, *O. croatica*, *O. flavescens*, *O. kervilli*, *O. pannonica*, *O. pontica*, *O. pulchra*, *O. spectabilis*, *O. sphagneticola* und *O. xerothermica*. *O. subnigra* wird mit *O. pulchra* synonymisiert. Die Verbreitung und Ökologie von Arten der '*sphagneticola*' Untergruppe wird dargestellt. *O. stebaevae* sp. nov. wird vom Kaukasus beschrieben.

### 1. Introduction

At present the chaetotaxy of polychaetotic Entomobryidae is one of the most difficult taxonomical characters. The rather old but fundamental monograph of Szeptycki (1979) shows the latent possibilities of using the arrangement of different kinds of seta-like components on the body for species identification. His notation system is very complex but it

does reflect the really high abundance and diversity of seta-like components.. However, he did not address the variability and practical use in species taxonomy. Christiansen & Bellinger (1980) and especially Jordana & Baquero (2005) used chaetotaxy in the identification of species in polychaetotic Entomobryidae, mostly in the genus *Entomobrya*. In the latter paper a generalised chaetotaxy of *Entomobrya* was presented. Jordana & Baquero (2005) identified setae using systems proposed by different authors: Soto-Adames (in press) and Mari Mutt (1979) for head, and Szeptycki (1979) for thoracic and three first abdominal tergites. Jordana & Baquero (2005) proposed a new setae notation system for the fourth abdominal segment and a scheme of coding of characters (H1, H2, ... of head, T1, ... of thorax, A1, ... of abdomen). The latter made it possible to compile formulas for the chaetom of any species of *Entomobrya*. One of the aims of the mentioned paper was to 'avoid the use of colour pattern'.

During our work on the revision of Palaearctic Orchesellinae as a part of the forthcoming volume of Synopses on Palaearctic Collembola, we faced the task to legibly describe the chaetotaxy of *Orchesella*, one of the largest entomobryids genera with strongly distinctive polychaetosis. The known system of setae notation of un-scaled Orchesellinae (Christiansen & Tucker 1977, Christiansen & Bellinger 1980, Mari Mutt 1984) described only several segments and disagreed with the system of Jordana & Baquero (2005) which is probably more viable, at least because it provides more information on chaetotaxy by involving more segments and more areas on the body. The system of Jordana & Baquero (2005) could be applied to *Orchesella* but calls for some modification because the generalised chaetotaxy of *Orchesella* and *Entomobrya* are similar but not identical. The modifications proposed by us are related to the circumscription of groups of setae, but not to the identification of individual setae. In our descriptions we also partly use the system of notation of Szeptycki if setal homology is possible to identify. The full use of Szeptycki's system was impossible since it conceptually requires study of ontogenetic development.

## 2. Materials and methods

Sixteen European species of *Orchesella* were studied using material deposited at the State Museum of Natural History Görlitz (Germany), Museum of Natural History, Lwiv (Ukraine), Institute of Systematics and Evolution of Animals of PAS, Kraków (Poland), Moscow State Pedagogical University (Russia), National Museum of Natural Sciences, Madrid (Spain), National Museum of Natural History, Paris (France), Zoological Museum, Amsterdam (Netherlands), Museum of Natural History, Genève (Switzerland) and some personal collections including collections by the author. Ten to 30 individuals of each species were examined to obtain data on chaetotaxy variability. The following species were studied: *O. albofasciata* Stach, 1960, *O. bifasciata* Nicolet, 1842, *O. cincta* (Linnaeus, 1758), *O. disjuncta* Stach, 1960, *O. flavescens* (Bourlet, 1839), *O. kervillei* Denis, 1932, *O. maculosa* Ionescu, 1915, *O. multifasciata* Stscherbakow, 1898, *O. orientalis* Stach, 1960, *O. pulchra* Stscherbakow, 1898, *O. quinquefasciata* (Bourlet, 1843), *O. spectabilis* Tullberg, 1871, *O. sphagneticola* Stach, 1960, *O. taurica* Stach, 1960, *O. villosa* (Geoffroy, 1762), *O. xerothermica* Stach, 1960. In addition, twelve more species were preliminarily studied using one to three specimens, but more material is wanted to get reliable data on them. Interference and phase contrast microscopy were used for the observations.

Abbreviations used: Th II, III – meso- and metathorax, Abd I – IV abdominal tergites, Ant I – IV - antennal segments I – IV.

### 3. Results and discussion

The chaetotaxy scheme of *Orchesella spectabilis* shown in Fig. 1 is rather representative for the genus despite the fact that many species have more macrosetae (see the remarks below). In notation of the characters we follow Jordana & Baquero (2005) as closely as possible. The following conventions have been followed to compile the scheme:

