



UDC 591.5.595

DOI: 10.48077/scihor5.2023.37

## Ecology of soil animals (*Diplopoda* class, *Myriapoda* group)

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### Article's History:

Received: 27.02.2023

Revised: 16.04.2023

Accepted: 3.05.2023

### Suggested Citation:

Kicaj, H. (2023). Ecology of soil animals (*Diplopoda* class, *Myriapoda* group). *Scientific Horizons*, 26(5), 37-45.

**Abstract.** Class *Diplopoda* plays an important role in natural ecosystems, because it supports biodiversity and soil stability, and a change in the number or distribution of centipede species can indicate changes in the environment, such as pollution, soil degradation, climate change, etc. The purpose of the study is to identify the existing species of soil animals of the *Diplopoda* class, as well as to determine environmental factors that can affect their distribution. Species' diversity was assessed by collecting individuals and classifying them into order, family, genus, and species. Climatic factors, namely temperature and precipitation, are also determined. As a result of the study, ecological aspects of centipede development were evaluated and their distribution and dependence on environmental factors, such as climatic, edaphic, and trophic factors, were analysed. In the southern region of Albania, 22 species of the *Diplopoda* class of the *Myriapoda* group were identified, among which mainly decomposers of organic remains and phytophages. The regions of Llogara and Šhašhica were noted as the regions with the highest diversity of millipedes. In addition, it was established that the variation of species is influenced by the environment, the presence of organic substances, and climatic factors. Temperature and humidity are determining factors influencing the distribution of the *Diplopoda* class in different biotopes. Species that have a large regional distribution and are most widespread in time throughout the year: *Pachyiulus cattarensis*, found in the period June-November, *Glomeris pulchra* – May-July, September-October, *Pachyiulus varius* – May-October. A less active period was noted for the following species: *Polydesmus complanatus*, *Glomeris latermarginata*, *Typhloiulus albanichus*, *Pachyiulus hungaricus*, *Glomeris pustullata*. The research, which was carried out, is of practical importance for nature conservation, as the *Diplopoda* class plays an important role in maintaining ecosystems and biodiversity and can be an indicator of the state of the environment

**Keywords:** millipedes; environment; plant remains; ecosystem; climate; phytophages



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## INTRODUCTION

*Myriapoda* group are important components of ecosystems on Earth. *Myriapoda* includes the following classes: *Diplopoda* (millipedes or millipedes), *Chilopoda* (scolopendras), *Symphyla* (symphylls) and *Paupoda* (pauropods). They have very different ecology and perform different ecological functions in soil ecosystems (Mukundan *et al.*, 2020).

The very study of the diversity and role of organisms in soil ecosystems is extremely relevant, because the soil is a living environment in which millions of different microorganisms live, performing various ecological functions, such as processing organic residues, forming humus, storing and transporting nutrients, maintaining the soil structure and protection against pests and pathogens.

In addition, the study of the diversity and ecology of these organisms helps to better understand their functions in the soil and influence the preservation and improvement of the state of soil ecosystems.

Soil animals, including the class *Diplopoda*, play a critical role in the maintenance and functioning of soil ecosystems. The class *Diplopoda*, commonly known as centipedes, are arthropods found in a variety of habitats around the world. In Albania, the density of their populations is limited, and some of them can serve as indicators of the state of the environment (Zhao *et al.*, 2020). The class *Diplopoda* has an important ecological role in soil ecosystems, which is related to the decomposition of organic matter, nutrient cycling, and soil structuring. Understanding their importance is important for ensuring the stability of soil ecosystems, which adds relevance to the research.

Study of the class *Diplopoda* in Albania is quite limited. Only more than 80 species of representatives of this class are known, which is a relatively small number compared to the area of the country. However, it is believed that the *Diplopoda* fauna in Albania may be represented by a slightly larger number of species. This expectation is based on the diversity of these species in the region and their wide distribution (Zahnle *et al.*, 2022). Research by G.L. Nunes *et al.* (2020) has established that the ecology of the class *Diplopoda* can vary greatly depending on habitat and diet. Most often, they can be found in a moist environment, for example, under fallen leaves, in the soil or under logs. Some species feed on fungi, roots and other soil organisms, which can affect the balance of the soil ecosystem.

