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Preface to the Proceedings of the 30th European Congress of Arachnology, Nottingham, 2017 August 20-25

The SpiderLab at the University of Nottingham was delighted to host the 30th European Congress of Arachnology in August 2017. Our organising 'team' here at Nottingham comprised Sara Goodacre together with Leah Ashley, Tom Coekin, Ella Deutsch, Rowan Earlam, Sarah Goertz, Alastair Gibbons, David Harvey, Antje Hundertmark, Liaque Latif, Michelle Strickland and Emma Vincent, but we were also supported by a fantastic team of colleagues from elsewhere, without whom the event could not have taken place. Sara was supported by co-organiser Dmitri Logunov, from the Manchester Museum, and by Geoff Oxford and Tony Russell-Smith, who were instrumental in putting together a very enjoyable scientific program. Yuri Marusik was also instrumental in making the event a success, by hosting the Russian party in addition to his scientific contribution to the meeting.

The Congress was attended by more than 100 participants with representatives from Europe (UK, Spain, Denmark, Germany, Belgium, Greece, Poland, Czech Republic, Liechtenstein, Switzerland, Finland, Austria, Netherlands, Sweden, Slovenia, Hungary, Serbia, Russia), and further afield - Asia (Israel, Russia, Sri Lanka, Japan, Pakistan), Oceania (New Zealand), Africa (South Africa, Algeria), Americas (Brazil, USA). A memorable feature of the meeting was that the formal salutations were followed by presentations by Torbjörn Kronestedt and Christian Komposch, who presented photos taken both from old and recent editions of the Congress, starting from the very first congress in 1960 (18 participants, Bonn, Germany) to the most recent one in 2015 (170 participants, Brno). This was a wonderful way to acknowledge that science and friendship often go hand in hand, and to reflect on past meetings.

The plenary talks given throughout the conference illustrated the breadth of research interests contained within our research community. Yael Lubin gave the first talk of the conference, presenting a fascinating talk on the behavioural ecology of colonial spiders. The afternoon saw a session on taxonomy and phylogeny in parallel with a session on database and engagement. ESA President Wolfgang Nentwig introduced this database and engagement session, presenting new ideas about the future development of these important web resources, which are increasingly used by the scientific community. A special symposium on predatory effects of spiders took place in parallel with the taxonomy session, with an introductory talk given by Ferenc Samu on the non-consumptive effects of spiders in biological control.

Subsequent plenary talks included that by Fritz Vollrath, who described the production of intricate silken 'windlasses', where sections of silk fibres spool around each other, thereby creating forces that act as a winch. Alistair McGregor's plena-



ry talk focused primarily on arachnid evolution and development, using *Parasteatoda tepidariorum* as a model study system to understand spider evolution. The final plenary talk was on nuptial gift-giving by male *Pisaura mirabilis*, which was given by Cristina Tuni.

These plenary talks were interspersed with contributed talks on a wide range of other subjects, from spider radiations in the Canary islands (Miquel Arnedo), to the study of cryptic *Eratigena atrica* species (Geoff Oxford), and adaptations to extreme environments such as caves (Marco Isaia). Other topics included wolf spiders' risk prone behaviour (Andrew Roberts), characterization of sensory organs found in male palps (Lenka Sentenská) and inventive methods to catch Idiopidae (Victoria Smith).

As was perhaps appropriate given the geographic location of the congress, the very last afternoon of the meeting finished with a session on Spider Recording Schemes in Britain. This was given by Peter Harvey of the British Arachnological Society and was followed by other colleagues speaking about similar schemes in Greece, the French Mid-Pyrenees and Germany (Maria Chatzaki, Samuel Danflous and Theo Blick.)

At the end of the meeting the audience celebrated the best student presentations and posters during an award ceremony. Marlis Dumke (Australia/Germany, First prize for Best Talk), Philip Steinhoff (Germany, Second Best Talk), Jan Raška (Czech Republic, Third Best Talk) and Jana Plíšková (Best Poster) were the winners of this year: congratulations!

We thank everyone who took part in the meeting and we hope to meet many colleagues at next year's congress!

Sara Goodacre and Dmitri Logunov



1 Ibrahim Salman, 2 Shou-Wang Lin, 3 Leah Ashley, 4 Sasanka Ranasinghe, 5 Ilesha Sandunika Ileperuma-Arachchi, 6 Angelika Dawidowicz. 7 Tanya Levy, 8 Igor Armiach, 9 Efrat Gavish-Regev, 10 Michelle Strickland, 11 Eytan Avital, 12 Sara Goodacre, 13 Yael Lubin, 14 André Walter, 15 Jana Plíšková, 16 Nicolas Langenegger, 17 Vladimír Hula, 18 Roman Bucher, 19 Karin Urfer, 20 Miriam Frutiger, 21 János Novák, 22 Hirotsugu Ono, 23 Eva Líznarová, 24 Victoria Smith, 25 Břetislav Novotny, 26 Muhammad Khalid Mukhtar, 27 Torbjörn Kronestedt, 28 Peter van Helsdingen, 29 Maria Chatzaki, 30 Alistair McGregor, 31 Chris Workman, 32 Lawrence Bee, 33 Holger Frick, 34 Kristína Štempáková, 35 Milan Řezáč, 36 Ejgil Gravesen, 37 Nilani Kanesharaknam, 38 Lenka Sentenská, 39 Jutta Schneider, 40 Marlis Dumke, 41 Gabriele Uhl, 42 Geoff Oxford, 43 Marco Isaia, 44 Richard Gallon, 45 André Giroti, 46 Monica Sheffer, 47 Erica Morley, 48 Steven Williams, 49 Christoph Muster, 50 Ferenc Samu, 51 Ella Deutsch, 52 Jan Beccaloni, 53 Cristina Tuni, 54 Stefano Mammola, 55 Seppo Koponen, 56 Tony Russell-Smith, 57 Konrad Wiśniewski, 58 Samuel Danflous, 59 Jackie Adams, 60 Christian Komposch, 61 Adrià Bellvert, 62 Jagoba Malumbres-Olarte, 63 Onno Preik, 64 Robert Bosmans, 65 Theo Blick, 66 Stano Pekár, 67 Michael Seiter, 68 Ondřej Michálek, 69 Bram Vanthournout, 70 Lena Grinsted, 71 Wolfgang Nentwig, 72 Dmitri Logunov, 73 Lucia Kuhn-Nentwig, 74 Andy Roberts, 75 Fritz Vollrath, 76 Matjaž Kuntner, 77 Miquel Arnedo, 78 Cor Vink, 79 Philip Steinhoff, 80 Ondřej Machač, 81 Arthur Decae, 82 Petr Dolejš, 83 Yuri Marusik, 84 Christian Kropf, 85 Jesús Hernández-Corral, 86 Alastair Gibbons, 87 Jan Raška, 88 Łukasz Trębicki, 89 Grzegorz Krawczyk, 90 Jakob Walter, 91 Peter Koomen – Congress photo, Nottingham August 24th, 2017. Photo courtesy Emma Vincent

Giovanni Canestrini's heritage at the Zoology Museum of Padova University (Italy): a rediscovery of his arachnological collections and described species

Luis Alessandro Guariento, Maria Chiara Bonvicini, Loriano Ballarin, Umberto Devincenzo, Giulio Gardini, Enzo Moretto, Paolo Pantini & Paola Nicolosi



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Abstract. Giovanni Canestrini (1835–1900) was the pioneer of arachnology in Italy, who published the first catalogue of Italian spiders and a total of 87 papers in the field. His interests covered almost all the Italian arachnid orders, although in the last part of his life he focused on acarology, in which he became a leading world expert. The remains of Canestrini's arachnological collection deposited in the Zoology Museum of Padova University are represented by spiders (about 850 tubes), mites (438 microscope slides, 115 tubes), harvestmen (120), pseudoscorpions (63), scorpions (19) and solifuges (1). The collection is now part of a large revision project aiming at better understanding and clarifying the scientific heritage of Canestrini, including an inventory of the type material from Canestrini and other European arachnologists who contributed to his collection (e.g., T. Thorell). The first results of the collection revision outlining different arachnid orders and highlighting the occurrence of type material are presented here. Brief historical information on Canestrini and his pupils is also provided.

Keywords: arachnids, curation, museum collection, type material

Zusammenfassung. Giovanni Canestrinis Erbe am Zoologischen Museum der Universität Padua (Italien): eine Wiederentdekkung seiner arachnologischen Sammlungen und beschriebenen Arten. Giovanni Canestrini (1835–1900) war der Pionier der Arachnologie in Italien, der den ersten Katalog der Spinnen Italiens und insgesamt 87 Fachartikel veröffentlichte. Seine Interessen lagen auf fast allen italienischen Spinnentier-Ordnungen, auch wenn er sich im letzten Abschnitt seines Lebens auf die Milbenkunde konzentrierte, in der er ein weltweiter Experte wurde. Die am Zoologischen Museum der Universität Padua verbliebene arachnologische Sammlung Canestrinis besteht aus Spinnen (circa 850 Röhrchen), Milben (438 Mikroskop-Präparate, 115 Röhrchen), Weberknechten (120), Pseudoskorpionen (63), Skorpionen (19) und Walzenspinnen (1). Der Sammlung wird nun großes Revisions-Projekt gewidmet, mit dem Ziel das wissenschaftliche Erbe Canestrini besser verstehen und einordnen zu können, einschließlich einer Inventarisierung des Typenmaterial von Canestrini und anderer europäischer Arachnologen, die zur Sammlung beigetragen haben (z. B. T. Thorell). Die ersten Ergebnisse der Revision der Sammlung fassen die verschiedenen Arachniden-Ordnungen zusammen und stellen die vorhandenen Typen heraus. Kurze geschichtliche Informationen über Canestrini und seine Schüler werden ergänzt.

The Zoology Museum of the University of Padova finds its roots in the 18th century natural history collections of Antonio Vallisneri (1661–1730), a professor of medicine. It became a proper Museum of Zoology in 1869 under the chair of Giovanni Canestrini (1835–1900), who made great efforts towards enlarging and cataloguing the entire zoological collections and providing the museum with an international profile.

Canestrini was one of the most eminent Italian zoologists of the 19th century, known for his first translation of Charles Darwin's "On the origin of species" in 1864 and for his effort in spreading the evolutionary theory in Italy (Minelli & Casellato 2001). After the completion of his studies at the University of Vienna in 1861, he became a professor of Natural History at the University of Modena from 1862 to 1869, working as a zoologist and anthropologist and publishing the first catalogues of Italian spiders together with Pietro Pavesi (1844–1907) (Canestrini & Pavesi 1868, Canestrini & Pavesi 1870). In 1869, he became Professor of Zoology,

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Comparative Anatomy and Physiology at the University of Padova where he remained until his death. During this period he dedicated most of his works to arachnology, publishing the first consistent studies on this field in Italy together with his students, among whom emerged relevant personalities of Italian zoology, such as Filippo Fanzago (1852–1889) and Antonio Berlese (1863–1927) (Minelli 1998, Bagella & Pantaleoni 2011, Guariento et al. 2016a). In the last two decades of his life, Canestrini worked almost exclusively on mites and from 1885 to 1889 published eight volumes of the catalogue of Italian Acari entitled "Prospetto dell'acarofauna Italiana", that was left unfinished, as well as several dozen of papers describing new species (Ragusa 2002). His work continued tirelessly until his death in Padova in 1900.

