18th INTERNATIONAL CONGRESS OF MYRIAPODOLOGY

25–31 AUGUST 2019, BUDAPEST, HUNGARY

PROGRAM AND ABSTRACTS

Hungarian Natural History Museum

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National Cultural Fund of Hungary

Editors:

László DÁNYI, Zoltán KORSÓS & Eszter LAZÁNYI

Budapest
2019

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Welcome from the Centre International de Myriapodology (CIM)

On behalf of the Executive Committee of the CIM, it is a pleasure to extend this welcome to the 18th International Congress of Myriapodology, to be held at the Hungarian Natural History Museum in Budapest from 25–31 August 2019. Our congresses are the highlight of the life of the CIM, eagerly anticipated by all who are fascinated by the scientific study of myriapods and onychophorans.

With 90 registered participants and 10 members of the Organizing Committee in attendance, coming from a total of 32 counties, this is a big, cosmopolitan gathering, with every continent represented. The talks and posters span the diversity of our field. Our core strengths in systematics, ecology and faunistics, and functional and descriptive morphology are well covered, and within those disciplines, new kinds of data and methods of analysis are being adopted. Next Generation sequencing, molecular phylogeography, and computed microtomography, just to note a few examples, are enriching traditional approaches, and state-of the-art bioinformatics comes to the fore in a number of talks. Being hosted in Hungary and in light of Central and Southern Europe's strong tradition in cave biology, it is appropriate to see a set of presentations on troglobionts.

The CIM appreciates the diligent efforts of the Organizing Committee of 18ICM, chaired by Professor Zoltán KORSÓS. This volume is just one of their many contributions to what will surely be a rewarding and enjoyable Congress.

Greg EDGECOMBE
President, CIM

Introduction

It was thirty-two years ago, when I for the first time participated at the 7th International Congress of Myriapodology in the beautiful small Italian town, Vittorio Veneto. The organizer was Professor Alessandro Minelli, who kindly accepted my invitation to the present congress, the 18th, to talk about arthropod segmentation in his keynote lecture on Monday morning. I am very fortunate and happy that I could participate at eleven congresses inbetween, from 1987 to 2017, and I am also grateful to the Council of the Centre International de Myriapodologie, that I was given the opportunity to organize the 18th ICM here, in Budapest.

When I made that offer, first in Olomouc, then in Krabi, I acted as general director of the Hungarian Natural History Museum, with the hope that I will have all the facilities of the museum at my disposal to organize a successful conference. It so happened for various, non-scientific reasons, however, that my second five-year term of directorship had been unexpectedly shortened and I stepped down as general director of the HNHM just three weeks ago at the end of July 2019. Nevertheless, preparation for the congress went more-or-less smoothly, mostly due to the help of my fellow organizers, to whom I am extremely grateful. Let me list their names here as the Organizing Committee of the 18th International Congress of Myriapodology:

Co-chair: Elisabeth HORNUNG
Secretary: Eszter LAZÁNYI
Members: Dorottya ANGYAL, Dávid BOGYÓ, László DÁNYI

Co-organizer: Hungarian Biological Society
Managing Director: Melinda MECSNÓBER

Staff members: Péter BEZZEGH, Pál BÓDIS, Bernadett DÖME, Ágnes ERŐS, Edit HORVÁTH, Péter HORVÁTH, Attila KORSÓS, Rebeka KORSÓS, Ágnes MOLNÁR, Tibor SZATMÁRI, Ágnes VAJDA.

For me personally, it is a great pleasure to greet here, in Budapest, my home town, this exceptional selection of excellent myriapodologists from around the entire world. Most of them became close friends during the past three decades, and it is my only sorrowful regret that I cannot show my hospitality to those great colleagues whom I have met and admired but who have already passed away: Edward H. Eason, John G. Blower, Stephen P. Hopkin, Konrad Thaler, Joachim Adis, Casimir A.W. Jeekel, Richard L. Hoffman, Jean-Marie Demange, Otto Kraus, Rowland M. Shelley, Wolfram Dunger, and Stefan Negrea.

I sincerely hope that this congress will be a worthy successor to the previous meetings, and its more than one-hundred participants will have fruitful conversations, and perhaps also save some time to enjoy our beautiful city.

Zoltán KORSÓS
Chair of the Organizing Committee

General information

Registration desk

The registration desk is open on Sunday the 25th of August between 14:00–18:00, and is located in the Semsey lecture hall (Hungarian Natural History Museum, Ludovika tér 2-6, 1083 Budapest, Hungary). There will be an option to register later: on Monday the 26th of August between 8:00–9:00 in the morning (before the first lectures) next to the Semsey lecture hall. Staff at the registration desks will offer information, accept cash payments (preferably in HUF), and lunch can also be arranged there.

Wireless internet connection will be available in the museum building during the congress using specific login and password.

Presentations

The lectures are limited to 20 minutes including discussion (keynote lectures are 40 minutes). Please pass your presentation files to the staff in the Semsey lecture hall in time before your lecture, *i.e.* on the first day or the latest in the morning of the day of your lecture.

Posters can be put on display in the hall for temporary exhibitions throughout the entire congress. Please pass your posters to the organizers at the registration desk and they will help you to arrange them.

Social programs, coffee breaks and lunch

The Welcome Party will take place in the Central Hall of the museum on Sunday the 25th of August from 18:00 to 22:00.

Coffee or tea breaks will be served in the temporary exhibition hall.

About 10 minutes from the Congress Venue there is an all-you-can-eat restaurant where participants can have lunch together on conference days (Üllői út 119, 1091 Budapest, *http://royalcampus.hu/*). Lunch can be preordered for the four days only during registration on Sunday, payable in cash only (vouchers will be distributed), after that individual lunches can be payed for at the restaurant. Other fast food places are also available at the nearest metro station, Nagyvárad tér.

The Farewell Dinner will be held on Friday the 30th of August at the Lázár Equestrian Park (2182 Domony, *https://lazarlovaspark.hu/en/*) about 50 km from Budapest. Meeting time and point for the transfer buses will be at 15:15 at the main entrance of the Museum. Arrival back in Budapest is expected to be at approximately 23:00.

Congress Excursion

The whole-day Congress excursion will take place on Wednesday the 28th of August. Meeting time and point for the buses will be at 9:00 at the main entrance of the Museum. First we will be going on a field trip to the Buda Hills for ca. 4 hours, easy walk with resting places, sightseeing points, and possible collecting sites (only singling, no mass collection allowed). Small packed snacks and water will be provided. At around 14:00 the bus will take us to the nearby Bajai Halászcsárda (*https://www.bajaihalaszcsarda.hu/*) for a traditional Hungarian lunch. Arrival back to the Museum is expected around 17:00.

Partners' programs

We list several possibilities below, please feel free to contact the congress organizers for details or individual arrangements.

Monday, 26th August: Free pedestrial guided tour to the historical city centre of Budapest (length 3–4 hours). Meeting point at the main entrance of the Museum at 9:00.

- metro line M3 to the Deák tér, main viewpoints at the square
- "millenium underground railway" (metro line M1, the "old underground") to the Vörösmarty tér, walk to the Danube River
- walk on the Lánchíd (Széchenyi Chain bridge)
- optional walk or travel with the Buda Castle Funicular up to the Castle
- walk around the Budapest Castle Square (part of the UNESCO World Heritage), Halászbástya (Fishermen's Bastion), Szentháromság tér
- public bus back to Deák tér, optional visit to the St. Stephen's Basilica and/or the the Great Synagogue

Tuesday, 27th August: Escape Rooms of the Hungarian Natural History Museum: "The mystery of life" and "Buried alive – Time travel in the Crypt". The escape rooms are advised for groups of 2-6 people, available for 7500 HUF/group (~25 EUR/group). Escape time is one hour. Tours can be booked during registration or later on Monday by the organizing team.

Wednesday, 28th August: Whole-day congress excursion visiting the Buda Hills. Meeting point for buses will be at 9:00 at the main entrance of the Museum. The excursion fee (guide, transport, snacks and lunch) is included in the partner's registration fee.

Friday, 30th August: Bus trip to the Farewell Dinner at Lázár Equestrian Park (2182 Domony, *https://lazarlovaspark.hu/en/*). Meeting point for the buses will be at 15:15 at the main entrance of the Museum. The price of the Farewell Dinner (40 EUR) is not included in the registration fee. Additional seats can be ordered until Wednesday the 28th of August the latest.

All participants and partners will have free entrance to the Museum's exhibitions throughout the whole conference with the name badge received at registration.

Partners will have one-time free entrance to the Budapest Zoo (Állatkerti krt. 6-12, 1146 Budapest, *https://zoobudapest.com/en*) with the badge received at registration. The Zoo is located next to the city park called Városliget, right behind the Heroes' Square, close to the Vajdahunyad Castle. This program is usually for a whole day and is perfect for children too.

There is a large park behind the Museum called Orczy Garden, with playgrounds for children, outdoor gym, running route and adventure park for both children and adults; a nice pond with light refreshments available and boats to rent.

The University Botanical Garden, called "Füvészkert" in Hungarian (*http://www.fuveszkert.org/*) is only 5 minutes away from the conference venue (Illés u. 25, 1083 Budapest).

Congress venue

Congress venue

PROGRAM

Program overview

Date, time	Activities	Venue
Sunday, 25 August 2019		
14.00–18.00	**Registration**	Semsey Room
19.00–22.00	**Welcome Party**	Central Hall
Monday, 26 August 2019		
8.00–8.50	**Registration**	
8.50–9.00	**Welcome speaches**	Semsey Room
9.00–9.40	**Keynote Lecture**	Semsey Room
9.40–10.40	**Session 1**	Semsey Room
10.40–11.00 Coffee/Tea break		*Exhibition Hall*
11.00–12.00	**Session 2**	Semsey Room
12.00–13.20 Lunch		
13.20–14.40	**Session 3**	Semsey Room
14.40–15.00 Coffee/Tea break		
15.00–16.20	**Session 4**	Semsey Room
16.30–18.00	**Poster session**	*Exhibition Hall*
Tuesday, 27 August 2019		
9.00–9.40	**Keynote Lecture**	Semsey Room
9.40–10.40	**Session 5**	Semsey Room
10.40–11.00 Coffee/Tea break		*Exhibition Hall*
11.00–12.00	**Session 6**	Semsey Room
12.00–13.20 Lunch		
13.20–14.40	**Session 7**	Semsey Room
14.40–15.00 Coffee/Tea break		*Exhibition Hall*
15.00–16.20	**Session 8**	Semsey Room
16.30–17.00	**Group photo**	museum entrance
17.00–18.00	**Poster session**	*Exhibition Hall*
Wednesday, 28 August 2019		
Excursion		
Thursday, 29 August 2019		
9.00–9.40	**Keynote Lecture**	Semsey Room
9.40–10.40	**Session 9**	Semsey Room
10.40–11.00 Coffee/Tea break		*Exhibition Hall*
11.00–12.00	**Session 10**	Semsey Room
12.00–13.20 Lunch		
13.20–14.40	**Session 11**	Semsey Room
14.40–15.00 Coffee/Tea break		*Exhibition Hall*
15.00–16.20	**Session 12**	Semsey Room
16.30–18.00	**Verhoeff Panel**	Semsey Room
Friday, 30 August 2019		
9.00–9.40	**Keynote Lecture**	Semsey Room
9.40–11.00	**Session 13**	Semsey Room
11.30–13.00 Lunch		
13.00–15.00	**CIM General Assembly**	Semsey Room
15.15–23.00	**Farewell Dinner**	*Lázár Equestrian Park, Domony*

SUNDAY, 25 August

14.00–18.00 **Registration**
Hungarian Natural History Museum, Semsey Room
Ludovika tér 2-6, 1083 Budapest, Hungary

19.00–22.00 **Welcome party**
Hungarian Natural History Museum, Exhibition Hall
Ludovika tér 2-6, 1083 Budapest, Hungary

MONDAY, 26 August, Semsey Room

8.00–8.45 **Registration**
Hungarian Natural History Museum,
Ludovika tér 2-6, 1083 Budapest, Hungary

8.50–9.00 Welcome remarks
Gregory D. Edgecombe
Zoltán Korsós

9.00–9.40 Keynote lecture
Alessandro Minelli: Arthropod segments and segmentation – lessons from myriapods, and open questions

Chairperson: Stylianos Simaiakis

9.40–10.00 **Victor Carvalho Calvanese, Antonio Domingos Brescovit & Lucio Bonato:** Towards a comprehensive revision of Aphilodontinae (Geophilomorpha, Geophilidae): morphology, phylogeny and new Neotropical species

10.00–10.20 **Lucio Bonato, Marco Orlando, Jörg Spelda, Thomas Wesener, Bortolin, Giada De Zen, Peter Decker, Norman E. Lindner & Karin Voigtländer:** The diversity of *Strigamia* (Chilopoda, Geophilomorpha) in central Europe: intra-population variation, geographic differentiation, speciation

10.20–10.40 **Anne-Sarah Ganske, Varpu Vahtera, László Dányi, Gregory D. Edgecombe & Nesrine Akkari:** Phylogeny of the centipede genus *Lithobius* Leach, 1814 (Lithobiomorpha, Lithobiidae) based on molecular and morphological data, with a focus on European species

10.40–11.00 Coffee/Tea break

Chairperson: Bob Mesibov

11.00–11.20 **Arkady A. Schileyko:** The overview of the system of the order Scolopendromorpha, with notes on some morphological characters

11.20–11.40 **Warut Siriwut, Gregory D. Edgecombe, Chirasak Sutcharit & Somsak Panha:** Molecular systematics of scutigeromorph centipedes in Thailand and adjacent countries

11.40–12.00 **Emiliano Peretti, Chiara Cecchin, Luca Gregnanin, Giuseppe Fusco & Lucio Bonato:** Integrative species delimitation in endogean myriapods: the case of *Clinopodes carinthiacus* across the Southeastern Prealps

12.00–13.20 Lunchbreak

Chairperson: Pavel Stoev

13.20–13.40 **Stylianos Simaiakis, Cyril Hammoud, Konstantinos Kougioumoutzis, Sietze Norder, Van Loon, Kostas Triantis, Kenneth Rijsdijk:** Patterns in the distribution of centipedes (Chilopoda) in the Aegean archipelago

13.40–14.00 **Carlos A. Martínez-Muñoz & Andy Sombke:** A new species of *Newportia* (Scolopendromorpha, Scolopocryptopidae) from Cuba, with a standardized terminology for cuticular structures and aspects of the transformation of ultimate legs

14.00–14.20 **Robert Mesibov:** The "armori" line: a millipede parapatric boundary in Tasmania

14.20–14.40 **Zoltán Korsós & Eszter Lazányi:** Millipede fauna of Hungary: present status

14.40–15.00 Coffee/Tea break

Chairperson: Ivan H. Tuf

15.00–15.20 **Megan Short:** New species of Polyxenida from Israel

15.20–15.40 **Cuong Huynh & Anneke Veenstra:** A new species of penicillate millipede from genus *Mauritixenus* (Diplopoda, Polyxenidae) found in Vietnam

15.40–16.00 **Joseph T. Hannibal & Dmitry E. Shcherbakov:** New tomiulid millipedes from the Triassic of European Russia and a re-evaluation of the type material of *Tomiulus angulatus* from the Permian of Siberia

16.00–16.20 **Roghaieh Zarei & Mahvash Seifali:** Use of geometric morphometrics to differentiate intraspecific variation of *Clinopodes flavidus* in Alborz Mountains

16.30–18.00 **Poster session**

TUESDAY, 27 August, Semsey Room

9.00–9.40 Keynote lecture
Gregory D. Edgecombe: Fossils, molecular dating and the timing of myriapod terrestrialization

Chairperson: Bruce Snyder

9.40–10.00 **Thomas Wesener & Leif Moritz:** Discovery of an extinct millipede order in Cretaceous Amber from Myanmar (Myriapoda, Diplopoda)

10.00–10.20 **Petra Sierwald, Derek Hennen, Xavier Zahnle, Anh D. Nguyen & Julián Bueno-Villegas:** Siphoniulida: 125 years after discovery found alive

10.20–10.40 **Andrej Mock, Beáta Haľková & Karel Tajovský:** Unique external morphology of millipedes of the family Trachygonidae (Diplopoda, Chordeumatida): Case study on *Heteracrochordum evae* (Loksa, 1960)

10.40–11.00 Coffee/Tea break

Chairperson: Megan Short

11.00–11.20 **Florentyna Anna Kaszuba, Anna Ostróżka, Grażyna Wilczek, Piotr Wilczek, Sebastian Student & Magdalena Rost-Roszkowska:** The effect of gluten on the activation of cell death in millipede midgut epithelial cells

11.20–11.40 **Magdalena Rost-Roszkowska, Izabela Poprawa, Alina Chachulska-Żymełka, Łukasz Chajec, Małgorzata Leśniewska, Grażyna Wilczek, Piotr Wilczek, Sebastian Student, Anna Ostróżka & Florentyna Anna Kaszuba:** Cell death activated by cadmium concentrated in soil: midgut epithelium and salivary glands of a centipede – *Lithobius forficatus* (Myriapoda, Chilopoda)

11.40–12.00 **Vladimír Šustr, Alica Chroňáková, Roey Angel, Terézia Horváthová, František Lorenc, Anna Koubová, Lucie Faktorová & Karel Tajovský:** Functional morphology, enzymology and microbiology of the millipede digestion

12.00–13.20 Lunchbreak

Chairperson: Jean-Jacques Geoffroy

13.20–13.40 **Boyan Vagalinski, Plamen Mitov, Ivelin Pantchev, Lidia Stefanova & Goritsa Rakleova:** From troglophily to troglobiism? A case study on the endemic Bulgarian millipede *Omobrachyiulus beroni* (Strasser, 1973), with remarks on the systematic position of the genus *Omobrachyiulus*

13.40–14.00 **Vukica Vujić, Luka Lučić, Sofija Pavković-Lučić, Bojan Ilić, Zvezdana Jovanović, Slobodan Makarov & Boris Dudić:** Sexual size and shape dimorphism in the millipede *Brachydesmus troglobius* Daday, 1889 (Diplopoda, Polydesmida)

14.00–14.20 **Dalibor Z. Stojanović, Ana Komerički, Pavel Stoev & Dragan Ž. Antić:** Blind species of the genus *Lithobius* Leach, 1814 (Chilopoda, Lithobiomorpha, Lithobiidae) from Southeast Europe

14.20–14.40 **Varpu Vahtera & Pavel Stoev:** The troglobite population of *Cryptops anomalans* Newport, 1844 (Chilopoda, Scolopendromorpha)

14.40–15.00 *Coffee/Tea break*

Chairperson: *Helen J. Read*

15.00–15.20 **Dragan Ž. Antić & Slobodan Makarov:** A review of cave-dwelling millipedes (Myriapoda, Diplopoda) in the Balkan Peninsula

15.20–15.40 **Hans S. Reip & Dragan Ž. Antić:** The juliform millipedes of Caucasian caves: *Archileucogeorgia/Leucogeorgia* (Diplopoda, Julida, Julidae) – a forgotten group of diplopods

15.40–16.00 **Aleksandr Evsyukov, Sergei I. Golovatch, Hans S. Reip & Didier Van den Spiegel:** Revision of the millipede tribe Leptoiulini in the Caucasus, with notes on the generic composition of the tribe (Diplopoda, Julida, Julidae)

16.00–16.20 **Yevette Gounden, Oliver T. Zishiri & Taro Mwabvu:** Population genetic diversity of a Southern African millipede, *Bicoxidens flavicollis* Attems 1928 (Diplopoda, Spirostreptida, Spirostreptidae)

16.30–17.00 **Group photo** (in front of the museum entrance)

17.00–18.00 **Poster session**

WEDNESDAY, 28 August

Congress Excursion

Meeting time 9:00 at the main entrance of the Museum, from where buses will take us to a guided field trip to the Buda Hills (Normafa region) for ca. 4 hours (easy walk with collecting places and sightseeing points). Packed snacks and water will be provided. At around 14:00 the bus will take us to the near Bajai Halászcsárda for a traditional Hungarian lunch. Arrival back to the Museum is expected around 17:00.

THURSDAY, 29 August, Semsey Room

9.00–9.40 Keynote lecture
Henrik Enghoff: The Eastern Arc Mountains of Tanzania – a biodiversity hotspot, also for millipedes

Chairperson: *Peter Decker*

9.40–10.00 **Jan Philip Oeyen, Oliver Niehuis, Bernhard Misof & Thomas Wesener:** Analysis of transcriptome data to reconstruct a robust phylogeny of the pill millipedes (Myriapoda, Diplopoda, Glomerida)

10.00–10.20 **Nattarin Wongthamwanich & Thanawan Tejangkura:** Taxonomic relationship of the *Zephronia siamensis* group from Easthern Thailand

10.20–10.40 **Piyatida Pimvichai, Henrik Enghoff, Somsak Panha & Thierry Backeljau:** Taxonomy and phylogeny of the millipede family Pseudospirobolellidae in Southeast Asia

10.40–11.00 Coffee/Tea break

Chairperson: Thomas Wesener

11.00–11.20 **Bojan Ilić, Aleksandra Korać, Milica Labudović Borović, Zvezdana Jovanović, Luka Lučić & Slobodan Makarov:** Ultrastructural features of adipocytes in the parietal fat body of *Apfelbeckia insculpta* (L. Koch, 1867) (Diplopoda, Callipodida, Schizopetalidae)

11.20–11.40 **Zvezdana Jovanović, Marija Aleksić, Igor Golić, Luka Lučić, Slobodan Makarov & Aleksandra Korać:** Study of the defensive glands of *Pachyiulus hungaricus* (Karsch, 1881) (Diplopoda, Julida): morphology and ultrastructure

11.40–12.00 **Bojan Ilić, Aleksandra Divac Rankov, Jelena Milovanović, Zvezdana Jovanović, Luka Lučić & Slobodan Makarov:** In vitro and in vivo assessment of toxicity of the defensive secretion of *Megaphyllum unilineatum* (C. L. Koch, 1838) (Diplopoda, Julida, Julidae)

12.00–13.20 Lunchbreak

Chairperson: Elisabeth Hornung

13.20–13.40 **Jean-François David:** Tree-millipede relationships in European forests

13.40–14.00 **Helen J. Read, C. Philip Wheater, Martin Albertini & Martin Woolner:** Changes in myriapod communities during the restoration of woodland to wood pasture

14.00–14.20 **Leilei Shi, Hongzhi Zhang, Tao Liu & Shenglei Fu:** Interactive effects of millipede and nitrogen deposition on soil micro-food webs and nutrient dynamics in a subtropical forest

14.20–14.40 **Irina Semenyuk:** Competition in millipede community: Abundant ephemeral species shove resident ones out from their trophic niches

14.40–15.00 Coffee/Tea break

Chairperson: Nesrine Akkari

15.00–15.20 **Andy Sombke, Matthes Kenning & Carsten H.G. Müller:** Functional morphology of the ultimate legs in *Haplophilus subterraneus* and other Geophilomorpha

15.20–15.40 **Carsten H.G. Müller, Matthes Kenning, Vanessa Schendel, Eivind A.B. Undheim & Andy Sombke:** Functional ultrastructure of the posterior legs of *Lithobius forficatus* (Chilopoda: Lithobiomorpha) with emphasis on telopodal glands

15.40–16.00 **Benjamin Naumann, Hans S. Reip, Nesrine Akkari, Jörg U. Hammel & David Neubert:** Inside the head of a cybertype – 3D reconstruction of the head muscles of *Ommatoiulus avatar* Akkari et Enghoff, 2015 (Diplopoda, Juliformia, Julidae)

16.00–16.20 **Grzegorz Antoni Kania & Jerzy Lechowski:** Bioaccumulation of some elements in *Cylindroiulus caeruleocinctus* (Julida, Julidae)

16.30–18.00 **Verhoeff Panel**
Carlos A. Martínez-Muñoz: The Myrioverse of Karl Wilhelm Verhoeff – Problems, progress and future solutions

FRIDAY, 30 August, Semsey Room

9.00–9.40 Keynote lecture
Sergei I. Golovatch & Weixin Liu: Diversity, distribution patterns and faunogenesis of the millipedes (Diplopoda) of mainland China

Chairperson: Henrik Enghoff

9.40–10.00 **Peter Decker:** EDAPHOKEYS – An information portal, interactive identification key and recording application for woodlice, millipedes and centipedes (Isopoda: Oniscidea; Myriapoda: Diplopoda, Chilopoda) of Germany

10.00–10.20 **Markus Koch, Christine Driller, Claus Weiland, Thomas Hörnschemeyer:** Modern information technologies for the study of myriapod biodiversity

10.20–10.40 **Manoela Karam-Gemael & Amazonas Chagas-Jr:** Worldwide Myriapoda threatened species

10.40–11.00 **Leif Moritz, Alexander Blanke & Thomas Wesener:** The morphology of millipedes – new insights using synchrotron micro-computer tomography

11.30–13.00 Lunchbreak

13.00–15.00 **CIM General Assembly**

15.15–23.00 Farewell Party

We will depart by bus from the main entrance of the Museum and will arrive at the Lázár Equestrian Park in Domony after approximately 1.5 hours. A spectacular one hour Hungarian horse show awaits us at 17:00 then we'll have some free time in the Park (possible CIM Council Meeting) until dinner at 19:00. Arrival back to the Museum is expected around 23:00.