The class *Diplopoda* can also play an important role in soil structure and humus formation. Members of this class help return nutrients back into the soil, which can improve soil fertility and plant growth. In addition, centipede activity in the soil can help enrich it with oxygen and improve water infiltration, which reduces erosion and run-off (Tóth & Hornung, 2019). C. Wang *et al.* (2020) note that invertebrate members of the class *Diplopoda* help provide the soil with important

minerals. They also promote the development of fungi and other organisms that depend on the decomposition of organic matter in the soil (Wang *et al.*, 2020). According to L. Bundone *et al.* (2022), the class *Diplopoda* is an important component of soil, and understanding their role and interactions with other organisms is critical to maintaining healthy and sustainable soil ecosystems.

N. Pano *et al.* (2006) claim that an important factor that regulates the number of millipedes is external conditions. Thus, temperature and humidity affect the distribution and activity of soil animals, and the study of these factors can help in the development of strategies for the conservation and management of soil ecosystems.

Therefore, an objective study of the distribution factors and species diversity of the *Diplopoda* class can help ensure optimal conditions for the development of plants and other organisms in the soil, reduce the risk of its contamination and preserve biodiversity in soil ecosystems, which is the relevance of the study. Outlining the existing problems of the topic, the purpose of the conducted research is to identify the existing species of soil animals of the *Diplopoda* class and to determine the environmental factors affecting their distribution.

To achieve the goal, the following tasks were performed: to determine the existing species of soil animals of the *Diplopoda* class, to establish climatic, edaphic, and trophic factors that can affect their distribution, to evaluate the ecological aspects of centipede development.

## MATERIALS AND METHODS

The criteria used to determine the areas of collection and the definition of soil animals are geographical location of the sites, soil types, habitat type, altitude above sea level, climatic conditions.

Sampling was carried out at different heights above sea level up to 2000 m, where soil animals were found under stones, in fallen leaves, in the bark and hollows of trees, as well as in the upper layers of the soil. All the material was collected by hand, with the subsequent sifting of the soil using a soil sieve. A soil sieve is a special tool consisting of a metal frame and a mesh with different sizes of holes. The net was placed on the frame, after which a small amount of soil was poured on it and sifted. Parts of the soil that did not pass through the mesh remain in the sieve, and soil animals that are in smaller fractions fall through the holes in the mesh. The species were collected at all times of the year, but in the summer, they were collected in limited microhabitats, under the bark, in wet areas places or in the soil that is associated with arid period.

In order to preserve the collected living material, individuals of soil animals were preserved in 80% alcohol with the addition of ether (several drops). The addition of ether to alcohol helps to reduce the possibility of damage to soft tissues during the preservation

process, because ether affects the preservation of the morphology of animals and avoids their decomposition.

In order to reflect the diversity of soil animals in a certain environment and changes in their distribution depending on time and climatic factors, records were made about the temperature of the environment, the date of collection, the flora, and the type of locations of the samples.

The following criteria were used to determine the type of soil animals:

1. Morphological characteristics: size, body shape, colour, number of segments, presence of antennae, number of pairs of legs, presence, or absence of gonopods, etc.

2. Location and habitat type.

3. Analysis of morphological features under a microscope: Morphological features such as the presence of antennae and microscopic structures on the body were studied in more detail using a stereomicroscope.

In addition, the determination of soil types in the study was based on the appropriate methodology (Mauries *et al.*, 1997).

The climate of the research area is influenced by the geographical location and the topography of the area. However, this is a typical Mediterranean climate, in which there is sometimes a deviation from the average long-term indicators, in particular in the minimum and maximum temperature, amount of precipitation, solar insolation, etc. In the southern region of Albania, some subtypes of the Mediterranean climate are observed, namely: the lowland Mediterranean climate characteristic of the Albanian Riviera and the high-altitude Mediterranean climate, mainly on the mountain tops.

Processing of the received research results for reliability was carried out using the multivariate method of variance analysis MANOVA using Microsoft software Excel and Statistica 10 software package. Differences received results possible per level significance  $P \leq 0.05$  according to the Student's test.