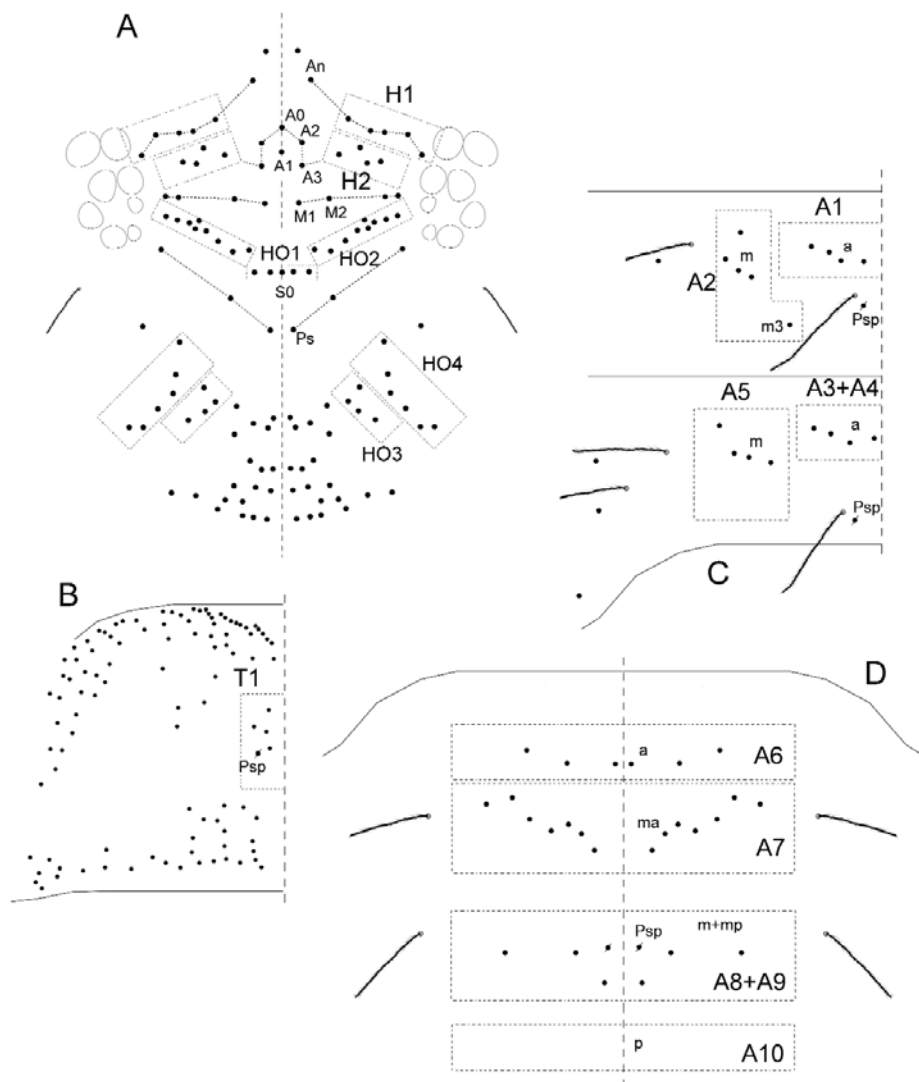


Fig. 1 Scheme of chaetotaxy of *Orchesella spectabilis*, notation of characters. A: head, B: mesonotum, C: urotergites II - III, D: -urotergite IV.

– All sockets of macrosetae are equal. Generally, it could mean that the lengths of macrosetae are equal. In reality, both sockets and length of macrosetae are unequal. Sometimes it is difficult to discriminate between macroseta and mesoseta or large microseta, but the setae difficult to classify are inserted mostly on the posterior margin and lateral tergal areas, which are not considered here.

– Number and position of macrosetae are the same on right and left sides in the scheme. In reality both these characters are mostly asymmetrical, excluding areas where few macrosetae are observed. The position of macrosetae on right and left sides can also be different. The observed asymmetry was one of the reasons for using setal groups in species identification instead of individual setal identity. Although the schemes show one side of one individual they reliably reflect the grouping of macrosetae and can be used for generalisation.

– Chaetotaxy of lateral areas is not shown. These areas bear numerous meso- and macrosetae which are traditionally left out of taxonomical study. Only macrosetae located in central part of head and Th II and in inner position to trichobothria on Abd II – IV are considered.

– This scheme does not discriminate between primary, secondary and additional macrosetae, as defined by Szeptycki (1979). The particular macrosetae could be defined as primary in all species. Nevertheless, in areas where many secondary setae arise, the choice of whether a macroseta is primary or secondary is arbitrary since the ontogenetical development of chaetotaxy in the species under study is not known. In addition, the type of macrosetae is usually unimportant in the taxonomical separation by Jordana & Baquero (2005), who distinguished all three types of macrosetae mentioned above in their generalised scheme, but only the number of setae was used as taxonomical characters to separate species. We do not consider ontogenetic aspects in our work and our scheme is applied only to large sub-adult and adult individuals.

### **The characters and peculiarities of chaetotaxy of *Orchesella* (Fig. 1)**

Head (characters of group H).

– H1: Number of An macrosetae (excluding An1) is always 4 or more due to the addition of secondary macrosetae of different sizes. Asymmetries are common.

– H2: Number of A macrosetae between A3 and ocular patch. The situation is as in H1. Unpaired macroseta A1 always present in A-row (missing in *Entomobrya*). This macroseta is present in other unscaled and sometimes in scaled genera (*Pseudodicranocentrus* Mari Mutt, 1981) of Orchesellinae. Some species have an additional group of macrosetae between A and M rows. This group is considered as part of group H2.

– HO1: Posterior group of S-row. This group includes S0, S2 and secondary macrosetae around them. They are arranged in a single transversal row (like in *O. spectabilis*) or in a double irregular row. If double, the anterior macrosetae are unlikely homologous to S'0, S1 and S3 setae, which are situated in a much more anterior position in *Entomobrya*.

– HO2: Lateral group of S-row. This group includes S3, S4, S5 macrosetae and all secondary macrosetae around them. The number of these macrosetae strongly varies depending on the individual, but sometimes differs between species.

– HO3 and HO4: In P-rows (incl. Pi, Pa, Pm, Pp) numerous macrosetae mask the primary

chaetom. The only groups we found useful for species separation are two diagonal rows of macrosetae in the more lateral area of the head. In most species these fields bear 4 and 6 macrosetae and we call them HO3 and HO4 characters, respectively. The homology of these groups of setae is not fully clear at present.

#### General remarks on chaetotaxy of the head of *Orchesella* and *Entomobrya*

H1 and H2 characters as defined by Jordana & Baquero (2005) are applied in both genera.

M-row has no secondary macrosetae (excluding one species of *Orchesella*). Four macrosetae (M1-M4) are always present, therefore this row is not useful in the taxonomy of either genera.

H3 (presence/absence of S'0) and H4 (S1,S3,S4) characters of Jordana & Baquero (2005) can not be applied in *Orchesella* in the strict sense. S'0 and S1 macrosetae probably absent. In polychaetotic species some smaller secondary macrosetae can occasionally take the place of S'0 and S1, but this varies intraspecifically among individuals. S1 is present in first instar *Seira* as macroseta (Soto Adames, in press) but we have not found the associated macroseta in adult instars of *Orchesella*. In S-row the posterior and lateral groups of setae containing S0, S2 and S3-S5, respectively, can be used in the taxonomy of *Orchesella*. Thus, the new characters HO1 and HO2 are erected by us (the abbreviation means association with (H)ead and (*O*)rchesella, see above).

