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PEDICIIDAE LARVAE (INSECTA, DIPTERA) IN THE CARPATHIAN BASIN: PRELIMINARY RESULTS AND FURTHER PERSPECTIVES

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PEDICIIDAE-LÁRVÁK (INSECTA, DIPTERA) A KÁRPÁT-MEDENCÉBEN: ELŐZETES EREDMÉNYEK ÉS JÖVŐBELI KILÁTÁSOK

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ABSTRACT: In the present study we analyze and compare 12 different morphological features on the head capsule and body segments in 34 Pediciidae larvae (instars III. and IV.) to test the selectivity of the already known external characters in species level identification. Our results show that Pediciidae has good characters to separate taxa at subfamily, genus and subgenus level. The following characters have a high taxonomical importance: the shape of the locomotor structures, the spiracular field and the length and pubescence of ventral lobe, the shape and segmentation of the anal lobes, the shape of the head capsule, the structures on the labrum, the shape of the mandibles and the shape of the hypostomal teeth. However, the tested features have no selectivity at species level identification. SEI ultrastructures are proposed to test new characters (the sculpture of the head capsule, the attachment points of the first body segment to the head capsule, sensory structures position) to improve the existing identification keys for Pediciidae.

Key words: Pediciidae, Diptera, Insecta, larval morphology, comparison, SEI, species level identification

KIVONAT: Jelen tanulmány 12 különböző morfológiai jelleget hasonlít össze Pediciidae (Diptera, Insecta) lárvák esetében, tesztelve a jellegek

alkalmasságát a faji szintű határozásban. A szakirodalomban javasolt morfológiai jellegek összehasonlító vizsgálatát 34 egyeden, főként, III. és IV. stádiumú lárvákon végeztük. Eredményeink azt mutatjak, hogy a Pediciidae lárvák jellegzetes morfológiájuk alapjan jól elkülöníthetőek más Diptera családoktól és jól határozhatóak alcsalád és génusz szintig. Fontos elkülönítő jellegek azonosíthatók a potrohszelvények mozgásban résztvevő kitüremkedésein, a spirakuláris mezőn, különbségek tapasztalhatók a ventrális lebenyek hosszában és szőrözöttségében, a fejtok alakjában, a felső ajak struktúráiban, a rágók alakjában és a hypostomális fogak alakjában. Ezzel szemben a génusz alatti taxonómiai kategóriák határozása az ismert jellegek alapján bizonytalan. Példáink azt mutatják, hogy új jellegek bevezetése és főleg a SEM alapú ultamorfológiák összehasonlító vizsgálata jelentősen javíthatja az ismert határozókulcsok szelektivítását.

Kulcsszavak: Pediciidae, Diptera, Insecta, lárva morfológia, összehasonlítás, SEI, faji szintű határozás

Introduction

Investigation of the peimaginal stages of majority of insects species are highly neglected. However knowledge on larvae morphology and its habitat requirement can offer good solutions in biomonitoring or phylogenetic studies (Pauls et al. 2009). Advanced technologies, as scanning electron microscopy (SEM), scanning electron imagining (SEI), transmission electron microscopy (TEM) has major implications in generating keys with high resolution in species level identification, which meets the present needs of the environment managers (NELSON 2001, SUNDERMAN et al. 2007). Larvae taxonomy has major implications in two important directions. At first, identification of species in juvenile stages is crucial to evaluate the real diversity of the natural habitats. Larvae are involved in almost all major ecological processes and forms different functional feeding groups, rather than the short living adults (GRAF et al. 2008). Secondly, the evolutionary reconstructions based on larval characters offer better solutions as adult morphologies, because larvae conserve an important amount of plesiomorphy, connecting sister groups, rather than the highly specialized and modified adult morphologies (ARCHANGELSKY 2008). Feeding habits of the larvae offer high resolution in evolutionary studies, mostly among closely related taxa or cryptic species complexes (PAULS et al. 2009). Aquatic Diptera larvae are often the most abundant and most diverse group among benthic macroinvertebrates. However they are consequently neglected in water management activities, due to serious gaps on knowledge on taxonomy of larvae (VALLENDUUK and LIPINSKI 2009). Pediciidae is a small family of nematocerous Diptera of about 75 extant species or subspecies in the West Palearctic area (OOSTERBROEK 2010). They were separated from Limoniidae by STARÝ(1992) due to important differences in adult morphologies (pubescent eyes, spurred tibiae in combination with some venational features). 53 species (70% of West Palearctic species) are present in Carpathian Basin area. Our results on morphology and genetic variability on selected species show deep divergence between different populations in the Carpathians Basin area, which suggest that the family could be more species rich (UJVÁROSI et al. 2009). The Pediciidae larvae are hemicephalic and metapneustic, with a strongly fused head capsule (which is conspicuously narrowed, as compared with other tipulomorphan families), and with only two lobes