## RESULTS

*Diplopoda* – a group of arthropods with jaws and appendages, whose body consists of several ring segments with many pairs of legs. A distinctive feature of this group is the presence of duplicated body segments or diplosegments, resulting from the fusion of two initially separate segments. Each diplosegment has two pairs of legs, hence the name of the class. Diplosegments are also visible from the inside, where there are two pairs of nerve centres in each segment. The majority of representatives of this class have black-brown colour, some can be red and orange, while spotted types are not common (Kime & Golovatch, 2000).

*Diplopoda* are heliophobes, sensitive to sunlight light, that's why they are hiding, to avoid it. Light and temperature as well as other environmental and physiological factors are more favourable when they are stable. It is worth noting that relatively a bit of millipedes

is able to dive deep into the water, even up to 30 cm (Giribet & Edgecombe, 2019).

In the class *Diplopoda*, there are a lot of families, most of which include millipedes that live in the soil and decompose organic matter. Some of the more common families in this class include:

1. *Julidae* – the family includes most of the common millipedes that live in the soil.

2. *Spirostreptidae* – the family that includes long millipedes with a spiral body shape.

3. *Polydesmidae* – the family includes millipedes with a harder outer shell.

4. *Glomeridae* – the family includes millipedes with a hard outer shell and the ability to curl into a ball.

5. *Sphaerotheriida* – includes millipedes capable of curling into a ball, with a large, hard outer shell.

6. *Blaniulidae* – this family includes short-bodied, ground-dwelling millipedes with flat feet (Tóth & Hornung, 2019).

There are several environmental factors that influence the distribution of *Diplopoda* and other soil invertebrates. The main ones are the following:

1. Climatic conditions: the class *Diplopoda*, like most invertebrates, depends on temperature and soil moisture. They usually live in warm and humid places, but can survive in conditions of reduced humidity and temperature.

2. Soil Type: *Diplopoda* are usually more common in fertile soils with a high organic matter content. They can also be found in other soil types, but their numbers may be smaller.

3. Food availability: Millipedes are phytophagous and saprophagous, so their distribution may depend on the availability of food in the soil. Their number can increase in places with a high concentration of organic substances.

4. Competition with other organisms: Different organisms in the soil, such as insects and other invertebrates, can compete with millipedes for access to food and other resources.

5. The presence of predators: frogs, lizards, birds, and some invertebrates can affect the number of millipedes, limiting their distribution in some areas (Qu *et al.*, 2020).

All these factors can interact with each other and affect the distribution of the *Diplopoda* class in different areas. Understanding these factors can help to explore species diversity and distribution possibilities.

Orders, families, and species found in areas that are observed in the southern region of Albania are:

- Family *Julidae*. In the conducted study, the most representatives of this family were found, they were found in almost every type of soil. Identified genera are given below:

- Genus *Pachyiulus*: *Pachyiulus cattarensis*, *Pachyiulus dentiger*, *Pachyiulus varius*, *Pachyiulus valonensis*, *Pachyiulus hungaricus*.

- Genus *Brachyiulus*: *Anoploiulus apfelbecki*, *Brachyiulus littoralis*.
- Genus *Megaphyllum*: *Megaphyllum karschi*.
- Genus *Ommatoiulus*: *Ommatoiulus sabulosus*.
- Genus *Cylindroiulus*: *Cylindroiulus boleti*.
- Genus *Leptoiulus*: *Leptoiulus trilineatus*, *Leptoiulus macedonicus*, *Typhloiulus albanicus*.
- Family *Blaniulidae*. In the study, representatives of this family were found under leaves, rotten wood, in the soil. One genus has been identified:
  - Genus *Nopoiulus*: *Nopoiulus kochii*.
- Family *Glomeridae*: Found in soil, under stones and in forest areas. One genus was identified in the study:
  - Genus *Glomeris*: *Glomeris hexastica* var., *Glomeris pulchra*, *Glomeris bureschi*, *Glomeris balcanica*, *Glomeris pustulata*, *Glomeris latermarginata*. Family *Glomeris* is widespread in Europe, as well as in Albania. Its representatives are found in all investigated areas at an altitude of up to 2000 m.
- Family *Polydesmidae*. Soil animals are identified in the undergrowth, on the meadows, especially in wet places, are characterized by saturated colours, and were represented by two genera:
  - Genus *Polydesmus*: *Polydesmus complanatus*.
  - Genus *Strongylosoma*: *Strongylosoma stigmatosum balcanicum*.

