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Description of the larva of *Zwicknia gattolliati* Vinçon & Reding, 2018, with notes on the distribution of the genus *Zwicknia* Murányi, 2014 in Italy (Plecoptera: Capniidae)

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Abstract
The specimens of the genus *Zwicknia* Murányi, 2014 from the Ravizza collection stored in the Museum of Zoology, Lausanne, Switzerland, are revised and re-identified to species level. Whereas most of them were identified as belonging to the species *Zwicknia gattolliati*, one male collected in Southern Italy corresponded to *Z. bifrons*. The hitherto unknown larva of *Zwicknia gattolliati* is described and illustrated on the basis of morphology.

Key words: *Zwicknia gattolliati*, *Zwicknia bifrons*, larval morphology, distribution, Italy, Ravizza collection, *Capnia bifrons*.

Introduction

The description of the species *Zwicknia gattolliati* Vinçon & Reding, 2018 had to leave open the following two problems: first, the larva went undescribed, since only adult males and females were available at the time, and second, the question whether *Z. gattolliati* is the only species of the genus *Zwicknia* Murányi, 2014 present in the Italian region had also to be left unanswered (Vinçon & Reding 2018). In the past, the now obsolete taxon *Capnia bifrons* (Newman, 1838) has been mentioned from the Italian region by many authors (Ravizza 1976, 1998, and references therein; Fochetti & Tierno de Figueroa 2008; Vinçon & Reding 2018, and references therein), but since most of these records have not yet been revised after the breaking up of the taxon into different species of the genus *Zwicknia*, it had not been possible to decide whether all of them belong to *Zwicknia gattolliati*, or to different, currently described or yet unknown species, of the genus *Zwicknia*. We expected, therefore, that the revision of specimens of the genus *Zwicknia* collected in Italy (*sub nom. Capnia bifrons*) and stored in the Ravizza collection in the Museum of Zoology, Lausanne, Switzerland (MZL), where numerous adults and larvae collected from many different sampling stations are present, would at least provide partial answers to these questions.

Material and Methods

The collection of the Italian plecopterologists Elisabetta Ravizza Dematteis and Carlalberto Ravizza has been deposited in the MZL in 2016. The exemplary handling (storage, labelling and digitalization) of several thousands of specimens by the staff of the MZL has by now enormously facilitated the access to this collection and enabled the present revision. Adults and larvae from the Ravizza collection of *Zwicknia*, collected between 1973 and 1985, are preserved in ethanol (container CB 18518, MZL). Terminology for adults follows that of Murányi et al. (2014). Terminology and description technique for larvae follows Reding (2020). Illustrations of the specimens were produced by the author with the help of a Nikon E5400 camera attached to a Leica S8-APO stereomicroscope.

The following abbreviations are used: ♂ = adult males; ♀ = adult females; L♂ = male larvae; L♀ = female larvae; ex = exuviae; MZL = collections of the Zoological Museum of Lausanne, Switzerland.

Material examined (locations transcribed from original labels; square brackets mark supplemented indications).

Zwicknia gattolliati
LIGURIA (SV) Appennino Lig[ure] Savona-Montenotte rusc[ello] M[on]te S. Giorgio, 750 m, no date [07.03.1974,

27♂, 9♀; 19.02.1975, 1♂; 13.03.1982, 12♂, 1♀, 2L♂, 4L♀; 08.04.1982, 24♂, 4♀; 28.12.1982, 5L♂, 11L♀; collection dates are restored *fide* Ravizza and Ravizza Dematteis 1983], leg. C. Ravizza (MZL, catalogue number: GBIFCH00899041)

LIGURIA Pontinvrea t[orrente] Erro, 400 m, 07.03.1974, 8♂, 9♀, leg. C. Ravizza (MZL, catalogue number: GBIFCH00899050)

LIGURIA t[orrente] Erro, Montenotte, 600 m, 07.03.1974, 3♂, 1♀, 1ex, leg. C. Ravizza (MZL, catalogue number: GBIFCH00899046)