at the margin of the spiracular field, except for Ulinae, which larvae has five such lobes. Some abdominal segments bear creeping welts (*Pedicia, Tricyphona, Ula*), or pseudopods (*Dicranota*). All species, except Ulinae has aquatic or semiaquatic larvae (70 species), especially in springs and headwaters. They are important predators on mites, oligochaetes, insect larvae and the like. Pediciidae larvae are weakly characterized taxonomically. General morphological features are only described for about 14 species in the West Palearctic area (less than 18%) (OOSTERBROEK and THEOWALD 1991, PODENIENE 2003). Most of them have been described from Great Britain (CRISP and LLOYD 1954, BRINDLE 1962, 1967) and Germany (LINDNER 1959, HENNIG 1973, REUSCH 1988, BRINKMANN 1991). Compilation on morphology and available literature on Pediciidae larvae were published by OOSTERBROEK and THEOWALD (1991) and REUSCH and OOSTERBROEK (1997). These descriptions and keys are largely discredited containing only a few number of largely distributed taxa or are inadaptable to regional fauna due to the high number of endemic taxa with restricted distributions. Up to the present no comprehensive studies on Pediciidae larvae have been published in the Carpathian Basin area. In the present study we test the selectivity of the morphological characters mentioned in literature to separate genera or species of aquatic Pediciidae. Comparative morphological investigations are conducted to discover new morphologies which can offer better resolutions in different taxa and the methods of SEI is proposed for the first time to improve the selectivity of the already published identification keys.

Material and methods

Pediciidae larvae were collected in 17 localities, distributed in 5 different countries (Table 1).

Most of the last instars larvae were sieved form samples taken from an area of 25x25 cm area of a 10 cm depth from sandy, gravel or muddy bottom of streams. Specimens were studied with an Olympus SZ51 dissecting microscope up to 40x magnification. Head capsules were prepared and studied by immersing overnight in cold NaOH 10% solution and preserved in glycerine. Additionally few previously gold covered larvae were examined by a SEM (JEOL JSM 5510 LV) for ultramorphology details. A number of 12 different morphological features were selected for the present study (fig. 1). The terminology and morphological features generally follows that of OOSTERBROEK and THEOWALD (1991). A total of 35 IIIth and IVth instars larvae were examined and compared. The material is deposited in the Zoological Museum, Lujza Ujvárosi Diptera Collection (LUC) of the University of Babes-Bolyai, Cluj, Romania.

Results

Species diversity in the Carpathian Basin area

In the Carpathian Basin area a total number of 53 species of Pediciidae was identified, which represents 70% from the total number of species from the West Palearctic region. A list of the species with information on immature stages morphology is presented in Table 2. The literature data were taken from OOSTERBROEK and THEOWALD (1991). Additional information on larvae taxononomy was published by BRINKMANN (1992), REUSCH and OOSTERBROEK (1997) and PODENIENE (2003).

Table 1. Collection data of individual Pediciidae larvae. Abbreviations: BG - Bulgaria, CH - Switzerlad, DE - Germany, RO - Romania, LT - Lithuania, a.s.l. - above sea level

Code	Country	Region	Locality	Habitats	Elevation (a.s.l.)	Collection date	Collector
Dicranota 1	BG	Jundola distr.	Belovo	Rila Mts.	1890 m	08.06.2008	M. Bálint
Dicranota 1	BG	Bansko dist.	Razlog	Pirin Mts.	2060 m	09.06.2008	P. Neu
Dicranota 1	BG	Bansko dist.	Razlog	Pirin Mts.	2060 m	09.06.2008	P. Neu
Dicranota 2	BG	Velinigrad dist.	Velinigrad	Rhodope	1490 m	11.06.2008	M. Bálint
Dicranota 2	BG	Velinigrad dist.	Velinigrad	Rhodope	1490 m	11.06.2008	M. Bálint
Dicranota 1	BG	Jundola distr.	Belovo	Rila Mts.	1890 m	07.06.2008	P. Neu
Pedicia 2	CH	Sarganserland	Azmoos	Alps	500 m	18.03.2008	M. Bálint
Dicranota 1	DE	Baden Würtenb.	Seebach	Swartzw.	550 m	15.03.2008	P. Neu
Dicranota 1	DE	Baden Würtenb.	Seebach	Swartzw.	550 m	15.03.2008	P. Neu
Dicranota 1	DE	Baden Würtenb.	Hundsech	Swartzw.	730 m	16.03.2008	P. Neu
Dicranota 1	RO	Carpathians	Borsa	Rodnei Mts.	1000 m	13.04.2007	M. Bálint
Dicranota 1	RO	Carpathians	Moroieni	Bucegi Mts.	1450 m	06.06.2007	M. Bálint
Dicranota 1	RO	Apuseni dist.	Baisoara	Gilau Mts.	1500 m	30.05.2007	M. Bálint
Dicranota 1	RO	Carpathians	P. Marului	Tarcau Mts.	1400 m	16.06.2008	M. Bálint
Dicranota 2	RO	Carpathians	Vlahita	Harghita	800 m	03.06.2008	M. Bálint
Dicranota 1	RO	Carpathians	Herculane	Godeanu	540 m	14.06.2008	P. Neu
Dicranota 1	RO	Carpathians	Herculane	Godeanu	540 m	14.06.2008	P. Neu
Dicranota 1	RO	Carpathians	Herculane	Godeanu	540 m	14.06.2008	P. Neu
Dicranota 1	RO	Carpathians	Sibiu	Cibin Mts.	1600 m	12.05.2007	M. Bálint
Dicranota 1	RO	Carpathians	Tulghes	Giurgeului.	700 m	27.11.2009	L.P. Kolcsár
Dicranota 1	RO	Carpathians	Tulghes	Giurgeului	700 m	27.11.2009	L.P. Kolcsár
Dicranota 1	RO	Carpathians	Tulghes	Giurgeului	700 m	27.11.2009	L.P. Kolcsár
Dicranota 1	RO	Carpathians	Tulghes	Giurgeului	700 m	27.11.2009	L.P. Kolcsár
Pedicia 3	LT	Vazena distr.	Vazena	Gruda river	240 m	29.07.2006	V. Podeniene
Pedicia 3	LT	Vazena distr.	Vazena	Gruda river	240 m	29.07.2006	V. Podeniene
Pedicia 3	RO	Carpathians	Borsa	Rodeni Mts.	1000 m	13.04.2007	M. Bálint
Pedicia 3	RO	Carpathians	Borsa	Rodnei Mts.	1000 m	13.04.2007	M. Bálint
Pedicia 3	RO	Carpathians	Borsa	Rodnei Mts.	1000 m	13.04.2007	M. Bálint
Dicranota 1	RO	Carpathians	Sesuri	Rodnei Mts.	1000 m	13.04.2007	M. Bálint
Pedicia 2	RO	Transylvania	Cluj	Faget	400m	18.05.2008	J. Csepregi
Pedicia 2	RO	Carpathians	Borsa	Rodeni Mts.	1000 m	13.04.2007	M. Bálint
Pedicia 1	RO	Carpathians	Tulghes	Giurgeului	700 m	27.11.2009	L.P. Kolcsár
Pedicia 2	RO	Carpathians	Tulghes	Giurgeului	700 m	27.11.2009	L.P. Kolcsár
Pedicia 3	RO	Carpathians	Tulghes	Giurgeului	700 m	27.11.2009	L.P. Kolcsár