KEYNOTE LECTURES

Arthropod segments and segmentation – lessons from myriapods, and open questions

Alessandro MINELLI

Department of Biology, University of Padova, Padova, Italy

The current understanding of the segmental organization of myriapods and its developmental and evolutionary underpinnings is dramatically different from the traditional views. This is due both to fresh research on a number of myriapod species, and to progress in comparative developmental biology at large. Within the new discipline of evolutionary developmental biology (evo-devo), myriapods have played an important role in the lively and still ongoing debate on segmentation; this is iconically witnessed by the geophilomorph centipede chosen to feature on the cover of the first issue of the journal Evolution & Development, published in July 1999. In the late eighties, the emerging paradigm of ecdysozoan, rather than articulatan affinities of arthropods prompted a revisitation of the traditional concept of the segment as archetypical body unit, often represented among myriapods by unconventional derivatives such as the millipede "diplosegment". At the same time, fresh approaches to myriapod comparative morphology and pioneering studies on the developmental genetics of segmentation of centipedes (*Strigamia maritima*, *Lithobius atkinsoni*) and millipedes (*Glomeris marginata*) fuelled both the definitive abandonment of the Articulata hypothesis and a reformulation of concepts, morphological (segmental units) and developmental (segment production and patterning) alike. Rather than as archetypical units of body architecture, segments should be viewed as the product of a functional integration between a number of serially repeated features, such as neuromeres, tergites, etc., distributed along the main body axis with the same periodicity or in easily compatible ratios, such as 1:2, but not necessarily in strict dorsoventral alignment: the segmental mismatch is not an "inconvenient noise", but a trait of possibly great phylogenetic importance. In the light of this refreshed interpretation of myriapod segmented architecture in developmental and evolutionary perspective, we must take distance from a number of well-entrenched naïve views, eg, that segment production is necessarily prior to segment patterning, both in development and evolution; that serial features necessarily (or mainly) evolve according to Williston's law (from polymerous and poorly patterned to oligomerous and strongly patterned series); that major changes in morphogenesis are necessarily associated to the divide between embryonic and post-embryonic development. A number of open questions remain, among them, to which extent the production of serial structures along the main body axis of myriapods is hierarchical rather than sequential.

Fossils, molecular dating and the timing of myriapod terrestrialization

Gregory D. EDGECOMBE

Department of Earth Sciences, The Natural History Museum, London, United Kingdom

The second wave of molecular phylogenetics – phylogenomic approaches drawing on large gene samples offered by transcriptomics – has solidified the monophyly of Myriapoda and its sister group relationship with Pancrustacea. The morphologically implausible grouping of Symphyla and Pauropoda (the Edafopoda hypothesis) in early molecular phylogenies has been overturned in favour of molecular datasets also recovering the classical grouping of pauropods and diplopods (Dignatha). Crown-group pancrustacean fossils from the early Cambrian predict a Cambrian origin of Myriapoda, and molecular dating consistently estimates the divergence of Chilopoda and Progoneata to be in the Cambrian. This substantially predates the earliest body fossils of Myriapoda, which are crown-group chilopods and diplopods in the Silurian. The trace fossil record provides evidence for Late Ordovician diplopods, partly bridging the gap between the body fossil and molecular records, but the trackway-bearing sediments have been reinterpreted as of subaqueous rather than terrestrial origin. The last common ancestor of the myriapod crown-group is inferred to be terrestrial and tracheate, but the marine provenance of early-derived Mandibulata and Pancrustacea predicts a marine stem-group for Myriapoda as well. Among candidates for marine or amphibious stem-group myriapods, Euthycarcinoidea are potentially the most compelling. They include late Cambrian marine members and are confidently associated with subaerial trackways on middle Cambrian to Early Ordovician tidal flats. New observations on the Devonian euthycarcinoid *Heterocrania rhyniensis* reveal myriapod-like structure of the preoral chamber. Cambro-Ordovician diversification between the deepest branches of the myriapod tree is paralleled in Chelicerata by molecular time-trees for Arachnida, which predict rapid divergence between arachnid orders and an earlier terrestrial history than is suggested by the fossil record.

The Eastern Arc Mountains of Tanzania – a biodiversity hotspot, also for millipedes

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The Eastern Arc Montains consist of a long chain of very old mountains blocks stretching from southern Kenya so southern Tanzania. They have enjoyed a high degree of climatic stability and form the core of the Eastern Afromontane biodiversity hotspot. The Eastern Arc Mts are home to innumerable endemic animal and plant species including several recently discovered medium-sized mammals (e.g. a new genus of monkeys). Due to intense fieldwork by staff of the Natural History Museum of Denmark (NHMD) and by the NGO "Frontier Tanzania", NHMD possesses a very large collection of millipedes from the Eastern Arc Mts. of Tanzania, especially from the Udzungwa Mts which constitute the largest among the Eastern Arc blocks. This collection has recently been subject of several taxonomic papers, mostly focused on the endemic Afrotropical family Odontopygidae, but also in part on Spirostreptidae, Paradoxosomatidae and Gomphodesmidae. Main features of the odontopygid fauna of the Eastern Arcs, especially the Udzungwas, will be presented, along with general features of the bewildering diversity of this family. An ongoing phylogenetic study on an almost endemic Eastern Arc genus of Spirostreptidae will also be presented.

Diversity, distribution patterns and faunogenesis of the millipedes (Diplopoda) of mainland China

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As millipedes represent a very large, ancient and widespread class of saprophagous, meso- to hygrophilous, land arthropods mainly confined to the floor of forested biomes, the group has long been acknowledged as being an excellent model for biogeographic reconstructions. China is huge in area and outstanding in habitat diversity, including high mountains and karst caves. Based on all available information, 335 species from 64 genera, 25 families and 11 orders of Diplopoda have hitherto been recorded from mainland China. Since our knowledge of the fauna is still very far from complete, the list is sure to considerably increase in future. As a result, the diplopod fauna of the country can generally be considered as very rich, comprising various zoogeographic elements and populating very different environments. Because China's climates range from harsh sharply continental in the arid northwest and southwest, through temperate and warm temperate in the central and eastern parts, to subtropical and tropical in the south and southeast, diplopods mainly occur in various woodlands, in caves and high in the mountains. Most species (>90%, usually highly localized, including 152 cavernicoles), 18 genera and 2 families are endemic to continental China. Mapping not only the horizontal, but also the vertical distributions of Diplopoda in China shows the bulk of the fauna to be expectedly restricted to forested lowland to mountain biomes or their remnants. Yet some Chordeumatida, Callipodida, Polydesmida, Julida and even Spirobolida seem to occur only in the subalpine to alpine environments and thus may provisionally be considered as truly high-montane. The long acknowledged notions of China being a great biogeographic zone transitional between the Palaearctic and Oriental regions generally find good support in millipede distributions as well, in particular at the higher taxonomic levels (generic, familial and ordinal). While the Palaearctic/Holarctic components expectedly dominate the fauna of the northern parts of the country, the Oriental ones prevail in its south and along the Pacific coast. Both realms are increasingly mixed and intermingled towards China's centre. However, in addition to the above traditional views, based on distribution patterns alone, southern China seems to harbour a rather small, but highly peculiar faunal nucleus, or origin centre of its own, whence the Himalaya could have become populated by younger lineages. The millipede fauna of continental China is thus a tangled mixture of zoogeographic elements of various origins and ages, both relict and more advanced. The few anthropochores must have been the latest faunal "layer" to populate China.

ORAL PRESENTATIONS*

* All oral presentations are listed in alphabetical order according to the first author

A review of cave-dwelling millipedes (Myriapoda: Diplopoda) in the Balkan Peninsula

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In terms of subterranean biodiversity, the Balkan Peninsula is long known not only as one of the three main refugia in entire Europe, but also as one of the world's major biodiversity hotspots. This is particularly true for the Dinaric region of the Balkans which is characterized by numerous unique and relict cave animals, both aquatic and terrestrial. In addition to the Dinarides, the Balkan Peninsula includes some other mountain massifs: the Carpatho-Balkan arc, the Rhodope mass and the Scadro-Pindhic system. In this region, complex geological events in the past, in combinations with climatic changes and the presence of powerful limestone deposits, could have caused the development of underground habitats with numerous animal groups and their independent evolution in many different phyletic lineages. One of the main groups of terrestrial arthropods rich in cave-dwellers in the Balkans is millipedes. So far, there are about 150 troglobitic or presumably troglobitic millipede species and 34 genera endemic to this region, altogether representing about 50 genera, 12 families and four orders. Moreover, endemism concerns not only the generic or species level, as there are also three endemic chordeumatidan subfamilies inhabiting the Dinaric region, viz. Acherosomatinae, Biokoviellinae and Macrochaetosomatinae. The largest number of troglobitic species belong to the order Chordeumatida (57 species in 21 genera and six families), followed by Polydesmida (42 species from 14 genera and three families), Julida (30 species, 8 genera and one family) and Glomerida (16 species, four genera and two families). The endemic Balkan genera are particularly numerous in the order Chordeumatida, with 18 such genera being involved, while the Polydesmida, Julida and Glomerida are far less diverse, with nine, six and one endemic genus, respectively. If mountain ranges are to be considered, the greatest number of troglobitic millipede species inhabit the Dinaric Karst (66 species) and the Carpatho-Balkan arc (53 species), while the number of species in other mountain ranges is far lower: 16 in the Scardo-Pindhic system, nine in the old Rhodope mass, and only one in the Romanian part of Dobrogea. As regards the endemic genera, the greatest diversity is observed in the Carpatho-Balkan arc (17 genera) and the Dinaric Karst (10 genera), while the Scardo-Pindhic system and the old Rhodope mass are characterized by three endemic genera each. Yet such an extraordinarily rich fauna of subterranean millipedes as presently estimated in the Balkan Peninsula is far from exhausted, as during the last decade alone a large number of new taxa have been described. The complex and long geological history, coupled with palaeoclimatic changes, must have resulted in a great subterranean biodiversity in the Balkans, a region which indeed merits the term of one of the main biodiversity hotspots of endogean fauna globally.

The diversity of Strigamia (Chilopoda: Geophilomorpha) in central Europe: intra-population variation, geographic differentiation, speciation

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Species of *Strigamia* (Geophilidae: Linotaeniinae) are common in the biocenoses of the forest soils in most parts of Europe, therefore they are among the most frequently recorded and studied geophilomorphs. Different taxonomists have contributed to species diagnoses and intraspecific taxonomy, however inter- and intraspecific diversity of forest-dwelling *Strigamia* are still known only approximately and incompletely. We have tried to elucidate the true pattern of diversity focussing on a broad geographical longitudinal stripe across central Europe, spanning from the Italian region, through the Alps, to the Baltic region. First, we have evaluated the within-population variation of anatomical characters in >10 populations, especially in relation to individual growth and sex dimorphism. Second, ignoring a priori identifications, we have drawn hypotheses on species boundaries from COX1 sequences and morphological data of >50 specimens from different sites. Third, we have obtained revised criteria for species assignment and have applied them to identify >3000 new specimens and to validate all previously published records. Our results confirm the existence of three species or species-complexes that approximately correspond to the traditional concepts of (i) *S. crassipes*, (ii) *S. acuminata* and (iii) *S. transsilvanica* and other narrow-ranging species. In addition we have found evidence that both S. acuminata and *S. transsilvanica* have strong genetic differentiation across Europe (p-distance up to 15%), but the former is relatively uniform in anatomical traits, with the exception of the shape of its forcipules, while the latter is much more differentiated in major anatomical features like body size and number of segments. Indeed, diverging populations of the S. transsilvanica species complex have sometimes been misidentified or even separated as distinct species.

Towards a comprehensive revision of Aphilodontinae (Geophilomorpha, Geophilidae): morphology, phylogeny and new Neotropical species

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The Aphilodontinae are a small lineage of geophilid centipedes living only in two separate areas (in South America and South Africa) and showing very unusual derived anatomical traits, especially in the feeding structures (shape of labrum, structure of second maxillae, articulation of forcipules, position of venom glands) and in the ultimate legs. The current understanding of the morphology and diversity of the Aphilodontinae is very unsatisfactory and therefore we have embraced a comprehensive revision of the group focusing on the Neotropical species. We have examined type specimens and newly collected specimens representing new species, with light and electron microscopy, and we have performed a first phylogenetic analysis on original morphological evidence. Our results corroborate the hypothesis that Aphilodontinae are a monophyletic clade and sister group of *Geoperingueyia*, which has a very similar amphi-Atlantic distribution. Moreover, in contract with current taxonomy, we found evidence that American and African species actually represent two different and diagnosable clades. Finally, new species of Aphilodontinae unveiled a broader anatomical and taxonomic diversity than previously known.

Tree-millipede relationships in European forests

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The ongoing SoiFor-Europe project investigates relationships between tree species diversity and soil biodiversity and their consequences for ecosystem functioning. In the spring of 2017, samples of soil macrofauna were collected at 64 forest sites in Italy (April), Poland (May), Romania (May) and Finland (June), using quadrats of leaf litter and soil (3 per site) and pitfall traps (4 per site for 1 week). In each region there were forest stands composed of one or three tree species, and stands dominated by evergreen or deciduous tree species. Preliminary results are presented here for relationships between stand composition and millipede and woodlouse communities. At the level of resolution achieved through the sampling plan, both macroarthropod taxa were virtually absent in Finland, the coldest area. Mean regional abundance and regional species richness were significantly lower in Poland (11 individuals m-2 for 5 millipede and 3 woodlouse species) than in Italy (39 individuals m-2 for 10 millipede and 6 woodlouse species) and Romania (46 individuals m-2 for 12 millipede and 5 woodlouse species). Mean macroarthropod abundance per site did not differ significantly between mono- and trispecific forest stands. However, there was an overall trend towards higher macroarthropod species richness per site in trispecific compared to monospecific stands. This was mainly due to a significantly positive response of millipedes to tree diversity in Poland and Romania, whereas there was only a marginally positive response of woodlice in Italy. Trispecific stands with certain mixtures of coniferous and deciduous trees, namely Picea-Carpinus or Pinus-Carpinus in Poland and Picea-Fagus in Romania, were particularly favourable to millipede species richness. Mean macroarthropod abundance per site did not differ significantly between evergreen and deciduous stands, but the results showed that coniferous trees common in Poland and Romania were not at all detrimental to the abundance and species richness of millipedes. Overall, although substantial variation occurred among similar forest stands due to many site-related factors that potentially influence soil macroarthropod communities, the results suggest that (1) tree diversity may have positive effects on millipede diversity, but (2) the identity of tree species in mixed stands also seems to be important.

EDAPHOKEYS – An information portal, interactive identification key and recording application for woodlice, millipedes and centipedes (Isopoda: Oniscidea, Myriapoda: Diplopoda, Chilopoda) of Germany

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The determination literature for soil animals has so far mainly been aimed at specialists. This means that most interested people are denied access to the native soil animals. In order to lower the inhibition threshold and facilitate the identification of soil animals, the Senckenberg Museum of Natural History Görlitz is developing a soil animal online portal called "EDAPHOKEYS" [German version: BODENTIER hoch 4] as part of the Germany-wide joint project "museum4punkt0" (*www.museum4punkt0.de*) funded by the Federal Government Commissioner for Culture and the Media. The big challenge is to bring these small and seemingly unattractive animals closer to interested people of different ages with understandable texts and intelligent identification keys. The portal will contain general introductions to the three different animal groups: terrestrial isopods (Oniscidea), millipedes (Diplopoda) and centipedes (Chilopoda). Species portraits with short descriptions, information on distribution and ecology as well as numerous images for the approximately 250 soil animal species that occur in Germany and some adjacent European countries (e.g. Scandinavia, Belgium, Netherlands) are provided. All texts will be written in a way that is generally understandable. With the support of (citizen) scientist colleagues, we create a comprehensible, user-friendly and interactive identification keys. The users, whether beginners or advanced, should quickly arrive at a safe determination result by means of preferably easily recognizable characteristics (if possible) and many illustrations and images from literature, colleagues or taken within this project. In addition, the application offers interesting information on the three animal groups. The particular record of an identified specimen can be transmitted to the portal together with information about the location and images. After verification by the experts, the incoming records are activated for these animal groups in the data portal or are publicly visible; and also transmitted to the soil zoological database of Senckenberg – Edaphobase (*www.edaphobase.org*). In case of misidentification or problems, a taxon expert is available to support the user in their work and to provide access to the scientific community. The user thus becomes a citizen scientist and can actively participate in the research of soil animals. The application will be available free of charge as a website and mobile application (Android, iOS) at the beginning of 2020. The application system is open-source, additional species and characters can be easily added and it supports also multiple languages. The application will be in German language and also most parts will be later available in English (keys, general texts).

Revision of the millipede tribe Leptoiulini in the Caucasus, with notes on the generic composition of the tribe (Diplopoda, Julida, Julidae)

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The millipede tribe Leptoiulini Lohmander, 1936, family Julidae, is widespread across the Palaearctic. The tribe presently comprises 11 genera: *Allopodoiulus* Verhoeff, 1898, *Chaetoleptophyllum* Verhoeff, 1898, *Hypsoiulus* Verhoeff, 1913, *Interleptoiulus* Mršić, 1988, *Kubaniulus* Lohmander, 1936, *Leptoiulus* Verhoeff, 1894, *Ophyiulus* Berlese, 1884, *Pacifiiulus*, *Peltopodoiulus* Lohmander, 1932, *Sibiriulus* Gulička, 1972 and *Xestoiulus* Verhoeff, 1893. The main differences between those genera lie in the structure of the 1st, 2nd and 7th legs pairs of the male, coupled with gonopodal conformations: the presence/absence flagella on the promeres and the degree of development of the phylacum and velum on the opisthomeres. In such a composition, the tribe Leptoiulini is probably paraphyletic and its relationships with some genera of the tribes Julini and Typhloiulini require further revision.

Only three genera of Leptoiulini occur in the Caucasus: *Chaetoleptophyllum*, *Leptoiulus* and *Kubaniulus*. The genus *Chaetoleptophyllum* is represented there only by one species, *C. flexum* Golovatch, 1979, which inhabits Georgia, Abkhazia and South Osetia. The large genus *Leptoiulus* presently includes three species in the Caucasus: *L. hastatus* Lohmander, 1932 from Armenia and Mountainous Karabakh, *L. tanymorphus* (Attems, 1901) from Azerdaijan and Dagestan (Russia), and *L. disparatus* Lohmander, 1936 from Georgia. We describe three new species of *Leptoiulus* from Armenia and Azerbaijan. The genus *Kubaniulus* presently contains only one species, *K. gracilis* Lohmander, 1936, from the Krasnodar Province, Adygea Republic. (both Russia) and Abkhazia. Two new species of this genus from Georgia are found and described. Only one species listed above, *L. hastatus*, occurs beyond the Caucasus in Iran. All other Leptoiulini are strictly endemic to the Caucasus.

All main diagnostic features of the Caucasian species, both old and new, are properly described and richly illustrated, with their distributions refined and mapped, based both on the literature records and abundant new samples.

To summarize, *Leptoiulus* is the most diverse and widespread genus of Leptoiulini in the Caucasus, both Greater and Lesser, and their congeners occur also in Europe and W Siberia. The genus *Chaetoleptophyllum* has one species each from the Dinaric Mountains, Balkans and the Greater Caucasus. Phylogenetic relationships between these two species are still unclear. The third genus, *Kubaniulus*, contains three endemic species that inhabit the Greater Caucasus.

Phylogeny of the centipede genus *Lithobius* Leach, 1814 (Lithobiomorpha, Lithobiidae) based on molecular and morphological data, with a focus on European species

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The Palearctic genus *Lithobius* Leach, 1814 contains more than 500 taxa and is currently interpreted as non-monophyletic based on morphological phylogenetic studies. However, very little is known about the species interrelationships of *Lithobius*, if its taxonomic classification into eight subgenera is valid, and how it is related to other Lithobiidae. To address those questions in the present study, we obtained molecular and morphological data to conduct phylogenetic analyses.

Our taxon sampling includes 43 mainly European *Lithobius* species from the four subgenera *Lithobius* Leach, 1814, *Monotarsobius* Verhoeff, 1905, *Sigibius* Chamberlin, 1913 and *Ezembius* Chamberlin, 1919, nine species of other lithobiid taxa as well as representatives of Henicopidae and *Scutigera coleoptrata* (Linnaeus, 1758) as outgroup. The morphological matrix codes for 61 characters and structural information was obtained from external and internal body parts (peristomatic structures, mandibles, first maxillae) using light and scanning electron microscopy. For the molecular part, we acquired sequences from the nuclear 18S and 28S rRNA and the mitochondrial 16S rRNA and COI gene regions. Both data sets were analyzed separately and in combination using maximum likelihood and parsimony as optimality criteria to compare the different evolutionary hypotheses.

The analytical output consistently recovers the genus *Lithobius* and its sampled subgenera *Lithobius*, *Monotarsobius* and *Sigibius* as non-monophyletic. Furthermore, we obtained data to reveal more cryptic species within *L. crassipes* L. Koch, 1862 and *L. crassipesoides* Voigtländer, Iorio, Decker & Spelda, 2017 and to consider the subspecies *L. tenebrosus setiger* Kaczmarek, 1977 and *L. variegatus rubriceps* Newport, 1845 as full species. Supporting previous morphological hypotheses, the molecular analyses consistently resolve a close relationship between *L. giganteus* Sseliwanoff, 1881 and the pterygotergine *Disphaerobius loricatus* (Sseliwanoff, 1881). Interestingly, the molecular trees suggest that the genus *Australobius* Chamberlin, 1920 is the sister group to all other sampled Lithobiidae. Our findings provide novel aspects to reconstruct the phylogeny of the genus *Lithobius* and represent a good basis for subsequent studies focused on open questions regarding certain species interrelationships.

Population genetic diversity of a Southern African millipede, *Bicoxidens flavicollis* Attems 1928 (Diplopoda, Spirostreptida, Spirostreptidae)

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The millipede genus *Bicoxidens* is endemic to Southern Africa. Of the nine species known, *Bicoxidens flavicollis* is the widest spread and occurs in Zimbabwe and Mozambique. *Bicoxidens flavicollis* populations exhibit phenotypic variation in body size, number of body rings and body colour amongst several other morphological traits. Body colour ranges from orange-yellow to black. Although much variation occurs within this species, gonopod morphology does not differ among sub-populations. Morphological traits appear to conceal significant genetic variation. As such, we used DNA molecular methods to unravel genetic variation in B. flavicollis. We used mitochondrial DNA 16S and 12S rRNA genes to detect levels of population genetic variation because mitochondrial markers express high variability thus they are suitable for phylogenetic studies. The 16S rRNA gene resulted in the generation of 22 haplotypes, derived from 42 sequences with strong haplotype diversity (Hd>0.9). AMOVA analysis demonstrated that variation among the populations was significantly greater (>80%) than the variation occurring within populations (<12%). A high fixation index (FST=0.88229) indicated a high level of population genetic differentiation. The 16S rRNA gene in *B. flavicollis* demonstrated distinct phylogenetic diversity and similarity for specific localities. Phylogenetic analysis using the 12S rRNA gene provided evidence of a distinct genetic structure between localities. Nineteen haplotypes were derived from 19 sequences, which indicated a genetically distinct population structure (Hd=1.000). The AMOVA analysis demonstrated that variation among the populations was greater (>60%) than the variation occurring within populations (<40%). A low fixation index (FST=0.37466) suggests a predominantly homozygous population structure. Despite the relatively high genetic variation among populations, these results support the notion that *B. flavicollis* is a single species that is made up of subpopulations that occur in distinct habitat patches.

New tomiulid millipedes from the Triassic of European Russia and a re-evaluation of the type material of *Tomiulus angulatus* from the Permian of Siberia

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The type material of the millipede *Tomiulus angulatus* Martynov, 1936, from southwestern Siberia, was once considered Early Triassic, but is now known to be terminal Permian. We identify new tomiulid fossil millipedes, however, that are Early Triassic, from the southern Cis-Urals and Kirov Province of northern European Russia. The specimens vary in preservation: parts of some specimens are badly crushed, but better preserved parts show details down to the cytoscute level. Some of the new specimens resemble *Tomiulus* in having generally similar body form and patterns of striate ornamentation, but differing in pleurotergal proportions, details of ornamentation, and other features. In one taxon, ozopores are especially prominent, in others they are missing or obscure. The type material of *Tomiulus angulatus*, and the new forms, have ventrally rimmed pleurotergites, and other indications of separate, narrow, sternites, so do not fit into the Xyloiuloidea as most recently diagnosed. We tentatively assign these forms to the Nematophora.

Thus the clade that contains *Tomiulus* occurs both above and below the Permo-Triassic boundary. This is in agreement with recent work indicating that end-Permian extinction was not as important for land organisms as for oceanic organisms.

A new species of penicillate millipede from genus *Mauritixenus* (Diplopoda, Polyxenidae) found in Vietnam

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Genus *Mauritixenus* Verhoeff, 1939, was erected based on the morphology of a group of penicillate millipedes found only on the Mascarene Islands, in Madagascar and West Africa. The characteristics of the seven described species in this genus are: 13 pairs of legs, 8 ommatidia, labrum with granular structure and tarsus 2 with a spine. A species of penicillate millipede was collected from Vietnam, Ninh Thuan Province, which proved to be a new species belonging to the genus *Mauritixenus*. This species differs from other members of the genus in the body length, number of sensilla present on gnathochilarium, anterior process in the claw and its genetic makeup; confirming that this is indeed a new species from the genus *Mauritixenus*.

Ultrastructural features of adipocytes in the parietal fat body of *Apfelbeckia insculpta* (L. Koch, 1867) (Diplopoda, Callipodida, Schizopetalidae)

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The millipede fat body plays an important role in storage of lipids, glycogen, proteins and uric acid. Also, this organ represents a site for the storage of waste metabolites. The fat body is a relatively large organ that can be found throughout the millipede body. The portion of the fat body located underneath the integument is known as the parietal fat body, while the central mass of this organ that surrounds the internal organs and fills the body cavity is known as the perivisceral fat body. The basic cell type of the fat body is the adipocyte, while another cell type, i.e., the oenocyte, can also be found in this organ. So far, several studies have addressed morpho-anatomical features of the fat body in Diplopoda, but none of them focused on any aspect of fat body biology in representatives of the order Callipodida. The aim of this study was to describe morphological and ultrastructural characteristics of adipocytes located in the parietal fat body of the callipodidan millipede *Apfelbeckia insculpta* (L. Koch, 1867). Tissue samples for light microscopy were fixed by immersion in 4% neutral buffered formaldehyde, dehydrated and embedded in Paraplast. Sections were stained with hematoxylin and eosin. The procedure of preparation of samples for transmission electron microscopy included fixation in a 3% solution of glutaraldehyde in 0.1 mol/dm^3 cacodylic buffer (CB) (pH 7.4) and post-fixation in a 1% solution of osmium tetroxide (OsO_4) in 0.1 mol/dm^3 CB. The tissue was then rinsed in CB and incubated in a 4.8% aqueous solution of uranyl acetate. After dehydration and embedding, the samples were cut into semi-thin (stained with toluidine blue) and ultra-thin sections and observed with an Olympus BX41 microscope and a Fei Morgagni 268D or CM12 transmission electron microscope. The parietal fat body in A. insculpta is a loose whitish tissue arranged in thin cords. Adipocytes are relatively large and organized in clusters. The cytoplasm of these cells is rich in organelles appearing as round or oval bodies with heterogeneous content and different electron densities. Some of them are large and lipid filled, while others are presumably protein bodies. Between or around these organelles, a large quantity of glycogen can be observed. Also, adipocyte cytoplasm contains a well developed granular endoplasmic reticulum dilated in some cell regions. The nucleus is oval and has an eccentric position, while small, tubular-type mitochondria are located peripherally. Further studies of morphological, chemical and physiological features of the fat body in Diplopoda will contribute to a better understanding of the nature of this organ and the role(s) it has in millipede biology.

