Morphology in Collembola systematics: the potential and limitations

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- geography of routine taxonomy
- re-estimation of widely accepted morphological characters and phenotypic plasticity (limitations)
- the characters newly introduced and new insight into systematics of higher taxa (potential)
our contribution to global diversity of springtails

based on data from
http://www.collembola.org
the whole number of described species of Collembola (8336)
regions analyzed
correlation between number of species and number of authors
number of described and recorded species in Europe

introducing of chaetotaxy
monograph of Christiansen & Bellinger

N America
(Mexico incl.)

Graph showing a trend line from 1921 to 2016.
Australia, New Zealand, New Caledonia

publications of Salmon and Womersley
Europe
taxonomy in China

Asia

Yosii

number of species of all Collembola

Neanuridae s.l. 1578 spp.

Hypogastruridae 675 spp.

Onychiuroidea 854 spp.

Isotomidae 1354 spp.

Entomobryoidea 2036 spp.

Symphypleona 1145 spp.

Betsch

Bretfeld
taxa with "explosive" taxonomy
Tomoceridae (174 spp.)

from Yu et al, 2016

descriptions in China

Yosii (Asia)
Neelidae (44 spp.)

from Schneider & d'Haese, 2013

Schneider & D’Haese

number of species of Neelidae

Entomobrya (270 spp.)

REBIRTH: Jordana’s taxonomical system

Stach (Europe and Asia) and Christiansen (America)

Salmon

number of species of Entomobrya
Sinella and Coecobrya (74 spp.)

Chen, Christiansen, Zhang, and Deharveng (China)

from Ding et al., 2015
taxa which almost found their final size?
Friesea (177 spp.)

(from Massoud, 2067)
Tetracanthella (91 spp.)

From Babenko, 1988

Monograph of Deharveng

Monograph of Cassagnau
Taxonomy of East and West: Overview of distributions of higher taxa on large biogeographical scale
genera with European distribution
genera with Euro-American distribution
genera with Palearctic distribution
genera with Holarctic distribution
genera with Nearctic distribution
genera with Asiatic distribution
Limitations of morphological taxonomy:
- value of strong sexual dimorphism and epitoky
- colour pattern
- mobile forms
Limitation of morphological taxonomy:
value of strong sexual dimorphism and epitoky
Symphypleona: males of “dimorphic” genera (from Betsch, 1980)

Sminthurides

Bourletides

Bovicornia
males of species of "non dimorphic" genera
(from Fjellberg, 2007)

**Heterosminththurus**

- *novemlineatus*
- *insignis*
- *claviger*

**Deuterosminththurus**

- *pallipes*
- *bicinctus*
Isotomidae: modified males

- **Rhodanella**
  - *Rhodanella minos* Denis, 1928
    - (Delamare-Deboubtville et al., 1969)

- **Jestella**
  - *Jestella armata* Potapov et al., 2005
    - (Potapov et al., 2005)

- **Ephemerotoma**

- **Guthriella**
  - *Guthriella muskegis* Börner, 1906
    - (Palacios-Vargas et Castaño-Meneses, 2009)

Separate “dimorphic” genera
Isotomidae: modified males

Vertagopus reuteri Schott, 1893
(Fjellberg, 1982)

Vertagopus

Archisotoma pulchela
Moniez, 1890 (Fjellberg, 2007)

Archisotoma

males of some species of "not dimorphic" genera
Ephemerotoma huadongensis (Chen, 1985) Asia: Shanghai
Scutisotoma stepposa (Martynova, 1975) Asia, Eastern Siberia
Folsomia candida Willem, 1902  Asia, Shanghai laboratory population (unpubl.)
courtship in *F. candida* (Shanghai laboratory population, unpubl.)
*Folsomia candida* Willem, 1902 Asia, Shanghai laboratory population (unpubl.)
Folsomia candida Willem, 1902  Asia, Shanghai laboratory population (unpubl.)
Scutisotoma stepposa (Martynova, 1975)
Asia, Eastern Siberia

adult males
Entomobryidae: “dimorphic” genera

“dimorphic” genus:
1-st pair of legs in *Tyrannoseira* (from Bellini & Zeppelini, 2011)

non “dimorphic” genus:
*Seira mantis*  
(from Zeppelini & Bellini, 2006)

*Seira domestica*  
(from Gisin & Gama, 1962)
Limitation of morphological taxonomy:

colour pattern
Isotomurus sp. nov. Asia: Kunashir Isl. (unpubl.)
Isotomurus sp. nov. Asia: Kunashir Isl. (unpubl.)

barcoding (COI)
Limitation of morphological taxonomy:

mobile forms – effect of current conditions
Proisotoma minima

+ P. dualis

P. dottrei
Folsomia sp. nov. (Asia, Far East of Russia, unpubl.)
Potential of morphological taxonomy:
- the characters newly introduced or re-estimated
- taxonomy of particular taxa
1. Re-estimation of value of body scales in Entomobryidae
Re-estimation of body scales in Entomobryidae

Phylogeny based on three DNA fragments (from Zhang, Chen, Dong, Deharveng, Stevens, Huang, Zhu, 2014)
2. Scale patterns in Tomoceridae

*Pogonognathellus bidentatus*  
*P. elongatus*  
*P. nigritus*

from Felderhoff, Bernard and Moulton (2010)
3. S-chaetotaxy of Entomobryidae
S-chaetotaxy of Isotomidae

*Subisotoma*

from Potapov et al. (2009)  

ms-chaetotaxy: 1,0/1,0,1
S-chaetotaxy of Isotomidae

varies considerably: Subisotoma, Desoria, Parisotoma, Pachyotoma, Isotopenola.

varies slightly: Anurophorus, Vertagopus, Isotoma, Isotomiella, Metisotoma, Isotomurus.

stable within a genus: Folsomia, Cryptopygus s.str., Scutisotoma, Tetracanthella, Isotomodes, Folsomides, Proisotoma,

s-chaetotaxy: 4,3/2,2,2,3,5
S-chaetotaxy of Abd. IV-V in *Folsomia octooculata*
### S-chaetotaxy of Entomobryidae

from Zhang & Deharveng (2014)

**ms-chaetotaxy: 1,0/1,0,0-1**

<table>
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<tr>
<th>Species</th>
<th>Th. II</th>
<th>Th. III</th>
<th>Abdt. I</th>
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<th>Abdt. III</th>
<th>Abdt. IV</th>
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### S-chaetotaxy of Entomobryidae

s-chaetotaxy: 1-2, 1-2/
0-1, 1-2(>2), 1-2(>2), 4->60, 1-10

From Zhang & Deharveng (2014)

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Orchesella

Heteromurus

ms-chaetotaxy: 1,0/1,0,1

from Zhang & Deharveng (2014)
Orchesella

Heteromurus

s-chaetotaxy: 2,2/1,3,3, …, …

from Zhang & Deharveng (2014)
4. Morphology at intra-specific level
Morphological characters in discrimination between strains of *F. candida*

from Tully & Potapov (2015)
“Phylogeny” of strains of *F. candida* from Tully & Potapov (2015)
particular taxa
Revision of *Megalothorax* (Schneider & D’Haese, 2013)

from Schneider & D’Haese (2013)
Our ongoing tasks in morphological taxonomy:
- description of diversity (faunas, lists of species, catalogues, new species descriptions)
- introducing new characters and careful re-estimation of known morphological characters
- closer connection to molecular taxonomy
Thank you