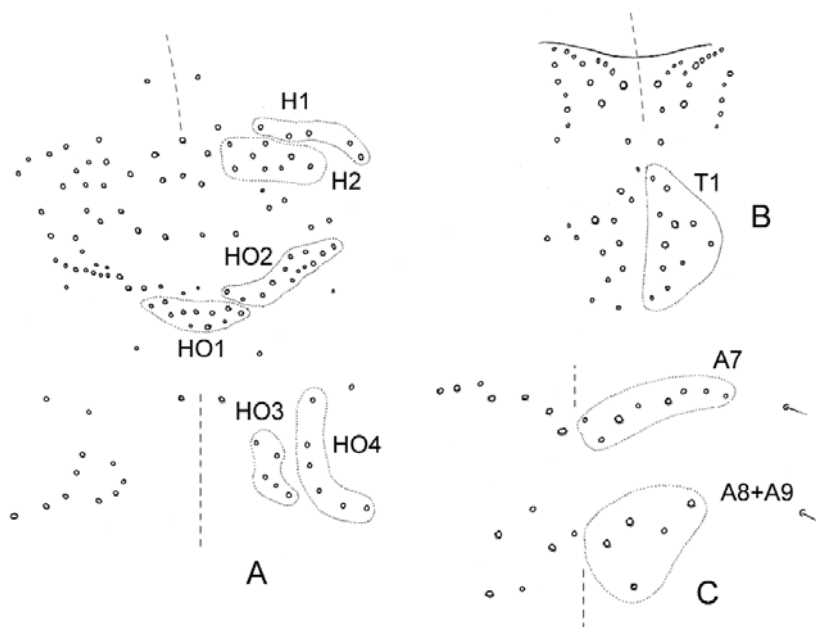


Fig. 2 Examples of polychaetotic chaetotaxy in *Orchesella*: A, B *O. multifasciata*, central part of head (A) and mesonotum (B), C – *O. flavescens*, central part of urotergite IV (pseudopores not shown).

Unlike in *Entomobrya* Ps-row invariably comprises three macrosetae and no secondary macrosetae. Ps2 is always well marked, Ps3 and Ps5 are always smaller. Some difference between the species can be observed in size of sockets (Ps3 and Ps5 half the size to only a little smaller than Ps2) but they are too small and variable to be used in taxonomy. Thus character H5 (number of Ps-macrosetae) is not used here for *Orchesella*.

Generally, we conclude that many secondary macrosetae arise on the head, their number is rather variable within a population of *Orchesella*. In *Entomobrya*, all mentioned groups have fewer setae and so their exact number is more useful in taxonomy. An example of the head of a polychaetotic species is shown in Fig. 2A.

### **Body segments [characters of groups T (thorax) and A (abdomen)]**

The peculiarities of the chaetom of unscaled Orchesellinae and, particularly *Orchesella* are given by Szeptycki (1979). Below we submit more generalised and practical information which is in agreement with the conclusions of this author.

– T1: Number macrosetae in m1-m2 group on Th II (Fig. 1B). This group was called as Mm-group of area M by Szeptycki (1979) and is normally well demarcated (never less than 4 setae on each side). Some secondary macrosetae can arise posterior to pseudopore, they are included in field T1 by us (but have no notation by Szeptycki 1979). All areas of tergite bear many secondary macrosetae (more than in most other Entomobryidae), their number varies considerably within a population (see Fig. 2B as an example). Group T2 (m4-m5-a5 – group) is often badly demarcated from the anterior group and does not show a reliable difference between species. Therefore, we did not consider it in *Orchesella*. In Th III and Abd I, many secondary macrosetae and poor demarcation of groups are also observed.

– A1: Group of a-setae is well demarcated on Abd II (Fig. 1C). It has more setae (particularly, a1 present) than in *Entomobrya* and is located frontolateral to the medial trichobothrium (versus lateral in *Entomobrya*). In *Entomobrya* the macrosetae of field A1 are less grouped. They correspond to the IA-group of Mari Mutt (1984).

– A2: Well demarcated group of m-setae positioned between A1-group and lateral trichobothrium on Abd II. In *Orchesella*, it is well divided into three subgroups, as: m3 (invariable) positioned posteriorly, m3e-subgroup positioned in central area, and m3ea-subgroup in anterior position. Macroseta m3 and m3e-subgroup together correspond to MP-group, and m3ea-subgroup corresponds to the OA-group of Mari Mutt (1984).

– A3+A4: According to Jordana & Baquero (2005), A3 character is the presence/absence of a1 macroseta and A4 is the number of macrosetae in front of the medial trichobothrium (a2 and a3) on Abd III. A3 and A4 are separated by a pseudopore in *Entomobrya*. In *Orchesella* a1 is always present and grouped with a2 and a3. This combined group is positioned well in front of both trichobothrium and pseudopore. Thus we treat A3 and A4 together (the associated character is called as A3+A4 by us). This combined group corresponds to the IA-group of Mari Mutt (1984) and Christiansen & Tucker (1977).

– A5: Number of macrosetae in m3-m4 group positioned between A3+A4-group and lateral trichobothrium of Abd III. In *Orchesella* it is divided into two (rarely three) subgroups, as: m3e-subgroup positioned in central area, and m3ea-subgroup in anterior position (in some species macroseta m3 is positioned posteriorly as a third subgroup). Subgroup m3e corresponds to group M, and subgroup m3ea corresponds to group OA of Mari Mutt (1984) and Christiansen & Tucker (1977).

– A6 and A7: These fields on Abd IV include macrosetae in rows a and ma, respectively. They correspond to the same characters in *Entomobrya*. Due to secondary macrosetae these characters are rather variable and asymmetry often occurs (Fig. 2C).

– A8+A9: Homologisation of macrosetae in the posterior half of Abd IV of *Orchesella* and *Entomobrya* is problematic because many more primary setae undergo macrochaetisation in the latter genus (Szeptycki 1979). This difference is attributed to the difference in the length of Abd IV (shorter in Orchesellinae). In *Entomobrya* A8 and A9 comprises macrosetae in rows m and mp, respectively. Both these rows are positioned anterior to the pseudopore, which forms the boundary with row p (Jordana & Baquero 2005). In *Orchesella* rows m and mp are possibly absent because no macrosetae are found in front of the pseudopores (apart from those in rows a and ma). Instead of this strong conclusion we accept less radical evolutionary transformation, as anterior migration of pseudopores. If so, the main part of posterior macrosetae are to be in m or mp-row. This diffuse group is hardly possible to divide into m and mp macrosetae and so we treat A8 and A9 together (the associated character is called as A8+A9 by us). If there are many macrosetae the position and number vary considerably (Fig. 2C).

– A10: In some species of *Orchesella* a pair of medial macrosetae was found in posterior part of Abd IV. They are stable within a species and treated as a separate character (A10) by us. Like in *Entomobrya* we do not use the numerous mesosetae and small secondary macrosetae arising along the posterior edge of this segment.