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In vitro and *in vivo* assessment of toxicity of the defensive secretion of *Megaphyllum unilineatum* (C. L. Koch, 1838) (Diplopoda, Julida, Julidae)

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Members of the diplopod order Julida are known to produce defensive secretions that are blends of quinones (usually as dominant compounds), esters, phenolics, alcohols, aldehydes, ketones and anthranilate derivatives. Such chemical diversity leads to the presumption that these natural products can exhibit a spectrum of biological activities. So far, it has been shown that julid defensive secretions possess antimicrobial, antioxidative and antineurodegenerative potentials. However, there are no data concerning the toxicity of these secretions.

The principal purpose of this study was to evaluate toxicity of the defensive secretion of *Megaphyllum unilineatum* (C. L. Koch, 1838) in vitro and in vivo. It is known that the defensive secretion of this julid contains p–benzoquiones, esters and ketones. We used A549 cells (adenocarcinomic human alveolar basal epithelial cells) for in vitro toxicity assessment, while embryos of zebrafish [*Danio rerio* (F. Hamilton, 1822)] were used as an in vivo model in our study. The A549 cells were treated with different concentrations of *M. unilineatum* defensive secretion extract and their viability after the treatment was assayed using the MTT test. The IC50 value was calculated using linear regression analysis and its value for the tested extract was 11 μg/mL. Zebrafish embryos were exposed to different concentrations of the chosen extract, which was diluted in the embryo medium. The exposure started 6 hours post fertilization (hpf) and continued until 72 hpf. At 24, 48 and 72 hpf, the embryos were observed, and survival, hatching and malformations were recorded. The LD50 value for *M. unilineatum* defensive secretion extract was 0.55 μg/mL. Embryos that were coagulated or where no heartbeat could be detected were considered dead. All concentrations above 1 μg/mL were lethal in the first 24 hours after exposure. The concentration of 0.5 μg/mL had a toxic effect, but around 55% of embryos survived the first 24 hours. These embryos showed slight growth retardation and hypopigmentation. The concentration of 0.25 μg/mL did not affect survival or development of zebrafish embryos.

Results of this study demonstrated that the defensive secretion of *M. unilineatum* reduced cell and zebrafish embryo viability and induced developmental malformations in the latter model system. Our data showed that the tested extract contains cytotoxic components, and pinpointing them will be the task of future studies.

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Study of the defensive glands of *Pachyiulus hungaricus* (Karsch, 1881) (Diplopoda, Julida): morphology and ultrastructure

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The quinonic defensive secretion of *Pachyiulus hungaricus* (Karsch, 1881) is produced, stored and released from a julid-type gland into the external environment. Toluidine blue staining of semi-thin sections, scanning electron microscopy and transmission electron microscopy were employed to investigate gland morphology and ultrastructural features of gland cells. After isolation and fixation in a mixture of 2% paraformaldehyde and 2% glutaraldehyde in 0.1 M phosphate buffer, glands were post-fixed in 1% osmium-tetroxide and then embedded in Araldite. Semi-thin sections (1 μm) were stained with toluidine blue and observed under a Leica DMLB microscope, while ultra-thin sections (80-100 nm) were mounted on copper grids and analysed under a CM12 transmission electron microscope. Following fixation and dehydration, glands were mounted on aluminum stubs and examined under a JSM–6390LV scanning electron microscope. In addition, the tracheal system surrounding the gland was visualized on material immersed in lactic acid under a Nikon SMZ 1270 binocular stereo microscope. Three morphologically distinct parts of ozadenes could be differentiated: the efferent duct, a region of cuticular spring-like folds and a reservoir. Structural regularity in the form of a ladder was evident in arrangement of the tracheal network, which encompasses basement membrane of the reservoir. The glandular wall surrounding the lumen of the gland is comprised of its basement membrane, a cuticular lining (more strongly developed in the duct region than in other sections of the ozadene) and a multicellular secretory layer in between. This layer is mainly developed in the reservoir and is missing in the efferent duct. Many pigment and secretory granules of varying size and density could be found in the secretory cells. A vast number of minute canals, or tubules, are observed in the cells, as well as several larger ones near the cuticular lining of the reservoir. It can be presumed that the minute canals receive the secretion from the cells and the secretion is then transported into larger collecting canals, from which it is secreted into the gland lumen. Comparable with the results of previous histological studies on millipedes with julid-type glands and on defensive systems of Opiliones and Coleoptera, these findings represent a significant part of ongoing research.

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Bioaccumulation of some elements in *Cylindroiulus caeruleocinctus* (Julida, Julidae)

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The millipede *Cylindroiulus caeruleocintus* (Wood, 1864) occurs throughout Europe. This species is common in Poland, with activity peaks in spring. The migrations of synanthropic *C. caeruleocintus* in Lublin, and Warszawa are observed. These millipedes are eurytopic, inhabit the open areas of fields, fallows, even lawns and pavements among residential houses as well as litter of various plant communities.

The specimens of *C. caeruleocintus* collected from Warszawa area, and from the less polluted Lublin, eastern Poland, were used to study elements. The content of elements was determined with the ICP metod on a VISTA MPX Varian spectrometer.

Elements content, from higher to lower concentration in Lublin were the following: Ca, Mg, K, Na, Al, Fe, Cu, Zn, Mn, and in Warszawa: Ca, Mg, K, Na, Al, Zn, Cu, Fe, Mn. Millipedes from Lublin showed 1.99, 1.77 and 1.62 times higher concentration of Mg, K and Na than millipedes of the same species collected from Warszawa. Millipedes from Warszawa indicated a higher concentration of the following elements: Zn, Mn, Al, Cu, Fe, Ni, 2.54, 2.25, 1.57, 1.17 and 1.13 times, respectively than those from Lublin. Some species of millipedes have been used as bioindicators of soil pollution sites.

Worldwide Myriapoda threatened species

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Red lists of threatened species are the most objective tool to assess species conservation status. They work as critical indicators of biodiversity conservation and may inform conservation planning, priorities setting and policy making. Red lists can be elaborated at global and national/regional levels and its assessments allow an overview of the current knowledge of a given group in a geographic range. The International Union for Conservation of Nature (IUCN) has been developing global red lists and objective criteria for species assessments since 1964. In the past decades several countries have also elaborated its own lists. National/regionals lists are essential for informing local conservation actions, but it results in scattered information. Here, we consulted red lists from 32 countries, and found Myriapoda species assessments in 11 countries' lists, creating a worldwide overview of the current conservation status of the group. We also gathered information from the IUCN Red List of Threatened Species. Our results show that 842 myriapod species have already been assessed for its extinction risks, including all Myriapoda classes: Diplopoda (80%), Chilopoda (17%), Pauropoda (3%), and Symphyla (1%). The orders more frequently assessed were Polydesmida (27%) and Spirobolida (16%) (among Diplopoda) and Lithobiomorpha (46%) and Geophilomorpha (41%) (among Chilopoda). Among all myriapods assessed, 31% (282 species) are considered as threatened with extinction (assessed as Critically Endangered, Endangered or Vulnerable). According to the assessments three species are extinct: *Eucarlia alluaudi* (Brolemann, 1896), *Orthomorpha crinita* Attems, 1900, and *Spirobolellus praslinus* (Saussure & Zehntner, 1902). Species assessed as Data deficient sum up 21%. The total number of worldwide assessed species represents 5% of all species known for the group (circa 17.000 species). Our results show that, surprisingly, none of the species assessed in regional/national lists are also listed in IUCN database. It means that local lists may inform local conservation decisions, but they do not feed a global database. Gathering scattered information help to improve global taxonomic coverage and thus provide a stronger base to enable better conservation and policy decisions. Besides identifying species needing targeted recovery efforts, a global database also helps to identify the key sites/habitats that need to be protected. Also, funding priorities may be set according to species/habitats risks of extinction, with the IUCN assessment of risk working as eligibility criteria for international calls for threatened species. Our results also show that some species were classified in different categories in neighbor countries. Then, expanding the geographic range of the assessment brings a broader overview of the group and may be a stronger evidence to inform conservation decision.

The effect of gluten on the activation of cell death in millipede midgut epithelial cells

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One of such food additives is gluten which is nowadays in the center of interests of dietetics, food production and nutrition technologists. It is a mixture of vegetable proteins (glutenin and gliadin), found in the grains of some cereals, including wheat, triticale, rye and barley. In recent years, the incidence of a wide spectrum of gluten disorders has increased (GRD disease – gluten-related disorders), because of the increased prevalence of this ingredient in the diet. The main aim of the project was to investigate, analyze and describe processes of the cell death which appear in the midgut epithelium after treatment organisms with gluten as the food additive. As a research object we chose *Telodeinopus aoutii* (Myriapoda, Diplopoda, Spirostreptida) the species that is herbivorous and detrivorous and gluten is absent in this millipede diet. For the analysis and comparison of changes at various levels of animal body organization, the midgut as the middle region of the digestive system of the above-mentioned species was selected.

Adult specimens of *T. aoutii* were cultured 30 x 35 x 60 cm aquaria at 20 – 25 °C (humidity about 70%), in garden soil with coconut fibers and crushed sepia as the source of calcium. The animals were divided into experimental groups: C – control group, animals cultured in garden soil with coconut fibers and crushed sepia, fed with fresh mushrooms; and experimental groups where animals were cultured in garden soil with coconut fibers and crushed sepia, fed with fresh mushrooms injected with gluten solution for different periods: G1 – 1 month; G2 – 3 months; G3 – 6 months; and G4 – 9 months. Processes of the cell death (autophagy, apoptosis and necrosis) have been analyzed using transmission electron microscopy (TEM), light and confocal microscopy and flow cytometry.

The tube-shaped midgut of T. aoutii is surrounded by two layers of visceral muscles – an inner layer that is formed by circular muscles and an outer layer that is formed by longitudinal muscles. It is lined with the pseudostratified epithelium composed of digestive, secretory and regenerative cells. Our studies revealed that adding gluten to the food for animals, which in a natural diet do not have this additive, activates cell death processes. The longer the period of gluten administration is, the cell death processes take place more intensively. The cell death was observed only in the digestive cells of the midgut epithelium, while no changes appeared in the regenerative and secretory cells.

Modern information technologies for the study of myriapod biodiversity

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The representation of taxonomic and anatomical data in ontologies has become a key asset for a variety of aspects related to science in general and to biodiversity research in particular. Among the most noteworthy benefits of ontology-based descriptions in semantic web language is the granting of public access and cross-domain usability of the available data, thus their overall compliance to the FAIR principles for scientific data management. The Senckenberg biodiversity informatics team started contributing to such benefits within the scope of a new specialised information service for biodiversity research called BIOfid (*https://www.biofid.de*). Based on interdisciplinary collaboration between librarians, text technologists, and biologists, BIOfid provides new text mining and semantic annotation tools that allow knowledge inference of biodiversity data from German scientific publications from modern times back to the 18th century. For this purpose, ontologies were developed for taxa prioritized by a target group of German biodiversity researchers, with an initial focus on vascular plants, moths and butterflies, as well as birds. In accordance with current demands, BIOfid now aims at expanding the taxonomic focus on soil arthropods, including myriapods. In order to promote this project, we present our intention of utilizing existing knowledge bases and taxonomic platforms like edaphobase, chilobase and millibase for the design of ontologies for centipedes and millipedes. The integration of taxonomic data with soil ecological data via the edaphobase repository especially aims at supplementing new tools for geotagging into text mining and semantic searches. Another focus of our presentation will be given to the benefit of ontologies for taxonomists and morphologists in general to overcome problems pertaining to terminology and accuracy in the description of morphological data via their contribution to unambiguity, consistency and transparency. Our survey corroborates the view that for reasons of sustainability the use and ministration of taxonomic and anatomical ontologies will necessarily add to the core competencies of a natural history museum curator.

Millipede fauna of Hungary: present status

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The millipede fauna (Diplopoda) of the territory of Hungary was summarized last time in 2005, on a poster for the 13th International Congress of Myriapodology, Bergen, Norway. Since then, several new species to the fauna have been approved, four of them published separately in individual papers (*Cylindroiulus burzenlandicus* Verhoeff, 1907, *C. caeruleocinctus* (Wood, 1864), *Leptoiulus liptauensis* (Verhoeff, 1899), *Megaphyllum silvaticum* (Verhoeff, 1898)). Here, we provide an updated list of the Hungarian Diplopoda, comprising altogether 105 species. Newly recorded and as yet unpublished species include *Brachyiulus lusitanus* (Verhoeff, 1898) and *Chondrodesmus riparius* Carl, 1914. Taxonomical relationship between *B. lusitanus*, *B. bagnalli* (Brolemann, 1924) and *B. pusillus* (Leach, 1815) is discussed in detail.

A new species of *Newportia* (Scolopendromorpha, Scolopocryptopidae) from Cuba, with a standardized terminology for cuticular structures and aspects of the transformation of ultimate legs

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Newportia Gervais, 1847 is the most diverse genus in the family Scolopocryptopidae Pocock, 1896, and ranks first among New World Scolopendromorpha. Martínez-Muñoz & Tcherva (2017) listed 66 different species, of which Chagas-Júnior (2018) synonymized two and Schileyko (2018) reduced one species to subspecific status, a change that was again reverted by Martínez-Muñoz & Pérez-Gelabert (2018). Previous Chilobase-based *Newportia* species counts missed *Newportia* (*Newportia*) *potiguar* Ázara & Ferreira, 2014, mistakenly registered as a member of the genus *Cryptops* Leach, 1814. In this contribution, we update the previous species count of *Newportia sensu lato* to 65 species, to which we add a species new to science. The new species is described from eight specimens from five localities and four provinces of the island of Cuba. For detailed examination of cuticular structures, scanning electron microscopic images of locomotory and ultimate legs of one paratype were prepared and standardized terms for these structures are proposed. Two new taxonomic characters from the ultimate leg sensilla and a new character state of the spurulation of the locomotory legs are proposed. The affinities of the new species to *Newportia weyrauchi weyrauchi* Chamberlin, 1955 and *Newportia weyrauchi thibaudi* Demange, 1981 are discussed. As a final aim, we update the count to 9 *Newportia* species recorded from Cuba.

The Myrioverse of Karl Wilhelm Verhoeff – Problems, progress and future solutions

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This oral presentation will be the introduction to a homonymous two-hour discussion panel. The panel intends to bring together myriapodologists and museum staff working with Verhoeff's taxa, specimens, literature and archives. The aim is to exchange information on 1) Verhoeff's problems: his practices regarding naming of new taxa, designation of type specimens and splitting and selling of material; and on 2) progress: availability of species lists, references list, literature, digitized archives, museum holdings (wet collections and slides), new collection fragments detected; as well as to discuss 3) future solutions: integrated database of Verhoeff's collections, desired data, data types, formats and accessibility, recommended workflow for revision and decision-making on Verhoeff's taxa. The outputs of the discussion panel are desired to be collated into a multi-authored publication.

The “armori” line: a millipede parapatric boundary in Tasmania

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Species in several genera of Tasmanian Dalodesmidae (Polydesmida) form distribution mosaics in which species ranges meet but do not overlap. The *Tasmaniosoma armatum/T. orientale* boundary in northeast Tasmania (here called the “armori” line) was mapped by sampling of *Tasmaniosoma* species in native forest and woodland from 2012 to 2019. Sampling was made difficult by unusually dry weather in six of the eight sampling years, and by clearing for farms in what might have been the parapatric zone in pre-European times. Like the *Tasmaniosoma compitale/T. hickmanorum* boundary in northwest Tasmania, the “armori” line ignores both vegetation type and geology, and runs from sea level to 600-700 m. However, the 50 km-long “armori” line is largely aligned with streams, whereas the 230 km-long northwest Tasmania boundary cuts across numerous rivers and smaller watercourses. As with the northwest boundary, the “armori” line is less than 100 m wide where intensively mapped. Sampling also showed that two gonopod variants of *T. orientale* inhabit different parts of the species range and are parapatric at several locations.

Unique external morphology of millipedes of the family Trachygonidae (Diplopoda, Chordeumatida): Case study on *Heteracrochordum evae* (Loksa, 1960)

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The diversity of cuticle structures of arthropods abounds with a variety of morphological shapes and functions at any hierarchical level. Even in well-studied systematic group, such as the Central European millipedes, we can experience surprising discoveries. The members of the family Trachygonidae are such example of atypical representatives within the order Chordeumatida. They are strongly adapted to the life in soil with depigmented, tiny and thin body, with shortened limbs and almost unrecognizable macrochaets.

Up to the present time, 6-8 species of 3-4 genera (unsolved synonymy) of this family were described till now from the Western Dinarids, east part of the Alps and the Bükk Mts., Hungary. Accordingly this indicates the family distribution mostly within wooded massifs of a wider surrounding of the Pannonian Lowland.

So far, only original descriptions of all taxa are available, in which the authors focused on the diagnostic male characteristics, with modest comments on the morphology of some other body parts. The last descriptions of the new species and (sub)genus were published by Loksa (1960). More recent studies are missing, except for description of vulvae of two species presented by Kurnik (1988). Spelda et al. (2011) in a preliminary COI analysis of the millipede dataset documented a high degree of un-relativeness of the family Trachygonidae to other chordeumatid taxa. We reviewed all the published data on the morphology, taxonomy, ecology and distribution of this family.

Recently the new records of *Heteracrochordum evae* in two distinct regions in Slovakia, representing the northernmost limits of the family distribution, allowed us to study in detail the external morphology of adults in both sexes and immature stages. Some peculiarities in morphology following the extreme adaptation to their edaphic life were observed: miniaturization of the body and appendages, cleaning tarsal structures and divided setae on the two first pairs of legs in both sexes, sculptured dorsal surface of body segments, fascicled short machrochaets, colorless cuticle and reduction of eyes. Evaluation of available immature stages confirmed early termination of growth.

The simple structure of the male copulatory organs, sward-like divided gonopods (8th legs) folded between the following pairs of limbs with rudimental 9th pair of legs and modification of the first four pairs of female legs, are likely to reflect particularities in the reproductive biology of these millipedes, the which is yet unknown.

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The morphology of millipedes – new insights using synchrotron micro-computer tomography

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Compared to other arthropod classes the Diplopoda are largely understudied. This is especially true for their phylogeny and morphology. Thus not a single molecular phylogenetic analysis includes all 16 orders and all morphological phylogenetic analysis code characters for orders and not species. The largest character matrix for millipedes comprises 64 characters, mainly from the literature. Many neglected morphological descriptions are only available in German, Italian and French, and often contradict each other. The study of morphological data is usually time consuming and complicated, especially regarding internal characters. Synchrotron micro-computer tomography (SR-μCT) offers the opportunity to study the internal and external anatomy of many specimens non-invasively in a relative short timeframe. In addition, important character complexes, especially skeletal and muscular systems, can be three-dimensionally reconstructed. Here we comparatively study the morphology of 48 millipede species representing all 16 millipede orders and 9 outgroup species using SR-μCT, and review the old, neglected literature. The aim of the project is to widen our knowledge of the morphology and phylogeny of the Diplopoda, and to make the generated data freely available. The studied character complexes will be the basis for a morphological phylogenetic analysis using an exemplary approach and maximum parsimony, including all 16 millipede orders. With this exemplary approach it will be possible to test the monophyly of orders and identify order-level apomorphies. Additionally the character matrix will be easy to expand in future studies with additional extant, as well as extinct, millipede groups.

Functional ultrastructure of the posterior legs of *Lithobius forficatus* (Chilopoda, Lithobiomorpha) with emphasis on telopodal glands

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Centipedes display a broad diversity of solitary, aggregated, and compound epidermal glands enabling the animals to deter competitors, ectoparasites and potential predators, to kill harmful soil bacteria and fungi, to initiate and support mating, to provide components for egg production, or to assist cleaning activities. Aggregated defense glands may be present on the sternites of Geophilomorpha, called sternal glands, as well as on the inner face of the distal podomeres of the posteriormost legs (including the ultimate legs) in some Lithobiomorpha, called telopodal glands. Flanking our proteomic and transcriptomic analyses to reveal their biochemical properties, we explored the ultrastructural organization of the telopodal glands of the lithobiid *Lithobius forficatus* with the aim to explore potential structural disparities that may indicate differential secretion qualities. Using SEM and TEM techniques we detected that the telopodal glands consist of 4 cells, namely (1) a canal cell, (2) an intermediary cell forming a collar around the apices of (3) a small and granulated secretory cell (type-1 cell) and (4) an elongated, non-granulated secretory cell (type-2 cell) encasing a voluminous, tubular reservoir. There is no gland-associated musculature but many neurites, in part myelinated, that can be observed at the base of glandular epithelium thereby getting in close contact to the bottom of the type-2 secretory cells. The ultrastructure of closely aggregated telopodal glands closely resembles that described for sternal glands and venom glands. This talk also addresses specific morphological traits in the podomeral configuration, intrinsic musculature, sensory equipment, and innervation patterns of the ultimate legs underscoring their exceptional role in the behaviour of centipedes in general and of *L. forficatus* in particular.

Inside the head of a cybertype – 3D reconstruction of the head muscles of *Ommatoiulus avatar* Akkari et Enghoff, 2015 (Diplopoda, Juliformia, Julidae)

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The origin and diversification of the arthropod head is one of the major topics in the field of evolutionary morphology of Arthropoda. Among the major arthropod groups, Myriapoda, and more precisely Diplopoda, are generally poorly studied regarding their head anatomy. However, this group is of a pivotal role to understand the evolutionary functional morphology of the arthropod head. In this study, we investigate the complete musculo-skeletal system of the diplopod head with a detailed description of the cephalic anatomy of the recently described species *Ommatoiulus avatar*. The comparison of our data with the literature data of the few other species available show that the morphology of the musculoskeletal system within the Juliformia, a sub-group of the Diplopoda, is relatively conservative. Using video recordings of the feeding movements in addition to the anatomical data we revise the mechanism of the mandibular movements in Juliformia. There was controversy whether mandibular abduction is an active process, facilitated by contraction of an abductor muscle, or a passive process, mediated by tentorial and gnathochilarial movements not involving a direct abduction by muscular contraction. We show that mandibular abduction in *Ommatoiulus* is an active movement involving the contraction of an abductor muscle. This is similar to the mandibular abduction in other arthropod groups.

Analysis of transcriptome data to reconstruct a robust phylogeny of the pill millipedes (Myriapoda, Diplopoda, Glomerida)

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The pill millipedes (Diplopoda: Glomerida) are a moderately diverse group comprising more than 300 species and 34 genera. The group shows a Holarctic distribution, with numerous genera in Europe and Southeast (SE) Asia, three genera in North America, and very few species spanning the gap between Europe and SE Asia, while being conspicuously absent in the southern 4/5th of India. Furthermore, several dwarf genera, with adult sizes of just 2–4 mm, exist in Europe. Recent studies in the Protoglomeridae (Oeyen & Wesener 2015), as well as a phylogenetic study based on micro-CT and scanning electron microscopy data (Oeyen & Wesener 2018) failed to recover a stable phylogeny of the Glomerida. In order to elucidate the relationships and biogeography of the Glomerida, we sequenced and analyzed transcriptomes encompassing more than 1.000 genes of 12 Glomerida species. The selected taxa cover the entire geographic distribution of the order, all suborders and families, as well as both normal sized and the dwarf genera *Adenomeris*, *Geoglomeris*, and *Trachysphaera*. The included species are: *Typhloglomeris martensi* (Glomeridelloidea, Europe), *Glomeridella minima* (Glomeridelloidea, Europe), *Protoglomeris vasconica* (Protoglomeridae, Europe), *Eupeyerimhoffia archimedis* (Protoglomeridae, Europe), *Haploglomeris multristriata* (Haploglomerinae, Europe), *Glomeris marginata* (Glomerinae, Europe), *Adenomeris gibbosa* (Doderiinae, Europe), *Geoglomeris subterranea* (Doderiinae, Europe), *Hyleoglomeris* sp. (Doderiinae, SE Asia), *Onomeris sinuata* (Doderiinae, N. America), *Rhopalomeris carnifex* (Doderiinae, SE Asia), and *Trachysphaera* sp. (Doderiinae, Europe).

Integrative species delimitation in endogean myriapods: the case of *Clinopodes carinthiacus* across the South-Eastern Prealps

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Delimiting species and, more in general, identifying diversity patterns, can represent a serious challenge for animals with low dispersal ability, including endogean myriapods such as most geophilomorph centipedes. However, the integration of multiple lines of evidence for speciation (e.g., morphological, genetic, biochemical, ecological or behavioural differentiation, eventually associated to the coexistence of lineages diverging in one or more of these features) has proved effective in shedding light on species boundaries. By adopting a similar integrative approach, we explored the geographic variation in populations of the geophilid *Clinopodes carinthiacus* throughout its range across the South-Eastern Prealps. After evaluating all published records, we sampled a dense set of 28 evenly spaced sites in between the Brescia Prealps (to the West) and the Pohorje (to the East). In detail, we investigated morphology by both traditional and geometric morphometrics, and analysed genetic variation, using both mitochondrial (COI and 16S) and nuclear (28S) loci. We applied an array of species delimitation protocols based on independent datasets and relying on different assumptions. Preliminary results show that diversity has been largely overlooked in *C. carinthiacus*, which probably comprises more than one species.