After Canestrini, the museum went through several periods of abandonment in the 20th century, with a discontinuous management and curation which resulted in the loss of important parts of the collections. A temporary recovery of the collections was completed by Marcuzzi (1966) but the museum reopened to the public only in 2004 (Nicolosi 2016). In 2015, when our project started, Canestrini's arachnological collection was in a precarious status with its content being unknown, despite an attempt at revision in the 1980s.

Material and methods

First, a comprehensive collection database has been completed, registering locality information from data labels in the Darwin Core standard (Wieczorek et al. 2012). Each label provides the name of a taxon, the locality, the date (often the date of inventory in the collection) and an inventory number referring to the original catalogues compiled by Canestrini. These catalogues, deposited in the Museum and descri-

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bed by Minelli & Pasqual (1982), are divided in: "Aracnidi e Miriapodi", registering specimens of Araneae, Opiliones, Pseudoscorpiones, Scorpiones and Solifugae from 1870 to 1889 (1035 records); "Catalogo degli acari conservati in alcool" registering mites preserved in ethanol from 1874 to 1898 (865 records); "Acari preparati microscopici" registering microscope slides from 1876 to 1888 (1078 records). Each catalogue mostly provides the same information as on the data labels, in addition to eventual notes on the collectors or regarding the exchanges of specimens with different arachnologists (e.g. T. Thorell, L. Koch). Both catalogues and data labels have been digitized and the database integrates the data obtained from both sources. Furthermore, an extensive search for historical documents (notebooks, correspondence, as well as Canestrini's scientific output) was performed in order to add additional information on the collections. Moreover, during the curatorial restoration, each glass tube was replaced with a new one and filled with 75% ethanol, while microscope slides are kept in the original folders.

The taxonomic revision of the collection is now under way involving three of us: Paolo Pantini (Araneae), Giulio Gardini (Pseudoscorpiones) and Luis A. Guariento (Scorpiones, Solifugae). Other arachnologists revised part of the collection in the past: Valle (1955) worked on the acaroteca preserved in ethanol, Brignoli (1983) on the spiders described by Canestrini, Hansen (1986) on spiders of the family Salticidae, and Chemini (1986) on Opiliones. The whole acaroteca needs extensive revision, and awaits an availability of acarologists.

Results

The results concerning each arachnid order are presented below. From a curatorial perspective, the overall conservation status of the collection was precarious since several tubes were found partially or completely dried, especially in the case of pseudoscorpions, and several microscope slides present a rather deteriorated mounting medium. Parts of the collection were returned by Italian museums where they were on loan since the last century, in particular the entire collection of harvestmen (Trento Museum of Science - MUSE) and some folders of microscope slides belonging to the acaroteca (Bergamo Museum of Natural Sciences). Concerning the search for historical documents, three notebooks have been recovered in the library of the Trento Museum of Science: i) "Studi sugli acari italiani di G. Canestrini e F. Fanzago e sul genere Dermaleichus (ed affini) di G. Canestrini, 1876 a 1878, studi fatti a Doss Tavon, Padova e Santa Maria di Cervarese"; ii) "Note di Giovanni Canestrini 1881, 1882, 1883" that deals with mites of the genus Gamasus and pseudoscorpions; iii) "Raccolta di acari parassiti degli insetti di Riccardo Canestrini, incominciata a Dos Tavon (Trentino) il 15 Agosto 1880". Moreover, from the same library about a hundred letters were recovered, some of which contained the signatures of T. Thorell and L. Koch. The study and translation of these documents could provide interesting information regarding the collection and the taxonomic research conducted by Canestrini.

Araneae

The spider collection contains specimens that mainly originated from Italy and, to a lesser extent, from European (i.e., Croatia, England, Finland, France, Germany, Spain, Sweden)

United States) countries. The foreign material often came from exchanges between Canestrini and renowned European arachnologists, as in the case of the collection from Germany (89 specimens from Nuremberg sent by L. Koch) and from Sweden (67 specimens sent by T. Thorell). According to the historical catalogue, the first spider material was registered in 1870; the last material was registered in 1887. The collection was in part revised by Brignoli (1983), who considered the species described by Canestrini. However, it seems that Brignoli (1983) did not see all the specimens in the collection, since the part of Canestrini's type material rediscovered by us was not mentioned in his revision. All but a few specimens of Salticidae were revised by Hansen (1986).

We found 28 out of the 41 species described by Canestrini (solely or in collaboration with Pavesi): they are presented in Tab. 1 following the nomenclature of World Spider Catalog (2018). In nine cases, the material surely represents types, while other eight specimens are recorded as "probable types" because they were not labelled as such and their collection data are too generic. Precisely, most of these probable types belong to the species described before the arrival of Canestrini to Padova in 1869 (Canestrini 1868a, 1868b; Canestrini & Pavesi, 1868) and they are simply indicated in the catalogue as registered "at the end of 1870", while the collection dates are not reported. Among the material, there are also three preserved species considered inquirendae by Brignoli (1983), for which further examination would clarify their taxonomic status: Melanophora kochi Canestrini, 1868, Prosthesima prognata Canestrini, 1876 and Linyphia furcigera Canestrini, 1873.

In the collection, type specimens of the species described by Thorell based on the material collected by Canestrini in Italy are preserved (Thorell 1872, 1875): Drassus tenellus Thorell, 1875, Drassus spinulosus Thorell, 1875, Epeira limans Thorell, 1875, Erigone nigrimana Thorell, 1875, Gnaphosa plebeja Thorell, 1875, Erigone hilaris Thorell, 1875, Linyphia arida Thorell, 1875, Erigone phaulobia Thorell, 1875, Lycosa nebulosa Thorell, 1875, Sagana rutilans Thorell, 1875, Theridion histrionicum Thorell, 1875, Xysticus kempeleni Thorell, 1872 and Xysticus ninni Thorell, 1872. An examination of these specimens should confirm/clarify their status as well.

Pseudoscorpiones

This collection includes specimens from Italy, and three tubes from Paraguay sent to Canestrini by his pupil Luigi Balzan (1865-1893) in 1889. Balzan became a specialist on pseudoscorpions under the supervision of Canestrini and conducted pioneering research on these arachnids in South America (Balzan 1890, 1892; Guariento et al. 2016b). His studies led to the description of 27 new species from Paraguay, many of which are still valid (Mahnert 2016). According to the historical catalogue, the first pseudoscorpion material was registered in 1873; the last material was registered in 1889.

As for spiders and harvestmen, Canestrini published the first consistent works on these arachnids in Italy (Canestrini 1875a, 1875b, 1876), presenting the state-of-the-art in the encyclopedic monograph "Acari, Myriapoda et Scorpiones hucusque in Italia reperta" edited by Berlese (Canestrini 1883, 1884, 1885). Of the six species he described, we found only four. All are represented by putative syntypes which we have examined confirming the current interpretation of these

Tab. 1: Species of the order Araneae described by Canestrini, with their current status in the collection (present in/absent from the collection and/ or the historical catalogue; types/not types)

Family/Species Status in the collection Agelenidae Tegenaria circumflexa Canestrini & Pavesi, 1868 = species inquirenda historical catalogue. Loc (Brignoli 1983) Vicenza, loc. Lonedo Amaurobiidae Amaurobius crassipalpis Canestrini & Present: type material Pavesi, 1870 Araneidae Epeira biocellata Canestrini, 1868 = Âgalenatea redii (Scopoli, 1763) historical catalogue Epeira ornata Canestrini, 1868 = Ĝibbaranea bituberculata (Walckenaer, 1802) (1983)Clubionidae Clubiona pulchella Canestrini, 1868 = species inquirenda (Brignoli 1983) typ.: Italy, Trentino Dictynidae Dictyna mandibulosa Canestrini & Absent from collection Pavesi, 1868 = Brigittea latens (Fabricius, 1775) Dictyna scalaris Canestrini, 1873 = Absent from collection Marilynia bicolor (Simon, 1870) Dysderidae Dysdera ninnii Canestrini, 1868 Absent from collection Dysdera tesselata Canestrini & Pavesi, Present: not type material 1868 = Harpactea hombergi (Scopoli, 1763)Harpactea (= Dysdera) grisea (Canestrini, 1868) (1983)Eutichuridae Cheiracanthium italicum Canestrini & Pavesi, 1868 = Cheiracanthium punctorium (Villers, 1789) (1983)Gnaphosidae Civizelotes (= Melanophora) gracilis Present: type material (Canestrini, 1868) Melanophora kochi Canestrini, 1868 = Present: not type material species inquirenda (Brignoli 1983) Loc. typ.: Italy, Modena Melanophora latipes Canestrini, 1873 Present: type material = *Setaphis carmeli* (O. Pickard-Cambridge, 1872) Micaria aurata Canestrini, 1868 = Micaria sociabilis Kulczyński, 1897 (1983)Micaria exilis Canestrini, 1868 = species inquirenda (Brignoli 1983) typ.: Italy, Modena Prosthesima anauniensis Canestrini, Present: not type material 1876 = Drassyllus praeficus (L. Koch, 1866) Prosthesima prognata Canestrini, 1876 Present: type material = species inquirenda (Brignoli 1983) Prosthesima tridentina Canestrini, Absent from collection 1876 = Zelotes longipes (L. Koch, 1866) Zelotes (= Melanophora) sardus (Ca-Present: type material nestrini, 1873) Linyphiidae Cresmatoneta (= Formicina) mutinensis Present: not type material (Canestrini, 1868) Formicina pallida Canestrini, 1868 = Present: probable type Cresmatoneta mutinensis (Canestrini, material 1868)

L Absent from collection and sp L typ.: Italy, Veneto, Lugo di 1 1 L N n Р Absent from collection and P_{i} = Present: probable type ma-1 terial. Examined by Brignoli S E Ρ Absent from collection. Loc N 1 n N n 1 PP ri Р 1 G Present: probable type ma-S terial. Examined by Brignoli n S Present: probable type material. Examined by Brignoli Sa Sa 18 S Sa Ρ A S 0 ve Present: probable type man terial. Examined by Brignoli Ί T Absent from collection. Loc P К Τ

1846)

Trachelidae

trini, 1868)

Zodariidae

rini, 1868)

