Ecological-taxonomical analysis of collembolans of the northeast of Uzbekistan

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ECOLOGICAL–TAXONOMICAL ANALYSIS OF COLLEMBOLANS OF THE NORTHEAST OF UZBEKISTAN

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Abstract

Paper is devoted to the ecological and faunistic analysis of the collembolans unit of the Northeast region of Uzbekistan. In the agrocnoses of apple orchard, wheat and surrounding ecosystems, 40 species of collembolans have been identified. Of these, 29 species were found in agrocnoses (apple orchard and wheat), and 40 (in natural communities). We observed the same pattern in a huge population density in the cenoses studied. It is significantly more in natural communities (12386 copies per 1 m$^2$ of soil) as compared with agrocnoses (6980 copies per 1 m$^2$ of soil). The horizons of the surface layer (10-20 cm) of soil are most densely populated by collembolans.

Keywords: collembola, agrocnosis, soil, sample, wheat.

Introduction

The springtails order (Collembola) is a relatively small, well-defined group of predominantly soil animals - one of the most ancient taxa of land arthropods, which retained a plesiomorphic level of organization [13], [11], [7], [2]. Collembolans are one of the leading groups of arthropods in the saprotrophic complex in soil biota. The significant role of collembolans in soil biodynamic is due to their abundance, taxonomic richness, and the rapid change of generations [5], [10], [8], [1], [3]. They are very sensitive to ecological conditions and quickly respond to environmental alterations that allows the use of collembolans for bio monitoring of contaminated and disturbed ecosystems [9], [14], [15], [23], [4].

Research of collembolans fauna in specific regions gives a complete picture of the taxonomic composition of certain groups, their interrelations in biogeoecenoses, and their role in the circulation of substances in nature [20]. Therefore, the research of taxonomic composition, distribution, quantity, biology, ecology of especially significant soil-forming species of collembolans in various agrocnoses and surrounding ecosystems is of great scientific practical importance [21].

The aim of our research is to determine the taxonomic composition of collembolans, the study of the seasonal dynamics of the number of individual groups of soil organisms in the biogeoecenoses of the Northeast of Uzbekistan.
1 Materials and methods

To study the structure and number of populations of soil collembolans, soil samples were collected in agrocenoses, and stationary studies of their surrounding ecosystems were conducted in the “Karakalpak” farm in Parkent district of Tashkent region. The material for the study was collected in all seasons of the year in three points.

To study the qualitative and quantitative composition of soil small arthropods, soil samples were taken from three points of each investigated agrocenosis and surrounding ecosystem in layers of three horizons (0-10, 10-20, 20-30 cm). In total, we received 405 samples in a fivefold repetition.

The extraction of collembolans from soil samples was carried out in the laboratory using an eclectic method. The extrusion of collembolans from substrate was carried out using a modified Berlese-Tulgren apparatus. Permanent preparations in liquid phora are prescribed [14],[18], [16], [17]. The counting and determination of the taxonomic affiliation of collembolans was performed under MBS-9 binocular microscope. The digital material was statically processed. A quantitative account of the number of collembolos was carried out on the basis of counting them in 1 dm³ of the soil sample. Based on the data obtained, recalculation was carried out for 1 m² for each soil layer. Digital material is statistically processed [6], [24], [23], [12].

2 Results and discussion

Analysis of the collected material showed that in wheat agrocenoses, an apple orchard and the surrounding ecosystem of the Parkent district of Tashkent region live 40 species of collembolans from 6 families belonging to Collembola order (Table 1).