Taxonomy and phylogeny of the millipede family Pseudospirobolellidae in Southeast Asia

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Species of the millipede family Pseudospirobolellidae are relatively small and slender compared to other Spirostreptida and Spirobolida families in Southeast Asia. The taxonomic study of this family has been largely neglected, and only two genera, viz. *Pseudospirobolellus* Carl, 1912 and *Benoitolus* Mauriès, 1980, comprising four species, have been reported worldwide. Yet, these figures probably severely underestimate the actual Pseudospirobolellidae diversity, particularly in SE Asia, a region that is known for its overwhelming species diversity of other millipede families (e.g. Harpagophoridae, Pachybolidae and Paradoxosomatidae). Hence, based on mainly gonopodal characters and mtDNA (COI and 16S rRNA) data, the present study proposes ten morphotypes as new species to science in the genera *Pseudospirobolellus* and *Benoitolus*. As such, the number of pseudospirobolellid species worldwide increases from four to fourteen. The mtDNA analyses also confirm that the Pseudospirobolellidae is a monophyletic group, an issue that hitherto was questioned. This implies that the presence of long and slender apodemes on the telopodite and coxite of the anterior gonopod is a consistent synapomorphy that distinguishes the Pseudospirobolellidae from the Pachybolidae and other related taxa.

Changes in myriapod communities during the restoration of woodland to wood pasture

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In the past it was though that most of Europe, prior to the influence of man, was climax woodland with more or less continuous tree cover and relatively small amounts of open areas. Recent research (Vera 2000) has indicated that it was more likely to have been dominated by a type of savannah with large herbivores driving the development of scrub and woodland and with a greater proportion of open, areas with scattered tree. In southern England in medieval times wood pasture was a common form of land management, coupling scattered trees, often managed for their small-scale wood, and domestic livestock. Abandonment of these traditional systems in the early 20th century resulted in loss to agriculture or building development, or through lack of grazing into woodland. Burnham Beeches is a Natura 2000 site for the ancient beech trees that were managed as pollards within a wood pasture system but by the 1980s the grazing had long ceased and secondary woodland swamped the old pollarded trees (cut on a regular cycle for their branches) and the area was almost entirely dense woodland. Restoration has involved clearance of younger trees and reinstatement of grazing.

Pitfall traps have been used to monitor the changes in ground running invertebrates for nearly 30 years during the restoration of one area from woodland to wood pasture, in comparison to a nearby plot where the woodland has been left untouched as a control. Traps generally were set during the summer months, sadly not ideal for myriapods.

Annual captures of both millipedes and centipedes were analysed over a 28-year period for a restored site and for 26 years for an unmanaged site, examining the numbers of individuals (adults and immature), species composition and community structure.

A total of 14 species of centipede and 14 species of millipede were found. Most of the species were common British ones with the most unusual being the centipedes *Lithobius muticus* and *Lithobius macilentus* and the millipedes *Chordeuma proximum* and *Cylindroiulus parisiorum.*

The variation over time was investigated in relation to the management of the sites. Variation in community structure was identified by measuring the change in ordinational space over time. Changes were generally more pronounced for the restored site compared to the unmanaged area for both millipedes and centipedes. The implications for managing these types of woodlands are discussed in relation to the ecology and conservation importance of the species involved.

The juliform millipedes of Caucasian caves: *Archileucogeorgia/Leucogeorgia* (Diplopoda: Julida: Julidae) – a forgotten group of diplopods

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The Caucasus is long known as a diversity hotspot for numerous arthropod groups, including millipedes (Diplopoda). During the last years, intensive efforts have been made to revise its millipede fauna, with lots of new or poorly-known taxa described or redescribed. The orders Glomerida, Polydesmida, Polyzoniida and Chordeumatida can be considered as quite well studied, but the major millipede group, the order Julida, in particular the large family Julidae, still lacks revision of most of its constituent genera. This is surprising because most of the species are quite common and medium- or large-sized.

With only four described species, almost completely forgotten are the cave julids of the genus group *Archileucogeorgia/Leucogeorgia*. Almost every western Caucasian cave supports representatives of this group. Even the regularly encountered specimens living in the Tskaltubo Cave, the major tourist cave of Georgia, contains a still undescribed species.

Special interest should be addressed to the genus *Leucogeorgia* which comprises cave-adapted species up to 3 cm in length and living up to 700 m deep, all showing highly modified mouthparts. The phylogenetic relationships between *Leucogeorgia* and *Archileucogeorgia* are yet unclear.

With this work we will give the first overview of the diversity of these mostly cave millipedes, especially their distributions, habitats and potentially new species.

Cell death activated by cadmium concentrated in soil: midgut epithelium and salivary glands of a centipede – *Lithobius forficatus* (Myriapoda, Chilopoda)

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Homeostasis of organs, tissues/cells is maintained as the cell number is controlled, and abnormal or disrupted cells are discharged. Programmed cell death (PCD) protects them from becoming inflamed or contributing to the death of the organism. It has been classified into three major types: apoptosis, autophagy and cytoplasmic cell death/paraptosis/necrosis. Cell death may be caused by numerous factors originating from the external environment, to which animals living e.g. in soil are exposed. Our studies on cell death are focused on a group of terrestrial invertebrates – centipedes (Myriapoda, Chilopoda) which play a very important role in breaking down decaying plant and animal material and in soil decomposition. As the object for studies we chose a brown centipede – *Lithobius forficatus*. The main purpose of the project was to describe processes of cell death, which are activated in the midgut epithelium and salivary glands after short- and long-term exposure to cadmium concentrated in soil and to investigate the relationship between these organisms. Adult specimens of *L. forficatus* were divided into experimental groups: C – the control group, animals cultured in laboratory conditions in horticultural soil and fed with *Chironomus* larvae maintained in tap water; Cd1 – animals cultured in horticultural soil supplemented with 80 mg/kg (dry weight) of CdCl2, fed with *Chironomus* larvae maintained in tap water, 12 days – short-term exposure; Cd2 –animals cultured in horticultural soil supplemented with 80 mg/kg (dry weight) of CdCl2, fed with *Chironomus* larvae maintained in tap water, 45 days – long-term exposure. Midgut and salivary glands were isolated from myriapod bodies and prepared for analyses, which were conducted using transmission electron microscopy (TEM), light and confocal microscopy and flow cytometry. Our study revealed that the number of late apoptotic and necrotic cells in both experimental groups (12 and 45 days of cadmium treatment) increased relative to the control group. However, autophagy was intensive after 12 days of cadmium exposure. Apoptosis and autophagy were observed only in digestive cells, while there were no apoptotic alterations in case of secretory and regenerative cells.

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The overview of the system of the order Scolopendromorpha, with notes on some morphological characters

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Our knowledge of taxonomy of the order Scolopendromorpha has been considerably improved during two last decades due to works of Lewis (2006), Shelley (2002), Shelley & Mercurio (2005), Edgecombe & Koch (2008, 2009), Koch et al. (2010), Edgecombe & Bonato (2011) and Vahtera et al. (2012ab, 2013) who have made some important proposals at the familial level.

The most recent review of the scolopendromorph genera and subgenera has been proposed by Edgecombe & Bonato (2011), who generalised the main part of the taxonomic novelties noted above. However, since 2011 some taxa of generic rank were revised (Chagas-Jr 2012, 2016, 2018; Vahtera & Edgecombe 2014, Lewis 2016, Schileyko & Solovyeva, 2019). Also, as a result of the studies by Edgecombe et al. (2012), Vahtera et al. (2012, 2013) some "small" genera (like *Tidops*, *Dinocryptops*, *Notiasemus*, *Ectonocryptoides*, *Kanparka*, etc.) were supposed to be the synonyms of the closely relative "large" ones. Thus, the number of the extant scolopendromorph genera should be considerably decreased, and the recent system of the order is presently out of date. Additionally, the outdated generic identification keys of Attems (1930) and Schileyko (1992) are at the moment the most recent ones.

The main aim of this work is to overview the number of the valid scolopendromorph genera and subgenera and to propose a corresponding identification key. The study has been carried out based on literature data and the scolopendromorph collection of Zoological Museum of Moscow Lomonosov State University, which contains representatives of ca. 140 species belonging to more than 20 genera and subgenera (sensu Edgecombe & Bonato 2011). As a result, the number of the extant scolopendromorph genera has decreased from 34 to 27. Also *Cryptops* (*Chromatanops*) is suggested to be a junior synonym of *Cryptops* s. str.; the subgeneric status is formally fixed for both *Cryptops* (*Paracryptops*) and *Cormocephalus* (*Campylostigmus*).

Another part of this study was a short analysis of some previously overrated (or unappreciated) morphological characters. These characters are: presence/absence of eyes (importance decreased), number of spiracles (importance decreased), length of forcipular tarsungulae (importance decreased), the structure of the ultimate leg tarsus (importance decreased/increased), presence of claw-shaped pretarsus of the ultimate legs (importance increased) etc.

Competition in millipede community: Abundant ephemeral species shove resident ones out from their trophic niches

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Millipedes are saprotrophic animals using leaf litter and other plant debris as a main food source. It seems to be an unlimited supply in temperate areas, but is only available for consumption for a short time in tropical monsoon forest (as conditions are not suitable in the dry season, and leaf litter disappears during the rainy season in only a few months mainly because of termite activity). The millipede community of Cat Tien National Park (Southern Vietnam) consists of about 40 species, which appear in different times of the year or are present in the community permanently; they may reach a high abundance of more than hundred individuals per sq. meter. Limiting food sources are the potential cause of competition in the community. In our research we aimed to find any trophic competition in the millipede community and discover the dynamic of trophic niches of resident and temporal species with time. We chose 10 millipede species of the same size class sharing microhabitats with each other, but with different seasonal strategies: permanent species, seasonal species, and ephemeral species. All species were of comparable abundance. There were three permanent species in the community during all seasons, three seasonal species that had peaks of abundance lasting a few months, and four ephemeral species which had a very sharp peak lasting about one month with complete absence in the other seasons. From October 2016 until August 2018 we collected material from model forest plot for Stable Isotopic Analyses once per two months, and counted the abundance of millipedes. We found that one permanent species, *Orthomorpha rotundicollis*, switched its trophic niche from leaf litter to a more algae-containing diet with the arrival of seasonal species; also its trophic niche becomes wider with the decline in number of coexisting species. Other permanent species, *Thyropygus carli* and *Tonkinbolus dollfusi*, had specialised niches which did not overlap with others so their niches were not altered with the appearance of seasonal species. All seasonal and ephemeral species occupy roughly the same trophic niche and had leaf litter as the main food source. It can be interpreted as seasonal species have a lack of time to specialise so they rely on the mass food source in the best time of year. Permanent species have to develop strategies for surviving in all seasons so they specialise their niches for the poor time of year and to avoid competition with seasonal species.

Interactive effects of millipede and nitrogen deposition on soil micro-food webs and nutrient dynamics in a subtropical forest

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As model detritivores, millipedes play an important role in ecosystem function. They process large amount of detritus and have a great implication for microbial communities and microfauna (micro-food web) and biogeochemical cycles in soil ecosystems. The soil micro-food web which drives organic carbon decomposition and nutrient cycling are sensitive to global change factors (i.e. nitrogen deposition). Although the effects of nitrogen deposition on soil microbial communities and carbon nutrient cycling have been a widespread ecological focus, the regulatory effects of the millipedes are rarely considered in these studies. We explore the potential of millipede to mediate the responses of soil micro-food webs and nutrient dynamics to nitrogen deposition in a microcosm study. Nitrogen deposition stimulated the fungal growth, which in turn increased the density of the fungivorous nematodes. In contrast, millipede grazing significantly decreased the fungal biomass and the fungivorous nematode density, thus offsetting the positive effects of nitrogen deposition on the fungi based micro-food chin. Millipede activity significantly increased the bacterial biomass and thus the bacterivorous nematode density. Nitrogen deposition did not affect soil bacterial biomass and the bacterivorous nematode density. However, the positive effects of millipede on bacteria based food chin were disappeared in the context of nitrogen deposition. The effects of millipede, nitrogen deposition and their interactions on soil micro-food web had great implications for carbon and nutrient cycling. Millipede activity enhanced the soilβ-glucodase and acid phosphatase activities. Millipede activity also increased carbon sequestration and phosphorus availability. In conclusion, our study suggested that millipedes are an important regulatory force in the responses of belowground micro-food web and biogeochemical cycles to global change factors, such as nitrogen deposition.

New species of Polyxenida from Israel

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Two new records in the family Lophoproctidae (Diplopoda, Polyxenida) are described from Israel. *Lophoproctus israelensis* sp. n. is morphologically close to *Lophoproctus jeanneli* Brolemann, 1910 but differs in the arrangement of antennal sensilla. *Lophoproctinus* sp. is very close to *Lophoproctinus chichinii* Condé, 1951 collected in Egypt and Lebanon, but differs in at least one morphological character. Collection of further material will be required to confirm that it is a new species. *L. israelensis* is more broadly found in Israel while one collection only has been made of *Lophoproctinus* sp. Morphological details of the Israeli population of *P. lagurus* are also recorded. The two new records bring the total number of Polyxenida species recorded in Israel to seven.

Siphoniulida: 125 years after discovery found alive

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Members of the cryptic order Siphoniulida were first described in 1894 from female specimens collected in Sumatra; the types are still housed in the Museum in Amsterdam. This enigmatic taxon was rediscovered in a bulk soil sample, originating from Tikal, Guatemala, and housed in the Geneva Museum. Eighty-five years later, Hoffman described the female specimens as *Siphoniulus neotropicus*. Some twenty-five years later, while sorting through Mexican soil samples housed in the Field Museum, Sierwald and coworkers, discovered new *Siphoniulus* specimens and described the gonopods of a male from Los Tuxtlas, Veracruz, Mexico, based on scanning electron microscope images. The first males known were tentatively identified as *Siphoniulus* aff. *neotropicus*. Most recently, during an NSF-funded international Myriapod & Arachnid Workshop at Los Tuxtlas Biological Station in Veracruz, Mexico in 2018, all 27 workshop participants revisited the Field Museum bulk sample locality. The team collected 27 live *Siphoniulus* specimens, including adult males, females and juveniles. This is the first live observation of this millipede group to be documented. Morphological features of these rather tiny specimens were investigated using visible light and UV microscopy, as well as scanning electron microscopy. We present a detailed and richly illustrated description of the morphological features and ecological information of this enigmatic millipede order. Ongoing investigations include X-ray computed tomography scanning as well as developing suites of molecular characters.

Patterns in the distribution of centipedes (Chilopoda) in the Aegean archipelago

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The Aegean archipelago is one of the largest archipelagos in the world with approximately 7600 islands and islets, lying at the crossroads of three different biogeographical regions, namely Europe, Asia and Africa. Most of the Aegean islands represent geological fragments of the Aegaeis landmass and their present biodiversity reflects island submergence and emergence, due to plate tectonics, volcanic activity and eustatic sea-level fluctuations. As a result of its palaeogeographical history, environmental heterogeneity and topographical characteristics, the Aegean Sea is an ideal natural laboratory for studying biogeographical patterns and processes. We selected centipedes (Chilopoda) to reveal the structure of island communities and explore the combined role of geography and palaeogeography in shaping biodiversity on the Aegean archipelago. We compiled a presence/absence island-species matrix for the studied area, containing 64 islands (with an area larger than 1 km^2) and a total of 70 centipede species (of which 5 are endemics). Information was based on published data in the Aegean archipelago and unpublished records coming from the collections of the Natural History Museum of Crete. We applied advanced palaeogeographic tools to reconstruct the geography of the area based both on present-day and Last Glacial Maximum sea-level configurations. We investigated the impact of present-day and past geographical settings on the current island species richness's using a Generalized Linear Mixed Models approach. We also studied the distribution of species to discover potential biogeographical networks (categorize islands according to their ecological role in the island-species network), and to highlight geographically nested subsets of centipede fauna. In general, centipedes tend to be faunistically relaxed, since species richness patterns are determined by present-day area and proximity to the mainland. Native species seem more abundant in land-bridge islands (islands with connection to the mainland during the Last Glacial Maximum), whereas endemic species are completely absent from them. Even though Crete went through extensive topographical changes, the island never reconnected to the mainland after the end of the Messinian (ca. 5 My ago). As a result of its long-lasting isolation, Crete is recognized as a network hub island (an island important to the coherence of the island-species network) that hosts a high percentage of endemic species (*Cryptops beroni*, *Lithobius cretaicus*, *Lithobius creticus* and *Scolopendra cretica*).

Molecular systematics of scutigeromorph centipedes in Thailand and adjacent countries

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The systematic study of Scutigeromorpha in SE-Asia is neglected, several areas having not yet been intensively collected. Recently, limestone karst has been a focus of attention because of problems of natural habitat destruction by cement production, especially in Thailand. Scutigeromorph centipedes represent a group that is often distributed specifically in limestone montane areas and is affected by human activity. In this study, scutigeromorph samples collected throughout Thailand and some parts of Laos and Myanmar were studied based on morphological examination and molecular analysis of multi-locus markers (e.g. COI and 16S). The taxonomic investigation indicates at least two molecularly and morphologically distinct groups that correspond to two scutigeromorph genera, *Thereuopoda* Verhoeff, 1904 and *Thereuopodina* Verhoeff, 1905. Morphological variability of some traditional characters such as the setae and spinulation patterns on tergite surfaces were detected in both of these genera. Molecular phylogenetic trees based on a partitioned gene dataset effectively discriminate the boundaries between scutigeromorph samples. Clades within the genus *Thereuopoda* depict two geographical groups distributed across Thai-Lao territory. The genetic distance among putative groups shows highly interspecific variation (18-21.6% in COI), and likewise a widespread species, *Thereuopoda clunifera*, also exhibits high intraspecific variation (17.4% in COI). The results of this study suggest that the diversity of scutigeromorph centipedes in mainland SE-Asia is underestimated, with previously unrecognized species resulting from habitat diversification and biogeographic transitions.

Functional morphology of the ultimate legs in *Haplophilus subterraneus* and other Geophilomorpha

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In comparison to walking legs, the last pair of legs in Chilopoda – the ultimate legs – are particularly unique as no other leg in centipedes shows a comparable functional, morphological, and behavioral heterogeneity. They never or only rarely are used for locomotion, and in different taxa they hold a variety of different functions. One particular aspect of ultimate leg morphology is sexual dimorphism found in many species, most eye-catching in Geophilomorpha. Here, males frequently possess substantially thickened ultimate legs featuring an intensive coverage with trichomes, sensilla, and other cuticular protuberances, indicating an elaborated sensory performance. We used histology, scanning- and transmission electron microscopy, as well as microCT analysis to explore characteristics of sexually dimorphic ultimate legs of the geophilomorph *Haplophilus subterraneus* in terms of leg morphology and diversity of sensory organs. However, the analysis of putative sensory structures led to rather different results. In contrast to earlier descriptions, the majority of the 3,000 plus cuticular structures does not represent cuticular sensilla, but rather elongated epidermal glandular shafts similar to spider spigots. In addition, the epidermis of the entire leg is riddled with glandular tissue. Hence, this is the first detailed account on centipede ultimate legs demonstrating the transformation from a former walking into a "secretory" leg. Its definite function in *H. subterraneus*, however, still has to be examined. As it is known that male geophilomorphs produce a silk web for spermatophore transfer, one possible explanation for this massive glandular tissue is that the ultimate legs might be responsible for production of silk. The secretion of sex-specific compounds, such as pheromones attracting mates, may be an alternative explanation. Based on this comprehensive morphological analysis, we will also explore the morphology of ultimate legs in other geophilomorph taxa. Future studies will also target the chemical composition of the secretion.

Blind species of the genus *Lithobius* Leach, 1814 (Chilopoda, Lithobiomorpha, Lithobiidae) from Southeast Europe

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With approximately 520 species and almost global distribution, the genus *Lithobius* Leach, 1814 is the largest and most widespread genus of Lithobiomorpha. Despite its high diversity, troglobites are less than 10% of all known species, while completely eyeless ones are even fewer. Most troglobites are rather cryptic and hard to find, and they are often known only from a single cave or limestone massif. Out of more than 100 species recorded in Southeast Europe, 16 species assigned to four subgenera are completely blind. Six species are recorded outside caves, mostly from hypogeic habitats (under stones or deep in the soil): *Lithobius* (*Lithobius*) *ergus* (Chamberlin, 1952); *L.* (*Monotarsobius*) *nudus* (Matic, 1976); *L.* (*Sigibius*) *apfelbecki* Verhoeff, 1900; *L.* (*S.*) *orghidani* Matic & Negrea, 1966; *L.* (*S.*) *reiseri* Verhoeff, 1900; and *L.* (*S.*) *subterraneus* Matic, 1962. The remaining 10 species are known from cave environments. These are: *L.* (*L.*) *lakatnicensis* Verhoeff, 1926; *L.* (*L.*) *matulicii* Verhoeff, 1899; *L.* (*L.*) *sketi* Matic & Dărăbanţu, 1968; *L.* (*L.*) *tiasnatensis* Matic, 1973; *L.* (*L.*) *troglomontanus* (Folkmanová, 1940); *L.* (*M.*) *auritus* (Verhoeff, 1943); *L.* (*M.*) *hauseri* (Dobroruka, 1965); *L.* (*M.*) *zveri* (Matic & Stenzer, 1977); *L.* (*Thracolithobius*) *dacicus* Matic, 1958; and *L.* (*T.*) *remyi* Jawłowski, 1933.

We here present new data on some blind *Lithobius* species found during sampling conducted in caves in Bosnia and Herzegovina, Croatia, Montenegro, North Macedonia and Serbia in the last two decades. *Lithobius matulicii* is reported from Croatia and Montenegro for the first time. Also, we here present the first records of *L. lakatnicensis* from North Macedonia and confirm its presence in Serbia, which significantly extends the range of this species to the west. Almost 70 years after its discovery, one adult female of *L. troglomontanus* was found at the type locality, Vodna Pećina Cave (near the village of Mulje in Bosnia and Herzegovina). This species was also collected for the first time in Montenegro, in the Pećina u Jabukovom Dolu Cave (near the village of Komarno, Rijeka Crnojevića), where an adult female was found wandering under water. Detailed morphological descriptions and comments on the distribution and relationships of the recorded species are provided.

Functional morphology, enzymology and microbiology of the millipede digestion

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In various species of millipedes food consumption, assimilation efficiency, energy contents of food, excrements and animal bodies, morphology and histology of digestive tract, physical and chemical conditions and metabolic products in different intestinal sections, activity of digestive enzymes and structure of microbial intestinal community were be studied to obtain a complex overview of millipede digestive processes and its ecological consequences. More wide species range including represenatives of the Julida, Glomerida, Spirobolida, Spirostreptida, Polyxenida was used for comparative studies, mainly large tropical millipedes *A. gigas* and *E. pulchripes* were used as models for detailed studies of functional morphology and physiology of digestion. Millipede food contain large portion of recalcitrant plant residues, asimilation efficiency is relatively low. Millipede gut is simple, divided to two main sections (rather acid midgut and neutral or slightly alkaline hindgut). Rich intestinal eukaryotes including nematodes and ciliate protozoans are present, mainly in hindgut. Anoxic and reducing conditions prevailed in intestinal tract, with higher individual variability in smaller species. Acetate and lactate are the most important fermentation products in the intestine, in hindgut of several taxonomic groups methane is produced as the end product of intestinal biochemical pathways. Wide spectrum of digestive enzymes were found in all studied species. Starch and laminarin cleaving enzymes prevailed quantitatively, but chitinases, general protesase, and relatively low activity of cellulases and disaccharidases were confirmed. The midgut content seems to be main niche of enzymatic digestion, showing the highest enzymatic activity at the physiological pH. Most of enzymes, including cellulases, were detected also in the midgut wall, supporting their autochthonous origin. Diverse microbial community was observed using cultivation dependent and independent approach (NGS microbiome) in millipedes' intestine including some fungi and yeasts, actinomycetes, fermenting bacteria and methane producing, mainly hydrogenotrophic methanogenic Archaea.The portion of cellulose really digested and assimilated by millipedes from leaf litter and the exact role of intestinal microbiota in its breakdown will be tested in planned experiments with stable isotope labelling (13C-cellulose) to trace the destiny of cellulose derived C in the digestive tract.

From troglophily to troglobiism? A case study on the endemic Bulgarian millipede *Omobrachyiulus beroni* (Strasser, 1973), with remarks on the systematic position of the genus *Omobrachyiulus*

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The enigmatic millipede *Omobrachyiulus beroni* is recorded for the first time after its original description in 1973, again from the type locality – Dyavolskoto garlo (The Devil's Throat) Cave in Western Rhodope Mts, Bulgaria. The species, which was considered a trogloxene due to the lack of any troglomorphic traits, was included in the Red Book of Bulgaria as critically endangered, after several research trips to both the cave and the surrounding area had not resulted in its finding. The material for the present study was hand-collected during two visits to Dyavolskoto garlo, in April 2017 and in May 2018. The samples included a total of 94 individuals of both sexes and in various post-embryonic stadia. Three specimens exhibited almost complete albinism, but were otherwise morphologically identical to the pigmented forms. Considering these observations together with the fact that no individuals of *O. beroni* have ever been found outside the cave, including during several days of intensive exploration of potentially suitable epigean sites in the same vicinity, it can be assumed that this species is either a pronounced troglophile or a young troglobiont in an initial stage of adaptation to subterranean way of life. A brief overview of the troglomorphic modifications in different groups of Julida is presented, and the results from the few available studies dealing with albinism in invertebrates are discussed. In addition to morphological observations, 28S rRNA sequences were obtained from several specimens of *O. beroni*, representing the first molecular data on the genus *Omobrachyiulus* Lohmander, 1936. Compared to the remaining brachyiulinine taxa for which 28S rRNA sequences are available, *O. beroni* appears either as the sister group of *Megaphyllum* s. str. against *Cyphobrachyiulus kinzelbachi* + *Brachyiulus* spp. + *Byzantorhopalum rossicum*, or nested on a separate branch within the *Cyphobrachyiulus–Brachyiulus–Byzantorhopalum* clade.

The troglobite population of *Cryptops anomalans* Newport, 1844 (Chilopoda, Scolopendromorpha)

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Movile Cave is located in southeastern part of Romania, not far from the Black Sea Coast. Being completely isolated from the outside environment for 5.5 million years the cave is remarkable for its unique ecosystem entirely dependent on methane- and sulfur-oxidising bacteria, which release nutrients through chemosynthesis for fungi and other cave animals along the food chain. Despite its harsh living conditions, the cave is known to harbor a diverse and unique fauna. Until now 48 species are known to inhabit the cave, of them 33 are local endemics, including highly adapted taxa such as the cave water scorpion *Nepa anophtalma*.

