# The millipedes and centipedes (Diplopoda, Chilopoda) of the UNESCO Biosphere Reserve Schorfheide-Chorin in Brandenburg (Germany)

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**Abstract.** In October 2019, an excursion of the Working Group of German-speaking Myriapodologists to the UNESCO Biosphere Reserve Schorfheide-Chorin took place with the aim to record its myriapod fauna and thus to increase the knowledge on distribution, habitat requirements and current stage of population development of the myriapod species in this selected area in the federal state of Brandenburg. At 24 locations from 9 biotope types 1,062 specimens from 28 millipede and 16 centipede species were recorded. Thus, together with known published data, a total of 31 millipede and 19 centipede species are now known from the Biosphere Reserve. Remarks on rare and noteworthy species are given.

**Zusammenfassung. Die Doppel-und Hundertfüßer (Diplopoda, Chilopoda) des UNESCO Biosphärenreservats Schorfheide-Chorin in Brandenburg (Deutschland).** Im Oktober 2019 fand eine Exkursion der Arbeitsgruppe deutschsprachiger Myriapodologen in das UNESCO-Biosphärenreservat Schorfheide-Chorin mit dem Ziel statt, dessen Myriapoden-Fauna zu erfassen und damit das Wissen über Verbreitung, Habitatansprüche und Bestandssituation der Arten in diesem ausgewählten Gebiet Brandenburgs zu erweitern. An 24 Standorten aus 9 Biotoptypen wurden insgesamt 1.062 Individuen aus 28 Doppelfüßer- und 16 Hundertfüßerarten erfasst und damit das Artenspektrum des Gebietes auf 31 bzw. 19 Arten erweitert. Anmerkungen zu in Deutschland seltenen und bemerkenswerten Arten werden gegeben.

**Keywords.** Biotope types, Hechtdiebel, Myriapoda, Nature reserve, Plagefenn, Collembola

## 1 Introduction

Despite their significant ecological importance, soil organisms like myriapods often are overlooked and neglected in the assessment of global biodiversity (WAGG et al. 2014), albeit recent studies have begun to close this gap (see VOIGTLÄNDER 2015, DECKER et al. 2016, REIP et al. 2016, and many other publications of the authors). So far, Myriapoda comprise more than 18,000 described species within the four groups Chilopoda (approx. 3,150 species, BONATO et al. 2011), Symphyla (195 species, SZUCSICH & SCHELLER 2011), Pauropoda (805 species, SCHELLER 2011) and Diplopoda (more than 11,000 species, ENGHOFF et al. 2015). They

are found in a great variety of habitats, in which they cover different ecological functions (VOIGTLÄNDER 2011a, b, DAVID 2015). Centipedes (Chilopoda) are predominantly predators feeding on other soil invertebrates (VOIGTLÄNDER 2009a), while millipedes (Diplopoda) are detritivores feeding on dead plant material and fungi (DAVID 2015). Many species are restricted to certain microhabitats, although it is not well understood what limiting factors for habitat preferences are. For Germany, 56 centipede (DECKER et al. 2016) and 122 millipede species (REIP et al. 2016) have been recorded as established. In the course of the compilation or continuation of the Red Lists for Germany, it is essential to know and recognize the species inventory, as well as the current situation of population size and distribution for each federal state. However, based on their more or less cryptic life style our knowledge on myriapod diversity and distribution is still fragmentary since it has not yet been possible to develop checklists for all federal states. Species checklists of the myriapod fauna are only present for eight of the 16 federal states: Baden-Württemberg and Bavaria (SPELDA 2005), North Rhine-Westphalia (DECKER & HANNIG 2011, DECKER et al. 2015), Thuringia (REIP & VOIGTLÄNDER 2009, HAUSER & VOIGTLÄNDER 2009a for Diplopoda), Saxony-Anhalt (VOIGTLÄNDER 2003, 2009b), Saxony and Brandenburg (HAUSER & VOIGTLÄNDER 2009a for Diplopoda), and Mecklenburg-Western Pomerania (VOIGTLÄNDER et al. 2018). Additionally, the millipede fauna of Germany has been summarized by HAUSER & VOIGTLÄNDER (2009b, 2019), the latter with new identification keys, current distribution maps, information about ecology, biology etc.

Although Brandenburg was one of the main areas of German myriapod sampling and research in the first half of the 20th century (as the working and collecting area of German myriapodologist Otto Schubart), it has been strongly neglected during the following decades. Only for the last 20 years, Brandenburg once again

**Figure 1:** The Working Group of German-speaking Myriapodologists during its autumn excursion 2019 in the UNESCO Biosphere Reserve Schorfheide-Chorin. Photograph: H. Reip.

got into the focus of myriapodologists, mainly due to investigations of the arthropod fauna of various areas by Dieter Barndt (e. g. BARNDT 2006, VOIGTLÄNDER in BARNDT 2008, 2010, 2012, 2019). Following his suggestion, an excursion of the Working Group of German-speaking Myriapodologists (Fig. 1) took place in October 2019 into the UNESCO Biosphere Reserve Schorfheide-Chorin. The aim of our field trip was to record the myriapod fauna of this area and thus to increase the knowledge on distribution, habitat requirements and current stage of population development of the Myriapoda species in this selected area in the federal state of Brandenburg.

The Biosphere Reserve Schorfheide-Chorin was established in 1990 and comprises a great variety of habitats on approx. 129,161 ha with 47 Habitats Directive (FHH) areas (49,000 ha) under special protection (LANDESAMT FÜR UMWELT BRANDENBURG 2019). The first investigation of the arthropod fauna of the Plagefenn bog (part of today's UNESCO Biosphere Reserve Schorfheide-Chorin) was made by DAHL (1912), also including Diplopoda and Chilopoda. Recently, it has been assessed – without consideration of Myriapoda – by WESTENDORF et al. (1993), SOMMER et al. (1994), and DATHE et al. (1996), who recorded 1,870 insect and spider species. Between 2014 and 2016, BARNDT (2019) examined two kettle bogs (Hechtdiebel, Plötzendiebel), recognizing 739 arthropod species, including 16 myriapod species and a first record for Brandenburg (*Lithobius borealis* Meinert, 1868). Recently, the area was used in a study to determine the potential of arthropods as bioindicators (GOSSNER et al. 2014) and to examine the effect of land use on arthropod diversity (SIMONS et al. 2014, SIMONS et al. 2016; BIRKHOFER et al. 2015). However, myriapods were not included in these studies. To overcome this fragmentary knowledge, we decided to sample this area again to foster knowledge on species diversity and distribution, and to include these data into the Red Lists for Germany.