Family *Julidae* is one of the richest families of the *Diplopoda* class and has about 900 species. Members of this family have a thin body with 15-100 pairs of legs that allow them to move in an ant-like manner. They feed mainly on dead plant remains and fungi, and can also be predators, preying on smaller invertebrates. Since these soil animals cannot efficiently digest leaf litter, they eat a large amount – 5-50% of their weight per day, and produce a huge amount of faeces, which are transported into the deeper layers of the soil.

Together with the rainy worms, they are of great importance for the fertility of soil. In some sandy soils, poor nutritious substances and moisture, these invertebrates fully replace rainy worms and are the only one's humus formers among macrofauna (Kime & Enghoff, 2017).

It is worth noting that interrupting physiological cycle was observed in many species when the temperature dropped. Slowing down and then its stopping at 5-10°C was noticed. Such adaptation allows soil animals to experience cold periods of the year. However, at very high temperatures, their life activity also suspends, dry soils are one of the factors affecting this. In places with moderate climate, most animals of the class *Diplopoda* maintain their activity during the whole life cycle. In the completed research, it is established that during preparation for winter, they burrow deeper underground, and then stop their activity and reproduction.

A great diversity of soils was observed on the territory of the study. It is the result of the interaction of soil-forming factors (relief, climate, vegetation cover, types of breeds), which differ depending on each other from height. The most common ones were brown soils, gray brown soils and less alluvial soils. In view of all changes observed in places of research, it was noted that millipedes can be met in almost all types of soil. However, they avoid limestone soils and soils with high salinity. They are found more frequently on brown and gray-brown soils at an altitude of up to 600 m. But their dissemination depends on combinations of different other factors, for example on the type and characteristics of places of existence.

According to the data of meteorological observations, it was noticed that on the territory of research the lasted summer drought may be observed (Table 1). Indexes of temperature and quantity of precipitation were used for constructing ombrothermal diagram of Gausson for the zone of research.

**Table 1.** Climatic Indexes of the southern region of Albania (average for 2011-2022)

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Temperature, °C	9.2	10	11.4	14.4	18.3	22	24.1	24.2	21.6	17.9	14.1	10.8
Number of falls, mm	126	99	83.5	69.6	53.5	22.8	16.7	29	57.9	111	148	136

**Source:** compiled by the authors

The number of centipede species collected in July-August is lower compared to the number collected

in May-June and September, this may be due to the influence of temperature and humidity (Table 2, 3).

**Table 2.** Quantity of collected species by month

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
In total	3	-	34	110	168	218	101	77	146	364	123	1458

**Source:** compiled by the author

**Table 3.** Quantity of found species by month

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
In total	1	-	3	3	7	6	5	4	7	13	5	1

**Source:** compiled by the author

The largest number of species was identified in the temperature range of 15-25°C. These temperatures, based on the collected data, are characteristic of the following months: May, June, as well as

September, October. The period July-August and partially June-September is confirmed as the dry period of the year according to the ombrothermal diagram of Gausson (Fig. 1).

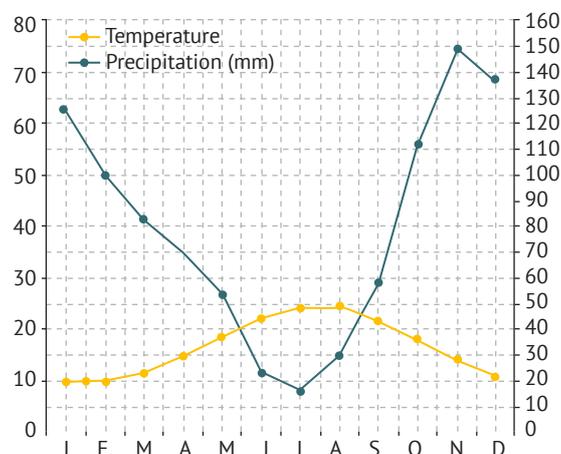


Figure 1. Gausson ombrothermal diagram

Source: compiled by the author

For the specified species, the collection time by month is indicated and the different periods of activity of each species are clearly defined (Table 4). The absence of precipitation, that is accompanied by low temperatures, leads to low activity of soil animals and even to their falling into diapause. On the researched territories, this period is quite short in January and February

due to the predominance of the Mediterranean climate. And in coastal areas, only a decrease in the activity of individuals, but not an interruption of activity, is observed.