Larvae of the genera *Nasiternella* is still unknown, as well as species belong to the subgenera *Ludicia.* Beside a few case of detailed morphological characterization of selected, largely distributed species the majority of Pediciidae larvae (82%) presents in the Carpathian Basin area are unknown or useful descriptions are not available (fig. 2)

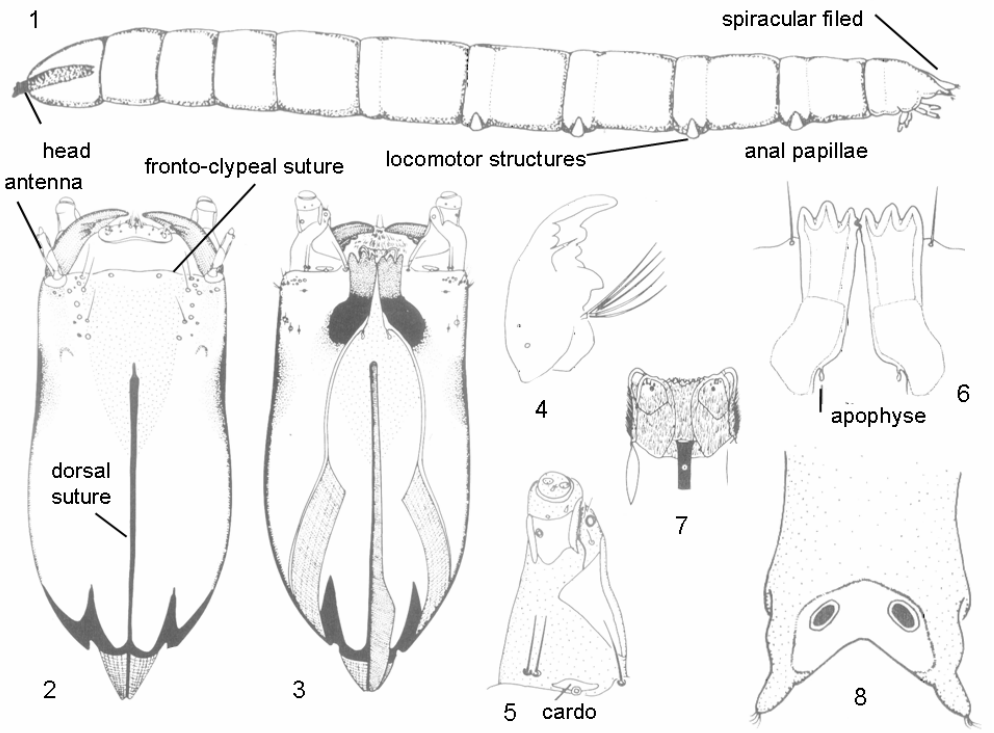


Fig. 1. *Tricyphona immaculata,* larvae characters. 1. Larvae, lateral view; 2. Head capsule dorsal view, 3. Head capsule, ventral view, 4. Left mandible, dorsal view, 5. Right maxilla, 6. Hypostoma, ventral view, 7. Prementum, ventral view, 8. Terminal segment, dorsal view (after OOSTERBROEK and THEOWALD 1991).

Table 2. List of Pediciidae species from the Carpathian Basin area (after OOSTERBROEK 2010)