1868 = Nurscia albomaculata (Lucas,

Cetonana (= Drassus) laticeps (Canes-

Zodarion (= Envo) italicum (Canest-

Family/Species	Status in the collection
<i>Linyphia albomaculata</i> Canestrini & Pavesi, 1870 = <i>Neriene furtiva</i> (O. Pickard-Cambridge, 1871)	Present: type material
<i>Linyphia furcigera</i> Canestrini, 1873 = species inquirenda (Brignoli 1983)	Present: type material
<i>Linyphia lithobia</i> Canestrini & Pavesi, 1868 = <i>Tapinopa longidens</i> (Wider, 1834)	Absent from collection and historical catalogue
Linyphia rubecula Canestrini, 1868 = Nematogmus sanguinolentus (Walcke- naer, 1841)	Present: not type material
Philodromidae	
Philodromus generalii Canestrini, 1868 = Philodromus emarginatus (Schrank, 1803)	Absent from collection
Salticidae	
<i>Euophrys obscuroides</i> Canestrini & Pavesi, 1868	Present: not type materi- al. Examined by Hansen (1986)
Marpissa nardoi Canestrini & Pavesi, 1868 (nec Ninni, 1868) = Macaroeris nidicolens (Walckenaer, 1802)	Present: not type materi- al. Examined by Hansen (1986)
Mendoza (= Marpissa) canestrinii Ca- nestrini & Pavesi, 1868 (nec Ninni, 1868)	Present: not type materi- al. Examined by Hansen (1986)
Pyrophorus flavicentris Canestrini & Pavesi, 1868 = Myrmarachne formica- ria (De Geer, 1778)	Present: not type materi- al. Examined by Hansen (1986)
Pyrophorus venetiarum Canestrini, 1868 = Myrmarachne formicaria (De Geer, 1778)	Present: type material. Exa- mined by Hansen (1985, 1986)
Sittilong (= Attus) longipes (Canestri- ni, 1873)	Present: not type materi- al. Examined by Hansen (1986)
Scytodidae	
<i>Scytodes unicolor</i> Canestrini, 1868 = <i>Scytodes velutina</i> Heineken & Lowe, 1832	Absent from collection and historical catalogue
Segestriidae	
<i>Segestria garbigliettii</i> Canestrini & Pavesi, 1870 = <i>Ariadna insidiatrix</i> Audouin, 1826	Present: type material. Exa- mined by Brignoli (1983)
Sparassidae	
Ocvpete nigritarsis Canestrini & Pa-	Absent from collection and
vesi, 1868 = <i>Olios argelasius</i> (Walcke- naer, 1806)	hist. catalogue
Theridiidae	
Theridium nicoluccii Canestrini & Pavesi, 1868 = Steatoda grossa (C. L. Koch, 1838)	Present: type material. Exa- mined by Brignoli (1983)
Thomisidae	
<i>Xysticus cor</i> Canestrini, 1873	Present: type material
Titanoecidae	. –
Amaurobius 12-maculatus Canestrini,	Present: probable type

Present: not type material. Examined by Brignoli (1983)

material

Present: probable type material. Examined by Brignoli (1983)

species (Tab. 2). The syntype of the valid species *Neobisium* (= *Obisium*) *dolicodactylum* (Canestrini, 1874) was examined by Callaini (1985), but it was absent from the collection during the cataloguing work. The three specimens collected by Balzan in Paraguay comprise *Gomphochernes* (= *Chernes*) *communis* (Balzan, 1888) (Chernetidae), *Paratemnoides* (= *Chernes*) *nidificator* (Balzan, 1888) (Atemnidae) and *Chernes capreolus* Balzan, 1888 = *Lustrochernes argentinus* (Thorell, 1877) (Chernetidae), all of which seem to appertain to the original type series.

Tab. 2: Species of the order Pseudoscorpiones described by Canestrini, with their current status in the collection (present in/absent from collection and/or the historical catalogue; types/not types)

Family/species	Status in the collection
Atemnidae	
Acis brevimanus Canestrini, 1883 = Atemnus politus (Simon, 1878)	Present: type material
Cheliferidae	
Chelifer ninnii Canestrini, 1876 = Dactylochelifer latreillii (Leach, 1817)	Present: probable type material
Chelifer brevipalpis Canestrini, 1874 = Dactylochelifer latreillii (Leach, 1817)	Absent from collection
Chelifer romanus Canestrini, 1883 = Rhacochelifer maculatus (L. Koch, 1873)	Present: probable type material
Geogarypidae	
Garypus meridionalis Canestrini, 1885 = Geogarypus minor (L. Koch, 1873)	Present: type material
Neobisiidae	
Neobisium (= Obisium) dolicodactylum (Canestrini, 1874)	Absent from collection

Scorpiones and Solifugae

The scorpions, collected almost exclusively from Italy, partly constituted the basis for the monograph on Italian scorpions published by Fanzago (1872), since several localities in the publication match those given in the catalogue. In fact, Canestrini never dedicated himself to scorpions, as demonstrated by the few specimens preserved in his collection, and left them to his pupil Fanzago who generalized the knowledge on these arachnids in Italy (Canestrini 1875b). In the collection, five specimens of Euscorpius (= Scorpius) canestrinii (Fanzago 1872) (Euscorpiidae) are preserved that almost certainly appertain to the original type series. Vachon (1978) described two specimens of this species belonging to the "Collection Canestrini" and deposited at the Hungarian Natural History Museum (Budapest), consequently designated by Kovarik (1997) as a lectotype and paralectotype. It is likely that these specimens were donated to the Museum in Budapest by Canestrini from the same syntype series currently deposited in Padova.

The collection also contains a single solifuge from Egypt, a Rhagodidae, Pocock, 1897, identified by Canestrini as *Solpuga melanus* Savigny. This specimen has not yet been re-examined.

Opiliones

The harvestmen collection was revised by Chemini (1986) and includes specimens from Italy and France, the latter collected by Eugène Simon. According to the historical catalogue, the first harvestmen material was registered in 1870; the last material was registered in 1875. In his pioneer works on harvestmen (Canestrini 1871, 1872a, 1872b, 1872c, 1873, 1874, 1875a, 1875b, 1876, 1888), Canestrini described 17 species from Italy and South America, most of which are represented by type series in the collection (Tab. 3).

Tab. 3: Species of the order Opiliones described by Canestrini, with their current status in the collection (present in/absent from collection and/or the historical catalogue; types/not types)

Family/species	Status in the collection
Gonvleptidae	
Pachylus spinosus Canestrini 1888 = Discocyrtus dilatatus Sørensen 1884	Absent from collection and historical catalogue
Pucrolia (= Pachylus) gracilipes (Canestrini, 1888)	Absent from collection and historical catalogue
Ischyropsalididae	
Ischyropsalis adamii Canestrini, 1873	Present: type material, defi- ned by Chemini (1986)
Nemastomatidae	
Histricostoma (= Nemastoma) argenteo- lunulatum (= dentipalpe var. argenteo- lunulata) (Canestrini, 1875)	Present: type material, defi- ned by Chemini (1986)
<i>Nemastoma dentigerum</i> Canestrini, 1873	Present: type material, defi- ned by Chemini (1986)
Phalangiidae	
Dicranopalpus (= Liodes) larvatus (Canestrini, 1874)	Present: type material, defi- ned by Chemini (1986)
Eudasylobus (= Opilio) graniferus (Canestrini, 1871)	Present: type material, defi- ned by Chemini (1986)
Dasylobus (= Opilio) argentatus (Canestrini, 1871)	Present: type material, defi- ned by Chemini (1986)
Megabunus (= Platylophus) rhinoceros (Canestrini, 1871)	Present: type material, defi- ned by Chemini (1986)
Odiellus (= Acantholophus) granulatus (Canestrini, 1871)	Present: type material, defi- ned by Chemini (1986)
Sclerosomatidae	
Astrobunus (= Hoplites) laevipes (Canestrini, 1872)	Present: not type material
Hoplites pavesii Canestrini, 1871 = Astrobunus helleri (Ausserer, 1867)	Present: type material, defi- ned by Chemini (1986)
Metasclerosoma (= Homalenotus) depressum (Canestrini, 1872)	Present: type material, defi- ned by Chemini (1986)
Nelima (= Leiobunum) doriae (Canestrini, 1871)	Present: type material, defi- ned by Chemini (1986)
<i>Leiobunum agile</i> Canestrini, 1876 = <i>Nelima doriae</i> (Canestrini, 1871)	Present: type material, defi- ned by Chemini (1986)
Pectenobunus (= Opilio) paraguayensis Canestrini, 1888	Absent from collection and historical catalogue
Trogulidae	
<i>Trogulus tuberculatus</i> Canestrini, 1876 = <i>Trogulus nepaeformis</i> Scopoli, 1763	Present: type material, defi- ned by Chemini (1986)

Acari

The Canestrini Acaroteca consists of 438 microscope slides, most of which originated from Italy (especially from Veneto and Trentino) and to a lesser extent from Europe (i.e. France, Germany, Hungary and Sweden) and extra-European countries (i.e. Brazil, Eritrea). In several cases, the host from which the specimens were collected is also indicated (e.g. domestic and wild animals, humans, foods or plants). Along with the acaroteca, the acarological collection also includes 115 samples in ethanol and glycerine, which were partly reviewed by Valle (1955) and therefore not examined during our curatorial revision. A number of Canestrini's students contributed to the acaroteca, among them the renowned Italian entomologist Antonio Berlese (slides of "Collezione Berlese"), who continued Canestrini researches and became a leading world scientist in the field of acarology (Ragusa 2002), as well as other personalities such as Canestrini's brother Riccardo Canestrini (1859–1891) and Enrico Sicher (1865–1915); both published several works on mites in cooperation with Canestrini or alone. Conversely, no slide reports the name of Filippo Fanzago, with whom Canestrini started his acarological studies (Canestrini & Fanzago 1876a, 1876b, 1877). Moreover, only a single slide received from a foreign acarologist is available in the collection: the slide from French Édouard Louis Trouessart (1842–1927) with whom Canestrini published a joint note (Trouessart & Canestrini 1895).

Of the over 140 species of Acari described by Canestrini, many are represented in the acaroteca by probable type series. Among them, two slides are labelled as holotypes by an anonymous, recent author (the holotypes of *Rhagidia gigas* Canestrini, 1886 and *Coccorhagidia clavifrons* Canestrini, 1886). The taxonomic review of this prestigious acarological collection is required to evaluate and to clarify the identity of numerous species.

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Supraspecific names in spider systematic and their nomenclatural problems

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doi: 10.30963/aramit5507 **Abstract**. Three different types of the names used in spider systematics are recognized and discussed: 1) typified taxonomic names, 2) non-typified taxonomic names, and 3) non-taxonomic names. Typified names are those from genus to superfamily group names; they are regulated by the ICZN. Non-typified names are used for taxonomic groups higher than superfamilies (e.g., Haplogynae, Mesothelae, etc.);

regulated by the ICZN. Non-typified names are used for taxonomic groups higher than superfamilies (e.g., Haplogynae, Mesothelae, etc.); they are not regulated by the ICZN but have an authorship, a fixed year of publication and are incorporated in a hierarchical classification. Non-taxonomic names are not regulated by any formal rules, unranked, have no authorship or description, and are non-typified. Some difficulties connected with the non-typified names in spider systematics are briefly discussed. Senior synonyms of some non-typified and non-taxonomic names are discussed, and suggestions are given on how to deal with the non-typified names lacking senior synonyms.