The position of trichobothria is stable in *Orchesella* and therefore the characters A11, A12, A13, A14 as defined by Jordana & Baquero (2005) are useless.

### General remarks on body chaetotaxy of *Orchesella* and *Entomobrya*

As Szeptycki (1979) also stressed, *Orchesella* shows more secondary and variable macrosetae than *Entomobrya* and this makes it difficult to use many areas of the body. We conclude that the characters of *Entomobrya* T1, A1, A2, A5, A6, A7 and A10 can be used in *Orchesella*. We do not use T2, A11, A12, A13, A14 at all and A3, A4, A8 and A9 in their strict understanding. The character A3 and A7 are combined with A4 and A8, respectively.

Jordana & Baquero (2005) used unpaired secondary macrosetae in m and mp-rows of Abd IV in *Entomobrya*. We have also seen unpaired secondary macrosetae in these areas in *Orchesella* but they are too variable to be used as a diagnostic character.

The use of pseudopores as markers to separate groups of macrosetae is very inconvenient in practical taxonomy because they are hardly visible and possibly absent in large individuals of some species of *Orchesella*. This conclusion can be inferred from the monograph of Szeptycki (1979), where pseudopores were not shown at all on most segments in final instar (vs. shown for *Entomobrya*).

After the study of variability, the chaetotaxy of *O. spectabilis* can be described as follows:

HEAD: H1: 5-6, H2: 6-8, HO1: 2+S0 (one row), HO2: 7-9, HO3: 4, HO4: 6. BODY: T1: 4, A1: 4, A2: 1+3+1, A3+A4: 4, A5: 0+3+0(1), A6: 3-4, A7: 6-7(8), A8-A9: 3. A10: 0.

### General comments on the use of chaetotaxy the in the taxonomy of *Orchesella*

As was shown by Frati et al. (2000) the genetic distances between 'colour pattern' species of *Orchesella* are high and indicate long evolutionary differentiation. Therefore, we strongly believe that the number of characters used in *Orchesella* taxonomy has to be as large as possible. Following our analysis, the number of macrosetae can be applied to species identification in most cases, but as in the case of colour pattern, considerable age- or instar-dependant variation among individuals takes place. Colouration remains a very sensitive and convenient taxonomical character to discriminate between species of *Orchesella*. The combined use of chaetotaxy, colour pattern, molecular methods and geographic analysis seems to be the best way to solve the taxonomical problems of this group.

### Redefinition of the '*spectabilis*' group

The '*spectabilis*' group was erected by Stach (1960) for five xerothermic species based on the presence of pronounced sex dimorphism, position of outer tooth on empodial appendage and long antennae. We studied the chaetotaxy of six species similar to *O. spectabilis* and redefine the diagnosis of this group using chaetotaxy, among other characters:

Diagnosis of the group: Large species (more than 3.5 mm) with long antennae which are equal to or about 0.8 the length of head and body combined. Outer tooth on empodial appendage is below half length of lamella. Most species show remarkable sex dimorphism. In males, dark pigments form wide transversal bands or cover several segments or all of the body. Females are almost unpigmented or in general less pigmented than males, with longitudinal lines, often interrupted, running from the head to the end of the abdomen. Some species have no (*O. xerothermica*) or only weak sex dimorphism (*O. flavescens*, *O. croatica*, *O. stebaevae* sp. nov.), females of the latter species also have some transversal marking on the body.

Chaetotaxy: HO1: 2+S0 (one row), HO2: 5-9, HO3: 3-4, HO4: 5-6. BODY: T1: 4, A1: 4-5, A2: 1+2-3+0-1, A3+A4: 4, A5: 0+3+0-1, A6: 1-7, A7: 6-8, A8-A9: 3-6. A10: 0.

The following characters define this group: colour sex dimorphism (with a few exceptions), well-marked transversal row of five macrosetae at the middle of head (HO1 character) and few macrosetae in fields T1 (4) on Th II, and A1 (4-5) and A2 (with only 0-1 macrosetae in OA-group) on Abd II.

The '*spectabilis*' group consists of two subgroups:

1. subgroup '*spectabilis* s.str.' Chaetotaxy more polychaetotic: HEAD: HO3: 4, HO4: 6, Th II: A2; 1+3+0-1 (Fig. 1). No strong 'brush' on antennae. Xerophilic and mesophilic species.

*O. bulgarica* Stach, 1960

*O. croatica* Stach, 1960

*O. flavescens* (Bourlet, 1839)

*O. pannonica* Stach, 1960

*O. pontica* (Ionesco, 1915)

*O. spectabilis* Tullberg, 1871

*O. xerothermica* Stach, 1960



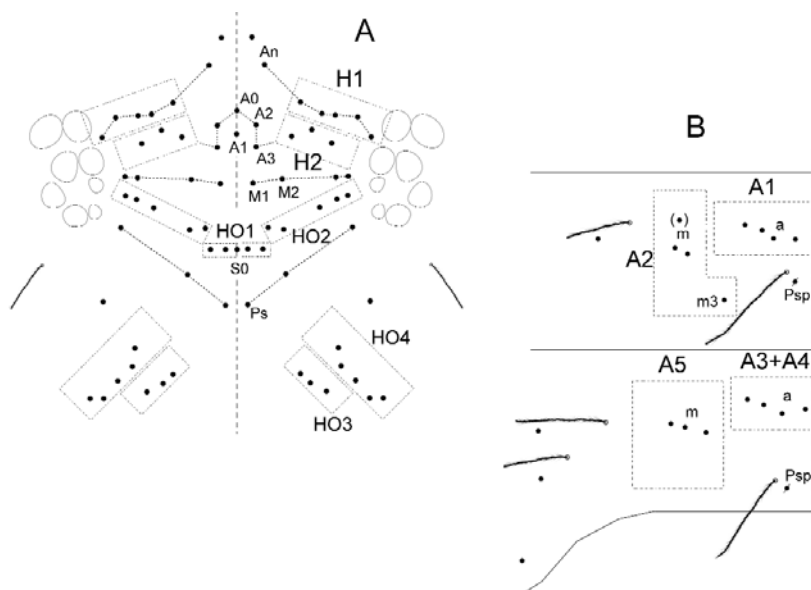


Fig. 3 Scheme of chaetotaxy of *O. sphagneticola*, *O. pulchra* and *O. stebaevae* sp. nov. A head, B urotergites II - III.