Nr.	Taxon name	Author	State of knowledge	Habitat
1	*Dicranota (Dicranota) bimaculata*	(Schummel, 1829)	larvae and pupae	aquatic
2	*Dicranota (Dicranota) guerini*	Zetterstedt, 1838	larvae	aquatic
3	*Dicranota (Ludicia) claripennis*	(Verrall, 1888)	no data	aquatic
4	*Dicranota (Ludicia) lucidipennis*	(Edwards, 1921)	no data	aquatic
5	*Dicranota (Paradicranota) brevicornis*	Bergroth, 1891	no data	aquatic
6	*Dicranota (Paradicranota) brevitarsis*	Bergroth, 1891	no data	aquatic
7	*Dicranota (Paradicranota) candelisequa*	Stary, 1981	no data	aquatic
8	*Dicranota (Paradicranota) capillata*	Lackschewitz, 1940	no data	aquatic
9	*Dicranota (Paradicranota) cinerascens*	Lackschewitz, 1940	no data	aquatic
10	*Dicranota (Paradicranota) consimilis*	Mendl, 1987	no data	aquatic
11	*Dicranota (Paradicranota) flammatra*	Stary, 1981	no data	aquatic
12	*Dicranota (Paradicranota) fuscipennis*	Lackschewitz, 1940	no data	aquatic
13	*Dicranota (Paradicranota) gracilipes*	Wahlgren, 1905	no data	aquatic
14	*Dicranota (Paradicranota) lackschewitziana*	Mendl, 1988	no data	aquatic
15	*Dicranota (Paradicranota) landrocki*	Czizek, 1931	no data	aquatic
16	*Dicranota (Paradicranota) martinovskyi*	Stary, 1974	no data	aquatic

Table 2. (continued)

Nr.	Taxon name	Author	State of knowledge	Habitat
17	*Dicranota (Paradicranota) mikiana*	Lackschewitz, 1940	no data	aquatic
18	*Dicranota (Paradicranota) minuta*	Lackschewitz, 1940	no data	aquatic
19	*Dicranota (Paradicranota) pallens*	Lackschewitz, 1940	no data	aquatic
20	*Dicranota (Paradicranota) pavida*	(Haliday, 1833)	no data	aquatic
21	*Dicranota (Paradicranota) reitteri*	Mik, 1882	no data	aquatic
22	*Dicranota (Paradicranota) robusta*	Lundstrom, 1912	larvae and pupae	aquatic
23	*Dicranota (Paradicranota) schistacea*	Lackschewitz, 1940	no data	aquatic
24	*Dicranota (Paradicranota) simulans*	Lackschewitz, 1940	no data	aquatic
25	*Dicranota (Paradicranota) subflammatra*	Stary, 1998	no data	aquatic
26	*Dicranota (Paradicranota) subtilis*	Loew, 1871	larvae	aquatic
27	*Dicranota (Rhaphidolabis) exclusa*	(Walker, 1848)	no data	aquatic
28	*Nasiternella regia*	Riedel, 1914	no data	?
29	*Nasiternella varinervis*	(Zetterstedt, 1851)	no data	?
30	*Pedicia (Amalopis) occulta*	(Meigen, 1830)	larvae	aquatic
31	*Pedicia (Crunobia) apusenica*	Ujvarosi and Stary, 2003	no data	aquatic
32	*Pedicia (Crunobia) littoralis*	(Meigen, 1804)	larvae	aquatic
33	*Pedicia (Crunobia) lobifera*	Savchenko, 1986	no data	aquatic
34	*Pedicia (Crunobia) nielseni*	(Slipka, 1955)	no data	aquatic
35	*Pedicia (Crunobia) pallens*	Savchenko, 1978	no data	aquatic
36	*Pedicia (Crunobia) riedeli*	(Lackschewitz, 1940)	no data	aquatic
37	*Pedicia (Crunobia) spinifera*	Stary, 1974	no data	aquatic
38	*Pedicia (Crunobia) staryi*	Savchenko, 1978	no data	aquatic
39	*Pedicia (Crunobia) straminea*	(Meigen, 1838)	larvae and pupae	aquatic
40	*Pedicia (Crunobia) zernyi*	(Lackschewitz, 1940)	no data	aquatic
41	*Pedicia (Pedicia) rivosa rivosa*	(Linnaeus, 1758)	larvae and pupae	aquatic
42	*Tricyphona (Tricyphona) alpigena*	(Strobl, 1910)	no data	aquatic
43	*Tricyphona (Tricyphona) alticola*	Strobl, 1910	no data	aquatic
44	*Tricyphona (Tricyphona) contraria*	Bergroth, 1888	no data	aquatic
45	*Tricyphona (Tricyphona) immaculata*	(Meigen, 1804)	larvae and pupae	aquatic
46	*Tricyphona (Tricyphona) livida*	Madarassy, 1881	no data	aquatic
47	*Tricyphona (Tricyphona) schummeli*	Edwards, 1921	larvae	aquatic
48	*Tricyphona (Tricyphona) unicolor*	(Schummel, 1829)	larvae and pupae	aquatic
49	*Ula (Ula) bolitophila*	Loew, 1869	larvae	terrestrial
50	*Ula (Ula) mixta*	Stary, 1983	no data	terrestrial
51	*Ula (Ula) mollissima*	Haliday, 1833	larvae and pupae	terrestrial
52	*Ula (Ula) succincta*	Alexander, 1933	no data	terrestrial
53	*Ula (Ula) sylvatica*	(Meigen, 1818)	larvae and pupae	terrestrial

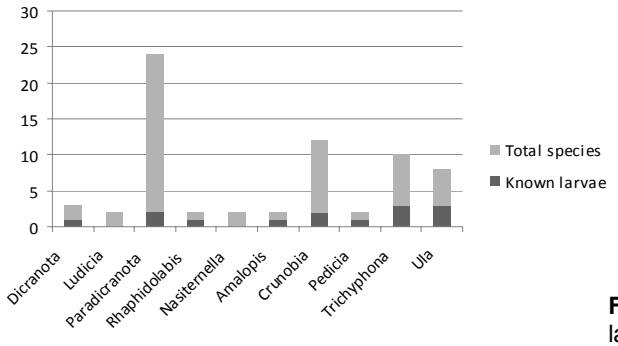


Fig. 2. State of knowledge of Pediciidae larvae in the Carpathian Basin area

Comparative morphology of Pediciidae larvae

To test the selectivity of the already known morphological features in 34 larvae belongs to aquatic Pediciidae (subfamily Pediciinae), majority collected in the Carpathian Basin area we select a number of 12 different morphological features in the head capsule and body segments. The studied features are then compared with the literature data (OOSTERBROEK and THEOWALD 1991, REUSCH and OOSTERBROEK, 1997) and analyzed at different taxonomic level.