Keywords: clade name, non-typified name, typified name.

Zusammenfassung. **Supraspezifische Namen in der Spinnensystematik und ihre nomenklatorischen Probleme.** Drei verschiedene Namenstypen in der Spinnensystematik werden diskutiert: 1) typisierte taxonomische Namen, 2) nicht-typisierte taxonomische Namen sowie 3) nicht-taxonomische Namen. Typisierte Namen reichen von Gattungen bis zu Überfamilien und sind durch die ICZN reguliert. Nicht-typisierte Namen werden für taxonomische Einheiten oberhalb von Überfamilien verwendet (z. B. Haplogynae, Mesothelae), sind nicht durch die ICZN reguliert, haben aber Autoren, ein Erstbeschreibungsjahr und werden in hierarchischen Klassifikationen verwendet. Nicht-taxonomische Namen sind ungeregelt, nicht hierarchisch und ihnen sind keine Erstautoren oder Erstnennungen zugeordnet. Schwierigkeiten der nicht-typisierten Namen werden ebenso diskutiert, wie ältere Synonyme einiger nicht-typisierter und nicht-taxonomischer Namen. Es werden Vorschläge gemacht wie mit den nicht-typisierten Namen ohne ältere Synonyme umgegangen werden kann.

Terminology in all fields of science, including arachnology, is critically important because, if used inconsistently, it may lead to confusion (Lotte 1961, Anonymous 1968). For instance, if the same term is applied to different morphological structures or phenomena (e.g., the conductor in Lycosidae and other members of the RTA-clade) or if various terms are used for the same (= homological) morphological structures (e.g., spermatheca – receptacle – receptaculum, vulva – endogyne – uterus externus). In taxonomy/systematics, names play a very important role, helping to communicate biological information. Unfortunately, as with the terminology, there is no consistency in their use. There are at least three different types of names used by arachnologists: 1) typified names, 2) non-typified names, and 3) non-taxonomic names.

What are typified names? These are the scientific family used for taxa higher than species group names up to the family group names (superfamily) (ICZN 2012). Each genus group name has a type species (= generotype), while for family group names a genus name is used as the type. For example, the type genus of the family Lycosidae Sundevall, 1833 and its nominative subfamily Lycosinae Sundevall, 1833 is *Lycosa* Latreille, 1804. Consequently, the type family of the superfamily Lycosoidea Sundevall, 1833 is Lycosidae.

Compared to typified names, taxonomic group names higher than the superfamily rank have no designated type families, and hence are called non-typified names (e.g., almost all order names in Hexapoda, Vertebrata, etc.). This is because the International Code of Zoological Nomenclature (ICZN) only governs the naming of taxa from species (subspecies, species, superspecies) to the family (subfamily, family, superfamily) group names (ICZN 2012: Article 1.2.2).

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Taxonomic names higher than superfamilies are not regulated by the ICZN.

The third type of names that are commonly used in spider systematics are non-taxonomic names, for example, RTAclade, Lost Trachea clade, Oval Calamistrum clade, etc. Such names are not regulated by any rules and are applicable to any taxon, from species to phyla ranks. These are poorly technical, non-scientific (and not Latinized) names, as compared to those regulated by the ICZN.

The aims of the present paper are (1) to briefly discuss all three name groups and their use in spider systematics, and (2) to indicate some nomenclatural problems related to non-typified and non-taxonomic arachnological names and to suggest possible ways to resolve them.

Typified names

These names present no problems because their use is strictly governed by the ICZN (2012), which is a set of very detailed rules compiled by an international consortium of experts in zoological systematics and agreed upon by the entire zoological community. Thus, when a spider genus name is discussed, its type species (i.e., the only objective member thereof) has to be considered in the first place. If a tribe, subfamily, family or superfamily name is discussed, the type genus needs to be primarily considered.

Fairly often, arachnologists, like other zoologists, use typified names at a level higher than family group names: e.g., Araneomorphae (based on Araneidae Clerck, 1757), Liphistiomorphae (based on Liphistiidae Thorell, 1869), or Theraphosomorphae (based on Theraphosidae Thorell, 1869). There are also group names that could be conventionally treated as partly "typified" names, for example:

- Mygalomorphae, based on *Mygale* Latreille, 1802, a junior homonym of *Mygale* Cuvier, 1800 (Mammalia), and the families Mygalides Sundevall, 1833 and Mygalidae Blackwall, 1845.
- Araneae, based on *Aranea* Latreille, 1804, the suppressed name with the type species *Aranea domestica* Clerck, 1757

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which is currently placed in *Tegenaria* C.L. Koch, 1837 (Agelenidae C.L. Koch, 1837).

 Avicularioidea (as an infraorder), based on Aviculariidae Simon, 1874, a junior synonym of Theraphosidae.

There are a number of non-typified names of unclear taxonomic rank, which can be considered infraorders (not regulated by the ICZN) or superfamilies, for example:

- Argiopoidea, based on Argiopidae Simon, 1890 (a junior synonym of Araneidae Clerck, 1757).
- Drassiformes, based on *Drassus* Walckenaer, 1805 (a junior synonym of *Gnaphosa* Latreille, 1804) and Drassoidae Thorell, 1870.
- Epeiriformes, based on *Epeira* Walckenaer, 1805 (a junior synonym of *Araneus* Clerck, 1757) and Epeiridae Fitch, 1882, a junior synonym of Araneidae Clerck, 1757, which is the oldest name in zoological systematics (ICZN 2012: Article 3.1).

There are many more names from family groups or a higher rank. An almost complete list of typified names for spider taxa higher than the family group is provided by Kluge (2017).

Non-typified names

There are many non-typified arachnological names, for instance (the currently used names are given in bold): Apneumanatae, Artionycha, Cribellatae, Deuterotracheata, **Dionycha**, Dipneumonatae, Ecribellatae, **Entelegynae**, **Haplogynae**, Hypodemata, Labidognatha, **Mesothelae**, Nelipoda, Neocribellatae, Octostiatae, **Opisthothelae** (= Opistothelae), Orbicularia, Orthognatha, **Palaeocribellatae** (= Paleocribellatae), Perissonycha, Proterotracheata, Quadrostiatae, Sexoistiatae, **Synspermiata**, Tetrapulmonata, Trionycha, etc. Almost a complete list of non-typified names suggested for spider taxa higher than the family group are provided by Kluge (2017).

Although some of these names are widely used, they are subject to much confusion. But why? For instance, the name Haplogynae Simon, 1893 was described to accommodate six families Caponiidae, Dysderidae, Hadrotarsidae, Leptonetidae, Oonopidae and Sicariidae. Hadrotarsidae are now treated as a subfamily of Theridiidae (Entelegynae), whereas Leptonetidae remain apart from other haplogynes (Wheeler et al. 2017). The remaining families currently included in the Haplogynae have different types of female copulatory organs: viz., Caponiidae, Dysderidae, Oonopidae and Telemidae have unpaired receptacles, whereas Filistatidae, Scytodidae and Sicariidae have paired receptacles. The single receptacle of Telemidae strongly differs from those of all other spider families in having the weakly sclerotized sac-like tube and therefore this family is likely to be excluded from the Haplogynae.

Simon's haplogyne families are currently split into more families, and many new families (e.g., Drymusidae, Ochyroceratidae, Orsolobidae, Segestriidae, Telemidae, etc.) have been added. Since the very beginning, Haplogynae had been a polyphyletic taxon due to the inclusion of Hadrotarsidae. Since Haplogynae is a non-typified name having no designated type family, it is impossible to properly discuss its limits and relationships. For instance, Lehtinen (1967) placed Filistatidae in the Haplogynae, although this taxon was originally placed in Mygalomorphae, then moved to Cribellatae, and later placed among the "classical Haplogynae (including the cribellate family Filistatidae)" (Platnick et al. 1991: p. 1). Now it is impossible to meaningfully discuss what the true Haplogynae is, or which of the families it currently contains should be excluded, because this taxon is not associated with any designated type family name.

A similar situation exists with Dionycha Petrunkevitch, 1928, the taxon uniting spider families having two tarsal claws. Recently, M.J. Ramírez, in his presentation on the 20th Congress of Arachnology (cf. Ramírez et al. 2016), argued that Sparassidae should not be a member of the Dionycha, although all sparassids have two claws and the family was included in this group by Petrunkevitch, the original author of this taxon. Yet, as the Dionycha has no designated type family, it is impossible to prove or refute the statement by Ramírez and his co-authors.

At the first glance, Mesothelae Pocock, 1892 (= Liphistiomorphae) looks like a well-defined taxon consisting of the single family Liphistiidae, which would be true if only extant spider families were considered. Yet, there are at least six fossil families in the group: Arthrolycosidae Frič, 1904, Arthromygalidae Petrunkevitch, 1923, Pyritaraneidae Petrunkevitch, 1953, Burmathelidae Wunderlich, 2017, Cretaceothelidae Wunderlich, 2017 and Parvithelidae Wunderlich, 2017. Although the Mesothelae is a non-typified name, it is clear what family was used as its "type" (by original monotypy). The same holds true with Palaeocribellatae Caporiacco, 1938, the group that was originally proposed for Hypochilidae Marx, 1888 only, and therefore Hypochilidae could be considered in some respects the type family of Palaeocribellatae.

There is another major problem associated with non-typified names: they are largely based on morphological characters and hence their names are often homonymous (= equivalent) with morphological terms. For example, the term 'haplogynes' can be either used for a taxon, or for spiders without an epigyne; the 'dionychans' can refer to either a taxon, or to the morphological trait seen in Sparassidae, which according to M.J. Ramírez do not belong to the Dionycha. Often it is not clear whether an author wrote about a taxonomic or morphological group. For instance, the fundamental work by Platnick et al. (1991) is entitled as follows: "Spinneret morphology and the phylogeny of haplogyne spiders". However, in the abstract (Ibid.: p. 1), the authors wrote: "Scanning electron microscopy is used to survey the spinneret morphology of representatives of 47 genera of araneomorph spiders with haplogyne female genitalia.... but including those palpimanoid and orbicularian taxa with haplogyne females". Both, the taxonomic name and the morphological term, are mixed up in the abstract. Based on this quote, there are no differences between 'haplogyne female genitalia' and 'haplogyne females', although the authors dealt both with the Haplogynae genera and with those of the Entelegynae having a haplogyne (the morphological term without a strict definition) type of copulatory organs. The same authors used the terms 'haplogyne spinneret morphology', although the female copulatory organs have no spinnerets. Some authors write about 'secondary haplogynes' spiders or 'haplogyne palp' meaning the male palp, although the prefix 'gyne' refers either to a female or to a female reproductive organ.

Some spider families outside of the Dionycha (sensu Ramirez et al. 2016) have two claws. The family Pholcidae is assigned to Synspermiata (Wheeler et al. 2017), although that synspermia was found only in a single genus of the eight studied (Michalik & Ramirez 2014). Lamponidae belonging to Opisthothelae have their spinnerets situated close to the epigastral furrow, close to the middle part of the venter, viz. in the same way as in Mesothelae. Orb webs (cf. Orbicularia) are known in the unrelated Araneoidea and Uloboridae (cf. Wheeler et al. 2017), and this is why these groups have been united in Orbicularia for a long time.