## 2 Material and Methods

### 2.1 Investigation area

The UNESCO Biosphere Reserve Schorfheide-Chorin is characterized by Young Drift morainic landscapes, which developed during glaciation 12,000-15,000 years ago, and is situated in a transitional zone between Atlantic and Continental climate. The area is among the driest in Germany (532 mm mean annual precipitation) and can be classified to a sub-continental climate. Half of the area (approx. 49 %) is covered by woodland. The present forests comprise some of the largest (near-)natural lowland beech forests in Europe. The common beech (*Fagus sylvatica*) dominates, partially mixed with hornbeam (*Carpinus betulus*), oaks (*Quercus robur*, *Q. petraea*), small-leaved lime (*Tilia cordata*), as well as Scots pine (*Pinus sylvestris*). In moist locations, the dominating species are common ash (*Fraxinus excelsior*), European white elm (*Ulmus laevis*), and sycamore (*Acer pseudoplatanus*) with a shift to alder-ash forest (Fraxino excelsioris-Alnetum glutinosae) and alder carr (Alnion glutinosae) and bog forests with downy birch (*Betula pubescens*) within fen-like basins. Most chosen sampling sites belong to the landscape of the Uckermärkisches Hügelland, while sites 1 to 5 and 17 belong to the Britzer Platte (according to SCHOLZ 1962).

The Hechtdiebel (Figs. 2, 3, 4) is a 1.4 ha large area assigned as a nature reserve (in German: Naturschutzgebiet, NSG) in 1937, and is today part of the Special Area of Conservation (SAC) Grumsiner Forst/Redernswalde and Poratzer Moränenlandschaft. This area that originated during the last Weichselian glaciations around 10,000 years ago. The Hechtdiebel is a small and shallow kettle bog of approx. 200 m in length and 90 m in width. It is primarily mesotrophic and slightly acidic with only few larger plants

(*Nymphaea alba* and *Nuphar lutea*). The swinging banks of the lake consist of *Sphagnum* moss and some other plant species (e. g. *Drosera rotundifolia*, *Vaccinium oxycoccus*, *Carex limosa*). The bank of the northern lake site tapers into a downy birch (*Betula pubescens*) forest, while the southeastern bank is bordered by an alder carr (Alnion glutinosae). The remaining surroundings of the Hechtdiebel show many ditches and drainages, and are populated by *Pinus* swamp forests with scattered *Alnus glutinosa*, *Betula pubescens* and *Sphagnum* meadows.

Figure 2: The Nature Protection Area (NSG) Hechtdiebel. Photograph: H. Reip.

Figure 3: Birch carr of site 6 at NSG Hechtdiebel. Photograph: H. Reip.

Figure 4: Alder carr of site 7 at NSG Hechtdiebel. Photograph: H. Reip.

The Plagefenn Nature Reserve, with approx. 1,056 ha in size, is located in the southeast of the Biosphere Reserve, east of the Chorin Abbey. The basin of both Plagesee lakes has been under nature protection since 1907, and was designated as a natural developmental area in 1990. A characteristic feature of this area is a complex of extensive forests with numerous marshy depressions, amply equipped with bogs (including the Bierpfuhl, sites 23 and 24) and water bodies. The Kleines Fischerbruch bog (sampling site 21 and 22) is a wet area with nitrophilic herb vegetation such as willow (*Salix* spp.) and sedges (*Carex rostrata* and *C. appropinquata*).

## 2.2 Sampling sites and methods

During the field trip from October 18th to 21st 2019, 24 localities were investigated (Fig. 5, Table 1). In all locations representing the spatial extent of the reserve as well as small-scale habitat structures, myriapods and Collembola were collected by hand or aspirator (in leaf litter, in dead wood, under tree stumps and bark etc.) as well as by sifting of soil and leaf-litter and other organic material (Fig. 6). Sampling was performed by U. Burkhardt, T. Dannenfeld, K. Heynen, S. Heynen, E. N. Lindner (additionally sites 18, 20-24), L. Moritz, B. Nauman, R. Orsakowsky, K. Packenius (additionally sites 18, 20-24), H. Reip, A. Sombke and K. Voigtländer. Specimens of common species were partially left at the locations after counting. Additionally, several soil and litter samples were taken for subsequent Berlese-Tullgren extraction in the lab from sites 3 to 16 (U. Burkhardt).

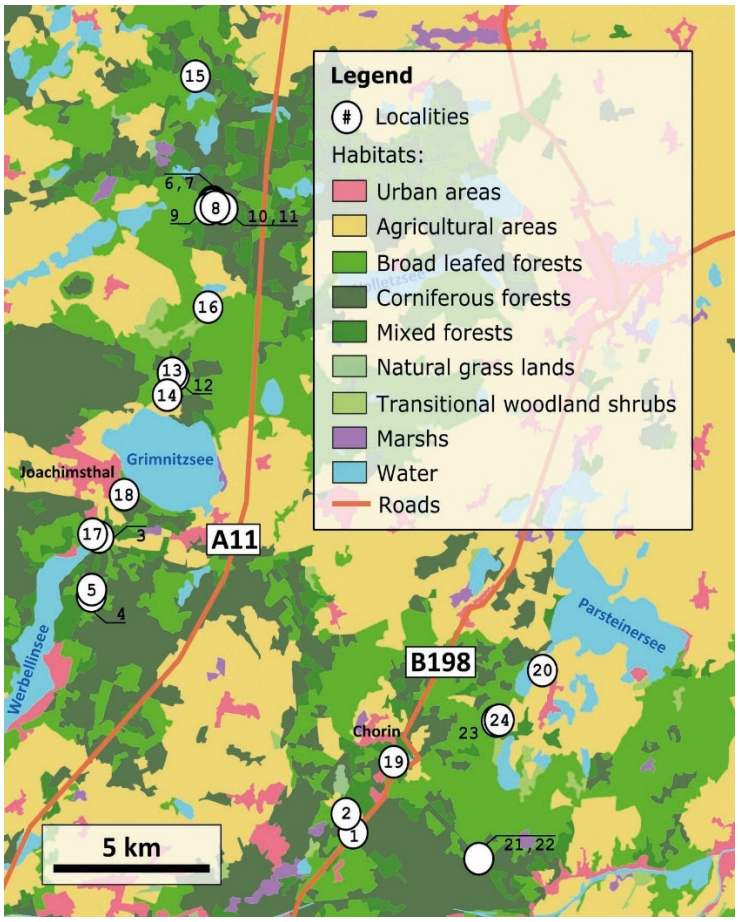


Figure 5: Sampling sites and land use in the UNESCO Biosphere Reserve Schorfheide-Chorin. Map modified from the Bundesamt für Kartografie und Geodäsie (2012), CORINE Land Cover 10 ha (CLC10).