The head capsule

1) Shape and sculptures on the head capsule

The head capsule is massive, predatory type in all aquatic genera. Lateral margins of the head capsule are more or less parallel in all Pediciidae. The head capsule is narrowest and longer in *Dicranota* (fig. 3/1,2,7,8; fig. 4/1), and shorter and broader in *Pedicia* (fig.3/21,22,23,27,31,32; fig. 4/7,10). The dorsal suture on the head capsule presents no differences in different genera as suggested by PODENIENE (2003). A conspicuous sculpture on the both side of the dorsal suture can be observed by SEI *Dicranota* type head capsule (fig. 4/2,3). This feature is absent in *Pedicia* (fig. 4/7).The attachment point of the skin of the first body segment to the head capsule is conspicuously different between *Dicranota* and *Pedicia* (Fig. 4/1,7).

2) Shape of the fronto-clypeal suture

The fronto-clypeal sutures shape is conspicuously different between *Dicranota* and *Pedicia.* In *Pedicia* type it is more or less straight (fig. 3/21,26,31), but deep concave in *Dicranota* (fig 3/1,7). Details on the fronto-clypeal suture proved to be good characters for distinguishing the genera.

3) Structure and localization site of antennae in addition with the distribution of other sensory structures

In general, the basal segment of the antenna is elongate in Pediciinae, but short in Ulinae. The antenna has two distinct apical papillae. In *Dicranota* and *Rhaphidolabis* the two apical papillae are short, while in *Tricyphona immaculat*a only one short papilla is present. In the Pediciidae material analyzed by us the basal part of the antenna was always long. It is relatively shorter in *Pedicia* but has two long basal lobe (fig 4/9). In examined *Dicranota* the basal segment of the antenna is relatively longer, but apical papillae are shorter (fig. 3/1). The distribution of the other sensory structures (ex. setae) was never analyzed before. These structures can be only compared using SEI (fig. 4/16,17) and suggest strong specific selectivity.

4) Shape of maxilla

Maxilla has a reduced cardo and a reduced inner lobe, which is aligned to a developed outer lobe (fig. 1/5).The outer lobe of the maxilla is well developed and relatively longer in *Dicranota*, while in *Pedicia* it is relatively shorter. The interior lobe in *Dicranota* is more reduced (fig. 3/1,2,7,8), but in *Pedicia* well developed (fig. 4/11,12). The apical lobe is relatively longer in *Dicranota* (fig. 4/5) and relatively shorter in *Pedicia* (fig. 4/12).

5) Shape of the labrum

The shape of the labrum proved to be one of the most important features separating species in *Dicranota*. In the examined material two different types of labrum were identified among *Dicranota,* which suggest that there were at least two different species. In the *Dicranota* type 1 the labrum is saddle like with setae and

papillae on its anterior margin (fig. 3/1,2,3,4), while in *Dicranota* type 2 the labrum is an oval plate with a rounded chitinous portion in its middle (fig. 3/7,8,9,10). Similar deep differences were never observed in the examined *Pedicia* material.