Three species of myriapods are hitherto known from the innermost parts of Movile – new, yet undescribed species of each *Archoboreoiulus* (Diplopoda) and *Symphynella* (Symphyla) and a troglobitic population of *Cryptops anomalans* Newport, 1844 (Negrea, 1993). It is worth mentioning that the latter taxon has been only studied morphologically (Negrea, 1993, 2004). Using molecular methods, we have now studied the Movile population of *C. anomalans* based on freshly collected material kindly provided by Dr. Serban Sarbu (The Ross School, East Hampton, New York).

We sequenced three molecular markers (COI, 16S rDNA, 28S rDNA) of the troglobite and a number of surface-dwelling populations of *C. anomalans* and performed a phylogenetic analysis to compare their evolutionary relationships. The results show the troglobitic specimens form a well-supported, monophyletic clade well separated of all other *C. anomalans* specimens.

We continue to search for sound morphological differences that would help discriminating and formally describing the putative new species.

Sexual size and shape dimorphism in the millipede *Brachydesmus troglobius* Daday, 1889 (Diplopoda, Polydesmida)

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In the Polydesmida, intersexual differences of morphological traits have been poorly investigated so far. In the present work, the method of geometric morphometric analysis is used to analyse sexual size and shape dimorphism evident in three morphological features (antennae, head and legs) in the millipede *Brachydesmus troglobius* Daday, 1889 from Serbia. For this purpose, the left and right legs and antennae (28 females and 21 males) as well as heads (27 females and 22 males) were included in the analysis. We dissected anterior leg-pairs of the 10th body ring, heads and antennae of all individuals under a Carl Zeiss Stemi-2000 binocular stereomicroscope. Photos of these structures were made with a Carl Zeiss Axiocam MRc camera. Twenty-six landmarks were placed on each picture of legs, 15 landmarks on each picture of heads and 32 landmarks on each picture of antennae in the TpsDig program. The CoordGen6 program was used to calculate centroid size (CS) of the aforementioned features, Canonical Variate Analysis (CVA) to investigate sexual shape differences in the analysed features and Statistica 7 to test the possible presence of intersexual differences in the CS of legs, heads and antennae. The obtained results indicated that sexual shape dimorphism is present only in legs (legs: $p=0.0019$; heads: $p=0.0882$; antennae: $p=0.6319$). However, intersexual differences of CS are present in all of the analysed features (legs: $p<0.0001$; heads: $p=0.0481$; antennae: $p=0.0081$). Males possess larger legs and antennae in comparison with females, while the opposite pattern is obtained in analysis of intersexual differences in head CS. Our research on morphological variation in the millipede *B. troglobius* represents a contribution to knowledge about intersexual differences in size and shape of the aforementioned features.

Discovery of an extinct millipede order in Cretaceous Amber from Myanmar (Myriapoda, Diplopoda)

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The Mesozoic fossil record of the millipedes is very fragmentary, with less than a dozen officially named species. Recently we investigated more than 460 Myriapoda specimens preserved in Burmese amber, dated to the Cretaceous (99MYA). Most of the identifiable (mainly male) specimens can be placed in extant families, in numerous cases even extant genera; all but four belong to extant orders. The four specimens, one male, one female and two juveniles, were trapped in a single amber piece, and exhibit morphological characters that cannot be observed in any extant millipede group. Leg pair 11 is modified to a gonopod (in extant Colobognatha leg pairs 9&10, in extant Eugnatha, leg pairs 8&9 are modified to gonopods). Several other characters are present in these fossils which do not exist in any extant millipede group: head unique, with very short antennae, collum with a leg pair, legs ventrally separated by huge sternites with eversible pouches. Most of these characters are in congruence with the oldest known Diplopoda body fossil and sole representative of the order Cowiedesmida *Cowiedesmus eroticopodus*, recorded from 385 MYA. This makes the Cowiedesmida the only known Diplopoda order which apparently survived the Permian mass extinction.

Utilizing micro-computer tomography and 3D reconstructions as well as light microscopy we were able to record numerous morphological characters of the Cowiedesmida amber specimens, allowing a scoring of the fossil in our Blanke & Wesener 2014 phylogenetic matrix. All analyses clearly recover the Cowiedesmida in a basal position inside the Helminthomorpha.

Taxonomic relationship of the *Zephronia siamensis* group from Easthern Thailand

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Zephronia siamensis Hirst, 1907 is the first Thai giant pill-millipede species which is reported from the east of Thailand. The members in this region share the same colour pattern with a few differences. Therefore, the objective of this study was to investigate the taxonomic relationship of the *Zephronia siamensis* group from Easthern Thailand. The specimens were collected from each province of Eastern Thailand, including the Plant Genetics Conservation Project under the Royal Initiation of Her Royal Highness Princess Maha Crakri Sirindhorn Area and the type locality, by direct observation during rainy season. Morphological characters and molecular data of the millipedes were investigated. The result showed that the *Zephronia siamensis* group was a monophyletic clade comprising different morphs. This might be a result of geographical isolation among local populations sampling from different localities. Further studies will be needed to clarify the evolutionary trajectories, which will include extensive areas across north-eastern and central parts of the country.

Use of geometric morphometrics to differentiate intraspecific variation of *Clinopodes flavidus* in Alborz Mountains

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Geometric morphometrics has an important role in elucidating morphological differences between specimens especially when linear measurements cannot be informative. Compared to genetic analysis, this method is quick and less costly. It also helps gain an understanding over complex variations in complicated geometries. In particular landmarks make it simpler to identify shapes, by visualizing them and testing hypotheses statistically. Geometric analysis can visually illustrate phenotypic variations among populations.

Clinopodes flavidus is among commonly found species of Geophilidae in Alborz Mountains, northern part of Iran. Cephalic plate of Geophilomorpha bears some significant identification characters, making it a suitable candidate for geometric morphometrics analysis. The aim of this study is to determine if cephalic plate morphology can discriminate between two populations of *Clinopodes flavidus* from north and south slopes of Alborz Mountains.

For analyzing 2D coordinate's data, photos were taken from ventral side of cephalic plate, including forcipular coxosternite and forcipular apparatus. Analysis of the Procrustes distances was carried out using MorphoJ and PAST software. Shape coordinates are subject to principal components analysis; also canonical variate analysis (CVA) was employed to explore relationships between the specimens. Shape differences among two populations were found significant. This study suggests that these two populations are distinguishable by cephalic palate shape. Whether this difference is because of factors influencing ontogenetic development, adaptation to local geographic factors, different responses to the selective pressures or long-term evolutionary diversification is not clear and needs further investigation.

POSTERS*

* All posters are listed in alphabetical order according to the first author

Analysis of the collections of millipedes from Madagascar in the collections of the Museum 'La Specola' in Firenze, Italy, with the description of three new species of giant pill-millipedes

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The millipede collections of the Zoological Museum 'La Specola' in Firenze, Italy, were investigated for Diplopoda from Madagascar. The examined material was mainly collected in 1989 and 1991 during two expeditions by Italian beetle and land isopod experts L. Bartolozzi and S. Taiti. Numerous introduced species were among the material, including the first records of three tropical tramp species, *Pseudospirobolellus avernus* (Butler, 1872), *Glyphiulus granulatus* (Gervais, 1847), and *Chondromorpha xanthotricha* (Attems, 1898). Samples collected from disturbed habitats often contained a Diplopoda community exclusively consisting of 3–6 introduced species. The most spectacular find was the discovery of three undescribed giant pill-millipedes, with already 81 strictly endemic species currently the most-diverse myriapod group on Madagascar. All three species belong to the *Z. coquerelianum* species-group, two of them to a subgroup seemingly specialized to transitional wet-dry forests in southern and southeastern Madagascar. DNA extraction and the sequencing of the COI barcoding sequence were successful for one of the three new species. Genetic distances to other described species of *Zoosphaerium* are high, 11–15% uncorrected p-distances. The closest, but with a p-distance of 11% still clearly separate, relative of the sequenced new species is *Z. alluaudi* (de Saussure & Zehntner, 1897), a microendemic, critically endangered species, occurring also in forests transitional between dry and rainforests in SE Madagascar.

Myriapoda within a cultural landscape

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Cultural landscapes, defined by UNESCO as the "combined works of nature and of man" are facing a wide range of aggressive factors and threats, ranging from natural (e.g. extreme weather or landslides) to anthropogenic (air pollution, logging, overgrazing, population) that induce stress to the soil, biota and even the visitors themselves.

Although myriapods are among the most abundant and common taxa in cultural landscapes, little is known about the efficacy of the sampling techniques used to estimate their diversity patterns and how environmental factors influence those patterns. In this study we tested the performance of three qualitative techniques (direct collection using tweezers, sifting leaf-litter with the Winkler sieve and soil samples) and one quantitative technique (Barber traps) to evaluate differences in myriapod community composition and structure and effects of environmental factors on myriapod communities from the Rupestral Assembly Bozioru Mountains: Aluniș, Romania. We sampled myriapods in four sites: Fundătura, Fundul Peșterii, Schitul lui Iosif and Agatonul Nou. The results revealed a rich species diversity of the cultural landscape: 19 species of Diplopoda, 23 species of Chilopoda, 2 species of Symphyla, 7 species of Oniscidea, 13 species of Opiliones, 45 species of Araneae, 57 species of Collembola. We found significant differences of myriapod communities composition and structure among sampling techniques, except between pitfall traps and direct collection. The environmental factors that significantly affected the myriapod community were the interactive effect of altitude and temperature at the ground level followed by the relative humidity at the ground level. Concerning the performance of sampling techniques, we found a significant effect of the sampling technique on the efficiency by effort and time but not for completeness. The most effective sampling technique both by effort and time was Winkler sieving. Thus for a full inventory of myriapod species and to understand the diversity patterns and how environmental factors contribute to patterns in myriapod diversity of the cultural landscapes we recommend a combination of both qualitative and qualitative sampling techniques.

Winter assemblage of myriapods and woodlice (Myriapoda, Isopoda) in Central Poland

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During the last years, global climate change has become an important scientific topic. Despite that most invertebrates are inactive during the winter and spend this time in diapause, some poikilothermic organisms stay active in winter. Low temperatures and limited available food reserves make the winter period unfavorable for most animals. Thus, their activity in low temperatures is usually dependent on a snow cover with a high insulation capacity. Winter activity of myriapods and woodlice has not been intensively studied till now. Obtained results are a part of large investigation studies on winter active invertebrates of the Central Poland. This study provides one of the very first systematic data on diversity and sesonal dynamics of this arthropods during winter. Myriapoda and Isopoda were collected using pitfall traps to catch them active on the ground, even under snow cover, during two winter seasons 2000–2002 in four nature reserves in Central Poland. Some samples were collected also from the snow surface. Among the nine myriapods, which were identified as winter active, five species of Diplopoda and four species of Chilopoda were distinguished. Two species of millipedes predominated in collected material: *Polydesmus complanatus* and *Julus scandinavius* and one centipede – *Strigamia acuminata*. Within the Isopoda one species *Protracheoniscus politus*, was clearly dominant in winter season. The results show that myriapods and woodlice are an element of subnivean invertebrate assemblage appearing on the snow surface only accidentally and may play a significant role in subnivean food chains. As winter active invertebrates are strongly dependent on weather and snow cover, changes in their annual cycles of activities may be well suited for observing the climate change. The depletion of snow cover in the temperate climate of Poland can make the study of winter active fauna impossible in the future.

Analysis of millipede microbiome and N-deposition

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The role of millipedes in nutrient cycling and decomposition is understudied. Particularly, millipedes' effects on the nitrogen cycle have not been examined. With the overabundance of nitrogen from fossil fuel combustion and nitrogenous fertilizer moving into natural systems, understanding the impacts of millipedes is increasingly important; additionally, nitrogen deposition may impact millipede overall health. To test the impacts of millipedes on nitrification, mesocosms were developed to model ecosystems with varying levels of nitrogenous soil pollution. Nitrate had three levels of treatment within the soil: ambient nitrate, +10 kg/ha, and +20 kg/ha. Furthermore, there were mesocosms with and without millipedes at all nitrate levels to examine how millipedes can impact the nitrogen cycle, and how added nitrates impact the millipedes' role in the nitrogen cycle. Millipedes (Xystodesmidae: *Cherokia georgiana georgiana*) were sexed at the beginning of the experiment and weighed at the beginning and end of the experiment. Nitrate levels were measured at the start of the experiment and after 5, 10, 20, and 30 days, after which the experiment was terminated. At these time points, leaf litter, soil, and fecal matter samples were collected to be analyzed for microbial biodiversity. Nitrification potential was measured at the start and end of the experiment. Millipede survival did not differ among treatment groups. Two time points (10 and 30 days) were used to elucidate the effects of and interactions between millipede presence and N-addition on microbial communities (bacteria and fungi via Illumina MiSeq). Preliminary results indicate that the ambient nitrate treatment had a higher bacterial richness than the +20 kg/ha nitrate treatment. Microbial richness differed by substrate, with soil highest, fecal intermediate, and litter lowest. Fecal communities were more similar to soil communities than litter communities, suggesting that the majority of the fecal microbiome originated from soil. This may provide some insight into *Cherokia* feeding. Surprisingly, fecal microbiome communities were unresponsive to nitrate levels in the soil, but did change over time.

Remarkable sexual dimorphism in Gosibiinae neotropical species (Chilopoda, Lithobiomorpha, Lithobiidae)

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Gosibiinae subfamily is the second with more number of species after Lithobiinae, but in Mexico is the Lithobiomorpha subfamily with the greater number of nominal species. As part of the second author master thesis project, a lot of morphological characters have been analyzed in order to redescribe the genera and species of Gosibiinae. Sexual dimorphism was observed but this has been poorly discussed in neotropical Lithobiomorpha species, overall in the subfamily under study, which has not been researched for several decades. Fresh and old specimens of *Labrobius*, *Delobius*, *Mexicobius* and *Atethobius* as well as unidentified specimens where analyzed and several and remarkable sexual dimorphic characters where found in the 14th and 15th tergal plates and in some podomeres of the 14th and 15th pairs of legs. All of them are clearly different and is possible use them to define species.

Insights about the Brazilian species of Oryidae (Chilopoda, Geophilomorpha), with new species of *Heniorya* and a barcoding analysis

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Orids are the largest geophilomorphs of the Brazil, both in number of leg-bearing segments and in body length. With registrations for all Brazilian territory, bibliographical data point to the presence of three genera and six species in this country: *Orphnaeus brevilabiatus* Newport, 1845, *O. brasilianus* Humbert & Saussure, 1870, *O. porosus* Verhoeff, 1937, *Heniorya longissima* Cook, 1896, *Notiphilides grandis* Brölemann, 1905 and *N. amazonica* Calvanese & Brescovit, 2017. In addition to the large number of leg-bearing segments, species of Oryidae can be distinguished from other geophilomorphs by the peculiar aspect of the mandibles and labrum, presence of 1–3 rows of paratergite and coxopleuron of the ultimate legs without pores. Although relatively well studied in the beginning and middle of the 20th century, the *Orphnaeus* species remain unclear, and there is no consensus as to the validity of *O. porosus* or on the introduction of the worldwide distributed *O. brevilabiatus*. So far, for *Heniorya* the only specimen recorded, the female holotype, is registered with locality only as "Brazil". The species of *Notiphilides* have been recently worked, however the lack of knowledge regarding to their distribution open gaps in the knowledge about the relation of their species. In this contribution we analyze the morphology of the Brazilian Oryidae from scientific collections and specimens obtained in field. On recently collected material, we sequenced the COI mitochondrial marker for specimens of *Heniorya*, *N. amazonica* and *O. brasilianus*, and compared to sequences obtained in GenBank for *O. brevilabiatus* and *Bothriogaster signata* Kessler, 1874 (Himantariidae) we calculate the distance between the species. Results of the sequence analysis indicate a shorter distance between species of *Heniorya* and *Notiphilides*, and we identify two distinct species of *Heniorya* for the State of Bahia, corroborated by both morphological and molecular data. As for *Orphnaeus*, we find morphological evidences that corroborate with the synonymy of *O. porosus* in relation to *O. brasilianus*, and molecular and morphological evidences that the variation *O. brasilianus nigropictus* Attems, 1903 (invalidated by Kraus in 1957) is a diverse species. We also discuss the possibility that *O. brevilabiatus* do not occurs in Brazil, and the Brazilian specimens related to this species in fact are exemplars of *O. brasilianus nigropictus*.

Alien centipede species in Brazil

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Alien species are species introduced outside its natural past or present distribution. The presence of alien species may lead to changes in the structure and composition of ecosystems, affecting ecosystem services, human economy and wellbeing. Species introduction may occur with intentional or accidental human assistance, by the movement and transportation of people and goods around the world. Alien species are the most common threat to amphibians, reptiles and mammals assessed by IUCN Red List. Arthropods are a common, abundant and functionally important group of organisms in most ecosystems which may also be sensitive to alien species presence. Among arthropods, centipedes (Myriapoda, Chilopoda) are known for its predatory behavior, being able to prey on other arthropods and even on small mammals. The earliest record of an alien myriapod dates back to 1836. At the present there are about 40 species regarded as alien in Europe. Here, we analyzed distribution data of non-endemic centipedes occurring in Brazil. Specimens from three of the major zoological collections in Brazil were examined: Instituto Butantan (IBSP), Museu Nacional/Rio de Janeiro (MNRJ), and Coleção Zoológica/Universidade Federal de Mato Grosso (CZUFMT). A total of eight species were regarded as aliens in Brazil; three scolopendromorphs: *Rhysida longipes* (Newport, 1845), *Scolopendra morsitans* Linnaeus, 1758, and *Scolopendra subspinipes* Leach, 1816; three geophilomorphs: *Mecistocephalus guildingii* Newport, 1843, *Orphaneus brevilabiatus* (Newport, 1845), and *Orphaneus brasilianus* (Humbert & Saussure, 1870), and two lithobiomorphs: *Lithobius obscurus* Meinert, 1852, and *Lamyctes emarginatus* Newport, 1844. A total of 231 specimens were examined. All of the eight species are known for its distribution in other continents than Americas. Our results show that alien species are always restricted to urban areas in Brazil. Some of them (*Rhysida longipes*, *Scolopendra subspinipes*, and *Mecistocephalus guildingii*) may be found in houses and buildings in neighborhoods very close to urban protected areas, but not inside the areas, which may be an evidence of the restriction of its occurrence only in urban areas. Our results also show that possibly the Mediterranean *Scutigera coleoptrata* Linnaeus, 1758, known as the "house centipede", may also occur in Brazil. The species has been registered in Argentina and in the border of Uruguay and Brazil, and it seems really close to *Brasiloscutigera viridis* Bücherl, 1939, which occurs in southern Brazil. However its type has been lost and it could not be confirmed. So far, we do not have evidence on serious threats caused by alien centipedes to Brazilian economy or its impact to native biodiversity. Our data may be deepened with the examination of other Brazilian zoological collections, which would expand distribution data of the species regarded as alien to Brazil.

Male secondary sexual characters of *Lithobius* and two new species of centipedes from Taiwan (Chilopoda, Lithobiomorpha, Lithobiidae)

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The male secondary sexual characters are diverse in Taiwanese *Lithobius*. Takakuwa (1939) described that several longitudinally long setae were present on the ventral surface of male tibia 15 in *L. trichopus*. Chao et al. (2018a) described a small tunnel at the top of a longitudinal excavation on the dorsal surface of 14th tibia in male *L. ongi* Takakuwa, 1939, and the tunnel and bottom of the excavation bearing numerous small pores. Chao et al. (2018b) described a large ventral swelling on male 15th femur in *Lithobius* (*Monotarsobius*) *meifengensis*, and the apical region of the swelling bearing numerous small pores. We here add the descriptions of male tibia 15 in *L. trichopus*, about 40 long setae longitudinally arrange on the outer ridge of the ventral excavation, and most setae concentrated in the posterior ridge. We also describe two other types of the male secondary sexual characters in two new species from Taiwan, *Lithobius keelungensis* **sp. n.** and *Lithobius* (*Monotarsobius*) *qingquanensis* **sp. n.**

Description of *L. keelungensis* **sp. n.**: body length about 13 mm; body dark brown; 20 elongate antennal articles; 7–9 ocelli arranged in three irregular rows, [1 + 2, 3(4), 2(1)], posterior ocellus largest, two posterosuperior ocelli large, ventral seriate ocelli smallest; Tömösváry's organ larger than adjacent ocellus; 2+2 coxosternal teeth; porodonts posterolateral to the outer tooth; all tergites lacking posterior triangular projections; TT1, 3 and 5 with complete posterior ridges; T7 slightly rectangular, 0.5 times as long as wide, posterior margin of T7 straight; posterior margin of TT1, 3, 5, 8, 10 and 12 concave, posterior margin of T14 lateral deeply concave, middle straight; all tarsi well-defined; coxal pores 4–6, round; male secondary sexual characters on 14–15th femurs and tibiae markedly thick, and 14–15th femurs with a deep furrow on each dorsal surfaces; male 14–15th tibiae oval, with a wide shallow excavation on each dorsal surfaces; female gonopods with 2+2 sharp coniform spurs, terminal claw undivided, a small sharp lateral denticle on the base of terminal claw; male gonopods short and small, as a semi-sphered bulge with three long setae.

Description of *L.* (*M.*) *qingquanensis* **sp. n.**: body length about 8mm; body colour brown; 17–18 elongate antennal articles; 3 ocelli arranged in one row, middle ocellus largest; Tömösváry's organ in front of ocelli, slightly small than anterior ocellus; 2+2 coxosternal teeth; porodonts posterolateral to the outer tooth; all tergites lack posterior triangular projections; TT1, 3 and 5 with continuous lateral and posterior ridges; posterior margin of TT1, 3, 5, 8, 10 and 12 weakly concave, posterior margin of T14 concave; tarsi fused on legs 1–13; male secondary sexual characters on the dorsal surface of 15th femur, a small wart-like outgrowth with about 15 slightly curved setae on the posteroinner surface; coxal pores 3433, round; male gonopods short and small, as a semi-sphered bulge with two long setae.

Two new species of centipedes from Southwestern China

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The centipedes of Southwest China were rarely investigated. We studied new material collected from Dali, Weibaoshan, Lijiang, Lufeng, and Chengjiang, Yunnan Province, China. We revealed two new species of centipedes, *Tygarrup daliensis* **sp. n.** and *Australobius cangshanensis* **sp. n.**.

Tygarrup daliensis **sp. n.** differs from other *Tygarrup* species by its each side of clypeal plagula with up to 15 setae; the labral posterior ala un-smooth, with longitudinal slanting stripes near to the mid-piece tooth; apical claw of second maxillary absent; and each coxopleuron of last leg-bearing segments with ca. 50 pores of various size. The other characters are as follows: body length about 40 mm; invariantly with 45 leg-bearing segments; body colour yellow with dark patches; speculum absent; a seta on the each antero-external corners of the clypeal areolate part; mandible with 8 pectinate lamellae, 1st lamella bearing 5 teeth, an average intermediate lamella bearing ca. 10 teeth; forcipular articles I with a large denticle, II and III each with a small denticle, tarsungulum without basal denticle; sternal sulcus apparently not furcated; sternite of last leg-bearing segment about 1.2-times as long as wide; a large anal pore on each ventro-lateral sides of telson.

Australobius cangshanensis **sp. n.** is distinguished from congeners by a row of about 60 short setae transversely on each posterior part of 6th and 7th sternites; forcipular coxosternite with 10+9 or 7+8 coxosternal teeth, porodonts slender, between 5th and 6th inner teeth with 9 or 10 teeth or between 4th and 5th inner teeth with 7 or 8 teeth. The other characters are as follows: cephalic plate smooth, wider than long, cephalic plate markedly wider than all tergites; antennae with 23 elongate articles, distal article up to 3.5-times as long as wide; eight ocelli, [1+4, 3], arranged in two irregular rows; Tömösváry's organ moderately small, slightly smaller than adjacent ocelli; all tergites without posterior triangular projections; TT1, 3, 5, 8, 10 and 12 with continuous lateral and posterior marginal ridges, other tergites with lateral marginal ridges; coxal pores 5–7, most of them ovate, few round; tarsi well-defined on all legs; no male secondary sexual modifications; female gonopods with 2+2 or 3+4 spurs, terminal claw undivided; male gonopods short and small as a semi-sphere bulge, with two long seta.

Cave biodiversity of Wulong and Jinfo Mountain Karst in Chongqing, China

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Chongqing area is a typical subtropical karst landscape, which is composed of Wulong and Jinfo Mountain World Natural Heritage Site of South China Karst. In August of 2018, cave biodiversity has been surveyed of 11 caves in these areas. Based on the preliminary collected specimens, more than 40 species of cave animals have been found. In summary, the cave biodiversity is relatively rich in this area, which has important value for scientific research and biological conservation.

A new species of *Epiperipatus* Clark, 1913 from a rainforest of Panama (Onychophora, Peripatidae)

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The Isthmus of Panama is a land bridge in the Americas (formed about 3 million years ago) that transformed land ecosystems in South and Central America. Although the Isthmus constitutes a vital part of Americas biodiversity, it is suggested that there are many species underestimated in the region. The onychophoran fauna of the Panama is an example of unknown diversity. The last study on onychophorans from Panama was carried out eighty years ago, however, recent studies suggest the presence of more species in the country. Seven species from five genera of Onychophora occur in Panama: one *Heteroperipatus*, one *Macroperipatus*, one *Peripatus*, two *Oroperipatus*, and two *Epiperipatus*. Here we present a new species of *Epiperipatus* from San José de David city, province of Chiriquí, in Panama. The specimens were collected in 2014 in a small fragment of tropical humid forest in the Puntarenas-Chiriquí biogeographical province. The new species is described based on the study of four female specimens hosted at the Museu de Zoologia da Universidade de São Paulo (Brazil). We examined its morphology and also their DNA fragments (18S, 16S rRNA and COI) that were sequenced aiming to phylogenetic studies. The new *Epiperipatus* species presents conspicuous dorsomedial furrow and very small accessory papillae on the furrow between the plicae. The primary papillae has a roundish dome insertion and asymmetrical regular spherical apical piece. Basal piece with a range of at least seven to ten ranks. Apical piece with two posterior scale ranks. Dental formula of inner and outer jaws, respectively: 1/1 and 1/2/12. The accessory tooth is thinner in the outer jaw. The second accessory tooth is reduced in the inner jaw. At least 29 pairs of legs. Males are unknown. The new species is nested in *Epiperipatus* due to the position of nephridial tubercles among to the third and fourth spinous pads of the fourth and fifth legs, and the roundish insertion of the primary papillae. Additionally, previous molecular studies give support for a new taxon (Peripatidae sp. in Giribet et al. 2018). The new species differs from *Epiperipatus biolleyi* and *Epiperipatus vagans* due to the robust apical piece and the presence of two incomplete fold, respectively. As onychophorans are highly susceptible to environmental changes and threatened by human activities, the new species may be considered as threatened with extinction. The new *Epiperipatus* species is the third species of *Epiperipatus* from Panama.