Another problem connected with non-typified names is the lack of a hierarchy and a principal impossibility to establish it. For example, it is not clear what taxon has a higher rank, Haplogynae or Synspermiata, because both groups have no distinct or rigorously specified limits. Does Haplogynae include Synspermiata, or vice versa, is Haplogynae a taxon of Synspermiata?

Finally, non-typified names cannot be synonymized with other names, unless they are monotypic.

Non-taxonomic names

These are a kind of technical or conventional names that are not-Latinized and in most cases consist of several words. Non-taxonomic names are common in the contemporary taxonomy, including arachnology, especially in cladistics/ phylogenetic studies (as clade names), although they are not regulated by any rules. These names lack a hierarchy and sometimes carry no meaningful information.

A clade name can refer to a species group or to a phylum. Such names can derive from a particular character (e.g., RTAclade, Lost Trachea clade, Cylindrical Gland Spigot clade, Oval Calamistrum clade, Oblique Median Tapetum clade) or lack any indication as to which spider group it could be referred (e.g., the Pedipalpi or Marronoid clade sensu Wheeler et al. 2017). As with non-typified names, clade names are not fixed with a certain taxon (type).

The most common clade name in arachnology is the RTAclade, uniting spiders having the retrolateral tibial apophysis (RTA) in the male palp with those (e.g., Lycosidae) lacking it. Furthermore, there are subfamilies/genera that are not included in the RTA-clade but possess the RTA: e.g., *Diphya* Nicolet, 1849 (Tetragnathidae, Dyphyinae); many Erigoninae (Linyphiidae); *Pikelinia* Mello-Leitão, 1946, *Lihuelistata* Ramírez & Grismado, 1996 (Filistatidae). Incidentally, the oldest taxonomic name for the RTA-clade seems to be Lycosoformes Simon, 1864, which is based on the family lacking the RTA.

The most unusual clade name seems to be the Marronoid clade (spelled either as Marronoid or marronoid, with adding 'clade' or 'group') "grouping together several spider families lacking striking characters" (Wheeler et al. 2017: p. 23). In fact, this clade was suggested to accommodate spider families which cannot be united by any other character(s).

Some arachnologists specify that they deal with a clade by just adding the word 'clade', while others manipulate with names without reference to their status.

In contrast to scientific names, non-taxonomic names have no authorship and they can (dis)appear without any justification. To describe/introduce a new typified name, an author should provide a detailed justification following the specify ICZN regulations, but it seems that there is no need to specify why a clade has its name and what is its etymology? For instance, here are the clade names introduced and used in the latest spider phylogeny (Wheeler et al. 2017): viz., Divided Cribellum clade, Canoe Tapetum clade, Reduced Piriform clade, Spineless Femur clade, Araneoid Sheet Web Weavers (the word 'clade' is not used for this group).

Some arachnological clade names introduced in cladistic/ phylogenetic studies have a hybrid status: e.g., Distal Erigonines, Higher Araneoids, Higher Lycosoids, Derived Araneoids. These names contain a taxon name, but have no information on what could be their type groups, and thus they are non-typified names. Furthermore, these as well as clade names such as RTA-clade, Divided Cribellium clade, Canoe Tapetum clade, Reduced Piriform clade, Spineless Femur clade and many others cannot be treated as taxonomic names because they are not uninominal as required by the ICZN (2012: Article 4.1).

Discussion

What could be a possible approach for sorting out non-typified names? There is no universal rule, and several suggestions can be considered regarding different cases.

1. In fact, several non-typified names do have senior synonyms, which are often more advantageous than those currently used. Although the ICZN does not formally regulate names higher than family groups, the conventional principle of priority seems to be applicable in such cases as well. Below, some examples of non-typified names that have senior synonyms are discussed: Araneae, Dionycha, Haplogynae, Entelegynae.

Aranei is based on Araneus Clerck, 1757 and Araneidae Clerck, 1757, the two oldest names in zoology (ICZN 2012, Kluge 2007, 2016). Araneae Linnaeus, 1758, is based on the suppressed name Aranea Linnaeus, 1758, of which the type species is Araneus domesticus Clerck, 1757 (= Tegenaria d., Agelenidae) (see Kluge 2007, ICZN 2009). In addition, the Latin words 'araneus' and 'aranea' have the same root meaning 'spider', but they are of a different grammatical gender. Originally, in the ancient Latin "araneus meant 'spider' and aranea meant 'spider web', but the first century B.C. poet Catullus (68.49) already used aranea to mean 'spider'" (Cameron 2005: p. 279). An additional point in favour of Aranei (not connected with any rules) could be that it is shorter than Araneae and easier to spell and pronounce. Despite the name 'Araneae' was conventionally accepted by a vote on the XIII International Congress of Arachnology (Genève, Switzerland) (see also Savory 1972), this act alone does not suppress the use of 'Aranei', which is the correct grammatical form for the order of spiders (Aranei is a plural from Araneus). Yet, in my opinion, the XIII Congress of Arachnology (see CIDA 1996) had no authority to establish special nomenclatural rules and thus 'Aranei' is to be treated as a valid taxonomic name.

Thomisiformes Simon, 1864 is an older name than Dionycha Petrunkevitch, 1928, whereas the scope of this taxon is identical to the classical definition of Dionycha (see above). Therefore, in my opinion, the name 'Thomisiformes' has an advantage over 'Dionycha' and can easily substitute for it. For instance, Dionycha makes it difficult or even impossible to discuss the problem of a correct assignment of the Sparassidae, which according to M.J. Ramírez (his presentation on the 20th Congress of Arachnology) do not belong to Dionycha (see above for more details). The ending of this taxon name can be modified, as it is not regulated by the ICZN, and be either Thomisidaeformes or Thomisoidea.

Scytodiformes Simon, 1864 is the oldest typified name for Haplogynae Simon, 1893 (and also for Synspermiata) and as such, in my opinion, should be given a priority, despite this act not being regulated by the ICZN. The oldest name for **Entelegynae** should be based on Araneidae, for instance, Araneiformes.

Hypochilomorphae Petrunkevitch, 1933 is a senior synonym of Palaeocribellatae Caporiacco, 1938 (originally monotypic, based on Hypochilidae, this name is often used in current classifications). However, there are two more synonyms: Hypochiloidea Lameere, 1933 and Umbellitelariae Marx, 1890 (non-typified name, suggested without any explanations). In my opinion, the name of Petrunkevitch should be further used, because it was given in a family covering all spiders.

- 2. Although there is no priority rule for taxa higher than a family group name, if a non-typified name is a senior "synonym", in my opinion, the oldest typified name is to be used. For instance, in my opinion, the younger name Liphistiomorphae Petrunkevitch, 1923 could be used instead of Mesothelae Pocock, 1892, because the latter name has no clear limits. In the future, an alternative possibility could be feasible: viz., if an author utilizes a non-typified name, a clear reference to a family that is seen by this author as the type would be extremely helpful to avoid ambiguity in interpretation of that non-typified name. For instance, the type family of Mygalomorphae could be either Theraphosidae, or any other family currently included in it; yet, such ambiguity could have been avoided, if the type family was clearly selected by the author who introduced the name in first place.
- 3. Although clade names are not scientific/taxonomic, poorly technical and hence there is no formal way to regulate them, some clade names are very popular and accepted by the majority of arachnologists, for instance, the RTA-clade. The oldest taxonomic name that, in my opinion, could be a suitable replacement for the name 'RTA-clade' is Lycosiformes Simon, 1864. Although Thomisiformes also belongs to the RTA-clade, they account only for its part (= Dionycha; see above for more details) and therefore cannot be used as a typified name for the entire RTA-clade.
- 4. There is another, a rather radical solution on how to operate with non-typified names, for instance, to apply rules of the circumscriptional nomenclature which has many advantages over the traditional nomenclature. Although to date this nomenclature has not yet been employed in the spider systematics, its effectiveness has been demonstrated for insects and their classification (e.g., Kluge 2000). Further details about this nomenclature can be found in Kluge (2010, 2017).

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Ontogenetic development and reproduction of Zorocrates guerrerensis (Araneae: Zoropsidae)

Petr Dolejš & Mojmír Hanko



Abstract: Zorocrates guerrerensis Gertsch & Davis, 1940 is a Mexican cribellate spider with almost no information about its biology. As the species could potentially be of medical interest, it was decided to study basic aspects of its life history under laboratory conditions. The life cycle lasts a year, with spiders undergoing up to 12 instars to reach maturity. The courtship behaviour includes tactile communication. Copulation consists of two palpal insertions, each with a single haematodochal expansion. Both males and females can mate more than once; components of the first and second copulation do not differ. On average, the total copulation duration lasts for more than five minutes. Some details of the copulation process are discussed and compared with those of other lycosoids.

Keywords: copulation, courtship, cribellate spider, instar, life history, Mexico, polyandry, polygyny, tactile communication

Zusammenfassung. Ontogenese und Reproduktion von Zorocrates guerrerensis (Araneae: Zoropsidae). Die Biologie der mexikanischen cribellaten Spinne Zorocrates guerrerensis Gertsch & Davis, 1940 ist nahezu unbekannt. Da die Art potentiell medizinisch interessant ist, wurde ihr Lebenszyklus und ihre Lebensweise unter Laborbedingungen studiert. Ihr Zyklus dauert ein Jahr, in dem die Spinnen nach bis zu 12 Häutungen erwachsen werden. Beim Paarungsverhalten spielt taktile Kommunikation eine Rolle. Die Kopulation besteht aus zwei Insertionen der Palpen, jede mit einer einmaligen Expansion der Hämatodocha. Sowohl Männchen als auch Weibchen können sich mehr als einmal paaren; die Komponenten der ersten und zweiten Kopulation unterscheiden sich nicht. Durchschnittlich ist die Dauer der gesamten Kopulation länger als fünf Minuten. Details des Kopulationsprozesses werden diskutiert und mit dem anderer Lycosoidea verglichen.

New spider species to science continue to be discovered all over the world. Their descriptions are usually based on morphology, whereas bionomy, ecology or behaviour are rarely considered. However, behavioural data can contribute to the spider taxonomy, not only for distinguishing morphologically similar species (e.g., Kronestedt 1990, Töpfer-Hofmann et al. 2000) but also for placing them in correct genera (e.g., Rovner 1973). Surprisingly, we often lack basic information even about common, widespread species known to everybody. Recent research on long neglected animal species brought surprising results. For instance, large common (and even edible) European animals, such as the slow worm Anguis fragilis Linnaeus, 1758, the Turkish snail Helix lucorum Linnaeus, 1758 and the Roman snail Helix pomatia Linnaeus, 1758, were split up into five, two and two species respectively (Gvoždík et al. 2010, 2013, Korábek et al. 2014, 2016).