[PIEMONTE] BIELLESE (VC) Mongrando, torrente Viona, 340 m, 16.03.1981, 31♂, 1♀, 1L♂, 1L♀, 5ex, leg. C. Ravizza (MZL, catalogue number: GBIFCH00899042)

PIEMONTE Sardigliano (AL) rio Bocca d'Asino, 26.03.1977, 1♀, leg. I. Bucciarelli (MZL, catalogue number: GBIFCH00899045)

PIEMONTE Savezzano (AL), 14.04.1974, 1♀, leg. R. Monguzzi (MZL, catalogue number: GBIFCH00899047)

PIEMONTE Borgoratto (AL), 02.02.1975, 1♀, leg. I. Bucciarelli (MZL, catalogue number: GBIFCH00899048)

[PIEMONTE] ALPI COZIE f[ium] Po, Rocchetta, 550 m, 21.03.1982, 6♂, 4♀, leg. C. Ravizza (MZL, catalogue number: GBIFCH00899049)

PIEMONTE torr[ente] Erro Cartosio, 185–290 m, 29.01.1975, 1L♂; 19.02.1975, 2L♂, 2L♀; 29.02.1975, 2L♂, 1L♀, leg. C. Ravizza (MZL, catalogue number: GBIFCH00899052)

PIEMONTE Val Sesia Romagnano f[ium] Sesia, 14.02.1976, 7L♂, 8L♀, leg. C. Ravizza (MZL, catalogue number: GBIFCH00899054)

PIEMONTE Borgoratto Alessandrino, 110 m, 15.03.1977, 2♀, leg. V. Rosa (MZL, catalogue number: GBIFCH00899055)

LOMBARDIA Oltrepò Pavese S. Martino Varzi, t[orrente] Staffora, 500 m, 25.02.1973, 7♂, 1♀, 8ex, leg. C. Ravizza (MZL, catalogue number: GBIFCH00899043)

[LOMBARDIA] APPENN[INO] LOMBARD[O] Casanova Staffora torrentello, 550 m, 12.03.–27.03.1973, 8♂, 1♀, 3ex, leg. C. Ravizza (MZL, catalogue number: GBIFCH00899056)

[EMILIA-ROMAGNA] EMILIA (PC) Farini d'Olmo t[orrente] Nure, 500 m, 02.04.1975, 1♂, 1♀, leg. C. Ravizza (MZL, catalogue number: GBIFCH00899053)

[EMILIA-ROMAGNA] APP[ENNINO] EMILIANO strada Ferriere Lago Moo, 800 m, 22.02.1976, 1♂, leg. C. Ravizza (MZL, catalogue number: GBIFCH00899057)

Zwicknia bifrons

[ITALY]: MOLISE (CB) Guglionesi, Grotta dei Gessi, 10.03.1985, 1♂, leg. A. Antonucci (MZL, catalogue number: GBIFCH00899051)

GERMANY: Hesse, Rüdesheim am Rhein, Nothgottes, 06.03.1985, 3♂, 2♀, leg. R. Rupprecht (MZL, catalogue number: GBIFCH00899044) [locality identified *fide* Rupprecht 1997].