Comparative studies of millipede species (Diplopoda) in forest of Lublin region, Poland

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Research on the species composition and the dominance structure of the millipede assemblages was conducted in 2018–2019 on four study plots differing in the age of tree stand, light conditions and soil humidity: *Potentillo-Quercetum*, *Querco roboris–Pinetum*, and in ecotone of *Pinus sylvestris*. Species composition at the particular sampling sites was not similar. Altogether, the millipedes include *Glomeris hexasticha*, *Strongylosoma stigmatosum*, *Polydesmus complanatus*, *Leptoiulus proximus*, *Ommatoiulus sabulosus*, and *Proteroiulus fuscus*. The reserve Las Królewski is located near the village of Krzczonów, reserve Chmiel, and Olszanka are located near Chmiel and Olszanka villages, respectively. Kozłowiecki Forest North of Lulin predominantly belongs to *Querco roboris–Pinetum* and *Pin-Quercetum*.

Leg morphology and muscle systems in millipedes investigated utilizing synchrotone micro-CT (Myriapoda, Diplopoda)

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In the course of a large scale project funded by the German Science Foundation (DFG), 48 millipede species, covering all 16 orders and 38 different families representing the morphological diversity of the class Diplopoda were examined with the help of Micro-Computed Tomography. The samples were preserved in Ethanol or Bouin, critical point dried, and scanned at the high-resolution DESY, PETRA III synchrotrone in the P05 beamline in Hamburg, Germany. From this treasure chest of morphological information, the composition and muscular system of the walking legs of 20 millipede taxa were investigated in great detail, including computer-aided 3D-reconstructions. Furthermore, macro photographs of the posterior view of the legs of 16 species were taken. While the legs of all Diplopoda look superficially similar, a surprising variety in the anatomy, regarding e.g. the number of leg podomeres, varying between six and eight, or the attachment points of muscle tissue, can be observed.

The myriapod collection at the University Museum of Bergen, Norway

Per DJURSVOLL

Natural History Collections, University Museum of Bergen, Bergen, Norway

The myriapod collection at the University Museum of Bergen, Norway is digitized and published online to *GBIF.org* by using MUSIT (The Norwegian university museums database). Currently 3719 catalogue numbers, each representing a unique sample identified to species or genus rank, are recorded and geo-referred. Most of the samples are collected in Norway: 1816 Diplopoda, 893 Chilopoda, 42 Symphyla and 10 Pauropoda.

This collection has been started by Prof. Hans Kauri in the late 1950's. Later Bjarne Meidell, Åge Simonsen and Per Djursvoll have contributed to the largest collection of myriapods in Norway. There are still about 20% not digitized from different faunistical projects.

They are safely housed in a new building with good climate control constructed for alcohol samples, and are easily accessible.

On the identity of *Craspedosoma rawlinsii simplex* Němec, 1896

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Bohumil Němec (1873–1966), otherwise a famous plant physiologist, described six new taxa of millipedes. Two of them are still valid [*Choneiulus palmatus* (Němec, 1895) and *Leptoiulus proximus* (Němec, 1896)] and three were synonymised [*Strongylosoma vejdovskyi* Němec, 1895 = *Strongylosoma stigmatosum* (Eichwald, 1830), *Blaniulus armatus* Němec, 1895 = *Nopoiulus kochii* (Gervais, 1847) and *Julus coerulans* Němec, 1896 = *Kryphioiulus occultus* (Koch, 1847)]. The sixth taxon, *Craspedosoma rawlinsii simplex* Němec, 1896, however, remained neglected. Since its description, it was never quoted in any publication. In the "Review of animal species described from the Czech Republic" (Bezděk 2011), it is thus considered a *nomen dubium*. The subspecies (or variety) was described based on specimens (i.e. syntypes) from five localities (i.e. type localities) in Bohemia: Prague – Chuchle, Ohrobec – Károv, Dolní Břežany – Jarov, Lovosice – Oparenské Valley, and the valley near the Bradlec Hill. The differential diagnosis was based on several characteristics of male gonopods. In Němec's collection deposited in the National Museum in Prague, only a single female from Jarov was found, thus not enabling us to make any decision on the subspecies based on type material. To solve the status of *C. rawlinsii simplex*, we collected fresh material (including males) from two of the type localities (Jarov and Károv) enabling us to compare male gonopods. For the study, we used both optical and scanning electron microscopy. We conclude that *Craspedosoma rawlinsii simplex* is a subjective junior synonym of its nominal taxon, *Craspedosoma rawlinsii* Leach, 1814 (Dolejš & Kocourek in prep.).

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Three new species and new recorded habitat of the Pauropoda was found in China

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In the past year, we collected pauropod samples from the Motuo County in southeastern Tibet, China, and also collected samples from some islands in southern China. We identified and reported three new species: *Decapauropus biconjugarus*, *Decapauropus tibeticus* and *Hemipauropus quadrangulus* belonging to Pauropodidae. Among these three species, the genus *Hemipauropus* is the first recorded in China. This research on the pauropods is the second time from Tibet, and increases the taxonomical number of the Pauropoda from one family, one genus to two families and three genera from Tibet. On the islands in southern China, we found a member of the family Sphaeropauropodidae. This family was found in China again after thirty years, and it is the third time recording the distribution of the Sphaeropauropodidae in China. We have known the family to be distributed in Motou, Shennongjia, and Wailingdin island. The environment of these areas are different, so we concluded that this family has higher adaptability and diversity.

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Elevational diversity and endemism of cave diplopods: examples from Dinaric Karst

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Dinaric Karst, situated in western part of Southeast Europe, is the world hotspot of subterranean biodiversity, with high number of cave-adapted species, abundant populations, and several distinct faunal elements, such as the only known cave sponge, cnidarian, bivalve, polychaete and flying troglobiont insect. Subterranean biodiversity is not equality distributed in Dinarides. Two centers of endemism and high diversity are detected: the north-west part and the south-east part of this mountain range are known as "hotspots within hotspots" of subterranean fauna. Diplopod fauna is also specific, with numerous endemic species and genera. Some of these peculiar taxa are restricted to higher elevations. Here we present data for two Dinaric mountains, Velebit and Biokovo, both of them showing similar diplopod elevation pattern. Caves and pits situated in mountain foothills harbour in most cases common or widespread troglophile diplopods, while on higher elevation specific troglobitic fauna occurred. Elevated plateau on mountain Biokovo (above 1300 m) is the outstanding local hotspot of subterranean diplopod diversity, represented by *Balkanodesmus biokovensis* Antić & Reip, 2014 and *Biokoviella mauriesi* Mršić, 1992, both genera being endemic to Dinarides. Southeast part of Velebit is represented by *Velebitodesmus cavernicolus* Antić & Reip, 2014, *Brachydesmus likanus* Strasser, 1962 and still undescribed troglobiont species from family Glomeridae. These findings imply that elevation is also important factor in shaping subterranean diversity and endemism. Future research of high elevation caves and pits systems will surly reveal new faunistic elements of diplopods and subterranean fauna in general.

The centipede (Chilopoda) fauna of Kazakhstan

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Kazakhstan is the largest country in Central Asia; more than 50% of this territory is covered by deserts and semi-deserts, about 35% is covered by steppes. Large mountains are situated in the southern, eastern and northeastern parts of this territory; central part is occupied by uplands. In course of years 2016–2019 centipede fauna of Kazakhstan was studied. Several expeditions were carried out in western, southern and eastern parts of the country. Materials from the collections of the Moscow State University, Perm State University and Altai State University were also examined.

At present, 50 species of centipedes belonging to 20 genera, 10 families and 4 orders are known to occur here. Among them, 20 species (40% of centipede fauna) and 2 genera (4% of centipede fauna) seem to be endemic. Most of them are members of the order Lithobiomorpha (15 species, 30% of centipede fauna; 46% of lithobiomorph fauna of Kazakhstan), while Geophilomorpha members are represented by 4 endemic species (8% of centipede fauna; 26% of geophilomorph fauna) and Scutigeromorph centipedes by 1 species (2% of centipede fauna; 50% of scutigeromorph fauna).

The highest richness and distribution of endemic taxa within this territory are irregular. The most number of species (33 species, 67% of centipede fauna of Kazakhstan) are related with mountains: Kazakh part of Altai Mts (11, including 1 endemic species), Dzhungarian Alatau (11, including endemic lithobiomorph genus *Dzhungaria* and 7 endemic species), Northern Tian-Shan (11, including 3 endemic species), Western Tian-Shan (4, including endemic geophilomorph genus *Krateraspis* and 3 endemic species) and Tarbagatai Mt Range (6, including 1 endemic species).

To date, 5 species from 4 genera, 4 families and 3 orders are known as anthropochore introductions: *Scutigera coleoptrata*, *Lamyctes emarginatus*, *Lithobius crassipes*, *L. forficatus* and *Geophilus proximus*.

The taxonomic status of 10 taxa from 3 orders need to be clarified: *Escaryus* sp. (Karatau Mt Range), *Geophilus* cf. *procerus* (vicinity of Almaty City), *Stigmatogaster* sp. (Western and Northern Tian-Shan) and *Strigamia* cf. *transsilvanica*, *Lithobius* cf. *juniperius*, *L.* cf. *stajnegeri*, *Lithobius* sp. 1, *Lithobius* sp. 2, *Escaryus* sp. (Kazakh part of Altai Mts), *Allothereua kirgisorum* (eastern Kazakhstan).

Present study refined distribution of 20 centipede species and added 8 species as new to the fauna of Kazakhstan (including family Linotaeniinae, genera *Arctogeophilus*, *Strigamia*, *Scutigera*, *Lamyctes*). Besides, 2 species described as new to the science: *Lithobius monocoxaporus* and *L. trisspurus*.

However, there can be no doubt that the level of chilopod richness in the country is far greater, because a significant part of Kazakhstan is still unstudied, while the centipede fauna is highly original, being characterized by a high rate of endemism.

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Do you have a glue? – A characterization of the defense secretions of three different centipede species

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Centipedes are known for their hunting behaviour with the use of highly lethal venoms. Beside this toxic predation strategy, some centipedes defend themselves through a fast secreting glue. In geophilomorphs this glue is produced in sternal glands, which are located on the ventral surface of each sternite. The current project focuses on the characterization of three centipede species (*Henia vesuviana*, *Haplophilus subterraneus* and *Strigamia maritima*) with the aim to characterize the chemical properties of the defensive glue components. This comparative study provides insights into the diversity of epithelial secretions in centipedes and thus elucidates the process of glue synthesis and secretion in this large arthropod taxon. The project aims to provide a chemical characterization of the glue as well as a description of morphological differences in the gland system between the three centipede species. EDX (energy dispersive X-ray spectroscopy) data show a higher sulfur concentration in the glue of *Haplophilus subterraneus* than in *Henia vesuviana*. Lectins are compounds that react specifically with defined carbohydrate structures and using them to stain glue particles gives information on the proteins present in the adhesives. Recently performed affinity tests with lectins showed a clear specificity for a few lectin-binding proteins in the glue of *Haplophilus subterraneus* and *Henia vesuviana*. Some lectins (*Galanthus nivalis* lectin-GNL, peanut agglutinin-PNA) are present in both species. Others show a high affinity for concanavalin agglutinin (ConA) and *Griffonia simplicifolia* lectin (GSL) in *Henia vesuviana* or wheat germ agglutinin (WGA) and *Sophora japonica* agglutinin (SJA) in *Haplophilus subterraneus*. Following, a biochemical and transcriptome analyses will serve to determine glue-specific gene signatures in the sternal glands.

First record of centipedes of the genus *Schizonampa* Chamberlin, 1914 (Geophilomorpha, Geophilidae) from Brazilian caves

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Geophilomorphs outnumber all other orders of centipedes, not only in species richness, but also in number of families. They are considered as an advantageous group for colonization of underground environments, because they present pre-adaptations to live in the hypogean environment, such as nocturnal habit, cryptobiotic and non-visual orientation. Of the 13 families known for the order, seven occur in Brazil: Geophilidae, Ballophilidae, Oryidae, Mecistocephalidae, Macronicophilidae, Aphilodontidae and Schendylidae. Geophilidae is a highly diversified family with about 560 species classified in 100 genera. The genus *Schizonampa* presents three species described so far, one species from Pará state, Brazil (type locality of the genus), and two species from Africa (Congo and Liberia). Here, new records of the genus confirm its presence in Pará state, register the genus in caves for the first time, and present a new species. Four specimens (3 ♂; 1 ♀) of *Schizonampa* hosted in the Instituto Butantan, São Paulo, Brazil, were examined. The specimens were collected in two Brazilian caves in the Amazon Forest, inserted in the iron ore lithology, in the cities of Parauapebas and Canaã dos Carajás, Pará, Brazil. *Schizonampa* species' present body length reach to 10–20 mm, 37–53 leg pairs; head and forcipules elongated; telopodites of the second maxilla with lateral projections; sternites without pores; coxal organs opening in two ventral cavities in each coxopleron; and a spiny tuber on the tip of the legs. The new species here described shares all those characters, except the absence of sternal pores, which are present in the posterior part of the body in the new species. It was also observed asymmetry in the antennas in one of the specimens, corroborating with recent studies that evidenced this characteristic in geophilomorphs from subterranean environments. The present work expands *Schizonampa* distribution, and brings new information on the taxonomy of the genus. This new data reinforce the importance of caves conservation, which gathers high endemic species, and are habitats under great threat.

Lithobius forficatus (Linnaeus, 1758): First complete 3D documentation with a special emphasis on the female reproductive system (Lithobiidae, Lithobiomorpha)

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The female reproductive system of the family Lithobiidae was examined and described in detail for only a few species such as *Lithobius forficatus* (Linnaeus, 1758), *Eupolybothrus transsylvanicus* (Latzel, 1882) and *Harpolithobius banaticus* Matic, 1961. The two-dimensional line drawings and histological sections presented in these studies provided a good understanding of the internal organs of the reproductive system and their microanatomy. However, spatial information, e.g. the natural position and shape of the organs in situ and their relative position and size are hitherto lacking.

In the present study, we explore and document, for the first time, the female reproductive system of *L. forficatus* based on volumetric data and three-dimensional reconstruction of an adult specimen obtained with micro-computed tomography (μCT). High resolution scans of the posterior body part enabled us to identify and isolate the different constituents of the reproductive system, including paired sausage-shaped seminal receptacles, two paired accessory glands, the genital atrium, the ovary including eggs and the oviduct. This information represents the first 3D reconstruction of the most common *Lithobius* species in Europe, and a detailed information on the reproductive system of the family Lithobiidae in general. The information further allowed us to complete the existing description for this species and compare it to other species and genera of the same family viz. *Eupolybothrus grossipes* (C.L. Koch, 1847) (unpublished data), for which studies are still in progress. As a next step, the reproductive system of more lithobiids of both sexes will be explored using the same methodology to search for potential apomorphic and plesiomorphic characters within Lithobiidae.

Subterranean biodiversity and depth distribution of myriapods in forested scree slopes of Central Europe

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Forested scree slopes represent one of the unique shallow subterranean habitats (MSS) with the presence of characteristic fauna. Weathered rock and sediments, covered by the layer of soil, create isolated and stable conditions, similar to those in cave environment. Air-filled voids in scree slope habitats form interconnected network of corridors, suitable as shelters for various groups of invertebrates. Due to stable condition and climate different from surrounding habitats they also serve as a refuge for relict fauna. Depth distribution and diversity of myriapods in various forested scree slopes were studied at 11 locations of 7 different geomorphological units of Slovakia and the Czech Republic in the period 2005–2016 using subterranean traps. Each trap consisted of 110 cm long perforated PVC tube (approx. 10 cm in diameter), with 10 cups located gradually at 5 to 95 cm below the soil surface. As a fixative solution, either 4% formaldehyde or water solution of ethylene-glycol were used. Traps were exposed for more than a year at each of the studied locations. In addition, at several locations, long-term continuous temperature measurements were carried out in place of buried traps. Forested scree slopes have distinctive temperature regime and the temperature stabilizes with depth. In total, 13 individuals of symphylans (not identified), 281 individuals of centipedes (23 spp.) and 572 individuals of millipedes (32 spp.) were sampled. At none of the study sites were myriapods the dominant component of macrofauna. The overall depth distribution of both, centipedes and millipedes, appeared to have relatively similar pattern, with both groups being found at all depth levels. Nevertheless, this pattern depends on locations. Although it is hard to generalize, the presence of MSS was evident, as clearly higher trapped numbers of myriapods at depths 65-95 cm were observed on several localities. On those localities, millipedes were more numerous in deeper layers than centipedes. Forested scree slopes are largely colonized by forest, surface-dwelling species. Some epigeic species were sporadically distributed along the whole depth gradient, but concentrated at the soil surface, while some subterranean species were recorded in the deepest parts of the gradient. Subterranean species, such as the centipede *Lithobius lucifugus* and the millipedes *Geoglomeris subterranea*, *Cibiniulus slovacus* and *Archiboreoiulus pallidus*, were found. These species occur very rarely, or not at all, in the surface habitats in Central Europe. Massive at least seasonal migration of soil macrofauna from the surface to the deeper subterranean habitats was not confirmed. The study of deeper layers of forested scree slopes reveals another dimension of heterogeneity of the environment affecting overall biodiversity, but also unveils refugia of rare fauna.

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Is the Jurassic "millipede" *Decorotergum* a peracarid crustacean?

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Although the Jurassic arthropod *Decorotergum warrenae* Jell, 1983 has been accepted as being a millipede, the original two interpretations of the fossil as either an oniscomorph or a polydesmid millipede have not been accepted by specialists. The taxon does have characters that could be interpreted as those of a millipede, including multiple similar segments, constricted "prozonites" and expanded "metazonites", and a rounded cross-section. "Pleurites" as originally described, however, are more probably coxal segments, and the number of preserved tergites (evidently based on its interpretation as an oniscomorph) is less than the 13 as originally described. The tergites also differ from those typical of millipedes as the posterior of the "prozonite" is more distinctly separated from the "metazonite" than in most millipedes and some of these tergites have ventral borders with a broad invagination that partially surround the coxae.

This fossil can be alternatively interpreted as a crustacean. Some peracarid isopod fossils, for instance, bear a resemblance to *Decorotergum* in having tergites with ventral borders that have an invagination that partially surrounds coxae of appendages. Phreatoicidean peracarid isopods are also known from the Triassic of Australia.

There is a long history of other organisms (other types of animals, including crustaceans, and plants) having been identified as myriapods, and of myriapods being identified as other organisms (animals and plants). Reassignment of *Decorotergum* to the Crustacea would eliminate the only record of a millipede from the Jurassic.

The Good, the Bad and the Future: Myriapodology in Hamburg after a century of systematic research

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The Good: The Zoological Museum in Hamburg houses significant collections of millipedes and centipedes, including more than 1000 species of millipedes, 400 centipede species and roughly 600 type series. The collection goes back to Karl Kraepelin who worked extensively on scolopendrid centipedes and is one of the fathers of systematic myriapodology. **The Bad:** Active research on this group in Hamburg ceased in the past decades and the collections are poorly documented and not catalogued. **The Future:** New exciting projects are on the horizon: Danilo and Nadine are currently working on richly illustrated type catalogues and lead major digitization projects aiming to document the collections. Stephanie and her student Valentin are working on *Sinocallipus* millipedes (family Callipodidae) from south-east Asia and investigate patterns of cave adaptations – molecular and morphological – in one of the rarest millipede lineages. Stelios will join us next year and analyze data from centipedes to test predictions of island biogeography in the Aegean Archipelago of Greece, one of the most dynamic and complex island regions in the world. Please see his poster! Myriapod research is finally back in Hamburg and we are picking up the good tradition!

Fragments of woodland in rural landscape as the refugees for myriapods

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Fragments of woodland fulfil many irreplaceable functions in the agricultural landscape including being the main source of biodiversity of soil invertebrates. Due to intensive farming and land consolidation, especially in the second half of the 20th century, fragments of woodland in agricultural landscape almost disappeared. This has led to a decrease in the diversity of invertebrates, especially those for which the presence of these woodland habitats in the landscape is a key element for survival. Aim of our study was to evaluate the importance of forest fragments (characterised by their area, vegetation structure, the amount of leaf litter layer and soil humidity) on the distribution of centipedes and millipedes in the agricultural landscape of South Moravia (Czech Republic). Myriapods were collected using pitfall traps during summer in 2016 and 2017. Our results showed that the number of species increased with increasing numbers of individuals in the catch and abundance of myriapods was positively correlated with thickness of leaf litter layer. Moreover, the diversity of myriapods was positively correlated with increasing size of forest fragments although higher myriapod diversity was found in a rather uniform woodlands in term of diversity of tree species.

Ultrastructural features of adipocytes in the parietal fat body of *Apfelbeckia insculpta* (L. Koch, 1867) (Diplopoda, Callipodida, Schizopetalidae)

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The millipede fat body plays an important role in storage of lipids, glycogen, proteins and uric acid. Also, this organ represents a site for the storage of waste metabolites. The fat body is a relatively large organ that can be found throughout the millipede body. The portion of the fat body located underneath the integument is known as the parietal fat body, while the central mass of this organ that surrounds the internal organs and fills the body cavity is known as the perivisceral fat body.

The basic cell type of the fat body is the adipocyte, while another cell type, i.e. the oenocyte, can also be found in this organ. So far, several studies have addressed morpho-anatomical features of the fat body in Diplopoda, but none of them focused on any aspect of fat body biology in representatives of the order Callipodida. The aim of this study was to describe morphological and ultrastructural characteristics of adipocytes located in the parietal fat body of the callipodidan millipede *Apfelbeckia insculpta* (L. Koch, 1867).

Tissue samples for light microscopy were fixed by immersion in 4% neutral buffered formaldehyde, dehydrated and embedded in Paraplast. Sections were stained with hematoxylin and eosin. The procedure of preparation of samples for transmission electron microscopy included fixation in a 3% solution of glutaraldehyde in 0.1 mol/dm3 cacodylic buffer (CB) (pH 7.4) and post-fixation in a 1% solution of osmium tetroxide (OsO_4) in 0.1 mol/dm3 CB. The tissue was then rinsed in CB and incubated in a 4.8% aqueous solution of uranyl acetate. After dehydration and embedding, the samples were cut into semi-thin (stained with toluidine blue) and ultra-thin sections and observed with an Olympus BX41 microscope and a Fei Morgagni 268D or CM12 transmission electron microscope.

The parietal fat body in *A. insculpta* is a loose whitish tissue arranged in thin cords. Adipocytes are relatively large and organized in clusters. The cytoplasm of these cells is rich in organelles appearing as round or oval bodies with heterogeneous content and different electron densities. Some of them are large and lipid filled, while others are presumably protein bodies. Between or around these organelles, a large quantity of glycogen can be observed. Also, adipocyte cytoplasm contains a well developed granular endoplasmic reticulum dilated in some cell regions. The nucleus is oval and has an eccentric position, while small, tubular-type mitochondria are located peripherally. Further studies of morphological, chemical and physiological features of the fat body in Diplopoda will contribute to a better understanding of the nature of this organ and the role(s) it has in millipede biology.

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Millipedes (Diplopoda) from the town of Zamość, Poland

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The investigated sites were represented by suburban areas, parks, gardens, lawns and cemeteries, abandoned and ruderal areas, composts and green houses in Zamość, Poland.

The sampling took place from 2014 within the studied sites up to the present time.

The family Julidae was characterized by 9 species: *Proteroiulus fuscus*, *Blaniulus guttulatus*, *Choneiulus palmatus*, *Kryphioiulus occultus*, *Cylindroiulus caeruleocinctus*, *Cylindroiulus latestriatus*, *Ommatoiulus sabulosus*, *Unciger foetidus*, *Leptoiulus proximus*.

Polyxenidae and Glomeridae were represented by one species: *Polyxenus lagurus* and *Glomeris hexasticha*, respectively.

The recorded species *Brachydesmus superus*, *Polydesmus inconstans*, *Polydesmus complanatus*, *Strongylosoma stigmatosum*, and *Oxidus gracilis* belong to Polydesmidae.

Some individuals of the cosmopolitan *Oxidus gracilis* have been found, during scorching period of late summer, under the plant pots.

The biodiversity of the species were noted in the suburban areas, gardens and parks.

Population structure of *Cylindroiulus caeruleocinctus*, was analyzed between 2017–2019 in gardens and in residential houses. Regular increase of individuals has been observed in subsequent years, *C. caeruleocinctus* must be treated as a nuisance pest.