Table 1: Investigation sites of the excursion in and nearby the UNESCO Biosphere Reserve Schorfheide-Chorin.

| Site No. | Locality | Date | Habitat | Coordinates |
|---|---|---|---|---|
| 1 | Eberswalde, Sandkrug, Ragöser Mühle; river lowland of Ragöser Fließ | 18.X.2019 | Edge of *Alnus* carr with sporadic *Corylus avellana, Acer platanoides*, mainly in leaf litter of *Corylus* | N52.8765°, E13.8619° |
| 2 | Eberswalde, Sandkrug, Ragöser Mühle, north of the bungalow village | 18.X.2019 | Mixed forest with *Carpinus betulus, Betula pendula* and *Quercus* | N52.8816°, E13.8591° |
| 3 | Chorin, Joachimsthal, small valley near Werbellin-Kanal, near Jägerberg | 18.X.2019 | Mixed forest | N52.9593°, E13.7498° |
| 4 | Chorin, Joachimsthal towards Altenhof, near Alte Tongrube | 18.X.2019 | Beech forest (*Fagus sylvatica*) with sporadically *Pinus sylvestris*, without undergrowth | N52.9439°, E13.7444° |
| 5 | Chorin, Joachimsthal towards Altenhof, near Alte Tongrube | 18.X.2019 | Steep slope with *Alnus glutinosa*, *Pinus sylvestris*, *Larix decidua, Populus, Betula pendula* | N52.9456°, E13.7448° |
| 6 | Chorin, Joachimsthal, Glambeck, Poratz Morainic landscape, **NSG Hechtdiebel** bog | 19.X.2019 | *Betula pubescens* carr close to march with sedges and pines | N53.0454°, E13.8137° |
| 7 | Chorin, Joachimsthal, Glambeck, Poratz Morainic landscape, **NSG Hechtdiebel** bog | 19.X.2019 | Alder carr in lagg zone | N53.045°, E13.8135° |
| 8 | Chorin, Joachimsthal, Glambeck, Poratz Morainic landscape, **NSG Hechtdiebel** bog | 19.X.2019 | Slope with *Fagus sylvatica* near lake, without undergrowth, in leaf litter | N53.0447°, E13.8136° |
| 9 | Chorin, Joachimsthal, Glambeck, Poratz Morainic landscape, **NSG Hechtdiebel** bog | 19.X.2019 | Beech forest (*Fagus sylvatica*) with a lot of dead wood | N53.0437°, E13.8118° |
| 10 | Chorin, Joachimsthal, Glambeck, Poratz Morainic landscape, **near NSG Hechtdiebel** | 19.X.2019 | Former power line, clearing surrounded by *Pinus sylvestris* and *Betula pendula* | N53.0435°, E13.8185° |
| 11 | Chorin, Joachimsthal, Glambeck, Poratz Morainic landscape, near **NSG Hechtdiebel** | 19.X.2019 | Spruce forest (*Picea abies*), without herb layer | N53.0441°, E13.8147° |
| 12 | Chorin, Joachimsthal, Glambeck, Dovin Lake | 20.X.2019 | Beech (*Fagus sylvatica*) mixed forest with *Quercus rubra*, *Acer pseudoplatanus* | N53.0004°, E13.7904° |
| 13 | Chorin, Joachimsthal, Glambeck, Dovin Lake | 20.X.2019 | Spruce forest (*Picea abies*), with fern and dense moss cover | N53.0011°, E13.7894° |
| 14 | Chorin, Joachimsthal, Glambeck, Dovin Lake | 20.X.2019 | Beech mixed forest with large-leaved lime, European oak, sycamore | N52.9954°, E13.7864° |
| 15 | Chorin, Joachimsthal, Glambeck, Welse brook | 20.X.2019 | Beech forest (*Fagus sylvatica*) with a lot of dead wood, sporadically *Quercus robur*, *Carpinus betulus* | N53.0789°, E13.8092° |
| 16 | Chorin, Joachimsthal, Glambeck, Welse brook | 20.X.2019 | *Alnus glutinosa* with reed | N53.0178°, E13.8084° |
| 17 | Chorin, Joachimsthal, near Jägerberg, southeast shore of the lake Werbellinsee | 20.X.2019 | Deciduous mixed forest with *Fagus sylvatica*, *Quercus petraea*, *Betula pendula*, *Pinus sylvestris,* without herb layer, mossy | N52.9602°, E13.7468° |
| 18 | Chorin, Joachimsthal, Grimnitz location | 18.X.2019 | Dispersed bungalow resort, isolated old trees and tree stumps (*Pinus sylvestris*) on sandy soil | N 52.9700°, E13.7630° |
| 19 | Chorin, Chorin Abbey, near the Amtssee pond | 21.X.2019 | Shore area with *Alnus glutinosa*, mixed deciduous forest | N52.8944°, E13.8833° |
| 20 | Chorin, Brodowin location | 22.X.2019 | Isolated rural area, under stones and small pieces of wood | N52.9155°, E13.9567° |
| 21 | Chorin, **NSG Plagefenn**, Kleines Fischerbruch, in close vicinity to site 22 | 22.X.2019 | Wet basin with willow shrubs | N52.9001°, E13.9208° |
| 22 | Chorin, **NSG Plagefenn**, Kleines Fischerbruch | 22.X.2019 | Deciduous mixed forest with dominance of *Fagus sylvatica* and *Carpinus betulus* | N52.9006°, E13.9211° |
| 23 | Chorin, Bierpfuhl bog, **near NSG Plagefenn** | 22.X.2019 | Peatland birch forest (Vaccinio uliginosi-Betuletum pubescentis | N52.9027°, E13,9338° |
| 24 | Chorin, Bierpfuhl bog, **near NSG Plagefenn** | 22.X.2019 | Slope at the bog, beech forest (*Fagus sylvatica*) | N52.9033°, E13.9347° |

Specimens were fixed in 70 % and 96 % ethanol or isopropanol and are stored at the Senckenberg Museum of Natural History Görlitz (SMNG), the Zoological Research Museum Alexander Koenig (ZFMK), and the private collections of Norman Lindner and Ulrich Burkhardt. For identification of centipedes the keys by BARBER (2008, 2009), VOIGTLÄNDER & SPELDA (2019), IORIO & LABROCHE (2015), and KOREN (1986, 1992) were used. For identification of millipedes the keys by HAUSER & VOIGTLÄNDER (2009b, 2019), and VOIGTLÄNDER & SPELDA (2019) were used.