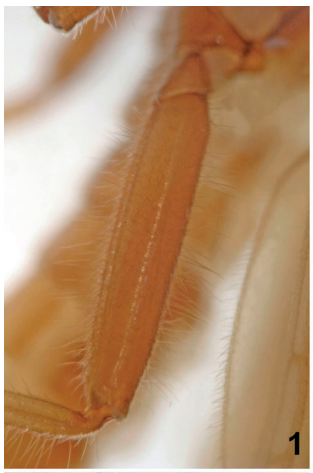
Results

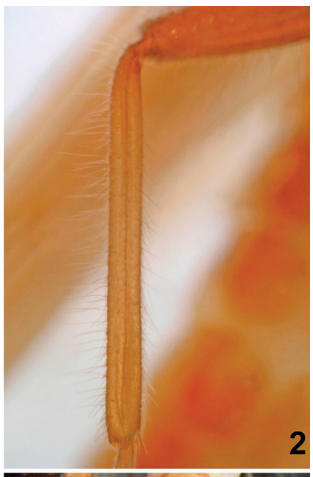
Whereas no species of *Zwicknia* other than *Z. gattolliati* was identified from Northern Italy during the present revision of the Ravizza collection, one single record from Southern Italy corresponded to *Zwicknia bifrons*. Additional data from Southern Italy mentioned by Nicolai & Fochetti (1991, *sub nom. Capnia bifrons*) from Isernia (IS) province in Molise region and Foggia (FG) province in Apulia region correspond most probably also to *Zwicknia bifrons*: Molise, F. Trigno, Pescolanciano (IS), 02.04. 1984, 1♀; Aff. F. Trigno, Collemeluccio (IS), 02.04 1984, 2♂, 1♀; Puglia, Sorg. F. Celone, Faeto (FG), 21.04.1984, 6♂, 13♀.

The two species *Zwicknia bifrons* and *Z. gattolliati* thus exhibit a complementary distribution in the Italian region, with the latter species abundantly represented in Northern Italy, while the former is only sparsely found in very specialized biotopes, such as caves and springs, in the southern part of the country. Moreover, the distribution of *Zwicknia bifrons* in Italy seems to be reduced to regions adjacent to the Gargano Promontory (the "spur" of the Italian "boot"), rendering plausible the hypothesis of the dispersal of the species in the Italian region during the Messinian Salinity Crisis (5.96 to 5.33 Ma, dessiccation of the Mediterranean Sea) by allowing specimens from the Balkan Peninsula to cross the Adriatic Sea. Further investigations are needed to find out where the dividing line between both species in Italy can be drawn.

The most striking feature of the species *Zwicknia gattolliati* is the sexually dimorphic setation in male and female adults. Adult females of *Zwicknia gattolliati* stand out by the remarkable pilosity of their femora and tibiae, abdominal tergites and cerci (Figs 1–5; Vinçon & Reding 2018, figs 8–11), in contrast to their corresponding males, whose femora and tibiae have only very short setae (Fig. 6). Moreover, this feature sets apart female adults of *Zwicknia gattolliati* not only from those of *Z. bifrons*, but also from all other known species of *Zwicknia* from Western and Southern Europe (compare Fig. 1 to Figs 7, 8). Adult males of *Zwicknia bifrons* have a wide and bulky epiproct with a straight, ogive-shaped tip (Fig. 9), whereas the epiproct of *Z. gattolliati* is much slenderer, with a pointed and slightly upcurved tip (Fig. 10).

Since sexually dimorphic setation could also be expected in larval stages of *Zwicknia gattolliati*, we chose to provide separate descriptions for male and female larvae, at the cost of some redundancy. A generic key for separating the larvae of *Capnia nigra* (Pictet, 1833) (= *Capnia sensu stricto, sensu* Murányi, 2014) and *Capnia vidua* Klapálek, 1904 (= *Capnia [sensu lato] vidua, sensu* Murányi, 2014) from those of the genus *Zwicknia*, which now replaces the former species complex *Capnia bifrons*, is provided by Aubert (1959), Ravizza (1998), Fochetti & Tierno de Figueroa (2008) and Reding (2020).





Figs 1-4 – *Zwicknia gattolliati* Vinçon & Reding, 2018, adult female. 1, hindleg, lateral view; 2, tibia of middle leg, lateral view; 3, middle leg, lateral view; 4, sternites, ventral view. **Figs 5-6 –** *Zwicknia gattolliati* Vinçon & Reding, 2018. 5, adult female, cerci, ventral view; 6, adult male, hindleg and tibia, lateral view. **Fig. 7 –** *Zwicknia bifrons* (Newman, 1838), adult female, hindleg, lateral view. **Fig. 8 –** *Zwicknia ledoarei* Reding, Launay, Ruffoni, Vinçon & Boumans, 2016, adult female, hindleg, lateral view.