Thus, the climate has a significant influence on the distribution and activity of soil animals of the class *Diplopoda*, especially it relates to the combination of temperature and humidity of the environment.

Table 4. Identified species of the *Diplopoda* class by months

No	Species/Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1	<i>Pachyiulus cattarensis</i>						+			+	+	+	
2	<i>Pachyiulus dentiger</i>			+	+	+		+			+		
3	<i>Pachyiulus various</i>					+	+	+	+	+	+		
4	<i>Pachyiulus hungaricus</i>										+		
5	<i>Pachyiulus valonensis</i>				+		+		+		+	+	
6	<i>Ommatoiulus sabulosus</i>	+		+	+	+			+		+	+	
7	<i>Anoploiulus apfelbecki</i>						+				+		
8	<i>Cylindroiulus boleti</i>									+	+		
9	<i>Megaphyllum karschi</i>			+					+	+	+	+	+
10	<i>Brachyiulus littoralis</i>						+	+		+	+		
11	<i>Leptoiulus macedonicus</i>										+		
12	<i>Glomeris hexastica</i>								+	+			
13	<i>Leptoiulus trilineatus</i>					+			+				
14	<i>Typhloiulus albanicus</i>					+							
15	<i>Nopoiulus kochii</i>					+			+				
16	<i>Glomeris Balkan</i>					+							
17	<i>Glomeris pulchra</i>					+	+	+		+	+		
18	<i>Glomeris bureschi</i>												+
19	<i>Glomeris latermarginata</i>					+							

Table 4, Continued

No	Species/Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
20	<i>Glomeris pustulata</i>							+					
21	<i>Strongylosoma stigmatosum</i> <i>balcanicum</i>										+		+
22	<i>Polydesmus complanatus</i>					+							

Source: compiled by the author

Given the climatic values, it was noted that two periods are characterized by a relatively low number of collected species and individuals: the winter diapause period (January-February) and the dry season period (July-August). *Pachyiulus cattarensis* was detected in the period June, September-November, *Anoploiulus apfelbecki* – June, November, *Glomeris pulchra* May-July, September-October, *Pachyiulus varius* – May-October. The presented species are widely distributed. Such species as: *Polydesmus complanatus*, *Glomeris latermarginata*, *Typhloiulus albanichus*, *Pachyiulus hungaricus*, *Glomeris pustulata* have a shorter active period.

So, in the course of the research carried out in the southern region of Albania, 22 species of soil animals of the Diplopoda class of the Myriapoda group were identified, which are typical representatives of soil animals. The regions with the highest diversity are the districts of Llogara and Šhašhica. The presence of forest habitats, decomposing organic matter and favourable elements of the microclimate affects a high level of species variation. The influence of temperature and humidity is a determining factor of their distribution in various biotopes of the studied territory.

## DISCUSSION

Soil animals of the *Diplopoda* class are useful because they participate in decomposition processes. They can be found everywhere in places where there are plant remains, in wet areas, especially in wooded areas. In these environments, they can find a sufficient amount of food and the necessary moisture for their development. However, according to N. Pano *et al.* (2006), the distribution of invertebrates is more related to hydrothermal conditions, while the type of forest and soil is of secondary importance, which was also established in the conducted study.

Another confirmation of the obtained results is found in research by V. Fontana *et al.* (2020), who note in his writings that there is a significant influence of altitude on the diversity of soil animals, and most soils and vegetation play a secondary role. According to E. Kostantinidis *et al.* (2020), only some millipedes are found in dry places, because their cuticle does not have layers that protect them from lack of water. In addition, they are very sensitive to air humidity. This is usually the main reason for choosing their place of residence. These soil animals prefer to stay in the environment of the remains of leaves, wood, under the bark of trees, stones, under tree trunks, in bird nests, worm shelters, etc. (Kostantinidis *et al.*, 2020).