Coordinates of the sampling sites were taken with the mobile app maps.me (https://maps.me/). Localities were mapped in QGIS 3.8 Zanzibar (https://www.qgis.org/de/site/) on the CORINE Land Cover 10 ha (CLC10) map (https://gdz.bkg.bund.de/index.php/default/open-data/corine-land-cover-10-ha-clc10.html) provided by the BUNDESAMT FÜR KARTOGRAFIE UND GEODÄSIE (2012). Distribution information and assessments of ecology were based on original literature and the soil zoological database "Edaphobase", GBIF information system for taxonomy, literature and ecology (http://www.edaphobase.org, BURKHARDT et al. 2014).

**Figure 6:** Selection of a sifting sample during the autumn excursion 2019 (from left to right: Reinhard Orsakowsky, Karin Voigtländer and Ulrich Burkhardt). Photograph: H. Reip.

## 3 Results and Discussion

### 3.1 Species overview

As a result (Table 2), we found 28 millipede species (1 Polyxenidae, 1 Polyzoniidae (Fig. 7), 1 Glomeridae, 5 Polydesmidae, 1 Craspedosomatidae (Fig. 8), 1 Chordeumatidae, 5 Blaniulidae, 13 Julida) and 15 centipede species (9 Lithobiomorpha, 1 Scolopendromorpha, 5 Geophilomorpha). Supplementary material 1 and Supplementary material 2 provide a detailed overview of the species from each site including numbers of individuals. A total of 1,062 specimens were identified (772 millipedes and 290 centipedes).

### 3.2 Diplopoda

#### 3.2.1 Species list and abundances

There were no extremely rare or very rare species among the collected 28 millipede species (compare REIP et al. 2012, 2016). All recorded millipede species (Supplementary material 1) are considered being rare, moderately frequent or frequent, and thus not endangered. Since mainly deciduous forest sites have been investigated, it is not surprising that the most frequent species are typical forest species.

Table 2: The millipede and centipede species found in and near the Biosphere Reserve Schorfheide-Chorin.

| Diplopoda | Chilopoda |
|---|---|
| **Polyxenidae** | **Lithobiomorpha** |
| *Polyxenus lagurus* (Linnaeus, 1758) | *Lithobius agilis* C.L. Koch, 1847 |
| **Polyzoniidae** | *Lithobius calcaratus* C.L. Koch, 1844 |
| *Polyzonium germanicum* Brandt, 1837 | *Lithobius crassipes* L. Koch, 1862 |
| **Glomeridae** | *Lithobius curtipes* C.L. Koch, 1847 |
| *Glomeris marginata* (Villers, 1789) | *Lithobius dentatus* C.L. Koch, 1844 |
| **Polydesmidae** | *Lithobius erythrocephalus* C.L. Koch, 1847 |
| *Brachydesmus superus* Latzel, 1884 | *Lithobius forficatus* (Linnaeus, 1758) |
| *Polydesmus angustus* Latzel, 1884 | *Lithobius microps* Meinert, 1868 |
| *Polydesmus complanatus* (Linnaeus, 1761) | *Lithobius mutabilis* L. Koch, 1862 |
| *Polydesmus inconstans* Latzel, 1884 | *Lithobius tenebrosus* Meinert, 1872 |
| *Propolydesmus testaceus* (C.L. Koch, 1847) | **Scolopendromorpha** |
| **Craspedosomatidae** | *Cryptops hortensis* (Donovan, 1810) |
| *Craspedosoma rawlinsii* Leach, 1816 | **Geophilomorpha** |
| **Chordeumatidae** | *Geophilus carpophagus* Leach, 1816 |
| *Melogona voigtii* (Verhoeff, 1899) | *Geophilus flavus* (De Geer, 1778) |
| **Blaniulidae** | *Geophilus truncorum* Bergsøe & Meinert, 1866 |
| *Blaniulus guttulatus* (Bosc, 1792) | *Schendyla nemorensis* (C.L. Koch, 1837) |
| *Boreoiulus tenuis* (Bigler, 1913) | *Strigamia acuminata* (Leach, 1816) |
| *Choneiulus palmatus* (Němec, 1895) | |
| *Nemasoma varicorne* C.L. Koch, 1847 | |
| *Proteroiulus fuscus* (Am Stein, 1857) | |
| **Julidae** | |
| *Brachyiulus pusillus* (Leach, 1816) | |
| *Cylindroiulus caeruleocinctus* (Wood, 1864) | |
| *Cylindroiulus britannicus* (Verhoeff, 1891) | |
| *Cylindroiulus latestriatus* (Curtis, 1845) | |
| *Cylindroiulus punctatus* (Leach, 1816) | |
| *Enantiulus nanus* (Latzel, 1884) | |
| *Julus scandinavius* Latzel, 1884 | |
| *Kryphioiulus occultus* (C.L. Koch, 1847) | |
| *Leptoiulus proximus* (Němec, 1896) | |
| *Ommatoiulus sabulosus* (Linnaeus, 1758) | |
| *Ophyiulus pilosus* (Newport, 1843) | |
| *Unciger foetidus* (C.L. Koch, 1838) | |
| *Xestoiulus laeticollis* (Porat, 1889) | |

*Proteroiulus fuscus* (Fig. 9) was the most common species, occurring on 71 % of study sites. *Cylindroiulus punctatus* was found on 67 %, and *Julus scandinavius* (Fig. 10) nearly in a half of all examined sites.

In the Hechtdiebel Nature Reserve (sites 6-9, Figs. 3 and 4), a total of 10 species (Supplementary material 1) was found in the various habitats of the core zone of this kettle bog. *Polyxenus lagurus* (Fig. 11)

and *C. punctatus* are new records for this area. *Cylindroiulus arborum* Verhoeff, 1928, detected in 2015 on a cotton grass-birch area, was not found again, although corresponding habitats (in rotten wood and under bark of dead trees, in tree stumps, etc.) were intensively searched. Surprisingly, no new record was made for *Polydesmus denticulatus* C. L. Koch, 1847 either. Sites 10 and 11 (outside the core zone of the nature reserve) did not yield any new records for the area.

In the Plagefenn Nature Reserve (Kleines Fischbruch, sites 21, 22), only 3 millipede species were found (Supplementary material 1), maybe due to the lower number of collectors at this site. With the exception of *Proteroiulus fuscus* and *Cylindoiulus punctatus* (Fig. 12), all species found were already reported by DAHL (1912) for the Plagefenn area. Furthermore, DAHL (1912) reported the species *Polydesmus denticulatus*, *Nopoiulus kochii* (Gervais, 1847) (possibly confused with *P. fuscus*) and *Megaphyllum unilineatum* (C. L. Koch, 1838), the latter is also reported by SCHMITT & ROTH (1998, 1999) for grassland at the border of the Biosphere Reserve Schorfheide-Chorin.