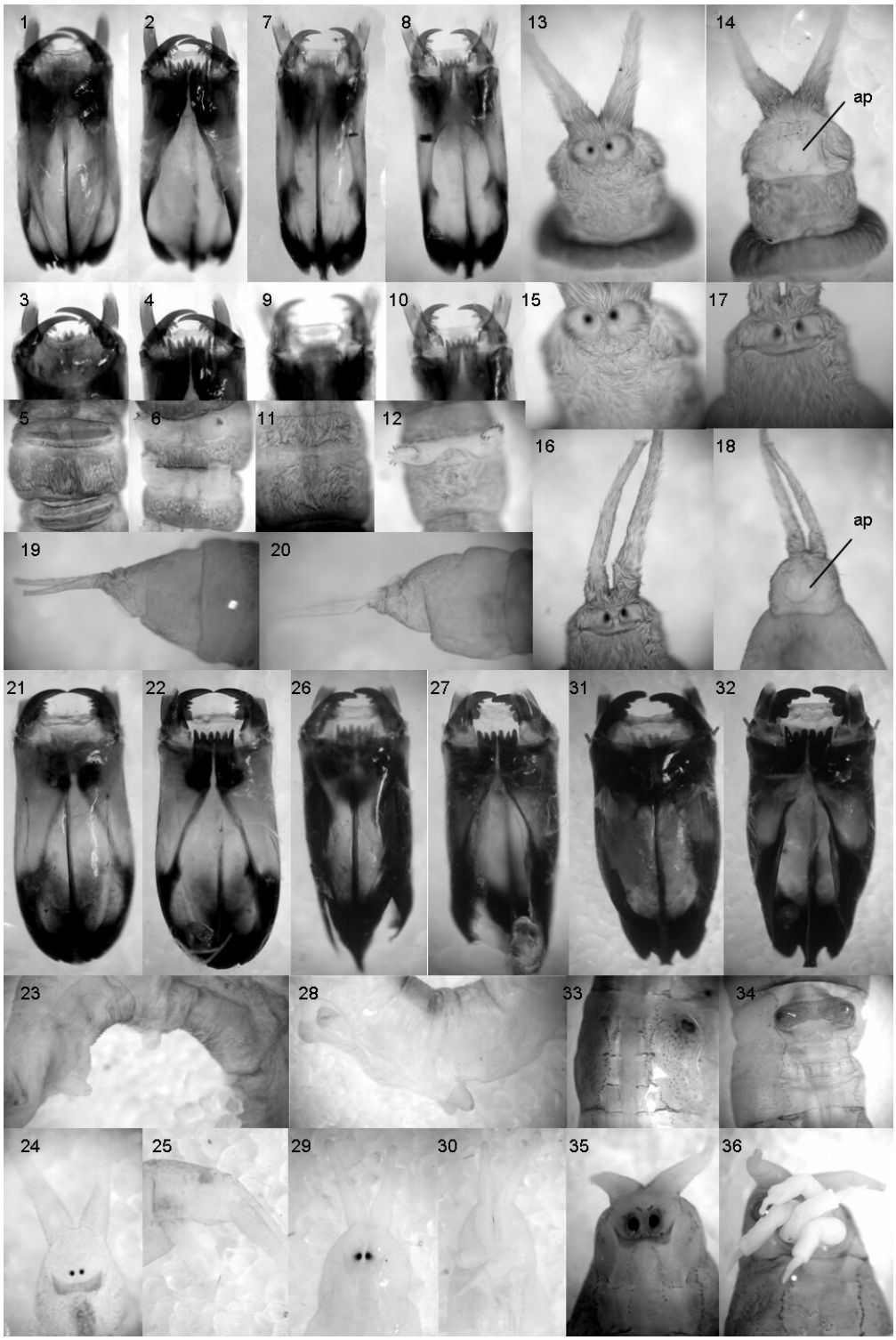
6) Shape of mandible

The shape of the mandible is very variable between the different genera and species. The mandible of carnivorous Pediciidae larvae is sickle shaped with four large ventral teeth in different length and shape (fig. 3/1,2). In *Dicranota* the tooth near the basal part is triangle followed towards the apical end by two narrowed teeth and a small one (fig. 4/1,4). In *Pedicia* the mandibula is relatively broader and curved, with a rectangular basal tooth; followed by smaller triangular teethes (fig. 4/11,12,14). In the two different types of *Dicranota* identified in the present study the shape of the mandible is conspicuously different. In *Dicranota* type 1 the mandible is relatively longer, slighlty curved in its apical end (fig. 3/1,2,3,4; fig.4/1,4). In *Dicranota* type 2 the apical end of the mandible is relatively shorter and strongly curved (fig. 3/7,8,9,10). Based on the shape of the mandible three different *Pedicia* morphological types were identified in the present study. In *Pedicia* type 1 the mandible is strongly curved with a sharp end, details on the dorsal surface sculptures are much alike *Tricyphona* (fig. 1/4; fig. 3/21,22). In *Pedicia* type 2 the two middle teeth in the mandible are equally developed. In *Pedicia* type 3 the two teethes in the middle of the mandible is differently developed. In *Tricyphona* and *Ula* the mandible is different from that in *Dicranota* and *Pedicia* due to their mostly omnivorous or fungivorous feeding (fig. 1/4).

7) Shape of hypostomal teeth and the prementum

The hypostomal plate is divided into two equal parts in the middle (fig. 1/3), each with three teeth. Between the two parts there is a push-button connection in *Dicranota* (fig. 4/14) and *Tricyphona* (fig. 1/6), while they are clearly separated without a push-buttons connection in *Pedicia* (fig. 4/18). The shape of the hypostomal teeth is sharply different between *Dicranota* and *Pedicia.* The three teeth are narrowed with a sharp end in *Dicranota* (fig. 4/6), while they are rounded in *Pedicia* (fig. 4/14,15). Differences in the shape and length of the different teeth can be observed among *Dicranota* species as well as among *Pedicia* species. The prementum is a lob-like structure, with two laterally humps in its anterior end and covered with dense setae (fig. 1/7).

Fig. 3. Pediciidae, larvae characters. 1. *Dicranota* type 1, head capsule dorsal, 2. idem, ventral, 3. detail in head capsule dorsal, 4.detail in head capsule, ventral,5. abdominal segment 8, dorsal, 6. idem, ventral, 7. *Dicranota* type 2, head capsule dorsal, 8. idem, ventral, 9. detail in head capsule dorsal, 10.detail in head capsule, ventral,11. abdominal segment 8, dorsal, 12. idem, ventral, 13. *Dicranota* type 1, terminal segment, dorsal view, 14. idem, ventral, 15. spiracular field, 16. *Dicranota* type 2. terminal segment, dorsal view, 17. spiracular field, 18. terminal segment, ventral, 19. *Dicranota* type 1, terminal segment lateral, 20. *Dicranota* type 2, terminal segment, lateral. 21. *Pedicia* type 1, head capsule dorsal, 22. idem, ventral, 23. abdominal segments 7-9, lateral, 24. terminal segment, dorsal, 25. Idem, lateral, 26. *Pedicia* type 2, head capsule dorsal, 27. idem, ventral, 28. abdominal segments 7-9, lateral, 29. terminal segment, dorsal, 30. Idem, ventral, 31. *Pedicia* type 3, head capsule dorsal, 32. idem, ventral, 33. abdominal segments 8, dorsal, 34. abdominal segment 8, ventral, 35. terminal segment, dorsal, 36. idem, ventral. -►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The abdominal segments