The class *Diplopoda* plays an important role in soil ecology because it promotes nutrient cycling and the breakdown of organic matter. Millipedes are detritivores, that is, they feed on decaying plant remains, and other substances contained in the soil. They use their mandibles to grind food and then swallow it with their mouthparts. By doing this, they help break down complex organic molecules into simpler ones that can then be used by plants and other organisms in the soil.

Millipedes also play an important role in soil structure and aeration. By sinking into deeper layers, they create tunnels and channels that allow air and water to more easily penetrate through the soil. This helps maintain favourable soil conditions for the growth of plants and other soil organisms. In addition, centipedes can serve as an important food source for other animals such as birds and small mammals, thereby contributing to biodiversity. And in recent decades, in the light of dynamic climate changes, it is especially important to preserve biodiversity to ensure ecological sustainability and preserve valuable natural resources for future generations.

A number of scientists, including Y. Zhao *et al.* (2020), L. Gong *et al.* (2020) and W.L. So *et al.* (2022), various aspects of centipede biology and ecology were investigated, including their distribution and dependence on environmental factors. As a result of these studies, the authors found that millipedes can be found in a variety of environments, including forests, fields, water bodies, and mountainous regions. They can also spread by transferring soil, plants, and other materials, which is also reflected in the obtained results of the performed research.

In addition, research by H. Kicaj and M. Qirjo (2008) confirm that centipede activity can depend on various environmental factors, such as climatic conditions, soil type and availability of food resources. G. Giribet and G.D. Edgecombe (2019) research shows that some centipede species may be more common in temperate climates, while others may be found in more tropical regions. Also, the presence of plant cover and other food sources that can provide a sufficient level of nutrition for these soil animals is important.

L. Moritz and T. Wesener (2021) used a regression analysis of the influence of climatic factors on the number of millipedes and established that the composition of soil organisms is formed precisely from environmental changes related to water availability, energy supply, and climatic stability. Considering the active period of centipede activity, research by G.L. Nunes *et al.* (2020), shows that these animals can be active throughout the

year, although some species may be less active in winter. There is also information about the interruption of centipede activity, when they may be in a state of diapause or hibernation, which also correlates with the conducted research.

As for the number of individuals identified, this depends on many factors, including the type of environment, collection methods and the centipede's own biology. So, J.C. Means *et al.* (2021) state that the number of millipedes found can vary depending on the type of soil in which they live and the presence of plant cover. In addition, collection methods may affect the number of individuals caught, as some methods may be more efficient than others. And research by Y. Shen *et al.* (2022) shows that the use of traps can be more effective for centipede collection than methods that require active search and collection.

In addition, the own physiology of millipedes can also affect their number. For example, some species may be more susceptible to population fluctuations, while others are less sensitive to environmental changes. In addition, millipedes can have different growth and reproduction rates, which can affect their total abundance in a given environment (Tóth & Hornung, 2019).

M.E. Brookfield *et al.* (2020) believe that some centipede species are quite common and have a large range. For example, *Glomeris pulchra*, *Anoploius pusillus* and *Pachyiulus cattarensis* are ubiquitous, which may indicate their adaptability and ability to adapt to different environmental conditions. However, according to A. Perrigo *et al.* (2019), other species can be more specific and can be found only in certain conditions. For example, *Anoploius apfelbecki*, *Leptoiulus macedonicus*, *Glomeris hexastica*, *Typhloiulus albanichus*, *Glomeris balcanica*, these species probably have limited ranges and can only be found in certain ecosystems or environments with specific microclimate conditions.

The results of the performed research are also reflected in scientific works by C. Powell *et al.* (2020), who argue that centipedes are an important link in food chains that help maintain healthy and sustainable biotopes. Millipedes can be indicators of the state of the natural environment, as their presence, diversity, and number can indicate the stability of the ecosystem. Research on the study of the class *Diplopoda* helps to establish ecological processes in natural environments, which is important for understanding the functioning of ecosystems and developing strategies for the conservation and protection of biodiversity (Tyagi *et al.*, 2020).

However, L.F. Iniesta *et al.* (2020) believe that changing environmental conditions can affect the existence of millipedes, which are so necessary for the ecosystem. For example, the construction of roads or the development of territories can lead to the loss of natural habitats of centipedes, so it is imperative to make decisions about the preservation and protection of the natural distribution areas of these soil animals.