The evaluation of the studies by DAHL (1912), SCHMITT & ROTH (1998, 1999), BARNDT (2019), and our sampling results in a species number of 31 millipede species for the Biosphere Reserve altogether. That is 66 % of the species documented for the state of Brandenburg (HAUSER & VOIGTLÄNDER 2009a). This means that the species inventory for the Biosphere Reserve, a comparatively small area, can be assessed positively.

### 3.2.2 Species composition in the different habitats

In beech forests and mixed deciduous forests, typical hygro- and mesobiont species occur, such as *Cylindroiulus punctatus* (Fig. 12), *Glomeris marginata*, *Julus scandinavius*, *Leptoiulus proximus*, *Polydesmus angustus*, *Polydesmus complanatus*, and *Proteroiulus fuscus*. Central European deciduous (mixed) forests are usually populated with 4 to 14 millipede species (e. g. DUNGER & STEINMETZGER 1981, SCHALLNASS et al. 1992, TAJOVSKÝ 1993, 2002, WYTWER & TRACZ 2003, VOIGTLÄNDER 2008a). With 4 to 13 species per site, the beech and deciduous mixed forests of the Biosphere Reserve fit within this range. The most species-rich site is a mixed deciduous forest near the settlement of Jägerberg (Table 1, site 3).

The alder carrs and birch swamp woods and other wet habitats are populated by species typical for such habitats (*Craspedosoma rawlinsii*, *Brachydesmus superus*, *Brachyiulus pusillus*, *Cylindroiulus punctatus*, *Ophyiulus pilosus*). However, *Polyzonium germanicum* and *Xestoiulus laeticollis*, which are usually also found in floodplain forests, were surprisingly missing from our collections at these locations. Between 9 and 13 species are usually found in such biotopes (DUNGER 1958, ZULKA 1991, WYTWER 1997, ZERM 1999, VOIGTLÄNDER 2008a, TAJOVSKÝ & WYTWER 2009, DECKER & MARX 2017, unpubl. collection data of SMNG in Edaphobase 2020). These numbers are not reached here.

While in the spruce forest at site 11 not a single diplopod could be found, the spruce forest at site 13 was comparably well populated with 6 millipede species. Here, the most frequent species were *Proteroiulus fuscus* and *Cylindroiulus punctatus* sifted from litter and dead wood. Coniferous forests are generally populated by only a few species of millipedes, as their habitat conditions (microclimatic conditions, humus form, pH value, food available in the form of hard-to-decompose needle litter, etc.) are extremely unfavourable for the saprophagous millipedes.

### 3.2.3 Remarkable species

*Polyzonium germanicum* Brandt, 1837 (Fig. 7) is the only polyzoniid species known from Germany. It is a northeastern European species with preference for floodplains and swamp forests (VOIGTLÄNDER 2011a). WEGENSTEINER (1982) carried out extensive experimental studies on the ecology of this species and described a preference for cool and humid conditions. Its occurrence in the mixed deciduous and beech forests of the Biosphere Reserve corresponds to this. On site 12 the species was found underneath a rotten trunk on a corticoid fungus (Fig. 7).

*Polydesmus angustus* Latzel, 1884 (Fig. 13) and *Polydesmus complanatus* (Linnaeus, 1761) (Fig. 14) is a species pair that has its eastern (*P. angustus*) and western (*P. complanatus*) distribution border in Germany, with an area of overlap. *P. complanatus* is widespread and common in eastern Germany, it occurs to the west up to the Holstein-Elbe-Saale-Naab-Danube-Lech line and shows a clear preference for forests and humid habitats, which is also illustrated by our records, especially in the NSG Hechtdiebel. The main distribution area of *P. angustus* is in Western Europe and the western half of Germany, with records in near-natural habitats, especially in woods. In recent times, some records have been made for eastern Germany, especially from synanthropic locations. It is assumed that they are spread through garden waste and drifting along rivers (Elbe, Neisse, Oder) (DECKER & VOIGTLÄNDER 2012). In Brandenburg, *P. angustus* was previously known from Potsdam (Sanssouci Park) and from strips of alder and deciduous forests on lakes in the Potsdam area (SCHUBART 1930, 1934, 1957). The northernmost records from Brandenburg come from the area around the Himmelreich Lake near Rheinsberg and from the Stechlin Lake near Neuglobsow (unpubl. collection data of SMNG in Edaphobase 2020), the easternmost from the NSG Oderberge near Lebus (VOIGTLÄNDER 2010). The current record from the Biosphere Reserve closes the gap between the Berlin/Potsdam area and the northern locations in Brandenburg. The two areas of distribution of the originally strictly separated species are increasingly mixing due to the constant advance of the western species *P. angustus*. The larger ecological potential of *P. angustus* could explain its more successful dispersal compared to *P. complanatus*, as postulated by HAUSER & VOIGTLÄNDER (2008). There were even sites in the study area where both species occurred together (sites 1 and 3). Such locations should be tested again in the long term in order to verify the "displacement hypothesis".

*Craspedosoma rawlinsii* Leach, 1816 (Fig. 8) is characteristic of disturbed locations. It is therefore often found in floodplain forests, which are subject to different water regimes and even inundation. On the other hand, the species is also known as a first-time colonizer on freshly heaped, vegetation-free dumps from lignite opencast mining (DUNGER & VOIGTLÄNDER 2009). Its short life cycle of one to a maximum of two years (VERHOEFF 1929) makes the species viable and competitive in such locations. Based on the pH measurements (5.3-8.2), no dependence on soil reaction can be determined (HAACKER 1968). In the biosphere reserve it was only found in the alder carrs and the immediately adjacent, also very moist site 6.

*Boreoiulus tenuis* (Bigler, 1813) (Fig. 15) occurs in western Germany under near-natural conditions, but otherwise is exclusively synanthropic (HAUSER & VOIGTLÄNDER 2019). This corresponds to its occurrence at site 3 (settlement of Jägerberg).

*Choneiulus palmatus* (Němec, 1895) (Fig. 16) in Germany occurs almost exclusively in synanthropic habitats. As a bark inhabitant, it is hardly detected in soil traps and, due to its small size, can easily be overlooked in hand samplings. In addition, these special habitats (such as under tree bark) are rarely sampled.

Figure 7: *Polyzonium germanicum* on a corticoid fungus. Photograph: L. Moritz.

Figure 8: *Craspedosoma rawlinsii*. Photograph: H. Reip.

Figure 9: *Proteroiulus fuscus*. Photograph: H. Reip.