Zorocrates guerrerensis Gertsch & Davis, 1940 is also a relatively large, common, hemisynanthropic animal (Jiří Král pers. observ.), which seems to be of potential clinical importance (Sánchez-Vega et al. 2016). Despite this, *Z. guerrerensis* is a rarely studied species. Its name has appeared in only three publications: in its description (Gertsch & Davis 1940), a generic revision that provided its distribution in Mexico (Platnick & Ubick 2007) and a report on its bites (Sánchez-Vega et al. 2016). Based on morphological (Dahl 1913, Lehtinen 1967, Griswold et al. 1999, Raven & Stumkat 2005) or combined (Polotow et al. 2015) analyses, the genus *Zorocrates* has been transferred among various families (Miturgidae, Tengellidae, Zorocratide, Zoropsidae) several times. In the latest treatment (Wheeler et al. 2017), the genus was assigned to the subfamily Tengellinae of the family Zoropsidae, being

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considered a member of the superfamily Lycosoidea or the Oval Calamistrum clade. Biological and ethological observations that could support its correct taxonomic placement are, however, completely absent. Thus the aim of the present paper is to provide initial, basic information on the life history of this Mexican cribellate species.

Material and methods

Several specimens were collected by Jiří Král in Mexico, Querétaro State, Juriquilla, in the campus UNAM (20.7036°N, 100.4474°W, 1920 m a.s.l.) on 20.vi.2009. The further breeding of Z. guerrerensis was carried out by Jaromír Hajer at the Jan Evangelista Purkyně University in Ústí nad Labem, Czech Republic. Fourteen spiderlings of the third instar from this breeding were reared from four egg sacs (constructed in 3.VII.-12.IX.2013). Exuviae of the previous two instars were available to us. Juveniles were held individually in plastic tubes (length 100 mm, diameter 15 mm; later length 115 mm, diameter 28 mm) supplied with wet cotton wool as a source of water. Spiders were reared at room temperature (20-23 °C) under natural photoperiod and fed weekly with wingless Drosophila melanogaster, Tenebrio larvae, crickets of appropriate size and seasonally available insects. Beginning with the third ecdysis, i.e. the fourth free instar, dates of each moult were recorded and the length of all shed carapaces was measured using a stereomicroscope (PZO Warszawa: MST 127) equipped with an ocular micrometer. To calculate the relative percent growth between subsequent instars for each individual, the equation of Mallis & Miller (2017) was used: $100 \times L_N$ $L_{N-1} - 100$ (L = carapace length, N = instar). From these values, the population mean was calculated. The nomenclature and numbering of ontogenetic stages follow Downes (1987): the first instar is the stage that left the egg sac. We did not count the postembryonic moults inside the egg sacs (i.e. between the postembryo and the first nymphal instar), therefore we treated the first ecdysis as the one terminating at the first instar (after Dolejš et al. 2014).

After reaching a maturity, mating of nine females and four males (one reared juvenile died accidentally during manipu-

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lation) was observed in Petri dishes (diameter 90 mm, height 50 mm) under laboratory conditions (room temperature and a natural photoperiod). A white, moistened filter paper was placed into the Petri dish to provide a substratum suitable for spider locomotion, to improve contrast during videotaping and to allow the spiders to remain hydrated. An adult female was placed into the Petri dish 2 h before the trial to allow her to habituate to the new surroundings and to deposit silk and pheromones. After introducing a male, the spiders' behaviour was recorded for 15 min, using a digital Panasonic NV-GS400 video camera. Such a 15 min period was enough for all observed copulations to be completed. The females were paired with randomly chosen males. All but one mated female was paired in one more trial to determine whether females are monandrous or polyandrous (one female had produced an egg sac before the second trial began).

Seventeen copulations were observed and analysed. Latency (the time between introducing the male and the first physical contact), courtship and copulation duration were recorded. Numbers of insertions and of side shifts were counted. Behaviour of mating spiders was recorded. The moment when a male climbed onto a female was designated as the beginning of copulation, and the moment when the spiders physically separated as the end of copulation (Stratton et al. 1996). After copulation, each female was placed back in their plastic tube where later on they constructed their egg sacs. The production of egg sacs, the process of egg laying, hatching and postembryonic development inside the egg sacs were not investigated.

The software NCSS 2007 (Hintze 2006) was used to test the normality of continuous variables (all data were normally distributed) and to calculate descriptive statistics of the following variables: latency, courtship and copulation duration, number and duration of palpal insertions and hematodochal expansions, delay between copulation and egg sac production and number of offspring. Of the descriptive statistics, means (\bar{x}) and standard errors (SE) were calculated. The first and second copulations were compared using a Paired t-test. Voucher specimens have been deposited in the National Museum, Prague (N°s P6A-6468 and P6d-14/2017).

Results

The life cycle of *Z. guerrerensis* lasted a year. Spiders underwent up to 12 instars; on average, the instar duration was 42.4 days (SE = 10.82) (Tab. 1). Males reached adulthood in the

10th (n = 1) or 11th (n = 3) instar, females in the 10th (n = 2), 11th (n = 4) or 12th (n = 3) instar. The between-instar growth factor was approximately constant (Tab. 1). The following instars were about 20.0 % (SE = 3.88) larger than the previous ones; the relative growths had a descending tendency (Tab. 1). Adult males were about 11.7 % smaller than females.

Pre-mating interactions between males and females started quite rapidly; the first contact occurred 28 s (SE = 34) after introducing the male into the arena with a female. Males touched the tibia or head region of the females with its first pair of legs. Females located the introduced males, raised its first or two first pairs of legs and held them either parallel to each other (Fig. 1) or at an angle of 30-60 degrees. Further contact was tactile. Males tapped (using their front legs) the patellae and tibiae of the female's front legs and also her carapace, and the femora and tibiae of the female's third and fourth legs (Fig. 2). On the average, the tactile interactions lasted for 123 s (SE = 146). During this courtship, the males waggled several times with their opisthosoma up and down and climbed onto females. When the male prosoma was above the female carapace, the females performed on average 5.5 (SE = 2.43) very vigorous jerks forwards using their third and fourth pairs of legs (the front legs were still raised) but their tarsi did not change their position, standing still on the same place. All tested females (n = 9) were receptive. Then, males mounted the females (Fig. 3) so that the male's prosoma was above that of the female, but the spiders were facing in opposite directions.

Once the males reached the copulatory position ["Position II" after Gerhardt & Kästner (1941) or "Type 3" after Foelix (2011)], they immediately inserted one palp equilaterally. The palp was inserted between the third and fourth leg of the females (Fig. 4). Just before insertion, the males briefly scraped the epigyne using rapid movements of their palps. The haematodocha was expanded (and leg spines erected) immediately after the palp was inserted (Fig. 5); during the palpal insertion, only one haematodochal expansion occurred. Males left their palps close to the epigyne (but not in direct contact with it) for some time after the haematodocha had collapsed and the spines returned to their original position (Fig. 6 and the supplementary video file). Males switched sides only once, thus each palp (right and left) was used only once. In four out of 17 copulations, the so-called 'flubs' were observed: males inserted their palps, but the haematodocha never expanded in full and males usually used the other palp. Such unsuccessful

Tab. 1: Summary of the ontogenetic development of *Zorocrates guerrerensis*. Carapace lengths, percentage of growth in carapace length during moults and duration of each instar given separately for males (n = 4) and females (n = 9). Means and standard errors (in parentheses) are provided.

Instar	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Carapace length (mm) 9	1.0 (0.06)	1.2 (0.10)	1.4 (0.07)	1.7 (0.20)	1.9 (0.27)	2.4 (0.22)	2.9 (0.22)	3.4 (0.39)	4.2 (0.52)	5.1 (0.49)	5.5 (0.34)	_
Carapace length $(mm) \delta$	1.0 (0.08)	1.2 (0.13)	1.5 (0.17)	1.8 (0.21)	2.2 (0.28)	2.6 (0.22)	3.3 (0.26)	3.9 (0.35)	4.5 (0.45)	5.2 (0.52)	6.0 (0.50)	6.4 (0.35)
Relative growth (%)♀	-	21.6 (4.36)	22.2 (7.96)	20.2 (8.11)	18.8 (3.02)	21.8 (5.90)	20.3 (3.98)	20.6 (4.49)	20.3 (6.46)	22.3 (6.46)	10.3 (4.38)	-
Relative growth (%) ♂	-	26.5 (9.47)	20.8 (6.95)	18.4 (6.08)	20.1 (5.56)	22.3 (7.87)	19.1 (3.48)	24.3 (7.25)	18.1 (3.80)	16.8 (6.43)	19.5 (5.74)	12.7 (4.42)
Duration (days) 9	;	;	;	40.0 (5.488)	33.5 (4.04)	36.0 (2.71)	38.0 (4.16)	45.0 (15.78)	54.0 (11.22)	68.3 (4.51)	-	-
Duration (days) る	?	;	;	37.9 (2.09)	36.2 (4.09)	38.0 (8.12)	34.8 (3.38)	46.1 (12.47)	50.1 (7.29)	48.6 (12.04)	46.0 (15.39)	-



Figs. 1-6: The mating of *Zorocrates guerrerensis*. **1** – Male is approaching and courting female, making contact using the first pair of legs; female orientates toward the male and raises its first pair of legs. **2** – Male and female communicate with each other using their front legs and the male is touching the female's carapace. **3** – Male is climbing onto female, reaching a copulatory position; the beginning of copulation. **4** – Insertion of the left palp, note that the palp is inserted between the third and fourth pairs of legs of the female. **5** – Haematodochal expansion, note erect leg spines. **6** – The end of palpal insertion, the haematodocha has collapsed but the palp is still close to the epigyne.

palpal insertion was not counted. The whole copulation event (i.e. including both palpal insertions but without courtship) lasted on average about 5 minutes and 18 seconds (SE = 2 min. 3 sec.). After each copulation, males spun a rectangular sperm web (Fig. 7) and charged their palps.

All but one of the females mated twice and all males mated multiply. The first copulation (of a virgin female) and the second copulation (of a mated female) did not differ in any of their components (Tab. 2). The only difference was in total copulation duration: matings of virgin females were shorter than those with already mated females, given by slower shifting of the palps from the first to the second insertion during the second copulations. However, the difference in duration of the first and second copulation was only marginally significant (Tab. 2).



Fig. 7: Sperm web of Zorocrates guerrerensis spun in a plastic tube

Fertilised females were allowed to construct up to four egg sacs under laboratory conditions. The first egg-sac was constructed in 31.9 days (SE = 12.26, n = 9) after the first mating. From each egg sac, on average 42 spiderlings (SE = 17.8, n = 17) emerged after about a two-month period (\bar{x} = 60.6 days, SE = 21.23, n = 16) of incubation.