Table-1

<table>
<thead>
<tr>
<th>№</th>
<th>Species</th>
<th>apple orchard agrocenosis</th>
<th>wheat agrocenosis</th>
<th>environmental ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0-10 cm 10-20 cm 20-30 cm</td>
<td>0-10 cm 10-20 cm 20-30 cm</td>
<td>0-10 cm 10-20 cm 20-30 cm</td>
</tr>
<tr>
<td>1</td>
<td>Family: Hypogastruridae Triacanthella michaelsoni Schaffer,1897</td>
<td>14 20 10</td>
<td>12 24</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Achorutes inermis Tullberg, 1876</td>
<td></td>
<td>14 25 11</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Willemia anophthalma Borner,1901</td>
<td>21 13</td>
<td>9 19 6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Xenyilla maritima Tullberg,1869</td>
<td></td>
<td>15 31</td>
<td></td>
</tr>
</tbody>
</table>
| 5 | *Acheronitella*  
    Sabina  
    Bonet, 1945 | 13 | 9 | 15 | 35 | 8 |
| 6 | **Family:**  
    *Onychiuridae*  
    *Lipura sibirica*  
    Tullberg, 1876 | 10 | 7 | 12 | 18 | 11 |
| 7 | *Lipura groenlandica*  
    Tullberg, 1876 | 24 | 32 | 24 | 10 | 9 | 25 | 7 |
| 8 | *Tullbergiay tricuspis*  
    Borner, 1902 | | | | | | | 21 |
| 9 | *Onychiurus ramosus*  
    Folsom, 1917 | 10 | 6 | 8 | 13 | 25 | 32 | 6 |
| 10 | *Uralia schilov*  
    Martynova, 1976 | 8 | 6 | | | | 7 |
| 11 | *Lipura armata*  
    Tullberg, 1869 | 9 | 5 | 11 | 10 | 18 |
| 12 | *Podura ambulans*  
    Linnaeus, 1758 | 6 | 17 | | | | 13 | 16 |
| 13 | **Family:**  
    *Neanuridae*  
    *Brachystomella maritima*  
    Agren, 1903 | 19 | 16 | 10 | 18 | 24 | 8 |
| 14 | *Triaeana mirabilis*  
    Tullberg, 1871 | | | | | | | 11 |
| 15 | *Schoetella maxima*  
    Schot, 1901 | 9 | 14 | | | | 6 | 12 | 4 |
| 16 | *Pseudachorutes subcrassus*  
    Tullberg, 1871 | | | | | | | 15 | 7 |
| 17 | *Micranurida pyg- 
    maec* Borner, 1901 | | | | | | | 8 | 14 |
| 18 | **Family:**  
    *Odontellidae*  
    *Odontiella evingi*  
    Folsom, 1916 | 23 | 11 | 21 | 6 | 13 | 10 |
| 19 | *Xenyloides armatus*  
    Axelsson, 1903 | 24 | 13 | 31 | | | 20 |
| 20 | **Family:**  
    *Isotomidae*  
    *Pentacanthella decemculata*  
    Deharaverg, 1979 | 14 | 18 | 5 | 3 | 9 | 11 |
| 21 | *Anurophorus laricus*  
    Nicolet, 1842 | 9 | 21 | | | | 22 | 23 |
| 22 | *Folsomina candida*  
    Willem, 1902 | 11 | 6 | | | | 8 | 17 |
The number of species constituting these complexes in the studied cenoses is not the same. Since the apple orchard identified 29 species, wheat field 17, the surrounding ecosystem, 40 species. Representatives of the families Isotomidae (14 species), Onychiuridae (17), Entomobryidae (7) and Neanuridae (5 species) dominated.

From found 40 species of collembol, 17 species: *Lipura sibirica, Lipura groenlandica, Brachystomella maritima, Odonitella ewingi, Xenyllodes armatus, Onychiura*...
urus ramosus, Lipura armata, Pentacanthella decemoculata, Folsomina onychiurina, Istoma producta, Cryptopygus antarcticus, Istoma minor, Istoma sensibilis, Istoma notabilis, Desoria saltans, Digeeria muscorum, Parasira ornata), found in the soil layers of agrocenoses and natural ecosystems; 9 species (Achorutes inermis, Xyella maritima, Tullbergiyia tricusps, Triacena mirabilis, Pseudachorutes subcrassus, Micranurida pygmaea, Podura palustris, Istomodella pusilla, Istoma communia) were characteristic only for the soils of natural ecosystems.

In wheat agrocenoses of Parkent district - Isotomiella (Isotoma) minor, Folsomina candida (30, 34%) are dominant species. High prevalence of dominant species Frisea (Triacena) mirabilis, Xenyllodes armatus, (Isotoma) minor, Folsomina candida, Folsomina onychiurina falls on spring.

In the soil layers of the wheat fields of Parkent area the dominant species Xenyllodes armatus, Isotomiella (Isotoma) minor belong to the Collembola subgroup of the surface layers of the soil litter; Folsomina onychiurina and Folsomina candida species belong to the collembolan subgroup living under vegetation and in the soil; Frisea (Triacena) mirabilis belongs to the subgroup of collembolans inhabiting deep layers of soil.

In apple agrocenoses of Parkent area, the dominated species are Isotomiella (Isotoma) minor, Folsomina candida, Folsomina onychiurina Denis, 1931 (18 and 32%, respectively). In apple agrocenoses of Parkent district - Folsomina candida (32%). High prevalence of dominant species of Isotomiella (Isotoma) minor, Folsomina candida, Folsomina onychiurina is observed in spring.

In apple fields, located in Parkent area, the dominant Isotomiella (Isotoma) minor species belong to the collembolan subgroup living on the surface layers of the soil litter; Folsomina onychiurina, Folsomina candida belong to the subgroup of collembolans living under vegetation and in the soil.

In the soil layers of the natural ecosystem of Parkent region - Acherontiellina (Acherontiella) sabina, Folsomina onychiurina, Isotomiella (Isotoma) minor (39, 42%). High incidence of dominant species Acherontiellina (Acherontiella) sabina, Folsomina onychiurina, Isotomiella (Isotoma) minor Schaffer, 1896 is observed in autumn.