Figure 10: *Julus scandinavius*. Photograph: H. Reip.

Figure 11: *Polyxenus lagurus*. Photograph: L. Moritz.

Figure 12: Ground beetle larva (Carabidae) feeding on *Cylindroiulus punctatus* at site 2. Photograph: L. Moritz.

Figure 13: *Polydesmus angustus*. Photograph: A. Steiner.

Figure 14: *Polydesmus complanatus*. Photograph: H. Reip.

Figure 15: *Boreoiulus tenuis.* Photograph: H. Reip.

Figure 16: *Choneiulus palmatus.* Photograph: H. Reip.

Figure 17: *Brachyiulus pusillus.* Photograph: H. Reip.

Figure 18: *Cylindroiulus latestriatus.* Photograph: H. Reip.

***Brachyiulus pusillus*** **(Leach, 1816)** (Fig. 17) is widespread throughout Germany and, according to SCHUBART (1934), bound to the vicinity of water. HAUSER & VOIGTLÄNDER (2019) classified it as a hygrobiont forest species. This corresponds to their occurrence in the alder carr of site 1. *B. pusillus* often colonizes synanthropic sites as well, e. g. SCHMITT & ROTH (1998, 1999) found the species also at arable fallows.

***Cylindroiulus latestriatus*** **(Curtis, 1845)** (Fig. 18) is extremely eurytopic and has a preference for higher temperature conditions (HAACKER 1968). Hence, this species is found in open land, mixed forests, field trees, bogs, and sandy biotopes of inland and coastal areas (DECKER & HANNIG 2020). It shows a pronounced preference for sandy soils and is often the only millipede to be found on sand dunes in coastal and inland areas. Since these habitats are among the endangered biotope types in Germany (FINCK et al. 2017), *C. latestriatus* is classified in category 2 (highly endangered) in the Red List of Saxony-Anhalt (VOIGTLÄNDER et al. 2020).

***Xestoiulus laeticollis*** **(Porat, 1889)** only occurs in the northeast of Germany. It is characterized by a strong preference for moisture and was assessed by VOIGTLÄNDER (2011a) as a hygrobiont woodland species with high preference for floodplains and swamp forests, rarely found in drier habitats such as arable fallows (SCHMITT & ROTH 1998, 1999). Since it is limited exclusively to alluvial and swamp forests, both endangered biotope types of the adjacent state of Saxony-Anhalt (SCHUBOTH & PETERSEN 2004), habitat losses have a particularly drastic effect, *X. laeticollis* is classified in category 2 (highly endangered) in the Red List for Saxony-Anhalt (VOIGTLÄNDER et al. 2020). The situation is likely to be similar in the still pending Red List for Brandenburg.

## 3.3 Chilopoda

### 3.3.1 Species list and abundances

A total of 16 species of centipedes was found on our sampling sites (Supplementary material 2). BARNDT (2019) also detected *Lithobius borealis* Meinert, 1868, SCHMITT & ROTH (1998, 1999) *Lamyctes emarginatus* (Newport, 1844) and *Lithobius melanops* Newport, 1845, so that a total of 19 centipede species are known for the Biosphere Reserve. For the state of Brandenburg there is currently no up-to-date list of species that could have been used to evaluate the number of species. However, at least 30 species can be expected (33 species are so far known from the neighbouring state Saxony-Anhalt; VOIGTLÄNDER 2016). On this basis, the species inventory of the centipede collection area can also be classified as very rich, although not quite as pronounced as that of the millipedes. All the species found are not endangered, but in addition to many species that are common and moderately common in Germany, the very rare species *Geophilus carpophagus* has been identified (REIP et al. 2012, DECKER et al. 2016). *Lithobius forficatus* (at 83 % of the sites) (Fig. 19), *Schendyla nemorensis*, *Cryptops hortensis* (46 % each) as well as *Lithobius mutabilis* (33 %) (Fig. 20), are the most frequently occurring species in the study area. These are eurytopic forest species that occur preferentially in leaf litter, in dead wood, under bark of dead trees and similar habitats. *Lithobius forficatus* is an extremely eurytopic species, probably the *Lithobius* species that inhabits the broadest range of habitats. In the two spruce forests investigated (sites 11 and 13) *Lithobius calcaratus* (preference for dry-warm, open locations) and the eurytopic species *S. nemorensis* (Fig. 21) were found; two species typical of coniferous forests (VOIGTLÄNDER 2009a). The range of species of the open area of the power line (site 10) does not differ from that of the other surrounding sites.

Figure 19: *Lithobius forficatus*. Photograph: J. Rosenberg.

Figure 20: *Lithobius mutabilis.* Photograph: J. Spelda.

Figure 21: *Schendyla nemorensis.* Photograph: J. Rosenberg.

Figure 22: *Strigamia acuminata.* Photograph: J. Rosenberg.

Figure 23: *Cryptops hortensis.* Photograph: H. Reip.

Figure 24: *Lithobius microps.* Photograph: H. Reip.

Figure 25: *Geophilus carpophagus.* Photograph: J. Rosenberg.

Figure 26: *Geophilus truncorum.* Photograph: H. Reip.

In the Hechtdiebel Nature Reserve, 7 species have been recorded (Supplementary material 2). The species *Lithobius crassipes*, *Strigamia acuminata* (Fig. 22), and *Cryptops hortensis* (Fig. 23) are new for this area. The rare species *Lithobius borealis*, which was found in 2015 in the alder lagg of the Hechtdiebel (BARNDT 2019), could not be recorded again. On sites 10 and 11 outside the core zone also *Lithobius calcaratus* and *Schendyla nemorensis* were found. A total of 11 species was recorded for the Hechtdiebel and its immediate surroundings.

In the Plagefenn Nature Reserve (Kleines Fischbruch and Bierpfuhl, sites 21-24), only 7 centipede species were found (Supplementary material 2). With the exception of *Lithobius microps* (Fig. 24) and *Cryptops hortensis*, all species found had already been recorded for the Plagefenn area by Dahl (1912). For *Geophilus carpophagus* see below.

Remarkable for all sites was the very low number of individuals, especially of all *Lithobius* species (Supplementary material 2). Typical species of forests and wetlands such as *L. dentatus*, *L. curtipes*, or *L. microps* were found remarkably rarely. Also, *Geophilus flavus* and *Strigamia acuminata*, which usually can be found everywhere, were recorded in the study area with only 5 individuals at 3 sites and 6 individuals at only 2 sites, respectively. In a sifting sample of leaf litter, an average of at least 20 centipedes can be found under normal weather conditions, a number that was not reached in any of the siftings during the excursion. In the Central European deciduous forests (especially beech forests) the population density of centipedes is between 50 and 250 ind./m$^2$ (see VOIGTLÄNDER 2009a and references therein) and can reach abundance maxima in spring up to 370 ind./m$^2$ (POSER 1989). Obviously, the preceding dry years 2018 and summer 2019 had a negative impact, which led to a reduction of centipede densities in autumn 2019.