Discussion

We observed the growth during a year and details of the reproductive behaviour of Z. guerrerensis, a Mexican cribellate spider from the family Zoropsidae. Reaching adulthood by Z. guerrerensis after 9-11 moults outside the egg sac is comparable with two other studied zoropsids, Tengella perfuga Dahl, 1901 and T. radiata (Kulczyński, 1909), reaching adulthood in 11-12 and 8-9 moults, respectively (Barrantes & Madrigal-Brenes 2008, Mallis & Miller 2017). The between-instar growth factor of Z. guerrerensis was approximately constant, contrary to T. radiata and T. perfuga, in which Barrantes & Madrigal-Brenes (2008) and Mallis & Miller (2017) observed some fluctuations in the growth factor in several instars. The observed decreasing tendency in the growth factor was caused by some individuals that needed more moults to reach maturity. Those should have also grown less during their early instars.

Males displayed the courtship of "Level I", i.e. the direct contact with the female (Platnick 1971). Communication between males and females was (beside an expected olfactory way) largely tactile. No visual or acoustic communication was recorded. Tactile communication was observed also in *T. perfuga* by Mallis & Miller (2017: video S2), but the difference was in the 'receptivity signal' (acceptance of the male and allowing it to assume a copulatory position). The 'receptivity signal' of the *Z. guerrerensis* female was in precise contacts by

Tab. 2: Comparison of behavioural components of mating virgin and once-mated females of *Zorocrates guerrerensis*. Means and standard errors (in parentheses) are given.

Behaviour	Copulation of virgin females (n = 9)	Copulation of mated females (n = 8)	P value (Paired t-test)
Courtship (s)	83.9 (121.46)	166.5 (167.47)	0.4393
First expansion of haematodocha (s)	19.6 (3.50)	16.7 (6.58)	0.1780
First palpal insertion (s)	91.9 (62.92)	98.4 (21.75)	0.9366
Second expansion of haematodocha (s)	23.0 (2.83)	22.5 (7.69)	0.4627
Second palpal insertion (s)	112.8 (46.77)	121.8 (61.03)	0.9660
Total copulation duration (s)	246.6 (53.13)	390.1 (133.75)	0.0515

legs I and II, whereas the *T. perfuga* female had their front legs stretched at the moment when the male was climbing onto it (Mallis & Miller 2017: video S5). The 'receptivity signal' of *Z. guerrerensis* was rather similar to that of the wolf spider *Arctosa (Tricca) lutetiana* (Simon, 1876) (Dolejš et al. 2010). In *T. perfuga*, Mallis & Miller (2017: video S3) observed that males spun the so-called 'bridal veil' [the silk deposited across the female's carapace and legs; also a common part of court-ship in certain *Xysticus* species (Platnick 1971)] prior to co-pulation. No such behaviour was observed in *Z. guerrerensis*; instead, females were jerking with their whole bodies when males were climbing onto them. A possible explanation of such behaviour occurring just prior the copulation could be that it was the female's last chance to chase away a male that for some reason would not be an ideal partner.

The copulatory position of Z. guerrerensis resembled that of wolf spiders and T. perfuga, but differed from the copulation position of T. radiata, in which spiders were orientated towards each other by their ventral sides (Barrantes 2008). The males of Z. guerrerensis inserted their palps between the third and fourth legs of the females. Such a position corresponds to what can also be seen in videos about T. perfuga (Mallis & Miller 2017). However, it differs from the position observed in wolf spiders in which males insert their palps behind the females' fourth legs (e.g., Montgomery 1903, Dolejš et al. 2010, 2012, Foelix 2011). Unfortunately, we are not aware of any literature dealing with this difference among various families. Thus, any conclusions about the sense, function or mechanical limitations of different ways of palpal insertions would be too preliminary now.

The pattern of copulation of *Z. guerrerensis* with a single insertion of each palp and a single expansion of haematodocha is a frequent one not only among the lycosoids but also in the unrelated cribellate genera *Amaurobius* and *Titanoeca* (Stratton et al. 1996). However, in both *Tengella* species, repeated insertions of the same palp were observed (Barrantes 2008, Mallis & Miller 2017). The second difference is in the duration of haematodochal expansion in relation to that of palpal insertion. In wolf spiders and the zoropsid *T. radiata*, almost the whole duration of palpal insertion is composed of the haematodochal expansion (Barrantes 2008, Dolejš et al. 2010, 2012). The males of *Z. guerrerensis*, however, switched to use the second palp sometime after the haematodocha of the first palp had collapsed. During this period, when males were apparently doing 'nothing', perhaps the copulatory courtship occurred in relation to the cryptic female choice (e.g., Huber 1998, Peretti & Aisenberg 2015).

Some males of Z. guerrerensis were observed having an obvious problem to insert their palps correctly. We call this behaviour 'flubs', despite some uncertainties existing about their definition and true meaning (e.g., Huber 1998, Barrantes 2008, Sentenská et al. 2015). In our opinion, the flubs were apparently mistakes as was defined by Watson (1991) and further observed by Dolejš et al. (2012) and Toscano-Gadea & Costa (2016). Thus, the flubs observed by us are not regularly observed palpal scraping of the epigyne just before the palpal insertion. Zorocrates guerrerensis appeared to be both polyandrous and polygynous species. Among the Lycosoidea, the same characteristics is known for the pisaurids (Nitzsche 2011 and references therein), whereas lycosid females are monandrous (Norton & Uetz 2005, Dolejš et al. 2012). Construction of the first egg sac by Z. guerrerensis and the emerging of spiderlings from it were in identical time intervals as in T. radiata (Barrantes & Madrigal-Brenes 2008).

Overall, very little is still known about the courtship and copulatory pattern of the zoropsids. The situation that some mating characteristics of *Z. guerrerensis* are more similar to *T. perfuga* and wolf spiders than to *T. radiata* is surprising because it was expected that related species would have similar behaviour. When behavioural details of more species of Zoropsidae are known, they may be of some use for improving the phylogeny of Lycosoidea.

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Supplementary File (*.wmv)

Courtship and copulation of *Zorocrates guerrerensis*. The video shows all behavioural components of the mating, but several longer-lasting components of the copulation were shortened.

On two cases of male dimorphism in dwarf spiders (Araneae: Linyphiidae)

Robert Bosmans & Pierre Oger



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Abstract. *Diplocephalus cristatus* (Blackwall, 1833) is confirmed as a dimorphic species, having two morphs: *cristatus* and *foraminifer*. This view was first proposed by Georgescu (1969), but not supported in the literature. *Diplocephalus foraminifer* (O. Pickard-Cambridge, 1875), *D. bicephalus* (Simon, 1884), *D. rectilobus* (Simon, 1884), *D. foraminifer thyrsiger* (Simon, 1884) and *D. arvernus* (Denis, 1948) are here considered **junior synonyms** of *D. cristatus* (Blackwall, 1833). *Diplocephalus bicephalus* belongs to the morph *cristatus*, *D. rectilobus*, *D. thyrsiger* and *D. arvernus* to the morph *foraminifer*. A lectotype (d) is designated for *Diplocephalus bicephalus* Simon, 1884; the paratype female of *D. bicephalus* was incorrectly identified and actually belongs to *Dicymbium nigrum* (Blackwall, 1834). *Savignia harmsi* Wunderlich, 1980 is another dimorphic species, with the two strongly differing male morphs: *typica* and *cor*.

Keywords: Araneae, dimorphic Linyphiidae, Diplocephalus, Savignia

Zusammenfassung. Zwei Fälle von Dimorphismus bei Zwergspinnen (Araneae: Linyphiidae) Diplocephalus cristatus (Blackwall, 1833) wird als dimorphe Art bestätigt, mit zwei Formen: cristatus und foraminifer. Diese Meinung wurde erstmals von Georgescu (1969) vertreten, aber in der Literatur nicht unterstützt. Diplocephalus foraminifer (O. Pickard-Cambridge, 1875), D. bicephalus (Simon, 1884), D. rectilobus (Simon, 1884), D. foraminifer thyrsiger (Simon, 1884) und D. arvernus (Denis, 1948) werden nun als jüngere Synonyme von D. cristatus (Blackwall, 1833) betrachtet. Diplocephalus bicephalus gehört zur Form cristatus, D. rectilobus, D. thyrsiger und D. arvernus zur Form foraminifer. Ein Lectotypus (d) wird für Diplocephalus bicephalus Simon, 1884 ausgewiesen; der weibliche Paratypus von D. bicephalus ist fehlbestimmt und gehört zur Art Dicymbium nigrum (Blackwall, 1834). Savignia harmsi Wunderlich, 1980 ist eine weitere dimorphe Art mit zwei sich deutlich unterscheidenden Männchen-Formen: typica und cor.

For a long time, dimorphic erigonid spiders were not recognised as such and considered separate species. Only when morph differences were small, for example in the size of the cephalic tubercle or the post-ocular sulci, were these sometimes considered variations. Holm (1979: p. 269) wrote about Pelecopsis mengei (Simon, 1884): "The males occur in two different forms, the one, which is the most frequent, with a high cephalic lobe and large sulcal orifice, the other with lower lobe and with much smaller orifice. ... As no intermediate forms have been found and moreover, the two types of males have quite similar palpal tibiae and bulbs and are found together, the males of *P. mengei* seem to be dimorphic". Similarly, Bosmans & Abrous (1992) considered the specimens of Pelecopsis oranensis (Simon, 1884) with small and large postocular sulci, but having identical palpal tibiae and bulbs, as morphs of the same species. Diplocephalus marijae Bosmans, 2010 from Spain is another species occurring in two morphs (Bosmans et al. 2010). The decision to recognise species as being dimorphic is not easy or consequent. Roberts (1987) proposed Troxochrus scabriculus (Westring, 1851) and T. cirrifrons (O. Pickard-Cambridge, 1871) to be one, dimorphic species, but this is not followed in the World Spider Catalog (2018) where they are still considered two separate species. On the contrary, when the same author (Roberts 1987) proposed Diplocephalus connatus Bertkau, 1889 and D. jacksoni (O. Pickard-Cambridge, 1904) to be forms of the same species, this opinion was accepted in the World Spider Catalog (2018).

The best documented case of dimorph linyphiid spiders is that of *Oedothorax gibbosus* (Blackwall, 1841) and *O. tuberosus* (Blackwall, 1841) having very different cephalic tubercles and because of that considered separate species in older identifi-

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cation books (e.g., Locket & Millidge 1953, Wiehle 1960, Palmgren 1976). After a detailed study of the male palps of several *Oedothorax* species, Bosmans (1985) concluded that all palpal sclerites of *O. gibbosus* and *O. tuberosus* were completely identical and the two species names were synonymized. De Keer & Maelfait (1988) provided further evidence from breeding experiments. They reared spiderlings from the same egg sac and obtained both forms. In our opinion, when palpal sclerites are identical, specimens should be treated as belonging to the same species.

The aim of the present paper is to discuss two more cases of male dimorphism in Linyphiidae.

Material and methods

The material studied was collected by the authors or loaned from museum collections. Species were examined by mean of a Nikon SMZ1270 stereo microscope. Details of male palps and female epigynes were studied with an Olympus CH-2 microscope with a drawing tube. Left palps are illustrated.

Male palps were detached and transferred to glycerol for examination under the microscope. Female epigynes were excised using sharpened needles. These were then transferred to clove oil for examination under the microscope. Later, palps and epigynes were returned to 70% ethanol.