In the soil layers of the natural ecosystem of Parkent region the dominant species - Acherontiellina (Acherontiella) sabina belong to the subgroup of collembolans living on the surface layers of the soil litter; Folsomina onychiurina belongs to the subgroup of collembolans living under vegetation and in the soil; Isotomiella (Isotoma) minor belongs to the subgroup of collembolans inhabiting the surface layers of the soil litter.

It was studied the seasonal dynamics of the number of collembolans in the soil layers to a depth of 30 cm of clover, wheat, cotton, apple agrocenoses and natural ecosystems of Parkent area of Tashkent region of northeast Uzbekistan. In winter, i.e. in December, February in agrocenoses and natural ecosystems of the Parkent area in soil layers of 1 m² on average 8060 sps. of collembolans.

In winter, in the wheat and apple agrocenoses and natural ecosystems of Parkent area in the soil layers up to 0-30 cm per 1 m² there are an average of 1,683 collembolans (table 2). In winter, i.e. in December and February, in wheat and apple agrocenoses
and the natural ecosystems of Parkent area in the soil layers up to 10-20 cm deep, there is a high occurrence of collembolans, i.e. in 1 m² of wheat agroecenosis soil is 1,700 copies, in apple agroecenoses there are 2,550 copies, and in soils of natural ecosystems there are up to 2,500 collembolans on average. In soil horizons up to 0-10 cm, collembolans are less common than in other layers.

Table 2

The number of collembolans in the soil layers of agroecenosis and natural ecosystems of the Parkent territory in winter

<table>
<thead>
<tr>
<th>Soil layer</th>
<th>Wheat agroecenosis</th>
<th>Apple agroecenosis</th>
<th>Natural ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>XII*</td>
<td>II</td>
<td>XII</td>
</tr>
<tr>
<td>0-10 cm</td>
<td>200**</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>10-20 cm</td>
<td>800</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>20-30 cm</td>
<td>400</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>Total</td>
<td>1400</td>
<td>2000</td>
<td>2300</td>
</tr>
</tbody>
</table>

* - the ordinal number of the months of the year
** - in 1 m²

In the spring, in the wheat and apple agroecenoses and natural ecosystems in Parkent area in the soil layers up to 0-30 cm per 1 m² there is an average of 7066 collembolan specimens (table 3).

Table 3

The number of collembolans in the soil layers of agroecenoses and natural ecosystems of the Parkent area in the spring

<table>
<thead>
<tr>
<th>Soil layers</th>
<th>Wheat agroecenosis</th>
<th>Apple agroecenosis</th>
<th>Natural ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IV*</td>
<td>V</td>
<td>IV</td>
</tr>
<tr>
<td>0-10 cm</td>
<td>600**</td>
<td>1400</td>
<td>600</td>
</tr>
<tr>
<td>10-20 cm</td>
<td>1600</td>
<td>2000</td>
<td>2400</td>
</tr>
<tr>
<td>20-30 cm</td>
<td>900</td>
<td>800</td>
<td>2000</td>
</tr>
<tr>
<td>Total</td>
<td>3100</td>
<td>4200</td>
<td>5000</td>
</tr>
</tbody>
</table>

* - the ordinal number of the months of the year
** - in 1 m²

In the spring, i.e. in April-May, in Parkent area in the soil layers of wheat and apple agroecenosis and natural ecosystems in 10–20 cm deep, there is a high occurrence of collembolans, i.e. in 1 m² of soil of wheat fields in April, an average of 1600 copies,
in May, 1600 copies; in the apple agrocenosis in April, an average of 2,400 copies, in May, 3,100 copies; in soils of natural ecosystems in every 1 m² in April 9000, in May 4800 copies. In soil horizons up to 0-10 cm, collembolans are less common than in other layers.

During the summer months, 5,450 copies of collembolans were found in the wheat and apple agrocenoses of Parkent region in soil layers of 0-30 cm on average per 1 m² of land (table 4).

Table 4
The number of collembolans in the layers of soil Parkent area in the summer

<table>
<thead>
<tr>
<th>Soil layers</th>
<th>Wheat agrocenosis</th>
<th>Apple agrocenosis</th>
<th>Natural ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VII*</td>
<td>VII</td>
<td>VII</td>
</tr>
<tr>
<td>0-10 cm</td>
<td>400**</td>
<td>200</td>
<td>600</td>
</tr>
<tr>
<td>10-20 cm</td>
<td>800</td>
<td>600</td>
<td>2400</td>
</tr>
<tr>
<td>20-30 cm</td>
<td>1400</td>
<td>800</td>
<td>2800</td>
</tr>
<tr>
<td>Total</td>
<td>2600</td>
<td>1600</td>
<td>5800</td>
</tr>
</tbody>
</table>