8) Number and shape of the locomotion structures

The number and shape of the creeping welts in Pediciidae is a good feature in distinguishing different genera. Ventral creeping welts on the anterior part of the sternits 7-10 are present in almost all species, excepting *Dicranota, Paradicranota* and *Rhaphidolabis* of which abdominal sternits bear pseudopods in segments 6-10 (fig. 1/1). The creeping welts are concave in the middle, laterally elevated into humps. The creeping welt of *Tricyphona* is different, its shape is as found in other Tipuloidea (fig. 1/1). The pseudopods are apically set with rings of curved claws. In *Dicranota* the well developed creeping welts (pseudopods) have two rings of claws in their apical parts and are situated in pairs at the anterior part in the sternits of the anterior the abdominal segments 6-10 (fig. 3/6,12). In *Pedicia* the creeping welts have two prominent lobes laterally, without claws (fig. 3/23,28).

9) Shape and details of the notum of the abdominal segments

The shape and pubescence of the notum of the abdominal segments is a good distinguishing characters for species or group of species in *Dicranota,* as it was observed in the case of *Dicranota* type 1 (fig. 3/5) and *Dicranota* type 2 (fig. 3/11). Such features were not observed in *Pedicia* (fig. 3/33).

10) Shape of the stigmal field

The shape of the stigmal field is a good feature distinguishing different genera. The spiracular field is small and the spiracles stay close together, exept for *Ula* where the spiracular field is large with the spiracles apart. The spiracles are situated in two more or less preeminent elevations (Pediciinae). The spiracular field has two elongate ventral spiracular lobes, except for *Tricyphona*, which has a shorter ventral lobe (fig. 1/8). In *Ula* the spiracular field has five such lobes, as it is in majority of Limoniidae. In the investigated material the spiracles are situated on prominent elevations in *Dicranota* (fig. 3/13,14,15,16) while the elevations are not conspicuous in *Pedicia* (fig. 3/24,29,35).

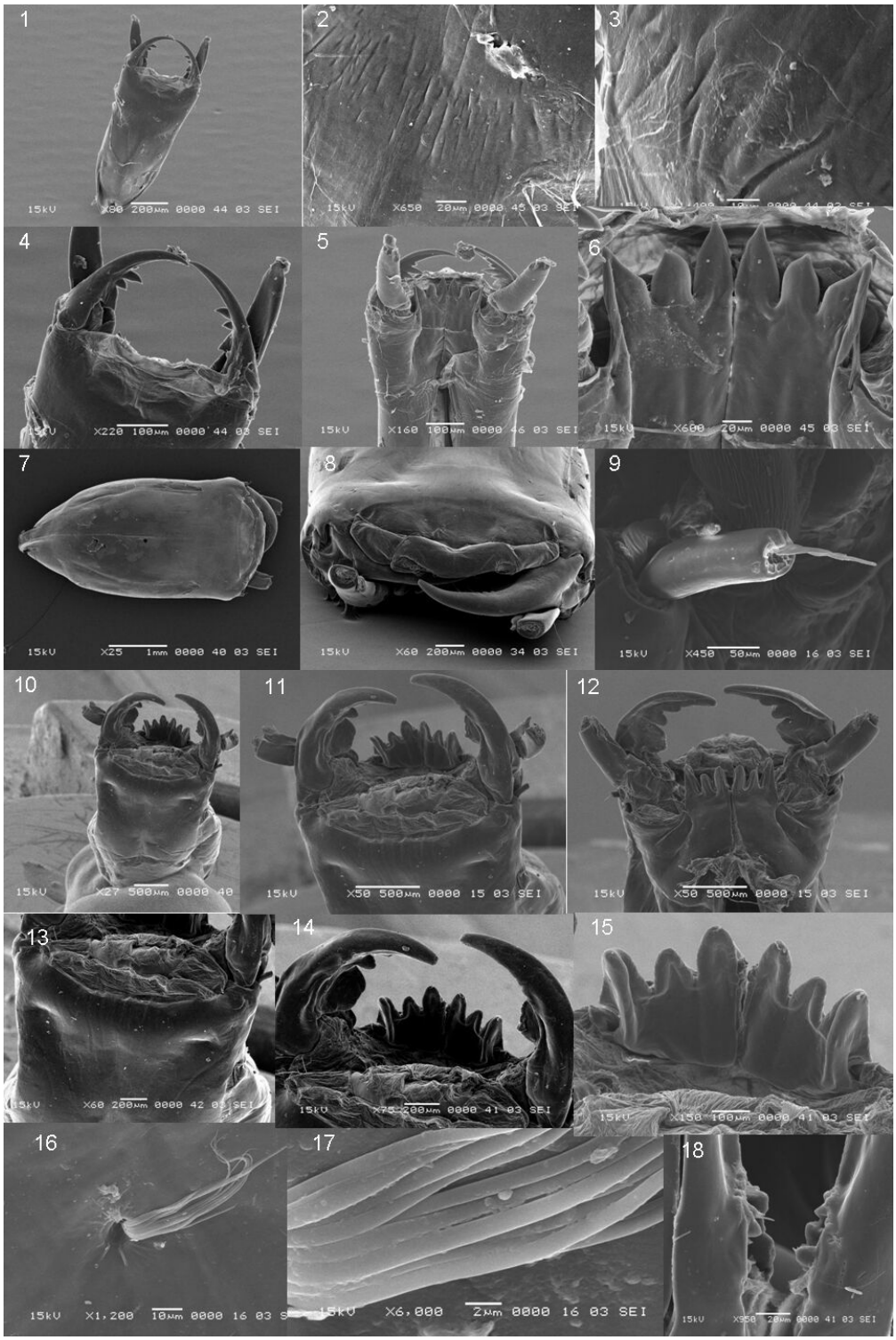
11) Length of the ventral lobes of the spiracular field