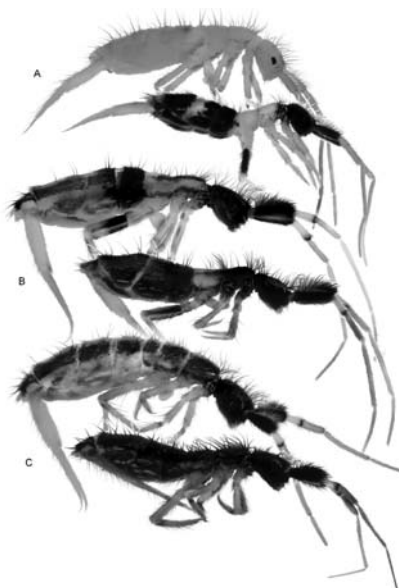


Fig. 4 Sex dimorphism in colouration of *O. sphagneticola* (A), *O. stebaevae* sp. nov. (B) and *O. pulchra* (C).

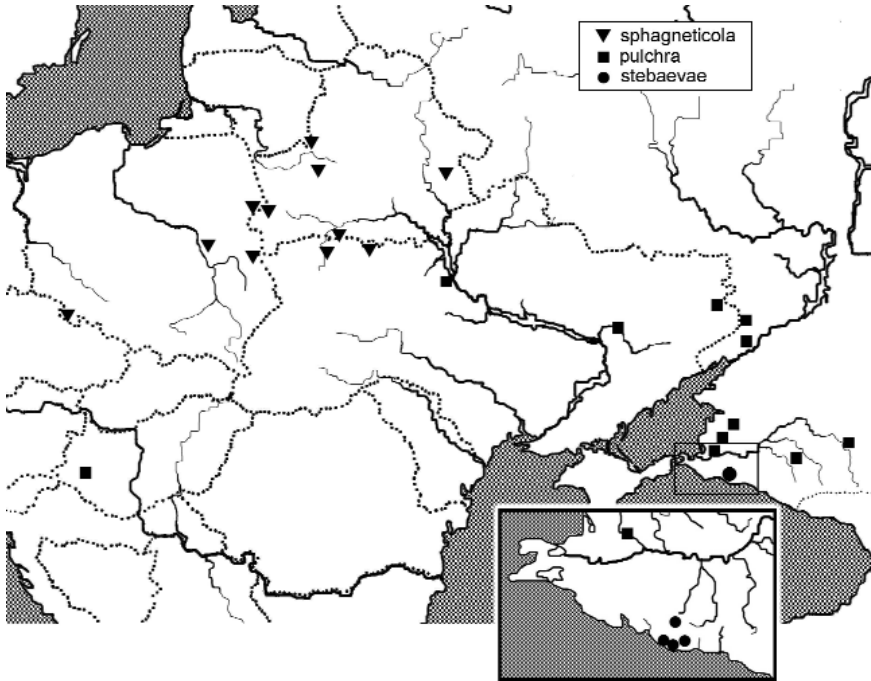


Fig. 5 Geographic distribution of records for *O. sphagneticola*, *O. pulchra* and *O. stebaevae* sp. nov.

2. subgroup '*sphagneticola*'. Chaetotaxy less polychaetotic: HEAD: HO3: 3, HO4: 5. Th II: A2: 1+2+0 (rarely 1+2+1). (Fig. 3). With strong 'brush' of bristles on distal sub-segment of Ant I (less developed in *O. sphagneticola*). Hygrophilic species.

*O. pulchra* (Stscherbakow, 1898)

*O. sphagneticola* Stach, 1960

*O. stebaevae* sp. nov.

This subgroup of large-sized species has the least number of macrosetae on the head (characters H2, OH1, OH2, OH3, OH4) and Abd II (character A2) among European species of the genus we studied. In the Nearctic, according to literature data (Christiansen & Tucker 1977, Mari Mutt 1984, Snider 1997) the chaetotaxy of Abd III mostly undergoes reduction. Chaetotaxy of the head is unstudied in Nearctic species. Three species of the subgroup '*sphagneticola*' (Fig. 4) combine very distinctive group. They are very similar ecologically and are possibly geographically replacing each other (Fig. 5). All of them prefer damp places and are absent from sites without fresh or stagnate water. *O. sphagneticola* is the northernmost species and common near lakes, in grass of peat damp meadows and glades, floodplain open sites, and avoids close floodplain woods. *O. pulchra* is found in the southern plains and inhabits exclusively reeded river banks, lake shores and similar habitats near water, sometimes litter of floodplain woods, also in moderately saline damp lands. *O. stebaevae* sp. nov. is found in valleys of the NW Caucasus. We found this species only in woods and grasslands near streams running among low mountains. On nearby slopes other species of *Orchesella* occur. *O. stebaevae* and *O. pulchra* (in western areas) are very predictable and easy to find in appropriate sites.

No reliable differences have been found between *O. pulchra* and *O. stebaevae* sp. nov. in chaetotaxy but only in colouration. However, the sharp geographical separation of these distinct 'colour forms' suggest that they represent individual species or subspecies. *O. sphagneticola* is a more distinct species and differs from the other two in both chaetotaxy and colouration.

### Remarks to species

#### *Orchesella flavescens*

Colour forms of *O. flavescens* have been discussed frequently in literature (see Stach 1960 for more details). Lindenmann (1950) evidently showed sex dimorphism in this species: males are generally darker and becoming 'melanocephala form' earlier in ontogenesis than females. Strong individual and age variabilities, however, considerably mask the colour difference of sexes. Besides, based on the literature and our own data, populations from different biotopes and geographic areas can have slightly dissimilar colouration, indicating that several species are hidden within this species. In characters of chaetotaxy this species is a typical member of '*spectabilis*' group (based on our study of specimens from Germany, Poland, Norway, Ukraine and Russia).