### 3.3.2 Species composition in the different habitats

With 5 or 6 species, sites 7, 10, 12, 15, and 17 had the highest species density (Supplementary material 2). Due to the low number of samples, however, no clear tendencies or habitat preferences of the species can be derived. Therefore, reference is made here to general trends of the species found in the area (according to VOIGTLÄNDER 2009a). The species *Lithobius mutabilis*, *L. forficatus*, *L. crassipes*, and *L. curtipes* are found frequently without preference to a specific forest type. *Lithobius erythrocephalus*, *L. dentatus*, and *L. microps* are less common, but can also be found in various forest associations. Among the Geophilomorpha, primarily *Strigamia acuminata*, *Schendyla nemorensis*, and *Geophilus flavus* colonize all types of deciduous forests. Cool and moist red beech and oak-hornbeam mixed forests in Germany and Poland feature between 4 and 14 centipede species per site (see VOIGTLÄNDER 2009a and references therein). The species *Lamyctes emarginatus* and *Lithobius curtipes* occur regularly in alluvial forests, more rarely *Lithobius crassipes*, *L. dentatus*, *L. forficatus*, *L. mutabilis*, and *L. microps* (VOIGTLÄNDER 2009a). We found no plausible explanation for the absence of *Lamyctes emarginatus* at suitable habitats in our investigations.

### 3.3.3 Remarkable species

***Lithobius agilis*** **C. L. Koch, 1847** is an eurytopic species with a preference for moist to very moist forests, which is also confirmed here by the occurrence in the alder carr (site 7) and in the adjacent beech forest of the kettle bog Hechtdiebel (site 9).

***Lithobius crassipes*** L. Koch, 1862 is a species with rather unknown distribution, as recently a new albeit morphologically very similar species was described from Spain (*Lithobius crassipesoides* Voigtländer, Iorio, Decker & Spelda, 2017). So far, this new species was only recorded in Spain, however, its distribution has not yet been clarified hence all records of alleged *L. crassipes* may need verification.

*Geophilus carpophagus* Leach, 1816 (Fig. 25) is widespread in Germany but rarely found (REIP et al. 2012). From the state of Brandenburg only one site is known so far (mixed deciduous forest in the surroundings of Bad Muskau; unpubl. collection data of SMNG in Edaphobase 2020), which is very likely due to a lack of records. Most of its records come from heat-favoured sites (with oak-hornbeam or pine forests) or synanthropic sites, such as in or on houses, avenue trees and orchards. The site 12 at the Dovin Lake, is also very frequented by tourists. DAHL (1912) included *G. carpophagus* in the analytical part of his centipede identification key, but did not name the species from any of the previously listed sites or biotope types.

*Geophilus truncorum* (Bergsøe & Meinert, 1866) (Fig. 26) is a species typical of the North German Plain, in contrast to the closely related species *G. ribauti*, which occurs particularly in the low mountain ranges of Germany. Both taxa were separated a few years ago (BONATO & MINELLI 2014), so that particular attention should be paid to identification and detection of both species. *G. truncorum* lives mainly in bogs, swamp and deciduous forests (e. g. DECKER et al. 2015, VOIGTLÄNDER et al. 2018). *G. truncorum* is relatively small (12-20 mm length) and thus can easily be overlooked in hand collections. Due to its preferred mode of life on trees (a microhabitat that is usually not taken into account in sampling), the species is rarely detected with soil traps. We obtained a number of records using sifting samples (Supplementary material 2).

### 3.4 Collembola

Among the rich finds of springtails (Collembola), *Bilobella braunerae* Deharveng, 1981 (Fig. 27) stands out for its noticeably orange-red colour. This species was found in larger numbers at site 3 on decaying wood and is typical for humid forests with a high content of dead wood. *Orchesella cincta* (Linnaeus, 1758) (Fig. 28) is often found in dry to humid forest sites.

Information on further Collembola finds will be given in a separate publication (BURKHARDT in prep.).

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Figure 27: *Bilobella braunerae*. Photograph: H. Reip.

Figure 28: *Orchesella cincta*. Photograph: L. Moritz.

Figure 29: Prof. Dr Dieter Barndt at NSG Hechtdiebel. Photograph: H. Reip.

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## Supplementary materials

**Supplementary material 1:** Numbers of sampled and determined Diplopoda per site, species and from literature. For species that were very frequent at one site, not all observed specimens were collected or counted. Individual numbers thus only illustrate trends. ° = sites within and near NSG Hechtdiebel; " = sites within and near Plagefenn Nature Reserve.