* - the ordinal number of the months of the year
** - in 1 m²

Table 5
Collembolans content in soil layers of agrocenoses and natural ecosystems of Parkent area in autumn

<table>
<thead>
<tr>
<th>Soil layers</th>
<th>Wheat agrocenosis</th>
<th>Apple agrocenosis</th>
<th>Natural ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X*</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>0-10 cm</td>
<td>1600**</td>
<td>1400</td>
<td>1200</td>
</tr>
<tr>
<td>10-20 cm</td>
<td>4000</td>
<td>3500</td>
<td>3600</td>
</tr>
<tr>
<td>20-30 cm</td>
<td>2600</td>
<td>2800</td>
<td>2400</td>
</tr>
<tr>
<td>Total</td>
<td>8200</td>
<td>7700</td>
<td>7200</td>
</tr>
</tbody>
</table>

* - the ordinal number of the months of the year
** - in 1 m²

In the summer, i.e. in July and August, there were a large number of collembolans in the soil layers of 20-30 cm of wheat and apple agrocenoses and natural ecosystems of Parkent area, that is, 1,400 copies in July per 1 m² in the wheat agrocenosis and
800 copies in August; in July on the apple agrocenosis an average of 1 m² is 2,800 copies in July, 2,600 copies in August; In July, an average of 4,800 specimens per m² was observed in the soils of natural ecosystems, and 4,000 copies in August.

During the autumn season, it was found that in soil layers of 0-30 cm per 1 m² of wheat and apple agrocenoses, as well as in the natural ecosystems of Parkent area, an average of 7,7333 collembol are observed (table 5).

In autumn, that is, in October and November, in the area of Parkent, in wheat and apple agrocenoses and soils of natural ecosystems, a large number of collembol are observed in layers of 10–20 cm, i.e. 4,000 copies per 1 m² of wheat agrocenoses in October and 3,500 in November; in apple agrocenosis in October, an average of 3,600 specimens per m² and 3,800 specimens in November were observed; in soils of natural ecosystems, an average of 7,600 specimens per 1 m² in October and 8,300 specimens in November.

3 Conclusions

Results of the research allowed finding out the ecological and faunistic analysis of the collembolans of the surveyed region. In the agrocenoses of apple orchard, wheat and surrounding ecosystems, 40 species of collembolans have been identified.

From found 40 species of collembol, 17 species- Lipura sibirica, Lipura groenlandica, Brachystomella maritima, Odonitella ewingi, Xenyllodes armatus, Onychiurus ramosus, Lipura armata, Pentacanthella decemculata, Folsomina onychiurina, Istoma producta, Cryptopygus antarcticus, Istoma minor, Istoma sensibilis, Istoma notabilis, Desoria saltans, Digeeria muscorum, Parasira ornate met in the soil layers of agrocenoses and natural ecosystems; 9 species- Achorutes inermis, Xenylla maritima, Tullbergiya tricuspis, Triacana mirabilis, Pseudachorutes subcrassus, Micranurida pygmaea, Podura palustris, Istomodella pusilla, Istoma communae were characteristic only for the soils of natural ecosystems.

It has been established that the agrocenoses of apple orchard and wheat are much poorer by the species of collembolans than those in natural communities. Thus, in the agrocenoses, 29 species of collembolans were noted (6980 copies per 1 m²). In natural communities, however, there are 40 species respectively (12386 copies per 1 m² of soil). The horizons of the surface layer (0–20 cm) of soil are most densely populated by collembolans.

As can be seen from the data obtained as a result of research, dominate in the soil layers of wheat agrocenoses, species dominate - Frisea (Triacana) mirabilis, Xenyllodes armatus, Isotomiella (Isotoma) minor, Folsomina candida, Folsomina onychiurina. In the soil layers of the agrocenoses of apple orchards, the dominance of the species is observed - Isotomiella (Isotoma) minor, Folsomina candida, Folsomina onychiurina. The soil layers of natural ecosystems dominated by species Isotomodella (Isotomodella) pusilla, Panchaetoma (Isotoma) communae, Schoettella (Achorutes) ununguiculatus, Acherontiellina (Acherontiella) sabina, Folsomina onychiurina, Isotomiella (Isotoma) minor, Oligaphorura (Lipura) groenlandica.

In the soil layers of wheat, apple agrocenoses and natural ecosystems of Parkent
area of Tashkent region of northeastern Uzbekistan, when studying the seasonal dynamics of the number of collembolans, the following were identified. When studying the number of collembolans by seasons, their peak period is observed in spring and autumn. When studying by the soil layers, in the middle layers of the soil (10-20 cm), their maximum number is observed. In spring and autumn, in the 10-20 cm soil layers of agrocenoses and natural ecosystems, an average of 1 m$^2$ revealed 3,558 specimens, and in autumn 3298 specimens.

References