#### *O. spectabilis* and *O. xerothermica*

We studied a rather large number of populations (about twenty) of *O. spectabilis* from Ukraine (mostly collected by I. Kaprus'). Primarily we concluded that *O. xerothermica* is the dark-coloured female of *O. spectabilis*. Normally, the following forms occur together in a population: variant with broad transversal bands on Th III, Abd II and Abd IV corresponding to males of *O. spectabilis* (Fig. VIII-4 in Stach 1960), pale variant (usually smaller in size) with two thin and interrupted dorso-lateral lines running from head to Abd VI corresponding to females of *O. spectabilis* (Fig. VIII-3), and variant with more complex colouration corresponding to *O. xerothermica* (Fig. VII-3). With rare exceptions, individuals of the last variant were females, therefore we consider *O. xerothermica* a synonym of *O. spectabilis*, as the former seems to be only the dark-coloured females of the latter species. In addition, we have seen many individuals intermediate between colour patterns of female *O. spectabilis* and '*O. xerothermica*'. Two exceptions we found were two males with colouration of *O. xerothermica* (we have seen the male genital plate of these individuals). We also studied Stach's type material for *O. xerothermica*. The sample from Zaleszcziki (Ukraine) contains large-sized male moulting from subadult to adult (according to manubrial organ and genital cone). We studied the chaetotaxy of *O. xerothermica* and *O. spectabilis* in both sexes and found no differences. Thus, at present the dark females of these two species can not be discriminated, neither by colouration nor by chaetotaxy. Stach (1960) proposed a rather limited distribution for *O. xerothermica*, which was said to occur only in neighbouring areas of Poland and Ukraine. At present, the records of *O. xerothermica* cover more countries (Moldova, Austria and others) and the distribution of both species is very similar, possibly reflecting the misidentification of dark females of *O. spectabilis*. The relationship of these two species calls for further study.

### Other species of the '*spectabilis*' s.str. subgroup

Material studied:

*O. bulgarica*: Type specimens of J. Stach labelled as 'Bulgaria Witorza ... 1000 m, 10 V 1936 ... Drenowski', 2 males, and 'Bulgaria Rila 900 m, 12 VIII 1935 ... I. Drenowski', several females and one juvenile male. Chaetotaxy of male from Witorza and two females from Rila were studied by us.

*O. croatica*: Type specimens of J. Stach labelled as 'Italia Fiuma. 15.VI.1893 L. Birich, J. Stach', 2 spc. Stach (1960) indicated another label for these individuals, as '... Rjeka in Croatia ...'. Chaetotaxy of females (Fig. IX-3 in Stach 1960) was studied by us.

*O. panonica*: Type specimens of J. Stach labelled as 'Budapest ... 19 IV 1922 ...' 3 sp. (2 males and 1 female). The chaetotaxy of one male was studied by us.

*O. pontica*: Romania, leg. M. Gruia, coll. G. Busmachiu, 1 sp. Chaetotaxy studied by us.

The following characters are shared by the four species listed above: HEAD: HO1: 2+S0 (one row), HO3: 4, HO4: 6. BODY: T1: 4, A1: 4, A2: 1+3+1, A3+A4: 4, A5: 0+3+0, A10: 0, and so all of them belong to subgroup '*spectabilis* s.str.' Data on chaetotaxy of less stable characters are given in the tab.

Tab. 1 Data on chaetotaxy of less stable characters of four species of the '*spectabilis*' subgroup

Species	Number of specimens studied	H1	HO2	A6	A7	A8+A9
<i>O. bulgarica</i>	3	4 – 6	7 – 9	2 – 3	7	3
<i>O. croatica</i>	1	5 – 6	7 – 8	5	6 – 7	7
<i>O. panonica</i>	1	?	9	?	?	?
<i>O. pontica</i>	1	4	7 – 9	5	7	3 – 4

Some differences are possible between these species but the material is old and in such poor condition that reliable conclusions cannot be drawn. It is important to note that only the specimen of *O. panonica* had head macroseta S0', so HO character is as 2+ S0+ S0'.

*Orchesella pulchra* Stscherbakow, 1898

Bas.: *Orchesella rufescens* var. *pulchra* Stscherbakow, 1898

Syn. nov.: *Orchesella subnigra* Stach, 1960

Material:

Russia:

Rostov-Don Area, highway Rostov-Don – Moscow, Tuzlov River, reeded (*Phragmites*) flood plain, near the water edge, leg. MP. (=M. Potapov). 19 May 2007. Rostov-Don Area, highway Rostov-Don – Moscow, Kundruch'ya River, reeded (*Typha* and *Urtica*) flood plain, near the water edge, leg. MP. 19 May 2007. Krasnodarsky Krai, road Krasnodar-Timashevsk, (southern vicinity of Timashevsk), near v. Tantsura, reeded shore of lakelet in floodland of Kirpili River, leg. MP. 22 April 2007. 'Timoshevskaya-village ... 10 V 1928' (as *O. subnigra* in Stach 1960). Krasnodarsky Krai, road Timashevsk-Slavyansk-na-Kubani, (ca 10 km W Timashevsk), near vil. Sovetskiy, moist reeded shore of lakelet, leg. MP. 22 April 2007. Krasnodarsky Krai, road Timashevsk-Slavyansk-na-Kubani, vicinity of Slavyansk-na-

Kubani, floodland of Protoka River, in litter of poplar forest leg, MP. 22 April 07. Krasnodarsky Krai, road Maikop – Armavir, eastern vicinity of Maikop, reeded (*Typha*) shore of lake, near the edge of water, leg. MP. 24 April 07. Stavropol'sky Krai, road Nevinnomyssk - Mineral'nyie Vody, (ca 10 km SE Nevinnomyssk), bank of channel, leg. MP. 25 April 07.

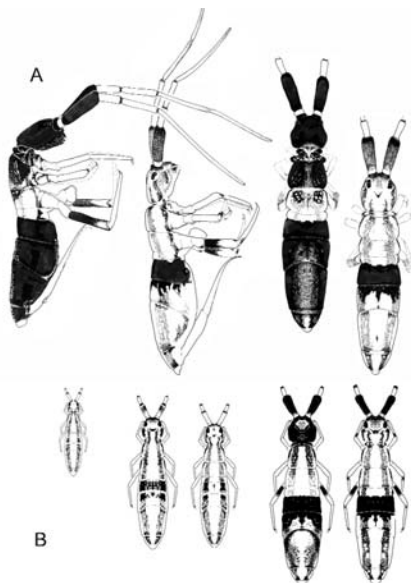


Fig. 6 Colour patterns of *O. stebaevae* sp. nov. A – male (left) and female (right) adult individuals, B – earlier age instars.

#### Ukraine:

Dnepropetrovsk Area, under the rush near Samara River, leg. N. Kuznetsova. ‘environs of Kiev ...’ (Stach 1960, we did not see this material). ‘Lugansk ...23 VIII 1928’ (Stach 1960, as *O. subnigra*).

#### Hungary:

‘Balaton, on the shore of the lake ... 1926’ (Stach 1960, we did not see this material).