Abbreviations: CAR-S = Personal collection of Antony Russell-Smith (UK), CPO = Personal collection of Pierre Oger (Belgium), CRB = Personal collection of Robert Bosmans (Belgium), CSD = Personal collection of Samuel Danflous (France), MNHN = Muséum National d'Histoire naturelle, Paris, France (curator: C. Rollard).

A forgotten case of dimorphism

Males and females of *Diplocehalus cristatus* (Blackwall, 1833) were first described by Blackwall (1833) from England as *Walckenaeria c.* Subsequently, O. Pickard-Cambridge (1875) described *Erigone foraminifera* Pickard-Cambridge, 1875 from France. Differences between the two species were based on differently shaped cephalic lobes. Pickard-Cambridge (1875: p. 208) stated that "*E. foraminifera* is also allied to *E.*

cristata, but the very different form of the caput and its cleft ... will distinguish it at once".

Later, Simon (1884, 1926) also gave considerable importance to the shape of cephalic lobes in describing several (sub) species in the genus *Prosoponcus*: *P. bicephalus* Simon, 1884, *P. rectilobus* Simon, 1884 an *P. thyrsiger* Simon, 1884. None of these species was matched to a female, except for *P. bicephalus bicephalus*; yet the female of the latter species appeared to be that of *Dicymbium nigrum* (Blackwall, 1834). Denis (1948) added one more species to this species group, *D. arvernus*, from France, Auvergne. He stated that this species was closely related to *D. foraminifer*, but slightly differed in the shape of cephalic lobe. Georgescu (1969) was the first author to propose that *D. cristatus*, *D. foraminifer*, *D. bicephalus*, *D. rectilobus* and *D. thyr-siger* all belong to the same species, occurring in two morphs: *cristatus* and *foraminifer*. She also included *Diplocephalus crassilobus* (Simon, 1884) in that list, but the conformation of the male palp of the latter species is completely different (cf., Millidge 1979, Pesarini 1996). The suggestion by Georgescu has not been followed and in the World Spider Catalog (2018), these names are currently listed as separate species. We have been able to re-examine the material of all these *Diplocephalus* species, including the types of *D. bicephalus* and *D. rectilobus*, and can confirm Georgescu's proposal.



Fig. 1: a-c. Diplocephalus cristatus (Blackwall, 1833) (Belgium), d-f. D. rectilobus (Simon, 1884) (the holotype), g-i. D. foraminifer (O. Pickard-Cambridge, 1875) (Greece), j-l. D. bicephalus (Simon, 1884) (the lectotype), m, o: D. arvernus Denis, 1948 (from Denis 1948, figs 1-8); n. D. foraminifer (O. Pickard-Cambridge, 1875) (from Deltshev, 1985, fig. 7); a, d, j, m. Male prosoma, lateral view; b, e, h, k, n. Male palp, lateral view; c, f, i, l, o. Male palpal tibia, dorsal view.



Fig. 2: Diplocephalus cristatus morph foraminifer (Pickard-Cambridge, 1875) (Greece, Lefkada). a. Male prosoma, lateral view; b. Male palp, lateral view; c. Male palpal tibia, dorsal view; d. Embolic division, antero-lateral view; e. Epigyne, ventral view; f. Vulva, ventral view.

Diplocephalus cristatus (Blackwall, 1833) (Figs 1a-n, 2a-f) Walckenaeria cristatus Blackwall, 1833: 107 (♂?); the type from England, Manchester, Cheetham, not examined. Erigone foraminifera O. Pickard-Cambridge, 1875: 207, pl. 28, fig. 15 (♂); the type from France, Hautes-Alpes, Col de Natoya; not examined. **N. Syn.**

Prosoponcus foraminifer; Simon 1884: 572, 382-383, figs 672, 673.

Prosoponcus bicephalus Simon, 1884: 575, figs 388, 389 (d). N. Syn.

Prosoponcus thyrsiger Simon, 1884: 574, figs 386-387 (descr. d); not examined. **N. Syn.**

Prosoponcus rectiloba Simon, 1884: 573, figs 384-385 (d); examined. **N. Syn.**

Diplocephalus rectilobus; Simon 1926: 377, 495.

Diplocephalus bicephalus; Simon 1926: 495, figs 672-673 (δ only, $\mathfrak{P} = Dicymbum nigrum$).

Diplocephalus foraminifer, Simon 1926: 377, 495, figs 667-668.

Diplocephalus foraminifer thyrsiger, Simon 1926: 378, 495, figs 669-671.

Diplocephalus arvernus Denis, 1948: 238, figs 1-8 (89); not examined. N. Syn.

Type material. Lectotype & of *Diplocephalus bicephalus* Simon, 1884 (designated here) from France, Pyrénées-Orientales, between Prats-de-Mollo and La-Preste, Coll. Simon 4914 AR 12084 (MNHNP); 2 & paralectotypes of *D. bicephalus* belonging to *Dicymbium nigrum* (Blackwall, 1834). – Holotype & of *Prosoponcus rectiloba* Simon, 1884 from France, Haute-Savoie, Les Contamines, Coll. Simon 25107 AR12085 (MN-HNP); examined.

Further material examined. BELGIUM: Antwerpen: Mol, 7 δδ (morph *cristatus*), 6 \$\$, 15.vi.1973, R. Bosmans leg. (CRB). – FRANCE: Savoie: St-Julien-Molin-Molettes, 1 δ (morph *cristatus*), in litter, 28.x.2014, P. Dubois leg. (CPO). Haute-Garonne, Le Plan, 1 δ (morph *foraminifer*), 9.v.2015, Samuel Danflous leg. (CSD). – GREECE: Ionian Islands: Lefkada: Nidri, 2 δδ (morph *foraminifer*), 1 \$, under rocks below waterfall, 26.v.1993, A. Russel-Smith leg. (CAR-S). – SPAIN: Cantabria: Lebeña, 1 δ (morph *foraminifer*) 1 \$, 16.vii.1985, R. Bosmans leg. (CRB).

Comments on the type material

The only material of *Diplocephalus bicephalus* (originally as *Prosoponcus b.*) that is available in MNHNP is the male,



Fig. 3: Savignia harmsi Wunderlich, 1980. a. Morph typica, dorsal view; b. Morph cor, dorsal view c. Male palp of morph typica, lateral view, d. Ibid. of forma cor.

which is therefore designated as the lectotype. The two accompanying females belong to *Dicymbium nigrum* (Blackwall, 1834), and Simon's figure 674 (Simon 1884) obviously shows the epigyne of this species. The only material of *Prosoponcus rectilobus* available in the MNHNP is the male holotype.

Comments on the synonymy

We first became interested in the *Diplocephalus cristatus* complex, while studying specimens collected by Antony Russell-Smith from Lefkada, Greece (Fig 2). A number of males and females were collected from near a spring and they are illustrated in Fig. 2. Having tried to identify these specimens, we found out that their palps and epigynes were completely similar to those of the common European species *D. cristatus*, but the males had very different cephalic lobes. Further research showed a clear match with *D. foraminifer* and *D. arvernus*, as illustrated by Deltshev (1985), Denis (1948) and Georgescu (1969) – compare above the section "A forgotten case of dimorphism".

Figs 1b-c, e-f, h-i, k-l and n, o show the male palps and palpal tibiae of respectively *D. cristatus*, *D. rectilobus*, *D. foraminifer*, *D. bicephalus* and *D. arvernus*. Detailed examinations of all palpal sclerites and palpal tibiae revealed no differences. Simon (1926: p. 495) already wrote about *D. rectilobus* in a footnote: "Peut-être une forme ou variété de *D. cristatus*". Thus, in our opinion, the males of *D. cristatus* occur in two morphs: viz., Figs 1a, d show the morph *cristatus* with a low cephalic lobe, and Figs 1g, j, m and 2a show the morph *foraminifer* with a high cephalic lobe.

Distribution and habitat

Specimens of *Diplocephalus* morph *cristatus* occur all over Europe (Nentwig et al. 2017). On the contrary, the morph *foraminifer* has a much smaller distribution: northern Spain, southern France, Switzerland and northern Italy in the western part of Europe, and Bosnia and Hercegovina, Macedonia, Montenegro, Bulgaria, Serbia and Romania in the eastern part (Nentwig et al. 2017).



Fig. 4: Savignia harmsi Wunderlich, 1980. a. Morph *typica*, lateral view of prosoma; b. Morph *cor*, lateral view of prosoma; c. Morph *typica*, dorsal view of prosoma; d. Morph *cor*, anterior view of prosoma.

The morph *cristatus* occurs in a variety of habitats: "in grass, straw, moss, etc." (Locket & Millidge 1953), "auf offenen Flächen, an Waldrändern, in Gärten" (Heimer & Nentwig 1991). The morph *foraminifer* occurs in a much narrower range of specialized habitats. These spiders are frequently found under stones at high altitudes in the Cantabrian Range, the Pyrénées, the Massif Central and the Alps (Simon 1884, 1926, Bosmans & de Keer 1985, Denis 1953, 1955, Hänggi & Stäubli 2012, Müller 1985). At lower altitudes, these spiders occur in more restricted habitats such as caves, near springs and rivulets and in screes and cracks (Denis 1934, Georgescu 1969, Deltshev 1985), rarely in deciduous woodlands (Grbic & Savic 2010).



Fig. 5: Savignia harmsi Wunderlich, 1980. a. Morph typica, dorsal view of prosoma; b. Morph typica, lateral view of prosoma; c. Morph cor, dorsal view of prosoma; d. Morph cor, lateral view of prosoma; e. Male palp, retrolateral view; f. Male palpal tibia, dorsal view; g. Embolic division, prolateral view. Savignia harmsi Wunderlich, 1980 (Figs 3a-d, 4a-d, 5a-g) Savignia harmsi Wunderlich, 1980: 332, figs 45-51 (descr. δ , \mathfrak{P}).

Material examined. SPAIN: Granada: Baza, 5 & 1 \, pitfalls in dry riverbed, 12.xi.1990, L. Zarcos coll. (CRB).

Comments. At first glance, the five studied males appear to belong to different species, because their prosomas have very different shapes (Figs 4a-c, 5a-c). However, their palp conformation is identical (cf. Figs 3e and 3d). The first morph (Fig. 4a-b) has a nose-like projection carrying the anterior median eyes, like in *Savignia frontata* Blackwall, 1833. Apparently, because of this resemblance Wunderlich (1980) placed the species in the genus *Savignia*. The second morph (Fig. 4c-d) has a completely different cephalic lobe in the form of a large, rounded lobe, heart-shaped in the anterior view (Fig. 4d). For this morph, the name *cor* (Latin for heart) is herein proposed. If this morph was found first, the species would probably have been described in *Diplocephalus*.

Distribution. *S. harmsi* was described from both sexes from Spain, in the province of Malaga (Wunderlich 1980). It was recollected from the neighbouring province of Granada. It was not yet recorded since the original description (Morano et al. 2014).

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