The length of the ventral lobes of the spiracular field is a good feature in distinguishing the species or group of species in genus *Dicranota* as it was observed in the case of *Dicranota* type 1 (fig. 3/13) and *Dicranota* type 2 (fig. 3/16).

12) Shape of the anal lobes

The shape and length of the anal lobes is a good feature in distinguishing different genera. In *Dicranota* species the anal lobes are relatively shorter (fig. 3/14,18,19,20), while in *Pedicia* they are much longer (fig. 3/25,30,36). In *Pedicia* the anal lobes are always segmented, but differences in number of segments, as it was proposed by REUSCH and OOSTERBROEK (1997) were not observed during the present study.

Fig. 4. Pediciidae, larvae characters. 1. *Dicranota* type 1, head capsule, dorsal, 2. Detail in head capsule dorsal, 3. idem, 4. antennae and mandible, 5. anterior end of the head capsule, ventral, 6. hypostomal teeth, 7. *Pedicia* type 3. head capsule dorsal, 8. idem, anterior end, 9. antennae, 10. head capsule, antero-dorsal view, 11. anterior end of the head capsule, dorsal, 12. anterior end of the head capsule, ventral, 13. head capsule, dorsal, detaile, 14. mandible, dorsal, 15. hypostomal teeth, dorsal, 16. sensory structures, 17. sensory structures, detail, 18. connection between the hypostomal plates. -►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Discussions

A comparative analyses of selected morphological features on the head capsule and body segments, combined with the available literature data suggest good criteria in distinguishing the two subfamilies (Ulinae and Pediciinae) and the genera of Pediciidae. The most important differences between Ulinae and Pediciinae are the shape of the spiracular field and the number of the spiracular lobes. Among Pediciinae larvae of only four genera are known. Larvae of the fifth genera, *Nasiternella* still remain unknown. Among Pediciinae the different genera could be well separated based on the structure of the creeping welts in addition with some features on the head capsule (fronto-clypeal suture, antennae, mandible, maxillae, hypostomal teeth), spiracular field and annal lobes. Among *Dicranota* important differences were discovered between the shape and structure of the labrum, shape of the fronto-clypeal suture, shape and teeth of the mandible, as well as on the spiracular field and length of the ventral lobes. Based on these features two well separated groups of *Dicranota, Dicranota* type *1* (fig. 3/1,2,3,4,5,6,13,14,15; fig. 4/1,2,3,4,5,6) and *Dicranota* type 2 (fig. 3/7,8,9,10,11,12,16,17,18,20) were identified. The subgenus and species identity of the two groups is unknown. A good separation at subgenus level among *Dicranota* is still problematic*,* since the larvae of *Ludicia* are unknown and informations on the remaining three subgenera *Dicranota, Paradicranota* and *Rhaphidolabis* recorded from the Carpathian Basin area are rather limited. A comprehensive investigation on morphology of larvae belonging too all four subgenera is needed to improve the subgeneric separation of the *Dicranota larvae.* Among *Pedicia* only separation at subgeneric level was possible. Three different morphological types of *Pedicia* larvae were identified in the present study, which correspond with the three different subgenera presents in the Carpathians Basin area. *Pedicia* type 1 belonged to the subgenera *Amalopis*, with a very different shape of mandibula, structure of the teeth on the mandible and shape of the spiracular field (fig. 3/21,22,23,24,25). As only one species is present in the Carpathian Basin area, the studied larvae were assigned to be *Pedicia (Amalopis)* occulta. Pedicia type 2 belonging to the subgenera *Crunobia* has head capsule, mandible teeth and spiracular field as in fig 3/26,27,28,29,30. No differences between the number of segments of the anal papillae were observed between *Crunobia* and *Pedicia. Pedicia* type 3 belonging to subgenera *Pedicia* has head capsule, mandible teeth and spiracular field as in fig 3/31,32,33,34,35,36 and fig. 4/7,8,9,10, 11, 12, 13, 14, 15, 16, 17,18). As only one species is present in the Carpathian Basin area, the studied larvae were assigned to be *Pedicia (Pedicia) rivosa.* Larvae belonging to the genus *Tricyphona* was not identified in the present study, but literature data (LINDNER 1959, BRINDLE 1997, OOSTERBROEK and THEOWALD, 1991) offer detailed morphological descriptions, useful for generic level identification. Based on the available literature data we can conclude that species level identification in Pediciidae is not possible, due to the high number of unknown larvae in the Carpathian Basin area. SEM technologies can provide additional informations on ultrastructures, especially in the structures and position of the sensory structures, wich could help in species identifications, but complemetary methods as molecular assoctiations between larvae and adults are recommended as well.

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