Colouration varies from almost black (corresponding to *O. subnigra* var. *obscura*) to light with two broad dark dorsolateral lines running from Th II to Abd V (corresponding to *O. pulchra* s.str.). Head, large distal subsegment of Ant.II and distal ring of basal sub-segment of Ant.III always black in large individuals (Fig. 4C). Colouration of body depends on sex: trunk of some males almost wholly black with only medial areas of segments paler (Fig. XII-6 in Stach 1960), individuals with two broad dorsolateral lines running from Th II to Abd V are females. In females the lateral sides of segments have some additional diffuse dark spots which vary from weak (Fig. XII-1,2 in Stach 1960) in pale-coloured and juvenile females to large and covering almost all the lateral sides. Dark-coloured females can be somewhat similar to light-coloured males.

Chaetotaxy: HEAD: H1: 5, H2: 3-4, HO1: 2+S0 (one row), HO2: 5-6, HO3: 3, HO4: 5. BODY: T1: 4, A1: 4, A2: 1+2+0, A3+A4: 4, A5: 0+3+0, A6: 2-3, A7: 6-7, A8-A9: 3. A10: 0.

*Orchesella subnigra* was described by Stach based on two specimens, one of which came from SE Ukraine and another from the plain area of N Caucasus (Timoshevskaya). We have seen these specimens (coll. of Institute of Systematics and Evolution of Animals of PAS, Kraków) and also collected many specimens from the second place [N Caucasus, vicinity of Timashevsk (former Timoshevskaya-village)]. In this, like in all other localities with a considerable number of individuals, *O. subnigra* occurred together with *O. pulchra*. Subsequent analysis showed that '*subnigra*' corresponds to males and '*pulchra*' to females of the same species. Apart from colouration, Stach (1960) proposed to differ these species by length of antennae (which probably reflects sexual dimorphism, see remarks to *O. stebaevae*), colour of bristles (in our opinion, that is also just one of the differences between sexes) and position of outer tooth on empodium ( $0.7 - 0.76 : 2$  in *O. pulchra* and  $0.54 : 2$  in *O. subnigra*). According to our material the last character varies as  $0.76 - 0.92 : 2$  in *O. pulchra* and Stach's type specimen of *O. subnigra* fits within this interval ( $0.8 : 2$  in males from Timoshevskaya).

We studied several individuals of *O. kervillei* Denis, (France, High Pyrenees, Gavarnie, Ribèredessus, 1400 m alt., det. et coll. W. Ellis). Both sexes of this species have two broad dorsolateral lines on corpus like in females of *O. pulchra*, but in the latter species head and distal sub-segment of Ant I are totally black, vs. almost uncoloured in *O. kervillei*. Head and body of *O. kervillei* bear more macrosetae. The chaetotaxy of *O. kervillei* is H1: 5, H2: 4-5, HO1: 3+S0 (one row), HO2: 8-11, HO3: 4, HO4: 6, T1: 7-9, A1: 6, A2: 1+3+2, A3+A4: 4, A5: 0+3+1, A6: 5, A7: 5-6, A8-A9: 5-6. A10: 1.

The distribution of *O. pulchra* is shown in Fig. 5, but the record from Hungary has to be verified.

### ***Orchesella sphagneticola* Stach, 1960**

Material studied:

Lithuania:

SE from Vilnius, vicinity of Kurmelienys, in grass tussock near the peat-bog lake, leg. MP. 01 July 1984.

Byelorussia:

Highway Mogilev – Gomel', in sedge near small lake. 1983, leg. MP. 'Lietuna SSR - Švitež-lake (distr. Nowogródek) under oak-leaves on the shore of lake, 27 VII 1930' (Stach 1960, this lake is in Byelorussia now). 'West Ukrainskaya SSR, Polesie, Biała on river Horyń (distr. Stolin), in a very moist pine-forest ... in dead grass ... in moist moss ... 1932' (Stach 1960, this area is in Byelorussia now or near its border). Brest area, Belovezskaya Puscha N.R., moist peat flooded meadow, 04 July 2006. leg. MP.

Ukraine:

Polesie, Polessky N.R., Perganskoye Forestry, boggy mixed forest, 4 July 1983, leg. M.Taraschuk. 'Polesie, Antonówka river Horyń (distr. Sarny), in mouldering roots of rushes on a marsh ... 1929' (Stach 1960).

**Other material:**

Poland (all samples leg. and det. M. Slawska, partly published, not seen by us):

E Poland, Białowieża Primeval Forest N.R., pine bog forests and alder bog forests. E Poland, 'Szerokie Bagno' N.R. (ca 50 km SE from Warsaw), *Sphagnum* bog (oligotrophic). E Poland, Poleski N.P. (close to Szacki, near the border with Byelorussia and Ukraine). *Sphagnum* bog. SW Poland 'Zieleniec' reserve (Sudety Mountains, SW from Kłodzko), pine bog forest.

Well-defined species due to striking sex dimorphism described by Stach (1960). Corpus of females almost unpigmented, only Abd II sometimes with some rest of pigmentation (in fresh individuals) (Fig. 4A). Chaetotaxy as: HEAD: H1: 5, H2: 3-4, HO1: 2+S0 (one row), HO2: 5, HO3: 3, HO4: 5. BODY: T1: 4, A1: 4(5), A2: 1+2+0-1, A3+A4: 4, A5: 0+3+0, A6: 1, A7: 5-6, A8-A9: 3. A10: 0. Generally chaetom as common for subgroup, but A1 often with a macroseta in OA-position and A6 with only one pair of macrosetae.

Distribution is shown in Fig. 5.

***Orchesella stebaevae* sp. nov.**

**Holotype:** Male. Russia (NW Caucasus), Krasnodarsky Krai, S from Gelendzik, v. Dzankhot, flood plain deciduous wood along Khotetsay River, near edge of water. 23 April 2007, leg. M. Potapov. Paratypes: 10 specimens from the same locality. 15 specimens from ibidem, SE from Gelendzik, v. Vozrozdniye, flood plain of small river, in poplar litter. 05Sept. 1987. leg. S. Stebaeva. Holotype and 10 paratypes are deposited in Moscow State Pedagogical University (Russia), 5 paratypes in State Museum of Natural History, Görlitz (Germany)

**Derivatio nominis.** The species is named after Sophia Stebaeva who was the first to collect this species.

**Other material:** Russia (NW Caucasus), Krasnodarsky Krai, S from Gelendzik, v. Praskoveevka, pasture in flood plain of Zhane River, 23 April 2007, leg. M. Potapov. Ibidem, E from Gelendzik, vicinities of Tkhab Mt (biotope unknown). May 1987. leg. A. Babenko.