The fine structure of midgut epithelial cells in starved and re-fed *Lithobius foricatus* (Chilopoda) specimens

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The centipede digestive system is divided into three sections – the foregut, the midgut as the middle region and the hindgut as the posterior intestine. The midgut is responsible for digestive processes, it participates in the storage of reserve substances, the detoxification of toxic substances that can be taken with food and penetrate from the external environment. Its epithelium consists of three types of cells – regenerative, secretory (probably endocrine) and digestive. Many external factors may contribute to anomalies in the structure of the midgut epithelium. One of such stressors is the starvation, when there is the lack of food in environment. During different periods of starvation caused by the lack of food, animals increase their ability to survive by activation different mechanisms which participate in homeostasis maintenance. The aim of this study was to describe processes of the cell death (autophagy, apoptosis, necrosis) in midgut epithelial cells of one of centipede species *Lithobius forficatus*. It is a well-known and a widespread European species, that lives under upper layers of soil, under stones, litter, rocks and leaves. It is also commonly found in human habitats, e.g. gardens and parks. This species is a predator, but also feeds on litter with organic and inorganic matter (omnivorous species). The material was collected in forests of Poznań (Poland). Animals were divided into experimental groups: C – control group, S1 – starved for 2 weeks, S2 – starved for 2 weeks and re-fed for 1 week, S3 – starved for 2 weeks and re-fed for 2 weeks, S4 – starved for 2 weeks and re-fed for 3 weeks. Due to histochemical staining (Sudan black B, Bonhag method, PAS method) and transmission electron microscopy (TEM), it was possible to show the effect of starvation on the midgut epithelium and the accumulation of the reserve substances in the cytoplasm of digestive cells. We can conclude that the starvation affects the midgut epithelium while the re-feeding enables cells regeneration and the accumulation the reserve materials de novo.

Sensing from both ends? Functional morphology of scutigeromorph ultimate legs

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The arthropodium can be regarded as one, if not the eponymous key innovation of arthropods. In taking on a sheer plethora of functions, arthropodia are one of the most versatile, most specialized, and thus probably one of the most widely modified features known in arthropods. Besides the head with its sensory and feeding appendages, it is the posterior end of centipedes that shows a considerable disparity of appendages, namely the ultimate legs.

In all centipedes, this last pair of legs displays a huge morphological but also behavioural diversity, implying that these transformations are by no means restricted to its outer morphology. In fact, this particular centipede character was also subjected to a whole cascade of adaptations in terms of anatomy, neuroanatomy, physiology, and behavior.

We used a multimethodological approach comprising histology, immunohistochemistry, backfills, confocal laser scanning microscopy, scanning- and transmission electron microscopy as well as electrophysiology to explore the scutigeromorph ultimate legs as they underwent a massive transformation into a conspicuous sensory appendage.

The diversity, abundance and distribution pattern of sensory structures, their association with elaborated primary processing centers in the ventral nerve cord, as well as behavioural observations of dose dependency response curves strongly suggest that the elongated, multi-annulated ultimate legs of Scutigeromorpha predominately work as sensory appendages at the posterior end of the body. Given their overall appearance one may truly call them posterior antennae.

Millipedes (Myriapoda: Diplopoda) in Miller's collection in the National Museum in Prague (Czechia)

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Professor František Miller (1902–1983) was a famous Czech arachnologist. After graduating at the Faculty of Science of Charles University in Prague, he taught in secondary schools in Štubnianske Teplice (today Turčianske Teplice) and Žilina in Slovakia, and Jindřichův Hradec and Soběslav in Czechia. In 1947, he habilitated at the University of Agriculture in Brno and worked there until his death. During his fruitful life (65 published papers), Miller studied mainly spiders. As formalin pitfall traps are the most frequently used method for collecting spiders, Miller's material also contains other epigeic invertebrates, including millipedes. The major part of his large private collection was purchased by the National Museum in Prague in 1983 and deposited into the zoological collection of the Natural History Museum under accession numbers 100/83 and 103/83. A catalogue of millipedes from this part of collection was already published (Kocourek & Dolejš 2016). Additional material (unsorted and containing much more millipedes) from Miller's collection was transferred from the Faculty of Science, Charles University (Prague) in 2006. The millipedes were sorted out of mixed samples, identified according to current diplopodological knowledge and databased. The entire millipede collection contains 446 specimens stored in 80% ethanol, representing 44 species belonging to six orders. The material was collected in 1927–1969 in modern-day Czechia and Slovakia, and former Yugoslavia. The collection is valuable because it contains historical records of particular value namely for Slovak faunistics. *Chelogona carpathica*, *Polydesmus tatranus tatranus* and *Trachysphaera acutula* are species of special importance. *Glomeris klugii* is the first record for Slovakia.

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Diversity and distribution patterns of the millipedes (Diplopoda) in Georgia, Caucasus

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The diplopod fauna of Georgia, Transcaucasia, is very rich given the country's relatively small territory: it presently comprises 103 species from 44 genera, 12 families, and 7 orders. Most of the Diplopoda known from Georgia (86 species, or 83%) demonstrate Caucasian distribution patterns, 36 and 46 species, as well as 8 and 9 genera being endemic or subendemic to the country, respectively. All 44 Caucasian species and 20 genera of the large order Chordeumatida belong to a single Holarctic family, Anthroleucosomatidae, in which 27 species and 14 genera are endemic or subendemic to Georgia. Likewise, all species from the orders Polyzoniida, Siphonocryptida, Glomerida and Chordeumatida, as well as most species of Julida and Polydesmida are native, also endemic or subendemic to the Caucasus, but the genera and families they represent are widely distributed at least across the Euro-Mediterranean realm. Most of the presumed troglobites in the Caucasus appear to be confined to western Georgia's karst caves (14 species, 5 genera). Within Georgia, the fauna of the western part (= Colchis) is particularly rich and diverse, the faunas of the central and eastern parts of the country growing increasingly depauperate inland and apparently following a rather gradual climatic aridisation gradient from west (the Black Sea coast) to east (Armenia and Azerbaijan). The vertical distribution of the Diplopoda in Georgia, as well as in the Caucasus generally, shows the bulk of the fauna to be expectedly restricted to forested lowland to mountain biomes, with only very few Chordeumatida and *Julus* species which seem to occur only in the subalpine to alpine environments and thus may provisionally be considered as truly high-montane. Ongoing and future research on the millipedes of the Caucasus, especially in cave and high-montane environments, will undoubtedly allow for many more novelties and details to be revealed or refined in the presently obtained diversity and distribution patterns of Georgia's Diplopoda.

An insight into centipede diversity of Krokar virgin forest

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Slovenia, often addressed as "the green heart of Europe", sustains 58.4% of forest cover. A closer look, though, reveals that only 540 ha (0.0004%) of the forests actually represent prime or virgin forests (hereafter natural), which were formerly part of larger forest complexes. Krokar virgin forest is a Dinaric fir-beech forest with an area of 74.5 ha and a recent UNESCO designated area which represents the largest natural forest fragment in Slovenia. As an undisturbed area, Krokar enables studies of the structure, processes and diversity of the natural state of Dinaric fir-beech forests. Located at the southern border of Slovenia, in the Dinaric mountains that stretch over 650 km from NW to SE, it forms an orographic barrier between the Adriatic Sea and the Pannonian basin. It served as a glacial refugia during the Pleistocene and its diverse landscape and relatively mild climate with high rainfall facilitated a diverse flora and fauna with high endemism. Ground-dwelling invertebrate diversity, however, is largely unknown and is limited to isolated samplings of frost hollows in the area. Krokar virgin forest, for example, has not even been thoroughly studied yet. Here we present preliminary results of an extensive systematic sampling in Krokar virgin forest using a variety of sampling methods – leaf litter sifting, pitfall traps and soil sampling – to cover different microhabitats occupied by ground-dwelling invertebrates. We are focusing on centipedes that, along with other ground-dwelling predatory invertebrates, play an important regulatory role in forest floor and soil. Centipedes are good bioindicator organisms as they quickly respond to habitat change and are also highly susceptible to changes at lower trophic levels due to their mesopredator position in the trophic cascade. Two main objectives of the study are to gather data on centipede community of Krokar virgin forest that will serve as a reference point for future work and to create a DNA-barcode library of the collected ground-dwelling invertebrates.

Observations on the biology of *Henia vesuviana*, *Haplophilus subterraneus* and *Strigamia maritima* (Chilopoda, Geophilomorpha) within the context of the project "Glue characterization in chilopods"

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Most geophilomorph centipedes have segmental clusters of sternal glands with opening pores arranged in more or less well-defined sternal pore areas. These glands excrete a sticky secrete for the purpose of defense or prey capture. The project "Glue characterization in chilopods" is focused of three species from different families Dignathodontidae [*Henia vesuviana* (Newport, 1845)], Himantariidae [*Haplophilus subterraneus* (Shaw, 1794)] and Linotaeniidae [*Strigamia maritima* (Leach, 1817)].

For the "adhesive" extraction a high number of specimens of these species had to be sampled and kept in the lab. This allowed a lot of observations on habitat/microhabitat, (social) behaviour outdoors and in the lab, dependence of the amount of secretion delivered (body part, weight, food influence, time and number of repetitions etc.), and some morphological studies (e.g. number of leg pairs, weight, body length).

Chemical characterization of the defensive secretions of some members of the order Spirostreptida (Diplopoda, Juliformia)

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Most millipedes are chemically defended against predators by producing a variety of noxious secretions. The defensive compounds of diplopods are mostly volatile and in some cases strongly odorous, repelling both vertebrates and invertebrates. In terms of diversity, Spirostreptida is one of the most species-rich orders of Diplopoda, with more than 1,000 described species which occur on all continents except Europe and Antarctica. However, only little is known about the chemical arsenal of spirostreptids. Chemoprofiles have been published for 27 species, but no recently published papers are available. In this work, we present data on the defensive gland chemistry of African spirostreptids belonging to two families: *Doratogonus uncinatus*, *D. rugifrons*, *D. flavifilis* and *Doratogonus* sp., of the family Spirostreptidae; and *Chaleponcus* sp., *Patinatius* sp., *Chaleponcus* sp., and undetermined specimen of the family Odontopygidae. Analysis by gas chromatography-mass spectrometry revealed the presence of very uniform, exclusively quinonic chemoprofiles. We identified five compounds in the analyzed samples: 1) 2-methyl-1,4-benzoquinone; 2) 2-hydroxy-3-methyl-1,4-benzoquinone; 3) 2-methoxy-3-methyl-1,4-benzoquinone; 4) 2,3-dimethoxy-1,4-benzoquinone; and 5) 2-methyl-3,4-methylenedioxyphenol. The compounds with the greatest relative abundance were 2-methoxy-3-methyl-1,4-benzoquinone in representatives of the family Spirostreptidae; and 2-methoxy-3-methyl-1,4-benzoquinone and 2-methyl-1,4-benzoquinone in analyzed members of the family Odontopygidae. There was no sign of any non-quinonic compound, as recently shown to appear in some other juliformians (julids and spirobolids). The chemoprofiles of the four analyzed odontopigids were very uniform, with four quinones but differing in the lack of compound 4. Within the *Doratogonus*, compounds 2, 3 and 5 occurred in all species, while chemicals 1 and 4 showed habitat-dependent variability. With the limited number of chemically analyzed spirostreptids, it is difficult to draw conclusions about the evolutionary history of defensive secretions in the Juliformia. Compounds 1, 3 and 4 are shared by all juliformians. While quinones 2 and 5 are known from julids and spirobolids, compound 5 has not been identified in spirostreptids previously, and compound 2 has been reported in one spirostreptid only. The occurrence of these chemicals in some of the analyzed spirostreptids tentatively implies that the chemical arsenal in ancestral juliformians was already more diverse than hitherto hypothesized. The present study shows that the variety of chemicals in millipedes is far from being well-known. Furthermore, analysis of a larger number of species could provide important phylogenetic signals.

Taxonomic notes on some species-group of *Scolopendra viridicornis* Newport, 1844 (Chilopoda, Scolopendromorpha, Scolopendridae)

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Currently are known in Brazil six species and three subspecies of *Scolopendra*: *S. angulata* Newport, 1844, *S. explorans* Chamberlin, 1914, *S. morsitans* Linnaeus, 1758, *S. spinipriva* Bücherl, 1946, *S. subspinipes* Leach, 1816, *S. viridicornis* Newport, 1844, *S. viridicornis nigra* Bücherl, 1946, *S. angulata moojeni* Bücherl, 1943, and *S. pomacea minuscula* Bücherl, 1946. One species and the three subspecies occur only in the Brazilian territory. As *S. spinipriva*, *S. viridicornis nigra* and *S. pomacea minuscula* share diagnostic characters with the nominal species *S. viridicornis*, we proposed a taxonomical review of the species-group names of endemic *Scolopendra* from Brazil. The types of *S. spinipriva*, *S. viridicornis nigra* and *S. pomacea minuscula* belonging to Instituto Butantan (IBSP), and 176 specimens of *S. viridicornis* from Instituto Butantan (IBSP), Instituto Nacional de Pesquisas da Amazônia (INPA) and Coleção Zoológica da UFMT (CZUFMT) were examined. It was observed that the types of *S. spinipriva* and *S. pomacea minuscula* are juvenile specimens and that in both there are no spines on the dorsal-distal face of the prefemur of the legs 1–17, as also observed in juveniles of *S. viridicornis*. We noticed a spine on the telepodite 3 of the maxilla of the holotype of *S. spinipriva* that was not described by Bücherl. This spine is present in all examined specimen of *S. viridicornis*. In addition, the length of the body that was used to distinguish *S. spinipriva* from *S. viridicornis* is not a good character to separate these two taxa, because *S. spinipriva* was described based on a juvenile specimen. Therefore, *S. spinipriva* is suggested as a junior synonymous of *S. viridicornis*. *Scolopendra pomacea minuscula* also presents a series of *S. viridicornis* characters such as S2–20 with complete paramedian sutures, spine on telepodite 3 of the maxilla 2, short coxopleural process with one apical spine and two subapical spines, T5–21 margined, and a weak longitudinal median keel on T21. This longitudinal median keel on T21 is very weak because the specimen is a juvenile. Therefore, *S. pomacea minuscula* is also suggested as a junior synonymous of *S. viridicornis*. *Scolopendra viridicornis nigra* was described as a subspecies of *S. viridicornis* based in the color pattern and by the length of the coxopleural appendix. We noticed that these characters vary in the Brazilian *S. viridicornis* populations, but we verified some differences in T21. *Scolopendra viridicornis nigra* has on T21 a longitudinal median keel without median suture and without lateral protuberances; *S. viridicornis viridicornis* has on T21 a longitudinal median keel and a median suture and lateral protuberances. In the type series of *S. viridicornis nigra*, eight of 12 specimens have protuberances on the sides of the keel. As the information on *S. viridicornis nigra* and *S. viridicornis viridicornis* are preliminary, we will keep the status of *S. viridicornis nigra*.

The Myriapoda collection at the "Musée Zoologique de Strasbourg"

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This work was conducted with the expectation of revitalizing the Myriapoda collection at the Musée Zoologique de Strasbourg (MZS) and of encouraging its use by present day myriapodologists. We specifically aimed 1) to inventory the components of the collection, 2) to unveil the past contribution of the collection to Myriapodology and 3) to digitize valuable sources of information (catalogues, letters, card indexes). Within objective 1, all collection objects, including exhibition, dry- and wet-preserved specimens, and the slide mounts received catalog numbers. The collection object information was entered in the WebMuseo database under collection acronym MZS Myr, for a total of 861 objects and 100% digitization. Beyond label information, such as collector, locality, date and identification, the preservation method and the length of most specimens were also databased. Within objective 2, the connections of the following personalities to the museum and the Myriapodology are presented: Georges Louis Duvernoy, Ludwig Heinrich Philipp Döderlein, Karl Wilhelm Verhoeff, Karl Matthias Friedrich Magnus Kraepelin, Casimir Albrecht Willem Jeekel and Etienne Iorio. Within objective 3, important resources were digitized: Bibliographic cards and specimen cards from the German times (1871–1918); letters from and to Verhoeff, Kraepelin and Jeekel; and slide mounts. Letter transcription to machine readable formats and translation to English language are ongoing, primarily focused on Verhoeff's letters. Curatorial work with the collection and digitization of Verhoeff's letters unveiled previously unrecognized type specimens. Additional types by Kraepelin and Jeekel were found misplaced out of the Myriapoda collection cabinets. As a final integrative step, the questionnaire on "Millipede Collection Survey" was applied to the whole Myriapoda collection. This action fills the previous MZS information gap in the monographic work "The Millipede Collections of the World" and goes beyond it by adding Chilopoda information. The MZS collection and its newly digitized resources will be especially helpful to myriapodologists revising the scientific work of Karl Kraepelin and Karl Verhoeff.

Reinvestigating a hotspot – diversity of centipedes (Chilopoda) in Bosnia and Herzegovina

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Biodiversity is not evenly distributed. Some regions do not only contain a high biodiversity but also a number of unique species. If such a region also harbours many threatened species, it is commonly called a hotspot. On Earth, there are currently 36 recognized biodiversity hotspots, of which the Mediterranean Basin is one. The aim of this study is to draw attention to the importance of the Balkan Peninsula, and its mountainous western region in particular, as a hotspot of centipede diversity.

The present paper is based on critically reviewed literature records and unpublished material recently collected. The centipede fauna of Bosnia and Herzegovina is represented by 80 species: one Scutigeromorpha, 45 Lithobiomorpha, seven Scolopendromorpha, and 27 Geophilomorpha. The most characteristic families are Lithobiidae (56.25% of all centipede species found in Bosnia and Herzegovina) and Geophilidae (25%). Of the total number of centipedes established within the study region, six (*Eupolybothrus spiniger*, *Geophilus bosniensis*, *Harpolithobius komareki*, *Lithobius absoloni*, *Stenotaenia cribelliger*, *Thracophilus subterraneus*) are endemics.

The stigmatic plate in the Polyxenida

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The minute and soft-bodied bristly millipedes (Polyxenida) comprise less than 200 described species in three families. Within the Diplopoda, the Polyxenida are unique by possessing an uncalcified cuticle, trichobothria and serrate setae, and are considered to be the sister taxon to all other millipedes, the Chilognatha. Therefore bristly millipedes are fundamental for understanding the evolution of the Diplopoda. Nevertheless, only little (mainly about *Polyxenus lagurus*) is known about their morphology, thus in overviews of the body-ring architecture in millipedes the bristly millipedes are often neglected. Here we study the body-ring architecture of the three polyxenidan families, represented by females of the three species *Phryssonotus novaehollandiae* Silvestri, 1923, *Lophoproctus coecus* Pocock, 1895 and *Polyxenus lagurus* (Linnaeus, 1758), using modern synchrotron micro-computer tomography. The following condition is found in body-rings of the Polyxenida from the first segment onwards: Undivided tergite, paired pleurites, paired stigmatic plates fused to the legs coxa, and entire central sternite. Previously it was thought that the fusion of the first stigmatic plate to the first coxa in females is an apomorphy of the Chilognatha. Furthermore, the *Polyxenida* share with the Pentazonia the presence of separated stigmatic plates, and with the Glomeridesmida the presence of a free sternite and the fusion of the stigmatic plate to the coxa of the mid-body legs. Therefore it is possible that the fusion of the stigmatic plate to the coxa as well as the presence of a free central sternite belong to the groundplan of the Diplopoda.

99 million years of morphological stasis? Micro-CT and gonopod reconstruction of an extant genus from Cretaceous Burmese amber

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The diverse yet understudied millipedes (Diplopoda) were among the first terrestrial animals and play a fundamental role in terrestrial ecosystems as destruents and major soil-forming organisms. Despite their long evolutionary history, the fossil record of the Diplopoda is extremely poor; especially for the Mesozoic. Aside from the low number of known fossils, one problem is that a close study of the male copulation legs (gonopods) is needed for the secure assignment of a millipede, even to family level. Only rarely can the gonopods of the few male fossils be studied in detail. The recent rediscovery of exceptionally well-preserved arthropod inclusions in Burmese amber (ca. 99 my), and modern micro-computed tomography (μCT) allow to widen our understanding of the Cretaceous millipede fauna. With the 3D-reconstruction of gonopods and the comparisons to extant millipedes, several fossil specimens could be placed within extant genera, revealing morphological stasis in some millipede groups since at least the Cretaceous. Among these bradytelic millipedes is the enigmatic family Heterochordeumatidae, with at least two fossil species which can be placed within the extant genus *Heterochordeuma* Pocock, 1893. The described specimens are not only the first fossils of the family Heterochordeumatidae, but also the oldest records of the order Chordeumatida. Therefore the minimum age of the Heterochordeumatidae is ca. 99 my. The hypothesis, that the Chordeumatida are a fast evolving clade due to their extremely short life-cycle, can be refuted here, with representatives nearly resembling modern forms after ca. 99 million years of evolution.

Tömösváry organs are absent in flat-backed millipedes (Diplopoda: Polydesmida)

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The Tömösváry organ (TO) is a sensory structure of the head and a character often used in taxonomic descriptions and phylogenetic analyses of millipedes. Nevertheless, its occurrence among the 16 millipede orders is uncertain and confusion exists regarding its presence or absence in several groups. This also holds true for the most diverse millipede order, the Polydesmida. The structure of the TO has been described in detail by Hennings (1906) for flat backed millipedes, and his statement on the presence of the TO in Polydesmida has been adopted by almost all subsequent researchers. Seifert (1932), in contrast, denied its presence in Polydesmida, and its absence in Polydesmida has subsequently become "common knowledge" among some myriapodologists. The aim of this study is to finally clarify whether the TO is present or absent in the Polydesmida. For this purpose we combined classical histological studies of the head with modern micro-computer tomography (μCT). Here we show that the structure formerly interpreted as TO in the Polydesmida in fact is the distal tip of the tentorial transverse bar, projecting through the head capsule towards the widened end of its incisura lateralis, and that the TO indeed is absent in the Polydesmida. Based on this example, we demonstrate the great potential of μCT applied in combination with histology, and the general importance of the accessibility of literature, data, and software for morphological research.

Structure and ultrastructure of the midgut epithelium in *Haplophilus subterraneus* (Chilopoda)

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The digestive system is treated as one of the barriers in animal bodies against any stressors which originate from the environment. Therefore, many invertebrates which live in the upper layers of soil are treated as bioindicators of the environment (e.g. myriapods). *Haplophilus subterraneus* (Chilopoda) is a centipede species which lives in the litter and upper layers of soil. It is distributed in the North-western part of Europe, occurring in natural sites from the Pyrenean region to southern British Isles and western Germany. In the remaining part of central and northern Europe isolated populations of the species occur, probably due to recent introduction. In Poland, the species was first recorded in 1991 in the Cytadela Park in Poznań. The aim of this study was to analyze the structure and ultrastructure of the middle region of the digestive system – the midgut, which is treated as the organ which takes part in homeostasis maintenance. The material for these studies (adult specimens of *H. subterraneus*) was collected on October 4, 2017 in the Cytadela Park in Poznań. The analyses were carried out using transmission electron microscopy (TEM), light microscopy and histochemical methods (PAS method – detection of glycogen and polysaccharides), Bonhag method (detection of proteins), Sudan Black B staining – detection of lipids).

During the study, it was observed that the midgut epithelium of the *H. subterraneus* centipede consists of two types of cells – digestive and regenerative cells. It is a pseudostratified epithelium which rests on the basal lamina and it is surrounded by visceral muscles. Regenerative cells are located individually between the basal regions of the digestive cells. In the cytoplasm of the digestive cells a distinct regionalization in the arrangement of the organelles has been noticed, thus it is possible to distinguish the apical, perinuclear and basal cytoplasm. The digestive cell cytoplasm contains large amounts of accumulated reserved substances of various types, which was revealed using histochemical methods. The precise ultrastructure of the digestive and regenerative cells has been presented. Our studies confirmed the general ultrastructure of the midgut epithelium in centipedes.

The fine structure of the midgut epithelium in some millipedes (Diplopoda)

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The midgut (the endodermal part of the digestive system) of invertebrates is not only the organ responsible for secretion, absorption, synthesis and accumulation of reserve substances, but it takes part in homeostasis maintenance thanks to the ability to accumulate toxic substitutes e.g. heavy metals, pesticides or even neutralizing pathogens. In the mono-layered midgut epithelium of millipedes, the digestive (absorptive) cells, secretory (endocrine) cells and regenerative cells have been described. The aim of this study was to analyse the structure and ultrastructure of the middle region of the digestive system – the midgut in some millipede species and to describe the chemical character of the reserve substances accumulated in the cytoplasm of the digestive cells.

The following species, which represent four millipede orders, were selected as the objects for our studies: *Polydesmus complanatus* (Linnaeus, 1761) (Polydesmida), *Epibolus pulchripes* Gerstäcker, 1873 (Spirobolida), *Unciger transsilvanicus* (Verhoeff, 1899) (Julida) and *Glomeris tetrasticha* Brandt, 1833 (Glomerida). The analyses were carried out using transmission electron microscopy (TEM), light microscopy and histochemical methods (PAS method for detection of glycogen and polysaccharides, Bonhag method for detection of proteins, Sudan Black B staining for detection of lipids).

During the study, it was observed that the midgut epithelium of the investigated millipede species is lined with the pseudostratified epithelium composed of three types of epithelial cells: the digestive cells, regenerative cells and secretory cells. The epithelium rests on the basal lamina and is surrounded by two layers of visceral muscles: the circular and longitudinal muscles. The epithelium is separated from the midgut lumen by the peritrophic membrane. In three millipede species (*P. complanatus*, *E. pulchripes*, *U. transsilvanicus*) the regenerative cells resting on the basal lamina are located between basal regions of the digestive cells along the entire length of the midgut. However, in *G. tetrasticha* these cells form regenerative nests in which the dividing regenerative cells are located in the central part, while the differentiating cells are placed externally.

First steps towards the knowledge of the order Polydesmida (Diplopoda) in Uruguay

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Despite their high diversity, ecological role and importance as biogeographical indicators, there are few studies on millipedes in the Neotropical region, and virtually none in Uruguay. This country has only six species recorded, the newest from 1903, that belong to the orders Spirostreptida and Polyxenida. Uruguay is a South American country located in the eastern region of the American Southern Cone. It is bordered to the northeast by Brazil, to the west and southwest by Argentina, and has coasts in the Atlantic Ocean. Given that Uruguay is located at the biogeographical crossroads with the intersection of biota, it is expected that the diplopod diversity of Uruguay is much higher than currently known. As a first approach to improve the knowledge of the Uruguayan millipede fauna we proposed the study of specimens deposited in Uruguayan collections and the implemented a standardized sampling protocol in different ecosystems. The order Polydesmida, not yet recorded for the country, is widely represented in the specimen collection. Our first goal was to generate a data baseline of the order Polydesmida by generating a species list and a taxonomic key. We examined the diplopod material deposited in the Myriapoda collection of the Facultad de Ciencias, Universidad de la República, Montevideo, and we also examined the material collected recently by manual collection and Berlese-Tullgren funnel and Winkler extractions. The results evidenced that the specimens from the diplopod collection were collected about 60 years ago, and new taxa were recorded in recent field works. The following Polydesmida taxa are recorded for the first time from Uruguay: (1) Chelodesmidae, with six species, which have been collected under stones mainly in elevated areas of the country. (2) Paradoxosomatidae, with four species, most of them found in natural areas, both from elevated areas and riparian forests, and one of the species found in urban areas. (3) Dalodesmidae, represented by two species founded in leaf litter and bark of trunks in riparian forests. (4) Furhmannodesmidae, represented by only one species collected in leaf litter in semi-urban areas and in riparian forests. These data represent the first approach in the knowledge of the diversity of millipedes in Uruguay. Future studies will focus on the diversity of the Diplopoda in different natural and synantropic environments of the country.