Description of female larvae of *Zwicknia gattolliati*.
Body length: 7.5–10 mm. Macropterism clearly prefigured (Fig. 11). In dorsal view, tip of tergite 10 rounded, not protracted (Fig. 12). Dorsal edge of tibiae of all three legs with a continuous and dense row of long and fine setae (Figs 13, 14). Dorsal edge of femora of hindleg with a series of long and thin setae interspersed with very short and sparse setae (Fig. 15). In dorsal view, the central region of the abdominal tergites is hairless, while the lateral part (near the junction of abdominal tergites and sternites) has a dense and compact setation made up of very short and stiff setae (Figs 12, 16). In lateral view, setation of head and pronotum with short, dense, stiff, upright setae of about the same length (Fig. 17). Cerci with a single whorl of setae around each cercal segment, consisting of several short setae in dorsal and ventral position, and one or two longer setae laterally on both sides (Fig. 18).

Description of male larvae of *Zwicknia gattolliati*.
Body length: 6–7.5 mm. Micropterism clearly prefigured (Fig. 19). In dorsal view, tip of tergite 10, which prefigures both epiproct and process on tergite 9 of male adults, pointed and protracted (Fig. 20). In lateral view, tip of tergite 10 neatly truncated in shape, provoked by the pressure exerted by the acuminated tip of the epiproct against the dorsal end of the tergite (Fig. 21). Dorsal edge of femora of hindleg with alternately long and short setae (Figs 22, 23). Dorsal edge of tibiae of middle and hindleg with very short setae (Figs 22, 23). Setation on head and pronotum, tergites and cerci similar to that of female larvae (cf. Figs 17, 12, 16, 18).

Morphological affinities. Mature female larvae of *Zwicknia gattolliati* and *Z. bifrons*.
The most reliable criterion for separating female larvae of *Zwicknia gattolliati* from those of *Z. bifrons* is the presence, in the former species, of a dense and continuous row of long, thin setae on the dorsal edge of the tibiae of all three legs (Figs 13, 14). In *Zwicknia bifrons*, on the contrary, these setae are less dense and less numerous and never form a continuous row on the tibia of the hindleg (Fig. 24). The setae on the dorsal edge of the femur of the hindleg of *Zwicknia gattolliati* (Fig. 15) are also longer than those

Fig. 9 – *Zwicknia bifrons* (Newman, 1838), adult male, epiproct, lateral view. **Figs 10-12** – *Zwicknia gattolliati* Vinçon & Reding, 2018. 10, adult male, epiproct, lateral view; 11, female larva, wingpads, dorsal view; 12, female larva, tergites, dorsal view. **Figs 13-16 –** *Zwicknia gattolliati* Vinçon & Reding, 2018, female larva. 13, tibia of hindleg, lateral view; 14, tibia of middle leg, lateral view; 15, femur of hindleg, lateral view; 16, tergites, dorsal view.

of *Z. bifrons* (Fig. 24; Reding 2020, vol. IV, fig. 17B7). The setation of head and pronotum, tergites and cerci do not offer any stable discriminatory criteria to separate both species in the larval stage (cf. Figs 17, 12, 16, 18).

Morphological affinities. Mature male larvae of *Zwicknia gattolliati* and *Z. bifrons*.
In dorsal view, the epiproct of *Zwicknia bifrons* is long and conical, with sinuous lateral margins and a blunt tip (Fig. 25), whereas it is pointed in *Z. gattolliati* (Fig. 20). In *Zwicknia bifrons*, the epiproct is long and asymmetrically rounded, in lateral view (Fig. 26), whereas it is pointed and neatly truncated in *Z. gattolliati* (Fig. 21). The setation of head and pronotum, tergites and cerci do not offer any discriminatory criteria to separate both species in the larval stage (cf. Figs 17, 12, 16, 18).