**Description:** Body length 3.5 – 4.0 mm. Antennae from 4/5 to equal body and head combined, and about 4 times longer than the diameter of the head (see remarks). Ground colour of the body dirty yellowish. Abd II, anterior part of Abd III, distal subsegment of Ant I and basal half of femur of leg III always black. Apart from markings described above the females with two longitudinal bands running from head to Abd V, head from moderately to dark coloured. Adult males darker, with posterior half (Abd II - Abd V) and anterior third (head, Th I, II) of body almost totally black or diffusely blackish. Small juveniles with two longitudinal bands only. Colour variants of juveniles of older age instars are shown in Fig. 6b.

Distal subsegment of Ant I thick, almost twice as thick as Ant II and dark, its length about as long as the diameter of head or a little shorter (see remarks), and densely covered with straight and stout bristles, black reddish, in both sexes. Ant IV without apical bulb. 8+8 ommatidia, G and H smaller and without corneae. Legs long. Claw with an outer tooth, a pair of stout lateral teeth and weak inner teeth. The size and number of inner teeth as common for the genus, two pored at the middle and two distal, inserted on edge by the distances (4,5-5,6)-(6,5-7,8)-(8-9)-10. Outer tooth of empodial appendage inserted below half the length in a ratio of 0.66-0.86 : 2. Males with manubrial organ common for the genus.

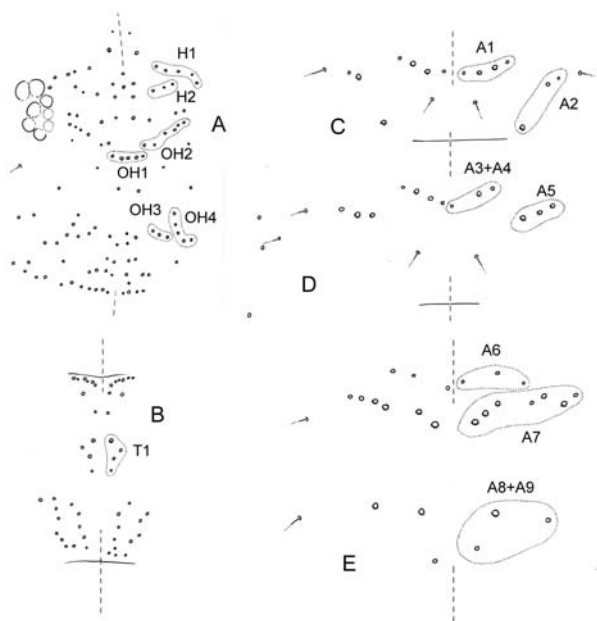


Fig. 7 Chaetotaxy of *O. stebaevae* sp. nov. A-head, B-mesonotum, C-urotergites II, D-urotergite III, E – urotergite IV (pseudopores not shown).

**Chaetotaxy:** HEAD: H1: 5(6), H2: 3(4), HO1: 2+S0 (one row), HO2: 6, HO3: 3, HO4: 5. BODY: T1: 4, A1: 4, A2: 1+2+0, A3+A4: 4, A5: 0+3+0, A6: 2-3, A7: 6-7, A8-A9: 3. A10: 0. (Fig. 7)

**Remarks:** Closely related to *O. pulchra* and differs in colouration.

In the September population (leg. S. Stebaeva) adult males have more contrast colouration, longer legs and antennae, distal subsegment of Ant I as long as head diagonal (Fig. 6A). In other samples males and females do not show significant differences in body limb ratios. Epitoky is possible but more study is necessary to demonstrate it.

**Distribution:** It was repeatedly collected in the same area of NW Caucasus and is probably a very localised species (Fig. 5). In more northern areas *O. stebaevae* is probably replaced by *O. pulchra*; the south-eastern limit of its range is less understandable.

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## 5. References

- Christiansen, K. & B. Tucker (1977): Five new species of *Orchesella* (Collembola: Entomobryidae). – Proceedings of the Iowa Academy of Science. **84** (1): 1 – 13
- Christiansen, K. & P. Bellinger (1980): Part 3. Family Entomobryidae, The Collembola of North America North of the Rio Grande. – Grinnell College, Iowa: 785 – 1042
- Fрати, F., E. Dell'ampio, S. Casasanta, A. Carapelli & P. P. Fanciulli (2000): Large amount of genetic divergence among Italian species of the genus *Orchesella* (Insecta, Collembola) and the relationships of two new species. – Molecular Phylogenetics and Evolution **17** (3): 456 – 461
- Jordana, R. & E. Baquero (2005): A proposal of characters for taxonomic identification of *Entomobrya* species (Collembola, Entomobryomorpha), with description of a new species. – Abhandlungen und Berichte des Naturkundemuseums Görlitz **76** (2): 117 – 134
- Lindenmann, W. (1950): Untersuchungen zur postembryonalen Entwicklung schweizerischer Orchesellen. – Revue Suisse de Zoologie. **57** (8): 353 – 428
- Mari Mutt, J. A. (1979): Revision of the genus *Dicranocentrus* Schött (Insecta: Collembola: Entomobryidae). – Agricultural Experiment Station University of Puerto Rico, Bulletin 259: 79 pp.
- Mari Mutt, J. A. (1984): Five New Species of Orchesellini from Central Mexico. – Proceedings of the Entomological Society of Washington **86** (4): 808 – 820
- Snider, R. J. (1997): New *Orchesella* species (Collembola: Entomobryidae) from North America. – Entomological News **108** (5): 372 – 378
- Soto-Adames, F. N.: Postembryonic development of the dorsal chaetotaxy in *Seira dowlingi* (Collembola, Entomobryidae); with an analysis of the diagnostic and phylogenetic significance of primary chaetotaxy in *Seira*. – Zootaxa (in press)
- Stach, J. (1960): The Apterygotan fauna of Poland in relation to the world-fauna of this group of insects. Tribe Orchesellini. – Acta Monographica Musei Historiae Naturalis Krakow: 151 pp.
- Szeptycki, A. (1979): Chaetotaxy of the Entomobryidae and its phylogenetical significance. Morpho-systematic studies of Collembola. – IV. Polska Akademia Nauk, Zakład Zoologii Systematycznej Doswiadczalnej: 219 pp.

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