| Taxon | Dahl (1912) Literature | Schmitt & Roth (1998, 1999) Literature | Barndt (2019) Literature | Site 1 Alder carr | Site 2 Deciduous mixed forest | Site 3 Deciduous mixed forest | Site 4 Deciduous forest | Site 5 Deciduous mixed forest | Site 6° Birch swamp wood | Site 7° Alder carr | Site 8° Deciduous forest | Site 9° Deciduous forest | Site 10° Mixed forest | Site 11° Coniferous forest | Site 12 Deciduous mixed forest | Site 13 Coniferous forest | Site 14 Deciduous mixed forest | Site 15 Deciduous forest | Site 16 Alder carr | Site 17 Deciduous mixed forest | Site 18 Rural area | Site 19 Deciduous mixed forest | Site 20 Rural area | Site 21" Willow bush | Site 22" Deciduous mixed forest | Site 23" Peatland birch forest | Site 24" Deciduous forest | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Polyxenus lagurus* | x | x | | | | | | 1 | | | | | | | 6 | 1 | | | | | | | | | | | | 8 |
| *Polyzonium germanicum* | x | | x | | | 1 | 1 | | 1 | | | | | | 4 | | | 4 | | | | | | 1 | | | | 12 |
| *Glomeris marginata* | | | x | | | | | | | | 8 | 5 | | | 5 | | | | | | | | | | | | | 18 |
| *Brachydesmus superus* | | x | | 4 | | | | | | | | | | | | | | | | | | | | | | | | 4 |
| *Polydesmus angustus* | | | | 2 | | 31 | 2 | | | | | | | | | | | | | 9 | | 10 | | | | | | 54 |
| *Polydesmus complanatus* | x | | x | 1 | | 1 | | | 12 | 2 | | | | | 1 | | 1 | | | | | | | | | | 1 | 19 |
| *Polydesmus inconstans* | | x | | | | | | | | | | | | | 3 | | | | | 1 | | | | | | | | 4 |
| *Propolydesmus testaceus* | | | | | | 3 | | 19 | | | | | | | | | | | | | | | | | | | | 22 |
| *Craspedosoma rawlinsii* | x | | x | 4 | | | | | 6 | 5 | | | | | | | | | 10 | | | | | | | | | 25 |
| *Melogona voigti* | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Blaniulus guttulatus* | | x | | 1 | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Boreoiulus tenuis* | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | 2 |
| *Choneiulus palmatus* | | | | | | 1 | | 1 | | 1 | | 1 | | | | | | | | | | 12 | | | | | | 16 |
| *Nemasoma varicorne* | | x | | | | | | | | | | | | | 14 | | | | | | | | | | | | | 14 |
| *Proteroiulus fuscus* | | x | x | | | 27 | 2 | 3 | 42 | 10 | 10 | 6 | 1 | | 53 | 56 | | 3 | 4 | 22 | | 9 | | 1 | 2 | 6 | | 257 |
| *Brachyiulus pusillus* | | x | | 7 | | | | | | | | | | | | | | | | | | | | | | | | 7 |
| *Cylindroiulus caeruleocinctus* | x | x | | | | 1 | | | | | | | | | 3 | | | | | | 1 | 1 | 4 | | | | | 10 |
| *Cylindroiulus britannicus* | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | 2 |
| *Cylindroiulus latestriatus* | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | 1 |
| *Cylindroiulus punctatus* | | | | 1 | 1 | 31 | 3 | 2 | | | 40 | 10 | | | 29 | 12 | | 37 | 1 | 12 | 6 | 16 | | 1 | 1 | | | 203 |
| *Enantiulus nanus* | x | | x | | | 4 | 5 | 1 | | | 12 | 1 | | | 1 | 1 | | | | | | | | | | | | 25 |
| *Julus scandinavius* | | x | x | | | | 10 | 2 | 1 | 2 | 13 | | | | 1 | 8 | 5 | 1 | | 1 | | 2 | | | | | | 46 |
| *Kryphioiulus occultus* | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Leptoiulus proximus* | x | | x | 2 | | | | | | 1 | | | | | | 1 | | | 9 | | | | | | | | | 13 |
| *Ommatoiulus sabulosus* | x | x | | | | 1 | | | | | | | | | 1 | | | | | | | | | | | | | 2 |
| *Ophyiulus pilosus* | | | | 1 | | | | | | | | | | | | | | | | | | 1 | | | | | | 2 |
| *Unciger foetidus* | x | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | 1 |
| *Xestoiulus laeticollis* | x | x | | | | | | | | | | | | | | | | | | | | 2 | | | | | | 2 |
| **Sum individual numbers** | | | | 23 | 1 | 105 | 24 | 29 | 62 | 21 | 83 | 23 | 1 | 0 | 122 | 79 | 6 | 45 | 24 | 45 | 9 | 53 | 4 | 3 | 3 | 6 | 1 | 772 |
| **Sum species number** | 10 | 11 | 8 | 9 | 1 | 13 | 7 | 7 | 5 | 6 | 5 | 5 | 1 | 0 | 13 | 6 | 2 | 4 | 4 | 5 | 3 | 8 | 1 | 3 | 2 | 1 | 1 | |

Supplementary material 2: Numbers of sampled and determined Chilopoda per site, species and from literature. For species that were very frequent at one site, not all observed specimens were collected or counted. Individual numbers thus only illustrate trends. ° = sites within and near NSG Hechtdiebel; " = sites within and near Plagefenn Nature Reserve.

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Lithobius agilis* | | | x | | | | | | | 2 | | 1 | | | | | | | | | | | | | | | | 3 |
| *Lithobius calcaratus* | x | x | | | | | | | | | | | | 2 | 1 | 1 | | 6 | | | | | | | | | | 10 |
| *Lithobius crassipes* | | | | | | 1 | | | | 1 | | | | | | | | | | 3 | | | | | | | | 5 |
| *Lithobius curtipes* | x | | x | | | | 1 | | | | | | | | | | | | | | | | | | | | | 1 |
| *Lithobius dentatus* | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Lithobius erythrocephalus* | x | | x | | | | | | | | | 1 | | | 2 | | | 1 | 2 | | | | | 1 | | | | 7 |
| *Lithobius forficatus* | x | x | x | | 2 | 1 | 5 | 1 | 8 | 5 | 2 | 6 | 2 | | 6 | 2 | | 5 | 1 | 6 | 11 | 3 | 3 | 7 | 1 | 1 | | 78 |
| *Lithobius microps* | | | | 1 | | | | | | | | | | | | | | 1 | | | | | | | | 2 | | 4 |
| *Lithobius mutabilis* | x | | x | | | | 6 | | 1 | 1 | 11 | 4 | 1 | | | | 1 | | | | | | | | 1 | | | 26 |
| *Lithobius tenebrosus* | | | | | | | | | | | | | | | | | | | 7 | | | | | | | | | 7 |
| *Cryptops hortensis* | | | | | | 11 | 1 | | | | | 4 | 4 | | 4 | 9 | | 4 | | 9 | | 1 | | 2 | | | 3 | 52 |
| *Geophilus carpophagus* | | | | | | | | | | | | | | | 3 | | | | | 1 | | | | | 4 | | | 8 |
| *Geophilus flavus* | x | x | | 3 | | | | 1 | | | | | | | | | | | | | | 1 | | | | | | 5 |
| *Geophilus truncorum* | | | | 2 | | | | | | | | | 17 | | 2 | 1 | | 1 | | 1 | | | | | | | | 24 |
| *Schendyla nemorensis* | x | x | | | 1 | | 12 | 2 | | | | | 2 | 2 | 5 | 15 | | 3 | | 5 | | 5 | | | 1 | | | 53 |
| *Strigamia acuminata* | | | | | | | | | | 1 | | | | | | 5 | | | | | | | | | | | | 6 |
| **Sum individual numbers** | | | | 7 | 3 | 13 | 25 | 4 | 9 | 10 | 13 | 16 | 26 | 4 | 23 | 33 | 1 | 21 | 10 | 25 | 11 | 10 | 3 | 10 | 7 | 3 | 3 | 290 |
| **Sum species number** | 7 | 4 | 5 | 4 | 2 | 3 | 5 | 3 | 2 | 5 | 2 | 5 | 5 | 2 | 7 | 6 | 1 | 7 | 3 | 6 | 1 | 4 | 1 | 3 | 4 | 2 | 1 | |