Integrative descriptions of two new species of giant pill-millipedes, genus *Zephronia*, from southern Thailand (Diplopoda, Sphaerotheriida, Zephroniidae)

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Despite their presence in virtually every natural forest in Thailand, only two species of giant pill-millipedes (order Sphaerotheriida), have been officially described from Thailand, *Zephronia siamensis* Hirst, 1907 and *Sphaerobelum truncatum* Wongthamwanich et al., 2012. Here two new species of the genus *Zephronia* are described from southern Thailand. Both species are currently only known from a single site, but might be more widespread given more targeted inventory data. Type specimens come from the collections of the Natural History Museum of Denmark. The species are described utilizing light microscopy, as well as scanning electron microscopy. Types of each species were also scanned utilizing a micro-CT scanner to create a virtual "cybertype", which will be deposited for open access of Morphbank. Because genetic barcoding data of the COI gene is available for all known Thai giant pill-millipede species, as well as for all species known from Laos and Cambodia (see Wesener 2019), it was also attempted to extract DNA from the type specimens.

Cadmium concentrated in soil causes changes in salivary glands of the centipede – *Lithobius forficatus* (Myriapoda, Chilopoda): ultrastructural studies

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Salivary glands of centipedes are organs that belong to the digestive system and take part in the synthesis, accumulation and secretion of many substances (e.g., enzymes, anticoagulants, antibodies, etc.) or even in osmotic regulation. Therefore, they are good organs for studies of all the changes and alterations that occur under stressor conditions caused by e.g. heavy metals. Cadmium belongs to those heavy metals, which are known as accumulated in organisms affecting them in a toxic way. The main aim of the project was to investigate, analyze and demonstrate all alterations in salivary glands of centipedes caused by short- and long-term exposures to cadmium concentrated in soil. As the species for this project, one of terrestrial bioindicators of the natural environment – a centipede, *Lithobius forficatus* (Myriapoda, Chilopoda, Lithobiomorpha), has been chosen. Adult specimens were collected in 2017 in Poznań parks. The animals were divided into experimental groups: C – the control group, animals cultured in laboratory conditions in horticultural soil and fed with *Chironomus* larvae; Cd1 –animals cultured in horticultural soil supplemented with 80 mg/kg (dry weight) of $CdCl_2$, fed with *Chironomus* larvae maintained in tap water, 12 days – short-term exposure; Cd2 –animals cultured in horticultural soil supplemented with 80 mg/kg (dry weight) of $CdCl_2$, fed with *Chironomus* larvae maintained in tap water, 45 days – long-term exposure. The studies were conducted using light and transmission electron microscopy (TEM). The paired salivary glands of *L. forficatus* are localized in the neighborhood of the foregut. They are irregular in shape and formed by numerous acini. Cadmium exposure caused numerous changes at the ultrastructural level after 12 and 45 days of experiment. We observed changes in structures of cisterns of the endoplasmic reticulum, mitochondria and the amount of reserve materials. After 12 days of cadmium exposure many hemocytes were observed in the neighborhood of salivary glands, while their number decreased after 45 days of exposure. Intensive necrosis has been detected in Cd2 experimental group. The study was financed by the National Science Centre, Poland, grant no. 2017/25/B/NZ4/00420.

Millipede regulation of microbial communities and coupled C, N, and P dynamics in a soil-litter system

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Species interactions and their role in ecosystem functioning are cornerstone of ecological study. In the species diverse brown-food-webs, litter-feeding millipedes are key regulator of microbial communities, and thus key drivers of C and nutrient cycling. The biogeochemical cycles of C, N, and P are closely interlinked by microbial metabolism, owing to the conserved elemental stoichiometry of microorganisms. Despite the importance of detritivore in regulating microbial communities and nutrient cycling, it is largely unknown how millipede influences the stoichiometric balance of microbial C, N, and P acquisition activity, and the coupled C and nutrient dynamics in soil-litter systems. Here, we used a widely distributed temperate larger millipede *Spirobolus bungii* to investigate this topic by a laboratory incubation experiment. We found following major results:

(1) Millipede activity significantly altered microbial communities in soil-litter systems; in the uningested litter, both the gram-positive and gram-negative bacteria were increased but the fungi were reduced, resulting in a significant decline of fungal: bacterial biomass ratio (F:B); in the fecal pellets, gram-positive bacteria increased but fungi decreased, causing a reduction in F:B and a increase in biomass ratio of gram-positive and gram-negative bacteria; unlike litter and feces, detritivore activity promoted fungi growth in the soil.

(2) Millipede activity significantly changed the stoichiometric balance of microbial C, N, and P acquisition activity in soil-litter systems; in the processed uningested litter, microbial P-acquiring phosphatase activity decreased significantly, causing increases in enzymatic ratios of C:P and N:P acquisition by microbial communities; in the feces, either N-acquiring β-N-acetylglucosaminidase activity or P-acquiring phosphatase activity was reduced significantly, resulting in increased microbial C:N and C:P acquisition ratios; in the soil, detritivore activity increased β-1,4-glucosidase activity but decreased phosphatase activity, causing increases in enzymatic ratios of C:P and N:P acquisition by soil microbial communities. These results suggested that microbial P limitation was replaced by C and N limitation under detritivore activity in soil-litter systems.

(3) Millipede activity also significantly changed the balance between C, N and P in soil-litter systems. In the uningested litter, detritivore reduced total C but increased total and dissolved N, thus reduced C:N and C:P ratios (either for total or dissolved fraction), and increased dissolved N:P ratio. In feces, total and dissolved C, total N were reduced, but total and dissolved P was increased, causing C:P and N:P ratios significantly reduced. In the soil, detritivore increased concentration of dissolved C, N, and P, and thus microbial biomass C, N, and P. The greater increase in labile soil P than C causes a significant reduction in dissolved and microbial C:P ratios.

Floating creatures on insular landmasses: the shape of biodiversity in the Aegean archipelago

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With about 7600 islands and islets, the Aegean Sea is an ideal experimental area to test hypotheses on island biogeography. The current proposal addresses fundamental biogeographical issues concerning the shape of island communities in continental islands in the Aegean archipelago and explore the combined role of geography and palaeogeography in shaping biodiversity both on the Hellenic Island and the South Aegean Volcanic Arcs. Using novel methodological tools that will elucidate the biogeographical history of the Aegean Islands, we will select four groups of soil-dwelling arthropods (centipedes, millipedes, pseudoscorpions and spiders), that differ significantly in their ecological requirements, dispersal abilities and evolutionary history, to reveal patterns and processes. We will combine taxonomic, biogeographical and ecological data to explore: (1) the hypotheses of vicariance versus dispersal pattern, in particular the role of land-bridge islands in the dispersal of species communities, (2) the distribution of species within and between communities to discover potential biogeographical networks, and categorize islands according to their ecological role in the island-species network, (3) for potential island disharmony (e.g. gigantism) related to certain taxa across the Aegean islands, and for possible explanations of the patterns observed, and, (4) whether species assemblages among islands support nested patterns (e.g. species comprising smaller local assemblages constitute a subset of the species in richer ones).

Can invasive plant species influence assemblages of epigeic and soil invertebrates? A case study on small balsam (*Impatiens parviflora*) vs. millipedes and centipedes

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Invasive plant species may significantly influence the structure, dynamics and functioning of native ecosystems. Whereas impact of invasive plant species on above ground invertebrates (e.g. herbivorous insects, pollinators) is well known, indirect effects, such as impact on soil properties and assemblages of soil invertebrate fauna, has so far been poorly studied.

Structure and changes of assemblages of saprophagous millipedes (Diplopoda) and predatory centipedes (Chilopoda) were investigated at three plots with invasive small balsam (*Impatiens parviflora*) and three control plots in oak-hornbeam forests in the Wigry National Park, Northeastern Poland, in 2017–2018 using the pitfall trapping and soil sampling.

The elaborated material from the both sampling seasons based on the combination of both methods comprises in total 4,324 individuals of millipedes representing 10 species and 2,496 individuals of centipedes representing 9 species. Within them, the occurrence of the centipede *Lithobius proximus* is interesting from the faunistic point of view.

Disregarding low differences in densities in all plots, higher epigeic activity of millipedes was observed at the plots with small balsam, but they decreased during the drier season 2018. Edaphic part of centipede assemblages did not seem to be dependent on the presence of growth of invasive plant. Only epigeic activity of centipede assemblages showed increasing trend, both in summer and autumn. More important factor shaping dominance structure seems to be soil humidity, as indicated lack of some centipede species (e.g. *Schendyla nemorensis*) on the drier plot, otherwise dominating in other centipede assemblages, or decrease of hygrophilous species of millipedes and an increase of xerotolerant ones, both in drier of the second year of observation. The influence of the small balsam on soil invertebrates indirectly throughout changes in composition of herb stratum and consequently in changes of leaf litter seems to be weak and apparently overlaps with other environmental factors.

Millipede succession in abandoned fields. Thirty-three-year time series of monitoring

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Since 1986, four different stands (arable and abandoned fields, meadow, deciduous forest) were sampled for monitoring of basic parameters of millipede assemblages. After intensive initial observation in the first years, the sampling continued annually till 2003 except for 1996. After that, the same sampling pattern was applied in 2009 and actually in 2017–2018. Obtained thirty-three-year time series provided large datasets about the communities of millipedes and their changes in the rapidly and differently developing abandoned fields as well as in the more stable meadow and forest stands, all under the conditions of other factors and environmental changes.

Depending on previous agricultural management, assemblage of millipedes in the field after abandonment and development into the grassland fallow subsequently increased with the maximum of density in 1997 (138 ind/m^2). A rich community was then observed during the following 15–20 years. Renewed agrotechnics in 2017 completely reduced to almost destroyed the developed millipede community. The development of spontaneous shrub vegetation in the second observed young fallow field supported faster growth of millipede populations already in the first years of succession (1988–1990, with maximum density up to 140 ind/m^2), followed approximately since the tenth year of succession by their subsequent decrease down to the densities around 20 ind/m^2. Such a low densities characterise this fallow till present. Whereas grassland fallow was characterised initially by dominance of polydesmid species, replaced gradually by representatives of the orders Julida and Glomerida, the shrub fallow was initially dominated by juliform millipedes, in succession age 6–10 years temporarily replaced by dominating *Glomeris hexasticha*. The meadow stand, considered as an older fallow, showed an increase of densities in the third year after cessation of haymaking (since 1989) for a longer period till 2001, again with significant increase of *Glomeris hexasticha* and total densities reaching up to 250 ind/m^2. The millipede assemblages in the forest stand (mixed oak forest corresponding to climax stage of the region) fluctuated during the whole time of observation, with the maxima in 1989–1990 (117 ind/m^2) and 1997–1998 (97 ind/m^2) and with later population decrease since 2002.

Long termed study showed in the last 15 years of observation (approx. since 2002–2003) significant decrease in densities of all developed millipede assemblages. These changes could indicate or even correspond with more general negative decline of density and diversity of invertebrates in the last decades. Which environmental or other ecological factors affect these declines is questionable and will be discussed.

Morphological and genetic diversities of giant pill-millipedes from Southeastern Thailand

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Two species of giant pill-millipedes have been reported from Thailand, *Zephronia siamensis* in the east and *Sphaerobelum truncatum* in the north. At the present, there is no data concerning species distribution throughout the southern part of the country. Therefore, this research aimed to investigate morphological differentiation and genetics of giant pill-millipedes from Southeastern Thailand. Specimens were collected from three provinces, Prachuap Khiri Khan, Surat Thani and Nakhon Si Thammarat. Morphological characters were examined based on the key characters of the millipedes. A mitochondrial gene, cytochome c oxidase subunit I (COI), was used to analyze evolutionary relationship. The results showed that at least two genera were presented in this region. Further studies will be needed to clarify the taxonomic status of the giant pill-millipedes from the south of Thailand.

Urban effects on diversity and composition of Diplopoda assemblages in Budapest, Hungary

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The role of soil arthropods in nutrient cycle has been known for a long while. They significantly contribute to detritus decomposition through their feeding and burrowing activities, thereby affecting organic matter level in soil. Since millipedes (Diplopoda) are considered to be a key taxon in litter breakdown, studying diversity and species composition of their assemblages is crucial. This is even more urgent in the context of increasing urbanization, as what is one of the main causes of biodiversity loss or alteration.

The aim of our research was to assess the Diplopoda assemblages of differently urbanized woody patches of Budapest, and to find similarities and differences comparing the two sides of the city separated by the barrier of the river Danube (based on 24–23 sample sites, respectively). The degree of urban disturbance was expressed using an urbanisation index (UI) based on built-up density and vegetation cover recorded in the 400 x 400 m area around the sampling plots. To characterize physicochemical properties of topsoil (pH, soil plasticity, humus, $CaCO_3$ etc.), samples were taken (0–10 cm depth). For species-level identification millipedes were collected by time-restricted hand sorting (60 minutes per site) during their main activity seasons (spring and autumn) in 2016 (Buda side) and in 2018 (Pest side).

Altogether 24 millipede species were found with one new species to the fauna of Budapest: *Cylindroiulus caeruleocinctus* (Wood, 1864). Degree of urbanization influenced negatively the species richness and had significant effects on species composition, too. Moreover, soil plasticity and humus content proved to be relevant factors in this regard. Considerable differences in assemblage structure were found between the Buda and Pest sides. Many species occurred only in Buda (eg. *Leptoiulus trilineatus*) or only in Pest (eg. *Cylindroiulus caeruleocinctus*).

The results of our study show that urbanization has a negative effect on the species richness of the macrodecomposer taxon in question. The composition of the assemblages is basically determined by the intensity of urbanization and the division of the capital along the Danube. The latter might be also explained by the specific geological, soil and vegetation characteristics of the two sides, which affected their species pools. Due to increasing urban disturbance it is worth to provide appropriate detritus and shelter site supply during the management of green spaces in order to maintain species richness, abundance and function (breakdown, food source) of species. Therefore, we suggest that remnants of natural habitats within cities receive further attention in urban planning.

When is suitable to rake leaf litter according to myriapods?

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Leaf litter raking is abandoned management of deciduous forests in Central Europe, which was practiced for centuries. Leaf litter was used as an animal bedding and/or field fertilizer. Such long-term management, in combination with animal-punching in forests, led to intensive export of biomass from forests and nutrient depletion of forest soils.

Amount of leaf litter affects the density of centipedes and millipedes. It can be positive as well as negative when the accessibility of prey for centipedes can be lower in sites with leaf accumulations. We tried to evaluate if litter raking affects communities of myriapods.

Experimental sites were situated in oak forests in the Podyjí National Park. Altogether 45 experimental plots of the size 5×5 m were randomly divided into three groups differing by treatment. A third of plots were raked at spring, one third at autumn and last 15 plots were left as the control group. Raking was applied once per year for 6 years. Soil invertebrates were sampled using soil corer (diameter 27.2 cm, depth 10 cm) at autumn of the seventh year, before raking. Invertebrates were heat-extracted in Tullgren funnels in the laboratory.

Altogether, 166 centipedes (6 spp.) and 20 millipedes (4 spp.) were extracted. Control unaffected plot hosted richer and more diverse communities, i.e. all species. Nevertheless, a spring leaf litter raking had significantly more negative effect to myriapod communities comparing to an autumn raking. The explanation is probably connected with the exposition of soil in next months – exposed bare soil during summer, when all animals are active, is more hostile than in winter when animals are hidden in deeper layers of soil. We can suppose, also traditional litter raking was more intensive during autumn when livestock was prepared for in-wintering.

Rediscovery of the millipede *Eurygyrus ochraceus* C.L. Koch, 1847 in Bulgaria (Diplopoda, Callipodida, Schizopetalidae), with observations of its post-embryonic development

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The callipodidan millipede *Eurygyrus ochraceus* C.L. Koch, 1847, native to western Asian Turkey, is rediscovered in the park of the Euxinograd Palace, on the northern Black Sea coast of Bulgaria, nearly 90 years after the species was last recorded from the country. A total of 196 individuals were collected from the park with pitfall traps or by hand sampling in the course of a two-year study of the invertebrate diversity in the area. All specimens were found in close proximity to the sea shore, with the bulk of them originating from a small site with limestone ruins. The species is shown to be semelparous and teloanamorphic. The number of pleuroterga is constant within a given stadium, at least from stadium IV onwards, while small variations in the number of leg-pairs occur in most stadia. Maturity is reached in stadium X, and sex can be reliably identified from stadium VII on. The modification of male leg-pair 8 into gonopods appears as a gradual process occurring during three consecutive moults starting after stadium VII. Collecting data suggest a 1.5-year life cycle, with two distinct reproductive periods – from early to mid-spring and from early to mid-autumn. Compared to the few callipodidan species for which data on the course of anamorphosis is available, *E. ochraceus* is most similar to *Dischizopetalum illyricum* (Latzel, 1884), while it differs considerably from *Apfelbeckia* sp., and even more from *Callipus foetidissimus* (Savi, 1819).

The millipede genus *Globanus* endemic to São Tomé and Principe – a potential "insular species swarm"

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During a soil zoology expedition to São Tomé made in 2010 by the California Academy of Sciences, millipedes of the genus *Globanus* were sampled. Samples of *G. marginescaber* and *G. integer* were recovered in addition to a new species. Illustrations and descriptive notes are given for the three species. A key to the three species of the genus is given and a distribution map is given.

Addenda and corrigenda to the Catalogue of Chilean Chilopoda, with the first confirmed record of *Scolopendra* Linnaeus, 1758 (Scolopendromorpha, Scolopendridae) and an updated key to the Scolopendridae of Chile

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The Chilopoda list of Chile is augmented and corrected. The previous figure of 70 species is herein increased by more than 10%, up to 78 species. Six species were added by means of a new bibliographic search, one species by Chilobase 2.0 geographic search and one genus and species by examination of museum specimens. The bibliographic search retrieved two species of Scolopendromorpha, one of Geophilomorpha and three of Lithobiomorpha that were formerly overlooked. The Chilobase 2.0 geographic search was performed with some difficulty. Chilobase's countries don't match geopolitical countries but rather the list of codes used in the World Geographical Scheme for Recording Plant Distributions. We checked all the pertinent "Country or major area" and "Country or minor area" divisions. Only 11 species, about 1/7 of our current total, were retrieved for Chile. Of those, 10 are Geophilomorpha and 1 belongs to Lithobiomorpha. One was missing from the 2018 Chilean list, the geophilomorph *Pachymerium ferrugineum* (C. L. Koch, 1835). The 8th species was obtained from museum collections and represents the first reliable record of *Scolopendra* Linnaeus, 1758 from Chile. It remained elusive in the literature not because it was unknown but because imprecise reporting by Frederik Meinert back in 1886. Herein we validate the presence of *Scolopendra morsitans* Linnaeus, 1758 from two Chilean localities. Additionally, we hypothesize the occurrence of *Scolopendra galapagoensis* Bollman, 1889 in the country but prefer not to include it until a doubtful specimen of *Scolopendra gigantea* Linnaeus, 1758 is re-examined. We provide an updated table with the orders, families, genera and species of Chilopoda recorded from Chile. We also simplified the previous identification key for Scolopendromorpha families and Scolopendridae species in Chile, given that the family Scolopocryptopidae Pocock, 1896 is not recorded from the country. The couplets were further modified to include the newly reported genus *Scolopendra* and *Scolopendra morsitans*. As a final recommendation, we encourage Chilobase 2.0 to include geopolitical divisions in the geographic search, so that both country species lists and broad, country-level records become retrievable.

Reproductive behaviour of *Megaphyllum unilineatum* (C. L. Koch, 1838) (Diplopoda, Julida) in laboratory conditions

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In millipedes, reproductive behaviour has so far been insufficiently studied in laboratory conditions. In a previous study, we investigated two julidan species, *Pachyiulus hungaricus* (Karsch, 1881) and *Megaphyllum bosniense* (Verhoeff, 1897). Courtship and mating of the species *Megaphyllum unilineatum* (C. L. Koch, 1838) were investigated in the present work, in which we identified and quantified several behavioural sequences, such as mating latency, copulation duration, contact to copulation time and duration of contact without copulation. Also scored was the time elapsed from the introduction of individuals into "mating boxes" until establishment of physical contact between male and female, both when these contacts ended in mating and when they did not.

Reproductive behaviour of the aforementioned species was investigated in three different types of tests, viz., the mating arena, female choice and male choice tests. Further, mating preference toward the previous partner or a new partner was analysed in both types of "choice" tests. Differences in sequences of precopulatory behaviour and in copulation duration between the mating arena test and "choice" tests were analysed using the t-test. Preference toward the previous or a new mating partner was analysed using the Chi-square test.

In the mating arena test, mating latency lasted, on average, approximately 24 min, while copulation duration was approximately 2 hours. Physical contacts established between the male and female regardless of whether or not they have finished mating lasted a relatively short time (approximately 1 min). Copulation lasted significantly longer in the female choice test in comparison with the mating arena test ($p = 0.0001$). Significant preference toward the previous mating partner was observed only in the male choice test.

In comparison with previously published data on other taxa, the results obtained in investigating the precopulatory sequences and mating of *M. unilineatum* in the present study indicate many similarities of reproductive behaviour among different species of the order Julida.

Moisture requirements of Polydesmida: Xystodesmidae

Nathan WHATLEY, Amarah SHAKUR & Bruce A. SNYDER

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All organisms must maintain an appropriate water balance to ensure their survival. Within the soil fauna, millipedes are particularly prone to water loss due to an inability to close their spiracles and, relative to insects, fewer lipids in their cuticles. Because the maintenance of proper internal moisture levels is critical to millipede survival, they employ several strategies to retain moisture. Millipedes gain most of their water through feeding. Behaviorally, millipedes seek out environments that are high in moisture. They also can curl up to reduce moisture loss from spiracles and reduce cuticular evaporation. Temperature and moisture are the two most important factors for soil fauna, yet moisture requirements are only known for a few millipede species. We investigated the soil moisture requirements of species within the millipede family Xystodesmidae, a major component of the soil fauna of the Southeastern United States. A better understanding of millipede ecology can be developed with greater knowledge about how millipedes define niches, and this information could potentially be used to predict millipede movement (vertical, horizontal, seasonal, etc.) or distribution. We collected *Cherokia georgiana georgiana* specimens from Middle Georgia mixed pine-hardwood forests and measured soil moisture conditions at each specific collection location. We then assessed the millipedes' survival at 7.1%, 8.5%, and 10.7% soil moisture, based on these field measurements. Experimental units were shoebox-sized plastic containers that each held 40 g of *Acer rubrum* leaf litter, 3000 g of sieved soil, and five *Cherokia* individuals. Soil moisture was maintained by weighing containers daily and adding water as needed. Containers were incubated at 20°C until mortality of all individuals. We repeated the experiment using the larger *Cleptoria rileyi*. The 8.5% moisture condition was expected to result in the highest survival rate as this was the average moisture condition measured in the wild. The 7.1% moisture condition was expected to have the lowest survival rate as it would result in the most drying effects on the millipedes. *Cleptoria rileyi* was expected to have better survival rates across all conditions as it is larger. There were no significant differences in survival rates between soil moisture treatments for either species. However, *Cherokia* mortality rates were high initially due to attempts to mark individuals. Future experimentation will use additional millipede species and investigate the effect of millipede density on survival.

General Assembly of the Centre International de Myriapodologie

Friday, 30 August, 13:00–15:00, Semsey Room

AGENDA

1. Opening words and moral report by the President Greg Edgecombe
2. Activity report by the General-Secretary Stylianos Simaiakis
3. Financial report by the Treasurer Hans Reip
4. CIM Myriapoda literature report by the Webmaster Peter Decker
5. CIM Members and new candidates for membership
6. Honorary members proposed by representatives of the former board
7. Plan for publishing the Proceedings of the 18th ICM
8. Proposal for the 19th International Congress of Myriapodology, 2021

   Bogotá (Colombia) by Sebastián Galvis Jiménez & Julián Bueno-Villegas (on behalf of Eduardo Florez)
9. Proposals for the 20th International Congress of Myriapodology, 2023
10. Renewal and election of the new CIM Council:

    3 re-eligible Councillors (in alphabetical order): **Nesrine Akkari** (Austria), **Peter Decker** (Germany), and **Piyatida Pimvichai** (Thailand), and, 7 new nominees received by the CIM secretariat on 24 July 2019

    Candidates (in alphabetical order): **Dragan Antic** (Serbia), **Lucio Bonato** (Italy), **Amazonas Chagas-Jr** (Brazil), **László Dányi** (Hungary), **Carsten Müller** (Germany), **Petra Sierwald** (USA) and **Varpu Vahtera** (Finland)
11. Election of the President and Vice President
12. Miscellaneous themes
13. Closure of the General Assembly (2019)

Meeting of the CIM Council (2019–2021)

Friday, 30 August, 18:00–19:00, Lázár Equestrian Park, Domony

AGENDA

1. Appointment of the General-Secretary Stylianos Simaiakis (Greece), and appointment of the Associate-Secretary Jean-Jacques Geoffroy (France)
2. Appointment of the Treasurer Hans Reip (Germany)
3. Next Council Meeting
4. Miscellaneous themes
5. Closure of the Council Meeting

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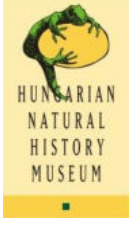
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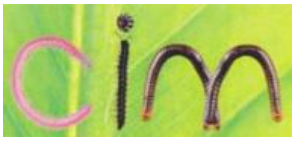
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