Thus, the study of soil animals of the *Diplopoda* class can help to establish the species' presence in a certain region, their interaction with the environment, their role in supporting the ecosystem, as well as the strategy of human activity aimed at the preservation and management of natural resources.

## CONCLUSIONS

The class *Diplopoda* plays an important role in natural ecosystems, helping to maintain biodiversity and soil sustainability. Representatives of this class are decomposers of organic remains and can serve as a food base for various types of animals, such as birds, amphibians, reptiles and other invertebrates. Changes in the abundance or distribution of certain centipede species can indicate changes in the environment, such as pollution, soil degradation, climate change, etc.

As a result of the research, 22 species of the *Diplopoda* class of the *Myriapoda* group were identified, which were found in the southern region of Albania. Basically, typical representatives of this class include mainly decomposers and phytophages. The districts of Llogara and Shashica are the regions with the highest diversity of millipedes. The significant variation of species is influenced by the environment, the presence of organic substances and the climate. The influence of temperature and humidity is a determining factor affecting the distribution of the *Diplopoda* class in different biotopes.

Based on the temperature and humidity values in the study area, the dry season lasts from mid-June to early September. The presence of centipede species and their individual numbers significantly decreases during this period and almost stops in January-February, when they enter diapause. The greatest distribution in time during the year was characterized by the following species: *Pachyiulus cattarensis*, found in the period June-November, *Glomeris pulchra* – May-July, September-October, *Pachyiulus varius* – May-October. These species have a wide regional distribution. A less active period was marked by the following species: *Polydesmus complanatus*, *Glomeris latermarginata*, *Typhloiulus albanichus*, *Pachyiulus hungaricus*, *Glomeris pustullata*.

The study of the *Diplopoda* class has practical implications for nature conservation, as millipedes play an important role in maintaining ecosystems and biodiversity and can serve as indicators of environmental conditions. The prospect of further research lies in a better understanding of the biology of the class *Diplopoda* and the study of evolutionary changes in the composition and distribution of different species in different environments.

## ACKNOWLEDGEMENTS

None.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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## Екологія ґрунтових тварин (клас *Diplopoda*, група *Myriapoda*)

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**Анотація.** Клас *Diplopoda* відіграє важливу роль у природних екосистемах, оскільки підтримує біорізноманіття та стабільність ґрунту, а зміна чисельності чи поширення видів багатоніжок може вказувати на зміни в навколишньому середовищі, такі як забруднення, деградація ґрунту, зміна клімату тощо. Метою дослідження є виявлення існуючих видів ґрунтових тварин класу *Diplopoda*, а також визначення екологічних факторів, які можуть впливати на їх поширення. Видову різноманітність оцінювали шляхом збору особин і класифікації їх на загони, родини, роду та види. Визначаються також кліматичні фактори, а саме температура й опади. У результаті дослідження оцінено екологічні аспекти розвитку багатоніжок, проаналізовано їх поширення та залежність від факторів зовнішнього середовища, таких як кліматичні, едафічні та трофічні фактори. У південному районі Албанії ідентифіковано 22 види класу *Diplopoda* групи *Myriapoda*, серед яких переважно розкладачі органічних решток і фітофаги. Регіони Ллогара і Шхашаца були відзначені як регіони з найбільшим різноманіттям багатоніжок. Крім того, встановлено, що на мінливість видів впливають навколишнє середовище, наявність органічних речовин, кліматичні фактори. Температура і вологість є визначальними факторами, що впливають на поширення класу *Diplopoda* в різних біотопах. Види, які мають велике регіональне поширення та найбільш поширені в часі протягом року: *Pachyiulus cattarensis*, зустрічається у червні-листопаді, *Glomeris pulchra* – травень-липень, вересень-жовтень, *Pachyiulus varius* – травень-жовтень. Менш активний період відзначений у видів: *Polydesmus complanatus*, *Glomeris latermarginata*, *Typhloiulus albanichus*, *Pachyiulus hungaricus*, *Glomeris pustullata*. Проведене дослідження має практичне значення для збереження природи, оскільки клас *Diplopoda* відіграє важливу роль у підтримці екосистем та біорізноманіття та може бути індикатором стану навколишнього середовища

**Ключові слова:** багатоніжки; середовище; рослинні рештки; екосистема; клімат; фітофаги