Discussion

The expected sexually dimorphic setation of male and female larvae of *Zwicknia gattolliati*, though confirmed, does not show up in the same way as in adults. Whereas adult females of *Zwicknia gattolliati* differ from their corresponding males by the remarkable setation on the dorsal edge of their femora (compare Fig. 1 to Fig. 6), female larvae of *Z. gattolliati* differ from their males by the presence of a dense and continuous row of long and fine setae on the dorsal edge of the tibiae of their middle and hindlegs (compare Figs 13, 14 to Figs 22, 23). This type of sexually dimorphic setation in male and female larvae seems also to be limited to the taxon *Zwicknia gattolliati*; it has not been observed in *Z. bifrons*, *Z. ledoarei* Reding, Launay, Ruffoni, Vinçon & Boumans, 2016 and *Z. westermanni* Boumans & Murányi, 2014, whose female and male larvae are alike in having the same type of long and fine setae on their tibiae, only much shorter and sparser than those of female larvae of *Z. gattolliati*. For female larvae of *Zwicknia gattolliati*, the closest morphological affinities in setation are noted with those of *Zwicknia ledoarei* (Fig. 27) and alpine specimens of *Capnia vidua* (Fig. 28), which are, however, exempt from any kind of sexually dimorphic setation.

Figs 17-20 – *Zwicknia gattolliati* Vinçon & Reding, 2018, male larva. 17, head and pronotum, lateral view; 18, cerci, dorso-lateral view; 19, wingpads, dorsal view; 20, epiproct and tergites, dorsal view. **Figs 21-23 –** *Zwicknia gattolliati* Vinçon & Reding, 2018, male larva. 21, epiproct, lateral view; 22, femur of hindleg, lateral view; 23, tibia of hindleg, lateral view. **Fig. 24 –** *Zwicknia bifrons* (Newman, 1838), female larva, femur and tibia of hindleg, lateral view.

Disclosure statement

No potential conflict of interest was reported by the author.

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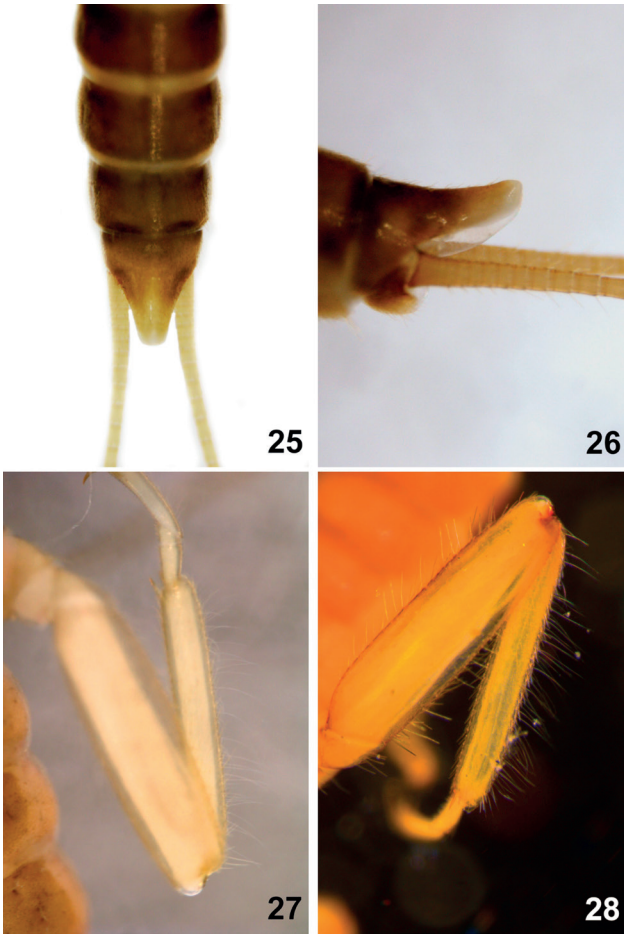

Figs 25-26 – *Zwicknia bifrons* (Newman, 1838), male larva. 25, epiproct, dorsal view; 26, epiproct, lateral view. **Fig. 27 –** *Zwicknia ledoarei* Reding, Launay, Ruffoni, Vinçon & Boumans, 2016, female larva, tibia of hindleg, lateral view. **Fig. 28 –** *Capnia vidua* Klapálek, 1904, female larva, femur and tibia of hindleg, lateral view.

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